

Aggregate Return on Investment for R&D Investments in the U.S. DOE Office of Energy Efficiency and Renewable Energy

Prepared by Jeff Dowd, U.S. Department of Energy, February 2016

The Office of Energy Efficiency and Renewable Energy (EERE) in the U.S. Department of Energy is committed to ensuring our investments in 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 are finding that EERE funding is generating clean energy while also resulting in a positive economic impact for the United States.

Since 2010, EERE has commissioned five R&D impact evaluation studies to answer the important question about our economic return on investment (ROI) in energy R&D. Independent evaluators use a rigorous counterfactual analysis method to help address the question – “Would today’s commercialized technologies likely have happened at the same time, and with the same scope and scale, without EERE’s efforts?”

Independent professional evaluators and economists developed a peer-reviewed R&D evaluation method to determine the "realized" economic benefits and costs, energy and environmental impacts, and other impacts of the EERE R&D investments. See,

- **Evaluating Realized Impacts of DOE/EERE R&D Programs. 2014 Final Report.**
Prepared by: Rosalie Ruegg (TIA Consulting Inc.), Alan C. O'Connor (RTI International), and Ross J. Loomis (RTI International)
http://energy.gov/sites/prod/files/2015/05/f22/evaluating_realized_rd_mpnacts_9-22-14.pdf

To date, this methodology has been used for five completed studies (listed below), covering a fraction (about one-third) of EERE’s total R&D investments over the period 1976 to 2012. The five studies were conducted by independent professional evaluators and economists.

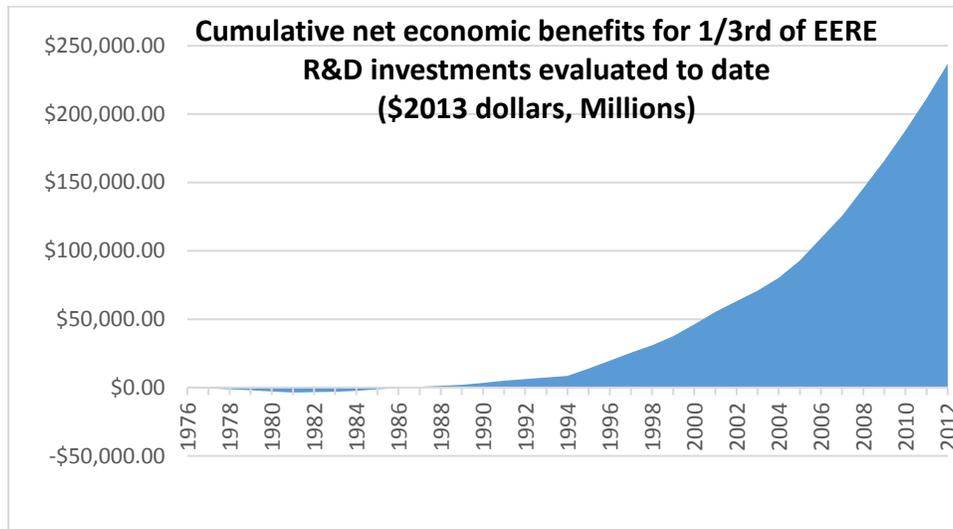
- **Benefit-Cost Evaluation of U.S. DOE Investment in Energy Storage Technologies for Hybrid and Electric Cars and Trucks**, Albert N. Link, Alan C. O'Connor, Troy J. Scott, Sara E. Casey, Ross J. Loomis, J. Lynn Davis (RTI International), December 2013.
- **Retrospective Benefit-Cost Evaluation of DOE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

Currently, two additional R&D ROI studies are in progress.

The results from the studies reflect a conservative estimate of the share of economic outcomes that can be reasonably attributed to the EERE investment rather than to other causes.

Each of the five studies produced economic performance results using measures such as net economic benefits¹, benefit-to-cost ratio², and rate of return³. The individual economic benefit and cost cash flows derived from each independent study are combined to develop the aggregate benefit and cost cash flows for EERE's R&D in solar photovoltaic energy systems, wind energy, vehicle combustion engine, advanced battery technologies for electric-drive vehicles, and geothermal technology R&D. Economic discounted cash flow analysis is then performed.

The Figure below illustrates the combined economic results for the five R&D programs, representing about one-third of EERE total R&D investment.



The following are the conclusions of the combined economic analysis results for the R&D studies.

- To date, third-party evaluators have assessed one-third of EERE's total R&D portfolio (by amount invested from 1976 to 2012) through multiple impact evaluations covering R&D investments in solar photovoltaic energy systems, wind energy, vehicle combustion engine, advanced battery technologies for electric-drive vehicles, and geothermal technologies. The combined results of these studies show that the total EERE taxpayer investment of \$12 billion (inflation-adjusted 2013 dollars) for the R&D investments evaluated has already yielded an estimated net economic benefit to the United States of more than \$230 billion, with an overall annual rate of return on investment of more than 20%.
- The benefit-to-cost ratio is 7 to 1, at 7% discount rate, indicating that benefits have far exceed the cost of the R&D investments.
- EERE's investments in clean energy have enabled EERE to achieve its mission objectives and provided a positive return on investment to the U.S. economy.

¹ Gross economic benefits (undiscounted) less EERE investment costs (undiscounted).

² 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.

³ The percentage yield on an investment.