ANALYSIS OF ALTERNATIVE ENERGY SECTION REBUTTAL BY LUMINANT GENERATION COMPANY IN DEFENSE OF COMANCHE PEAK LICENSING APPLICATION

I, Paul Robbins, have reviewed the COL Application Part 3, Environmental Report Revision 1, Update Tracking Report Revision 0 for Comanche Peak Units 3 & 4. Numerous flaws in the arguments made by the Applicant are laid out below in relation to the relevant citations.

The Applicant states that CAES, compressed air energy storage, facilities using wind power that are the size of CPNPP Units 3 & 4 have never been built. The Applicant fails to acknowledge that there is nothing preventing CAES and wind combinations, and that nothing prevents the use of multiple small facilities instead of a large facility.

Relevant Citation: 9.2-38, Criterion 1

> The ability to generate baseload power comparable to that proposed by CPNPP Units 3 and 4 using wind power combined with CAES has yet to be demonstrated and has not been developed or proven, and is not available in the relevant area, or at any location in the world.

The flaws in this argument are as follows:

1. CAES using conventional power has been built. Applicant admits this on page 9.2-34. There is nothing in physics differentiating an electron of wind power from nuclear power, and nothing preventing CAES from being used with wind power. In fact Luminant and Shell WindEnergy, Inc. announced in a 2007 press release that they are exploring the possibilities of CAES with wind.[1]

2. Two CAES plants have been built and have successfully operated for many years, one at 110 MW and another at 290 MW (Applicant, page 9.2-34). Nothing prevents numerous small facilities from taking the place of a large facility.

3. There has not been a reactor of the specific type as CPNPP Units 3 & 4 (US-APWR) that has ever been built. The proposed reactors themselves fail to meet Criterion 1, although this is the standard the Applicant applies to all other technologies. At the same time, the Applicant discounts the possibilities of electric generation using CAES, without valid justification.

The Applicant states that wind power and CAES are not available for baseload power.

Relevant Citations: 9.2-38, 9.2-39, Criterion 1-3

> As discussed in Subsection 9.2.2.1, wind power is considered to not be available as a technology capable of generating baseload power comparable to that of the proposed CPNPP Units 3 and 4 within the project time frame. As discussed above, wind power combined with CAES is not currently available and this combination of technologies is still under development.

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[1] Luminant and Shell Join Forces to Develop a Texas-Sized Wind Farm, 7/27/07, http://www.luminant.com/news/newsrel/detail.aspx?prid=1087

> Wind power, as a developed, proven, and available technology in the relevant region, was discussed in Subsection 9.2.2.1. However, wind power is not available as baseload power….

The flaws in these arguments are as follows:

1. Nothing prevents a combination of CAES and wind from being used for baseload. It is preferred for peak and intermediate power because it allows the project to recoup a higher price. Competing with a new, high-cost nuclear plant will allow CAES/wind baseload to compete with intermediate and (often) peak prices.[2]

2. The Applicant admits wind is available as a power source, but does not quantify how much is available in conjunction with CAES. The chart below quantifies that existing wind and wind potential dwarfs production that would result from the proposed CPNPP plants. The data is derived from the ERCOT Report on the Capacity, Demand and Reserves in the ERCOT Region, December 2009. Pages 13-16. [3]

TEXAS WIND POWER POTENTIAL AS REPORTED TO ERCOT – December 2009

Wind Power Status	MW	Annual MWH	Wind as % of CPNPP 3 & 4
Current Capacity	8,916	27,355,179,600	115%
New Wind Generation Online in 5 Years	1,881	5,771,096,100	24%
Potential Public Wind Resources	4,961	15,220,844,100	64%
*Potential Confidential Wind Resources	29,812	91,467,117,630	384%
	45,570	139,814,237,430	586%
Comanche Peak 3 & 4	3,200	23,843,520,000	
At 85% capacity	2720		
Wind Capacity Factor	35%		

CPNPP capacity is estimated at 85%.
**The Developer has only disclosed information to ERCOT and not to the general public.*

Note that this chart assumes 35% wind capacity. In recent testimony by Shell WindEnergy, Inc., there were estimates of wind in the Briscoe County in West Texas with capacities as high as 45%, and references to ERCOT Study capacities of 37-38% in the Gulf Cost region and 39-40% in the Central Western Texas region.[4]

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[2] Mason, James, Wind with CAES Power Plant Model: Base Load Capacity Option, Farmingdale, NY: Renewable Energy Research Institute, May 28, 2009, p. 2. http://www.solarplan.org/Research/Wind-CAES_Base%20Load%20Power%20Plant%20Option_RERI_28%20May%202009.pdf

[3] ERCOT Report on the Capacity, Demand and Reserves in the ERCOT Region, December 2009. Pages 13-16, http://www.ercot.com/content/news/presentations/2009/2009CDR_DecUpdate.pdf

[4] Public Utility Commission of Texas, Direct Testimony of Chris Ziesler on Behalf of Shell WindEnergy Inc., PUC Docket 33672, April 24, 2007, p. 2. http://interchange.puc.state.tx.us/WebApp/Interchange/Documents/33672_963_564300.pdf

3. The Applicant stated in a July 2007 press release their intention to explore developing CAES units,[5] but in their Environmental Report addition they cite no data from their own studies that would suggest that they no longer consider CAES a feasible alternative or worthy of further exploration. The Applicant has had a long time to analyze CAES potential since their 2007 announcement. The lack of statements to the contrary signals that the Applicant still considers CAES worthy of exploration.

The Applicant portrays large Environmental impacts and land use from wind and additional impacts from CAES.

Relevant Citations: 9.2-39, 9.2-40, Criterion 4

> Due to the large land requirements, wind power projects comparable to CPNPP Units 3 and 4 have the potential for LARGE impacts on land use and aesthetics, MODERATE impacts on ecological resources, protected species, and cultural resources, and SMALL impacts on water quality, air quality, human health, and waste management.
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> The Princeton Environmental Institute (PEI 2008) estimated that a CAES facility capable of generating baseload power for 88 hours would require a land area of approximately 14 percent of the wind turbine array. In Subsection 9.2.2.1, based upon the size of the Horse Hollow Wind Energy Center, the size of a wind farm to generate 3200 MW of energy was estimated to be between 452,000 to 816,000 ac of land. For 88 hours of power generation, a CAES facility could therefore cover between 63,280 and 114,420 ac of land. Since the CAES facility and wind farm may not be in the same geographic location, the impacts related to the CAES acreage would be in addition to the impacts of the wind farm.

The flaws in these arguments are as follows:

1. Land use of wind power is consistent with other uses such as agriculture and ranching. Wind power does not render land uninhabitable or unusable for other purposes.

2. The Applicant cites a Princeton study saying land use of a CAES plant would be 14% of the size of a 3,200 MW wind plant, or between 63,280 and 114,420 acres of land. Applicant should have read the report they cited. The report states the *underground reservoir* had this footprint, *not the surface*. [6]

3. The Princeton report further states underground reservoir footprint was based on geology specific to the proposed plant in Iowa, a 3,000-foot anticline in a porous sandstone formation. The underground reservoir where compressed air will be stored is only 10 meters deep.[7]

4. The site for the 268-MW proposed Iowa facility is 40 acres. Extrapolating, that would make a 3,200 MW plant 478 acres.[8]

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[5] Luminant and Shell Join Forces to Develop a Texas-Sized Wind Farm, 7/27/07, http://www.luminant.com/news/newsrel/detail.aspx?prid=1087

[6] Compressed Air Energy Storage: Theory, Resources, and Applications for Wind Power, Princeton Environmental Institute, Energy Systems Analysis Group, Princeton, New Jersey, p. 36. Online at: http://www.princeton.edu/~ssuccar/caesReport.html

[7] Compressed Air Energy Storage: Theory, Resources, and Applications for Wind Power, Princeton Environmental Institute, Energy Systems Analysis Group, Princeton, New Jersey, p. 25. Online at: http://www.princeton.edu/~ssuccar/caesReport.html

[8] Ibid.

5. The geology of Texas natural gas storage facilities is not porous sandstone. It is either solution-mined salt caverns or depleted oil/gas reservoirs. These two categories are listed in monthly natural gas storage reports at the Texas Railroad Commission's Gas Storage Statistics Web site.[9]

6. The McIntosh CAES site is also 40 acres surrounded by other commercial/industrial development, containing a 110 MW plant.[10] It is hard to draw a direct comparison in land use because the site also contains 2 combustion turbines working independently of the CAES system, and 2 more combustion turbines are being added.[11] The geology of the McIntosh site in Alabama is a solution-mined salt cavern 222 feet in diameter and 1,000 feet tall.[12]

The Applicant portrays solar as requiring large amounts of land to generate the same power as CPNPP.

Relevant Citation: 9.2-43, Criterion 4

> Just the simple requirement to generate power for both baseload and storage would double the size of the solar plant required. In terms of land requirements, the footprint of the solar power facility would, therefore, range from approximately 55,510 ac to 76,000 ac. Additional acreage would be needed for the molten salt storage towers and the various pieces of equipment needed to operate the molten salt storage facility and generate power from storage units. LARGE impacts on land use, aesthetics and ecological resources would be, therefore expected.

The flaws in this argument are as follows:

1. The land discussed is desert area that is uninhabited. The largest commercial solar projects have been built in desert environments. These facilities may impact wildlife, but should have very minimal impact on land use and aesthetics related to people due to their location.

> The Mojave Desert, located in the zone where southern California, Nevada, Utah, and Arizona meet, contains some of the best available solar radiation in the U.S. It also contains the hottest location in North America – Death Valley. It's no wonder the largest solar power plant in the world is located in the Mojave. Called Solar Energy Generating Systems (SEGS), it consists of nine solar power plants that have a combined capacity of 354 megawatts (MW), more than any other system of its kind.
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> Now, Mojave Solar Park is in the works with a completion date set for 2011. At that point, Mojave Solar Park is anticipated to cover nine square miles of desert and generate 553 MW of solar thermal power, far outdoing even SEGS. The capacity of 553 MW is equivalent to powering 400,000 homes.[13]

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[9] Texas Railroad Commission's Gas Storage Statistics Web site. Online at: http://www.rrc.state.tx.us/data/gasstorage/index.php

[10] Land footprint from PowerSouth Energy Cooperative, Alternatives Report, Proposed Peaking Load Generation Unit, Andalusia, AL, October 2008, PDF p. 50, report page 6-8. www.usda.gov/rus/water/ees/.../AEC%20Alternatives%20Report_102108.pdf

[11] Power plant inventory from PowerSouth Web site. See: News and Projects, "Construction begins on new McIntosh Power Plant units." http://www.powersouth.com/news_release_detail.aspx?id=3644&terms=mcintosh

[12] U.S. Dept. of Energy Distributed Energy Program, Case Studies: Energy Storage Technologies. http://www.eere.energy.gov/de/cs_energy_storage.html#compressed_air

[13] World's Largest Solar Plant, SEGS, http://solar.calfinder.com/blog/news/worlds-largest-solar-plant-segs

2. The applicant states that 55,510 to 76,000 acres would be needed for a solar facility to generate solar and store the energy, which would be 86.73 to 118.75 square miles. This is far from the reality of the Mojave Solar Park, set to be completed in 2011. This 553 MW solar thermal facility will take up 9 square miles of land, so even if storage facilities were added, it would be no where close to the 86.73 to 118.75 square miles claimed by the applicant. Again, CAES storage facilities have a small footprint, as the storage is underground.

The Applicant states that solar power with molten storage would cause economic hardship because power that could be sold at peak for high prices would be diverted to lower cost intermediate load power.

Relevant Citation: 9.2-43, Criterion 4

> In terms of socio-economics, the combination of solar power generation with storage would be expected to have a LARGE adverse impact. As discussed previously, under this technology combination, energy stored at the most expensive, peak hour prices would be placed into storage because solar power can only be generated during the daytime hours. The power would then be generated from storage at the lower intermediate and non-peak hour prices. With each day, substantial economic losses will be suffered due to the differential between the higher peak hour costs when the power is put into storage and the lower intermediate or non-peak costs when the power is generated from storage.

The flaws in this argument are as follows:

1. There are some economic benefits of storage that were not considered by the applicant. A Sargent and Lundy Consulting Group report comparing solar with and without storage showed costs levelized O&M costs with thermal storage to be significantly less.

> The reduction in O&M cost is primarily a result of the increase in plant size and the increase in annual plant capacity factor. The plant capacity increases directly as a result of the increases in thermal storage. Increasing the size (MWe) and capacity factor of the power plant incurs minimal increase in the fixed O&M expenses ($/year).[14]

According to Sargent and Lundy, solar with thermal storage would reduce the Applicant's O&M costs that would result in a savings. Further because solar generated electricity can be sold at peak and surplus energy can be stored and sold, this represents additional sources of revenue that would be realized with solar and thermal storage. Therefore, there is no basis for the Applicant's claim of "substantial economic losses."

2. Solar energy is generated at times that match peak demand so the power can be used on peak and sold at higher peak prices. Storage allows the option to capture excess heat generated at the time and use it to generate electricity later if desired. Having storage ability does not require that all energy be stored, or

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Also, find a description of SEGS at http://www.flagsol-gmbh.com/flagsol/cms/front_content.php?idcat=18

[14] Sargent & Lundy Consulting Group, Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts, SL-5641, October 2003, PDF page 75, Report page 4-24. Figure 4-5 and description that follows below. http://www.nrel.gov/csp/pdfs/35060.pdf

that it be sold later at lower prices.

If it is less profitable to generate electricity at intermediate and non-peak times, investing in Comanche Peak Units 3 & 4 is called into question since it a baseload plant. More profit could be generated by facilities that produced power at peak.

3. The applicant ignores the reliability added to the solar plant from storage, which will be reflected in the market price.

4. The Applicant ignores positive job impact to regions of Texas with sparse employment. A 2004 study measuring the local economics of a 100-MW solar plant in New Mexico estimated a minimum of 1,588 jobs would be created in the two-year period of construction, which would generate $57.4 million in wages. During operation, the plant would create 85 permanent jobs, which would generate $3.1 million in wages.[15]

The Applicant assumes that combining solar with solar thermal storage and natural gas would necessitate three separate and redundant generation systems, but this is not true.

Relevant Citations: 9.2-44, 9.2-45, 9.2-47, 9.2-48

> There are two primary scenarios for the combination of renewable energy sources with energy storage and natural gas power generation. Under the first scenario, the baseload power would be generated principally by the renewable energy source and, when the renewable energy power generation is not available, the baseload power would be generated from the energy storage facility.
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> This alternative, to provide baseload power comparable to CPNPP Units 3 and 4, would require:
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> • a 3200 MW renewable power plant (either wind or solar) to generate power when the renewable resource is available;
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> • a 3200 MW storage facility (either CAES with wind power or molten salt storage with solar power) to generate power when the renewable resource is not available; and
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> • a 3200 MW natural gas power plant to generate power when the renewable resource not available and the storage units are depleted and the baseload power cannot be generated.
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> Therefore, this alternative combination would increase the environmental impacts as compared to the alternative of generating 3200 MW of power from a natural gas plant alone.
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> Under the second scenario, the primary source of the baseload power would be the natural gas plant. Power from the renewable energy source or from the energy storage facility displace the natural gas plant generation at the times that power from the renewable energy source or the energy storage facility is available.

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[15] The University of New Mexico, Bureau of Business and Economic Research, Economic Impact of Concentrating Solar Power in New Mexico, December 2004. pp. 19-20.
http://www.emnrd.state.nm.us/ECMD/Multimedia/PublicationsandReports.htm

> This alternative, to provide baseload power comparable to CPNPP Units 3 and 4, would require:
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> • a 3200 MW or lesser capacity renewable power plant (either wind or solar) to generate power when the renewable resource is available;
>
> • a 3200 MW or lesser capacity energy storage facility (either CAES with wind power or molten salt storage with solar power) to generate power when the renewable resource is not available; and
>
> • a 3200 MW natural gas power plant to generate baseload power that could be ramped back when supplemental power is available from the renewable resource and the energy storage units.
>
> Since this alternative would require both renewable energy facilities and energy storage facilities in addition to a 3200 MW natural gas power plant, this combination technology alternative would have greater environmental impacts than just a natural gas power plant alone.

The flaws in the arguments are as follows:

1. This is not the case. Separate facilities would not be needed. The nine Solar Energy Generating Systems (SEGS) plants in California have natural gas backup boilers that can be used to augment solar generation if desired.[16] No analysis of using this strategy has been done by the Applicant.

2. No analysis of using wind power to add heat to thermal storage at solar plants has been done. No analysis of using solar power to add energy to CAES has been done.

The Applicant contends reliable solar with storage is not proven.

Relevant Citation: 9.2-45. 9.2-46, Criterion 1

> Therefore, a renewable power source combined with an energy storage option supplemented by natural gas is not developed, proven, or available in the relevant (ERCOT) region.

The flaws in this statement are as follows:

While this statement is technically correct the Applicant ignores what has been proven. Solar with natural gas backup is proven, as is natural gas with CAES. The are nine solar plants (SEGS) that went online in California between 1984-1990 with natural gas backup. They have operated reliably for as long as 25 years. SEGS 1 had natural gas backup and energy storage, all three components together, which the Applicant portrays as not developed.[17] It is a simple matter to export technology from California and CAES techniques from Alabama to Texas and the ERCOT region.

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[16] National Renewable Energy Laboratory, U.S. Parabolic Trough Power Plant Data, http://www.nrel.gov/csp/troughnet/power_plant_data.html

[17] Ibid.

The Applicant underestimates the role that solar or wind with energy storage can provide when used in combination with natural gas.

Relevant Sections: 9.2-48, Criterion 2

> Therefore, although a renewable power source combined with an energy storage option supplemented by natural gas does not have the capacity to generate baseload power equivalent to the planned generation from CPNPP Units 3 and 4; the option of producing the majority of the baseload power from a natural gas plant with only intermittent power from the renewable source or the storage units might be feasible.

The flaws in this argument are as follows:
The Sargent and Lundy Consulting Group report states capacity factors for solar with thermal storage backup at 56.2 -72.9%.[18] This does not take into account additional thermal storage or energy provided by wind power. The Applicant has not done analysis or provided data to prove their statement. The Applicant admits that using natural gas supplemented by renewable energy sources or storage might be feasible, but the option was not evaluated.

[18] Sargent & Lundy Consulting Group, Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts, SL-5641, October 2003, PDF page 96, report page 4-46, http://www.nrel.gov/csp/pdfs/34440.pdf, Table 4-22 – S&L Base Case for the Year 2020