THE UNIVERSITY OF MAINE

1.0 Introduction

This report consists of a preliminary study of the feasibility of developing an up to 30 MW "stepping stone" floating offshore wind project and larger commercial-scale (100 – 300 MW) in federal waters off the coast of Maine. It provides key information to developers to help prepare successful bids in response to the Maine Public Utilities Commission (PUC) Request for Proposals (RFP) titled ***Request for Proposals for Long-Term Contracts for Deep-Water Offshore Wind Energy Pilot Projects and Tidal Energy Demonstration Projects***. The RFP was issued in September 1, 2010 with proposals due in May 1, 2011. The University of Maine *Advanced Structures and Composites Center* (AEWC) led the effort to obtain and collect this information in order to facilitate the preparation of successful proposals to the Maine PUC. Funding to collect this information was received primarily from the Department of Energy (DOE), with significant contributions in kind from the University of Maine (UMaine). UMaine is committed to providing additional technical support leading to the most cost-effective floating designs, while minimizing risk, environment impact, and impact on other human activities.

This report includes (1) a summary of available information on the physical characteristics and wind and wave resources in the Gulf of Maine (GoM); (2) a study of potential electric grid interconnection points and offshore electric cabling requirements; (3) an evaluation of permitting requirements, potential environmental impacts and stakeholder considerations; (4) a summary of available construction and assembly resources in Maine; and (5) a summary of economic and policy implications. Section 8 also includes a detailed summary of findings, critical issues for project development, and permitting considerations.

1.1 MAINE DEEPWATER OFFSHORE WIND PLAN – A NATIONAL ELECTRIFICATION MODEL

As recommended by the Maine Ocean Energy Task Force, supported by the Maine Legislature, and announced in the State of the State Address on January 21, 2010, Maine plans to construct a five (5) Gigawatt (GW), $20 Billion network of floating offshore wind farms, 20 – 50 miles offshore. This is part of an electrification strategy to reduce Maine's dangerous reliance on fossil fuels for heating and transportation, and to contribute to the renewable energy needs of the Northeast United States. Maine is the most reliant state on heating oil in the United States, with 80% of Maine families using it to heat their homes. More than residents of any other state, Mainers are exposed to and are negatively impacted by the increasing costs of gasoline and heating oil.

Maine has one of the best offshore wind resources in the United States, with156 GW of capacity within 50 nautical miles (nmi) (Schwartz et al., 2010). On the East Coast, Maine has the deepest waters near its shores, approximately 200 ft deep at three (3) nmi. Of Maine's 156 GW offshore wind resource, 80% resides in waters deeper than 200 feet (ft) (Schwartz et al., 2010). With Maine's plans to construct five (5) GW of deepwater offshore wind, its extensive maritime industry infrastructure, and its proximity to large northeast region energy markets, UMaine was selected in October 2009 through a DOE competition to lead a 35-member university-industry consortium, *DeepCwind*, focused on deepwater offshore wind research and development (See Section 1.2).

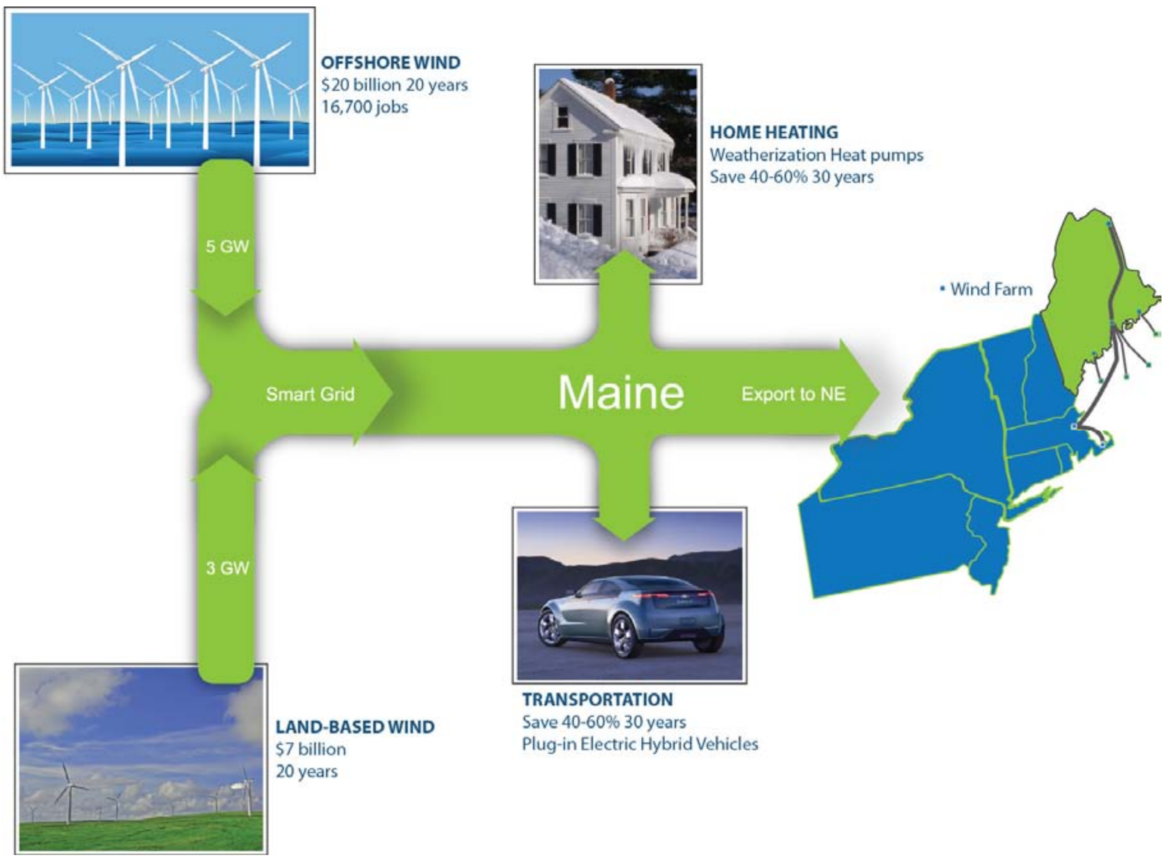

Figure 1-1: The Maine Plan - A National Electrification Model

In addition to five (5) GW of offshore wind development, the Maine Plan envisions the development of a smart grid to address the intermittency of wind, and for gradual conversion to home heating using electricity and to transportation to using electric vehicles (See Figure 1-1). This conversion may save the average Maine family thousands of dollars annually in energy costs by the end of this decade.

Figure 1-2 shows the potential growth in energy cost for the average Maine family as a portion of the total family budget. With the average Maine family using approximately 800 – 1,000 gallons of heating oil annually, the home heating bill is nearly $4,000 per year at $4 – $4.50 per gallon heating oil. At the same price for gasoline, the average Maine family pays approximately $5,000 per year in transportation costs. Including electricity costs (approximately $800 – $1,000 per year per family); energy costs for the Maine family would be approximately $10,000 per year, meaning 20% of the annual Maine family income of $40,000 – $45,000 would be needed to cover energy costs. Offshore wind generated electricity, coupled with electric heat pumps or electric thermal storage units, and enhanced-range electric vehicles, can reduce energy costs well below this level in the next two decades, and help provide a hedge against escalating liquid fossil fuel prices.

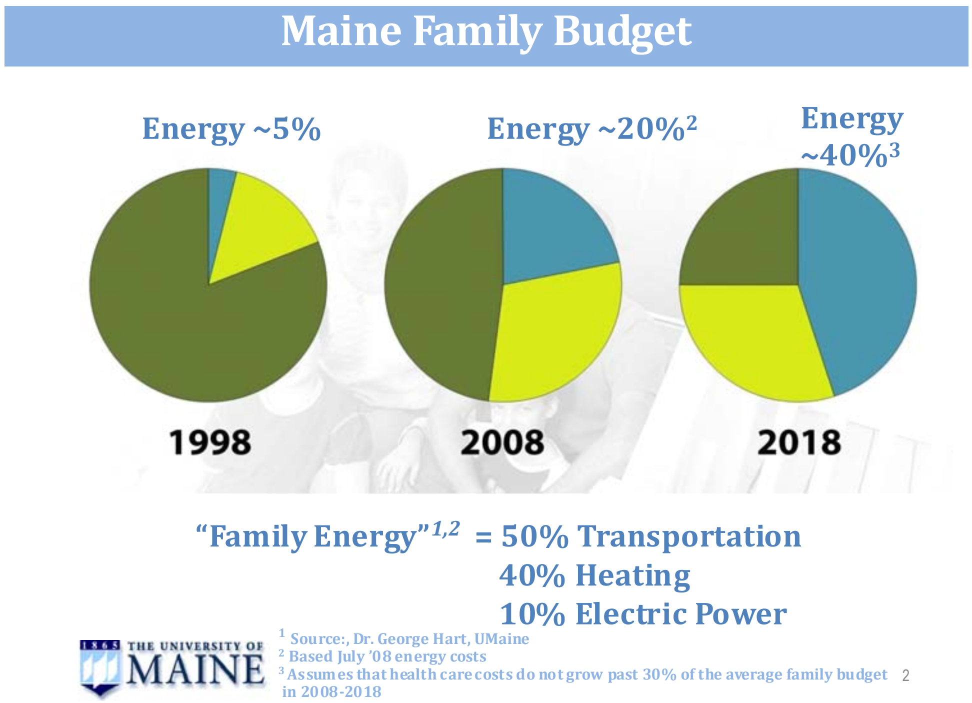

Figure 1-2: Maine Family Energy Costs - Transportation, Heating, and Electricity

Besides reducing the impact of rising prices of gasoline and heating oil, the five (5) GW, $20 Billion Maine Deepwater Plan is estimated to create 7,000 – 15,000 jobs needed to design, build, construct, operate and maintain this vast infrastructure. The number of jobs created will depend on the degree of success in developing the supply chain within the State of Maine. Approximately twice the state budget, $5 Billion, leaves Maine every year in fossil fuel costs. Keeping just 20% of these dollars in Maine over time by developing Maine's renewable energy sector would mean an additional $1 Billion per year would available to add to the Maine economy, further creating local jobs.

Beyond the Maine interest, floating deepwater wind farms placed 20 nmi or greater offshore can play a critical role in reaching the DOE 20% by 2030 goal, as their related viewshed issues diminish, which have delayed or prevented some nearshore United States projects. In addition, their strategic offshore location can place energy generation closer to the demand of major United States population centers on both the East and West coasts. Likewise, they allow access to a more powerful Class 6 and 7 wind resource; and over time, they reduce wind energy costs by reducing transmission costs from remote land sites, and by simplifying deployment and maintenance logistics. Deepwater wind is the dominant United States ocean energy resource, representing a capacity of nearly 3,000 GW, compared to a United States electricity generation capacity of nearly 1,000 GW.

1.2 UMAINE *DEEPCWIND* PROGRAM AVAILABLE TO HELP DEVELOPERS SELECT FLOATING TECHNOLOGY

The UMaine-led 35-member *DeepCwind* Consortium, funded by DOE in October 2009, focuses on the development of floating offshore wind farm technologies, with an ambitious but achievable goal of reaching eight to ten cents per Kilowatt-hour (8 - 10 cents/kWh) by 2020 at the grid connection point.

The *DeepCwind* Consortium is currently working with DOE's National Renewable Energy Laboratory (NREL) and others to verify coupled aeroelastic hydrodynamic models for floating wind turbines. In April 2011, three 1:50 scale models of different floating wind turbine foundation designs will be tested in a wind-wave basin, and data will be used to refine and validate computational tools. This is the first test of its kind in the world and will utilize fully operational scale wind turbines with pitching blades and different control algorithms.

DeepCwind has also conducted a review of 14 floating foundation designs, as part of an RFP sponsored by the consortium in 2010. A Blue Ribbon Panel (BRP) consisting of personnel from UMaine, NREL, DOE, and representatives from three industry leaders in each of: the offshore sector, heavy manufacturing sector, and heavy construction sector, reviewed and assigned scores to the 14 proposals. The BRP narrowed the field down to seven (7), and used a value-risk evaluation methodology to score and rank the top designs.

The BRP unanimously agreed that there were multiple high-value designs received, and agreed that testing more than one of the leading designs at 1:3 scale would be critical in furthering floating wind turbine technology and allowing model validation across different platform configurations. The University of Maine plans to deploy the leading design at the 1:3 scale in July 2012 off Monhegan Island, and additional designs at the 1:3 scale in July 2013. Data from these tests will be available to help select and optimize the most cost-effective design concept. Optimized designs tested at the 1:3 scale will be available by 2014.

1.3 MAINE DEEPWATER OFFSHORE WIND PLAN

The purpose of this introduction is to put the Maine PUC RFP within the context of the overall Maine Plan for deepwater offshore wind development, and other supporting activities currently ongoing within the State. It is important for developers to understand the overall objectives in Maine, the level of careful planning that the State and UMaine have undertaken for the program to succeed, and the level of support that will be available to them as they embark on a program in Maine. It is telling that two offshore wind bills were passed by the Maine Legislature in 2010 nearly unanimously. It is also telling that Maine voters in June 2010 supported a bond proposal that provided $11 Million for offshore wind research and development (R&D), and this was the highest-ranked bond among many that the voters could select on the ballot.

The PUC RFP is an integral part of a carefully-designed, "walk-before-you-run" plan to cost-effectively deploy five (5) GW of deepwater floating offshore wind, 20 – 50 miles off the coast of Maine by 2030. **It is the goal of UMaine and *DeepCwind* to develop floating technology to compete economically ($/kWh) with other forms of energy without subsidies by 2020 and beyond.**

The overall 20-year implementation plan is shown in Figure 1-3, and includes the following five (5) carefully integrated phases:

- Phase 1, ends 2012 – Initial Model validation (Research and Development (R & D)); develop & validate robust design and modeling tools.
- Phase 2, ends 2015 – Design optimization (R & D); develop optimum designs for floating turbines, continue model validation.
- Phase 3, ends 2016 – 25 Megawatt (MW) stepping-stone farm; start with one (1) full-size turbine, then build rest of pilot
- Phase 4, ends 2020 – Expand the 25 MW stepping-stone farm into a 500 – 1,000 MW commercial farm
- Phase 5, ends 2030 – Build a number of 500 – 1000 MW farms reaching five (5) GW by 2030, add Transmission and Distribution (T & D) system

The Maine PUC RFP represents Phase 3 leading to Phase 4 of the plan in Figure 1-3. To the majority of developers, the unknowns of floating offshore wind are many and maybe daunting. However, the 20-year implementation plan is designed to reduce risk, as developers can take advantage of Phases 1 and 2 of the plan, which are currently being conducted by UMaine and its *DeepCwind* R & D partners.

A developer is not expected to have all the answers regarding which floating foundation design to use, or what electricity costs to bid, in time for the May 2011 PUC deadline. Instead, the developer needs to present a plan of how they would get this information, taking advantage of Phases 1 and 2 of the program that are currently ongoing. By the time, a developer signs a contract with the Maine PUC (possibly 2012), the developer has five (5) years to complete the 25 MW farm.

By 2014, UMaine's *DeepCwind* Consortium will have robust modeling tools, validated through 1:50 scale tank testing and approximately 1:3 scale platform testing at the UMaine's deepwater demonstration site off of Monhegan Island. This R&D effort will produce at least one – and possibly more - optimized designs. UMaine is available to work with developers in preparing a proposal to the Maine PUC. This will allow developers to take advantage of the extensive *DeepCwind* Consortium's R&D efforts, the related DOE and state funding, and will significantly reduce technical risks.

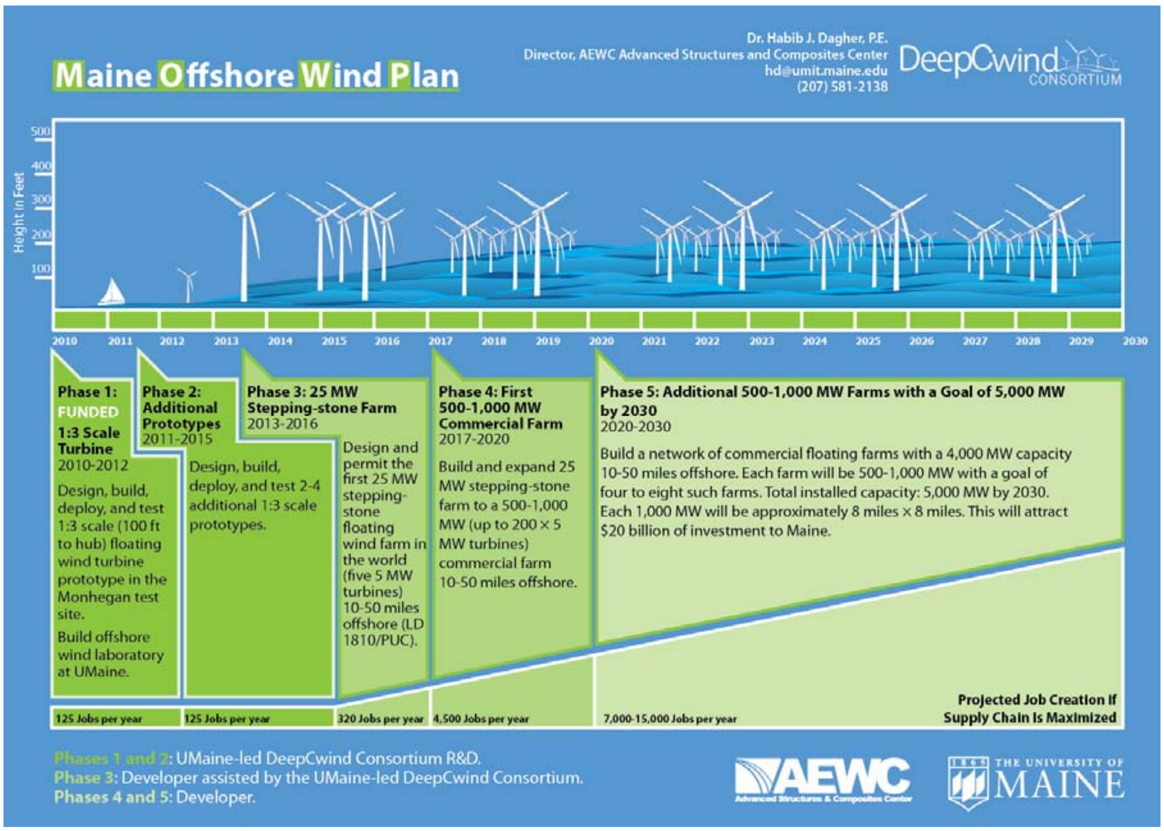

Figure 1-3: A Five-Phase, 20-Year Plan for Deepwater Deployment off Maine's Coast