ENTERGY NEW ORLEANS, INC.
CITY OF NEW ORLEANS
Docket No. UD-16-02

Response of: Entergy New Orleans, Inc.
to the Eighth Set of Data Requests
of Requesting Party: Alliance for Affordable Energy

Question No.: AAE 8-19 Part No.: Addendum:

Question:

Regarding the transmission options that could replace the need for the 226 MW OPS, provide any analyses on the undergrounding of those facilities or the undergrounding of existing transmission facilities to increase reliability.

Response:

Without performing a detailed scoping analysis, it is unknown to what extent existing underground construction for the referenced transmission facilities would be feasible or possible. However, it is well known that the expected incremental cost of restoration of overhead transmission facilities does not justify the cost of underground transmission construction and nor does the cost of underground conversion of overhead to underground transmission conversion justify the benefits received from doing so. As an example, Quanta services performed an analysis quantifying the cost of underground transmission within 50 miles of the Texas coast and found that underground transmission construction to be infeasible. A relevant excerpt of this report is provided as an attachment to this response.

close to true), underground conversion is not even close to being cost-effective. These results are similar to other analyses that have been done in other states.

Underground conversion can actually be detrimental in areas subject to storm surge damage. Overhead distribution facilities are generally much faster to repair compared to underground equipment that has been flooded, eroded away, or otherwise damaged by storm surges.

Undergrounding of new facilities is potentially cost-effective, provided the location is not subject to storm surge, depending upon the cost differential of overhead construction versus underground. A typical distribution structure costs about $4000 to replace during hurricane restoration. The failure rate of poles can be approximated by the following equation:

Wood Pole Failure Rate = 0.0001 x exp(0.0421 x W)

W is sustained wind speed in miles per hour.

This equation is explained in the report *Undergrounding Assessment Phase 3 Final Report: Ex Ante Cost and Benefit Modeling*, submitted to the Florida Public Service Commission per order PSC-06-0351-PAA-EI.

Using these assumptions, the cost per year in restoration costs can be computed for each of the hurricane prone areas. This analysis is shown in Table 5-6. The highest annual expected restoration cost is $1.69 for the Corpus Christi area. Assuming a wood pole life of 60 years and a discount rate of 10%, this amounts to a present value of about $16.85. With 40 distribution poles per mile, this amounts to $674 per mile. Therefore, installing new facilities underground is worthwhile if the incremental cost per mile is less than $674 per mile. This amount will vary based on region and distribution span length, but in any case will be small as a percentage of total construction cost since typical new overhead distribution facilities cost between $100,000 and $200,000 to construct.

Greater societal benefits will not result from hardening of new facilities since the percentage of hardened facilities is small and total storm restoration time is not likely to be affected.

Although the undergrounding of new distribution may not be justified purely on reduced hurricane damage, underground may be desirable for other reasons. If the primary issue is hurricane damage, hardening the overhead design may be more cost-effective. For example, a Class 1pole is 50% stronger than a Class 5 pole, but typically only costs about $200 more. At 40 poles per mile, this amounts to $8000 per mile for a much stronger system. Because of these economics, some utilities in hurricane-prone areas design their distribution systems to Grade B construction rather than Grade C.

Table 5-6. Annual restoration cost of wood distribution poles.

	Hurricane Category					
	1	2	3	4	5	
	Annual Probability of Occurrence					
Beaumont-Port Arthur	4.45%	1.18%	0.38%	0.11%	0.01%	
Brownsville-Harlingen	1.61%	0.30%	0.08%	0.01%	0.01%	
Corpus Christi	4.34%	1.09%	0.42%	0.09%	0.07%	
Houston-Sugar Land-Baytown	3.54%	0.83%	0.17%	0.03%	0.00%	
Victoria	3.87%	0.75%	0.37%	0.03%	0.00%	
Sustained wind speed (mph)	84.5	103	120.5	143	168	
Failure rate	0.35%	0.76%	1.60%	4.12%	11.79%	
	Annual Restoration Cost ($/yr)*					Total ($/yr)
Beaumont-Port Arthur	0.62	0.36	0.24	0.18	0.05	1.46
Brownsville-Harlingen	0.23	0.09	0.05	0.02	0.05	0.43
Corpus Christi	0.61	0.33	0.27	0.15	0.33	1.69
Houston-Sugar Land-Baytown	0.50	0.25	0.11	0.05	0.00	0.91
Victoria	0.54	0.23	0.24	0.05	0.00	1.06

* -Annual restoration cost is equal to the restoration cost per structure ($4,000) multiplied by the failure rate multiplied by the probability of occurrence. For example, the annual restoration cost in Beaumont-Port Arthur due to Category 1 hurricanes is $4,000 x 0.35% x 4.45% = $0.62 per year.

In terms of total conversion, there are 28,263 miles of overhead distribution within 50-miles of the Texas coast. At $1 million per mile, total overhead to underground conversion is estimated to cost $28 billion. Assuming that 70% of hurricane damage is eliminated (80% is due to distribution), annual reductions in utility restoration costs are $126 million and annual societal benefits are $85.4 million.

5.6 Underground Transmission

Underground transmission is extremely expensive. New underground transmission is roughly ten times the cost of overhead, and presents other technical challenges due to the high phase-to-ground capacitance. Hardening existing transmission structures has already been examined in Section 5.3, and has been shown to not be cost-effective. New transmission is already required to be built to NESC extreme wind criteria. Therefore, any incremental benefit in moving from an extreme-wind-rated overhead transmission design to underground will be minimal, although the additional cost will be substantial.

Using the hardened transmission failure rate assumptions represented in Figure 5-5, the cost per year in restoration costs can be computed for each of the hurricane-prone areas. This analysis is shown in Table 5-7. The highest annual expected restoration cost is $25.18 for the Corpus Christi area. Assuming a transmission structure life of 60 years and a discount rate of 10%, this amounts to a present value of about $251. With 10 transmission structures per mile, this amounts to $2510 per mile. Therefore, installing new transmission facilities underground is worthwhile if the incremental cost per mile is less than $2510 per mile. This amount will vary based on region and transmission span length, but in any case will be small as a percentage of total construction cost since typical new overhead transmission facilities cost $1 million per mile or more.

Table 5-7. Annual restoration cost of wood transmission poles.

	Hurricane Category					
	1	2	3	4	5	
	Annual Probability of Occurrence					
Beaumont-Port Arthur	4.45%	1.18%	0.38%	0.11%	0.01%	
Brownsville-Harlingen	1.61%	0.30%	0.08%	0.01%	0.01%	
Corpus Christi	4.34%	1.09%	0.42%	0.09%	0.07%	
Houston-Sugar Land-Baytown	3.54%	0.83%	0.17%	0.03%	0.00%	
Victoria	3.87%	0.75%	0.37%	0.03%	0.00%	
Sustained wind speed (mph)	84.5	103	120.5	143	168	
Failure rate	0.12%	0.13%	0.77%	8.74%	34.64%	
	Annual Restoration Cost ($/yr)					Total ($/yr)
Beaumont-Port Arthur	3.20	0.92	1.76	5.77	2.08	13.73
Brownsville-Harlingen	1.16	0.23	0.37	0.52	2.08	4.37
Corpus Christi	3.12	0.85	1.94	4.72	14.55	25.18
Houston-Sugar Land-Baytown	2.55	0.65	0.79	1.57	0.00	5.55
Victoria	2.79	0.59	1.71	1.57	0.00	6.65

* -Annual restoration cost is equal to the restoration cost per structure ($60,000) multiplied by the failure rate multiplied by the probability of occurrence. For example, the annual restoration cost in Beaumont-Port Arthur due to Category 1 hurricanes is $60,000 x 0.12% x 4.45% = $3.20 per year.

Like the case for distribution, greater societal benefits will not result from hardening of new facilities since the percentage of hardened facilities is small and total storm restoration time is not likely to be affected.

In terms of total conversion, there are 6,577 miles of overhead transmission within 50-miles of the Texas coast. At $5 million per mile, total overhead to underground conversion is estimated to cost $33 billion. Assuming that 15% of hurricane damage is eliminated (20% is due to transmission), annual reductions in utility restoration costs are $27 million and annual societal benefits are $18.3 million.