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Prospective Evaluation of Applied Energy Research and Development at DOE (Phase one): A First Look Forward—*Summary*

BOARD ON ENERGY AND ENVIRONMENTAL SYSTEMS

Background

In 2001, the National Research Council (NRC) completed a congressionally mandated assessment of the benefits and costs of DOE's fossil energy and energy efficiency R&D programs, *Energy Research at DOE: Was It Worth It?* The Congress followed this retrospective study by directing DOE to request the NRC to develop a methodology for assessing prospective benefits. The first phase of this project—development of the methodology—began in December 2003. Phase two will make the methodology more robust and explore related issues, and subsequent phases will apply the methodology to review the prospective benefits of different DOE fossil energy and energy efficiency R&D programs. In developing this project, three considerations were particularly important. First, the study should adapt the work of the retrospective study. Second, the project should develop a methodology that provides a rigorous calculation of benefits and risks, and a practical and consistent process for its application. Third, the methodology should be transparent, should not require extensive resources for implementation, and should produce easily understood results. This report presents the results of phase one. It focuses on adaptation of the retrospective methodology to a prospective context.

Findings

Essential Features of Prospective Benefits Evaluation. The retrospective methodology rested on two principal concepts. The first is the benefits matrix that focused attention on economic, environmental, and security benefits. These elements formed the rows of the matrix. The matrix also identified a number of possible outcomes of the R&D program. The second concept was the "cookbook" that contained detailed instructions for calculating benefits for each matrix cell. The cookbook provided a consistent set of assumptions, concepts, and rules that all analysts should use in calculating benefits.

Prospective benefit evaluation, however, is complicated by uncertainty about the future including: uncertainty about the technological outcome of a program; uncertainty about the market acceptance of a technology; and uncertainty about the future states of the world. While each applies to all R&D programs, the relative impact of a given category will vary from program to program.

Proposed Methodology. Prospective benefit methodology has six main elements.

- A rigorous definition of benefits to be used consistently for all programs.
- Scenarios about future world states that are common to all technologies.
- Procedures for estimating probabilities for relevant uncertainties of the decision tree.
- A decision tree framework for ensuring that the role of government support and the key technology and market uncertainties are considered in the benefits calculation
- A results matrix that uniformly summarizes important data and estimated benefits.
- Simplified models for calculating benefits for each decision tree critical pathway.

As important as the methodology is the process by which it is applied. The process should center on establishing expert panels to review DOE programs. The panel should begin with a technical assessment followed by an assessment of the program's conditional benefits should it reach its goals. The expertise of the panel and the decision tree assessment tool should then be used to develop the probabilities for the program's technical and market risk. Next, the results of the probability analysis should be used to estimate the expected value of the program benefits. Finally, the results should be reported along with comments on program risks.

Conclusions and Recommendations. Reliance on expert opinion means that judgments may ensue about which reasonable people may disagree. Eliminating such disagreements, even if possible, would be undesirable. In addition, the methodology is designed to make transparent the underlying assumptions and range of judgments.

*Value of the Proposed Methodology for Decision Making***.** As part of Phase One of this study, this methodology underwent initial tests on three DOE programs. These tests identified some weaknesses that need to be fixed. In addition, it uncovered a number of inconsistencies and weaknesses in DOE's current benefits estimates. The testing also showed that consistent application of the methodology will improve the quality and comparability of the benefits analyses. Specific areas of DOE's analysis that could be improved include:

- DOE's benefits definitions do not always conform to those of the methodology.
- DOE calculates benefits assuming cost and performance goals are obtained. Expected value of the benefit is a better parameter for comparing programs.
- Comparing benefits across programs requires comparable assumptions.

The methodology can also provide substantive insights for allocating resources. Examples include:

- The difference in benefits of a particular technology from one future scenario to the next can be crucial information for decision makers.
- The benefits expected for a given R&D funding pattern is essential information for allocating resources.

- Estimated benefits of high-risk, high-payoff programs might exceed their costs by a large amount. The methodology helps pinpoint key risks to which the benefits are sensitive.
- Even if DOE's goals for the program—which are often stretched beyond what can be reasonably expected—are not met, performance levels might still be achieved at which costs are exceeded.

Need for Adequate Resource and Management Priority. Applying this methodology will require the use of scarce DOE financial, program management, and analytic resources. DOE should explicitly recognize in its resource allocation processes the need to support the use of the methodology. Such resources are not likely to be large in relation to the size of the programs being evaluated or the value of the prospective benefits analysis.

For further information;

Copies of *Prospective Evaluation of Applied Energy Research and Development at DOE (Phase one): A First Look Forward* are available from the National Academy Press; call (800) 624-6242 or (202) 334-3314 (in the Washington metropolitan area), or visit the NAP Web site at < http://www.nap.edu>.

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