

Preface

In Northern Europe, a significant fraction of wind power growth in the past decade has occurred offshore where winds are typically stronger and more constant; by contrast, in the U.S. there are currently no offshore wind farms operational or under construction. The slow progress in offshore wind development in the U.S. has been attributed to several factors including challenging economics, less government involvement, environmental concerns, lack of public acceptance, poorly capitalized development companies, and the lack of a regulatory system for leasing. By late 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement had created a regulatory system for offshore wind development, several developers had signed power purchase agreements and formed partnerships with larger companies to facilitate financing, and public resistance had subsided in many areas. Construction of several offshore wind farms is expected within the next decade.

The purpose of this book is to develop models of two related costs experienced by offshore wind developers: installation costs and decommissioning costs. Installation costs are the second largest component of capital expenditures for offshore wind after procurement and play an important role in determining the overall profitability of a development. Decommissioning costs, while expected to be a fraction of installation costs, are important to policy makers because they determine the financial assurance regulators will require before allowing development to proceed. Identifying the proper value of this assurance is important; if the assurance is set too low, the government may be left financially responsible for decommissioning operations; if the assurance is set too high, an unnecessary cost for developers is created.

Chapters 1 through 4 provide introductory and background material. In Chap. 1 the current status of offshore wind farms in Europe and the U.S. is discussed and information on generation capacity and capacity growth in Europe are presented. The European market holds more than 95% of global cumulative installed offshore capacity and is the dominant world market, and given the number of installation vessels being delivered to European firms, future large capacity additions are probable. In Chap. 2 the system components of wind farms are defined, and in

[Chap. 3](#), the general stages of wind development are reviewed from a contractual perspective and offshore state and federal leasing regulations are highlighted. [Chapter 4](#) provides a conceptual basis for subsequent chapters whereby the factors that influence project costs, cost estimates, and liability are discussed and comparisons to the European wind market and U.S. oil and gas market are made.

[Chapters 5](#) through [7](#) provide the technical details used to inform the cost estimation modeling. In [Chap. 5](#), a primer on installation methods is provided and data on installation times for turbines, monopiles and cable projects in Europe are analyzed. This analysis is used to inform estimates of installation costs and decommissioning times and sets a baseline for operational activity. In [Chap. 6](#), the vessels required for installation and decommissioning, their dayrates and required spreads are discussed. No U.S. market currently exists for turbine installation vessels, and so a central question for developers is the expected cost of vessel dayrates. In [Chap. 7](#), we address this question and develop empirical models of installation vessel dayrates and mobilization costs.

In [Chap. 8](#) a reference class approach is used to normalize and quantify the capital costs of offshore wind farms in Europe. We describe how European costs may differ from those experienced in U.S. markets and the factors that impact the differences. The estimates presented provide the context for installation and decommissioning costs.

In [Chap. 9](#) a model of installation cost is developed based on the expected duration of installation activity and the daily vessel costs. The installation costs at three planned U.S. wind farms (Cape Wind, Bluewater Delaware, and Coastal Point Galveston) are estimated and sensitivity analysis performed to identify the variables most responsible for uncertainty and risk.

[Chapters 10](#) through [12](#) focus on decommissioning. In [Chap. 10](#), the regulations that specify decommissioning bonds, the stages of decommissioning, and expected work flows are outlined. An alternative method for turbine removal which involves felling the turbine like a tree, rather than removing it piece-by-piece with a large elevating vessel, is proposed. The formulation of viable alternative removal methods such as felling illustrates the uncertainty in decommissioning procedures and cost estimation early in the life cycle of development.

In [Chap. 11](#) component weights are estimated for the structural components of wind farms. These weights are used to estimate the scrap value and disposal costs of decommissioning in [Chap. 12](#). [Chapter 12](#) uses models similar to those developed in [Chap. 9](#) to estimate removal and disposal costs. The scrap value of steel in the foundations, towers, and turbines is included and the costs of alternative removal options are modeled. The models are parameterized with available data on proposed U.S. offshore developments.