REVIEW DRAFT – January 2005

CAPM Valuation of Conventional And Renewable Electricity Generating Technologies

Or

Estimating Electricity Generating Costs: A CAPM Approach

The Effects of Market Risk and Taxes

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January 2004

FOREWORD

The techniques by which we value new technology have received considerable attention over the last two decades, with much of the interest focused on innovative capital-intensive manufacturing process technologies such as computer-integrated-manufacturing (CIM). This effort to develop improved cost measurement tools spawned new insights and procedures for estimating the costs and benefits of new manufacturing technologies and practices. Ironically, in spite of these developments, manufacturing firms in the US and elsewhere failed to adapt their investment choices until global competitive pressures and the threat of financial failure forced them to ultimately abandon outmoded analytic techniques.

In the electricity generating industry, wind, photovoltaic and other capital-intensive renewable energy technologies exhibit financial and economic characteristics that resemble the attributes of the new manufacturing technologies: high capital and low operating costs and systems that are flexible, modular and rapidly deployed. The same cost valuation techniques that 20 years ago repeatedly indicated that CIM and other new technologies were "not yet" cost effective, are now showing that renewables are not competitive with traditional alternatives. But, as the experience in manufacturing has demonstrated, the singular focus on engineering unit cost measures such as cost/KWh is often an incorrect basis for comparing alternatives; "least cost" energy choices made on this basis may not be the most efficient for our economies.

This book brings a new finance-oriented perspective to the process of valuing generating technologies. It develops and applies to the energy sector principles of investment analysis, portfolio theory and accounting theory. These successfully helped modernize manufacturing and other industries 25 years ago. The message of the book is simple: to make meaningful comparisons, energy alternatives must be valued using models that reflect their risk; the risk associated with each technology's capital and operating outlays affects it true economic cost.

This book enables policy makers and investment analysts to better understand the influence of risk and tax policy on the costs of electricity from alternative technologies. The work is most timely, since the principal barrier to the market success of renewables has been the perception of too-high costs. But as all investors recognize, cost can be properly understood only in terms of its risk. Using procedures to adjust for risk, this book provides theoretically defensible cost-of-electricity estimates for renewables and conventional electricity which suggest that renewables are considerably more cost-effective than previously believed.

This book provides new insights into the relationship between energy and sustainable development and shows that the influence of fossil fuel price volatility on the general economy can be measured and reduced through diversification using non-fossil technologies to mitigate that risk.

PREFACE

This volume provides me an opportunity to extend and update previously published work in the area of risk adjusted, portfolio-based electricity cost estimates for generating technologies. Cost-of-electricity estimates are generally prepared using traditional engineering- economics models. The cost-of-electricity estimates in this volume take a different approach, and are based on finance-oriented capital-budgeting models that reflect the effects of taxes and market risk. Taxes affect the relative cost of different technologies through the effects of depreciation and other tax mechanisms. Risk affects all project outlays for all resource options, but is particularly pronounced in the case of fossil fuel. Fossil fuel prices are risky in the finance theory sense that their fluctuations are at least somewhat systematic, which means that their risk cannot be entirely eliminated through diversification. In the case of conventional fossil-fired technologies, risk-adjusted cost estimates tend to be considerably higher relative to estimates produced by traditional engineering models. Capital-intensive renewables, on the other hand, exhibit little systematic risk to the extent that their cost streams are sunk and, therefore riskless. As a consequence, their risk-adjusted cost-estimates are generally slightly lower than the estimates produced by traditional models.

The effect of taxes and market risk combine to make renewables considerably more attractive than is widely recognized, a point I have stressed and empirically demonstrated since the late 1980's. Renewables can provide insurance against future fossil fuel price-shocks and therefore should be given a more significant role in our energy policies. These insights have gone largely unnoticed by public policy makers who have been generally comfortable about our energy security needs during a decade that until relatively recently, has been marked by low fossil prices.

In the past several years, there has been a growing commitment on the part of many governments to support the rapid market uptake of renewables. These policies have been based on the view that that renewables are environmentally friendly and close enough to cost-competitiveness to warrant government intervention to facilitate market growth. The extra "push" of investment needed to make renewables fully competitive has been principally justified on the need to achieve environmental goals.

This book argues that renewables, by virtue of their price certainty, provide powerful benefits beyond their environmental contribution. Clearly a more prominent role for these technologies can be justified on the basis of the valuable contribution their price-certainty makes to the economies of fossil consuming countries by enhancing energy security and diversification objectives. Along these lines, proper cost estimation that reflects the market risk of fossil fuel and other cost streams is crucial for effective energy policymaking. It is towards this issue that this volume is directed.

Introduction and Motivation for this Book

In Europe, the US and other countries, national energy planners value electric generating technologies using outmoded techniques, conceived around the time of the Model-T Ford. These models, long since discarded in manufacturing and other industries, bias in favor of riskier fossil alternatives while understating the true value of low-risk, capital-intensive renewable technologies that are modular and passive.[1] Lenders and investors likewise do not yet fully understand the unique financial attributes of many renewables as differentiated from traditional fossil alternatives. Through this book, policy makers have an opportunity to strengthen analytic tools so they to include valuation models that more properly reflect modern finance theory and practice.

Traditional engineering-economics based cost models used to estimate the cost-of-electricity were first conceived nearly a century ago. They work reasonably well in an environment characterized by technological stasis and homogeneity— i.e. where technology alternatives have similar financial characteristics and mix of operating and capital costs. In today's environment, however, planners can choose from a diverse set of resources ranging from traditional, risky fossil options to low risk, passive, capital-intensive renewables with virtually no operating costs.

Renewable technologies, some of which have near-zero operating costs and virtually no moving parts, offer a unique cost-risk menu along with other valuable attributes that traditional valuation models, conceived long before such attributes became technologically feasible, cannot "see" because they are steeped in the vocabulary and measurement concepts of a different technological era. Properly understood and exploited, the attributes of distributed fuel-less technologies, including renewables, could undoubtedly form the basis for re-conceptualizing the electricity production and delivery process to create a vast new set of cost reductions.

Traditional engineering cost models do not reflect market risk differentials among competing technology choices, which means they are inherently biased in favor of riskier fossil alternatives. Indeed engineering-economics based cost comparisons almost always imply that fossil alternatives are more cost effective than fuel-less options, an outcome that is roughly analogous to telling an investor that high-yielding junk bonds are always a better investment than lower yielding, lower-risk government bonds.

This book develops and clarifies finance approach to dealing with portfolio risk as it applies to the valuation of generating technologies. Portfolio-based valuation directly impacts energy security and diversity issues. These procedures can help private sector decision-makers and public policy-makers. They demonstrate how to evaluate the costs of dissimilar technologies in a consistent framework.

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[1] A passive technology, (e.g. computers or photovoltaics) as further defined in Chapter 2 is one whose costs are not much different whether it is turned on or left off.

In a recent communiqués, IEA Energy Ministers indicated a belief that current energy planning and practices are not sustainable. The analysis presented here provides insights regarding the limitations of current techniques in prescribing appropriate paths toward energy sustainability. By evaluating energy resources in terms of their financial risks as well as costs, this analysis provides a useful contribution to the current dialogue about energy security and sustainable development.

The objective of this work is to adapt and apply contemporary finance theory and to successfully adapt valuation models from other sectors— notably finance and manufacturing— to improve the energy sector's performance. An important empirical result of this finance theory application is that renewable energy appears considerably more competitive with conventional technologies than previously understood.

Brighton, UK
January, 2005

Plan of the Book

Chapter 1 introduces finance-oriented valuation and qualitatively discusses the importance of two factors that must be included in the cost-of-electricity estimates: financial risk and taxes. With this discussion as a basis, the Chapter graphically presents a set of post-tax, risk-adjusted levelized cost-of-electricity estimates for various conventional and renewable technologies, and proceeds to discuss the effects of tax policy on these estimates. The chapter concludes with a cautionary note intended to clarify and help readers properly interpret levelized cost estimates from any model. This Chapter is accessible to a general audience and is intended for public and private policy makers.

Chapter 2 addresses the question: "If many renewables are cost effective as the results of Chapter 1 indicate, why are they not being deployed in greater numbers?" The Chapter shows that failures in the adoption of new technology are not limited to the electricity business It illustrates valuation errors American manufacturers and others have made in the past and develops a set of principles, based on contemporary accounting theory, that can help improve the valuation of electricity generating alternatives today. The Chapter argues that because they operate in oligopoly (or regulated) markets, electricity generators today have insufficient incentives to adopt more appropriate cost estimation models. This chapter conveys several essential messages for policy makers regarding the interpretation and use of quantitative cost-of-electricity data.

Chapter 3 defines risk quantitatively and reviews the relevant finance theory for discounting risky costs. The Chapter also presents important evidence from the economic literature that supports the idea that fossil fuel price increases have a negative affect on economic activity. This has important implications for energy security as well as the valuation (discounting) of fossil fuel outlays. The chapter then applies this theory

to the proper valuation (discounting) of cost in energy analyses. Chapter 4 discusses and illustrates how project cost streams contribute to risk and how this affects their valuation. Chapter 5 provides an analytic description the finance-oriented cost model and gives illustrative calculations that show how to deal with tax effects and risk. Energy analysts and planners should find Chapters 3, 4 and 5 accessible.

Chapter 6 provides an operational definition of Beta, the finance systematic risk measure, and describes the empirical procedures used to estimate fossil fuel betas. It is not for the faint-of-heart. The procedures it describes are based on the work of two noted American economists, Eugene Fama and Kenneth French that provides an empirical beta estimation procedure applicable in an international context. The empirical result of this Chapter is a set of fossil betas, which are small and generally negative, consistent with expectations. The chapter also develops a set of nominal, post tax discount rates for discounting the cost stream of generating projects.

Acknowledgments

This book would not have been possible without the assistance of a number of people. Some of the research for this book was conducted while I was Senior Advisor for Energy Economics, Finance and Technology at the IEA in Paris. I thank Sebastian Linnemayr and Chrita Clapp for their research assistance. Mr. Fatih Birol, Head of IEA's the Economic Analysis Unit and Maria Argiri provided detailed cost and other inputs used in IEA's WEO models.

A number of people reviewed earlier drafts of this book and have provided helpful comments: Richard Bower, Michael Crew, Paul Kleindorfer, Diego Piacentino, Andrew Vesey, Daniel Hoffmann, Demetrios Papathanasiou (World Bank), Robert Kleiburg, Shell Renewables, Frank Esslinger, Resources for the Future, Anthony Owens, Robert Dixon Roberto Vigotti

This book would also not have been possible without the Swedish Government, whose financial support I gratefully acknowledge, along with the efforts of Ms. Yvonne Fredrickson and Mr. Lars Guldbrand of the Swedish Energy Ministry

I also acknowledge the USDOE, the Interstate Renewable Energy Council, REEEP, and UNEP, all of whom have encouraged and supported my research on the valuation of energy technologies over the last two decades. Any remaining errors, of course, are my own.

Finally, I thank *Morgan Stanley Capital International Incorporated (MSCI)* particularly Mr. Vezen Wu of its New York City office and Ms. Helene Denis of its office in Paris, for providing their *MCSI Europe Index* financial market data that I used to develop the fossil fuel risk estimates in Chapter 6. All MSCI indices are the exclusive property of MSCI and may not be used in any way without the express permission of MSCI.

Key words: generating technology cost, busbar costs, COE, CAPM, risk-adjusted discount rates, valuing risky cash outflows or cost streams, present value, revenue requirements, estimating cash flow betas for risky cost streams

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