IMA EDUCATIONAL Case Journal | Case Study

The Association of Accountants and Financial Professionals in Business

ISSN 1940-204X

THE TENNESSEE VALLEY AUTHORITY: THE COST OF POWER

Bob G. Wood
Salisbury University

Steven B. Isbell
Tennessee Tech University

Cass Larson
Tennessee Valley Authority

INTRODUCTION

Driving back to Knoxville on Friday afternoon, Morgan finally had some time to think. She'd spent most of the week in Nashville meeting with many of the Tennessee Valley Authority's (TVA) largest industrial customers. As the new VP of energy supply management, Morgan was responsible for formulating a plan to meet expected energy needs. The plan must address how TVA can satisfy its multiple stakeholders and mission in a long-term strategy, while at the same time maintaining the flexibility to address near-term financial and operational challenges.

I. THE TENNESSEE VALLEY AUTHORITY

TVA is the nation's largest public power provider and is wholly owned by the U.S. government. Although owned by the federal government, TVA is not financed with tax dollars; rather, the utility's funding comes from the sale of power to its customers. Additional funding comes from borrowings using debt issues in the financial market. TVA has a three-fold mission: (1) provide reliable, competitively-priced power, (2) manage the Tennessee River system and associated lands to meet multiple uses, and (3) partner with local and state governments for economic development. TVA's unique mission has served as the foundation of its business endeavors, providing the context for TVA to establish its business objectives and internal processes.

While TVA's core mission has remained constant, the landscape of the industry has changed considerably, and the future remains very uncertain. The recent economic turmoil has caused unprecedented volatility in the prices for commodities that are used as fuel to produce electricity and the cost of materials to build plants. There is also a high level of uncertainty in the industry with respect to potential legislation requiring significantly more renewable and clean energy generation sources in the coming years. Legal issues, including a recent lawsuit in North Carolina, challenged TVA to seek costly alternatives for power generation. On top of these challenges, the lethargic economy has created an uninterrupted stream of calls from customers asking TVA to keep electricity rates where they are.

The major focus of today's meeting was TVA's obligation of meeting all energy needs while at the same time keeping rates as low as possible. Last year, TVA generated the majority of needed electricity using fossil fuel plants (55%), nuclear plants (28%), hydropower plants (4%), natural gas plants (1%), and renewable sources (1%). In addition, TVA purchased 11% of the needed power from other providers, since TVA generation assets were unable to meet the needs of the valley. Of the costs associated with generating electricity last year, 92% came from two sources: fossil fuel costs and purchased power. Nuclear power production is TVA's most efficient production process (providing 28% of the electricity generated last year, but only accounting for 7% of total costs). Electricity generated using hydropower and renewable sources is the least expensive (having zero input cost), but it is also the least efficient and has reliability issues.

The energy needs in the Tennessee Valley have grown at more than 2.5% per year for the last 20 years. Demand is expected to continue to grow at about 1% per year over the next 20 years, even with the recent economic downturn slowing things considerably in the short term. Even with the downturn, TVA's current generation plants are unable to meet current needs. TVA is well known for providing a very reliable source of power to its customers, and the agency wants to maintain that reputation.

Two options exist to supply the increasing power needs: TVA can build new generating capacity or it can buy energy from others. Management wants to limit electricity purchases to emergency situations—periods where demand exceeds generation capacity. In addition to their cost, prices in this market are extremely volatile. Even with the slower economy, TVA needs to build new generating units at the rate of one large coal or nuclear unit every four years to be able to meet forecasted demand. Smaller units will also be constructed to meet individual customers' needs.

II. THE GREEN REVOLUTION

Driving by Carthage, Al Gore's hometown, Morgan smiled as she thought about how drastically attitudes have changed towards being "green" in the Tennessee Valley. As interest at all levels of government leads to new environmental policies, Morgan knows that TVA will need to provide leadership in the area of providing cleaner, more renewable energy. The unusual operating characteristics and reliability issues of green resources makes their adoption a challenge, however.

In addition to thinking about cleaner and more cost-effective energy sources, Morgan could not help but think of another hot topic of interest for TVA. In addition to renewable supply side alternatives, TVA has recently committed to increasing efforts to gain more savings from energy efficiency and demand response programs. These initiatives are targeted to achieve maximum benefits during the highest periods of power demand on the TVA system. TVA's overall goal is to reduce energy use during times when the demand for power is highest—often referred to as the "peak"—by about 5% by the end of 2014.

By helping consumers use energy more efficiently, TVA is hoping to save money for the entire valley. In fact, TVA is targeting total energy efficiency savings to be about 3.5% of sales by 2017, which would roughly translate to 0.1% annual load growth to that period. Although the concept seems simple on the surface, Morgan knows that there's a lot of work to be done with limited resources, introduction of new technologies, and capital expenses for some of these programs.

On the other hand, some individuals are extremely skeptical of energy efficiency initiatives. Many of these people believe that, given the current shape of the economy, money should not be spent on energy-efficiency programs in the near term. Morgan definitely has her work cut out for her in this area. She wonders: "Is it in TVA's best interest to invest in these energy-efficiency programs? If so, how can her team analyze which energy-efficiency programs are best for TVA?"

III. POWER GENERATION ALTERNATIVES

Returning to the more critical issue, Morgan remembered a recent discussion at TVA about a report that summarized the benefits and costs of each type of power generation. She knows that any plan she develops must consider these factors. Highlights of the report include:

- **Coal: Pulverized**
  - Coal accounted for over 40% of power generation in the U. S. in 2011.
  - Coal plants are classified as "high-emitting" with respect to pollutants.
  - Carbon-related legislation could add 50-100% to the cost of future coal power generation due to stricter requirements for carbon and expensive carbon controls, possibly even making it necessary to close some existing units.
  - While coal has been a cheap and domestically available fuel source, the world's increased use of coal generation, particularly in China (China builds a coal plant every week), is causing increased volatility in coal prices.
  - Coal prices cannot be managed using derivatives and they rely on longer-term bilateral contracts with suppliers who, in general, have poor financial stability.
- **Natural Gas: Combined Cycle**
  - Using essentially the same technology used in jet engines, combined cycle plants are built around one or more combustion turbines.
  - Modern combined cycle plants, which have a relatively low construction cost and modest environmental impacts, can be used to meet base-load, intermediate, and peaking demand, since they are easy to start and stop as power is needed.
  - These plants can be built fairly quickly and are very efficient.
  - Natural gas, which fuels combined cycles, has had significantly greater price volatility when compared to coal in recent years, and carbon legislation could add about 25% to the cost. Still, natural gas volatility can

be managed using financial contracts to lock in prices well in advance of needing the fuel. Table 1 compares coal and natural gas prices from 1990 to 2010.

TABLE 1
Cost of Selected Fossil-Fuel at Electric Generating Plants 1990-2010*

Year	COAL ($/MMBTU)	NATURAL GAS ($/MMBTU)
1990	1.46	2.32
1991	1.45	2.15
1992	1.41	2.33
1993	1.39	2.56
1994	1.36	2.23
1995	1.32	1.98
1996	1.29	2.64
1997	1.27	2.76
1998	1.25	2.38
1999	1.22	2.57
2000	1.20	4.30
2001	1.23	4.49
2002	1.25	3.53
2003	1.28	5.39
2004	1.36	5.96
2005	1.54	8.21
2006	1.69	6.94
2007	1.77	7.11
2008	2.07	9.01
2009	2.21	4.74
2010	2.27	5.09

*U.S. Energy Information Administration Monthly, Energy Review, 201

- **Nuclear**
  - Nuclear power plants use the heat produced by nuclear fission to produce steam that drives a turbine to generate electricity.
  - Nuclear plants are characterized by high investment costs but low variable operating costs, including low fuel expense. Because of the low variable costs and design factors, nuclear plants in the United States operate exclusively as base-load plants (operating and providing energy continuously).
  - Nuclear power supplied almost 20% of the nation's electricity in 2011.
  - Construction of a nuclear plant requires approval from the Nuclear Regulatory Commission, which until this year had not approved the construction of a new plant for 16 years. But in February of 2012, approval was given to the Southern Company for the construction of a two-reactor facility. The industry views this as a commitment to expanding nuclear energy in the United States.
  - Nuclear generation is "zero-emitting" while producing, but has waste disposal (spent nuclear fuel rod) issues.
  - One advantage of nuclear power is that it provides large amounts of base-load electricity without releasing carbon dioxide. This furnishes a steady supply of reliable electricity for industries looking to expand or relocate operations to the valley.
- **Wind**
  - Wind power plants (sometimes referred to as wind farms) use wind-driven turbines to generate electricity.
  - Wind is a variable renewable resource because its availability depends on the whims of the weather. The Southeast U.S. is fairly wind-poor, and transmission from the middle of the country may be required if wind energy is used in large amounts.
  - Wind supplied 3% of total U.S. power in 2011. Assuming no changes to current law and regulation, the Energy Information Administration estimates an increase to 20% by 2030.
  - The high capital costs and unpredictable generation make wind power costly when used for large generation purposes.
- **Solar**
  - Solar photovoltaic (solar PV) power uses solar cells to directly convert sunlight to electricity. To date, most of the solar PV installations in the United States have been small (about 1 MW or less). Solar cells produce energy only about one-third of the time.
  - It would take a great deal of land area to produce large quantities of energy—about 2 acres to provide 1 MW of generation. To match the energy of a nuclear unit, it would take around 4,000 acres of solar panels.
  - Smaller photovoltaic solar units could be "distributed" generation in many customers' locations, which could avoid transmission costs. These units are currently being built by a small number of environmentally sensitive customers. TVA has a program to pay customers a premium for the solar energy they produce.
  - The main issue is the cost. Though high, the costs continue to fall because of technological improvements. This is in contrast to the increasing cost of most other generation alternatives.

IV. THE UNIQUE NATURE OF ELECTRICITY

The biggest part of the rewrite of the strategic plan is developing a strategy for capital investments to increase capacity for future energy needs while at the same time minimizing electricity rates. Morgan keeps the following table of cost estimates from the Energy Information Administration on her laptop (shown in Table 2).

Capital costs, the costs that are incurred bringing a generating plant on-line, are amortized over the operating life of the plant. Costs of generation are realized as the generating plant operates. It is important to keep in mind that, like most government-regulated monopolies, TVA must set rates equal to long-run average cost.

Morgan remembered something else that the group failed to talk about. Electricity cannot be stored in the grid. Instead, it is consumed as it is produced. The problem with this is that electricity consumption varies not only by season of the year, but also by the time of day. On late afternoons and early evening on weekdays, demand rises. This increase is more pronounced during warm weather months. These high demand periods are known in the industry as "peak loads." At other times, especially in the very early morning hours, demand is quite low. Of course, electricity demand never falls to zero, so TVA must always be generating power to meet the minimum level of power demanded of the grid. This minimum level is called the "base load."

Electric utilities use different power generation technologies to serve base and peak loads. It can take many hours or even days to get nuclear or coal generation plants up to their functioning power levels. This trait makes them very inefficient as peak load power producers. Instead, they run continuously to serve base load demands. As power demand increases during the day, technologies that can be cycled up and down (natural gas plants) are used to produce the additional energy for the peak load. Base load plants have high fixed costs but very low marginal costs; peak load generators have lower fixed costs but much higher marginal costs of operation. Any strategic plan must take into consideration not only how much to increase total generation capacity, but also how the different loads will be met. This will require that forecasts be made of both peak and base load demands.

There is another strategy that should be considered, however. "Demand side management" programs could be implemented to reduce the costs of adding additional capacity to meet peak load demands. If there were some way to reduce power usage during the peak load times and move that power to the base load periods (a strategy known as "load shifting"), then building additional power generation

TABLE 2
Estimated Levelized Cost of New Generation Resources (USA)*

	Capacity Factor (%)	Levelized Capital Cost $/MW-year	Estimated Service Life (yrs)	Levelized Cost of Generation $/MWh
Conventional Coal	85%	$515,263	30	$31.20
Pulverized Coal	85%	$604,615	30	$29.30
Pulverized Coal with CCS	85%	$689,500	30	$36.70
Conventional Combined Cycle	87%	$174,525	20	$60.20
Advanced Combined Cycle	87%	$170,715	20	$56.90
Conventional Combustion Turbine	30%	$108,011	20	$98.40
Advanced Combustion Turbine	30%	$101,178	20	$85.00
Advanced Nuclear	90%	$748,192	40	$24.10
Wind	34%	$388,681	20	$18.80
Wind - Offshore	39%	$546,282	20	$31.20
Solar PV	22%	$726,169	20	$19.30
Solar Thermal	31%	$609,381	20	$32.20
Geothermal	90%	$693,792	45	$27.70
Biomass	83%	$532,950	20	$37.70
Hydro	51%	$463,290	50	$16.20

* Source: Energy Information Administration

capacity might be postponed for several years. TVA cannot dictate when power is used during the day, but it might be able to influence power usage by changing its pricing model. Instead of pricing power at long-run average costs, TVA could employ a "time-of-use" pricing model and price electricity close to the marginal cost of producing it. During base load periods, price per kilowatt would be lower; during peak load periods, price per kilowatt would increase with the increased costs of supplying the power. This strategy should reduce energy consumption during peak load periods and increase it during base load periods. In effect, total power usage doesn't change; it just moves from peak load to base load periods. This allows TVA to provide more power from less expensive base load generation plants. It could also save the cost of building additional generation capacity to meet future peak load needs.

Load shifting is not a new idea, but power utilities across the nation have not been able to implement it because of the difficulties of determining exactly what time of day a consumer actually uses a unit of electricity. But recent development of "smart meters" not only allows TVA to monitor power usage instantaneously, but also allows consumers to track their energy use and make adjustments that can reduce their utility bills. Appliance manufacturers are even developing "smart" appliances that communicate with the power grid to use real-time information on pricing and determine the optimum time to run, allowing the consumer to use a "set-it-and-forget-it" approach to managing energy needs.

Though this sounds like the ideal solution, consumers have been reluctant to embrace the technology. They also have trouble believing that the strategy benefits all parties involved—the consumer, the utility, and the environment. Morgan chuckled as she remembered the problems Pacific Gas & Electric had introducing smart meters to the San Francisco Bay area. In a unanimous vote, the County Board of Supervisors imposed a moratorium on "smart meter" installation, citing health (the devices allegedly caused brain tumors) and privacy (the collection of information on private household habits) concerns. If the devices can't be sold to environmentally-conscious Californians, what chance does TVA have with Tennessee Valley residents?

Morgan's smile slowly dissolved as she realized something else about the potential use of the newer technologies. Higher-income and highly-educated households are most likely to purchase the smart meters and to take advantage of the smart appliances. A part of TVA's service area is Appalachia—a region with pockets of extreme poverty where families live on the edge of destitution. If TVA follows this pricing model and passes on the costs of installing the new meters to all of its customers, these families would share those costs and almost certainly not be purchasing the smart appliances. In addition, many of these consumers are employed in manufacturing, doing shift work with schedules that would not allow them the flexibility of managing the timing of their energy use. The result of time-sensitive pricing would actually be increased energy bills for households that could least afford it.

Even worse, TVA could be accused of subsidizing higher-income households. Given the national conversation about increasing income inequality, this would not look good for TVA. But that's not the way to look at things, thought Morgan. The question is, What is the right thing to do?

V. FUNDING CONSIDERATIONS

TVA's current rate schedule is designed to cover operating expenses, interest and debt issue retirement, production plant fuels, and all other miscellaneous costs. The TVA board is allowed to raise rates as needed to cover costs, and a fuel-cost adjustment can be made on a quarterly basis to offset volatile fuel prices.

During periods in which TVA revenues fail to cover expenses, the agency reduces costs across functional areas, including slowing capital improvements, limiting new hires, and freezing wages. Alternatively, TVA can borrow funds. This solution may be optimal from a cost standpoint in that, as an AAA-rated agency, TVA can borrow money significantly below market rates. TVA's long-term debt ceiling, set by the U. S. Congress, is $30 billion, however. The ceiling has not been raised in the last four decades. Currently, long-term debt (traditionally reserved for capital projects) remains almost $9 billion, despite several years of debt-reduction efforts. TVA's outstanding long-term debt portfolio averages 5.5%. Although TVA has issued debt with maturities of up to 50 years in the past, the current economic climate will limit new issues to maturities of 15 to 30 years. Given the longer-termed asset life of most of the generation alternatives, Morgan believes that a new 30-year debt issue would be used to fund capital construction. Since TVA's current outstanding bond issues are of shorter maturity, Morgan knows that she must use U.S. Government bonds as a benchmark. She remembers a recent meeting with senior treasury officials at TVA; a premium of 80 to 100 basis points over current government rates is expected. Since there is so much uncertainty in today's economic and political environment, Morgan believes that 100 BPS is most likely. Table 3 shows current interest rates for outstanding TVA and U.S Government debt instruments.

TABLE 3

Tennessee Valley Authority Bonds*

Coupon %	Maturity (Month-Year)	Bid	Ask	Yield to Maturity %
6.00	3-13	103.26	103.27	0.01
4.75	8-13	104.21	104.23	0.13
6.25	12-17	128.12	128.30	0.76
6.75	11-25	148.12	148.25	0.65
7.13	5-30	158.00	158.17	2.89

U.S. Government Bonds

Coupon %	Maturity (Month-Year)	Bid	Ask	Yield to Maturity %
2.50	3-13	101.59	101.60	0.17
4.25	8-13	104.30	104.33	0.17
2.75	12-17	111.02	111.06	0.68
6.875	8-25	159.41	159.45	1.76
6.25	5-30	161.91	161.99	1.22
5.00	5-37	149.59	149.66	1.59
3.00	5-42	109.45	109.51	2.54

* Source: *Wall Street Journal*, July 23, 2012

Still another alternative to increase funding is to raise utility rates. Increasing the cost to customers is never a popular option, and it is TVA's mandate to keep rates as low as possible. Low rates are especially important given TVA's mission of economic development in the Tennessee Valley, and inexpensive energy costs keeps industry growing in the region. Besides, the outcry following a rate increase large enough to fund capital construction would be heard across the Southeast and in Washington.

VI. OTHER CONSIDERATIONS

While TVA has an extraordinarily low cost of capital, new generation means that bumping up against the debt ceiling is a real possibility. Morgan pursed her lips, thinking, "Because of the debt ceiling, I don't know the best way to think about rationing capital spending. Given the current economic and political environment, would it be possible to get our debt ceiling raised? Or am I better off to not even think about that?"

As Morgan approached Knoxville, she looked to her left and saw the Kingston-TVA coal facilities and considered that disastrous event. Coal units produce leftover fly ash that requires disposal. At the Kingston plant, the ash was stored in a collection pond near the facilities. Just before Christmas of that year, the walls of the pond ruptured, and the ash sludge flooded about 300 acres of land, including some people's homes. TVA management reacted quickly and did everything they could to right the situation, but at a cost of about $1 billion, the clean-up cost was enormous. There continue to be calls for increased regulation of coal combustion by-products.

TVA faces other financial difficulties on top of the costs associated with the Kingston situation. There's the decreased demand and lack of pricing-increase flexibility due to the weak economy. It is also faced with another $1 billion expense from complying with the air quality standards imposed by a lawsuit with North Carolina. Even though TVA had already developed a plan and had started construction on plant upgrades required for improving air quality, the lawsuit forced TVA to expedite its schedule, and in some cases required more money than originally budgeted. Finally, TVA has experienced a long period of drought, which has reduced hydro generation from dams, forcing the agency to replace that lost energy with expensive purchased power, since other generation assets are producing at or near capacity. Morgan thought how all of these unexpected events, taken together, equal almost 20% of one year's revenue.

VII. DECISION TIME

Finally, Morgan arrived at the TVA corporate tower in downtown Knoxville and sighed. How should she fit the complicated pieces together to form a strategy for TVA to satisfy its many stakeholders? What are the keys to TVA's strategy going forward? Before tackling these two questions, Morgan must look at what she knows.

From the most recent 10-K, Morgan knows that TVA currently has a 37,188 MW capacity; about 40% of capacity is generated from coal and the remainder is generated primarily by nuclear, hydro, and natural gas plants. Less than 1 percent of current capacity is from renewable resources. Last year's long hot summer caused TVA to exceed this capacity, which required purchasing power from other producers.

TVA has multiple options for producing power in order to ensure its commitment to reliable and affordable electricity to the service area in the future. Each of the options has unique capacities, cash flows, and useful lives.

Morgan wonders whether it would be better to go with longer-lived assets such as advanced nuclear or pulverized coal plants with expected lives of 30 years from the day construction is started, or shorter-lived assets such as advanced natural gas combined cycle, wind generation, or solar photovoltaic plants to take advantage of expected improvements in technology and production efficiency. Each of these alternatives has an expected life of 20 years.

Construction project costs and lengths also vary greatly. The $5.5 billion cost of a nuclear plant dwarfs the other alternatives and also has the longest construction time (4 years). A coal plant is less expensive to build (costing roughly one-third as much--$1.8 billion), but takes almost as long to build (3 years). Although much less expensive to construct ($650 million), a natural gas plant still requires 2.5 years for construction. Both of the renewable energy alternatives have short construction times (1 year); the costs differ significantly. The solar plant cost of $300 million is 20 times the cost of a wind plant ($15 million).

The alternative sources also have different production capacities. Coal and nuclear plants have significant production capacities (2,300 and 2,000 MW per year, respectively). The other alternatives have lower capacities. The gas plant's capacity is 720 MW per year, the wind plant's capacity is 150 MW per year, and the solar plant's capacity is 100 MW per year.

The cost of input materials also significantly affects the expected yearly cash flows from each production source. The cash inflows will begin in the year following the end of construction and will remain constant for the life of the asset. Given the long-lived nature of uranium, the nuclear plant's expected cash flow of $680 million per year is significantly higher than the other alternatives. The relatively high cost of production inputs used in the coal and natural gas plants reduces the expected cash flows from each of these plants to $97 million and $85 million, respectively. The expected yearly cash flow from the wind plant is $2 million; the yearly cash flow from the solar plant is $3 million.

Morgan thought, "There are so many factors that are unique to each of the production alternatives—capacity, reliability, input costs, etc. No one alternative dominates. What factors should I use to compare the alternatives? Are some factors more important than others?"

TVA recently revealed plans to retire multiple coal units by 2018 to comply with its goal to be a leader of clean energy. TVA will need to replace 5,670 MW of generation before these coal units are retired. Half of this generation will be met by converting the old coal plants with combustion turbines. At least 70% of the remaining needed capacity will be met with new base load generation; the remainder can be from peaking or intermittent transmission.

At least one thing should help. Since TVA has traditionally funded new power generation construction with debt, the low interest rates will reduce borrowing costs. In addition, the cost of capital used in discounted cash flow analysis should be easier to explain to those few "financially-challenged" board members, since TVA uses no equity costs in its capital budgeting process.

The TVA board will be looking to her for a plan to meet the customer needs within TVA's resource guidelines. Morgan wonders how she should evaluate the production alternatives, given their different cost and output characteristics. In addition, how do the other factors affect TVA's strategic direction? The meeting is scheduled for early Monday morning. Morgan realized that she wouldn't need those football game tickets after all.