Potential Climate Change Benefits of DOE Energy Efficiency and Renewable Energy Programs

Report to
National Renewable Energy Laboratory

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Executive Summary

In accordance with the Government Performance and Results Act (GPRA), programs within the US Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) are required to establish concrete goals and performance measures. Program performance is independently evaluated each year to facilitate strategic planning within EERE and to identify programs that may require modification.

Since 1994, this independent review process has been managed by Arthur D. Little of Cambridge, MA. Using a combination of in-house experts in technology development and commercialization and external peer reviewers, Arthur D. Little has assisted EERE in refining the evaluation methods and have worked with us to ensure our program performance measures are accurate. Arthur D. Little believes that the estimates of the future benefits as summarized in this report are credible due to the rigorous review of the EERE Planning Units since 1994.

Introduction

The Government Performance and Results Act (GPRA) requires federal agencies to establish performance goals for their programs. Programs within the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) develop goals through a process referred to as the GPRA data call, formerly known as the Performance Measurement and Quality Metrics data call. EERE systematically develops and confirms in an annual GPRA process and data call, credible, quantitative goals, both near term and longer-term, for the performance and impact of its programs. The goal of the EERE GPRA process is to measure, manage, and improve program performance and meet GPRA requirements for strategic planning and annual performance plans and reports. In addition, the GPRA process helps to manage resources within EERE more wisely.

Approach

ADL Internal Peer Review

Arthur D. Little has worked with DOE staff to review estimates and assumptions for selected Planning Units within four sectors of EERE since 1994. The review process for FY96, FY97, FY99, and FY00 was an interactive, iterative process between the individual Planning Unit managers and Arthur D. Little experts, in each case leading to a consensus regarding final submissions. Arthur D. Little undertakes the review process recognizing that the DOE portfolio of programs is highly diverse with a wide range of impact potentials, technology characteristics, and commercialization risks. As such, in the review process Arthur D. Little draws on its experience with industry technology development and commercialization processes to:

- Provide an overall assessment of the degree to which the program goals, milestones, and schedules are consistent with the technology status and the need to address remaining performance/cost uncertainties.

- Estimate the energy savings and emissions of each technology projected to the year 2020 assuming technology and cost performance goals are achieved. The energy savings and emission reductions are based on a review of market penetration assumptions and their consistency with commercial experience within the assumed competitive environment.

- Review performance measurements of each Planning Unit, which include near-term goals and milestones for the next five years designed to achieve the market penetration, cost, and performance objectives underlying the energy savings and emissions metrics.

With few exceptions, the discussions between Arthur D. Little and the Planning Unit managers within EERE have resulted in agreement on revised program impact estimates and related performance measures.

External Peer Review
For FY98, the Arthur D. Little/National Renewable Energy Laboratory (NREL) team identified a list of external peer reviewer candidates to review 22 of EERE Planning Units. Participants were selected based on both long-term experience in the Planning Unit area of interest and expert reputation. Overall, 52 potential peer reviewers were identified for the Office of Industrial Technologies (OIT), 47 for the Office of Building Technology, State and Community Programs (BTS), 33 for the Office of Utility Technologies (OUT), 13 for the Office of Transportation Technologies (OTT), and 3 for the Federal Energy Management Program (FEMP). The team tried to avoid selecting peer reviewers with any potential conflict of interest due to existing projects with DOE or who might for some other reason have a biased position. From the initial list, three to four peer reviewers were selected to provide external review for each Planning Unit.

Prior to conducting the phone interviews (or, in some cases, in-person interviews), the Arthur D. Little/NREL team prepared background material for each of the peer reviewers. That information included an interview guide presenting information on the assumptions and data used to generate the energy saving estimates derived by each Planning Unit.

The purpose of the external peer review was to gain expert opinions on the key technical, cost, and schedule assumptions underlying EERE energy and emission saving estimates for each Planning Unit reviewed. The comments and suggestions from the external reviewers were discussed between Arthur D. Little and the Planning Unit managers to make appropriate adjustments to the EERE assumptions and to come to an agreement regarding the final GPRA estimates. In general, the feedback from the external review process was highly positive in supporting the potential of the technologies to achieve the program goals and associated key milestones.

Planning Unit Selection
As shown in Figure 1, Planning Units were selected for review each year based on the several different criteria:

- large expected energy savings
- program visibility
- significant variables impacting the Planning Units from the previous year analysis (e.g., the Presidents Million Roof Initiative in the Photovoltaic Planning Unit)
- desire to review all Planning Units every four years
- budget requests

Overall Assessment of GPRA Estimates and Process

Arthur D. Little experts have worked with industry and have first hand knowledge of the inherent uncertainties associated with technology development/commercialization and how these can be managed within a highly structured approach to establish performance measures and a continuing review process. Through work with industry, Arthur D. Little experts understand the required timelines to commercialization, realistic market penetration estimates, and likely technology cost reduction potentials for a wide variety of technologies impacting EERE programs. Over the past five years, Arthur D. Little

experts and external experts have reviewed most of the Planning Unit assumptions and believe that the revised energy saving and emission reduction estimates are realistic and achievable.

Arthur D. Little has worked with DOE staff to develop credible estimates and assumptions impacting energy savings and emission reductions for EERE programs. Since the beginning of Arthur D. Little's work in 1994, there has been significant improvement in the credibility of the GPRA information, more consistency between Planning Units in the GPRA approach and assumptions, and improvement in the overall GPRA process. The estimates provided in Table 1 represent the final energy saving and emission reduction estimates for all of EERE Planning Units for FY00. Arthur D. Little believes that these estimates of the future benefits of these programs are credible due to the rigorous review of the EERE Planning Units since 1994.

Figure 1: Screening Criteria Used for Developing List of Planning Units for Peer Review (Example for FY98)

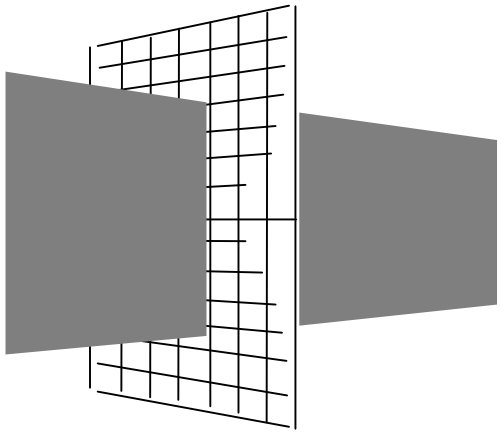
BTS
- Building Codes & Standards
- Lighting & Appliance R&D
- Space Conditioning R&D
- Commercial Buildings
- Lighting & Appliance Codes & Standards
- Best Practices
- Materials & Structures R&D
- State Block Grants
- Windows & Glazing R&D
- Weatherization Assistance Program
- Residential Buildings
- Municipal Energy Management Program

FEMP
- Federal Energy Management Program (FEMP)
- In-House Energy Management

OTT
- Biofuels
- Advanced Automotive Technologies
- Transportation Materials Technologies
- Advanced Heavy-Duty Vehicle
- Technology Deployment

OUT
- Wind Energy R&D
- Photovoltaic Systems R&D
- Solar Thermal Electric R&D
- Geothermal Energy R&D
- Biomass Power R&D
- Hydrogen Research R&D
- High-Temp. Superconductivity R&D
- Solar International
- Climate Challenge
- Energy Storage R&D
- Electric & Magnetic Fields R&D

OIT
- Motor Challenge
- Inventions & Innovations
- Climate Wise
- NICE-3
- Aluminum Vision
- Chemicals Vision
- Forest & Paper Products Vision
- Industrial Assessment Centers (IACs)
- Advanced Materials & CFCCs
- Petroleum Refining Vision
- Glass Vision
- Co-Generation
- Steel Vision
- Metals Casting Vision



Screening Criteria
- Large energy savings in 2000/2005
- Percent change in energy savings from previous year estimates
- Budget requests
- Program visibility
- Significant variables impacting the Planning Units from last years analysis
- Desire to review all Planning Units every four years

Planning Units for Peer Review

BTS
- Building Codes & Standards
- Lighting & Appliance R&D
- Space Conditioning R&D
- Commercial Buildings
- Lighting & Appliance Codes & Standards
- Best Practices

FEMP
- Federal Energy Management Program (FEMP)

OTT
- Biofuels
- Advanced Automotive Technologies
- Advanced Heavy Duty Vehicle

OUT
- Wind Energy R&D
- Photovoltaic Systems R&D
- Solar Thermal Electric R&D
- Geothermal Energy R&D

OIT
- Motor Challenge
- Inventions & Innovations Industrial
- Climate Wise
- NICE-3
- Aluminum Vision
- Chemicals Vision
- Forest & Paper Products Vision
- Industrial Assessment Center (IAC)

Table 1: Final Planning Unit Submission

Sector	Planning Unit	Primary Energy (Tbtu) 2000	2010	2020	Energy Cost Savings ($ billion) 2000	2010	2020	Carbon Reduction (MMTCE) 2000	2010	2020
BTS	**Commercial Buildings Integration**	10	207	535	$0.06	$1.54	$4.11	0.17	3.42	8.62
	Community Partnerships Program	8	225	434	$0.05	$1.49	$2.97	0.13	3.58	6.76
	Energy Star	3	106	210	$0.02	$0.79	$1.57	0.05	1.67	3.14
	Equipment, Materials & Tools	36	1,369	3,542	$0.30	$9.73	$23.77	0.77	21.23	49.55
	Residential Buildings Integration	2	131	341	$0.01	$0.99	$2.60	0.03	2.17	5.50
	State Energy Program	6	56	99	$0.03	$0.36	$0.65	0.10	0.90	1.59
	Technology Roadmaps and Competitive R&D	0	100	347	$0.00	$0.65	$2.04	0.00	1.39	4.22
	Weatherization Assistance Program	7	96	184	$0.04	$0.53	$1.05	0.11	1.53	2.94
	BTS TOTAL (non-integrated)	70	2,290	5,692	$0.52	$16.08	$38.74	1.36	35.88	82.32
	BTS TOTAL (integrated)	90	1,350	2,430	$0.67	$9.48	$16.54	1.40	25.30	51.90
OIT	**Advanced Materials (CFCC and AIM)**	0	93	237	$0.00	$0.29	$0.73	0.00	1.54	4.11
	Aluminum Vision	0	49	187	$0.00	$0.20	$0.60	0.00	1.04	4.44
	Chemicals Vision	0	151	830	$0.00	$0.34	$1.02	0.00	1.87	7.58
	Cogeneration – CHP	27	198	435	$0.16	$1.21	$2.71	0.65	5.52	14.85
	Forest & Paper Products Vision	0	194	1,508	$0.00	$0.74	$5.66	0.00	4.56	37.28
	Glass Vision	0	40	73	$0.00	$0.14	$0.30	0.00	0.70	1.27
	IAC	71	93	99	$0.30	$0.37	$0.38	1.51	1.98	2.11
	Integrated Delivery Program	27	158	331	$0.11	$0.60	$1.25	0.58	3.05	6.61
	Inventions & Innovations	112	107	117	$0.43	$0.45	$0.50	2.12	1.96	2.07
	Metals Casting Vision	0	20	77	$0.00	$0.09	$0.31	0.00	0.51	1.87
	NICE-3	19	109	144	$0.07	$0.46	$0.62	0.36	2.00	2.55
	Petroleum Refining Vision	0	218	340	$0.00	$0.66	$0.99	0.00	4.02	6.06
	Steel Vision	0	36	110	$0.00	$0.07	$0.24	0.00	0.63	1.94
	OIT TOTAL (non-integrated)	257	1,467	4,489	$1.07	$5.62	$15.31	5.22	29.38	92.74
	OIT TOTAL (integrated)	130	840	2,050	$0.54	$3.22	$6.99	2.60	16.70	43.60
OTT	**Advanced Automotive Technologies**	0	638	1,590	$0.00	$6.11	$15.71	0.00	10.00	27.19
	Biofuels	0	360	1,001	$0.00	$0.00	$0.07	0.00	6.77	18.84
	Heavy Duty Vehicle Technologies	7	205	396	$0.07	$2.75	$5.05	0.18	3.87	7.48
	Technology Deployment	0	0	0	$0.13	$0.85	$0.70	0.27	1.82	1.94
	Transportation Materials Technologies	0	12	50	$0.00	$0.16	$0.58	0.00	0.25	1.03
	OTT TOTAL (non-integrated)	7	1,215	3,037	$0.19	$9.87	$22.11	0.44	22.71	56.47
	OTT TOTAL (integrated)	70	960	1,660	$1.82	$7.80	$12.09	1.40	17.00	26.50
OPT	Biomass Power R&D	28	422	533	$0.01	-$0.15	-$0.21	0.62	10.49	12.95
	Energy Storage	0	1	1	$0.00	$0.00	$0.00	0.01	0.02	0.02
	Geothermal Energy R&D (Generation)	56	182	248	$0.11	$0.46	$0.71	1.08	3.10	4.06
	High Temperature Superconductivity	0	0	9	$0.00	$0.24	$1.03	0.00	0.00	0.14
	Hydrogen	4	92	642	$0.00	$0.10	$1.62	0.06	1.34	9.31
	Hydropower	8	80	183	$0.02	$0.20	$0.53	0.15	1.35	3.00
	Open Solicitation	1	3	3	$0.00	$0.00	$0.01	0.01	0.06	0.06
	Photovoltaic Systems R&D	0	6	49	$0.00	$0.02	$0.16	0.00	0.08	0.72
	Power Systems Integration	23	124	132	$0.00	$0.00	$0.00	0.50	2.70	2.82
	Solar Buildings	3	30	112	$0.00	$0.00	$0.00	0.05	0.47	1.70
	Solar Thermal	0	4	29	$0.00	$0.01	$0.09	0.00	0.06	0.42
	Wind Energy R&D	20	207	613	$0.04	$0.52	$1.76	0.39	3.52	10.05
	OPT TOTAL (non-integrated)	144	1,152	2,554	$0.17	$1.40	$5.70	2.90	23.19	45.26
	OPT TOTAL (integrated)	0	700	1,350	$0.00	$0.85	$3.02	-0.10	14.90	33.20
FEMP	FEMP	24	67	67	$0.16	$0.40	$0.38	0.44	1.21	1.21
	FEMP TOTAL	24	67	67	$0.16	$0.40	$0.38	0.44	1.21	1.21
EERE	TOTAL (non-integrated)	502	6,190	15,838	$2.11	$33.38	$82.25	10.36	112.36	278.00
	TOTAL (integrated + FEMP)	304	3,917	7,547	$3.18	$21.75	$39.01	5.74	75.21	156.41

Bold = ADL Reviewed Planning Unit