Memorandum from the Office of the Inspector General

March 28, 2014

David L. Owens, WT 9C-K
Scott D. Self, MR 6D-C

REQUEST FOR FINAL ACTION – AUDIT 2011-14477-01 – FOLLOW-UP AUDIT OF TVA'S FINANCIAL TRADING PROGRAM

The Office of the Inspector General contracted with Mercatus Energy Advisors to (1) provide a third-party review of the final actions taken by Tennessee Valley Authority (TVA) management with regard to the recommendations from Audit 2011-14477, Review of TVA's Financial Trading Program (FTP), and (2) determine if TVA's Financial Gas Hedging program[1] is designed and functioning in a manner to achieve program objectives in the most efficient and effective manner.

Mercatus is responsible for the attached report dated March 26, 2014, and the conclusions expressed in the report. In summary, Mercatus made nine specific recommendations in its report to improve the FTP:

1. **Determine Tolerance and Proper Size of FTP Risk** – TVA should undertake a formal process to sample the risk tolerance of ratepayers and resize the FTP to match no less than one quantified measure of risk tolerance. The size of the FTP should be determined by the amount of hedging required to reduce risk within the risk tolerance parameter(s) as defined by the risk tolerance determination process.

2. **Address and Communicate Volumetric Risk** – TVA's volumetric risk needs to be properly analyzed and well communicated between the various stakeholders who have a vested interest in this aspect of the FTP. This effort should include the development of a formal process for analyzing TVA's volumetric risk, on a regular and consistent basis, and should be a joint effort between the front office and the generation planning group. Furthermore, the results of this undertaking need to be well communicated to all necessary parties on a regular basis.

3. **Redesign Hedging Strategies** – TVA should redesign the hedging strategies it employs to better match the characteristics of the exposures which are being hedged via the FTP.

[1] Although the FTP has recently been renamed the "Financial Hedging Program," Mercatus' report refers to the program by its original name—FTP.

4. **Improve and Consolidate Performance Reports** – All interested parties should cooperate to produce a set of performance metrics that can be used by all functions related to trading and risk management. In addition, TVA should develop a historical volatility reduction metric specific to natural gas hedging given that natural gas is the largest part of the FTP (as indicated by the FTP being granted the majority of TVA's Value at Risk [VaR] capacity).

5. **Cease Using VaR as a Primary Risk Metric** – TVA should cease the use of VaR as a primary risk metric and replace it with an "at risk" type of metric(s) that includes not only the financial natural gas hedges but also the physical exposures being hedged via the FTP as this type of approach is more suitable for a power generator such as TVA. These new metric(s) could also be used in the risk tolerance determination and management processes.

6. **Conduct Stress Testing** – Stress testing needs to become a routine and regular part of Middle Office risk analysis and reporting. The results of said stress testing should be utilized with respect to decision making as well as monitoring TVA's potential risk exposure.

7. **Adhere to Governance Documents** – TVA needs to take action to ensure that it is performing all that is required of it by the FTP's governance documents, or if the language in the governance documents is inaccurate, governance documents should be revised to reflect actual practices.

8. **Conduct Proper Cost/Benefit Analysis** – In order to determine the true costs and benefits of the FTP, TVA should calculate the complete costs and benefits of the FTP since inception. The total should include all costs that would be eliminated if the FTP did not exist. Also, for forward looking risk reduction metrics, such as fuel cost certainty, TVA should compare the all-in hedged cost of fuel versus the cost of fuel without hedging (market price).

9. **Properly Analyze and Manage All of TVA's Energy Commodity Exposure** - The FTP should be analyzed as part of TVA's total energy commodity portfolio such that all energy commodity (i.e., coal and fuel oil) risks, both physical and financial, are being properly analyzed and managed.

Your written comments, which addressed your management decision and actions planned or taken, indicated that TVA management generally agreed with these recommendations and have been included as Attachment A to the report. Please notify us when final action is complete. In accordance with the Inspector General Act of 1978, as amended, the Office of the Inspector General is required to report to Congress semiannually regarding audits that remain unresolved after 6 months from the date of report issuance.

Mercatus' response to your comments is also included as Attachment B to the report. In its response, Mercatus (1) indicated TVA's planned actions should be acknowledged as improvements to the FTP and (2) provided additional clarification on a few issues.

Information contained in this report may be subject to public disclosure. Please advise us of any sensitive information in this report that you recommend be withheld.

If you have any questions, please contact David S. Shields, Audit Manager, at (865) 633-7364 or Rick C. Underwood, Director, Corporate Governance and Finance Audits, at (423) 785-4824. We appreciate the courtesy and cooperation received from your staff during the audit.

David P. Wheeler
Deputy Assistant Inspector General
(Audits)
ET 3C-K

RCU:BSC
Attachment
cc (Attachment):
Jerry E. Brown, MR 2B-C
Michael R. Corley, Mercatus Energy Advisors
Mark A. Creech, MR 2D-C
John M. Hoskins, WT 4C-K
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OIG File No. 2011-14477-01

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Review of Tennessee Valley Authority's Financial Trading Program

March 26, 2014

This report ("Report") has been prepared by Mercatus Energy Advisors, LLC ("Mercatus") for the Tennessee Valley Authority Office of the Inspector General (OIG) in accordance with the Contract for Professional Services between the Tennessee Valley Authority and Mercatus dated May 6, 2013 ("Contract") and on the basis of the scope and limitations set out below.

The Report has been prepared solely for the purposes of assisting the OIG in reviewing Tennessee Valley Authority's Financial Trading Program as set out in the Contract. It should not be used for any other purpose or in any other context, and Mercatus accepts no responsibility for its use in either regard.

The Report is provided exclusively for the OIG's use under the terms of the Contract. No party other than the OIG is entitled to rely on the Report for any purpose whatsoever and Mercatus accepts no responsibility or liability to any party other than the OIG in respect of the Report and/or any of its contents.

As set out in the Contract, the scope of our work has been limited by the time, information and explanations made available to us. The information contained in the Report has been obtained from the OIG and third party sources that are clearly referenced in the appropriate sections of the Report. Mercatus has neither sought to verify or audit this information. Furthermore, changes in circumstances after February 28, 2014 could affect the findings of the Report.

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1.0 Introduction

Mercatus Energy Advisors, LLC ("Mercatus") is a consulting firm specializing in energy trading and risk management, and was engaged by the Tennessee Valley Authority ("TVA") Office of the Inspector General ("OIG") to conduct a review of TVA's Financial Trading Program ("FTP") as a follow-up to the OIG's audit of the FTP (Review of TVA's Financial Trading Program - 2011-14477, September 28, 2012). To carry out this task, Mercatus assembled a team with extensive experience in energy consulting for many commercial power and natural gas utilities, and power and natural gas producers and marketers. Brief biographical summaries of these individuals are provided in Appendix D.

Please note that although the FTP has recently been renamed the "Financial Hedging Program," because this is a broad review of fuel hedging activities at TVA encompassing the history of the program, this report will refer to the program by its original name of the FTP.

1.1 Project Background

In September 2003 the TVA's Board of Directors approved a Financial Trading Pilot Program to hedge or otherwise limit the financial risks associated with the price of commodities included in TVA's Fuel Cost Adjustment (FCA). At that time, the maximum Value at Risk (VaR) for TVA's portfolio was not to exceed $5 million on an annual basis without the approval of the TVA Board. In May 2005, the TVA Board approved the request to expand and fully implement the FTP. At present, the FTP has an aggregate transaction limit of $130 million (based on a "one-day Value-at-Risk metric") of which $90 million is allocated to natural gas hedging. TVA's management has approved a hedging program that requires a minimum of 50 percent to a maximum of 75 percent of the forecasted natural gas volume for the fiscal year be hedged.

1.2 Project Scope of Work

This document has been organized generally along the lines of a subject outline included in the scope of work for this review. Minor changes to that outline have been made to enhance the flow of ideas and information.

This review is based on the analysis of approximately 150 documents which were provided by the OIG and TVA's front, middle and back office, and cover a variety of subjects which are relevant to determining if TVA's FTP is designed and functioning in a manner to achieve the program's objectives in the most efficient and effective manner, many of which will be referenced throughout this document. In addition, this review included the analysis of TVA's brokerage and counterparty monthly statements from January 2010 through May 2013. Furthermore, this review included interviews with the following individuals:

- Jerry Brown – Senior Program Manager, Financial Hedging
- Bradley Decker – Manager, Analytics & Portfolio Management
- Eric Kuenzli - Director, Gas Supply & Origination
- Cassidy Larson – Director, Structuring & Portfolio Management
- Gary Mazo – Director, Portfolio Risk Management
- David Owens – Vice President, Coal & Gas Services
- John Porter – Senior Trader
- Mary Nell Pruitt – Senior Financial Consultant, Corporate Finance
- Van Wardlaw – Executive Vice President, Customer Relations

This review is based solely on the information made available to us through February 28, 2014.

2.0 Recommendations

1) Determine Tolerance and Proper Size of FTP Risk

a. In order to determine the appropriate risk tolerance for the FTP, TVA should undertake a formal process to sample the risk tolerance of ratepayers. If this is deemed unfeasible, TVA should utilize internal resources to quantify, as best as possible, the risk tolerance of ratepayers.

b. Once TVA has determined the risk tolerance of ratepayers, it should re-size the FTP to match no less than one quantified measure of risk tolerance. The size of the FTP (amount of hedge coverage and the time horizon for hedging) should be determined by the amount of hedging required to reduce risk within the risk tolerance parameter(s) as defined by the risk tolerance determination process.

2) **Address and Communicate Volumetric Risk** – TVA's volumetric risk (the varying volume due to switching between coal and natural gas) needs to be properly analyzed and well communicated between the various stakeholders who have a vested interest in this aspect of the FTP. This is crucial given the significance of TVA's volumetric risk. This effort should include the development of a formal process for analyzing TVA's volumetric risk, on a regular and consistent basis, and should be a joint effort between the front office and the generation planning group. Furthermore, the results of this undertaking need to be well communicated to all necessary parties on a regular basis.

3) **Redesign Hedging Strategies** – TVA should redesign the hedging strategies it employs to better match the characteristics of the exposures which are being hedged via the FTP. The natural optionality of TVA's exposure to natural gas should be taken into account, as well as advantage of, during the strategy redesign process. The quantities to be hedged should be divided between baseload and variable quantities. The baseload quantities can be hedged fixed-price, fixed-quantity instruments such as futures and swaps would be optimal for hedging. The variable quantities should be hedged with options and perhaps even a variety of option strategies. In addition, TVA could develop a hedge optimization model which would determine, quantitatively, an optimal mix of fixed price instruments (i.e. futures) as well as options, to be utilized in order to meet quantified risk reduction targets.

4) **Improve and Consolidate Performance Reports** – As previously addressed, the hedge effectiveness of the FTP is not being reported currently i.e. volatility reduction as measured by the FRV (fuel rate volatility) metric is being reported as being effective when this is not the case. Little to no reduction in volatility cannot be considered effective given the exposures TVA is exposed to via the FTP (e.g. operational risk, credit risk, liquidity risk) and the costs expended to achieve these results. Furthermore, TVA has developed multiple volatility reduction performance metrics yet none were, to our knowledge, provided to the OIG during their recent audit of the FTP. In addition, the performance metrics produced by the Front Office in response to the OIG's recommendation differ from those produced by other functions within TVA and presented to the PROC. All interested parties should cooperate to produce a set of performance metrics that can be used by all functions related to trading and risk management. Lastly, TVA should develop a historical volatility reduction metric specific to natural gas hedging given that natural gas is the largest part of the FTP (as indicated by the FTP being granted the majority of TVA's Value at Risk capacity.

5) **Cease Using VaR as a Primary Risk Metric** - TVA should cease the use of Value at Risk as a primary risk metric and replace it with an "at risk" type of metric(s) that includes not only the financial natural gas hedges but also the physical exposures being hedged via the FTP as this type of approach is more suitable for a power generator such as TVA. These new metric(s) could also be used in the risk tolerance determination and management processes.

6) **Conduct Stress Testing** –Stress testing needs to become a routine and regular part of Middle Office risk analysis and reporting. The results of said stress testing should be utilized with respect to decision making as well as monitoring TVA's potential risk exposure.

7) **Adhere to Governance Documents** – As previously mentioned, TVA needs to take action to ensure that it is performing all that is required of it by the FTP's governance documents (e.g., stress tests, Cash-Flow-at-Risk), etc., or if the language in the governance documents is inaccurate, governance documents should be revised to reflect actual practices.

8) **Conduct Proper Cost/Benefit Analysis** – In order to determine the true costs and benefits of the FTP, TVA should calculate the complete costs and benefits of the FTP since inception. As previously noted, the total should include all costs that would be eliminated if the FTP did not exist. Also, for forward looking risk reduction metrics, such as fuel cost certainty, TVA should compare the all-in hedged cost of fuel versus the cost of fuel without hedging (market price).

9) **Properly Analyze and Manage All of TVA's Energy Commodity Exposure -** The FTP should not only be analyzed in isolation but also as part of TVA's total energy commodity portfolio such that all energy commodity (i.e. coal and fuel oil) risk, both physical and financial, are being properly analyzed and managed.

2.1 Executive Summary

As a result of the growth of TVA's FTP, the OIG scheduled an audit as part of their FY 2012 audit plan. As a result of their audit, on September 28, 2012, the OIG published a Review of TVA's Financial Trading Program - 2011-14477. The objectives of the OIG's audit were to evaluate the following items:

- Management oversight and the design of controls in place to mitigate operational risk exposure
- The program objectives and related performance measures
- Whether TVA is meeting defined performance objectives
- How the FTP impacts TVA's overall risk tolerance

The OIG's audit found that the overall design of TVA's FTP control structure was appropriate while identifying several areas where management oversight should be improved to validate the usefulness and effectiveness of the program as well as to ensure TVA's stakeholders' understanding of the program including the following:

- TVA has not conducted a comprehensive cost-benefit analysis to determine whether the benefits derived from the FTP are greater than the inherent risks of the program
- TVA does not currently measure the performance of the FTP against defined program objectives
- TVA's communications with its customers did not sufficiently convey the FTP's impact on rates

Subsequently, the OIG determined that in order to supplement its audit and ongoing discussions with TVA regarding the usefulness and effectiveness of the FTP, it should engage an independent, third party with relevant experience and expertise in energy trading and risk management to conduct and document a review. This intent of this review, in cooperation with the OIG, is to determine if TVA's FTP is designed and functioning in a manner to achieve the program's objectives in the most efficient and effective manner. This document presents the findings of this review as well as additional recommendations which can strengthen the FTP.

In general, we concur with the OIG's findings that the overall design of TVA's FTP control structure is appropriate and that there are several areas for improvement with respect to validating the usefulness and effectiveness of the program as well as to ensure TVA's stakeholders' understanding of the program. However, we have identified several, additional issues which require TVA's and OIG's attention and are outlined below.

1) TVA did not follow a process or undertake a specific effort to determine its risk tolerance associated with the FTP. To determine the size of the FTP, which according to best practices should be a function of a quantified risk tolerance, TVA relied heavily on information informally gathered directly from peers and on industry benchmark data provided by consultants as well as TVA executives who previously worked for other fuel hedging entities.
2) TVA's current volatility reduction metrics are incomplete measures of performance as they do not measure the cost of achieving reduced volatility.
3) As noted in the OIG's audit, TVA has yet to conduct a thorough cost/benefit analysis of the FTP. Such analysis should include no less than the following items:
    a. TVA's effective (hedged) cost of natural gas vs. a market (unhedged) cost
    b. Overhead and Personnel
    c. Risk Information Systems
    d. Cost of Capital
    e. Transaction Costs
    f. Feeds paid to consultants for services related to the FTP
    g. Losses due to credit defaults
4) While the documents which govern the FTP call for TVA to conduct various forms of stress testing, interview responses indicated that routine stress testing is rarely performed as outlined in the documents. However, in a response to the initial findings of this review, TVA indicated that the language in its governance documents regarding the requirements and conditions for the performance of stress tests was unclear, and that the language has been revised to reflect current practices.
5) One of the FTP's governance documents lists "CFaR" (Cash Flow at Risk) as an example of TVA Middle Office risk analytics yet the Middle Office is not calculating this metric. If

the Middle Office is not performing CFaR calculations, governance documents should be changed to reflect this; however, CFaR would be a useful metric for TVA that could be used to define its tolerance to liquidity risk.

6) TVA's forecasting models show that the economic dispatch displacement of coal versus natural gas is a substantial driver of the FTP's natural gas load forecast and resulting hedge targets, but to date, although TVA has conducted a considerable amount of research regarding volumetric variability, few results have been achieved in terms of specifying TVA's risk tolerance with respect to volumetric risk, and in terms of translating that risk tolerance into the requisite optionality for the formulation of dynamic hedge strategies and hedge targets.
7) TVA uses fixed-volume hedging instruments to hedge a natural gas price exposure that exhibits substantial volumetric variability, resulting in a mismatch of both hedging strategies and instruments. Changes in hedge targets drive considerable churning of the hedge portfolio, undermining hedging performance.
8) The Fuel Rate Volatility ("FRV") metric which has recently been introduced by TVA is being reported as "effective" while the reduction in the fuel rate volatility over the almost six year history of the FTP is zero. It should be noted that much of this result is a function of TVA's volumetric risk.
9) TVA's measurement of VaR ("Value-at-Risk") should be reconfigured so that it includes the physical exposures being hedged via the FTP. This would transform the metric into a fuel cost at risk metric, which would be a much more appropriate metric for managing the FTP.
10) The FTP should not only be analyzed in isolation but also as part of a cross-commodity portfolio which incorporates additional commodities such as coal and fuel oil, including both financial and physical positions.
11) Given that the premise of the FTP is to provide TVA's customers with reduced exposure to commodity price volatility, TVA needs to improve the process by which it determines its customers' risk tolerance. This can be accomplished via a number of ways including quantified sampling of customer's senior management and/or through formal surveys.

These issues are described in more detail throughout this report.

3.0 Findings

3.1 High Level Overview of the FTP and Overall Objectives

3.1.1 Overview

From an industry perspective, the FTP is a fairly straightforward and commonplace hedging program for a power generation fuel consumer. It features a programmatic strategic approach similar to dollar cost averaging, and has a conservative discretionary strategy for executing additional hedges at value prices.

Although the FTP has been expanded over the years to include multiple commodities, the largest component of the FTP is natural gas hedging. And at the heart of the FTP is a programmatic time-driven execution strategy for natural gas hedging known in TVA parlance as a "hedge ladder," with a purchase triggering mechanism somewhat like the conservative investment strategy of dollar cost averaging.

The discretionary strategy is primarily driven by discounts based on a historical price range of natural gas. "Discretion" is a misnomer because the word usually means that a trader or some other party has freedom of action. TVA traders have a degree of discretion for executing transactions, but do not have freedom of action regarding hedge strategies. A degree of transaction execution discretion is a commonplace feature of hedging programs (e.g., transaction execution can occur any time within a day to meet daily targets, any time within a month to meet monthly targets). A better term for TVA's "discretionary" hedging strategy, and one that is often encountered in the industry, is a "price-driven" or "value" strategy for executing hedge transactions in addition to those from a programmatic or "time-driven" strategy. Originally based on an eight-year look-back, the FTP's "discretionary" strategy now incorporates a shorter four-year historical range. When prices fall into the lower deciles of the historical range, additional hedge transactions are executed.

Both of these methods for triggering hedge transaction execution are commonplace in the energy industry, and conform to best practices. However, with regard to best practices, the FTP is lacking in the areas of risk and performance measurement, and risk tolerance, and it lacks a sufficiently sophisticated strategy to deal with the substantial uncertainty surrounding the volumetric targets for hedging. These issues are discussed at length throughout this document.

3.1.2 Overall Objectives

To a degree, the FTP meets its overall objectives of adherence to controls and of, "Increasing the predictability of TVA's fuel cost adjustment and to provide rate stability and predictability to TVA's customers," as set forth in TVA's Commodity Risk Management Policy. Recently developed performance metrics show that on a look-forward basis the current portfolio is reducing the uncertainty of future fuel costs (increasing fuel cost predictability) in accordance with policy objectives. However, another recently developed performance metric to measure historical performance shows that the variability of fuel rates for TVA's hedged fuel portfolio has matched, but has not reduced, the variability of an unhedged portfolio during the history of the program. No rate stability or increased predictability was achieved as of the date of the report (4th quarter 2012). This outcome does not meet the overall objectives of the program, and is due mainly to the tremendous uncertainty around TVA's fuel requirements and the large volumetric variability of the FTP's hedge targets. The issue of volume variability and how it affects the FTP is addressed in other sections of this document.

A further objective as stated in TVA's policy is that "the first priority of TVA's commodity trading activity is to provide stable, low-cost rates …" "Low-cost" is not defined however, and this lack of a definition makes it difficult to assess how well the FTP is meeting its low-cost objective.

3.1.3 Measurement and Determination of Organizational Risk Tolerance

To date, other than simple volumetric limits, TVA has not incorporated a measurement of risk tolerance in the FTP. Risk tolerance has been solely determined and defined by the hedging requirements and limits established in TVA's FTP governance documents. Risk tolerance compliance has been controlled through measuring and monitoring compliance with the FTP's prescribed targets and limits.

3.1.4 Statement and Definition of Risk Tolerance

In TVA's Commodity Risk Management Policy, no specific measurement or threshold of risk tolerance is mentioned or required. Risk tolerance is discussed mainly from the point of view of ensuring that risk is managed through the appropriate use of limits, procedures and controls. To illustrate, the following quote comes from Section 3.2.2 "Risk Appetite and Tolerance" of the policy document: "TVA's financial risk tolerance is defined by the requirements and limits set forth in this Policy. All risk taking and risk management activities will be carried out in accordance with this Policy."

It is a best practice to quantify risk tolerance using limits on exposures. But rather than using volume as in TVA's case, it is a best practice to define risk tolerance in terms of at least one measure of financial performance (see Section 3.2.3.1 Risk Tolerance). As an example, it is a best practice for self-regulated load-serving entities to develop and implement a limit around the uncertainty associated with power supply cost, fuel supply cost, or rate variability. Other metrics would include defining risk tolerance for liquidity risk (i.e., defining a limit on the tolerable amount of margin or collateral required to support a hedge program) and defining risk tolerance for credit risk (e.g., maximum tolerable exposure to replacement costs, maximum tolerable exposure to expected credit loss).

Once a limit on this metric(s) is chosen (i.e., the threshold between how much risk will and will not be tolerated), the size of a hedging program can be inferred by the amount of hedge coverage necessary to reduce the amount of risk to below that of the risk tolerance threshold(s). Size in this context is defined as the hedging time horizon and the number of contracts, or the volumetric amount, that equals the proportion to be hedged of the total exposure. This quantitative approach to risk tolerance, by quantifying financial performance, identifying a level beyond which the organization cannot tolerate, and then determining the amount of hedge coverage necessary to reduce risk(s) to the risk tolerance threshold (or below), is notably absent in TVA's FTP.

3.1.5 Process(s) Used to Determine TVA's Risk Tolerance

As determined from multiple statements in multiple interviews, TVA did not follow a process or undertake a specific effort to determine its risk tolerance. To determine the size of the FTP, which according to best practices should be a function of a quantified risk tolerance, TVA relied on information informally gathered directly from peers and on industry benchmark data provided by consultants and TVA executives who previously worked for other fuel hedging entities. Although TVA has a pass-through rate structure, it has assumed it should hedge fuel price risk to mitigate fuel cost variability and uncertainty on behalf of rate payers. But until recently, it appears that TVA management did not seek to measure or specifically determine the risk tolerance of rate payers. Thus, the size of the FTP (i.e., the amount to be hedged and the time horizon for hedge positions) was based heavily on what other hedgers were doing. Peer benchmarking can serve two useful purposes: 1) as a sanity check to make sure that a hedger's practices and approach aren't radically different from its peers (if so, to then make sure there's a valid reason for the difference), and 2) to develop ideas for program improvements or changes in areas not previously considered. But peer benchmark data should not be the primary rationale for sizing a program.

Further, TVA did not undertake an effort to determine how much risk it could tolerate and would be willing to warehouse as a result of price risk hedging. Hedging involves a trade-off between risks. It is a misconception that hedging can "eliminate" risk. Risk never goes away; it is converted into another form via hedging. Most hedging involves price risk mitigation through fixed-price transactions, which is essentially the transformation of price risk into other risks, including but not limited to credit risk, liquidity risk and operational risk, for which a hedger has a higher tolerance. In other words, prior to hedging, the hedging party is warehousing price risk, and through the process of hedging, the intolerable portion of price risk is subsequently converted to be warehoused as credit, liquidity and operational risk. The essential hedging trade-off is to convert intolerable amounts of one or more types of risk into tolerable amounts of other types of risk.

Stress testing is a mainstream approach to measuring potential financial performance for use in determining risk tolerance. Although TVA's Commodity Risk Management Policy appears to require regular performance of stress testing in three different sections (sections 3.1.10 Middle Office, 3.2.8 Quantification of Market Risk, 3.2.11 Key Market Risk Reports), and in the Standard Programs and Processes document (Appendix F of the TVA COP-SPP-21.4.1 Rev. 0005), interview responses indicated that routine or even ad hoc stress testing is rarely performed. In a response to the initial findings of this review, TVA indicated that the language in its governance documents regarding the requirements and conditions for the performance of stress tests was unclear, and that the language has been revised to reflect current practices.

Interview responses indicated that in sizing its FTP, TVA did not conduct stress tests on potential credit or liquidity risk (the main risks into which fuel price risk would be converted and warehoused). It is possible that proper stress testing of potential liquidity risk (e.g., the potential for margin calls on exchanged-traded futures positions) in the past would have led to a better understanding of TVA's risk tolerance, and TVA's potential intolerance for posting margin, and a reduced size of the FTP, or would have led to a different strategic approach.

Further, Appendix F of the Standard Programs and Processes document lists "CFaR" (Cash Flow at Risk) as an example of TVA Middle Office risk analytics yet the Middle Office is not calculating this metric. If the Middle Office is not performing CFaR calculations, governance documents should be changed to reflect this; however, CFaR would be a useful metric for TVA that could be used to define its tolerance to liquidity risk.

As discussed in several interviews for this project, only after experiencing substantial margin calls, and at the behest of TVA Treasury, TVA conducted analysis for the purpose of reducing the size of the FTP. In effect, sensitivity to cash flow constraints and margin funding requirements helped inform a better sense of TVA's risk tolerance. However, this was achieved indirectly through real-time experience, not directly through an initial determination of TVA's risk tolerance in the original design process of the program.

Lastly, interview responses indicated that the most recent versions of load and production forecasting models show that the economic dispatch displacement of coal versus natural gas is a substantial driver of the FTP's natural gas load forecast and resulting hedge targets. It appears that although the current personnel in the Front Office, the Middle Office, and in Structuring and Portfolio Management are aware of the substantial volumetric uncertainty driving instability in natural gas hedging targets, and despite conducting a considerable amount of research regarding volumetric variability, few results have been achieved in terms of specifying TVA's risk tolerance with respect to volumetric risk, and in terms of translating that risk tolerance into the requisite optionality for the formulation of dynamic hedge strategies and hedge targets. TVA has adopted recommended changes to reduce both the time horizon and quantity of its natural hedging program, but this has not involved a specific determination of its financial risk tolerance. Nor were any changes made to the fixed-quantity instruments that comprise the majority of FTP positions or to the strategies used in the FTP. See Section 3.13 Evaluation of the Effectiveness of the FTP for more detail on this issue.

3.1.6 Process and Metrics Used to Determine the FTP's VaR Threshold

Interview responses indicated that it appears no specific process was followed to determine the FTP's VaR threshold. The threshold for the natural gas portion of the FTP began with a $5 million limit in May of 2005 and was incrementally increased up to the current $90 million threshold as of June, 2009. According to interview responses, the VaR threshold was selected on an arbitrary basis by the former Chief Risk Officer, and it has no material impact on the management of the FTP.

3.2 Best Practices and the FTP

3.2.1 Sources of Best Practices

Before discussing findings regarding how well TVA's FTP conforms to industry best practices, it is important to establish a common understanding of the sources and implications of best practices for energy price risk management.

It is a common misconception that any suggestion issued or a standard discussed by a consultant working for one of the Big 4 consulting firms is in effect an industry best practice. Indeed, consultants are reliable sources for best practices, but the Big 4 firms are not the headwaters for trading and risk management best practices. Although many would struggle to identify the original sources of industry best practices, such sources exist and it is important to briefly discuss them to establish a bona fide set of best practices as a reference source for this project.

It is crucial to understand that the primary source of best practices for energy price risk management is not within the energy industry. The headwaters of best practices for price risk management (for any commodity or financial exposure) originate in the banking and financial services industries. And the "modern" financial industry is fairly young. The financial industry became a radically different and more complicated and risky place after the 1973 seminal research paper by Fischer Black and Myron Scholes, "*The Pricing of Options and Corporate Liabilities*", published in the Journal of Political Economy. Otherwise and more commonly known as the Black-Scholes option pricing model, this was a truly disruptive technology in the financial marketplace that allowed, for the first time, the widespread and consistent calculation of market instruments whose value was a function of probability. This model, and its widespread acceptance and use, led to a massive expansion in the listing and trading of probabilistic financial products. And it also led to a massive expansion of more complex derivative products, as the Wall Street banks literally hired rocket scientists and other quantitative experts to develop new types of exotic products.

The 1980s saw the explosive growth of exchange-traded derivatives, the widespread use of caps, floors, and collars, and a global financial crisis sparked by a U.S. stock market crash fueled by unprecedented levels of price volatility. The early 1990s saw the growth of OTC options, swaps, and more exotic derivative instruments, more volatile market shocks, and widely publicized and spectacular blow-ups. These events led regulators and policy makers to tackle the challenges of formulating new means of measuring and controlling risk.

The first and most significant step in this area was the 1993 publication by the Global Derivatives Study Group of the Group of Thirty ("G30"), entitled "*Derivatives: Practices and Principles*." The Study included over 20 recommended practices for managing derivatives trading activity. It was the first comprehensive collection of best practices for derivatives trading published by a leading global policy-making organization. It included the first published use of the term "value at risk" (Recommendation #5), defining it as "the expected loss from an adverse market movement with a specified

probability over a particular period of time." Value at risk made use of many of the same probabilistic statistical tools used in the groundbreaking Black-Scholes model.

As a brief aside, it was the burgeoning RiskMetrics group at J.P. Morgan that spawned the symbol "VaR" for value at risk in 1984. RiskMetrics developed and distributed the first widely used variance/covariance version of analytical VaR, and has since been spun off as a separate entity.

The G30 report was also the birth of the Middle Office, although the term Middle Office wasn't used in the report. Prior to this time, most organizations had "Trading" and a "Back Office," but did not have an independent risk management function sitting between them. Recommendation #8 in the G30 report called for "Independent Market Risk Management," with "clear independence and authority" to ensure that certain responsibilities were carried out: risk limit policies and policy compliance monitoring, stress testing, reporting, risk measurement and monitoring, and the review and approval of valuation models.

Another source at the headwaters of best practices is the Bank for International Settlements ("BIS"). The sub-group of the BIS with the most influence on best practices is the Basel Committee on Banking Supervision. Formed in 1974, the Basel Committee does not have any formal worldwide supervisory authority, and its conclusions do not have legal force. Its purpose is to formulate broad supervisory standards and guidelines, and to recommend statements of best practices with the expectation that individual banking regulatory authorities will take steps to implement the recommendations through detailed arrangements – statutory or otherwise – which are best-suited to their own national systems. Thus, even without official legal or regulatory authority, the Basel Committee encourages convergence towards common approaches and common standards.

The Basel Committee frequently focuses on capital adequacy. Measuring risk and determining the amount of capital necessary to support various types of risk-taking activities is the subject of a series of Basel Capital Accords that have been issued through the years. These have either specifically included a requirement to calculate value at risk (i.e., the 1996 Market Risk Amendment to the 1988 Basel I Capital Accord), or have required some type of probabilistic risk calculation for the determination of adequate capital.

3.2.2 Best Practices in the Energy Industry

A fundamental difference exists in applying best practices in the financial services industry versus applying them in the energy industry. Best practices as developed by organizations such as the G30 and the BIS were primarily intended to control risk-taking (speculative) activities by banks. Much of the early and principle development of trading and risk management best practices occurred before power was deregulated, and to a degree, before natural gas prices were deregulated as well. Most hedgers in the energy industry, TVA included, are transacting to mitigate price risk on physical exposures in order to reduce the net exposure to price risk. G30 and BIS best practices, and VaR, were designed to control trading where risk was incrementally added for profit-making purposes through transaction activities, not designed for risk reduction commodity trading.

VaR, and essential best practices, were developed for cash-rich (i.e., a large unencumbered balance sheet, or a large line of credit) and asset-poor trading organizations, not the typical asset-rich / cash-poor hedging entity in the energy industry. Consequently, a translation and adaptation of financial services best practices is necessary to establish best practice standards in the energy industry, especially for entities whose primary objective is risk reduction.

An excellent source of these translated and adapted best practices in the energy industry is the Committee of Chief Risk Officers ("CCRO"). Formed in the early 2000s not long after the demise of Enron and the subsequent near-fatal financial crises at other energy marketers (e.g., El Paso, Dynegy), the CCRO's objectives include advancing best practices for North American energy companies and markets, functioning as a centralized communications nexus for risk issues, establishing best practices for risk management in the energy industry, and providing guidance on new risk management methods and tools. Two of its main initiatives, due to observed widespread insufficiencies in the industry, are in the area of risk-adjusted performance measurement for profit-making activities, and in the area of capital adequacy, including metrics for measuring potential capital requirements such as stress testing and "at risk" types of measurements. The CCRO's principle tool for communicating best practices is a series of white papers available to members, and available to non-members for a fee.

3.2.3 Best Practices at TVA

As noted by the multiple consultants who have reviewed the FTP, many elements of the program, and the intent of the program, conform to best practices. Of note, these include TVA's trading and risk management organizational structure, including senior management risk committees, a Front Office, a Middle Office, and a Back Office, and an independent credit risk management function; a clearly stated objective for risk

management, an articulated hedge strategy with clearly defined hedge targets; an appropriate risk information system of record; and clearly defined limits and controls.

It is important to note that the recent introduction of performance metrics, prepared by the Front Office, is a violation of best practice segregation of duties. Clearly the Front Office can be involved in the design and use of such metrics, but they should be calculated and reported independently by the Middle Office. TVA can be given a pass for this violation because the reports have only been recently developed, but in steady state operations, the Middle Office should calculate and report the official version of all performance metrics.

However, beyond the performance metric issue, there are three important areas of TVA's FTP where the program falls far short of best practice standards: risk tolerance, stress testing (and the related area of capital adequacy), and performance measurement.

3.2.3.1 Risk Tolerance

A subset of the risk tolerance issue is the misapplication of VaR at TVA. As noted in section 3.14.1 The Misapplication of VaR at TVA, the application of VaR to date is essentially useless, other than to allow TVA to check the box that it "has VaR." To date, VaR has been calculated only on a portfolio of hedge positions. This is the original application of VaR as envisioned by the G30: to measure the risk of a derivatives speculative portfolio. Because TVA does not speculate, the current application of VaR is inappropriate.

The CCRO recommends that an organization's trading and risk management policy include a formal recognition of risk tolerance articulated, defined, and quantified in one of several ways including 1) a minimally acceptable earnings or cash flow level, 2) a minimally acceptable credit rating, or 3) a limit or target on a measure of financial variability which could include VaR (but only for speculative activities) or one of many "at risk" types of measures such as Earnings at Risk, Cash Flow at Risk, Fuel Supply Cost at Risk, or Rate Volatility (for load serving entities). Using VaR, or a VaR-like risk measurement, for this purpose would be an appropriate application of VaR at TVA.

During interviews for this project, TVA personnel from both the Front and Middle offices acknowledged the inappropriate application of VaR and the need to calculate some form of "at risk" type of metric to measure the risk of a portfolio including both hedge positions and the physical exposures being hedged. The addition of a measurement of "Fuel Cost at Risk" or of Rate Variability, along with an organizational effort to quantify

the dividing line between how much of those risks it is willing, and not willing, to tolerate, or how much rate payers are willing to tolerate, would be necessary to bring TVA up to best practice standards in the area of risk tolerance.

It is important to note that something similar to a "fuel cost at risk" type of metric is already being calculated. Based on the OIG's recommendations for producing performance metrics, TVA's systems planning group started producing Fuel Cost Certainty and Fuel Rate Certainty metrics (for more detail see Section 3.2.3.3 Performance Measurement below). These are based on stochastic modeling around fuel costs. Although not explicitly a VaR model, this stochastic modeling is essentially a VaR-like approach and can be a useful addition not just for performance measurement but also for use in the risk tolerance determination process.

Further, a prospective Fuel Cost Adjustment at Risk metric has been developed (see the TVA presentation entitled *Hedge Effectiveness, Portfolio Risk Oversight Committee*, dated August 14, 2012). This can also provide useful insight into TVA's risk tolerance, but because the metric involves all fuels, it would be difficult to use it to imply tolerances, limits, and targets for individual commodities like natural gas.

Given TVA's past sensitivity to margin calls, a measurement of liquidity risk, a quantification of TVA's liquidity risk tolerance, and a limit on the liquidity risk metric should be implemented.

A quantification of credit risk tolerance, and a limit on credit exposure, should be implemented as well. TVA's credit risk management policy addresses credit limits to a limited extent, and this subject is addressed in more detail in Section 3.12 Analysis of Credit Requirements and Controls.

3.2.3.2 Stress Testing and Capital Adequacy

The energy industry sports a litany of blow-ups driven mainly by capital shortages marked by inadequate measurement and control of potential capital required to support trading and risk management activities (see publicly available information regarding Metallgesellschaft, Constellation, and El Paso, as a few stark and notable examples among many). Although many of the more spectacular blow-ups involved marketing or trading businesses rather than load-serving businesses, they shared the common theme of crises triggered by substantial hedging-related margin/collateral calls.

As noted above, hedging involves a trade-off between risks. A hedger that fixes costs or revenues through the use of fixed-price transactions or purchased options is transferring price risk into other forms of risk for which it has more tolerance for warehousing. Price risk gets transformed into many types of risk, with the principle types including credit risk, liquidity risk, and operational risk.

And as noted above, many of the well-known blow-ups in the industry occurred because liquidity risk was not adequately measured and managed. One of the main tools for measuring potential margin or collateral requirements is stress testing. As noted elsewhere in this document, three different sections TVA's Commodity Risk Management Policy call for stress testing (sections 3.1.10 Middle Office, 3.2.8 Quantification of Market Risk, 3.2.11 Key Market Risk Reports), but contrary to policy requirements, stress testing is not being conducted. In a response to the initial findings of this review, TVA indicated that the language in its governance documents regarding the requirements and conditions for the performance of stress tests was unclear, and that the language has been revised to reflect current practices. Interview responses indicated that stress tests for potential margin requirements were not conducted in the past. Conducting those tests would not have ensured that TVA would have avoided the substantial margin calls of a few years past. But with appropriate stress scenarios, TVA management would have had a better understanding in advance of potential margin requirements.

It is an industry best practice to establish limits on measures of liquidity for all commodity-based businesses. Liquidity metrics, and limits on those metrics, are lacking for the FTP.

3.2.3.3 Performance Measurement

Until recently, TVA was not calculating a measure of hedging performance. In its Commodity Risk Management Policy, TVA's stated hedging objective is essentially volatility reduction, although it is not stated as such. The policy states that the risk management includes "Increasing the predictability of TVA's fuel cost adjustment and to provide rate stability and predictability to TVA's customers." Increasing the "predictability" of any price-related statistic means reducing the volatility of said statistic.

TVA has recently developed multiple volatility reduction metrics for natural gas hedging, including but not limited to: 1) Fuel Rate Certainty ("FRC"), 2) Fuel Cost Certainty ("FCC"), and 3) Fuel Rate Volatility ("FRV"). Please see Appendix B which includes definitions of these metrics.

The volatility of the hedged exposure (physical exposure plus hedge positions) is compared to the volatility of the unhedged physical exposure as a means of measuring the reduction in fuel cost volatility. This is an effective measurement of volatility reduction, but it does not go far enough as it simply measures volatility reduction without any regard for the cost of achieving the reduction. A trader for a long hedger could purchase 100% of a hedge target at the worst (highest) possible prices over a specific measurement period of volatility reduction, and the volatility reduction metric would still indicate a highly effective hedging program. But at what cost? It is incomplete to measure volatility reduction without understanding the cost of achieving the reduction.

The first two metrics, the FRC and the FCC, are look-forward metrics. They show probability distributions for potential fuel rates and fuel costs, respectively, on a hedged and an unhedged basis for the current hedge portfolio. Performance in terms of volatility reduction is expressed as the difference in value between the 95th percentile point on each distribution and the mean value of each distribution. In other words, if the difference between the 95th percentile value and the mean value for the hedged portfolio is less than the difference of those two values for the unhedged portfolio, it represents the amount of fuel rate or fuel cost volatility reduction that has been achieved by the FTP.

Based on a recent performance report (see Appendix B. TVA Financial Hedging Program Indicators), both the FRC and the FCC show that the current hedged portfolio is producing substantial volatility reduction benefits. The amount of volatility reduction should be called into question however, given that on an historical look-back basis as reported by the FRV (defined below in this section); the FTP has achieved zero volatility reduction (see Section 3.13.2 Quantitative Evaluation). The primary culprit for the lack of volatility reduction to date has been the substantial volumetric variability in TVA's physical short natural gas position that drives substantial churning of the hedge position. The FRC and the FCC should be reviewed to determine if volumetric variability, and its effect on the churning of hedges, is incorporated in the metrics. If not, given the substantial mismatch between look-forward volatility reduction (almost 25% according to the FRC) and realized look-back volatility reduction (0%), the accuracy of the look-forward measures of volatility reduction is questionable.

In both cases however, the mean value (expected cost) of the hedged portfolio is above the mean value of the unhedged portfolio. This is one measure of the cost of hedging (in terms of market costs only). In neither metric is this cost calculated, or compared to the amount of volatility reduced to give a clearer sense of the cost incurred to achieve volatility reduction.

The third volatility reduction metric, the FRV, is a look-back metric to measure how much volatility reduction has actually been achieved. The new metric compares the volatility of the annual fuel rate for past fiscal years on both a hedged and an unhedged basis. This is a standard performance metric for measuring volatility reduction (although others often calculate it with finer granularity such as quarterly or monthly) and it is a big improvement and addition to TVA's suite of performance metrics. But volatility reduction must be judged relative to the cost of achieving it, and it is the cost component that is lacking in TVA's performance metrics.

The description of the FRV in the FTP Indicators report (see Appendix B. TVA Financial Hedging Program Indicators) should be improved because it does not explain the metric in sufficient detail. Does the FRV measure the volatility of the hedged portfolio across the entire multi-year hedging horizon during a specific fiscal year, or does it measure the volatility of only the 12 months within a fiscal year? The FRV report should also include the actual values for each year, rather than presenting a column chart only with no values.

And what commodities are included in "Fuel?" This is not specified in the definitions for the metrics. Further, given that different fuels have substantially different volatilities, and substantially different hedge targets and hedge strategies, it would be useful to measure the discrete performance for individual commodities, especially for natural gas because it is such as large component of the FTP and TVA's fuel cost. This would result in a look-back Gas Cost Volatility metric and a look-forward Gas Cost Certainty metric.

In addition, a retrospective measure of risk management performance was developed and introduced last year. In the presentation delivered to TVA's Portfolio Risk Oversight Committee ("PROC") entitled *Hedge Effectiveness, Portfolio Risk Oversight Committee*, dated August 14, 2012), a retrospective Hedged Gas and Purchased Power Cost metric was introduced. The logic behind the construction of this metric is unclear. Why has natural gas been combined with power purchases, but other fuels excluded? It would be useful to discretely measure the volatility reduction of each aspect of the hedging and procurement, including natural gas, other fuels, and power.

In terms of measuring historical hedging performance, the various retrospective metrics are reporting inconsistent or unclear results. The Fuel Rate Volatility metric reports that no volatility reduction has been achieved from Fiscal Years 2006 through 2012 (i.e., 44% volatility for both the hedged and unhedged fuel portfolios from FY2006 through FY2012). And by examining the chart included in the report, it appears that very little volatility reduction was achieved in the shorter period of 2009 through 2012, whereas the Retrospective Hedged Gas and Purchases Power Cost metric reports a 23% reduction of volatility from 2009 through 2012. If this is true, then the only way to reconcile the two metrics is to imply that power purchases are responsible for the vast

majority of volatility reduction achieved in 2009 through 2012. Without explicitly calculating the performance of gas hedging only, it is difficult to ascertain the hedging performance of specific portions of the FTP.

3.2.3.4 Cost/Benefit

One of the recommendations of the OIG was for TVA management to perform a "comprehensive" cost/benefit analysis of the FTP. The resulting analysis lacked many of the cost components that should be incorporated – costs that have been included in other TVA analyses and presentations. Examples of these costs are presented below after the list of suggested cost components to be included.

In terms of costs for use in a cost/benefit analysis, there are two types of costs to consider. For a long hedger, the effective (hedged) cost of the commodity should be compared to the market cost. This comparison needs to be presented and considered carefully because in a market with declining forward prices, **any** long hedger will experience an effective cost that is above the market cost. This leaves the hedging program open to inappropriate or uninformed hindsight criticism. It is not the intention of this report to criticize the magnitude of past negative cash settlements and margin calls from futures hedges. However, it is the intention to point out that the FTP lacks a best practice metric for liquidity risk (potential margin/collateral requirements), and a quantification of TVA's liquidity risk tolerance.

Having an effective cost above the unhedged market cost is not in and of itself a problem. It would only become a problem if the gap between a higher effective (hedged) cost and the lower market cost became unacceptably large based on the hedger's tolerance for risk. This gap could become another metric for further defining TVA's risk tolerance, and it is an important measure of potential exposure that should be probed and tested through stress testing. Scenarios with large price movements should be developed, both positive and negative, and current or prospective hedges should be valued according to those scenarios. The lack of stress testing at TVA renders moot the point of probing the organization's risk tolerance through scenarios of large and potentially intolerable differences between the effective cost of fuel and the market cost of fuel.

The other type of cost to be measured and compared to the benefit of volatility reduction is any cost that would not be incurred if an organization was not hedging. The cost of hedging should include the following:

- **Overhead and Personnel (e.g., general and administrative overhead, compensation including benefits)** – this would not be just the specific personnel

involved in the FTP, but would also include a portion of the compensation for senior managers who oversee the program, plus support services and functions such as Treasury, IT, and auditing, and an allocation of overhead costs (office space, utilities, communication costs).

- **Risk Information Systems (e.g., deal capture and reporting system of record, external risk systems)** – this category would include the FTP's share of all software costs, implementation costs, and annual maintenance costs.
- **Cost of Capital for:**
    - Posting and maintaining margin or other collateral
    - Credit reserves (if maintained)
    - Risk reserves for operational risk (if maintained)
- **Transaction Costs:**
    - Commissions and fees
    - Bid/ask spread - unless TVA is a market maker, its hedging activities define it as a price taker, which means that it buys above fair value at the prevailing offer, and when it sells for liquidation purposes, it sells below fair value at the prevailing bid. Even if it buys based on scaled down limit orders, at the time a limit order is filled the limit price is at the current offer price, not at the fair market/mid-market value. [Note – this is not a trivial calculation, but an estimate of the average value of bid/ask spreads can be maintained and applied to all hedged volumes to produce a reasonable estimate of transaction costs. Bid/ask differential costs have been included in other recent analyses by TVA – see PROC NatGas Hedge Ladders v10.pdf.]
- **Fees paid to consultants for services related to the FTP**
- **Losses due to credit defaults**

Again, the common theme for this list is the inclusion of any cost that would not be incurred if a hedging program was not being operated.

Calculating the cost of hedging at TVA presents a challenge because multiple commodities, both physical and financial (e.g., physical gas, financial gas, coal, power), are being managed as part of an overall supply management and risk management effort. Many of these activities share many of the costs listed above; thus, to calculate the costs of the FTP for a single commodity (e.g., financial natural gas), an allocation scheme would need to be developed to allocate shared costs (e.g., risk information system costs).To quantify the benefits in a cost/benefit calculation, TVA used the FCC. This is an appropriate choice for a look-forward measure of the volatility reduction benefits of the program, but TVA should also use the FRV as a quantitative measure of historical benefits.

It is important to note that the cost/benefit analysis prepared by TVA management did not include certain costs that have been included in other FTP-related analyses and TVA presentations. Examples include the June 5, 2012 presentation to the PROC where margin funds and bid/ask spread differentials were included as costs, and the FY13 Fuel and Purchased Power Contracting Plan which includes natural gas hedging results as a cost component in the calculation of Total Gas Expense.

It is also important to address the issue of when to include mark-to-market or realized gains and losses in cost/benefit analyses. Realized gains and losses for the period being analyzed (e.g., a fiscal or calendar year) should be included in all historical (look-back) performance reports and cost/benefit analyses. The total effective cost of a hedged commodity should include all realized gains and losses for the time period in question. Mark-to-market (unrealized) gains and losses for all yet to be settled hedge transactions should be included in look-forward cost/benefit analyses and performance measurements. When hedging benefits are being measured and reported, such as a reduction in cost uncertainty, the corresponding effective hedged cost of the commodity, which should include unrealized gains and losses, should also be reported. As an example, consider the FRC and FCC performance metrics that were provided to the OIG in response to its audit. These are the first two metrics included in the performance report in Appendix B. The report quantifies the reduction in uncertainty (benefit) between unhedged and hedged portfolios, and yet while the graphs show a hedged cost above the unhedged cost, the report fails to quantify the market cost (based on unrealized gains and losses) of achieving the quantified benefit.

3.3 Effectiveness of the Control Environment

From a simple perspective, the control environment for the FTP is effective. As noted in numerous consultants' reports, TVA has a good track record of adherence to the FTP's primary limits, which are the hedge ladder and additional discretionary targets.

However, other controls are lacking that would be tied to a quantifiable risk tolerance(s) such as limits on fuel rate variability (e.g., a risk tolerance threshold/limit on "fuel cost at risk") and limits on actual or potential collateral/margin funding.

3.4 Trading Results

From FY 2006 – FY 2006, according to TVA's annual reports, as filed with the Securities Exchange Commission, TVA recognized natural gas hedging gains and (losses) as follows:

2006: ($23,000,000)

2007: ($45,000,000)
2008: $10,000,000
2009: ($405,000,000)
2010: ($152,000,000)
2011: ($164,000,000)
2012: ($352,000,000)

While analyzing the specific month-by-month trading results of the FTP is beyond the scope of this document, it is important to note that the design of the FTP is such that the program will produce material gains or losses if/when natural gas prices increase or decrease significantly and remain in the subsequent higher or lower price range for a sustainable period of time, as has been the case in recent years. These gains and losses are a result of the methodology of a "laddered" hedging strategy using fixed-price, fixed-quantity hedging instruments such as swaps and futures contracts, which is discussed at length in other sections of this report.

3.5 Organizational Structure and Compensation Policies

As a general rule, the organizational structure employed by TVA is similar to other power generation companies and generally meets industry standards, with one exception. As noted in 3.2.3, industry best practices dictate that the Middle Office should be responsible for calculating and reporting the official version of all performance metrics to ensure that said metrics are completely independent from the Front Office.

In addition, TVA could further improve the organizational structure as it relates to the FTP by reorganizing the Front Office so that all Front Office activities occur within the same group and physical location. Doing so should significantly improve the communication channels between the various stakeholders which, in turn, should improve TVA's ability to better manage and mitigate commodity risk exposure across the entire portfolio.

Regarding compensation policies, while compensation as a whole is beyond the scope of this review, interviews indicated that TVA's compensation policies meet industry best practices for companies who prohibit speculative trading in that compensation is not tied to the performance of the FTP or other trading results.

3.6 Review of Governance Documents

To a large degree, but with a few of notable exceptions, TVA's governance documents for the FTP are relatively effective and generally conform to best practice standards. The documents reviewed for this project include:

- Commodity Risk Management Policy: *TVA-SPP-13.18*
- Financial Trading Program (Procedures and Processes): *COP-SPP-21.4.1 Rev. 0005*
- Hedge Strategy: *Natural Gas Financial Hedge Strategy Sheet rev 8.8.01.11*

In terms of best practices, the three documents cover the purpose, scope, and objectives of the FTP; roles and responsibilities including the board of directors, senior management, risk committees, and support functions including credit, legal, and treasury functions; an appropriate segregation of duties; an identification of most of the important risks involved in the program; the inclusion of several important risk metrics; clear authorization and delegation of authority, and clear limits and controls; and a well-articulated hedge strategy.

However, there are some important issues not covered in the governance documents. As discussed elsewhere in this document, it is a best practice to quantify risk tolerance in terms of at least one measure of financial performance. The governance documents fail to define and quantify TVA's risk tolerance or to include limits on financial performance. The only reference in the policy document to a "financial" risk tolerance is that it is "defined by the requirements and limits set forth in this Policy."

Although many of the risks faced by TVA (e.g., price risk), or that are incurred because of the FTP (e.g., credit risk, operational risk), are addressed in the policy, important risks that have substantially impacted the FTP are not included. These include liquidity risk and instrument suitability risk. TVA has faced challenges with margin funding, and the performance of the FTP suffers from an instrument mismatch due to the use of fixed-quantity instruments to hedge variable volumetric exposures. The instrument suitability issue is discussed in more detail in Section 3.8.3 Strategy and Hedging Instrument Mismatch, and Section 3.13.1 Qualitative Evaluation.

The governance documents include best practice risk metrics and controls such as volumetric limits, dollar transaction limits, stop-losses, and VaR limits (although VaR limits are so high as to be generally ineffective), but fail to include a best practice metric and limit for liquidity risk (e.g., Cash Flow at Risk, Margin at Risk) which has proved through real-time experience to be a sensitive internal issue.

Lastly, although a written attestation of employees' understanding of their responsibilities under TVA's policy is included, the governance documents fail to include specific potential mitigating actions and repercussions that will occur when risk management limits and policies are violated.

3.7 Analysis of Risk Metrics

As is addressed in various sections of this document, VaR, the primary metric which is used to quantify the risk associated with the FTP, is often an inadequate, primary risk metric for a power generation company such as TVA (see section 3.2.3.1 Risk Tolerance which addresses VaR and makes recommendations for other metrics which are more applicable to a company such as TVA). While TVA has improved its analysis of various risk metrics since the OIG published their report (as an example, see OIG Financial Trading Program Audit – Completed Recommendations Rev 1), TVA's most significant risk as it relates to the FTP, volumetric risk, is still not being addressed, analyzed or stress-tested in a fashion that meets industry best practices. While various aspects of this specific issue are addressed at length in subsequent sections of this report, industry best practices would dictate that TVA should not only analyze the FTP in isolation but also as part of a comprehensive cross-commodity portfolio, which would include all relevant risk metrics (i.e. market, volumetric, operational, liquidity and credit risk) for all relevant commodities (e.g., natural gas, coal, power, fuel oil) A portfolio analysis of this sort will provide TVA with a much more thorough and quantitative understanding of its portfolio risk, which would in turn allow it to better mitigate and manage volumetric risk. While such a task will require a significant commitment of both time and resources, it is a necessary undertaking if TVA desires to meet industry best practices. See section 3.17.2 Performance Measurements for more on this topic. In addition, as addressed in other sections of this document, in order to meet industry best practices, TVA needs to improve its overall risk analysis as it relates to the FTP.

3.8 Analysis of Trading and Hedging Strategies

From one perspective, the FTP's trading and hedging strategies, and the instruments used, have been appropriate and effective. A conservative strategy of a hedge ladder, akin to dollar cost averaging, is the most common hedge strategy pursued by consumer hedgers and is the primary non-discretionary hedge strategy of the FTP. The hedge ladder also serves as the primary limit structure for FTP hedge executions and positions (see document: TVA Financial Trading Program – Strategy 1072 REV8 5.11.11, Appendix A). TVA has avoided using exotic instruments, and has stayed with plain vanilla futures, swaps, call options, collars (fences) and synthetic calls.

From a more advanced perspective, and from a best practice perspective, several strategic aspects of the FTP are lacking. These include:

- Some discretionary trading strategies
- The choice of hedging instruments from the perspectives of:
    - TVA's creditworthiness

    - A lack of appropriate risk metrics and associated controls
    - The lack of determination of risk tolerance for liquidity risk
- A lack of appropriate hedge targets and a lack of suitable market instruments that result in a strategic and instrument mismatch due to the substantial volumetric uncertainty of the natural gas exposures being hedged.

3.8.1 Discretionary Strategies

Some discretionary strategies have been ineffective and inappropriate – one example of an ineffective strategy is the discretionary strategy to execute additional hedges at perceived attractive values when prices fell into lower deciles of a trailing long-term historical price range (see document: TVA Financial Trading Program – Strategy 1072 REV8 5.11.11, Appendix C). Although the strategy of executing more hedges when the market meets specific price targets is an accepted best practice strategy, the use of an eight-year look-back period in TVA's strategy did not allow sufficient responsiveness to new market fundamentals driven by the disruptive technology of fracking and the rapid switch to a fundamentally new and much lower price regime. The strategic approach is not fundamentally wrong, but a long eight-year look-back period muted sensitivity to more recent market developments, and the substantial quantities purchased based on this discretionary strategy exacerbated the margin/cash flow issue that prompted a reexamination of the FTP and the subsequently reduced size of the program.

An example of an inappropriate discretionary strategy is the Trend strategy (see: TVA Financial Trading Program – Strategy 1072 REV8 5.11.11, Appendix D). This strategy utilizes a trend following model whereby additional hedges could be executed when a positive trend of the market was identified. However, accumulating hedge positions based on positive trend identifications is not appropriate for a hedging program unless the trend-based hedge positions are liquidated when the trend turns lower. The sole value of a trend following methodology is that it has proven to be the most effective long term technical method for extracting value from a market provided that the underlying market moves in trends of significant duration and magnitude, and all signals from the trend following model are followed faithfully. Multiple studies have shown that the success rate of trend-following systems ranges from 25% to 40%, success being defined as the percentage of trades closed at a profit inclusive of transaction costs. The fact that such an approach is guaranteed to produce more losing closed trades than winning closed trades necessitates that any position initiated on a trend indication must be liquidated when the trend signal reverses (or upon the signal from a complimentary exit indicator), otherwise average losses will exceed average gains. The only way for a trend system to produce value over a large sample size of trades is for the lower probability average profit per trade to exceed the higher probability average loss by a

large multiple (usually greater than 3:1 at a minimum). Thus, the liquidation aspect of the system is at least of equal importance to the entry signals.

Given that the TVA program was never intended to speculate, that hedges were never intended to be liquidated prior to maturity, and that a successful trend-following approach mandates the liquidation of previously initiated positions, this strategy is antithetical to a conservative hedging intent and approach. Fortunately, according to information gained from interviews, this particular discretionary strategy is no longer part of the FTP, and its contribution to FTP results was apparently not material, but it is indicative of some of the non-best practice strategic thinking and design of the FTP.

3.8.2 Liquidity and Credit Issues

Another strategic issue is the use of exchange-traded instruments without the best practice support of metrics and controls for liquidity risk, and without regard to optimizing TVA's credit standing in the marketplace. Substantial margin calls for the FTP occurred in the past which evidently exceeded the implicit risk tolerance of TVA as evidenced by the concerns voiced by Treasury. The occurrence of negative cash settlements and margin calls is not a problem in and of itself. This is a typical occurrence at some point in the history of any consumer hedger. But the problem lies in the magnitude of the cash flows and margin calls if, and only if, that magnitude effectively exceeds the risk tolerance of the hedging organization. In TVA's case, sufficient risk measurement, monitoring, and controls were not in place, and TVA's improved understanding of its liquidity risk tolerance was gained via real-time experience, not through testing in advance and research into determining TVA's risk tolerance.

The heavy reliance on exchanged-traded futures did not allow TVA to take full advantage of its superior creditworthiness. Futures exchanges demand collateral of all market participants as if each participant is junk-rated. No positive discrimination exists with regard to creditworthiness (i.e., better credits allowed to post less margin/collateral than worse credits). Consequently, TVA's use of futures contracts forces it to post collateral (margin) when it could avoid doing so by using an instrument such as a swap with an almost identical payoff profile but without the exchanged-traded requirement to post substantial margin.

Lately, the strategic focus of the FTP has shifted to a greater reliance on OTC swaps. This offers the benefit of reduced margin funding requirements by taking into account TVA's superior credit status and taking advantage of the large lines of unsecured credit offered by numerous creditworthy counterparties.

But it also presents the challenge that the effective cost of fuel from OTC swap hedging is less transparent than with futures hedging. One of the unintended benefits of the use of futures is that brokerage account statements are regularly sent to hedgers, and the constant ebb and flow of margin cash flows makes the results of futures trading highly visible within an organization. Whereas the use of OTC swaps, when combined with large lines of credit, tends to make the net effective above-market cost in cases where market prices fall below the purchase level of swaps much less visible in an organization. This must be addressed through middle office reporting to ensure that the hedged cost of gas (via hedging with OTC swaps) versus the market price of gas is highly transparent within an organization.

3.8.3 Strategy and Hedging Instrument Mismatch

TVA's use of fixed-price, fixed-quantity instruments to hedge an exposure with substantial quantity uncertainty is also an issue. The potential displacement of coal versus gas in TVA's generation portfolio drives substantial variability in TVA's fuel use forecasts, and consequently leads to substantial uncertainty and variability in the FTP's hedge targets. Hedging a price exposure with an uncertain quantity through the use of fixed-quantity hedging instruments such as exchange-traded futures and OTC swaps is a mismatch. TVA's short physical natural gas exposure is a two-part exposure where each part should be hedged with different instruments and strategies. This concept is discussed in more detail in Section 3.13.1 Qualitative Evaluation.

3.9 Analysis of Trading Discretion

As noted in 3.1.1, the types and amounts of trading discretion given to the individuals responsible for executing the FTP's hedging transactions are similar to the discretion given to those in similar roles at other power generation companies and conform to standard industry practices.

3.10 Analysis of Trading Limits and Controls

The trading limits set for those managing the FTP and the related controls conform to industry standards.

3.11 Analysis of Credit Requirements and Controls

As discussed in multiple sections of this document, the FTP's credit requirements have changed substantially through the years. In earlier periods, exchange-traded futures contracts were a primary hedging instrument of the FTP and required substantial margin funding. This resulted in TVA not optimizing its strong creditworthiness. Recent increased use of OTC swaps has reduced the funding requirement.

The FTP has suffered from a lack of metrics and controls focused on liquidity risks. Substantial margin funding requirements in the past have become a concern of Treasury and other areas within TVA. To date, no stress testing, or margin/collateral at risk types of metrics, have been used to measure or subsequently control potential funding requirements.

TVA's credit risk policy was reviewed as part of this project (TVA Corporate Credit Policy TVA-SPP-13.38 dated 08-13-2010). The only reference in the document to credit limits is in section "3.2.1 Guiding Principals (*sic*) (7)": "Corporate will assign a limit or threshold based on TVA's internal assignment of the counterparty's credit rating …" No reference is made to an overall credit limit, to a portfolio credit metric or to a risk tolerance for credit risk, other than on an individual counterparty basis. Specific counterparty credit limits are not included in the policy, nor is there a reference to where the credit limits are maintained. In response to the initial findings of this review, another copy of the credit policy was provided by TVA (Credit Policy 10-06-03). This copy of the policy includes credit threshold limits/maximum credit exposure limits. However, the credit limits are only single values for each credit rating, whereas the preferred industry practice is to base credit limits/thresholds on some form of equity multiplier or other size adjustment linked to credit ratings in order to account for the relative financial size of counterparties, further subject to a maximum amount per credit rating.

A copy of the Commodity Counterparty Report dated 05-03-12 was provided as part of the documentation for this project. An examination of this report found no credit limits. In a response to the initial findings of this review, TVA provided additional credit documents including a counterparty exposure report with total credit exposures along with credit limits and collateral amounts. However, the additional counterparty credit reports do not include concentration limits.

3.12 Model and Data Analysis

While an in depth analysis of the models and data analysis utilized by TVA for the purposes of the managing the FTP is beyond the scope of this review, numerous related topics are addressed throughout this document.

3.13 Evaluation of the Effectiveness of the FTP

3.13.1 Qualitative Evaluation

From a narrow perspective, that of evaluating the effectiveness of the FTP in achieving its primary goal of volatility reduction (fuel cost uncertainty); the FTP has been somewhat effective. Hedge ladder compliance is a major focus and driver of Front Office activities, and from this perspective, the program has been effective. The Front Office has a strong history of hedge ladder compliance, and by some measures the program has achieved a reduction in fuel cost variability and uncertainty. However, a historical performance measure shows that the FTP hasn't achieved a reduction in fuel rate variability (see Section 3.13.2 Quantitative Evaluation below).

One important event that disrupted the general effectiveness of the FTP from the perspective of hedge ladder compliance was a senior management intervention of the program in 2009. According to information obtained from interviews, the rationale for the intervention was that market prices were several dollars per MMBtu below budget, and management wanted to lock-in below budget fuel costs. The directive was to "completely hedge out for as far as we can." This senior management override of the hedge ladder execution schedule resulted in a much larger hedge portfolio of long positions which led to increased margin requirements and which triggered TVA Treasury's concern regarding liquidity issues and margin funding requirements. Although adding hedge positions to lock in fuel prices below budget technically met TVA's risk management objectives of increasing the predictability of TVA's fuel cost adjustment and of providing rate stability, it also exacerbated TVA's challenge of managing a hedge portfolio with uncertain volume requirements. The issues of volumetric uncertainty and churn in the hedge portfolio are addressed further below in this section of the document.

From a broader perspective, assessing the effectiveness of the program is a murkier proposition. As noted elsewhere in this document, volatility reduction shouldn't be judged in isolation, but in the context of the costs incurred to achieve volatility reduction. Because a more comprehensive and accurate cost/benefit analysis has not been conducted, it is difficult to assess the effectiveness of the program even from a qualitative standpoint. The recently produced cost/benefit analysis is lacking. As noted

elsewhere in this document, the initial cost calculation is incomplete. And to properly report and gauge hedge effectiveness, the average price of the hedged portfolio should be presented along with unhedged market costs whenever volatility reduction is reported.

Another murky area is risk tolerance. Many load-serving entities must satisfy regulators, and in recent years regulators have become much more knowledgeable about hedging alternatives, both in terms of quality and quantity, and about prospective benefits and costs. This has led to specific hedging mandates, including such specifics as hedge durations, amounts of hedge coverage and market instruments (e.g., use of options), or to tacit approval of utility's hedge plans that include such specifics.

TVA is different than most load-serving utilities that hedge natural gas for power production because it does not have to satisfy a regulator. Despite the ability to pass through fuel costs, TVA has decided it should mitigate fuel cost variability on behalf of its rate payers. However, TVA has done little analysis to date to sample and determine the specific risk tolerance of rate payers, or to quantify even a general risk tolerance. Without developing a more concrete sense and quantitative measurement of the risk tolerance of rate payers, and by basing the size of the FTP (hedge quantities and hedge durations) heavily on benchmarking and peer data, it is highly possible that the objectives of the program and the financial results to date are not sufficiently effective. The objectives of the program include reducing fuel cost volatility (actually, the objective is phrased in governance documents as "increasing the predictability of the fuel cost adjustment") and providing low-cost rates. Is the program meeting the risk reduction objectives of rate payers while conforming to their risk tolerance and meeting their cost objectives? At present, this fundamental and essential question cannot be answered. Thus, the effectiveness of the program is difficult to gauge.

Lastly, hedge targets are substantially driven by the price level of natural gas and by power dispatch forecasts including fuel use forecasts. The dramatic reduction of gas prices over the last few years has radically affected the fuel mix of TVA's generation fleet because natural gas has displaced coal to a large extent. Switching back and forth between coal and natural gas drives substantial volumetric uncertainty around TVA's expected fuel burns. For example, interview responses indicated that at $4.00 per MMBtu, TVA's anticipated annual natural gas consumption for power generation would be approximately 70 Bcf, whereas at $2.50 per MMBtu, the anticipated consumption would be 200 Bcf – almost a 3-fold increase. The gas burn from one year's peak season to the next can easily vary by as much as 2-fold. The charts in Appendix C illustrate the challenges of variable natural gas forecasts.

This uncertainty drives tremendous volatility in the FTP's natural gas hedge targets. The uncertainty surrounding hydroelectric generation further exacerbates the variability of natural gas hedging targets. Churning of the hedge portfolio driven by hedge target variability undermines the effectiveness of the FTP and is a concern of TVA management.

In 2012, TVA management attempted to address this issue. It conducted an extensive analysis with the intention of revising the FTP natural gas hedging strategy to improve the program's effectiveness. The conclusions reached from the analysis led to a shortening of the forward hedging time horizon and a reduction of hedge ladder quantities.

However, the reduction in hedging term and volume will only reduce the ineffectiveness of the FTP – the reduction will not go far enough to solve the essential problem. In the July 31, 2012 Natural Gas Hedge Ladders Price Strategy Presentation in which TVA management proposed the reduced hedge ladder, among the conclusions reached are that the revised hedge ladder "takes advantage of embedded physical options" and "promotes effectiveness of hedge types." The reduced hedge ladder will only somewhat take advantage of TVA's natural physical embedded option.

The proposed solution and adjustment to the hedge ladder is labeled as the "Coal Adjustment," with the proposed "Physical Option Model" leading to a "-0.35 Bcf\year adjustment" in hedge volume. Although not without a modest benefit, this is an insufficiently effective single point static solution to a dynamic problem of constant variability.

The main culprit in the historical ineffectiveness of the FTP appears to be that the uncertain volumetric targets are being hedged with unsuitable instruments based on volumetric certainty, such as futures contracts and swaps. Hedging uncertain volumes with market instruments based on volumetric certainty is an instrument and strategic mismatch. Only by using options and option hedging strategies can TVA fully take advantage of the embedded physical optionality that drives hedge target uncertainty. Probabilistic and uncertain exposures should be hedged with market instruments whose effective exposures and values are a function of probability. Physical optionality is better hedged with options and option strategies rather than with the fixed-quantity instruments that are currently the mainstay of the FTP. Even if fixed-price instruments are used to synthetically mimic an option exposure (and it is crucial to remember that only option delta can be synthetically created – the essential and unique characteristic of options, gamma, cannot be synthetically replicated[1]), the quantities and portfolio adjustments should be directed by the precision of an option valuation model, not

[1] It is also crucial to remember that a synthetic option approach involves an implicit volatility position (long or short depending on the strategy), something that many hedgers often overlook, and which may be inherently antithetical to their risk management policy, strategic restrictions, and controls.

through haphazard adjustments driven by periodic updates to a load forecast and subsequently refreshed hedge targets.

From interview responses and presentations to the PROC that were reviewed for this project, it is evident that the FTP's hedge targets progressively increase as natural gas prices fall because the fuel use forecast shifts to less coal and more gas, and when natural gas prices rise, the hedge targets decline as the expected fuel burn shifts to more coal and less gas. Considering this exposure in abstract, TVA's physical short natural gas exposure is like a put. A put increases its exposure when prices fall (TVA's physical natural gas exposure increases as prices fall), and the effective exposure of a put declines when prices rise (TVA's physical natural gas exposure decreases as prices rise). In options parlance, TVA's short natural gas exposure is a negative delta, positive gamma exposure. TVA is hedging this uncertain, probabilistic exposure with fixed-price, fixed-quantity instruments (positive delta but zero gamma) – a mismatch. Without drilling down too far into option theory, many hedgers have a dangerous negative gamma exposure in that as market prices move in an adverse direction their exposure grows – a double whammy. TVA is fortunate in that it does not suffer from this problem – it is fortunate to have a positive gamma exposure on the short side of its book. As market prices move in an adverse direction, its exposure shrinks. The FTP would be much more effective if TVA incorporates this beneficial quality of its exposure into its hedge strategy and choice of hedging instruments.

Although measuring the degree of this variable exposure and researching and formulating a specific recommendation for improving and optimizing TVA's natural gas hedging strategies, is beyond the scope of this review, it is evident even without conducting a detailed analysis that the FTP would be more effective if the short position would be divided into two tranches. As illustrated in Appendix C, Figure 4, Dividing Hedge Targets into 2 Tranches, Tranche 1 would be a baseload exposure representing the minimum short exposure regardless of coal/gas displacement. In other words, the Tranche 1 target(s) would be the same regardless of the price of natural gas. Tranche 2 would be a variable exposure driven by coal/gas optionality.

Tranche 1 is what the current FTP is designed to hedge: a fixed volume exposure hedged with fixed-price, fixed-quantity instruments. The current FTP strategy and instruments should be quite effective in hedging the Tranche 1 risk. Tranche 2 should be hedged with instruments and strategies giving TVA flexibility regarding the effective hedge exposure. As the natural gas burn forecasts cycles up and down, the Tranche 2 hedges should cycle up and down to a degree based on hedge instruments and strategies that produce asymmetrical payoff profiles, not the fixed-quantity, symmetrical payoff profile of futures and swaps.

In effect, based on the current FTP strategy where hedges are liquidated when the hedge targets decrease, the hedge portfolio is being traded as a portfolio of synthetic short put options using a rudimentary approach. As an example, consider what happens to natural gas targets when natural gas prices move up and down. The lower the gas price, the higher the hedge target (based on a higher expected natural gas burn), leading to greater purchase quantities of futures and swaps, and the higher the gas price, the lower the hedge target (based on a higher expected coal burn) which drives a liquidation of futures and swap hedges.

Buying more fixed-price, fixed-quantity contracts as prices fall, thereby increasing the long position, and liquidating contracts as prices rise, thereby reducing the long position, synthetically replicates a portfolio of short put options. And worse yet is that the synthetic short put approach does not provide the benefit of option premium collection that would occur if TVA was selling puts. The effective exposure of a short put increases as prices fall, and decreases as prices rise. Adjustments to the long hedge position driven by changes to the burn forecast (as driven by price movements in natural gas) lead to the unintended but implicit effect of synthetically replicating a short put position, which is not a ”TVA Approved Option Technique.” (Financial Hedge – Strategy Sheet, Appendix E) A short put is not an effective hedge against rising prices. Short puts can play a role in a consumer hedger’s program as income enhancement trades to lower the cost basis of physical fuel purchases, but a short put approach should not be the main component of a long hedging program. This strategic mismatch leads to an ineffective hedge result.

In conclusion, volumetric variability, which drives unwitting synthetic short put replication in the hedge portfolio, is not being effectively addressed and undermines the effectiveness of the FTP that primarily uses straightforward fixed-price, fixed-quantity instruments such as futures and swaps.

3.13.2 Quantitative Evaluation

To date, the primary performance metric that could be used to quantitatively evaluate the effectiveness of the FTP has been volatility reduction. But as discussed in section 3.2.3.3 Performance Measurement, volatility reduction metrics, as currently constructed, are incomplete measures of performance. They show that fuel cost volatility reduction is being achieved for the current portfolio (but not on an historical basis), but without a corresponding measurement of the cost of achieving the reduced volatility. And without a quantitative measure of TVA’s (or the rate payers’) risk tolerance, and without the ability to evaluate the degree of volatility reduction relative

to the costs incurred to achieve it, it is difficult to render a useful quantitative evaluation of the effectiveness of the FTP.

Further, a performance metric called Fuel Rate Volatility ("FRV") has recently been introduced. Like the FCC and the FRC discussed above in Section 3.2.3.3 Performance Measurement, this metric shows the fuel rate volatility of the hedged and unhedged portfolios. However, the FRV metric is a look-back measurement of historical performance, whereas the FCC and the FRC are look-forward metrics based on the current hedge portfolio.

In the report as of the 4th quarter of 2012 (see Appendix B TVA Financial Hedging Program Indicators), the FRV shows that the reduction in the fuel rate volatility over the almost six year history of the FTP is zero, yet the report grades the FTP as "Effective."

It is an overstatement to quantitatively judge the FTP as "effective" given that TVA has expended substantial costs – costs that have never been properly calculated to date - and given that the FTP has exposed TVA to substantial liquidity risk, operational risk, and potential reputation risk, while not achieving its stated policy objective of reducing fuel rate volatility.

One aspect of the failure is explained in a footnote to the report: "In FY09 volatility is increased by hedging activities rather than decreased due to over-hedging as a result of higher than planned hydro generation. Excluding this period, the overall volatility would have been reduced 4% by hedging activities." It is important to note that the reported cause of the failure to achieve volatility reduction, uncertainty around hydro generation, which contributed to volatility not being reduced despite substantial hedging, reinforces the findings and conclusions of this review as discussed above in Section 3.13.1 Qualitative Evaluation. The failure has to do with the mismatch of the FTP's hedging strategies and the substantial volumetric uncertainty of TVA's physical exposure to natural gas price risk.

However, taking into account the 2009 hydro-related issue, 4% volatility reduction is not an effective result given the substantial natural gas hedge quantities of the FTP. Examining the hedge ladder illustrated in Appendix A of the Financial Hedge – Strategy Sheet, the "Disciplined Hedging" hedge target minimums equal approximately 30% hedge coverage on average over a 60 month hedging horizon, and 50% across the first 12 months. Ideally, because of hedging with fixed-price, fixed-quantity instruments which reduce price volatility by 100% for every volumetric unit hedged, a hedge program in steady-state operation with approximately 30% to 50% hedge coverage should achieve a commensurate 30% to 50% reduction of volatility, not 4%.

However, taking into account the 2009 hydro-related issue, 4% volatility reduction is not an effective result given the substantial natural gas hedge quantities of the FTP. Because a volatility reduction metric is not available that measures the historical volatility reduction of natural gas hedging only, it is difficult to assess the exact contribution to fuel rate volatility reduction due to natural gas hedging. But it is surprising to find very little volatility reduction on an historical basis given the substantial quantity of natural gas that has been hedged as evidenced in Appendix A of the Financial Hedge – Strategy Sheet.

3.13.3 Assessment of the Management Style of the FTP

As noted in section 3.2.3 Best Practices at TVA, TVA's trading and risk management organizational structure, including senior management risk committees, a Front Office, a Middle Office, and a Back Office, and an independent credit risk management function; a clearly stated objective for risk management, an articulated hedge strategy with clearly defined hedge targets; an appropriate risk information system of record; and clearly defined limits and controls meet industry standards.

The management style of the FTP is similar to that of other power producers and consumer hedgers and generally conforms to industry standards. However, as noted in other sections of this report, one of the major deficiencies of the FTP is that the performance metrics being calculated at the behest of the OIG are occurring in the Front Office rather than the Back Office.

As noted in 3.13.1, management intervention of the nature stated is of particular concern.

While it is not uncommon for senior management to make emotional hedging and/or trading recommendations, especially in highly volatile market conditions such as the natural gas market from 2007-2009, such actions certainly violate industry best practices and often lead to undesirable results, as has been well documented in numerous cases such as the events which ultimately led to bankruptcies of SemGroup and MF Global, among others.

The subsequent creation of the Portfolio Risk Oversight Committee (see Portfolio Risk Oversight Committee Charter, FSO-SPP-01.1) is a very positive development and should be utilized to the fullest extent allowed by the charter.

3.14 Value at Risk Review

3.14.1 The Misapplication of VaR at TVA

To date, TVA has applied VaR as if it is measuring the potential loss on a derivative speculative portfolio. As noted in 3.2.1 Sources of Best Practices, VaR first hit the stage as a recommended best practice in the G30's seminal report "Derivatives: Practices and Principles" published in 1993, and was originally intended as a new and more comprehensive metric to measure the risk of derivatives speculative portfolios. Although TVA does not speculate, it has been measuring the value at risk of a portfolio comprised of hedge positions only, which is the traditional application of VaR for a speculative book. Unless VaR is applied to a portfolio of only hedge positions as a type of "at risk" metric for calculating potential margin calls, this application of VaR provides no value to TVA.

As noted in Section 3.2.3 Best Practices at TVA, TVA should reconfigure its VaR calculation to include the physical exposures being hedged. This would transform the metric into a fuel cost at risk metric, which would be much more useful for TVA.

As noted elsewhere in this document, fuel cost stochastic modeling conducted by Systems Planning is similar to this recommended approach.

3.14.2 Analysis of How VaR Drives Trading Activities

As currently configured, VaR does not drive TVA's trading activities. Interview responses for this project indicated that the limit placed on VaR (which is now up to $90 million for the FTP) was arbitrarily established by the former Chief Risk Officer. TVA's VaR for the natural gas FTP fluctuates far below the $90 million VaR limit, and consequently VaR does not affect how the program is managed or controlled.

3.14.3 Analysis of VaR Calculation Methodology

Although an in-depth examination of TVA's VaR calculation methodology was not part of this project, interview responses and an analysis of documents indicates that TVA's VaR model was recently changed to a Monte Carlo simulation approach from the original variance/covariance analytical approach. A Monte Carlo simulation model allows for capturing the effects of non-linear portfolio exposures (i.e., options) and in theory will report a more accurate VaR for a portfolio with substantial non-linear exposures. Further, a Monte Carlo simulation model allows for the introduction of volumetric

variability, and given the huge variability in TVA's portfolio due to the potential coal versus natural gas displacement for its generation fleet, the ability to incorporate volumetric uncertainty in "at risk" metrics would be very important.

3.14.4 Analysis of How Options and Volumetric Uncertainty are Treated in VaR Models

Through interview responses and the review of documents, as noted in Section 3.14.3 "Analysis of VaR Calculation Methodology" above, TVA recently improved its VaR model to a Monte Carlo simulation approach to take into account the influence of non-linear exposures (i.e., options). Although a Monte Carlo simulation allows for volumetric uncertainty, adjusting VaR for volumetric uncertainty is not a common practice in the energy industry and there was no indication it is in TVA's future plans. Incorporating volumetric uncertainty in a Monte Carlo simulation VaR model would not be a trivial undertaking.

3.14.5 Analysis of Data Sourcing and Processing

Interviews indicate that TVA is meeting industry best practices with respect to data sourcing and processing via its utilization of the Commodity XL ETRM (energy trading and risk management) platform, an industry leading platform. In addition, the platform receives data feeds from industry standard vendors such as Platts. However, interviews also indicated that has yet to take full advantage of all of Commodity XL's modules and functionality, which once fully utilized, would provide it with the ability to conduct comprehensive cross-commodity analysis as mentioned in other sections of this report. In addition, it would be ideal if TVA's other relevant systems (i.e. GenMan) are integrated with Commodity XL so that all relevant commodity risk management data can be maintained and analyzed within one "master" system.

3.14.6 Backtesting/Validation

As noted in 3.14.1, while TVA does conduct VaR analysis, at present it is misapplied because it calculates the VaR of the hedge position only. As such it is inappropriate to address the accuracy of the VaR analysis. In addition, TVA has begun modeling fuel cost certainty and produces a metric that is similar to the VaR of a hedged portfolio (inclusive of hedges and the exposures being hedged). While the development of such a metric is certainly a positive development, analysis of this metric with respect to backtesting and/or validation is beyond the scope of this review. For more on this subject see section 3.2.3.1 Risk Tolerance.

3.15 Additional Risk Metrics

A quasi risk metric, used as the primary basis for controlling trading activities, is measurement and adherence to hedge targets.

3.16 Additional Commodities

As has been addressed in several other sections of this report, for TVA to have the ability to better analyze and understand the risk associated with the FTP, the FTP should not only be analyzed in isolation but also as part of a cross-commodity portfolio which incorporation additional commodities such as coal and fuel oil. Furthermore, said analysis should include not only TVA's financial positions but physical positions as well as physical and financial positions can and often do offset one another.

3.17 TVA Management's Actions & Response to the OIG's Recommendations

An additional part of the scope for this project was to review and assess TVA management's actions and response to the recommendations included in the OIG's review of the FTP, entitled "Audit 2011 -14477 – REVIEW OF TVA'S FINANCIAL TRADING PROGRAM", dated September 28, 2012. The recommendations covered four broad areas, including:

1) A comprehensive cost/benefit analysis of the FTP.
2) Calculating performance metrics.
3) Monthly VaR backtesting.
4) Improve communication of the FTP performance with customers.

The scope for this project included a particular focus on the cost/benefit analysis and on performance metrics, although the other two points listed above will be addressed briefly.

For this project, management's responses have been assessed through interview findings and by reviewing management's response document entitled "OIG FINANCIAL TRADING PROGRAM AUDIT – COMPLETED RECOMMENDATIONS rev. 1."

3.17.1 Operational Risk, Reputational Risk, Cost/Benefit Analysis

TVA management provided a point by point response to the OIG's recommendations (see OIG Financial Trading Program Audit – Completed Recommendations rev. 1). In

addition to the cost/benefit analysis recommended by the OIG, TVA management committed to performing a qualitative assessment of operational risk and reputational risk, an assessment of counterparty risk, and an assessment of collateral/margin posting risk. These assessments were to be performed separately from the cost/benefit analysis.

In reviewing TVA management's response document, it does not appear that management responded with an assessment of operational risk or of reputational risk. In their response document, they restated the OIG's recommendations and then add the following response: "Perform a qualitative assessment of operational risks with respect to existing control processes. Conduct a qualitative review of potential reputational risk. These evaluations will be made separately from the natural gas price risk C/B analysis."): 'Action: See attached report to be distributed annually to quantify the costs and benefits associated with the Financial Hedging Program.'" No mention was made in TVA management's response document of addressing the operational risk assessment, nor the reputational risk assessment.

Reviewing the assessments of counterparty risk and of collateral/margin posting risk was not part of the scope of this project. However, a review of the cost/benefit analysis was included in the scope.

The cost components included in the cost/benefit analysis are lacking. There are many more costs that should be considered beyond the software costs and, administrative/overhead costs which are included in TVA management's cost/benefit analysis. And the cost summaries that were included have no reference to the individual cost components that make up each cost category. Software costs are listed as a single line item, as well as administrative costs for the Front, Middle, and Back offices. No details of individual costs within these categories were included. The cost elements that should be included in a cost/benefit analysis are discussed in Section 3.2.3.3 Performance Measurement.

3.17.2 Performance Measurements

As quoted in TVA management's response document, the OIG's second recommendation was to "Develop and implement performance metrics that specifically measure the objective of the FTP, which is FCA price volatility mitigation." In response, TVA developed three performance metrics. Two of the metrics are look-forward measures of volatility reduction (the Fuel Rate Certainty and Fuel Cost Certainty metrics), and the other metric is an historical look-back metric to measure how much volatility reduction has been achieved (the Fuel Rate Volatility metric). All three are good initial attempts to develop performance metrics, but each should be improved. The look-back indicator appears to meet industry standards for such metrics although

the report for the indicator fails to disclose sufficient details about the calculation, and fails to present sufficient quantitative detail. The two look-forward metrics appear to meet the objective of measuring potential volatility reduction, but need to go further to incorporate the volumetric uncertainty that has plagued the FTP to date and to calculate the effective cost of the volatility reduction. This is discussed in more detail in Section 3.2.3.3 Performance Measurement.

3.17.3 VaR Analysis

While TVA does conduct VaR analysis, at present it is misapplied because it calculates the VaR of the hedge position only, as if it were a speculative derivatives portfolio, and the current limit on VaR is so far above TVA's actual day to day VaR exposure as to have no bearing on day to day management or outcomes of the program. However, TVA has begun modeling fuel cost certainty and produces a metric that is similar to the VaR of a hedged portfolio (inclusive of hedges and the exposures being hedged). This is a beneficial development and can be used in risk tolerance determination.

3.17.4 Improve Communication of the FTP with Customers

Interview responses for this project indicate that initiatives are underway to improve communications with ratepayers about the FTP. Preferably, this would include gathering information from the ratepayers that could be used in a more formal risk tolerance process that would in turn better define the hedging mission and hedge quantities for the FTP. The issue of risk tolerance has been addressed in several subsections of Section 3.1 High Level Overview of the FTP and Overall Objectives, Section 3.2.3.1 Risk Tolerance, and in Conclusions.

4.0 Conclusions

Although the scope of this project involved an overall review of TVA's FTP, the OIG was particularly interested in the issues of a cost/benefit analysis of the FTP, including an appropriate calculation of program costs and an accurate assessment of program benefits.

TVA's initial attempt to calculate a cost/benefit analysis is lacking. Many more costs should be included in the cost/benefit calculation. There are two types of costs that should be calculated, and they should be evaluated separately and together. The first is any cost that has been incurred resulting from operating the FTP. In other words, it should include all costs that would not be incurred if TVA was not operating a financial

hedging program. The second type is to calculate the effective cost of natural gas inclusive of hedge results. TVA is calculating this cost but it is not being compared to the benefits of the program.

TVA has made a good initial effort in calculating the performance and benefits of the FTP, including the look-forward metrics of the FCC and the FRC, and FRV, a look-back metric. The effective cost of natural gas versus the market cost can be implied by TVA's calculation of the FCC and the FRC. This cost differential should be explicitly reported and compared to the amount of fuel cost certainty being achieved. Performance metrics should be improved through greater explanations of the metrics, and by measuring the performance of discrete components of the FTP (e.g., gas hedging, coal hedging, purchased power).

A related topic to the measurement of benefits is an assessment of the effectiveness of the FTP. From a simplistic perspective, that of adhering to the simple objectives of TVA's commodity risk management policy, the FTP can be considered effective. The sole means of measurement from this perspective is adherence to the hedge ladder.

But considered in a broader sense, the benefits and effectiveness of the FTP have been questionable. The historical perspective of the FRV performance metric shows that through the program's history it has not achieved any reduction in fuel cost uncertainty (volatility) – see the FRV report in Appendix B TVA Financial Hedging Program Indicators. Even on an individual year by year comparison, the FRV metric shows that fuel rate volatility reduction has been modest at best, and is very low relative to the amount of hedge coverage of the program.

With regard to risk tolerance, the size of the program (i.e., the amount of hedge coverage and the hedging horizon) was selected based on benchmark data and data from peer comparisons, not through a determination of TVA's risk tolerance or the rate payers' risk tolerance. Determining rate payer risk tolerance is not a trivial or easy task to accomplish. However, the authors of this report have been involved in projects for regulated and self-regulated utilities where risk tolerance has been quantified by sampling senior management or through conducting surveys of rate payers.

From a best practice perspective, several aspects of the FTP are lacking. The only reference to risk tolerance in the policy, or in the operation of the program, focuses on adherence to the volumetric limits of the hedge ladder. TVA has been sensitive to the magnitude of past margin requirements for maintaining exchange-traded hedge positions, yet apparently it did not conduct an analysis to determine its liquidity risk tolerance threshold prior to or during the operation of the program. Individual counterparty credit limits are mentioned in the credit risk management policy, but the

actual limits do not appear in any program-related documents, and the spreadsheet that reports credit exposures does not have any limits listed. It is a best practice to quantify risk tolerance through at least one measure of financial performance, and at present TVA is not doing so. And the best way to "size" a hedging program is to determine how much hedge coverage is necessary to reduce risk to below that of the risk tolerance program. This is not how TVA determined the size of the FTP.

As previously discussed, while TVA does conduct VaR analysis, at present it is misapplied because it calculates the VaR of the hedge position only. In addition, the current VaR limit on VaR exceeds actual day to day VaR exposure but such a magnitude that it has no impact on the FTP. However, TVA has begun modeling fuel cost certainty, which includes hedges and the exposures being hedged, and is a very meaningful metric with respect to TVA's risk tolerance and analysis.

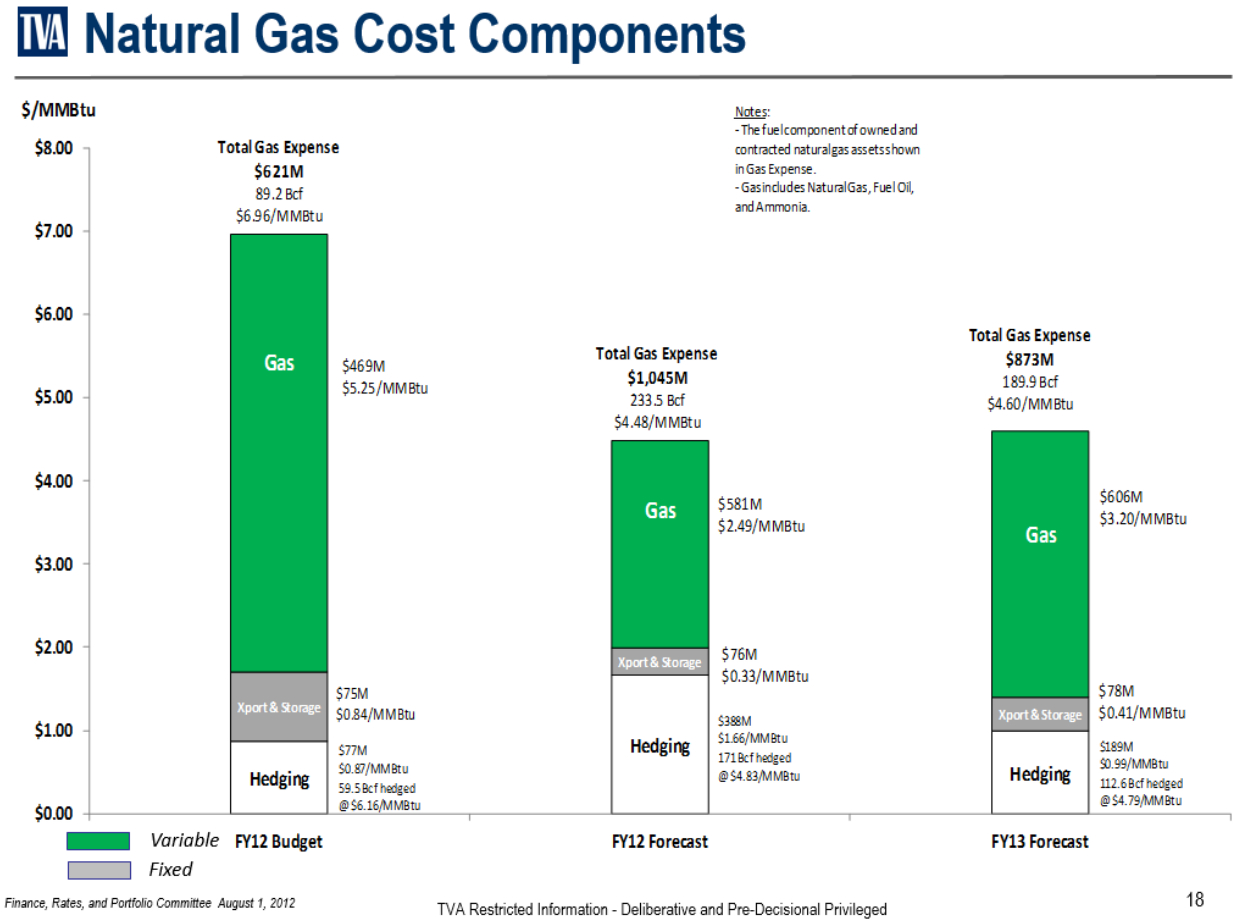
Despite multiple references to stress testing in the policy document and the procedures document, stress testing is not being conducted. This could also be used to test and inform risk tolerance discovery and determination. As noted above, there appears to be some confusion regarding the language in the policy and procedures documents on this point. TVA indicates that governance documents have been revised to reflect current practices. In addition, it should be noted that stress testing could also be used to test and inform risk tolerance discovery and determination.

Hedge effectiveness could be improved by modifying the hedge strategy and the choice of hedging instruments. At present there is a material mismatch between hedge instruments and TVA's price risk exposure to physical natural gas requirements. TVA has substantial volumetric uncertainty in its fuel burns and this translates into substantial uncertainty in the FTP's hedge targets. However, these exposures are being hedged with volumetrically certain instruments. The mismatch leads to a churning of the hedge portfolio which increases costs, and undermines volatility reduction and hedge effectiveness.

It is important to note that the new performance metrics being calculated at the behest of the OIG are being prepared by the Front Office. This violates best practice separation of duties. Although most Front Offices prefer to keep track of their performance, official performance metrics and reports should be the responsibility of the Middle Office.

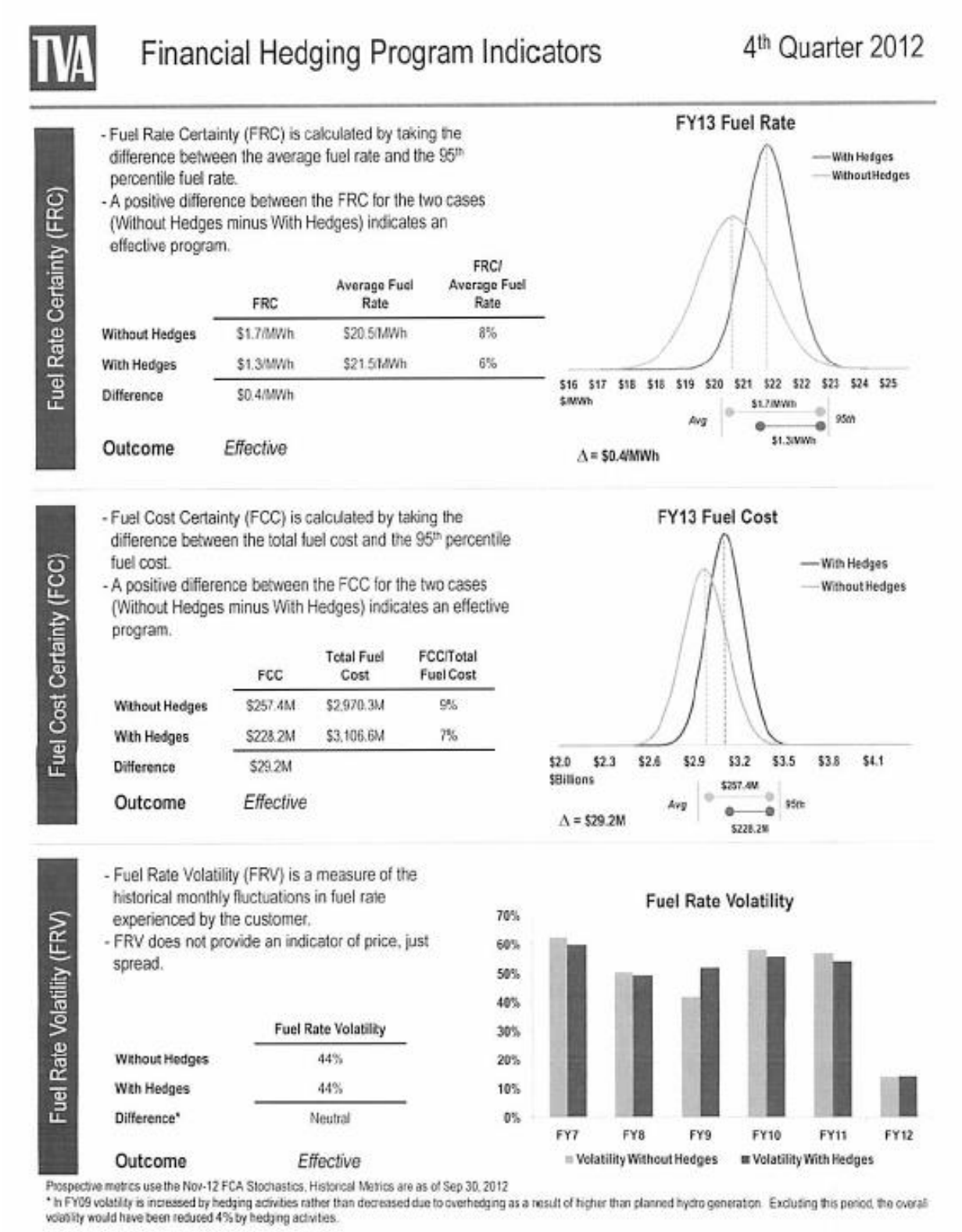
Appendix A.

Natural Gas Cost Components. Source: FY13 Fuel and Purchased Power Contracting Plan



Appendix B.

TVA Financial Hedging Program Indicators



Appendix B. (continued)

TVA Financial Hedging Program Indicators

Financial Hedging Program Indicators

Definitions

- Fuel Rate Certainty (FRC): One goal of an effective hedging program is to reduce the range of unfavorable potential outcomes for the fuel rate. FRC is the distance between the average fuel rate and the 95th percentile fuel rate, calculated with and without hedges. If there is a positive difference between the portfolio without hedges and the portfolio with hedges the program has reduced the range of unfavorable outcomes and is therefore effective.

  FRC Reduced = [95th Percentile Fuel Rate Without Hedges – Average Fuel Rate Without Hedges] - [95th Percentile Fuel Rate With Hedges – Average Fuel Rate With Hedges]

- Fuel Cost Certainty (FCC): FCC intends to quantify the potential unfavorable variance from the planned annual fuel cost in the future. One goal of an effective hedging program is to reduce the range of unfavorable potential outcomes for the fuel cost. FCC is the distance between the total annual fuel cost and the 95th percentile annual fuel cost, calculated with and without hedges. If there is a positive difference between the portfolio without hedges and the portfolio with hedges the program has reduced the range of unfavorable outcomes and is therefore effective.

  FCC Reduced = [Average Fuel Cost With Hedges – 95th Percentile Fuel Cost With Hedges] – [Average Fuel Cost Without Hedges – 95th Percentile Fuel Cost Without Hedges]

- Fuel Rate Volatility (FRV): FRV intends to quantify the historical impact to variability on customer rates. The fuel rate fluctuates monthly and the hedging program intends to mitigate these monthly fluctuations. FRV indicates the range of the monthly changes in each individual year (not range or magnitude of the fuel rates themselves). This is calculated using the annualized monthly volatility:

  *FRV = σ(monthly returns) * √12.*

Appendix C.

Figure 1: Gas Price Sensitivity. Source: TVA's FY13 Fuel and Purchased Power Contracting Plan

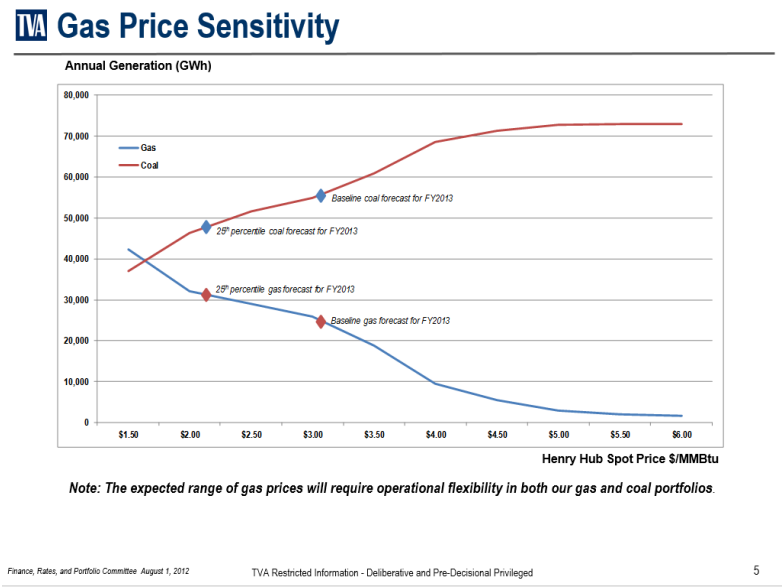
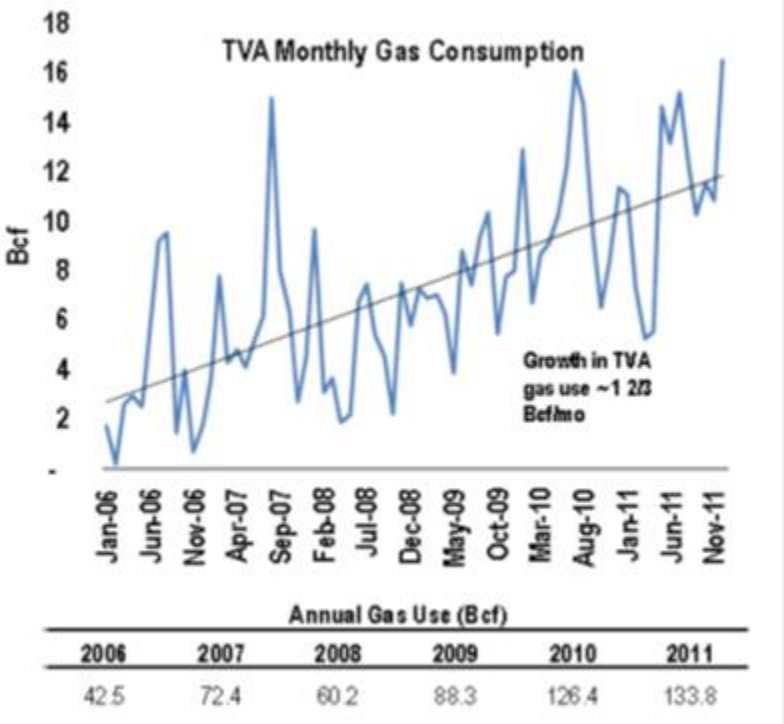


Figure 2: TVA Monthly Gas Consumption.



Appendix C. (continued)

Figure 3: Gas Hedge Reduction Bcf Based on Coal "Natural Hedge." Source: July 31, 2012 Natural Gas Hedge Ladders Price Strategy Presentation.

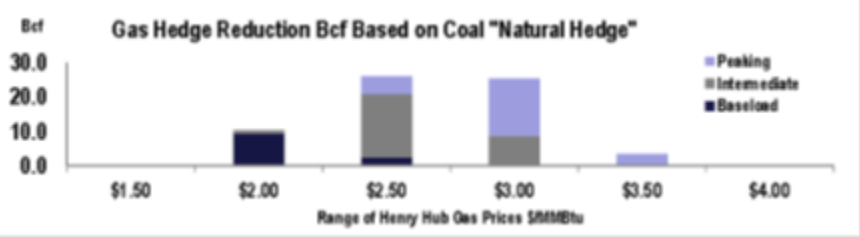


Figure 4: Dividing Hedge Targets into Two Tranches. Source: Mercatus Energy Advisors.

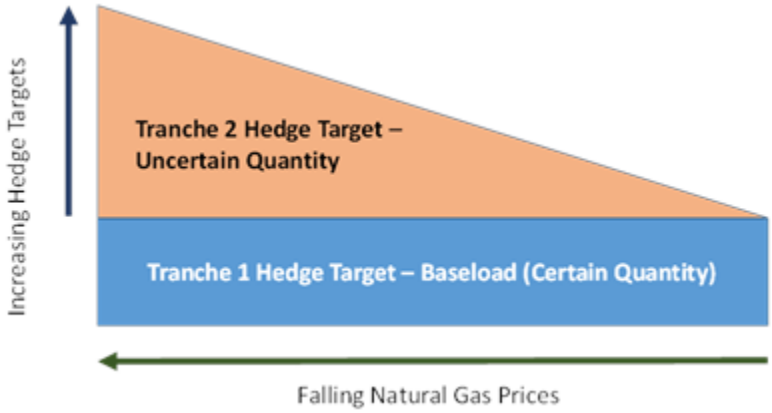


Figure 4 is only an example; it is not intended to illustrate a specific strategy which should be employed by TVA.

Appendix D.

Michael R. Corley

Michael Corley is the founder and president of Mercatus Energy Advisors, a Houston based energy trading and risk management advisory firm. In this role Mr. Corley leads the day to day operations of the firm as well as client engagements.

As of late, the client engagements Mr. Corley has lead have focused on the review and assessment of energy risk management programs; development of hedging and risk management policies; origination, implementation and management of energy hedging and risk management strategies; energy trading and risk system selection and structuring illiquid transactions. These engagements have involved clients in numerous industries including airlines, cruise lines, energy marketers, energy utilities, manufacturers and oil & gas producers, among others.

Prior to founding Mercatus Energy Advisors and its predecessor, EnRisk Partners, Mr. Corley led the natural gas liquids and refined products trading and risk management group at Asset Risk Management. Previously, Mr. Corley was an account executive with Hedge Solutions during which time he provided energy risk management consulting solutions and marketed energy derivatives to clients in various industries.

Prior to transitioning to energy trading and risk management consulting, Mr. Corley was an independent energy trader, during which time he traded crude oil and natural gas futures and options. Earlier in his career, Mr. Corley was a natural gas derivatives broker with TradeSpark, the former energy trading subsidiary of Cantor Fitzgerald. While with TradeSpark he also served as a natural gas hedging consultant to Peoples Energy Resources.

Mr. Corley began his career at El Paso Merchant Energy where he held various positions in trading, scheduling and quantitative analysis; covering crude oil, electricity, natural gas, natural gas liquids and refined products. While at El Paso, Mr. Corley also served as a natural gas trading consultant to Gasoductos de Chihuahua, a midstream joint venture between El Paso Energy International and Pemex Gas y Petrochimica Basica. In addition, Mr. Corley was a member of the team that developed and implemented El Paso's proprietary trading and risk management system.

Mr. Corley regularly leads educational seminars, training sessions and academic lectures on various aspects of energy hedging, trading and risk management to a wide range of audiences across the globe.

Mr. Corley earned a B.A. from The University of Oklahoma. He is also registered with the Commodity Futures Trading Commission (CFTC) and the National Futures Association (NFA) as a principal of a Commodity Trading Advisor (CTA).

Appendix D. (continued)

Larry G. Lawrence

Mr. Lawrence is a senior consultant with Mercatus Energy Advisors. Mr. Lawrence has over 25 years of experience in trading, risk management and compliance. His experience includes financial trading in energy, foreign exchange, fixed income and equity markets; consulting for risk management, compliance, and trading issues; derivatives portfolio management; technical and options analysis; and corporate education.

In recent years Mr. Lawrence has led numerous engagements with electricity generation companies and energy trading and marketing companies regarding the review and assessment of natural gas and electricity trading and risk management programs; development of compliance and risk management policies; and energy trading and risk system selection and implementation.

Mr. Lawrence has extensive experience in compliance, trading, and risk management implementation. His experience includes the review and assessment of risk management programs; compliance reviews, program design and implementation; the development of trading and risk management policies, procedures, and control structures; credit risk management; hedge strategy modeling, development, and optimization; value at risk assessment and implementation; performance measurement; trading and risk system selection and implementation; transaction structuring; tactical trading assistance; real option valuation and modeling; and the development of forward price curves and term structures of volatility.

Mr. Lawrence lectures extensively in North America, Europe, Asia, and Africa on trading, risk management and compliance issues to audiences including senior executives, government representatives, front, middle, and back office personnel, and compliance personal from financial institutions, sovereign energy entities, multinational energy companies, government agencies, and a variety of regulated entities.

Prior to founding Enterprise Risk Consulting, Mr. Lawrence was a principal of Teknecon Energy Risk Advisors, an energy trading and risk management consulting firm. Previously, Mr. Lawrence was an energy trading consultant and corporate trainer with Saladin, an energy trading and risk management software provider. Earlier in his career, Mr. Lawrence was the president of Eastbrook Futures, an institutional futures brokerage firm. Prior to joining Eastbrook Futures, Mr. Lawrence held various roles in brokerage, trading and technical analysis with Merrill Lynch, Elders Futures and GPR. Mr. Lawrence began his career with at Murfield Commodities where he was an institutional futures and options broker.

Mr. Lawrence earned a B.S. from The University of Texas at Austin. He is also registered with the Commodity Futures Trading Commission (CFTC) and the National Futures Association (NFA) as a principal of a Commodity Trading Advisor (CTA).

TVA Management Responses to OIG Report 2011-1447-01

Subject: TVA Management responses to OIG report 2011-14477-01 (issued 3/3/2014)

Recipient(s): Office of the Inspector General c/o David Wheeler

Introduction

TVA has reviewed the report issued by the OIG and their contractor, Mercatus Energy Advisors (Mercatus). We are providing the responses to the "Recommendations" (section 2.0) and the "Findings" in the Executive Summary (section 2.1) and believe that many of these recommendations will add to our continuous efforts to improve our efficiency and effectiveness. If we have another view or an alternative approach to meet the objective of the recommendation, we have proposed that for your consideration. Additional clarification for items included in the detailed report (section 3) is provided in Appendix A.

As outlined in section 1.2, the scope of the review included the analysis of approximately 150 documents gathered by the OIG from their previous audit dated September 28, 2012 and any additional data requests made by Mercatus. TVA made its best efforts to provide Mercatus the information they requested based on our understanding of the scope their review. Mercatus also interviewed nine TVA personnel in the July/August 2013 timeframe. However, there were no additional discussions between Mercatus and TVA personnel until December 2013 when a meeting was held to review the summary recommendations with the OIG, Mercatus, and TVA. As a result, this limited contact between TVA and Mercatus during the review. There were several facts and findings that TVA will attempt to clarify as part of this response. In addition, as part of our continuous improvement efforts, several changes were made to TVA's hedging program in the past six months that were not included in the scope of the Mercatus review. These changes are congruent with the direction provided by the Finance, Rates and Portfolio committee (FRP).

Highlighted activities include:

- Revised Fuel and Purchased Power Risk Guidelines were issued in November 2013 to replace the existing Commodity Risk Policy.
- Discussions at the Board Committee level around the hedging program in October and December 2013 to further explain the approach and discussed fuel rate risk tolerance.
- During the agency-wide reorganization analytical functions such as performance metrics and system planning were moved from the front office to Enterprise Planning. In addition, middle office now performs all risk monitoring.
- Under the TVA's newly implemented GOES model, the Governance for hedging activities has been transferred from front office to Enterprise Planning.
- Purchased a robust risk analytics solution with an expected implementation during FY14.
- In January 2014, a streamlined approach to governance over natural gas hedging was approved by the Executive Management Committee (EMC) and reviewed by the FRP which will greatly reduce the rebalancing of the portfolio.

We appreciate your continued collaboration and the opportunity to submit this response and action plans which align with the suggested recommendations for your consideration. TVA is committed to continuous improvement efforts and upon your approval, these responses will become the basis of TVA's action plan.

Responses (per the numbering schema in report section "Recommendations")

1) **Determine Tolerance and Proper Size of FTP Risk**

a. In order to determine the appropriate risk tolerance for the FTP, TVA should undertake a formal process to sample the risk tolerance of ratepayers. If this is deemed unfeasible, TVA should utilize internal resources to quantify, as best as possible, the risk tolerance of ratepayers.

b. Once TVA has determined the risk tolerance of ratepayers, it should re-size the FTP to match no less than one quantified measure of risk tolerance. The size of the FTP (amount of hedge coverage and the time horizon for hedging) should be determined by the amount of hedging required to reduce risk within the risk tolerance parameter(s) as defined by the risk tolerance determination process.

Action Plan

a) TVA agrees with the need to determine appropriate risk tolerances. However, prior to specifically looking at risk tolerance for financial hedging, it is important to articulate our risk tolerance for total fuel cost risk and impact on customer rates. To do that, we will look at the drivers of total fuel cost risk and tools (financial derivatives, physical fixed price transactions, inventory/storage optimization, and TVA generation assets) that are most appropriate for managing that risk. TVA will then determine the appropriate risk tolerance and rate impacts for hedging total fuel cost exposure. TVA will align the program to the principles issued by the Board of Directors and TVA's management team to ensure we are meeting the needs of our customers and stakeholders.

Action plan date - September 30, 2014

Action Plan

b) If financial hedging is deemed an appropriate risk management tool, TVA agrees with the recommendation to re-size the use of financial derivatives to the tolerances that allow the program to achieve the most effective risk reduction as part of a natural gas price hedging program. Over the past two years TVA has resized the price hedging program twice as Executive Management's risk tolerance levels have evolved. The most recent resizing of the program occurred in January 2014. Quantified risk tolerance measures that TVA will consider include fuel cost risk (volumetric and price), liquidity risk, and credit risk.

Action plan date - September 30, 2014

2) **Address and Communicate Volumetric Risk**

TVA's volumetric risk (the varying volume due to switching between coal and natural gas) needs to be properly analyzed and well communicated between the various stakeholders who have a vested interest in this aspect of the FTP. This is crucial given the significance of TVA's volumetric risk. This effort should include the development of a formal process for analyzing TVA's volumetric risk, on a regular and consistent basis, and should be a joint effort between

the front office and the generation planning group. Furthermore, the results of this undertaking need to be well communicated to all necessary parties on a regular basis.

Action Plan

As discussed in the recommendation, TVA is subject to significant volumetric risk when calculating the expected usage of natural gas and coal. While forecasted fuel burns used for hedging (which are based on around normal weather, normal load, expected hydro output, and expected forced outage rates among other things) are especially impacted by the ability to switch between natural gas and coal generation facilities, actual fuel costs can be greatly impacted by other volumetric risks. Volumetric risk in the operating month is influenced by generation performance, load variations, weather, system reliability, hydro availability, et cetera. We agree with the recommendation to address and communicate volumetric risk and the impacts / limitations on a price hedging program. We will continue to analyze this risk profile and effectively communicate the positions across the enterprise. With TVA's recent organizational realignment, organization design principles and segregation of duties (front/middle/back offices) should facilitate a more effective communication process.

Action plan date - September 30, 2014

3) **Redesign Hedging Strategies**

TVA should redesign the hedging strategies it employs to better match the characteristics of the exposures which are being hedged via the FTP. The natural optionality of TVA's exposure to natural gas should be taken in account, as well as advantage of, during the strategy redesign process. The quantities to be hedged should be divided between baseload and variable quantities. The baseload quantities can be hedged fixed-price, fixed-quantity instruments such as futures and swaps would be optimal for hedging. The variable quantities should be hedged with options and perhaps even a variety of option strategies. In addition, TVA could develop a hedge optimization model which would determine, quantitatively, an optimal mix of fixed price instruments (i.e. futures) as well as options, to be utilized in order to meet quantified risk reduction targets.

Action Plan

TVA has recently discussed the concept recommended in your report and is analyzing the price risk profile for base load and intermediate/peaking assets. TVA agrees that base load risk is best addressed utilizing swap instruments. TVA also understands that the fleet's ability to switch between coal and natural gas assets gives management the option to choose the most economic generation. We will continue to study how to manage the intermediate/peaking risk and are considering utilizing physical instruments, financial instruments and the operating assets to manage this risk most effectively.

Action plan date - November 30, 2014

4) **Improve and Consolidate Performance Reports**

As previous addressed, the hedge effectiveness of the FTP is not being reported currently i.e. volatility reduction as measured by the FRV (fuel rate volatility) metric is being reported as being effective when this is not the case. Little to no reduction in volatility cannot be considered effective given the exposures TVA is exposed to via the FTP (e.g. operational risk, credit risk, liquidity risk) and the costs expended to achieve these results. Furthermore, TVA has developed multiple volatility reduction performance metrics yet none were, to our knowledge, provided to the OIG during their recent audit of the FTP. In addition, the performance metrics produced by the Front Office in response to the OIG's recommendation differ from those produced by other functions within TVA and presented to the PROC. All interested parties should cooperate to produce a set of performance metrics that can be used by all functions related to trading and risk management. Lastly, TVA should develop a historical volatility reduction metric specific to natural gas hedging given that natural gas is the largest part of the FTP (as indicated by the FTP) being granted the majority of TVA's Value at Risk capacity.

Action Plan

TVA agrees with the recommendation to improve and consolidate performance reports for monitoring fuel costs and associated risks. Similar to the response in recommendation two, organization design principles established in TVA's recent organization realignment should facilitate a more effective communication process. We will examine the effectiveness of the risk measures currently reported and streamline the front- and middle-office reporting so that there is one official version of reporting metrics.

Regarding the Fuel Rate Volatility (FRV), this measure was not intended to measure the effectiveness of volatility reduction from hedging. Rather, it measured the month-to-month volatility in rates to customers (i.e. January compared to February compared to March, etc). Due to seasonal changes in usage, outages and prices, you would not expect a hedging program to significantly reduce the month-to-month volatility in rates. TVA would agree that FRV does not measure hedge effectiveness and should not be included as a "Financial Hedging Program Indicator" (Appendix B. of Mercatus Report).

However, TVA does not agree with the recommendation to develop a metric specific to natural gas exposure risk. While natural gas was historically the largest part of the previous Financial Trading Program (FTP), it is the smallest exposure in the total fuel cost. We believe that analyzing TVA's total energy commodity portfolio as recommended in recommendation nine below is a more effective approach. We will address action plans in recommendation nine.

Action plan date - October 31, 2014

5) **Cease Using VaR as a Primary Risk Metric**

TVA should cease the use of Value at Risk as a primary risk metric and replace it with an "at risk" type of metric(s) that includes not only the financial natural gas hedges but also the physical exposures being hedged via the FTP as this type of approach is more suitable for a power generator such as TVA. These new metric(s) could also be used in the risk tolerance determination and management processes.

Action Plan

TVA agrees that VaR should not be the primary risk metric and should be replaced with "at risk" measures such as fuel cost @ risk, liquidity @ risk, and individual counterparty maximum potential exposure limits (credit risk). TVA is in the process of implementing a programmatic solution for risk measurement and reporting which will be able to calculate fuel cost @ risk. We will also investigate whether or not the credit system currently being implemented can calculate liquidity @ risk and individual counterparty maximum potential exposure. If an automated solution is not available, TVA will develop a manual approach for monitoring these risks.

Action plan date - October 31, 2014

6) **Conduct Stress Testing**

Stress testing needs to become a routine and regular part of Middle Office risk analysis and reporting. The results of said stress testing should be utilized with respect to decision making as well as monitoring TVA's potential risk exposure.

Action Plan

Similar to the response to recommendation five, TVA is in the process of implementing a robust risk analytics solution for risk measurement and reporting which will provide a more automated approach to stress testing and scenario analysis. Thus, this will allow routine reporting.

Action plan date - October 31, 2014

7) **Adhere to Governance Documents**

As previously mentioned, TVA needs to take action to ensure that it is performing all that is required of it by the FTP's governance documents (e.g., stress tests, Cash-Flow-at-Risk), etc., or if the language in the governance documents is inaccurate, governance documents should be revised to reflect actual practices.

Action Plan

TVA agrees with the need to adhere to governance documents. However, TVA disagrees that the lack of routine stress tests and Cash-Flow-at-Risk calculations are examples of non-adherence to governance documents. TVA believes the findings identified by Mercatus would better support a recommendation to clarify governance documents to eliminate ambiguous language and ensure Standard Processes and Procedures (SPP) are retired when superseding documents are put in place.

As part of their scope, Mercatus reviewed the Commodity Risk Management Policy. As related to stress testing, it stated the Middle Office performs stress tests and were reported to the PROC upon request. Mercatus interpreted that to mean there was a requirement to routinely perform and only report them upon request. TVA performed stress tests upon request. TVA agrees that the language was ambiguous and should be clarified. In fact, when the new Fossil Fuel and Power Commodity Risk Guidelines went into effect on November 1, 2013 superseding the Commodity Risk Management Policy

the language surrounding stress tests was specifically changed. The guidelines now state that the "Middle Office will conduct scenario and stress testing as requested by appropriate management". The guideline was worded this way since, as noted in the response to recommendation six, TVA is in the process of implementing a robust risk analytics solution for risk measurement and reporting which will provide a more automated approach to stress testing and scenario analysis and could not currently create stress tests on a routine basis.

The other governance document that Mercatus reviewed that contained the Cash-Flow-at-Risk language was the Financial Trading Program SPP. This was a front office SPP that provided the original governance over financial hedging. Best practices would dictate that governance over hedging be owned by the independent risk management function. TVA's risk organization issued their first Commodity Risk Management Policy in September 2011. At that time, the Financial Trading Program SPP should have been retired. Since this oversight was brought to TVA's attention, the process to retire the Financial Trading Program SPP has been initiated.

As part of TVA's reorganization, TVA has emphasized clarity around governance. TVA has adopted a GOES (Governance, Oversight, Execution and Support) structure to identify ownership, governance and accountability. As a result, TVA is also restructuring the reviewing risk governance structure and reorganizing the governing committees, along with rewriting the charters to provide clarity for approvals. The issuance of the new guidelines in 2013 was part of that multi-phase effort to implement a more efficient governance framework.

Action plan date - November 30, 2014

8) **Conduct Proper Cost/Benefit Analysis**

In order to determine the true costs and benefits of the FTP, TVA should calculate the complete costs and benefits of the FTP since inception. As previously noted, the total should include all costs that would be eliminated if the FTP did not exist. Also, for forward looking risk reduction metrics, such as fuel cost certainty, TVA should compare the all-in hedged cost of fuel versus the cost of fuel without hedging (market price).

Action Plan

While we agree with the need to analyze and understand the costs and benefits of any hedging program, we do not believe that it would be the most effective use of resources to calculate the costs and benefits of the previous FTP from its inception. As recommended in this report and discussed in the responses above, considerable changes in processes and strategies are being evaluated. We believe a better approach would be to validate benefits and costs prior to implementing the proposed recommendations. Articulating the risk tolerance around fuel costs, as outlined in the response to recommendation one, will help in identifying the benefits of a natural gas hedging program. If the natural gas exposure is determined to be within TVA's risk tolerance, then a reduced hedging profile is needed. TVA will commit to implementing functions in the most efficient, cost effective manner (included on page 21 of the Mercatus report).

As discussed in the response to recommendation four, TVA intends to assess the risk reduction metrics on the total $3 billion energy commodity portfolio. As a result, any additions to the "all-in hedged cost" would be immaterial to forward looking risk reduction metrics, such as Fuel Cost Certainty.

Action plan date - November 30, 2014

9) **Properly Analyze and Manage All of TVA's Energy Commodity Exposure**

The FTP should not only be analyzed in isolation but also as part of TVA's total energy commodity portfolio such that all energy commodity (i.e. coal and fuel oil) risk, both physical and financial, are being properly analyzed and managed.

Action Plan

TVA agrees with this recommendation and recognizes the need to evaluate the physical and financial positions to effectively manage portfolio risks. We also recognize the need to address these risks for all managed commodities. As we implement these recommendations and update our governance documents, we will focus on TVA's total energy commodity portfolio.

Action plan date - November 30, 2014

Executive Summary Clarification and Comments

Executive Summary section, Mercatus also made some observations that require additional context.

1. TVA did not follow a process or undertake a specific effort to determine its risk tolerance associated with the FTP. To determine the size of the FTP, which according to best practices should be a function of a quantified risk tolerance, TVA relied heavily on information informally gathered directly from peers and on industry benchmark data provided by consultants as well as TVA executives who previously worked for other fuel hedging entities.

   TVA Response: TVA believes it appropriate to rely "heavily" on Executive Management in determining risk tolerance and sizing the FTP. TVA did use benchmark and peer data to help frame the program governance, as benchmarking is important to TVA and is especially useful when evaluating total rates and fuel rates. However, these were just inputs that went in to Executive Management's decision making process, along with risk analytics. The Executive Management, at the time, had decades of industry experience from major utilities across the country. Those experiences also played a major factor in sizing the hedging program.

   However, it would be a fair assessment that the risk analytics performed from 2009 to 2011 did not adequately assess the probability and impacts of the 50 to 60 percent drop in natural gas prices experienced over the past several years. Over the past year, TVA has made improvements to our risk analytic capabilities. Based on that improved

analysis and the market experiences of the past few years, Executive Management's risk tolerance has evolved and the hedging program has been resized. This is also aligned to the tolerance of the FRP committee.

2. TVA's current volatility reduction metrics are incomplete measures of performance as they do not measure the cost of achieving reduced volatility.

   TVA Response: It is our understanding that Mercatus views our volatility reduction metrics as incomplete measures because we do not view the mark to market losses as a cost of the program. TVA believes it has been transparent with both Executive Management and customers. The metrics show the impacts of the mark to market losses and are reflected in our analysis through the shifting of the expected hedge costs. As we mention above in our response to recommendation four, TVA agrees that there are opportunities improve our performance metrics and are committed to doing so.

3. As noted in the OIG's audit, TVA has yet to conduct a thorough cost/benefit analysis of the FTP.

   TVA Response: TVA performed a cost/benefit analysis in response to the initial OIG audit in December 2012.

   Such analysis should include no less than the following items:

   a) TVA's effective (hedged) cost of natural gas vs. a market (unhedged) cost

      TVA Response: Mark to market gains and losses were not included since they are not a program cost. We do report and monitor these separately.

   b) Overhead and Personnel

      TVA Response: This was included in the cost/benefit analysis performed by TVA.

   c) Risk Information Systems

      TVA Response: This was included in the cost/benefit analysis performed by TVA.

   d) Cost of Capital

      TVA Response: This cost is small for TVA, but should be considered in future cost/benefit analysis by TVA.

   e) Transaction Costs
      TVA Response: This was included in the cost/benefit analysis performed by TVA.

   f) Fees paid to consultants for services related to the FTP

TVA Response: This is a periodic cost to TVA; therefore it was excluded in the cost/benefit analysis performed by TVA.

g) Losses due to credit defaults

TVA Response: This was not a cost for TVA, but could be considered in future cost/benefit analysis by TVA.

4. While the documents which govern the FTP call for TVA to conduct various forms of stress testing, interview responses indicated that routine stress testing is rarely performed as outlined in the documents. However, in a response to the initial findings of this review, TVA indicated that the language in its governance documents regarding the requirements and conditions for the performance of stress tests was unclear, and that the language has been revised to reflect current practices.

TVA Response: TVA agrees with the importance of stress testing. However, Mercatus implied from the wording of the Commodity Risk Policy that routine stress tests were required, when the intent was that they would be produced upon request. As a result, TVA disagrees with the implication that we did not adhere to the governance document. TVA agrees that the original language could have been clearer, and it has since been revised. Governance documents effective November 2013 clearly state that Risk will perform stress testing at the request of management, which has been done by request.

5. One of the FTP's governance documents lists "CFaR" (Cash Flow at Risk) as an example of TVA Middle Office risk analytics yet the Middle Office is not calculating this metric, If the Middle Office is not performing CFaR calculations, governance documents should be changed to reflect this; however, CFaR would be a useful metric for TVA that could be used to define its tolerance to liquidity risk.

TVA Response: TVA agrees that CFaR is a useful risk metric and plans to include this in our analysis in the future. The reference to CFaR was located in the Appendix of the Financial Trading Program SPP. This was a front office SPP that was the original governance over financial hedging. As discussed in recommendation seven, the process to retire the Financial Trading Program SPP has been initiated.

6. TVA's forecasting models show that the economic dispatch displacement of coal versus natural gas is a substantial driver of the FTP's natural gas load forecast and resulting hedge targets, but to date, although TVA has conducted a considerable amount of research regarding volumetric variability, few results have been achieved in terms of specifying TVA's risk tolerance with respect to volumetric risk, and in terms of translating that risk tolerance into the requisite optionality for the formulation of dynamic hedge strategies and hedge targets.

7. TVA uses fixed-volume hedging instruments to hedge a natural gas price exposure that exhibits substantial volumetric variability, resulting in a mismatch of both hedging strategies and instruments. Changes in hedge targets drive considerable churning of the hedge portfolio, undermining hedging performance.

TVA Response: An area of disagreement that spans across findings six and seven is around the root cause of TVA Executive Management's concern that the front office was "churning" or excessively rebalancing the hedge portfolio. TVA interprets the report to say that Mercatus determined the root cause of TVA management's concern around rebalancing to be the lack of understanding/communication of volumetric risk and the lack of dynamic hedge strategies.

Over the years, TVA has developed a very good understanding of how price changes will impact the projected fuel burns used to set hedge positions. We have performed numerous analyses which show how the portfolio reacts under different price scenarios. In addition, System Planning runs 72 scenarios through their production cost model each month, and that output is used to create Fuel Rate Certainty and Fuel Cost Certainty indicators referenced in the report. The driver for rebalancing the portfolio was not that we did not know what type of volumetric volatility to expect over time, but rather issues with the governance structure that encouraged (and sometimes required) the front office to react to those changes to rebalance the portfolio. The hedge ladders were originally designed to give the front office discretion to manage the hedges (rebalance if they thought appropriate) as long as they were within the ranges. Hard stops were in place that required them to rebalance if they were above or below that limit. With the known volatility that moved estimated burns up and down 30 to 40 Bcf (20-30%) throughout the year, occasionally this resulted in rebalancing the out years of the hedge ladders. Additionally, rebalancing occurred in the prompt year and specifically the prompt three months, which are managed separately. These periods are managed with individual monthly hedge ladders, which resulted in frequent rebalancing with each update of the generation plan.

With regard to instruments, TVA agrees options can play a part in an effective hedging strategy. However, a bigger issue than the use of fixed volume swaps was the over reliance on the use of fixed volume annual strip swaps. Annual swaps allow hedgers to add volume quickly (buying 12 months at one time for the same volume in every month). Also, when hedging many years out, they are the most liquid product to use. The problem with this approach is when monthly expected burns vary, you will over-hedge some months and under-hedge others. Theoretically, the portfolio would be rebalanced over time to match the shape of the hedges to expected burns. However, the buying and selling needed to rebalance was viewed as churning by Executive Management.

These issues resulted in rebalancing beyond Executive Management's risk tolerance. Risk Management began addressing this issue last year after Executive Management articulated their concern about the level of rebalancing. The following actions were taken:

- In December 2012, the Natural Gas Execution Guidelines were updated to shorten the hedge tenor, which alleviated some of the issues around the need for annual strips and helped address some of the margin/liquidity concerns.
- In spring of 2013, the Portfolio Risk Oversight Committee (PROC) clarified the rules around rebalancing the hedge ladders. They only allowed rebalancing if the period was over the Hard Stop and limited the amount that could be sold to the top of the hedge range.

- As part of the reorganizational effort, all analytical services (System Planning, Structuring & Portfolio Management) were moved from the Front Office to Enterprise Planning, along with the Middle Office.
- Under the TVA's newly implemented GOES model, the Governance for hedging activities has been given to Enterprise Planning.
- In the fall of 2013, the PROC suspended all rebalancing activities until further guidance was received from Executive Management at a planned January meeting.
- In January 2014, a revised streamlined governance around natural gas hedging was approved that will greatly reduce the churning or rebalancing of the portfolio.

TVA agrees we need to better understand the area of volumetric risk, specifically related to the operating month and the real time dispatch of the generation fleet. The long term planning models make assumptions around normal weather, normal load, expected hydro output, and expected forced outage rates, among other things. The main driver of TVA's volumetric risk is with load, hydro and outage events that are not normal or expected. For example, in January 2014 we had significant volumetric risk as we set record loads, had a couple of large coal plants off line, and gas prices for Transco Zone 5 set all-time records trading as high as $136/mmbtu. This type of volumetric risk is not covered by the current use of financial derivatives and would not be covered under an options strategy. All financial gas hedges settle before the operating month begins, and the operating month is managed through physical gas transactions, which were outside of the scope of the Mercatus review. Some beginning of the month index physical natural gas is purchased for price certainty; some daily index physical natural gas is purchased for procurement reliability; and spot physical purchases are used for the balance of the requirements. Volumetric risk driven by load, hydro and outage events has the most significant impact on TVA, not coal/gas switching due to price fluctuations as stated in the report

While TVA does agree that we can improve on making these analyses more actionable in terms of risk tolerance, TVA would be concerned about the use of dynamic hedge strategies, depending on how Mercatus is using that term. "Dynamic" hedge strategies can be synonymous with "trading around assets" hedge strategies. TVA Executive Management has clearly stated that trading around assets is outside of their risk tolerance.

8. The Fuel Rate Volatility (FRV) metric which has recently been introduced by TVA is being reported as "effective" while the reduction in the fuel rate volatility over the almost six year history of the FTP is zero. It should be noted that much of this result is a function of TVA's volumetric risk.

TVA Response: FRV was not intended to measure effectiveness of volatility reduction from hedging. Rather, it measured the month to month volatility in rates to customers. (i.e. January compared to February compared to March, etc.). Due to seasonal changes in usage, outages and prices, you would not expect a hedging program to necessarily reduce the month to month volatility in rates. As we mention above in our response to recommendation four, TVA would agree that FRV does not measure hedge effectiveness and should not be included as a "Financial Hedging Program Indicator" (Appendix B. of Mercatus Report).

9. TVA's measurement of VaR ("Value at Risk") should be reconfigured so that it includes the physical exposures being hedged via the FTP. This would transform the metric into a fuel cost at risk metric, which would be a much more appropriate metric for managing the FTP.

> **TVA Response:** TVA agrees that if VaR was to remain a primary metric, we should include the physical exposures and would transform the metric into a fuel cost at risk metric. This had a known limitation at program inception and will be addressed with the implementation of the programmatic solution for risk measurement and reporting discussed in recommendation five.

10. The FTP should not only be analyzed in isolation but also as part of a cross-commodity portfolio which incorporates additional commodities such as coal and fuel oil, including both financial and physical positions.

> **TVA Response**: TVA agrees that the FTP program impacts should be viewed on the overall fuel portfolio. The reduction of price risk achieved should be understood as it relates to the system fuel costs. Fuel Rate Volatility and Fuel Cost Volatility indicators currently employed by TVA include all commodities, as well as physical and financial transactions.

11. Given that the premise of the FTP is to provide TVA's customers with reduced exposure to commodity price volatility, TVA needs to improve the process by which it determines its customers risk tolerance. This can be accomplished via a number of ways including quantified sampling of customer's senior management and/or through formal surveys.

> **TVA Response:** Since the inception of the FTP, TVA has established the Tennessee Valley Customer Planning Council, which is a tri-party collaboration between TVA, TVPPA, and TVIC. This group is comprised of executive leadership from TVA and the customers' organizations. The primary purpose is to increase sharing and transparency in all matters of finance and operations, with a focus on TVA long range financial plan and performance. This group meets 4 to 6 times yearly, coordinated with TVA Board meetings. The FTP structure, plan, and performance is a standing agenda item for annual review and may also be discussed upon request by the customer leadership.

Appendix A contains clarifications on findings that were found in the body of the report outside of the Recommendations and the Executive Summary sections.

APPENDIX A

Clarification and Comments on Report Observations

As referenced in TVA's response to the recommendations and executive summary, we also wanted to clarify the following observations stated as fact in the report.

3.1.1 Overview

- "However, with regard to best practices, the FTP is lacking in the areas of risk and performance measurement, and risk tolerance, and it lacks a sufficiently sophisticated strategy to deal with the substantial uncertainty surrounding the volumetric targets for hedging."

  TVA Response: TVA agrees improvement can be made to quantify customer risk tolerance and analysis around volumetric changes in the portfolio can be made more actionable. TVA disagrees that there is a lack of risk and performance measurement. We provide daily mark-to-market and VaR calculations as well as a quarterly performance metric report including Fuel Cost Certainty, Fuel Rate Certainty, and Fuel Rate Volatility. In section 3.2.3.1 of the Mercatus document, it is stated that "useful" metrics, including Fuel Cost Certainty (FCC) and Fuel Rate Certainty (FRC), are calculated. The report also calls these measures "effective" at quantifying volatility reduction.

3.1.2 Overall Objectives

- "No rate stability or increased predictability was achieved as of the date of the report (4th quarter 2012)."

  TVA Response: The Fuel Rate Volatility metric is not intended to measure increased predictability, only historical monthly volatility. As mentioned previously, TVA recognizes that by including that metric with the Financial Hedging Program Indicators, it left the impression it would be comparable to the forward looking metrics that show a reduction in volatility. TVA will develop more effective measures in our revised program governance.

- A further objective stated in TVA's policy is that "the first priority of TVA's commodity trading activity is to provide stable, low-cost rates.."

  TVA Response: The reference to "provide stable, low-cost rates" is referencing TVA's overarching goal of low cost rates to the people of the Tennessee Valley. This mission in ingrained in TVA employees, but should not have been listed as priority of TVA's commodity trading activity. This language was removed from the new Fossil Fuel and Power Commodity Risk Guidelines issued in November 2013.

3.1.5 Process(s) Used to Determine TVA's Risk Tolerance

- "It appears that although the current personnel in the Front Office, Middle Office and in Structuring & Portfolio Management are aware of the substantial volumetric

uncertainty driving instability in natural gas hedging targets, and despite conducting a considerable amount of research regarding volumetric variability, few results have been achieved in terms of specifying TVA's risk tolerance with respect to volumetric risk, and in terms of translating that risk tolerance into the requisite optionality for the formulation of dynamic hedge strategies and hedge targets.

TVA Response: As mentioned previously, TVA agrees we can improve by making such analysis more actionable in the future; however, TVA would be concerned about the use of dynamic hedge strategies, depending on how Mercatus is using that term. "Dynamic" hedge strategies can be synonymous with "trading around assets" hedge strategies. TVA Executive Management has clearly stated that trading around assets is outside of their risk tolerance.

3.1.6 Process(s) Used to Determine the FTP's VaR Threshold

- "According to interview responses, the VaR threshold was selected on an arbitrary basis by the former Chief Risk Officer, and it has no material impact on the management of the FTP."

  TVA Response: While TVA agrees the current VaR limits are not indicative of TVA's current risk tolerance, the current VaR limits were not "arbitrarily" determined. TVA believes that Mercatus received some erroneous information. The former CRO identified as setting the limit did not assume that role until several years later. TVA talked to analysts that were in the Risk organization at the time the VaR limit was set and determined it was based on stress test evaluations performed at the time the limits were set.

3.2.3.3 Performance Measurement

- "This is an effective measurement of volatility reduction, but it does not go far enough as it simply measures volatility reduction without any regard for the cost of achieving the reduction"

  TVA Response: TVA publishes the expected shift of Fuel Cost or Fuel Rate along with the Fuel Cost Certainty and Fuel Rate Certainty in the performance report. This is also expressed as a ratio of total cost to certainty.

- "Does the FRV measure the volatility of the hedged portfolio across the entire multi-year hedging horizon during a specific fiscal year, or does it measure the volatility of only the 12 months within the fiscal year?"

  "And what commodities are included in "Fuel"?"

  TVA Response: These are fundamental questions that TVA interviewees could have provided if asked. TVA believes further discussions with Mercatus on this topic were warranted. For example, the questions above have implications on the comparison between Fuel Rate Certainty (FRC) and Fuel Rate Volatility (FRV) metrics in this section. Fuel Rate Volatility (FRV) measures only the volatility of the fuel rate for the 12 months within the fiscal year. This measure cannot be directly compared to Fuel Rate Certainty, as Mercatus has done in this report.

- "…if would be useful to measure the discreet [SIC] performance for individual commodities, especially for natural gas because it is such a large component of the FTP and TVA's fuel cost. This would result in a look-back Gas Cost Volatility metric and a look-forward Gas Cost Certainty metric."

  TVA Response: Natural gas comprises only 9% of TVA's total fuel cost compared to 57% coal, 26% purchased power, and 9% nuclear. TVA analyzed eight performance metrics before choosing the three metrics used in this performance report. "Gas Cost Volatility," was found to be the most unsuitable metric due to the coal/gas switching in the portfolio. Gas price and gas cost move together causing counterintuitive performance results (gas price decreases and gas volume increases which results in an *increase* in gas cost). Mercatus references this work in the next paragraph, acknowledging we tested a similar metric.

- "Why has natural gas been combined with power purchases, but other fuels excluded? It would be useful to measure the volatility reduction of each aspect of the hedging and procurement, including natural gas, other fuels, and power."

  TVA Response: TVA publishes a total Fuel Cost Certainty and Fuel Rate Certainty measure, which includes all fuels. Additionally, in the referenced presentation, TVA tested a combined Natural Gas and Purchased Power measure because these hedging programs are combined as a result of purchased power being hedged with natural gas financial instruments. TVA also calculates Fuel Cost Certainty and Fuel Rate Certainty for coal, purchased power, and natural gas; however, these are not published in the Financial Hedging Performance report because they are physical transactions. This analysis is available and can be provided to Mercatus upon request.

3.2.3.4 Cost/Benefit

- "The resulting analysis lacked many of the cost components that should be incorporated – costs that have been included in other TVA analyses and presentations."

  TVA Response: See responses from the Executive Summary item #3.

3.6 Review of Governance Documents

- "...fail to include specific potential mitigating actions and repercussions that occur when risk management limits and policies are violated."

  TVA Response: The Commodity Risk Management Policy and new Fossil Fuel and Power Commodity Risk Guidelines both address the repercussions that occur when risk management limits and policies are violated. However, the new guidelines do not specify potential mitigating actions. TVA agrees that would improve the document and will include such language in the next revision.

3.7 Analysis of Risk Metrics

- "…industry best practices dictate that TVA should not only analyze the FTP in isolation but also as part of a comprehensive cross-commodity portfolio, which would include all relevant risk metrics (i.e. market, volumetric, operational, liquidity and credit risk) for all relevant commodities (e.g. natural gas, coal, power, fuel oil)."

  TVA Response: Fuel Cost Certainty and Fuel Rate Certainty include all relevant commodities as well as risk related to market risk, volumetric risk, and some operational risk. TVA's Credit Risk group publishes credit risk reports; however, this information was not requested by Mercatus.

3.8. Analysis of Trading and Hedging Strategies

- "From a more a more advanced perspective, and best practice perspective, several strategic aspects of the FTP are I lacking these include: Some discretionary trading strategies..."

  TVA Response: The TVA Board Authorization strictly prohibits speculative trading. Executive Management has determined that discretionary hedging strategies are outside of their risk tolerance and all discretionary hedging strategies have been discontinued.

3.11 Analysis of Credit Requirements and Controls

- "In response to the initial findings of this review, another copy of the credit policy was provided by TVA (Credit Policy 10-06-03). This copy of the policy includes credit threshold limits/maximum credit exposure limits. However, the credit limits are only single values for each credit rating, whereas the preferred industry practice is to base credit limits/thresholds on some form of equity multiplier or other size adjustment linked to credit ratings in order to account for the relative financial size of counterparties, further subject to a maximum amount per credit rating."

  TVA Response: TVA does assign credit limits to counterparties where there is credit exposure. The limits indicated in the credit policy are broad limits, used as guidance, and are not automatically assigned per credit rating. Credit limits are assigned as part of TVA's analytical process, which employs traditional financial statement analysis and utilizes a proprietary credit scoring model. The scoring model assigns a credit rating and credit limit based on a number of factors including a minimum equity and size component, among other items.

- "A copy of the Commodity Counterparty Report dated 05-03-12 was provided as part of the documentation for this project. An examination of this report found no credit limits. In a response to the initial findings of this review, TVA provided additional credit documents including a counterparty exposure report with total credit exposures along with credit limits and collateral amounts. However, the additional counterparty credit reports do not include concentration limits."

  TVA Response: The report that was provided does not include concentration limits. Credit concentrations are monitored separately and have always been

reported in TVA's annual 10-K filings as a recommended practice by TVA's external auditor, E&Y.

Many of these questions could have been answered and resolved before they were identified as issues had Mercatus spoken directly with the Director, Corporate Credit in the initial and/or follow-up interviews.

3.13.2 Quantitative Evaluation

- "Ideally, because of hedging with fixed-price, fixed-quantity instruments which reduce price volatility 100% for every volumetric unit hedged, a hedge program in steady-state operation with approximately 30%-50% hedge coverage should achieve commensurate 30%-50% reduction of volatility, not 4%."

  TVA Response: As mentioned previously, Fuel Rate Volatility (FRV) reflects historical TVA fuel rate volatility with and without natural gas hedges. This measure was not intended to measure the effectiveness of volatility reduction from hedging. Rather, it measured the month-to-month volatility in rates to customers (i.e. January compared to February compared to March, etc). Due to seasonal changes in usage, outages, and prices, you would not expect a hedging program to significantly reduce the month-to-month volatility in rates. Since Natural Gas comprises only 9% of the fuel cost, you would not expect to see significant differences with or without hedges.

3.17.2 **Performance Measurements**

- "The two look-forward metrics appear to meet the objective of measuring potential volatility reduction, but need to go further to incorporate the volumetric uncertainty that has plagued the FTP to date and to calculate the effective cost of the volatility reduction."

  TVA Response: The Fuel Cost Certainty and Fuel Rate Certainty metrics do incorporate volumetric uncertainty due to coal/gas switching, hydro, load, and unit performance. The Financial Hedging Performance Report also shows the associated volatility reduction for both of these metrics.

MERCATUS ENERGY ADVISORS

Response to TVA Management Responses to OIG Report 2011-1447-01

March 26, 2014

This response ("Response") has been prepared by Mercatus Energy Advisors, LLC for the Tennessee Valley Authority Office of the Inspector General as a response to TVA Management Responses to OIG Report 2011-1447-01 (TVA's Response).

As noted in our Review of Tennessee Valley Authority's Financial Trading Program ("Review") as well as TVA's Response, since November 2013 TVA has made significant changes to the Financial Trading Program. In addition, TVA has developed action plans to address additional aspects of the FTP, all of which should be acknowledged as improvements to the FTP.

However, we believe the following items, which were addressed in our Review as well as TVA's Response, deserve further consideration.

- While it is correct that mark-to-market losses do not necessarily equate to direct costs, the impact of mark-to-market losses should be taken into consideration when evaluating the FTP as mark-to-market losses can create significant cash flow and credit issues.
- When evaluating the costs and benefits of the FTP, all costs, both direct and indirect, associated with the implementation and management of the FTP should be considered as a large percentage of these costs would not exist if the FTP did not exist.
- As it relates to our opinion that TVA should consider the use of dynamic hedging strategies, we did not intend to imply that TVA should "trade around assets". Rather, our suggestion is that TVA should consider the use of dynamic hedging strategies which would provide TVA with the ability to further mitigate risk, particularly as it relates to volumetric risk.