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REPORT IN BRIEF

Review of DOE's Marine and Hydrokinetic Resource Assessments

Board on Energy and Environmental Systems · Division on Engineering & Physical Sciences ·
Ocean Studies Board · Division on Earth and Life Studies · **January 2013**

Increasing renewable energy development, both within the United States and abroad, has rekindled interest in the potential for marine and hydrokinetic (MHK) resources to contribute to electricity generation. In order to better understand the scope and feasibility of this potential, the Energy Policy Act of 2005 directed the Department of Energy (DOE) to estimate the size of the MHK resource base. The DOE funded assessments aimed at estimating the maximum extractable energy potential for resources derived from five MHK categories: (1) waves, (2) tidal currents, (3) ocean currents; (4) marine temperature gradients; and (5) free-flowing rivers and streams. This National Research Council (NRC) report evaluates all five of the DOE resource assessments individually and comments on the overall MHK resource assessment process more broadly.

Introduction

The five MHK resource assessments conducted by DOE should be of interest to a variety of parties. For instance, these assessments have the potential to help direct MHK-related project developers toward locations of greatest promise and to inform related policies.

This interest has already been indicated by the increasing number of permits that have been filed with the Federal Energy Regulatory Commission (FERC). As of December 2012, FERC had issued 4 licenses and 84 preliminary permits—this compared with the activity level from a decade ago, which was virtually nonexistent. However, the actual deployment of all MHK devices has been limited. The first project connected with the U.S. commercial grid—a tidal project in Maine that is due to be fully installed in 2013—is currently delivering just a fraction of the pilot project's planned 300kW capacity to the grid.

Select Findings and Recommendations

Development of an Overarching Conceptual Framework

Continued development of U.S. MHK resources requires clear conceptual and operational definitions and objectives. However, the U.S. MHK energy community has not converged upon a common set of definitions for resource assessment and development. In addition, the independent groups contracted by DOE employed different methodologies and terminology for each resource assessment.

The full NRC report outlines an overall conceptual framework for comparing the assessments of the five MHK resource categories within a single context and for conceptualizing the processes used to develop the resource assessment results. In order to develop this approach, the NRC study committee established a set of three terms—theoretical resource, technical resource, and practical resource—to clarify elements of the overall MHK resource assessment process as described by the five assessment groups.

The report defines the theoretical resource as the average energy available from an MHK energy source per year. The technical resource describes the portion of the theoretical resource that can be captured using a specified technology. This estimate specifically considers physical and technological constraints, or extraction filters, that are associated with MHK devices. The practical resource refers to the remaining portion of the technical resource that could be produced once all other constraints—including social, economic, regulatory, and environmental filters—have been considered.

Challenging social barriers, such as shipping lanes and environmentally sensitive areas, and/or economic barriers, such as proximity to utility infrastructure, will undoubtedly affect the power availability of all MHK resources. When all of the filters are considered, the MHK resource with the largest theoretical resource base may not necessarily have the largest practical resource base. Thus, it is not apparent that comparing the theoretical or technical resource among each MHK type or with other energy resources is the most valuable method for helping to determine the potential extractable energy from MHK resources.

Rather, it is the practical resource that will ultimately determine the potential contribution that any MHK resource could make to U.S. electricity generation. As recommended in the report, the DOE should develop or adopt a conceptual framework that clearly defines the theoretical, technical, and practical MHK energy resources.

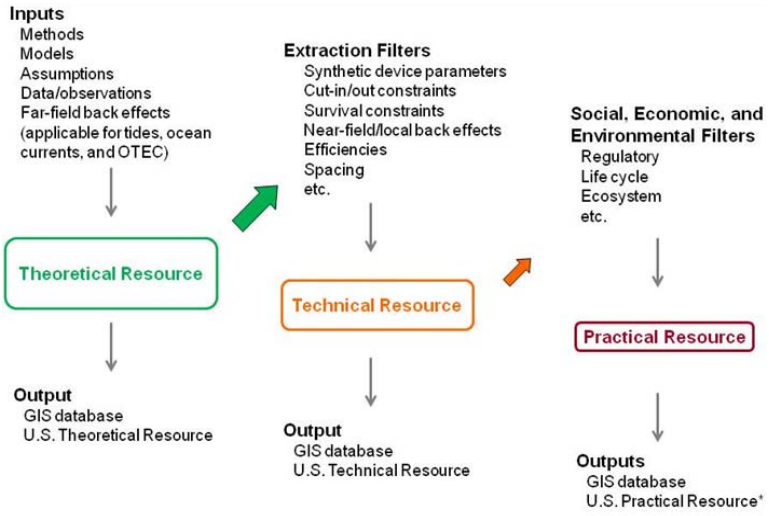

Figure S.1. Conceptual framework developed by the committee for MHK resource assessments. The asterisk in the third column denotes that the resource assessment groups did not attempt to evaluate the practical resource.

General Comparison of the Five MHK Resource Assessments

The methodology and level of detail in the five MHK resource assessments cannot be used to provide an estimate of the practical resource that might be available from each of the MHK categories. This is especially true given the assessment groups' varying degrees of success in calculating or estimating the technical resource base. Although DOE contracted for assessments that would provide the extractable U.S. MHK resource, the assessment teams focused on the theoretical and technical resource base at both national and regional levels, and they did not make it to the level of estimating the practical resource.

The NRC study committee was also concerned over the appropriateness of aggregating theoretical and technical resource assessments to produce a "single number" estimate for any one of the five MHK resources on a national or regional scale. While the DOE may want an aggregated value for internal research and/or investment purposes—such as comparing the sizes of individual MHK resources to each other or comparing the MHK resource base with other renewable resources—a single number estimate is inadequate for a realistic discussion of the MHK resource base that might be available for electricity generation in the United States.

Resource-Specific Recommendations

The resource assessment groups used a regional-scale approach that is most useful in understanding the utility-scale potential for MHK resources. Compared with small-scale MHK deployments, utility-scale projects require significant infrastructure and have more potential for substantial environmental impacts and conflicts with other ocean and freshwater uses. As a result, MHK resources likely will only be developed in areas where the high energy density of the resource warrants such investment or in small-scale applications where there are minimal local conflicts.

Each of the five resource assessments provides valuable information that can be used to identify geographic regions of interest for further study of potential MHK development. However, if the information is to be used for assessing whether an MHK resource could be practically available for electricity generation, improvements in methodology and characterization will be required. The assessment and development of each MHK resource will face unique challenges.

Overall, the practical resource for each of the individual potential power sources is likely to be much less than the theoretical or technical resource.

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This study is based on work supported by a contract between the National Academy of Sciences and the U.S. Department of Energy. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project, or the National Research Council.

Copies of this report are available free of charge from http://www.nap.edu/catalog.php?record_id=18278. Report issued January 2013.