Introduction

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Following a steep fall in oil price in the early 1980s, the renewable energy industry was nearly decimated. Significant investments by large oil companies such as Exxon in solar photovoltaics (PV) were sold off or abandoned, and interest in the sector stagnated for nearly two decades. At the end of the last century, only two countries, Japan and the United States, were producers of solar PV panels and the total investment in the renewable energy sector as a whole bordered on trivial.

Fast forward to the present day and we see a much more promising scene. Rising energy security concerns, mounting ecological problems, and remarkable technological innovation have re-shaped the perceptions about solar and other forms of renewable energy. Countries are now competing fiercely to establish themselves as players in the global supply chain for renewable energy equipment. China, nowhere on the scene 15 years ago, is now investing more in renewable energy than the United States and Japan combined. Around the world, renewable energy — excluding large hydropower — attracts more than \$300 billion in investment each year (Bloomberg New Energy Finance, 2018). Yet, despite many positive indicators, there

remains a real risk of a reversal in fortunes. Could lower oil and gas prices and the lack of meaningful international political action on climate change yet again darken the outlook for renewables?

The core motivation for *Renewable Energy Finance* is to bring forward to a wider audience the challenges associated with continued growth of investment in non-fossil fuel energy. Lofty goals will not by themselves deliver results. Numerous stakeholders — including government, industry, civil society, and the financial sector — share responsibility for the work needed to make a real transition toward a clean energy future. The perspectives of leading academics and finance executives contained in this book contribute to a deeper understanding of the magnitude of the task ahead and a sense of optimism that the job can indeed be done.

This introductory chapter is intended as a primer on renewable energy finance for non-specialists. As such, it helps frame and provides useful background information for the ensuing chapters. It has been written with the following objectives:

- define recurring terms used throughout the book;
- describe the concept of risk and return and its role in financial decision-making;
- identify some of the key difficulties of financing renewable energy at scale; and
- highlight the major topics to be explored by other chapter authors.

Historically, the energy sector has constituted state-owned companies. This situation began to change in the 1990s, as privatization and liberalization induced a shift from governments to companies as the primary source of sector investment. The trend is highly pronounced in the field of renewable energy, where private-sector investors, generating profits for shareholders, are the major actors in financing new renewable energy projects. The renewable energy industry is still in the process of building relationships with the mainstream capital providers. Making green energy the mainstream choice for new energy infrastructure will require expanding access to a diverse spectrum of private-sector investors around the world. An important premise of this book is that a better understanding of investors and their motives

may help reduce the risk of another false dawn for a future that must inevitably be powered by renewable energy.

1. Defining the Landscape

Understanding renewable energy from a financial point of view requires the definition of some key terms. Finance has its own language, and it seems that no matter where you go in the world these days, that language reflects the trends of globalization. In short, money speaks English. Although the language of finance has a common tongue, it remains poorly understood and is commonly confused. Academics, practitioners, and the media may use the same words, but often mean different things.

An *investment* involves an exchange of money for a claim on benefits to be generated by some asset. Investments can be made as *equity* (a form of partial ownership) or as *debt* (money loaned by one party to another). Assets can be defined in many different ways, following academic or popular conventions. For the present discussion, we shall identify assets in one of two ways, as either real or financial. *Real assets* are those which, for most people, most readily come to mind: steel structures, tracts of land, and heavy machinery. They are the foundations upon which all economic activity is built. *Financial assets* are less tangible, often having no physical properties whatsoever. Financial assets constitute a form of agreement between parties. They range from the straightforward (a certificate of deposit at your local savings bank) to the highly exotic (equity derivatives structured by a global investment bank).

Investors are buyers of real and financial assets. While investors may be government or private-sector entities, the primary focus in this book is on those in the private sector. Examples of private-sector investors include the following:

- Corporations (electric utilities, oil and gas, consumer-facing industries).
- Retail investors (individuals, family offices).
- Investment partnerships (hedge funds, private equity firms).
- Financial intermediaries (banks, insurance companies, pension funds).
- Endowment funds (foundations, universities).

Historically, private-sector investors in renewables have been made up of companies with an existing presence in the energy sector. Commonly referred to as *strategic investors*, these market participants often see a tight pairing between renewable energy and their core lines of business. Strategic investors may also refer to newly established companies for whom renewable energy *is* their core activity. *Financial investors* have also been involved since the early days of the industry, but their involvement was often limited to project-based loans offered by commercial banks. One of the most important developments in the renewable energy sector over the past decade is how this situation has begun to change. Hedge funds and private equity firms are now common players, and there is increasing action among insurance companies, pension funds, and endowment funds. Unlike strategic investors, financial investors usually have no specific impetus for getting involved in renewable energy and have not been obligated by governments to do so. As funding sources, they are quickly prone to flight during turbulent market conditions.

The key factor that sets financial investors apart from strategic investors is their preference for financial assets versus real assets. Financial investors also typically maintain a portfolio of investments in more than one asset class. An *asset class* is a grouping of assets that share similar risk–return characteristics. Major asset classes include the following:

- Equities.
- Fixed income.
- Real estate.
- Commodities.
- Derivatives.

Investments in the renewable energy sector span multiple asset classes. Investors may, for example, buy shares in publicly traded renewable energy companies (equities), lend directly to clean energy projects (fixed income), have ownership in manufacturing and production facilities (real estate), and speculate on the price of outputs such as electricity, liquid fuel, or emissions allowances (commodities).

Renewable energy is, therefore, not as an asset class itself, but rather a sub-category within several asset classes. Thinking of clean energy investment as a set of *asset class categories* is helpful in positioning the sector more exactly within the universe of investment opportunities available to large capital providers.

2. The Guiding Principles of Risk and Return

Investors use risk and financial return as their primary criteria for deciding whether to invest in a particular asset class. Some market participants are constrained by strategic aims or may have specific fiduciary responsibilities preventing certain types of investments. Many more will simply be on the sidelines, waiting for the data about risk and return in an asset class to become clear. For all investors, the key question about a new investment prospect is one of valuation: *Does the price at which the asset is trading today offer a good prospect for capital appreciation over time?* To answer this question, investment decision-makers choose an appropriate means of *asset pricing*.

Asset pricing methods differ according to the asset class being analyzed and investor sophistication. A large hedge fund does not, for example, evaluate sovereign bonds in the same way that a retiree would examine equities. Nonetheless, there is a generalized analytical process undertaken in asset pricing, represented by Cochrane (2005) as follows:

$$P_t = E (m_{t+1} x_{t+1})$$

where

$$\begin{aligned} P_t &= \text{asset price,} \\ x_{t+1} &= \text{asset payoff, and} \\ m_{t+1} &= \text{stochastic discount factor.} \end{aligned}$$

The equation describes the price of an asset as a function of its expected payoff (i.e., the anticipated cash flows) and a *discount rate*. There are a range of analytical techniques for estimating a discount rate, some employing mind-boggling computational methods. But regardless of how complicated, a discount rate has embedded within

it two basic judgments. The first is an estimation of the *time value of money*. This element of the discount rate compensates an investor for receiving a secure payment at some date in the future, rather than today. The second judgment is about the likelihood and timing of receiving the expected future payment.¹ We refer to this as the *risk premium*.

While there is broad consensus that risk and return are the primary measures used by investors to evaluate investment attractiveness, there is considerable debate about the precise method for accurately measuring investment risk. We summarize here two of the most well-known schools of thought.

Among the most basic tenets of *portfolio theory* (Markowitz, 1959) is the belief that investors hold a diversified bundle of financial assets and that investment risk is shaped by this diversification. Portfolio theory later gave rise to the *capital asset pricing model* (CAPM) (Sharpe, 1964; Lintner, 1965), in which investment risk is represented by a single mathematical coefficient. This coefficient, known as Beta, measures how the financial payoff from a specific asset varies in relation to the payoff from all assets in the market as a whole. Beta represents an asset's sensitivity to systematic risks faced by all investors. The CAPM is an analytical tool taught to nearly all aspiring finance practitioners around the world and cited as the most popular method among corporate finance directors for estimating company discount rates (Bruner *et al.*, 1998).

In contrast to the CAPM approach, *arbitrage pricing theory* (APT) (Ross, 1976) holds that discount rates are a function of multiple risk factors. Whereas using CAPM, investment risk varies according to just a single Beta term, APT places no restrictions on the number of risk factors to be used. The factors of an APT asset pricing model may include generic macroeconomic indicators such as government bond rates, oil prices, and various forms of inflation, as well as asset-specific risk indicators, such as liquidity. APT allows greater analyst discretion in representing the complexity of the real world of investing.

¹In the interest of simplicity, we do not differentiate between payments in the form of interest, dividends, or capital gains.

This analytical discretion does, however, come with a cost — namely the loss of simplicity, replicability, and standardization.

No matter what approach one takes to asset pricing, the basic analytical challenge remains the same. An investor must estimate their financial payoff by forecasting future cash flows from the asset. She must also compute an appropriate discount rate for the investment, taking into account investment risk. Stated most simply, the question of valuation asks whether the expected financial return is sufficient to compensate for the prevailing level of risk.

3. Renewable Energy as an Investment Type

Due to the numerous ways in which investments in the sector can be made and due to overlaps with other industrial sectors, renewable energy is challenging to be characterized as an investment type. Renewable energy bears resemblance to other types of infrastructure investment, such those in the water and transportation sectors. Like all these public services, the supply of energy from wind, solar, and biomass resources is regulated. Renewable energy also has aspects in common with conventional energy developments, like oil and gas exploration. As with conventional energy, non-fossil fuel projects are capital intensive, requiring much of the lifecycle investment costs to be made up front.

As an asset class category, renewable energy is typically most similar to the conventional electric power sector. For some investors, electric power still carries the legacy of a checkered past. High-profile debacles and bankruptcies have created long-lasting memories about getting burned in the power sector.

In addition to perceptions that spillover from other sectors, renewable energy has its own characteristics. By and large, investors are still in the process of recognizing the unique facts about renewable energy technologies:

- With the exception of biomass, they have no fuel costs, leading to complex price interactions with fossil fuel technologies in marginal cost-driven markets.

- They generate commodities that may be difficult to store and/or costly to transport.
- They encompass a broad range of technologies, each with distinct value chains, often having little technical resemblance to one another.
- Some rely upon the highly centralized energy networks for their viability, while others pose a competitive threat to them.
- Each renewable energy technology is at a differing level of commercial readiness and cost competitiveness.

There are numerous implications that investors can draw about renewable energy in reaction to its inherent diversity and complexity. In the long term, many of these characteristics are what give renewable energy the potential to induce a radical shift in the current energy market paradigm. But in the short term, these sources of complexity have created confusion among investors regarding the predictability of risk and return for renewable energy investments.

4. Financing Renewable Energy at Scale

Strategic investors, such as electric utilities, do not have the scale of financial resources at their disposal to meet the challenge of scaling up investment in clean energy to three to four times its current level. It is also becoming clear that renewable energy poses a direct competitive threat to the conventional utility business plan, straining the financial position of traditionally large players (Gillis, 2014). Awareness is growing that increased funding by financial investors will be necessary to meet renewable energy investment goals. But rather than replacing the investments being made by energy companies, direct funding from the capital markets should be viewed as complimentary. Increased participation by financial investors will help unburden utility balance sheets and encourage redeployment of funds into early-stage development projects.

Packaging mature investments with relatively stable risk–return profiles to large financial investors, while still embryonic, is a rapidly growing area of renewable energy finance. As stated previously, many

large investors — regulated financial intermediaries, in particular — tend to prefer financial assets. These assets tend to offer important benefits to investors, namely

- scale (the capacity to absorb sizable capital inflows/outflows), and
- liquidity (frequent trading that allows securities to be bought or sold immediately).

Investing in real assets, for example, via direct ownership of an offshore wind farm, does not offer the necessary scale or liquidity that many investors need to adequately manage an investment portfolio. While an offshore wind farm may be quite large, the investment opportunity is capped by the size of a single project. Furthermore, the investor is effectively stuck in the project until a subsequent buyer can be found. Contrast this situation with the market for large government bonds, which offer supply far greater than any single investor could absorb and transactions to buy or sell occur in a matter of seconds.

Making investment in clean power and renewable fuels available to investors as financial assets has the potential to unlock access to a \$600 trillion pool of global finance capital, nearly three times greater than the stock of real assets that underpin all economic activity in the global economy (Bain and Company, 2012). A growing trend in the renewable energy investment is for real assets to be transformed into financial assets. It is a form of commoditization playing out across nearly all fields of environmental protection and ecological restoration (Sandor *et al.*, 2013).

The transformation of geothermal power stations, biofuel refineries, and solar energy facilities into financial assets can be accomplished through packaging of asset-backed securities (ABSs). As their name implies, ABSs are financial assets whose income is generated from a collection of real assets. They are difficult to define exactly due to the fact that their exact nature depends upon the regulations of the country in which they are issued. In the United States, the world's largest capital market, renewable energy assets have been used as collateral to create such real estate investment trusts (REIT), C-Corporations

(Yield Co), and sector-specific debt securities (Climate Bonds). Common to all these forms of financing is their direct link to the capital markets.

Having stable cash flows and no fuel price risk, the returns from renewable energy financial assets may be weakly correlated or entirely uncorrelated with those of the major asset classes. For portfolio investors, weak correlations are a favorable indicator of attractiveness as they reduce the measured risk. It is incumbent upon the industry to demonstrate a track record of performance that firmly establishes whether it offers a diversification benefit to portfolio investors. To the degree it does, renewable energy will attract sizable investment at extraordinarily low discount rates (Awerbuch, 2007).

5. Laying Conceptual Foundations for a Renewable Energy Future

One of the key messages from this introductory chapter is that the required rate of return for private-sector investors is a function of risk. Although most investors have by now turned over the task of risk assessment to highly intelligent machines, risk will never be defined solely by data. Risk is a product not just of numbers but also of ideas. Even in the realm of highly quantitative finance, it remains a judgment shaped by interpretations and beliefs. No amount of data or sophisticated modelling will ever provide a complete answer to the question about what rate of return investors will demand from renewable energy projects in exchange for their money. Policymakers, academics, the investment community, and the general public all play a role in shaping the idea of risk that ends up being held in an investment decision-maker's mind. Risk is a judgment that emerges from within a complex social system.

There is nonetheless, a purely objective aspect of risk assessment that cannot be avoided. Information about risk and return on common asset classes such as equities, bonds, and commodities are available to investors instantaneously at any time of the day, in any language, all over the world. As an asset class category, renewable energy is still in the very early days of establishing itself. A key task

ahead is for the industry to generate a history of investment performance. Although historical returns are not always a reliable guide to the future, transparency about past investment performance will be necessary for investors — financial investors, in particular — to understand and articulate a story about risk and return in the renewable energy sector to their investment committees.

6. Looking Forward

The volume of capital needed for a widespread transition toward a renewable energy economy will require increasing participation of financial investors and continued adoption of innovative financing techniques. This need not undermine the importance of the continued role for strategic investors. It is, after all, within utilities, project development companies, and network operators that most of the technical knowledge about renewable energy is to be found. But it is also evident that for a step change to occur in capital flows to the sector going forward, funding must increasingly come from financial investors. These new players will need to be brought into the game, while retaining the core investors who have brought the industry to its current level. The ensuing chapters of *Renewable Energy Finance* tell important elements of the story of how to achieve this new balance.

Chapter 1 lays the groundwork by defining key terms and exploring the major drivers for the expansion of renewable energy. From Chapter 2 through to Chapter 8, a common theme is the inextricable link between energy markets and government policy. The authors describe the main ways in which governments support renewable energy and identify general principles of how policy influences investment decisions. Lessons learned over two decades of government support for renewables are expertly illuminated by these authors.

Moving on, Chapter 9 through to Chapter 13 delve into the real world of investing and consider the challenges and opportunities for commercial banks, private equity funds, institutional asset managers, and retail investors. The authors of these chapters have taken up the difficult work of sorting through the changes that have occurred since

the financial crisis of 2008 and charting the future direction for specific of investors. The collection touches upon recent innovations in renewable energy financing such as leasing and crowdfunding, as well as the adaptation of long-time corporate and project funders to the evolving dynamics of the financing market.

All told, this book seeks to illuminate the foundations upon which a renewable energy future can be built. There are many actions to be taken in the years ahead to broaden the investor base for renewable energy going forward. We hope that readers will find *Renewable Energy Finance* to be a resource that they return to many times over the ensuing years to deepen their understanding of this important topic — and hence, *their courage to act*.

References

- Awerbuch, S. (2007). *Unpublished book manuscript*. Available at: <http://www.awerbuch.com> [17 April 2012].
- Bain and Company, Inc. (2012). A World Awash in Money: Capital Trends through 2020. Available at: <http://www.bain.com/publications/articles/a-world-awash-in-money.aspx> [19 December 2014].
- Bloomberg New Energy Finance (2018). Global Trends in Clean Energy Investment 2018. Available at: <https://data.bloomberglp.com/professional/sites/24/BNEF-Clean-Energy-Investment-Trends-2018.pdf> [11 November 2019].
- Bruner, R. F., Eades, K. M., Harris, R. S., and Higgins, R. C. (1998). Best practices in estimating the cost of capital: Survey and synthesis. *Financial Practice and Education*, **8**: 13–28.
- Cochrane, J. (2005). *Asset Pricing* (revised edition). Princeton University Press.
- Gillis, J. (2014). Sun and wind alter global landscape, leaving utilities behind. *The New York Times*, 13 September. Available at: <http://www.nytimes.com> [10 October 2014].
- Lintner, J. (1965). Security prices, risk, and maximal gains from diversification. *Journal of Finance*, **20**(4): 587–615.
- Markowitz, H. M. (1959). *Portfolio Selection: Efficient Diversification of Investments*. New Haven, CT: Cowles Foundation, 94–95.
- Ross, S. A. (1976). The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, **13**: 341–360.

- Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, **19**(3): 425–442.
- Sandor, R., Clark, N., Kanakasabai, M., and Marques, R. (2013). Environmental Markets: A New Asset Class. CFA Institute Research Foundation. Available at: www.cfainstitute.org/foundation [5 November 2014].