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Energy From Offshore Wind

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Abstract

This paper provides an overview of the nascent offshore wind energy industry including a status of the commercial offshore industry and the technologies that will be needed for full market development. It provides a perspective on the status of the critical environmental and regulatory issues for offshore wind and how they are affecting the formation of the U.S. industry. The rationale provided describes why offshore wind has the potential to become a major component of the national electric energy supply. Future projections show this potential could result in over $100 billion of revenue to the offshore industry over the next 30 years in the construction and operation of offshore wind turbines and the infrastructure needed to support them. The paper covers technical issues and design challenges needed to achieve economic competitiveness for near term deployments in shallow water below 30-m depth. It also examines the requirements for future technologies needed to deploy systems in deeper water beyond the current depth limits. Although most studies to date indicate very low impacts to the environment, regulatory and environmental barriers have hindered the first offshore wind projects in the United States. A summary of these issues is given.

Introduction

Over the past two decades, on-shore wind energy technology has seen a ten-fold reduction in cost and is now competitive with fossil and nuclear fuels for electric power generation in many areas of the United States. Wind energy installations in the United States have grown from about 1,800 MW in 1990 to an estimated 9,200 MW at the end of 2005, and are expected to grow to 14,000 MW by the end of 2007 [1]. While onshore wind energy technology appears to be maturing rapidly by some measure, the need for further technology development still remains, as development booms have historically coincided with the existence of the 1.9-cent/kWh production energy tax credit for renewable energy sources. In addition, as wind energy penetrates a larger percentage of the grid, industry growth, dispatchability, and infrastructure, barriers will become critical long-term research issues.

Initial onshore wind development in the United States focused on the windiest sites (Class 6 that average 7.4 m/s at 10 m above surface annually), but these sites are generally in the more remote areas of the west, and on a few ridgelines in the east. The DOE Wind Program has led an initiative to drive the cost of wind energy down further through sustained technology innovations that have been identified, but have not yet been fully implemented under a Low Wind Speed Technology Program [2,3]. As lower costs are achieved, more sites are becoming economically viable in areas closer to energy constrained load centers, giving a higher value to the delivered electricity [4]. The full extent of the vast land-based resource is limited by transmission line access and capacity on the grid, which is making transport of electricity from the windiest areas more difficult [5]. Efforts to lower the onshore cost of energy (COE) and integrate wind energy into the electric utility grid are major technology areas that must continue for the United States to take advantage of its onshore domestic wind energy supply, but the full domestic wind electric potential cannot be realized in the United States without a broader perspective that includes the wind resources over the ocean.

Offshore wind generated electricity in the United States has the potential to become a major contributor to the domestic energy supply, on par with onshore wind, because it can compete in highly populated coastal energy markets where onshore wind energy is generally not available. Preliminary studies performed by the National Renewable Energy Laboratory (NREL) estimate the offshore resource to be greater than 1000 GW for the United States [6]. The wind blows faster and more uniformly at sea than on land. A faster, steadier wind means less wear on the turbine components and more electricity generated per turbine. The winds increase rapidly with distance from the coast, so excellent wind sites exist within reasonable distances from major urban load centers reducing the onshore concern of long distance power transmission. Figure 1 shows that in addition to the proximity to the load, the offshore resource tends to be geographically