United States General Accounting Office

GAO

Testimony

Before the Subcommittee on Energy and Environment, Committee on Science, House of Representatives

For Release on Delivery
Expected at
1:00 p.m. EDT
Wednesday
April 17, 1996

ENERGY R&D

Observations on DOE's Success Stories Report

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GAO/T-RCED-96-133

Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss the results of our review of the Department of Energy's (DOE) report, Success Stories: The Energy Mission in the Market Place. As you know, DOE's applied research and development (R&D) programs are designed to support the development of technologies that accomplish the nation's energy objectives, such as securing future energy supplies. In fiscal year 1995, DOE received appropriations of about $1.65 billion—almost 10 percent of its total budget—to spend on applied R&D programs. Some Members of Congress and the Congressional Budget Office (CBO) have questioned whether the federal investment in these programs is cost-effective.

In May 1995, DOE published its Success Stories report to respond to these concerns. The report briefly describes 61 technologies that were developed or supported by DOE's applied R&D programs. The report highlights how each technology resulted in measurable economic benefits, such as energy savings. Earlier this week, we issued a report to the Chairman of the House Committee on the Budget that focuses on whether (1) the claims DOE makes in the report are valid and (2) Success Stories can be used to assess the value of DOE's applied R&D programs.[1]

In summary, Mr. Chairman, our review showed the following:

- Although Success Stories makes some valid claims about the benefits of DOE's applied research, we found problems with the analyses DOE used to support the benefits cited in 11 out of the 15 cases we reviewed. These problems include basic math errors; problems in the supporting economic analyses, such as weak assumptions; and unsupported links between the benefits cited and DOE's role or the technology. These problems make DOE's estimates of the benefits for these cases questionable.
- While Success Stories shows that DOE's applied R&D programs do produce some benefits, we do not believe the report can be used to assess the effectiveness of DOE's applied research programs overall because it only describes the "successes" of a very small percentage of the projects DOE has funded. In addition, Success Stories does not report how much DOE spent to support any of the technologies we evaluated. Without a comparison of costs and benefits, the success of DOE's applied energy R&D programs cannot be determined.

[1]DOE's Success Stories Report (GAO/RCED-120R, Apr. 15, 1996).

Before discussing these issues in more detail, we would like to provide some background information on DOE's Success Stories report.

Background

For many years, DOE has devoted significant resources to energy R&D. From fiscal year 1978 through fiscal year 1993—the last year for which actual spending data are available—DOE spent $45.5 billion on R&D.[2] In fiscal year 1993, DOE provided almost one out of every two dollars spent in the United States on energy research. DOE received appropriations of about $2.37 billion in fiscal year 1995 for its research programs. Since the mid-1980s, DOE has dedicated about 70 percent of its total R&D spending to applied research, which develops scientific knowledge that has specific commercial applications.[3] DOE has also invested significant amounts in basic research. Basic research is directed at increasing the understanding of energy phenomena without regard for immediate commercial objectives. In fiscal year 1995, DOE received appropriations of $726 million for basic research in such areas as materials and chemical sciences.

Concerns have been raised about DOE's research and development activities. For instance, some critics maintain that applied research should be performed by the private sector, not the government. Also, in a 1994 report,[4] CBO contended that few successful technologies have emerged as a result of DOE's applied R&D programs.

In response to such criticism, DOE produced its Success Stories report. In developing this report, DOE's Office of Science Policy first asked its applied research program offices to provide examples of technologies they had developed that produced quantifiable benefits. Officials from this office then chose what they considered the best examples to include in the report on the basis of the significance of the R&D in terms of DOE's mission, quantifiable measures of its impact, and other factors. They also selected cases that illustrate the range of DOE's applied research programs.

[2]Figures are in 1994 dollars.

[3]To estimate DOE's spending, we obtained DOE's historical budget data, then applied the budget categories for basic and applied research developed by the Secretary of Energy Advisory Board's Task Force on Strategic Energy Research and Development.

[4]Reducing the Deficit: Spending and Revenue Options, Congressional Budget Office, Mar. 1994. CBO's February 1995 report on the same subject no longer states that few successful technologies have emerged from DOE's applied R&D programs. However, the report states that many lawmakers have questioned the value to the economy of those R&D programs.

The resulting Success Stories report provides brief case studies of 61 technologies that were developed or otherwise supported by DOE's applied R&D programs. The cases presented in the report vary greatly according to the size and type of the research project, the types of benefits attributed to the project, the time at which the benefits occur, and the sophistication of the methods DOE used to estimate the benefits. For example, some describe relatively small DOE R&D projects that were completed years ago, while others discuss multimillion dollar efforts still under way, such as DOE's photovoltaic program, which has been directed at developing ways to convert solar energy into electricity since the 1970s.

In describing the economic benefits attributable to the technologies, some case studies cite how a technology has conserved energy, cut production costs, or increased energy supplies, while others attribute increased exports or environmental benefits to the new technology. Similarly, the cases differ in the time frames in which the estimated benefits are achieved. Some cases estimate benefits that have accrued for one year, some estimate benefits throughout the 1980s and early 1990s, and others project benefits that will not occur before 2000 for recent or ongoing R&D efforts. In addition, DOE used different approaches or methodologies to estimate the benefits. In some cases, the analyses supporting the examples use market models or other sophisticated techniques, while in other cases the analyses rely on other approaches, such as a review of available sales data or an expert's best judgment about future markets.

To address questions about DOE's report, we evaluated the support for the benefits claimed for 15 of the 61 cases. The 15 case studies we selected for detailed review (1) covered all major program areas and fuel sources and (2) accounted for most of the large economic benefits identified by the report.[5]

Report Cites Supportable Benefits but Contains Many Weaknesses

Success Stories contains supportable claims for some of the benefits of DOE's research. For example, the atmospheric fluidized-bed coal combustor developed by DOE allows utilities to efficiently produce electricity from low-grade coal. DOE also documented its claim that DOE-2, a computer software program that helps reduce energy use in buildings, saved almost $2 billion in energy costs for buildings constructed through 1993.

[5]Because the case studies were not consistently prepared and because we did not select a random sample, we cannot quantitatively generalize from our sample of 15 to the 46 other technologies described in Success Stories.

However, we found problems with the analyses supporting the benefits cited for 11 of the 15 cases we reviewed. Although these problems cause us to question the amount of benefits claimed for these cases, substantial benefits may still be attributable to some of these cases. The problems we identified in the 15 cases fell into the following four general categories:

- Math Errors. Two of the case studies were based on analyses containing basic math errors that greatly affected the estimates of the benefits. For example, the supporting analysis for the benefits of the carbon dioxide sand fracture production technology—a new process that is expected to increase production from some gas wells—improperly applied the price of natural gas to an incorrect amount of expected increased production. This error resulted in an unrealistic estimate of the increased revenues that could be expected from each well using the new technology. Applying the price of gas to the correct amount of expected increased production from the test wells over their first 7 years of production leads to an estimate of increased revenues of between $216,000 and $294,000 per well—not the $20 million per well cited in Success Stories.[6]
- Problems with the supporting economic analysis. Nine of the 15 cases include estimates of benefits that are based on analyses containing weak economic reasoning, poor assumptions, or other errors. For example, when DOE projected the domestic sales of its integrated gasification combined cycle (a clean coal technology) from 1998 to 2030, it did not discount the sales figures to reflect the time value of money. Using a conservative interest rate, discounting would reduce DOE's claimed benefit from $150 billion to $44 billion. In another example, the supporting analysis for the mud-pulse telemetry project—a well-drilling technology developed by DOE that saves time and money—assumes that the total amount of money that the well-drilling industry has spent to purchase this technology equals the amount saved by the industry. This assumption incorrectly implies that every dollar spent on the technology is a savings attributable to the technology. The value of this technology to the industry is the amount of money the industry has saved by using it, rather that the amount of money the industry has spent on it.
- Weak or indirect link between the stated benefits and DOE's R&D activities. Although DOE claims in Success Stories that it developed the carbon dioxide sand fracture technology, the supporting documents provided to us state that the process was developed and patented in Canada. DOE is currently demonstrating the effectiveness of the process on a number of

[6]In this case, DOE also incorrectly assumed that the technology would increase production throughout the productive life of each well. However, the supporting documents provided to us by DOE indicate that the scientists and engineers conducting the project are not willing to assume that the wells will continue to produce at increased rates past the first 7 years of the project.

U.S. wells. In another case, DOE cites that the flame retention head oil burner technology has saved $5 billion over the past 15 years, although DOE's contribution was limited to testing and publicizing the technology. Although Success Stories makes it clear that DOE's role was limited, readers could be led to believe that the value of DOE's contribution is the estimate of the total energy savings for the technology. We do not believe that the total savings resulting from consumers' use of this technology should be linked directly to DOE's activities.

- Benefits did not result from the technology. In its discussion of the benefits of the AC electric drive train, Success Stories cites a California mandate for electric vehicles that is expected to create a $350 million market in 2003. However, according to an official with the California Air Resources Board, the mandate was developed independently of the AC electric drive train. Although the drive train may help automakers meet the mandate by improving the performance of electric vehicles, its development did not result in the mandate. Thus, the potential market created by the mandate cannot be considered a result of the drive train.

Report Cannot Be Used to Assess the Value of DOE's Applied R&D Programs

In our opinion, Success Stories cannot be used to assess the effectiveness of DOE's applied R&D programs overall for two reasons. First, none of the case studies we evaluated discuss how much DOE has spent on its R&D efforts supporting the technology. Such information is necessary to determine whether DOE's investment in applied R&D programs is cost-effective. For example, in describing the environmental advantages of the nuclear light-water reactor technology and the savings that will result if the operating licenses of current plants are extended, DOE does not mention that it has spent about $1 billion over the past 10 years on efforts to improve and advance the use of nuclear light-water reactor technology. DOE also does not discuss the environmental downside of nuclear power—the unresolved problem of long-term disposal of the high-level radioactive waste created by the reactors.

Secondly, we believe that the report cannot be used to evaluate DOE's applied R&D programs because it highlights only a small percentage of the projects funded by these programs and describes only what DOE considers to be the most successful of the technologies the Department has supported. The cases summarized in Success Stories are not a representative sample that can be used to evaluate DOE's applied R&D programs overall.

Observations

Assessing the effectiveness of DOE's total R&D programs is complex and important. In our opinion, DOE's report reflects the challenges decisionmakers face in trying to assess the effectiveness of federal R&D. We believe that the value of Success Stories in assessing federal investments in applied R&D is limited because it focuses solely on benefits and ignores the larger issue of whether DOE's applied R&D programs are cost-effective. DOE's applied research programs cannot be fairly evaluated on the basis of whether the Department can find several examples of success stories out of the thousands of projects funded under its programs. In our view, an objective evaluation would include an assessment of a representative sample of DOE's applied research projects that identified all relative costs and benefits and then used reasonable criteria to determine if funding these projects is cost-effective.

Mr. Chairman, this concludes our prepared remarks. We would be happy to answer any questions you may have.

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