FEATURES

ABSTRACT

Power plants, also called electricity generating stations, often present unique and interesting appraisal problems. Power plants can be worth billions of dollars or can have substantial liabilities. Their various technologies differ as much as those of motorcycles, cars, and trucks. Their markets are peculiar, with a mix of market forces and regulated affairs. The uses of the appraisals are also varied, ranging from acquisitions, financing, regulation, litigation, or property tax purposes, to IRS or SEC reporting. In this article, the issues, methodologies, and practice of power plant appraisal are reviewed.

The Appraisal of Power Plants

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Power plants, also called electricity generating stations, often present unique and interesting appraisal problems. Power plants can range in value from being worth billions of dollars to having substantial liabilities. Their various technologies differ as much as those of motorcycles, cars, and trucks. Their markets are peculiar, with a mix of market forces and regulated affairs. The uses of the appraisals are also varied, ranging from acquisitions, financing, regulation, litigation, or property tax purposes, to Internal Revenue Service (IRS) or Securities and Exchange Commission (SEC) reporting. The following discussion will address the issues and methodologies involved in power plant appraisal.

The Nature of Power Plants

Power plants generate electricity, their main product and income source, through a combination of processes depending on the technology. Most technologies convert one form of energy, such as chemical (heat from coal, gas, oil, or uranium to steam) or potential kinetic energy (gas, oil, hydro, wind, geothermal), to mechanical movement (turbines or engines) and then into electron flow (generators). Other technologies also exist, most notably solar. Power plants have other products and services, such as capacity revenue and other ancillary services, and these can be substantial sources of revenue.

Measures of Performance

The units of value for power plants are usually kilowatts (kW), megawatts (MW), kW hours (kWh), or MW hours (MWh). A common unit of performance is the *capacity factor*, which is analogous to occupancy/vacancy rates. Capacity factors measure what is actually produced compared to what could theoretically be produced, and are expressed as percentages. Capacity factors are driven by a combination of technological limitations and market demand. Typically, wind, hydro, and solar produce electricity only when there is wind, water, and sun. Nuclear and coal plants run nonstop until refueling or maintenance requires a shutdown. Gas turbines run when the market price for electricity supports the cost of operations. As plants age and become increasingly functionally obsolete, or less economically viable, their capacity factors fall, until economic infeasibility sets in. Table 1 shows the Energy Information Agency's (EIA's) estimates of typical capacity factors and life spans for a variety of different technologies, as well as a range of capacity factors encountered in the market.[1]

Another measure of performance is *heat rate*, which expresses the amount of heat energy needed to generate a unit of electricity. It is an expression of efficiency; the lower the heat rate is the better. The newer gas plants are so much more efficient that they often create obsolescence in older plants. Heat rates do not inform as to the impact of fuel prices. There are dramatic differences in the cost of different types of fuel. Table 2 shows the EIA data on typical heat rates and fuel costs for a variety of different technologies.

Another frequently used economic measure is the *spark spread*, which measures the difference between the price of the electricity and the price of fuel for a specific plant. It is useful to compare this to the sum of all other expenses at a specific plant at any given moment. As commodities, electricity and fuel prices can change from moment to moment, and frequently do so dramatically. Decisions to operate, or not to operate, must be made from moment to moment. When fuel prices are sufficiently lower than the price of electricity, it is financially feasible to operate the plant. Peaking plants, which generally run only when there is high demand, complete this analysis daily, sometimes hourly. Peaking plants, such as natural gas plants, may produce electricity only when electricity prices are high and fuel prices are low, as compared to base-load plants, such as nuclear, coal, and large hydroelectric plants, which

Table 1 Typical Capacity Factors and Life Span

	Capacity Factor		
Technology	**EIA Estimate**	**Market Experience**	**Life Span (yrs)**
Nuclear	90%	90%—95%	40—60
Coal	85%	50%—85%	55
Natural Gas	87%	3%—65%	35
Larger Hydro	52%	25%—60%	50—100+
Wind	34%	20%—35%	25
Solar	25%	18%—23%	25
Oil	10%—20%	0%—10%	25
Geothermal	92%	85%—95%	10—20

Table 2 Typical Heat Rate and Fuel Costs

Technology	EIA Heat Rate*	EIA Fuel Costs†
Nuclear	10,479	$0.70
Coal	10,498	$2.38
Natural Gas	8,039	$3.42
Hydro	N/A	$0.00
Wind	N/A	$0.00
Solar	N/A	$0.00
Oil	10,991	$12.48
Geothermal	N/A	$0.00

*Heat rate represents BTUs per kilowatt hour (BTU per kWh).
†Fuel costs are dollars per million BTUs ($/MMBTU).
Source: EIA *Annual Energy Outlook 2013*; data reported for 2011.

1. The US Department of Energy's Energy Information Agency (EIA) publishes volumes of reports on energy issues. The EIA reports are useful and are frequently used as benchmarks in the industry, but its data does not provide the accuracy needed for some appraisal work.

usually run regardless of the hourly fluctuations in electricity and fuel prices.

Unlike most general real estate, where it is extremely rare for prudent management to withhold renting space for temporary periods due to low market prices, peaking plants and older base-load technologies often prudently withhold production due to low market prices for electricity and/or high fuel costs. In effect, at those times the highest and best use analysis for these plants fails the test for financial feasibility, hopefully only temporarily. However, this may indicate economic or functional obsolescence. Since the decision to operate or not operate is an option, some power plant appraisals require option valuations, such as Monte Carlo simulations.

The various generation technologies have vastly different characteristics. Nuclear and coal are base load (intended to run nonstop for months at a time). They have historically represented the most common source of electricity in the United States, accounting for roughly 59%[2] of the supply. They are expensive to build, and construction takes many years. Natural gas is the supply technology at the margins, and in recent years has been taking away base-load market share from coal plants. In part this is because of advances in hydro fracturing extraction technology, which currently is lowering natural gas prices and therefore also electricity prices for all technologies. Natural gas plants are also generally less expensive to construct, and can be constructed in relatively short periods of time. Oil-fired power plants are rarely cost competitive at present, because petroleum prices are higher than the other energy sources for electricity generation. Hydro, solar, and wind have no substantial fuel expenses, but are very expensive to construct. There are numerous other less-common and developing technologies. Each technology has its own distinct physical and economic characteristics, and therefore appraisal considerations also must vary by technology.

Currently, there is no effective way to store electricity on a large scale. It must be consumed the moment it is generated. Further, the transmission and distribution grid (the grid) cannot contain any more or less supply than is precisely needed to meet current demand. Therefore, if demand increases or decreases in any given moment, the supply must be increased or decreased instantaneously in response. If demand increases over time, new grid additions are needed. Power plants must be located where the grid has an ability to receive the electricity, which is not always where the demand is located. This is both difficult and costly, and is why special payments, known as capacity payments, must be made to generators in order to ensure that the grid has the supply it needs the very moment it demands it and exactly where it needs it.

The demand for electricity in all markets changes substantially over time, both seasonally and hourly, with the summer afternoon hours often being the highest demand hours due to the need for air conditioning. In practice, in deregulated markets system operators make decisions for the grid about how much electricity to generate, and decide which plants will generate and which will not. The decisions are based on rules to minimize electricity prices, tempered with reliability and environmental considerations. In practice, system operators make dispatch plans a day in advance with hourly and sometime minute-by-minute adjustments. Generally, system operators plan well for day-ahead demand and supply. Still, electricity prices remain as variable as many commodity prices, and vary substantially throughout the year. Sometimes, such as during periods of unplanned maintenance at base-load plants or extreme weather, electricity prices can vary dramatically, as shown in the example in Table 3.

In the power generation industry, "at the margins" means when additional supply is needed to meet the newest or most-recent increment of demand. Under current market conditions, it is most likely a natural gas plant that will be dispatched to supply it. Base-load technologies, such as nuclear, coal, and larger hydro plants, are always dispatched first, because they are usually the least-expensive power. They are the least expensive because their fuel costs are lower and their very high original construction costs have been effectively paid down. Wind, solar, and small hydro plants are intermittent and are usually dispatched whenever they are available, as they are relatively inexpensive after construction subsidies are considered, and green initiatives prioritize these sources of energy. If this base-load and intermittent supply does not meet the demand in the market at any given moment,

2. EIA *Monthly Energy Review July 2014*; data reported for year 2013.

Table 3 Variability in 2012 Electricity Prices, PJM, Northern Illinois Hub

Statistic	($/MWh)
Average yearly price	$28.57
Average summer price (June, July, August)	$32.34
Average hourly price (9 am to 5 pm)	$32.51
Average hourly price (2 pm to 7 pm)	$35.29
Lowest yearly price	$0.00
Highest yearly price	$224.71
Range with one standard deviation below/above yearly average	$16.97/$40.17

Note: PJM is the system operator for the grid in a region of Illinois.

then other technologies such as gas and oil will be dispatched to fill the gap.

Each technology has its own economic life cycle. Power plants are more like automobiles than general commercial real estate in that they have finite physical and economic lives. Each type of power plant has unique construction costs and timing. Generally, nuclear, coal, and larger hydro plants take up to four to six years to build; gas and oil plants, as well as wind, take about eighteen months to complete and solar photovoltaic plants take around six months. Further, each type has its own operating costs. Consequently, it is difficult but not impossible to compare one technology to another. Such comparisons are needed for feasibility and planning, and government regulation, and are sometimes used in alternative-technology cost approaches and levelized cost of energy (LCOE) analyses.[3]

Power plants are complex combinations of real property, personal property (machinery and equipment), and often business intangibles[4] (like fuel supply contracts or power purchase agreements). The degree that a power plant consists of real or personal property or business intangibles depends on the definitions in the law that has jurisdiction over the appraisal context. For example, turbines may be considered to be real property in one state for ad valorem taxation, and personal property in another. They may also be classified as shorter- or longer-lived items for depreciation under state and federal law. Environmental safety improvements may be tax exempt in one state and fully taxable in another. Despite these complexities, the main revenues—electricity and capacity revenues—are earned from all the assets as a combination. It is rarely easy to discern what or how much of the income is attributable to real, personal, or business intangible property. Power plants are very rarely rented. The real property at power plants is also very rarely rented separately from the other assets, and when rented separately is usually part of structured financing that limits the lease's probative utility.

Electric Utility Deregulation

The electricity supply industry can be divided into four segments: generation, transmission, distribution, and miscellaneous services. Deregulation impacted the generation segment of the industry. Deregulation developed over a number of years and developed differently in different states. Many states are not yet deregulated. The differences have a critical impact on the appraisal of power plants.

The Federal Energy Regulatory Commission (FERC) was established in 1977 to regulate the electricity industry. Prior to 1977, the electricity industry throughout the country was conducted by state-regulated, vertically integrated monopolies (generation, transmission, and distribution). In 1992, the Energy Policy Act (EPACT), was signed into law. EPACT required open access for transmission in order to establish a wholesale electricity market. Utility monopolies could not refuse to transmit competitor's power over the monopolies' transmission and distribution grid.

3. *Levelized cost of energy* (LCOE) is the cost of generating electricity for a particular system, including all the costs of initial investment, operations and maintenance, fuel, and capital. The LCOE is the minimum price at which energy must be sold for an energy project to break even; http://www.nrel.gov/analysis/tech_lcoe_documentation.html.

4. *Intangible assets* include "non-physical assets such as franchises, trademarks, patents, copyrights, goodwill, equities, mineral rights, securities and contracts (as distinguished from physical assets) that grant rights and privileges, and have value for the owner." *International Glossary of Business Valuation Terms* available in Appraisal Institute, *The Dictionary of Real Estate Appraisal*, 5th ed. (Chicago: Appraisal Institute, 2010), 239.

In 1996, FERC issued Orders 888 and 889 to definitively resolve full wholesale power generation competition and open access to transmission and distribution. The intent was for each segment within the historically vertically integrated industry to be priced separately to prevent owners of transmission and power plants from offering preferential treatment to their own plants. As a result, public utility companies in many states have divested themselves of their electricy generating power plants into new "independent," deregulated companies, while retaining the regulated transmission and distribution activities. Also as a result of these acts and orders, the financial structure of the electricy generating industry changed from one of capital investment dependence (i.e., measured by construction cost) to one driven by competition and income (i.e., measured by operating income and expenses).

Impact of Deregulation on Appraisal

Today, only about one-third of the states are deregulated, and the country has two types of power generation markets: regulated and deregulated. Each has its own basis of value.

Regulated Markets. In the regulated monopoly states, the cost approach remains the best indicator of value, and the income capitalization and sale comparison approaches are rarely effective appraisal techniques. Historically, regulators allowed a regulated utility to construct power plant assets so that the utility could meet its obligations to provide electricity to consumers but only provide an adequate return to investors. The cost basis for the recovery (the rate base) was calculated to provide a predetermined return on investment for a plant, regardless of the economic fundamentals affecting the plant. As a result, appraisers rightfully favored cost methodologies because they more accurately reflected the true value of regulated power plants, as the regulating commissions had legally connected the income from the power plants to the cost of building the power plants. Efficiency and profitability were secondary concerns, but investment risk was low. In regulated power markets, income is fixed by regulation to the cost of construction, via a rate of return that is established by the regulating commission. Thus, the income capitalization approach is circular to the cost approach and is not probative to value.

In vertically integrated regulated utilities, power plants were rarely sold separately, and there was little or no market for such assets. In regulated markets, power plants are usually considered special property used solely by vertically integrated, regulated utilities. Thus, the sales comparison approach is also very rarely informative.

Deregulated Markets. Once the power market was deregulated, the legal link between cost and income was broken. Investors were required by the forces of economics, not regulation, to value electric generation power plants like any other income-producing asset—by forecasting the anticipated cash flows available to investors over the useful life of the investment. The value of a plant was no longer based on the cost to construct it but rather based on its profitability. Power plant developers would no longer be guaranteed a low-risk return (income) that matched their cost to build. Under deregulation, returns are not guaranteed and bankruptcy is a real possibility, but potentially higher returns are the new reward.

In deregulated markets, buyers, sellers, and analysts universally emphasize the income capitalization approach, where expected income and rates of return are based on unregulated market conditions. In deregulated markets, costs may be incurred, but the developer has no guarantee of making an adequate return. The cost approach in deregulated markets remains useful when the appraiser properly accounts for all forms of obsolescence, and the approach remains highly probative when appraising special improvements and assets within the combination of assets at a power plant. In a deregulated market, there is an active market for power plants separate from transmission and distribution assets. The sales comparison approach can be used when market data is sufficient, as with the sales comparison approach for any general commercial property. In conclusion, all three approaches to value usually can be applicable to power plants that are located in deregulated markets.

Cost Approach

Cost-Value Relationship and Disconnect

The basic concern surrounding the cost approach for power plants is that often cost does not equal value. When applicable, the cost approach reflects market thinking by recognizing that market participants sometimes judge the value of a power plant by considering the cost to create the improvements. However, depending on the cycle of the market and the age and legal status of the plant, simple, unadjusted cost is unlikely to equal market value. Unless the appraisal fully reflects all forms of depreciation (physical, functional, and external), then the cost estimate will diverge from market value.

The job of estimating each of the various forms of depreciation at power plants is often problematic and sometimes practically impossible. Unlike general real estate, where the property will continue to function if it is adequately maintained, even well-maintained power plants may suffer critical economic and functional obsolescence. Common types of obsolescence include obsolete engineering designs and inefficiency (from a poor original design or new technologies entering the market); obsolete environmental designs (legal/regulatory); original cost overruns; current operating-cost inefficiencies (excessive operating costs); and physical aging in a limited life span. Table 4 shows EIA data and market data on typical overnight construction costs for a variety of technologies. *Overnight construction costs* are the costs of construction if no interest was paid during construction, as if the project was constructed overnight. In Table 4, the interest expenses were estimated at a 7% interest rate over the period of construction in order to estimate the all-in costs of construction.

Cost Approach to Measure Parts of the Whole

While sometimes problematic for overall plant valuation, the cost approach is especially useful for appraising the different components of the overall power plant, including real and personal property, tangible and intangible property, taxable and non-taxable property, and the various classes of property at power plants. A power plant is sometimes referred to as a business combination, an overall asset, or a business enterprise.[5] The market value of the overall asset is referred to as the overall market value of the plant, or the value of a going concern.[6] The components are sometimes referred to as partial interests or asset classes. When used in conjunction with the sales comparison and income capitalization approaches, the cost approach affords one of the best appraisal techniques to allocate the market value of an overall asset to the various partial interests and asset classes of a plant.

Reproduction vs. Replacement Approaches

Both of the two main cost methods—reproduction cost and replacement cost—are regularly applied to power plants.

Table 4 Typical Construction Costs ($/kW)

Technology	EIA Overnight Costs*	Market Experience Overnight Costs	Time to Construct (yrs)	All-In Costs†
Nuclear	$5,530	$7,000	6.0	$10,641
Coal	$2,934	$2,800	4.5	$3,833
Natural Gas	$1,023	$1,100	1.5	$1,221
Hydro	$2,936	$4,000	5.0	$5,671
Wind	$2,213	$2,500	2.0	$2,875
Solar	$4,183	$2,000	0.5	$2,071
Oil	N/A	$800	1.0	$858
Geothermal	$4,362	$4,500	3.0	$5,548

* EIA *Annual Energy Outlook 2013*.
† Includes interest during construction; interest expense computed at 7.0%.

5. A *business enterprise* is "a commercial, industrial, service, or investment entity (or a combination thereof) pursuing an economic activity." Ibid., 237.
6. *Going concern value* is "the value of a business enterprise that is expected to continue to operate into the future. The intangible elements of Going Concern Value result from factors such as having a trained work force, an operational plant, and the necessary licenses, systems, and procedures in place." Ibid., 238.

Trended Original Cost Method

Although rarely utilized to value general real estate, the trended original cost (TOC) method, a type of reproduction approach, is frequently used for electric utility assets. Historical cost information, even if decades old, is regularly available on power plants.

In a TOC analysis, the reproduction cost new (RCN) is computed by trending the original (historical) construction costs to the effective date of the appraisal. This methodology is widely recognized by power plant appraisers, regulators, and courts. This is the predominant appraisal technique in regulated states for rate-base analysis. The usefulness of the TOC method is contingent on the accuracy and completeness of the historical cost information and on the trending method used. To successfully use trending, the costs by date of expenditure must be reliable and available for each class of assets for the entire plant, and the costs must also include capital repairs made since original construction.

Various widely accepted cost trend references provide the basis for the trending of power plant construction costs. The indices do not give prices for specific cost items in either the historical period or the current period. Rather they provide the change in cost, the delta, between the different dates. Appraisers apply that delta to the actual original cost at the subject plant to get an RCN as of the appraisal date. The proper indices can be applied to specific cost items, such as bricks, or to whole categories of power plant items, such as turbine generators.

Cost per Capacity Method

The cost per capacity method is a replacement cost approach. Cost per capacity is estimated by multiplying unit cost (usually $/kW of capacity) by the number of units at the subject plant. The unit cost can be developed from a variety of sources including research publications, government estimates, contractor estimates, manufacturer estimates, owner estimates, or the comparative-unit method.

The cost per capacity method is relatively practical and is used by many market participants because of its simplicity and availability. However, the apparent simplicity of the cost per capacity method can be misleading. It is sometimes difficult to reconcile the vast differences between the various cost sources and the subject plant, and between this cost approach and the other approaches. Also, this method often is less precise than others.

Alternative Technology Analysis

An alternative technology analysis (ATA) is a replacement cost technique. It is based on the principle that value is based on the functionality that the improvements afford its owner, not the materials and design used to make the improvements. This approach assumes that it is not the details of how the improvements generate the power that create value, but rather that the improvements generate a certain quantity and quality of power that is marketable in a certain way. For example, when appraising a nuclear power plant, an ATA could consider the cost to build a natural gas technology alternative plant with an identical MW rating and capacity factor. The ATA would consider the capital expenditure differences as well as the performance, operating, and fuel expense differences between the nuclear plant and the alternative gas plant.

Today, the popular choice for the alternative technology to use in such an analysis is natural gas, in part because it is the technology at the margins. For appraisers, who understand the importance of using comparable sales or replacement costs that match the functionality and highest and best use of the subject property, the ATA method is understandably valid. Some non-appraisers and courts have difficulty accepting this technique, even though it is commonly employed by market participants.

Depreciation

Physical Deterioration

Estimating physical deterioration is often the main source of concern about the validity of a cost approach on power plants. Typical depreciation techniques can be as simple as a single age-over-life ratio or as complicated as the breakdown of the subject's assets into their various components for individual consideration.

Models based on the economic age-life method are among the most widely used depreciation techniques for power plants. Physical deterioration can be estimated by the straight-line method, and by the age-life method, using mortality dispersion techniques. Often the effective age plus the remaining useful life is equivalent to the service life. Accounting and bookkeeping lives are not appropriate for appraisal purposes. Physical life may be longer than the average service life, but it may not accurately represent the usefulness of the service of an asset due to economic or legal reasons. The effective age should reflect the conditions of the plant, which often are not the chronological (actual or historical) age. It should also be recognized that the expected remaining service life of a plant might change during its life cycle for reasons other than progressing chronological age (i.e., economic or legal reasons).

Functional Obsolescence

Functional obsolescence is common at power plants and is often easily spotted. The types of functional obsolescence frequently found include deficiencies requiring an addition, deficiencies requiring a modification, deficiencies requiring additional operating costs, and super-adequacies. Often these deficiencies are incurable, in both the short and long term. Given that the reproduction approach is common for plants, but does not intrinsically exclude functional obsolescence, appraisers will expend considerable effort on determining functional obsolescence.

Economic Obsolescence

Changes in market demand, transmission and distribution, federal or state law, the economy, and any operational constraints external to the asset frequently cause economic obsolescence at power plants. Usually their impact on value can be measured by capitalizing the expected losses in earnings over the period that the condition is expected to exist. In the broadest sense, since deregulation was instituted, the capital improvements made before deregulation may no longer have the ability to produce the originally expected return on the investment. This loss in potential creates a form of economic obsolescence that is known as *stranded costs.*

Common techniques used for estimating functional and economic obsolescence include the capitalization of excess operating costs and the capitalization of income shortfalls. In both, income capitalization techniques are employed to evaluate the loss in value from specific operating or capital costs, or from an inability to earn income. While not adequate to measure the value of the obsolescence, the existence of obsolescence is often easily discovered by comparing overall income and sales values to the replacement cost new less physical depreciation (RCNLD). Any difference can be attributed to either functional or economic obsolescence or both.

Levelized Cost of Energy

An example of functional and economic obsolescence can be seen in Table 5. It is not enough to compare the cost to construct different types of power plants to measure the obsolescence. Fuel, for example, plays a major role in obsolescence. The table reflects the construction costs combined with fuel, operating expenses, and other considerations, such as financing costs, time to construct, capacity factors, and life spans. The table does not reflect the impact of current government incentives. Nor does it reflect external costs (pollution, decommissioning costs, transmission costs) or historically paid incentives and infrastructure (nuclear R&D, railroads, gas pipelines). The table shows that some technologies do not compete effectively. In practice, conditions at each plant vary substantially, making the obsolescence either better or worse.

Table 5 Levelized Cost of Energy ($/MWh)

Technology	EIA*	Market Experience	Reflecting Incentives	Reflecting External Costs†
Nuclear	$108.40	$46.08	$41.73	$49.35
Coal	$123.00	$47.17	$47.17	$49.98
Natural gas	$65.60	$52.17	$52.17	$52.17
Hydro	$90.30	$27.05	$27.05	$27.05
Wind	$86.60	$57.18	$46.24	$46.24
Solar	$144.30	$57.43	$45.61	$45.61
Oil	N/A	$556.37	$556.37	$564.21
Geothermal	$89.60	$59.21	$47.49	$47.49

* *EIA Annual Energy Outlook 2013*.
† Reflects decommissioning and external pollution abatement costs.

Land Value

The land at power plants often contributes little to the overall value. An across the fence method,[7] assuming highest and best use similar to the properties from "across the fence," is typically employed to measure the value of the underlying land. The value of licenses, permits, and approvals for the power-generation activity, which can be substantial, are generally accounted for in the soft cost of construction.

Real, Personal, and Business Residuals

Depending on the use of the appraisal, there are occasions when the value of some real and personal property, and business intangibles must be removed from the overall plant valuation. For property tax appraisal purposes, the value of any tax exempt property must be removed. For IRS and SEC reporting, the value of existing contracts must be separately reported from the rest. A residual technique is often the best method to isolate the value of the target assets. In general real estate appraisals, a land residual is where the overall real estate value ($V_{l\&b}$) minus building value (V_b) equals land value (V_l). In power plant appraisals, the residual formula is overall plant value (V_p) minus excludable value (V_{ex}) equals the value of the balance of the plant (V_{bal}), which is the appraisal target value of the subject property (V_s).

In property tax appraisal, excludable property commonly includes fuel inventory, pollution control improvements, contracts for fuel supply, contracts for the sale of electricity, power purchase agreements, workforce in place, specialized documents (including policies and procedures, manuals, computer software, and drawings), and working capital accounts. As discussed earlier, the cost approach is usually the best method to estimate the value of the excludable tangible property. The value of fuel inventory and of the workforce in place is usually estimated via avoided cost methods. Contracts are usually appraised via a comparison of the plant income streams with and without the contracts, in the same way that a leasehold analysis compares fee simple income streams to leased fee income streams.

Sales Comparison Approach

While the use of the sales comparison approach is common in the appraisal of general commercial properties, this approach is rarely useful in power plant appraisals. Research for information on sales of comparable power plants rarely yields appropriate and adequate data for use in a credible sales comparison approach. The market for power plants is national, and sometimes international. It is relatively easy to find evidence of an active sales market. However, relevant critical details about the individual sales are often unattainable. An important qualification of each credible comparable sale is the level of supporting data that is publicly available. Since many details concerning the sales of power plants are confidential, the sales are not adequately verifiable and/or cannot be soundly adjusted. Since power plants are typically business combinations, the sales are for combinations of assets: real, personal, and business assets. Most sales include corporate (business) and personal property assets. Further, these transactions often include assets beyond the tangible power plant, such as investment participation, financing, partial interests, offtake and supply contracts, and other valuable closing contingencies.[8] Buyers and sellers are under no obligation to publicly report the portion of the price attributable to the parts of the total sale price in a format that is useful to appraisers. For example, many power plant sales include power purchase agreements (PPAs), which usually have significant price-impacting characteristics. However, it is typically unclear from the publicly available data on the transactions what effect the PPAs had on each sale price. While there frequently is available data to identify comparable sales, there is not sufficient public data in many cases to complete a credible appraisal adjustment process.

A variety of adjustments are needed in the sales comparison approach. Market condition adjustments are important as values for power plants change frequently due to macroeconomic conditions, including trends in the general economy, fuel prices, regulations, and green energy. Adjustments for physical characteristics are typically made for plant design, fuel type, unit size, shutdown units, capacity factor, heat rate, plant condition, age, superadequacy,

7. The *across the fence method* is "a land valuation method often used in the appraisal of corridors. The across the fence method is used to develop a value opinion based on comparison to abutting land." *Dictionary of Real Estate Appraisal*, 5th ed., 3.

8. An *offtake contract* is an agreement between a producer of a resource and a buyer of a resource to purchase/sell portions of the producer's future production; *Investopedia*, www.investopedia.com/terms/o/offtake-agreement.asp.

functional utility, and remaining license life. However, the required adjustments for these factors often cannot be made reliably because many physical characteristics of the comparable plants are not released as public information.

Location-based revenue differences also should be analyzed, as electricity prices are usually dependent on the location of each plant. Other locational differences may include the proximity and availability of electric transmission lines, transmission congestion and bottlenecking, water supply, rail lines, and docks. Environmental conditions and the distance to switchyards and substations can have a significant impact on the locational value for a plant. Additionally, adjustments related to income tax differences may be necessary, as taxes are an important factor in the going concern value of each plant. For example the tax incentives play a major role in the feasibility of wind and solar.

It must be recognized that if the appraiser succeeds in finding adequate sales data and completes a credible sales comparison analysis, the resultant value will most likely be of the business combination. That going-concern value will need to be allocated to the real and personal property if that is the purpose of the appraisal.

Income Capitalization Approach

Traditionally, income strictly attributable to the real property of general commercial properties, such as offices and apartments, is ubiquitously prescribed by real estate leases or the market potential to be leased. There is no such rental market for power plants. Nonetheless, power plants are income-producing assets where the income is generated by the operation of the combination of real and personal property and any business intangibles.

At power plants, there is typically no credible and reliable way to isolate the income solely attributable to the real property, such as a lease. The income used in the income capitalization approach is from operation of the combined assets of the going concern or the business enterprise. Such intermingling conditions also exist at many other types of commercial property, such as hotels, theaters, hospitals, telephone companies, water companies, landfills, race tracks, and factory mills, among other types. The real property is rarely leased separately at these property types, and the income typically analyzed is from their business operations, just like at power plants. Given this issue, the appraiser must first conclude an overall business value of the going concern for the plant, and then employ various appropriate appraisal procedures to separate out the value of the real and personal property or other target interest at the plant. This is standard practice in the valuation of power plants.

The holding period for power plants is driven by physical considerations as well as legal, regulatory, and contractual conditions, and it is often prescribed by common practice among market participants. Under cost-of-service regulations, the holding period of a plant is the same as its expected useful life. For a deregulated power plant, the holding period is typically estimated based on its finite physical and economic life. In both cases, analysts look to the finite remaining life of the plant to form the basis of the holding period. As such, it is common practice to assume a holding period equal to a plant's estimated remaining economic life. Consequently, some discounted cash flow (DCF) analyses are projected for as long as 55 years.

Reversionary Value

A reversionary value is assumed in most DCF analyses for commercial real estate. This value captures the income generated from the asset after the end of the holding period, and it is typically calculated by using a direct capitalization method and then discounting that value to the valuation date. However, unlike general real estate, power plants have relatively short, finite lives. When the holding period for a power plant is assumed to be equal to its remaining economic life, then there will typically not be a reversionary value for the plant at the end of the holding period.

Assumptions made about disposition of the remaining assets (or liabilities) may be broken down in three categories: decommissioning liability, salvage value, and land value. In some cases, power plants carry a decommissioning fund that will be used to fully decommission the plant, eliminating a large future liability. In other cases, the plant will require expensive demolition and remediation work. These assumptions will determine the appropriate manner to estimate any reversionary value, positive or negative. Often, power plant appraisers conclude that the sum of the three reversionary considerations net to a zero value.

When a direct capitalization method is completed, the capitalization rate must be adjusted upward to reflect the fact that the income and value decline to zero over the holding period, since the reversionary value of a plant with a finite life is zero. It is common practice in power plant valuation to avoid this issue in DCF reversionary capitalization rates by setting the holding period equal to the plant's remaining economic life. In practice, only DCF analyses of larger hydro plants usually contain a reversionary capitalization of the plant's income, because their very long useful lives often approach infinite lives like with general real estate.

Power Purchase Agreements

Plant owners regularly contract in advance to sell their power to bulk consumers via power purchase agreements (PPAs) instead of selling power in the daily mass markets of the independent service operators (ISOs).

PPAs fall into two broad categories: those that have contract prices for the electricity at or near market prices, and those that have contract prices at substantially above or below market prices. Those that have contract prices for the electricity at substantially above or below market prices are often between related parties, or there might be more to the transaction than just the sale of electricity for a price. These PPAs do not meet the criteria of market-indicative transactions and cannot be used to determine market value for parts of the plant such as the real estate or personal property; however, these PPAs can certainly indicate the value of the going concern. This is analogous to appraising an office building's market value based on inter-company leases or sale-leasebacks that are not based on market terms. In such cases, if the purpose of the appraisal is to determine market value assuming fee-simple conditions, the atypical office leases are replaced with normal market-based terms.

Installed/Nameplate Capacity

The installed or nameplate capacity is the plant's claimed capacity designated by the manufacturer or by a capacity rating agency; capacity is usually described in MWs or kWs. Nameplate capacity is the amount of energy a power plant can produce instantaneously, not the amount it will generate over a period of time. Installed capacity and capacity factor assumptions are combined to forecast electricity available to be sold over time. Capacity factors vary from winter to summer and location to location for the same equipment based on construction, altitude, and local ambient temperature and humidity.

Independent Service Operators (ISOs)

In deregulated markets, merchant plants sell their electricity in markets operated and managed by ISOs. Analogous to trading floors, the power producers and buyers consider ISOs their primary public market. ISOs organize the markets, establish trading rules, and document market transactions and prices. The ISOs publish volumes of market data useful to the appraiser, including data on general market supply and demand.[9]

Long-Term Trending

Unlike DCF forecasts for general real estate, which are commonly for 10 years, power plant forecasts are commonly for 25 to 35 years, with some for as long as 55 years. The Consumer Price Indices (CPIs) provide an excellent source for forecasting electricity rates, fuel prices, and the general expense rate of inflation over the very long term.

The CPIs are well documented, and power plant market participants often rely on them. The data reveal a number of important trends. For example, electricity rates largely have not kept pace with general inflation over the decades. One theory is that commodities, like electricity, trend at rates lower than other products and services in the economy, and the CPI is the average of all products and services. Another theory is that deregulation, which began in the late 1990s and was supposed to lower electricity prices, has been effective.

The data also show that in the short term, price trends for any given plant will be driven by local market conditions. Appraisers must examine local plans for plant retirements and new additions as well as transmission constraints, and fuel supply conditions. These local trends can cause local prices to trend in dramatically different fashion than the long-term CPI trends, until a new market equilibrium is achieved.

Alternatives to trending prices using the CPI include using EIA long-term price forecasts,

9. For example, market data on historical electricity prices in the New York ISO can be seen at www.nyiso.com/public/markets_operations/market_data/pricing_data/index.jsp.

forecasts by other public entities, and information from private forecasting companies.

Fixed and Variable Expenses

Operations and maintenance (O&M) expenses are analyzed as is normally done in the appraisal of income-producing properties, with one exception. Considerable special efforts are typically made to forecast fuel expenses, separate and apart from other O&M expenses. Also, parent company administrative expenses may need to be apportioned down to the subject plant when the plant is owned and managed in a portfolio of plants.

Income Taxes

Unlike nearly all appraisals of general real estate, power plant income approaches are usually completed after deducting income taxes. This is useful and often necessary for several reasons. A major contributor to the value of many plants is its effective income tax rate. Power plants often have tax benefits, including accelerated depreciation, investment tax credits, exemptions, or others. Also, while traditional real estate appraisals are completed before income taxes and most of the theory and data in the real estate appraisal community is arranged for before-income tax analysis, business appraisals are traditionally completed on an after-income tax basis. Most of the financial market data available for the power industry is on an after-income tax basis, and nearly all market participants appraise on an after-income tax basis. In theory, both before- and after-income tax appraisals should yield the same indication of value, but only when the tax benefits are fully and properly adjusted for. Another advantage of the after-income tax analysis is that the inputs and adjustments are explicit and thus available for easier review.

When forecasting the tax rate for a power plant, it is necessary to use an effective income tax rate for the market. Plant owners rarely pay the statutory tax rates. This includes both federal and state income taxes but adjusts for typical exemptions, deferments, and abatements. Capital expenses, depreciation, and interest expenses must be determined in order to compute the effective income taxes. Depreciation expenses should be calculated utilizing the modified accelerated cost recovery system (MACRS). However, simpler methods may be acceptable in some cases. The power generation industry relies heavily on debt financing. If the goal is to estimate market value, appraisers forecast this expense by applying industry or market-specific interest rates as of the valuation date to the portion of the plant's value that is estimated to be financed with debt.

Capitalization and Discount Rates

Theoretically, there are several possible methods for estimating capitalization and discount rates, including market surveys, extraction from market sales, and various mathematical financial formulas. Extraction from power plant sales very rarely yields sound and adequate data. Also, there are no surveys of power plant capitalization and discount rates. Therefore, rates are usually determined using well-known financial formulas.

Power plant appraisers frequently complete a formula-based analysis of discount rates known as the weighted average cost of capital (WACC)[10] in the business appraisal community. In the real estate appraisal community, this formula is recognized as a band of investment formula.[11] The major difference is that the band of investment formula is typically used to determine capitalization rates for real estate before income taxes, while the WACC is typically used for discount rates after income taxes. The basic elements of yield (or capitalization) rates are debt and equity yield. When combined, they indicate the overall investment yield. This cost of capital analysis is "weighted" because it incorporates the percentage of the total investment that debt contributes and the percentage that equity contributes, which is a weighted-average concept. Algebraically, the WACC analysis is expressed in the following equation:

10. *Weighted average cost of capital* is "the cost of capital (discount rate) determined by the weighted average, at market values, of the cost of all financing sources in the business enterprise's capital structure." *International Glossary of Business Valuation Terms* available in *Dictionary of Real Estate Appraisal*, 5th ed., 240.

11. *Band of investment* is "a technique in which the capitalization rates attributable to components of a capital investment are weighted and combined to derive a weighted-average rate attributable to the total investment." *Dictionary of Real Estate Appraisal*, 5th ed., 16.

Formulaic Derivation of an After-Income Tax Discount Rate

Weighted Average Cost of Capital

$$Y_o = (M \times Y_m \times (1-t)) + ((1\text{-}M) \times Y_e)$$

where:

Y_o = overall yield rate

M = debt to value ratio

Y_m = debt yield rate

Y_e = equity yield rate

t = effective income tax rate

Equity and Debt Yields

There are several well-developed theories and widely used effective methods for estimating the equity cost of capital, including the build-up method and the capital asset pricing model (CAPM).[12] The build-up method is an additive model in which the equity return on an asset is estimated as the sum of a risk-free rate and one or more risk premiums. The risk-free rate is usually long-term US government bond yields. The risk premiums adjust for risks associated with systematic and unsystematic risks, size, and industry risk, illiquidity, and managerial effort and others. The CAPM formula takes into account the sensitivities to non-diversifiable risk (also known as systematic risk or market risk), often represented as a beta coefficient.[13] Like the build-up method, it begins with the expected return of a risk-free asset and then adjusts for the market-wide expected return. There is much literature on both the build-up and CAPM formulas, and thus they will not be covered further here.

Debt rates are estimated the usual way with one exception. The pre-income-tax debt rate is adjusted for the ability to deduct debt interest expenses from income taxes, by multiplying the cost of debt by one minus the effective tax rate.

Working with Other Professions

The power plant appraiser will frequently join with professionals from other disciplines in order to complete a power plant appraisal. Power plant appraisals often benefit from consultation with professional engineers. In fact, some states and courts require it. Further, appraisers regularly use the services of electricity- and fuel-price forecasters. Other professionals may include regulatory experts, economists, mathematicians, attorneys, and accountants who have expertise in some element related to the appraisal problem at hand.

Reconciliation for Overall Value

There are two considerations one must weigh when applying various approaches to value. First, appraisers should use those approaches commonly utilized by market participants.[14] Second, the supply of data within a market, or within a particular timeframe, may preclude the development of indications of value by one or more of the approaches to value commonly employed in other appraisal practice areas.

Generally, the sales comparison approach is not employed to determine the value of power plants due to the lack of reliable public market data. Within regulated markets, the cost approach is most often employed. In deregulated markets, all three approaches are frequently employed. However, in deregulated markets the income capitalization approach is the primary method used by market participants, and it is typically the approach prescribed by appraisal theory as being the most appropriate.

Allocations

In power plant valuations, the income capitalization and sales comparison approaches usually indicate going-concern values rather than purely real estate or personal property values. The appraiser must exercise care to report which type of value is concluded as of each point in the appraisal. If the purpose of the appraisal is to report the value of something other than the overall business value, as indicated by the income capitalization or sales

12. William F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk," *The Journal of Finance* 19, no. 3 (Sept. 1964): 425–442.

13. Ibid.

14. In USPAP, Standards Rule 1-6 states, "In developing a real property appraisal, an appraiser must: (a) reconcile the quality and quantity of data available and analyzed within the approaches used; and (b) reconcile the applicability or suitability of the approaches used to arrive at the value conclusion(s)." Appraisal Standards Board, *Uniform Standards of Professional Appraisal Practice*, 2014–2015 ed. (Washington, DC: The Appraisal Foundation, 2014),

comparison approaches, then some further analysis beyond the overall value from such approaches will be necessary. A cost approach analysis may or may not have been completed in a manner to indicate directly the target value to be appraised. If a unit-in-place cost approach was developed, then business intangibles were likely excluded, but real and personal property may still be intermingled, requiring further analysis. If a trended original cost approach was employed, it may have reported the value of real and personal property separately. Typically the further analysis will include the use of various allocation techniques.[15] Extraction techniques are not typically utilized due to the lack of detail usually available in the market data.[16]

Unitary Valuation

Sometimes it is more credible and reliable to appraise a single power plant by utilizing a unitary method of valuation.[17] Commonly used in some states for property taxation, unitary valuation is a type of allocation where the first step is to appraise the entire company that owns the subject plant alongside other business activities and assets. After concluding the value for the company, techniques are used to allocate the portion of the business value attributable to the subject plant. Lastly, if needed, the allocated plant value is further allocated to real and personal property and business intangible values.

Conclusion

Appraising power plants is a specialty practice and requires the utilization of infrequently employed appraisal theory and techniques, but in the end, no new practices will be needed for the well-read appraiser.

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15. *Allocation* is a method of estimating land value in which sales of improved properties are analyzed to establish a typical ratio of land value to total property value and this ratio is applied to the property being appraised or the comparable sale being analyzed. *Dictionary of Real Estate Appraisal*, 5th ed., 7. While written using land and building as examples, the underlying principle can be applied to other parts of an overall asset.
16. *Extraction* is "a method of estimating land value in which the depreciated cost of the improvements on the improved property is calculated and deducted from the total sale price to arrive at an estimated sale price for the land." Ibid., 73. While written using land and building as examples, the underlying principle can be applied to other parts of an overall asset.
17. In assessment, the unit rule is a method that values the property within a particular jurisdiction based on the fair share of the value of an operating enterprise of which the property is an integral part. The unit value concept values all the property as a going concern without geographical or functional division of the whole and includes tangible and intangible assets. The unit rule concept is typically associated with the valuation of public utilities, telecommunications networks, railroads, and other transportation properties. *Dictionary of Real Estate Appraisal*, 5th ed., 202.

Web Connections

Internet resources suggested by the Y. T. and Louise Lee Lum Library

American Public Power Association, Resources
http://www.publicpower.org/resources/

Electric Power Research Institute
http://www.epri.com

Federal Energy Regulatory Commission
http://www.ferc.gov

General Electric Power and Water
https://www.gepower.com/

National Renewable Energy Laboratory
http://www.nrel.gov/

Nuclear Energy Institute, Resources and Stats
http://www.nei.org/Knowledge-Center

US Department of Energy
—Office of Nuclear Energy
http://energy.gov/ne/office-nuclear-energy

—Energy Information Administration
http://www.eia.gov/

US Nuclear Regulatory Commission
http://www.nrc.gov/