

Aggregate Economic Return on Investment in the U.S. DOE Office of Energy Efficiency and Renewable Energy

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The Office of Energy Efficiency and Renewable Energy (EERE) in the U.S. Department of Energy is committed to ensuring our investments in research and demonstration (R&D) yield positive results for consumers and the economy. As part of this commitment, we have independent evaluators perform retrospective impact studies of our R&D investments to determine the degree to which EERE funding is making a difference relative to what the private sector would have done on its own. Third-party peer-reviewed evaluation studies have found that EERE R&D funding has resulted in a positive economic impact for the United States.

Since 2010, EERE has commissioned six R&D impact evaluation studies to quantify the economic return on investment (ROI) that has resulted from EERE investments in energy R&D. Independent evaluators use a rigorous counterfactual analysis method to help address the question, “Would today’s clean energy technologies have happened at the same time, and with the same scope and scale, without EERE’s efforts?”

To answer this question, independent professional evaluators and economists developed a peer-reviewed R&D evaluation method that is used to determine the "realized" economic benefits and the costs, energy and environmental impacts, and other impacts of the EERE R&D investments.¹ To date, evaluators have used this methodology in EERE R&D evaluation studies covering R&D investments in photovoltaics, wind energy, vehicle combustion engines, advanced battery technologies for electric-drive vehicles, and geothermal energy, as well as for HVAC (heating, ventilation and air conditioning), water heating, and appliance technologies.

The six commissioned EERE R&D impact evaluations studies are listed below, in order from most to least recent. All of these studies are done by third-party evaluation experts and undergo rigorous peer review by other evaluation experts and economists. One additional R&D ROI study is currently in progress.

1. [*Benefit-Cost Evaluation of U.S. Department of Energy Investment in HVAC, Water Heating, and Appliance Technologies*](#). Michael Gallaher, Troy Scott, Zachary Oliver, Kyle Clark-Sutton, and Benjamin Anderson of RTI International, with contribution from Rosalie Ruegg (TIA Consultants), September 2017.

¹ *Evaluating Realized Impacts of DOE/EERE R&D Programs*, Rosalie Ruegg (TIA Consulting Inc.), Alan C. O'Connor (RTI International), and Ross J. Loomis (RTI International), August 2014, https://energy.gov/sites/prod/files/2015/05/f22/evaluating_realized_rd_impacts_9-22-14.pdf

2. [*Benefit-Cost Evaluation of U.S. DOE Investment in Energy Storage Technologies for Hybrid and Electric Cars and Trucks*](#). Albert N. Link, Alan C. O'Connor, Troy J. Scott, Sara E. Casey, Ross J. Loomis, and J. Lynn Davis (RTI International), December 2013.
3. [*Retrospective Benefit-Cost Evaluation of DOE Investments in Photovoltaic Energy Systems*](#). A. O'Connor, R. Loomis, and F. Braun, August 2010.
4. [*Retrospective Benefit-Cost Analysis of U.S. DOE's Geothermal Technologies R&D Program Investments*](#). M. Gallaher, A. Rogozhin, and J. Petrusa, August 2010.
5. [*Retrospective Benefit-Cost Evaluation of U.S. DOE Wind Energy R&D Program: Impact of Selected Energy Technology Investments*](#). Tom Pelsoci, June 2010.
6. [*Retrospective Benefit-Cost Evaluation of U.S. DOE Vehicle Combustion Engine R&D Program: Impacts of a Cluster of Energy Technologies*](#). Al Link, May 2010.

Each of these six independent studies quantifies the economic performance results of EERE's R&D investments for its respective research areas and technologies, using measures such as net economic benefits,² benefit-to-cost ratio,³ and rate of return.⁴ We combined the individual economic benefit and cost cash flows derived from each study to develop the aggregate benefit and cost cash flows for EERE's R&D portfolio. We then performed a discounted cash flow analysis to take into account the time value of money.

The combined results of these six R&D ROI studies show that, for the EERE R&D investments evaluated to date,

- A total taxpayer investment of \$12 billion (inflation-adjusted 2015 dollars) in EERE's R&D portfolio has yielded more than \$388 billion in net economic benefits to the United States, undiscounted
- The overall annual rate of return on the R&D investments was more than 27%
- The undiscounted benefit-to-cost ratio was 33 to 1 (11 to 1 at a 7% discount rate), indicating that economic benefits have far exceeded the cost of these R&D investments.

These numbers are quite conservative for several reasons. First, the four 2010 economic studies listed earlier evaluated the savings accrued through 2008, but did not estimate future savings that would occur for already installed technologies for the remainder of its useful life.⁵ Any additional economic benefits that have accrued since 2008 from the technologies in these four studies, or that will continue to accrue during the useful life of the installed systems, have not been counted in the \$388 billion calculated net economic benefit.

² Gross economic benefits (undiscounted) less EERE investment costs (undiscounted).

³ A ratio formed by setting the numerator as the present value summation of monetized benefits resulting from EERE's investments, and the denominator as the present value of EERE investment costs, where discounting is performed at both 3% and 7% real discount rates.

⁴ The percentage yield on an investment.

⁵ For instance, if a photovoltaic system was installed in 2003 and is expected to last 20 years, the 2010 study would only have calculated its impacts for the first five years of its life without considering the fact that it will likely continue generation through 2023.

Further, the six studies performed involve in-depth economic assessments for only about a dozen R&D innovations and energy technologies that have entered the market as a result of EERE R&D funding, and science and technical support to the private sector. These investments represent only a small (less than one-third) portion of EERE's total R&D investments from 1976 to 2015. Full counterfactual economic analysis has yet to be performed over that time period for the remainder of EERE investments, which include investments in hundreds of other technologies, such as lighting (e.g., light-emitting diodes [LEDs]), advanced manufacturing, and vehicle lightweighting.

Without performing that analysis, we do not know the return of those investments. But even if one was to assume that the remainder of EERE investments over this time period yielded zero benefits, the net benefits from the dozen or so technologies evaluated to date alone have still resulted in a large benefit-to-cost ratio and a healthy rate of return. Therefore, the \$388 billion net economic benefits should be considered a lower-bound, conservative assessment.

These evaluations combine to demonstrate the value of EERE R&D investments. Besides the importance of these investments from a consumer savings and innovation perspective, they have also yielded an important, measurable economic return on investment to the U.S. economy.