

DIRECT TESTIMONY OF JOSEPH T. POKALSKY
GEORGIA PUBLIC SERVICE COMMISSION
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WITNESS FOR NUCLEAR WATCH SOUTH

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EXECUTIVE SECRETARY
G.P.S.C.

1 (1) Please state your name and position.

2

3 My name is Joseph T. Pokalsky (Po-KAHL-SKEE). I provide
4 advisory services to the energy and utility industry.

5

6 (2) What are your credentials and background?

7

8 I am a Chartered Financial Analyst (CFA). I earned an MBA
9 in Finance from the Wharton School of Business and a
10 Masters in City and Regional Planning from the University
11 of Pennsylvania.

12

13 (3) Please summarize your professional career.

14

15 I have worked in energy market making, risk management,
16 asset optimization, process management and business
17 transformation since 1991. Prior to that, I worked for five
18 years on Wall Street where I underwent training in Capital
19 Markets, conducting rotations in research and bank funding
20 operations, and was a market maker in interest rate and
21 currency derivatives.

22

23 As a Director of Commodity and Regulatory Risk, Energy and
24 Utility Advisory Services for PricewaterhouseCoopers, LLP
25 ("PwC"), I provided advisory services to a broad range of
26 clients across energy, power and utilities with a focus on

1 commodity trading, asset optimization and risk management,
2 including valuation and analytics, process and control
3 design, compliance frameworks, organizational
4 transformation, and technology specification.

5
6 Prior to joining PwC I led an important transformational
7 project for the New York Mercantile Exchange (NYMEX) Energy
8 Division. I spent five years at Energy Consulting Group, a
9 service company for Cooperative Energy Inc. (CEI), a
10 generation and transmission corporation organized by seven
11 electric membership corporations within the Oglethorpe
12 system in Georgia. My responsibilities included risk
13 management, pseudo generation dispatch and transmission
14 service optimization, market energy procurement and off-
15 system sales, energy clearing and settlement analysis,
16 counterparty contract and credit administration, financial
17 reporting, and representing CEI's interests in FERC
18 regulatory forums.

19
20 Now, my professional roles include being Industry Advocate
21 Member of the Committee of Chief Risk Officers and Managing
22 Director for Prosumers Energy. I am currently leading the
23 best practices initiative for power and natural gas
24 retailers.

25
26 (4) Are you currently employed or have you ever been employed
27 by any entity that is regulated by this Commission?

28
29 No. I was however recruited in 1996 by Southern Energy Inc.
30 (SEI), a non-regulated subsidiary of Southern Company to

1 build out their North American power and gas unit, Southern
2 Company Energy Marketing (SCEM). There, I built out a
3 three- person group into a 150-person organization and was
4 responsible for bringing the company from #27 to #2 in
5 power marketing and from zero to #9 in natural gas trading
6 in eighteen months, well ahead of the five year target. I
7 left the organization following a contract dispute in 1998.

8
9 (5) Please state the purpose of your testimony.

10
11 The purpose of my testimony is to inform the Commissioners
12 on the integrity of the financial analyses that have been
13 presented. My testimony will focus on the analysis from
14 PwC, including the Monte Carlo analysis.

15
16 (6) Have you provided testimony before this Commission
17 previously?

18
19 No.

20
21 (7) Have you provided testimony before other utility industry
22 bodies before? If yes, please describe.

23
24 I have. I have been responsible for filings in both comment
25 and technical hearing testimony formats. I have provided
26 testimony regarding implementation of FERC Order 890 in the
27 Southeast. I have also provided testimony on Southern
28 Company's Day Ahead Power Auction. These testimonies were
29 provided on behalf of EMC Members in the Cobb Energy
30 Scheduling Member Group within the Oglethorpe system.

1
2 (8) Please describe the Monte Carlo analysis, what it is, and
3 what it is used for.
4

5 Monte Carlo is a general term that refers to the Monte
6 Carlo Method and Monte Carlo Simulation. Both can be used
7 to solve statistical problems. For instance, one common
8 example of the Method is dumping 1,000 coins on the floor
9 at once and then calculating the ratio of heads to tails to
10 determine the expected outcome of 1,000 sequential coin
11 tosses with one coin. A Monte Carlo Simulation would not
12 use any actual coins but could be applied by randomly
13 drawing 1,000 times from a uniform probability density
14 function and assigning variables drawn from one-half of
15 that function as heads and the other half as tails in order
16 to estimate the outcome from 1,000 sequential coin flips.
17

18 (9) What is the origin of the Monte Carlo analysis?
19

20 In 1946, Stanislaw Ulam decided that it might be more
21 expedient to determine the probability of winning a game of
22 solitaire using 52 randomly ordered cards by playing
23 numerous games and counting the number of successful plays,
24 than to calculate the probability using then currently used
25 statistical methods. Ulam and colleagues at Los Alamos
26 then developed means to simulate the playing of solitaire
27 using computers in order to determine the probability of a
28 win.
29

1 (10) Have you used a Monte Carlo analysis before, and if so,
2 what for?
3

4 I have. For example, I conducted a Monte Carlo analysis to
5 look at potential risk in market-based revenue streams on a
6 project for energy production. We were able to use Monte
7 Carlo in that project to estimate the risk of the revenue
8 streams because we had a robust history of daily changes of
9 energy commodity prices that we could use to estimate the
10 distribution of longer-term price changes that would impact
11 the project. There was also a development cost aspect of
12 the project analysis.

13
14 Unlike the Monte Carlo analysis that has been provided to
15 this Commission for Vogtle Units 3 and 4, our team
16 explicitly chose not to use a triangle distribution to
17 evaluate the risks of the project development. Use of a
18 triangle distribution to evaluate development risks
19 undervalues the probability of the best and worst case
20 outcomes. This is a serious concern of the integrity of the
21 analysis that has been provided to this Commission.

22
23 In our Monte Carlo, possible outcomes for development costs
24 were more equally weighted and evaluated using a robust
25 database of reference project costs to conduct a scenario
26 analysis. This method was more informative and direct than
27 the P value method of sampling from a triangle
28 distribution.
29

1 (11) Are you saying that there is a more accurate and direct
2 Monte Carlo analysis that could have been provided to this
3 Commission?
4

5 Yes.

6
7 (12) What is a Triangle Distribution and how was it used in the
8 PwC analysis submitted to this Commission?
9

10 Unlike a scenario analysis, where it is assumed that all
11 outcomes are generally likely probable, a triangle
12 distribution such as the one used by Georgia Power is based
13 on major assumptions, such as assigning near zero
14 probability to the "worst case." In a scenario analysis you
15 would assume there is at least a 10-20% probability of
16 worst case based on the recognized factors that could
17 create the worst case scenario.

18
19 For example, while in a scenario analysis the decision
20 makers might after evaluating the nature and number of
21 project risks and assign a 10% or higher probability to the
22 worst case scenario, the triangle distribution assigns very
23 little probability to the worst case used to define the
24 triangle. In my examples that I present here the
25 probability assigned to the worst case outcome is close to
26 0.05 %, or 5/1,000, of the probability of 10%.

27
28 A triangle distribution assumes that one can determine the
29 Most Likely Outcome and the Best and Worst Outcomes. The
30 triangle is then defined using these three points.

1
2 (13) Why is that problematic?

3
4 A triangle distribution is problematic because in essence,
5 it sets its own limits. Because the probability density
6 function is not based upon sampling or simulation of real
7 world outcomes but a three-point estimate, it is often
8 referred to as the "lack of knowledge" distribution.

9
10 (14) In your opinion, is there a "lack of knowledge" in
11 conducting an analysis of Vogtle 3 and 4 that substantiates
12 use of such a model in such a manner?

13
14 No. Recognizing the numerous and recent changes in
15 leadership on the project, there is still plenty of
16 historical data that could have been used to conduct a more
17 direct, accurate cost estimate.

18
19 (15) In your opinion, what other methodology could have been
20 used?

21
22 Given the long history of the Vogtle 3 and 4 project, ample
23 historic data would allow for a Program Evaluation and
24 Review Technique (PERT) analysis.

25
26 (16) In your opinion, should that PERT analysis have been done?

27
28 Yes.

1 (17) In your opinion, should that analysis be done before this
2 Commission rules whether to continue?

3
4 Yes.

5
6 (18) In your opinion, should the Commissioners make a decision
7 to go forward with Vogtle 3 & 4 construction, based on the
8 analysis that has been provided to them?

9
10 No. The Commissioners should question the data provided
11 based on two factors: input and output. I am concerned that
12 the Commissioners may be of the impression that the
13 analyses provided are based on very precise historical or
14 like-project input data that was verified by independent
15 parties when, in fact, it is not.

16
17 It has been admitted that some critical inputs, including
18 the correlation coefficient were not based upon actual
19 data, but arbitrarily set.¹²³⁴ It was also stated by PwC that
20 the sensitivity of the results of the QRA are "quite
21 significant" to this arbitrarily set input.⁵

22
23 Additionally, it was admitted by PwC that risks too
24 difficult to quantify using PwC's QRA methodology were omitted
25 from the analysis despite the fact they could potentially have a
26 large impact on the project cost and timeline.⁶

27

¹ Transcript Page 891 at Line 24

² Transcript Page 892 at Line 6

³ Transcript Page 892 at Lines 11-14

⁴ Transcript Page 896 at Line 12

⁵ Transcript Page 895 at Line 22

⁶ Walcroft Direct Testimony, Page 11 at Line 16.

1 Lastly, the Monte Carlo simulation using triangle estimates
2 that was provided to this Commission produced a result that
3 indicates that there is less than a 10 percent chance that
4 updated budget for Construction/Capital to complete Vogtle
5 units 3 and 4 will have a cost overrun of 17%. P90 value
6 /P20 value = $10.461/8.981 = 1.1648$ or 16%.

7
8 Put another way, there is less than a 10 percent chance
9 that there will be a cost overruns on the go-to
10 Construction/Capital costs of 35%. $(10.461-8.981)/4.33 =$
11 0.34 or 34%

12
13 This estimate is very much at odds with the long history of
14 tremendous cost overruns for Vogtle 3 & 4. PwC would not
15 testify to the validity or certainty of this estimate.⁷ PwC
16 would not guarantee that the cost to complete the Vogtle
17 units would fall between the projected cost range which
18 Georgia Power is presenting to the Commission.

19
20 Commission staff has reiterated comments by Moody's
21 Investor Service on the fact that Southern Nuclear is an
22 operator of nuclear power plants, not a nuclear power plant
23 architectural/engineering design firm, or a mega-project
24 construction company. Its core competence is in nuclear
25 power plant operations rather than engineering design or
26 construction.⁸ I equate this to the notion of Delta
27 Airlines, a superb airline operator, being responsible for
28 the design, engineering, and construction of its next
29 airplane fleet.

⁷ Walcroft Direct Testimony, Page 15 at Line 16.

⁸ Roetger, Jacobs, Smith Direct Testimony, Page 25, line 19

1
2 Commission staff has also testified "The Company
3 independently estimated the remaining quantities to
4 complete the Project and applied unit rates, the number of
5 hours to install a given commodity, to develop an estimate
6 of the man-hours to go and then applied a performance
7 factor to determine total man-hours to complete the
8 Project. The estimate of total man-hours to complete the
9 Project was then adjusted to account for an analysis of the
10 critical path for the Project and congestion factors in
11 Project buildings." ⁹

12
13 Additionally, commission staff has noted that Southern
14 Nuclear did not use all available resources to develop a
15 project schedule. "As described above, the Company
16 independently verified the remaining quantities. Estimates
17 of unit rates and other needed factors could have been
18 provided from other sources such as Bechtel and WMI. This
19 data would have allowed the Company to develop a reasonable
20 estimate of man-hours to complete the Project and a high-
21 level estimate of the required schedule. Additional
22 information that was available to the Company could be
23 found in Exhibit A, Table 2, of the EPC Agreement."¹⁰

24
25 I've noted earlier that PwC has repeatedly admitted that it
26 did not independently validate the schedule and cost
27 information provided to it by Southern Nuclear or its other
28 advisors. Additionally, commission staff has noted that

⁹ Roetger, Jacobs, Smith Direct Testimony, Page 18, line 16

¹⁰ Roetger, Jacobs, Smith Direct Testimony, Page 19, line 9

1 "The analyses by the Company's third-party experts
2 primarily used information provided by the Company"¹¹ and;
3 "These experts, like Staff, did not independently verify
4 the Company's estimates for quantities to go, subcontractor
5 costs and other key estimates. **Therefore, it is not**
6 **surprising that these analyses which relied upon the**
7 **Company's estimates generally supported the Company's**
8 **results."** ¹²[emphasis added]

9
10 Lastly, the PwC Quantitative Risk Analysis (QRA) is dated
11 August 29, 2017. Commission staff has testified "The
12 Project team is developing a new Unit 3 Level 3 Integrated
13 Project Schedule ("IPS") which is forecast to be complete
14 at the end of November 2017. The Unit 4 IPS is forecast to
15 be complete by the end of December 2017."¹³ On December 12,
16 2017 commission staff testified that they had not yet seen
17 the IPS for Vogtle 3 or 4.¹⁴ Recognizing that the IPS for
18 Vogtle 4 is not yet due; it's seemingly impossible to
19 determine exactly what future activity to complete the
20 Vogtle units is, and is not, in the results presented by
21 PwC. This creates an issue regarding the prudence of
22 future additional costs above the PwC estimate of \$8.98 B
23 cost to complete the units.

24

¹¹ Roetger, Jacobs, Smith Direct Testimony, Page 22, line 4

¹² Roetger, Jacobs, Smith Direct Testimony, Page 22, line 17

¹³ Roetger, Jacobs, Smith Direct Testimony, Page 10, line 10

¹⁴ Roetger, Jacobs, Smith December 11, 2017

1 (19) Are you aware of other regulatory boards that either
2 conduct their own analysis or otherwise reviews the work of
3 industry stakeholders or their analysts?
4

5 Yes. At FERC, technical conferences are held to generate
6 expert-level data that is included in the Commission's
7 decision making. Additionally, Independent System Operators
8 (ISOs) have hired analysts of their own to evaluate the
9 work of industry analysts.
10

11 (20) Have you done that?
12

13 Yes. I did that while I was at PwC. We were hired by a
14 regulatory body to review and critique the analysis
15 conducted by another industry analyst.
16

17 (21) In your opinion can the P Values of a Monte Carlo
18 simulation using Triangle Distributions be pre-determined?
19

20 Yes. I've created the example below to illustrate this. In
21 the example, I am using \$50 million because it is a round
22 number and a large number that dramatically illustrates the
23 ability to manipulate the results by the choice of figures
24 that are plugged in to the model.
25

26 EXAMPLE: In order to be able to move forward on a project
27 with a \$50 MM budget expectation (Most Likely Case) it
28 needs to be demonstrated using a Triangle Distribution and
29 Monte Carlo Simulation that there is a 90% probability of
30 the project costing no more than \$75 MM which is the

1 accepted cost cap of the example and \$30 MM is plugged in
2 to be the best case expectation. The required P value in
3 this example is that there is a 90% probability that the
4 cost will be \$75 MM or less which is also known as the P
5 value of the cumulative distribution function for that
6 outcome.

7
8 A Triangle Distribution is created using the following
9 information and is illustrated by the blue triangle labeled
10 A in "Figure 1: Plotted Triangle Distributions." The P
11 values for Triangle Distribution A are calculated and
12 graphed in "Figure 2: P Values for Plotted Triangle
13 Distributions." P Values of 30 and 90 are highlighted in
14 red. We use the P values in this example to illustrate how
15 manipulating the project cost estimates, reducing the worst
16 case number, increasing the best case number, we can retain
17 the P value of for the expected cost and reduce the project
18 cost value for P90 to \$75 million. It can be seen that the P
19 Value for the Most Likely Case is 30 and the Project Cost
20 for the P Value of 90 is \$81 MM. These costs exceed the
21 requirement that the project cost no more than \$75MM for a
22 P Value of 90, so a second distribution is created changing
23 two of the numbers to attain a more favorable outcome.

24

Triangle Distribution A		
Best Case	Most Likely Case	Worst Case
\$30 MM	\$50 MM	\$100 MM

1 The second Triangle Distribution, the black triangle
2 labeled B, is generated and also plotted in Figure 1. The
3 Best Case and Worst Case outcomes are now adjusted (\$32 MM
4 and \$90.75 MM respectively) so that the P Value for the
5 Most Likely Case remains at 30 and that the P Value for a
6 project cost outcome of \$75 MM is 90, meaning that there's
7 a 90% chance that the project won't cost more than \$75MM.
8 This is represented in Figure 2.

Triangle Distribution B		
Best Case	Most Likely Case	Worst Case
\$32 MM	\$50 MM	\$90.75 MM

10
11
12 The requirement for project approval, again, is to
13 demonstrate that a Monte Carlo simulation indicates there
14 is a 90% chance the project will be completed for no more
15 than \$75 MM, for this example. A Monte Carlo simulation is
16 now conducted drawing 5,000 outcomes from Triangle
17 Distribution B. The results of this simulation are plotted,
18 along with Triangle Distribution B in "Figure 3: Plotted
19 Input and Output Distributions for Monte Carlo Analysis."
20 The results for the Monte Carlo simulation are labeled
21 "MC."

22
23 After the Monte Carlo Simulation is conducted, the P Values
24 for the simulation are calculated and plotted in "Figure 4:
25 P Values for Input and Output Distributions for Monte Carlo
26 Analysis."

1 It can be seen from this graph that the P values for both
2 the input Triangle Distribution B and the output Monte
3 Carlo Distribution are equivalent. Therefore, the project
4 could be approved, as established by the choices made in
5 the triangle distribution numbers, because the Monte Carlo
6 Simulation, based upon the second adjusted Triangle
7 Distribution B, indicates that there is a 90 percent chance
8 that the project can be completed for no more than \$75 MM.
9

Figure 1: Plotted Triangle Distributions

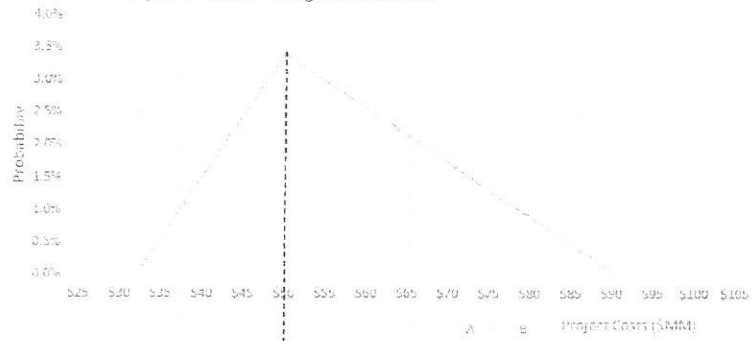


Figure 2: P Values for Plotted Triangle Distributions

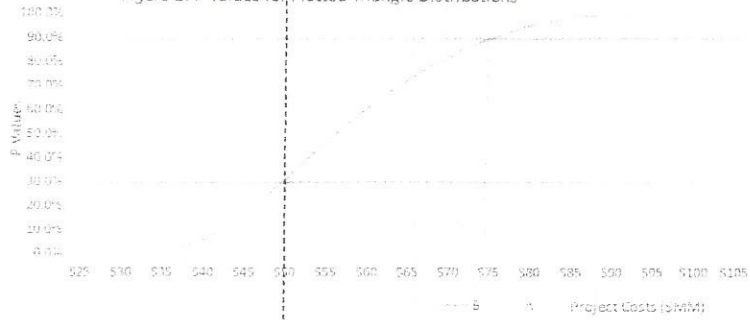


Figure 3: Plotted Input and Output Distributions for Monte Carlo Analysis.

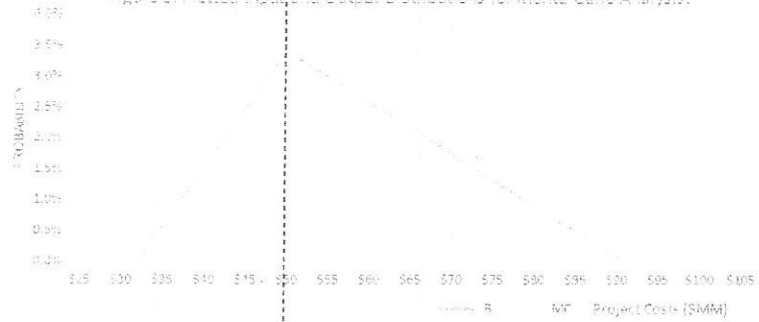
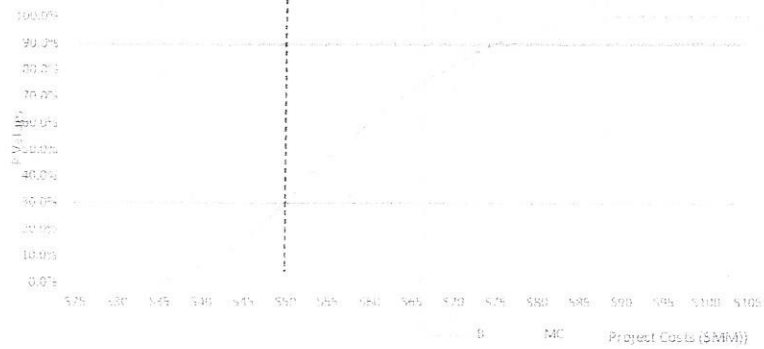


Figure 4: P Values for Input and Output Distributions for Monte Carlo Analysis



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(22) The results of PwC's Monte Carlo analysis included P values and an expected cost to complete Vogtle Units 3 and 4 of \$8.981 billion. How do you interpret these numbers?

Given the P values from the PwC analysis, there is a greater than 80% likelihood that the Total Construction and Capital costs for the project will be more expensive than the latest \$8.98 Billion dollar price tag, and quite possibly even much more given all the costs and potential risks that have been omitted from the analysis.

(23) In the energy marketplace, what do those projected costs mean?

The probability and costs mean that it is greater than 80% likely that the projected capital costs to complete this project are more than five times as expensive as the alternatives. This includes natural gas-fired combined cycle plants, the alternative standard this docket has historically used. The costs could quite possibly exceed a calculation of five times more expensive than alternatives, given all of the costs and potential risks that have been deliberately omitted from the analysis. Given the history of Vogtle 3 and 4, the risk around completing these units is likely much higher than for a gas fired or renewable facility, thus adding to potential costs.

(24) On what data are you basing that statement?

1 Primarily, on a very recent White Paper that compiled and
2 referenced the source of publicly available data published
3 by the Energy Information Agency (EIA) and industry
4 experts.¹⁵ Additionally, Lazard's Levelized Cost of Energy
5 Analysis estimates that the levelized cost of solar thermal
6 with storage is less than half of the cost of nuclear while
7 natural gas combined cycle plants are around 1/3 less
8 costly than for nuclear. ¹⁶

9
10 I estimate that comparing the to-go Construction/Capital
11 costs to complete the Vogtle units are approximately 4 ½ to
12 5.2 times per Megawatt of capacity than for a new gas
13 fired combined cycle unit. This number was derived by
14 using the Commission staff's estimate of to-go Construction
15 and Capital Costs of \$4.33 B, subtracting from this number
16 the expected cost from the PwC Analysis of abandoning the
17 project of \$671 MM, and dividing the net amount by 1,020
18 Megawatts. This results in a to-go cost of \$3.59 MM/MW
19 that was compared to the EIA's average cost per MW of
20 Combined Cycle Capacity of \$0.696 MM as well as the cost
21 per MW of Dominion Energy Virginia's Greensville/Brunswick
22 County, VA gas fired combined cycle plant which began
23 construction June 17, 2016 of \$0.818 MM. The information
24 for the comparisons came from U.S. Natural Gas Power
25 Engineering and Construction Trends and Outlook 2018.

26
27 Vogtle to-go Construction/Capital Costs for comparison:

28
29
$$\$4.33 \text{ B} - \$0.671\text{B} / 1,020 \text{ MW} = \$3.59 \text{ MM/MW}$$

¹⁵ U.S. Natural Gas Power Engineering and Construction Trends and Outlook 2018, Petrochemical Update, November 21, 2017. Attached as Exhibit 2.

¹⁶ Lazard's Levelized Cost of Energy Analysis, Version 11.0, November 2, 2017. Attached as Exhibit 3.

1 Ratio to Dominion Energy Project:

2 \$3.59 MM/MW / \$0.818 MM/MW = 4.4

3 Ratio to EIA average:

4 \$3.59 MM/MW / \$0.696 MM/MW = 5.2

5
6 For the Levelized Cost of Energy Comparison I used the to-
7 go Construction/Capital and Financing Costs of \$4.33 BB,
8 subtracted PwC's cost of \$671MM to cancel the units and
9 converted it to a to-go per \$kW of capacity of \$3,590. I
10 then used the ratio of this number to the Lazard
11 calculation of \$6, 500 per Kw in their low cost
12 construction and operating scenario to obtain a ratio of
13 55%. I applied this ratio to the cost of Capital per MWhr
14 in their low construction and operating cost case for a AP
15 1000 design with a 40 year economic life¹⁷, using a 6% Cost
16 of Debt and 10% Cost of Equity, leaving fixed and
17 variable O&M, and fuel costs unchanged. This results in a
18 LCOE of \$65/MWhr as opposed to \$112?MWhr in the Lazard base
19 case. I compared this result to Lazard's LCOE for the
20 same case for natural gas plants of \$42 MWhr and
21 ascertained that the LCOE of continuing to construct the
22 units range is just over 1 ½ times (\$65/\$42) to that for a
23 natural gas plant in the same scenario. Adjusting the
24 Lazard case for the difference in their natural gas
25 construction cost assumption to that for the higher

¹⁷ Currently it's proposed that the Vogtle 3 & 4 units be evaluated using a 60 year economic life. No information has been provided to support this claim for the new unproven technology, nor to pre-empt or refute any assessment that a gas fired combined cycle generation plant couldn't have an equivalent economic life. Steven D. Roetger testified on the afternoon of 12/11/17 that the circulation pumps at Vogtle 3&4 won't last 60 years.

1 construction costs of the Dominion VA CC plant results in a
2 LCOE of \$45 MWhr and a ratio of 1.45 (\$65/\$45)

3
4 QUESTION: Should I insert a Table Here of the cost comparisons?
5

6 The U.S. Energy Information Administration estimates that
7 as of January 1, 2015, there were about 2,355 trillion
8 cubic feet (Tcf) of technically recoverable resources of
9 dry natural gas in the United States. At the rate of U.S.
10 dry natural gas consumption in 2015 of about 27.3 Tcf per
11 year, the United States has enough natural gas to last
12 about 86 years.¹⁸

13
14 (25) In your opinion, has the fact that project leadership has
15 changed positively impacted an analyst's ability to run a
16 cost analysis that is based on actual expenses and
17 available market data?

18
19 Apparently not. The only risk analysis Georgia Power has
20 been able to provide the Commission to date is based upon a
21 Triangle, or lack of knowledge, probability distribution.
22 The analysis deliberately omits risks that allegedly cannot
23 be quantified, and the advisor PwC has strongly qualified,
24 time and time again in the given analysis, that the results
25 of the provided analysis do not guarantee successful
26 completion of Vogtle 3 & 4 within the new estimated cost-
27 to-complete.
28

¹⁸ <https://www.eia.gov/tools/Fact/Fact.asp?id=30&t=0>