ELECTRIC GENERATION SCENARIO MODELLING WITH UNCERTAIN FUTURE CO_2 PRICING

[Joel R.Theis, National Energy Technology Laboratory, 412-386-7333, Joel.Theis@netl.doe.govl]
[Charles A. Zelek, Phd., National Energy Technology Laboratory, 412-386-7304, Charles.Zelek@netl.doe.govl]
[Christopher J. Nichols, National Energy Technology Laboratory, 412-386-4172, Christopher.Nichols@netl.doe.govl]
[Peter C. Balash, Phd., National Energy Technology Laboratory, 412-386-5753, Peter.Balash @netl.doe.govl]

Overview

The development of new electricity generation in the U.S. has become more uncertain recently with the change of administrations and the uncertainty surrounding environmental regulations. Conventional power generation, namely coal- and gas-fired generation, have operational lives of over thirty years, and guessing how U.S. environmental policy might evolve will likely be addressed by investors in different ways. Many reported studies involve planning models that may include different costs of capital for different types of generation. The cost of capital (CoC) is defined as the cost of debt and the return on common equity required for investors to invest in new power generation. The CoC also incorporates risks perceived by investors. If investor risks are not incorporated accurately in the CoC, there is potential for results to be misleading, possibly leading to misguided investment choices.

This paper demonstrates how the misspecification of the CoC can lead to inaccurate electricity generation results in scenarios that are included in the aforementioned studies, and suggests that a method be used, such as the capital asset pricing model (CAPM), as a methodical and disciplined approach in scenario analysis for ensuring unbiased results in modelling future electricity generation resource plans. First, the difference between selecting a CoC for immediate financing of a generation project and financing a future project is provided. Subsequently, examples are provided that indicate significant differences in the levelized cost of electricity (LCOE) can occur with different CoC choices. The National Energy Modelling System (NEMS) is also used to demonstrate differences that can occur in resource selection when a risk penalty is incorrectly added to the CoC for fossil generation.

Methods

Choosing a CoC for immediate financing of a project and for financing a generic project several years into the future involves different investor perspectives. For immediate financing, the investor is known and a more specific approach to applying the CAPM is typically taken than the approach used for financing generation in the future when the investor is not specifically identified. The CAPM method of selecting a CoC for new generation is reviewed along with these differences. However, with uncertainty about future economic or regulatory conditions, one might be inclined to add a penalty (or additional premium) to the CoC for the future financing of select generation to account for the regulatory uncertainty. An increase of more than 1 percent in the CoC is shown to be significant in models that use a LCOE for new generation comparisons. The National Energy Modelling System (NEMS) is used to simulate scenarios with the correct and incorrect specification of the CoC to demonstrate the influence of a risk penalty on selecting generation in a resource planning model.

For illustration, one method that might be chosen to evaluate new generation is to apply a risk penalty to the CoC for generation emitting greenhouse gases such as methane and CO_2. For instance, one might determine that the cost of debt will be 6 percent for technologies that do not emit CO_2 and 7, 8, or 9 percent for technologies that do emit CO_2. In this case, the amount of the increase above 6 percent is referred to as the risk penalty for the cost of debt. Similarly, one might determine that the required return on equity for investors in new generation emitting CO_2 will be 1, 2, or 3 percent higher than for generation that does not emit CO_2. Scenarios are simulated in NEMS depicting economic growth in the U.S. that supports the addition of new power generation, and the risk penalties are applied to demonstrate how applying them incorrectly results in outcomes that would be significantly different if investor uncertainty were treated consistently across resource types. In addition, a cash flow analysis is used to demonstrate how applying a risk premium adder to the CoC for different fossil fuel generation could result in the implicit pricing of carbon so that an investor would have inconsistent views on the price per ton of CO_2.

Results

It is shown that specifying a risk penalty for the CoC can have a significant influence on the (LCOE) for a power plant. Simple LCOE calculations result in 1.5 to 4 percent increases for a 1 percent risk penalty. The LCOE increases by more than these amounts as the risk penalty increases. In a resource planning model, this translates into

significant differences in the amount and type of capacity that is selected for installation. Results from the NEMS modelling of three different scenarios shows that the risk penalty does influence the choice of new generation. Depending upon scenario assumptions, a 3 percent penalty in the CoC can eliminate some generation from being selected as viable. Furthermore, misspecifying the CoC by inconsistently applying a risk penalty adder results in pricing signals for the price per ton of CO_2 that misrepresent investor uncertainty.

Conclusions

Many studies that are widely circulated convey to investors and political leaders the outlook for future electric power generation. In these studies, the CoC usually has a role in the choice of power generation portrayed by these studies. Accordingly, this paper provides support for using common industry methods in selecting the CoC; the capital asset pricing model (CAPM) is suggested to be adequate in this regard. By developing appropriate levels for the cost of debt and return on equity for each generation type using the approach described in this paper for modelling generic resources, an analyst can avoid misrepresenting investor uncertainty. Furthermore, these results support modelling uncertainties in scenarios explicitly with assumptions about fuel costs, heat rates, CO_2 prices, and economic factors consistent within a scenario. With this approach, one can avoid having the CoC be the determining factor for the selection of new power generation in scenario modelling. Finally, if a risk penalty is applied to the CoC for electricity generation without demonstrating the validity of it through a commonly used industry method, the penalty can result in an outlook for new electricity generation that is misleading to investors, political leaders, and the public.

References

1. FERC Order No. 888, “Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities”, 61 Fed. Reg. 21,540, May 10, 1996.
2. FERC Order No. 2000, “Regional Transmission Organizations”, 65 FR 809 (January 6, 2000). 89 FERC ¶61,285 (December 1999).
3. J. Ishii and J. Yan, "Investment under Regulatory Uncertainty: U.S. Electricity Generation Investment 1996-2000," 2011.
4. International Energy Agency, Climate Policy Uncertainty and Investment Risk, Paris, France: International Energy Agency Publications Service, 2007.
5. K. Neuhoff, "Investment Decisions Under Climate Policy Uncertainty," University of Cambridge, Cambridge, England, 2007.
6. L. Tuthill, "Investment in Electricity Generation Under Emissions Price Uncertainty: The Plant-Type Decision," Oxford Institute for Energy Studies, Oxford, England, 2008.
7. P. Reinelt and D. Keith, "Carbon Capture Retrofits and the Cost of Regulatory Uncertainty," Energy Journal, vol. 28, no. 4, pp. 101-127, 2007.
8. B. Litterman, "What is the Right Price for Carbon Emissions?," Regulation, pp. 38-43, Summer 2013.
9. M. Allen et al., "Climate Change and Capital Markets," Stanford Graduate School of Business, Stanford, CA, 2015.
10. S. Kaplan, "Power Plants: Characteristics and Costs," Congressional Research Service, Washington, D.C., 2008.
11. J. Riesz et al., "Quantifying key uncertainties in the costs of nuclear power," International Journal of Energy Research, vol. 41, no. 3, pp. 389-409, 2016.
12. P. Simshauser, "The cost of capital for power generation in atypical capital market conditions," Economic Analysis and Policy, vol. 44, no. 2, pp. 184-201, 2014.
13. J. Makholm, "A Half-Century of Computing the Cost of Capital for Utilities at NERA," NERA Economic Consulting, Washington, D.C., 2015.
14. Damodaran, "Equity Risk Premiums (ERP): Determinants, Estimation and Implication - The 2011 Edition," SSRN Electronic Journal, 2011.
15. R. Sakar, "Future carbon regulations and current investments in alternative coal-fired power plant technologies," Energy Policy, vol. 35, no. 2, pp. 1064-1074, 2007.
16. Bodie, Kane, and Marcus, Investments, 3rd Edition, 1996. pp. 236-265.
17. W. Blyth et al., "Investment risks under uncertain climate change policy," Energy Policy, vol. 35, pp. 5766-5773, 21 August 2007.
18. S. Chretien and F. Coggins, "Cost of Equity for Energy Utilities: Beyond the CAPM," Energy Studies Review, vol. 18, no. 2, pp. 17-43, 2011.
19. M. Yang et al., "Evaluating the power investment options with uncertainty in climate policy," Energy Economics, vol. 30, no. 4, pp. 1933-1950, 2008.