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Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Post Hoc Evaluation of Long-Term Goals for Energy Savings in the Buildings Sector: Lessons from Hindsight

D.M. Anderson
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Prepared for the U.S. Department of Energy
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Preface

This report was prepared at the request of Jerry Dion, Senior Program Analyst in the Office of Policy, Budget Formulation, and Analysis (PBFA). PBFA is one office within the Office of Energy Efficiency and Renewable Energy (EERE) at the U.S. Department of Energy (DOE). This report is one of two that re-examines the forecasted impact of individual programs currently within the Buildings Technology Program (BT) and the Weatherization and Intergovernmental Program (WIP) that appeared in the fiscal year (FY)2000 presidential budget request. This report outlines the effects of re-estimating the FY2000 budget request based on overlaying project data from subsequent years—essentially revised out-year forecasts of project benefits. It shows that year-to-year long-term projections of primary energy savings can vary widely as models improve and programs change. Note that the FY2000 budget request was originally analyzed under the former Office of Building Technology, State, and Community Programs (BTS), where BT and WIP were previously combined. Throughout the document, reference will be made to the predecessor of the BT and WIP programs, BTS, as FY2000 reflected that organization.

A companion report develops potential methods for allowing inherent risk to be captured in the project-benefits analysis. The point estimates in this paper are not influenced by uncertainty or risk. That report develops potential methods for allowing inherent risk to affect the benefits analysis via Monte Carlo simulation.

Summary

The Government Performance and Results Act (GRPA), in part, requires that government agencies provide an estimate of the impact of the programs for which funds are requested in the President's annual budget request. The current benefits analysis process, as conducted with the EERE at DOE, estimates the stream of annual benefits resulting from the funding requested for each year's budget. Each year as part of that process, Pacific Northwest National Laboratory (PNNL) develops estimates of the benefits stream for a representative sampling of programs in the buildings portfolio.

In this report, we reanalyzed the FY2000 budget request and forecast of primary energy savings from programs funded in that request. That estimate became the analytical foundation for the BTS goal of saving 2 quadrillion Btu (QBtu) of energy per year in 2010, rising to 5 QBtu per year in 2020. In addition to the use of newer forecasting techniques, more recent benefits estimates are also available for FY2001, FY2002, and FY2003 based on actual budget submittals for those years as opposed to the projected amounts used in the original forecasts. Finally, information regarding the FY2000 BTS portfolio embodied in those subsequent analyses was applied in hindsight to the FY2000 budget to more accurately characterize those programs.

These new estimates are significantly lower than those originally reported for the FY2000 budget request. Based on this new analysis and information, primary energy savings would be over 17% lower in 2010 and 22% lower in 2020. Under these considerations, more appropriate energy-savings goals would have been 1.8 QBtu in 2010 and 3.5 QBtu in 2020. Results are summarized in Table S1.

Table S1. Summary of FY2000 Budget Request Re-estimation

FY2000 Budget	FY2000	2010		2020	
	Budget[(a)]	*TBtu*	*TBtu/ $MM*[(b)]	*TBtu*	*TBtu/ $MM*
Final Request as Reported	286.6	2,146	7.5	4,448	15.6
Final Request Re-Estimated	279.8	1,782	6.4	3,473	12.4
Difference	-6.8	-364	-1.1	-975	-3.2
Percentage Difference	-2.4%	-17.0%	-14.7%	-22.0%	-20.5%

(a) Reflects BTS budget request for programs actually modeled for energy savings, as opposed to the entire BTS budget.
(b) Reflects energy savings per million dollars.

These estimates differ from the estimates produced during the original FY2000 GPRA process for a number of reasons. Those reasons are summarized below and covered in greater detail later in the document.

- A National Energy Modeling System (NEMS) variant (here called NEMS-PNNL) was adopted for project modeling where deemed to improve the reliability of the results beginning with the FY2001 analysis effort.

- Several programs were transferred to the Office of Power Technologies (OPT) during FY2000.
- The "actual" final request budget differed slightly from the version originally modeled for the FY2000 GPRA effort.
- Project characterizations have improved over time as the programs have become better defined—translating to improved estimates of penetration and performance.
- Energy Information Administration (EIA) baseline forecasts can change substantially over short periods of time, and this information is also used to baseline the models used to develop these estimates.

The FY2000 Budget Appropriation reduced funding levels for measured programs by over 14% from the final request. These reductions have the effect of reducing projected energy savings disproportionately in the out years. The disproportionate effect results from the fact that most programs are projected to produce greater energy savings the further out in time we look. As a result, the FY2000 appropriation hampers the original goal-setting exercise by further reducing the effect of the FY2000 budget to 1.4 QBtu in 2010 and 2.8 QBtu in 2020. These results are summarized in Table S2.

Table S2. Summary of FY2000 Budget Request Re-estimation Versus the Appropriation

	FY2000	**2010**		**2020**	
FY2000 Budget	*Budget*[a]	*TBtu*	*TBtu/ $MM*[b]	*TBtu*	*TBtu/ $MM*
Final Request Re-Estimated	279.8	1,782	6.4	3,474	12.4
Appropriation	240.1	1,434	6.0	2,829	11.8
Difference or Differential	-39.7	-348	8.8[1]	-645	16.2[c]
Percentage Difference	-14.2%	-19.5%	-6.3%	-18.6%	-4.8%

(a) Reflects budgets for programs actually modeled for energy savings, as opposed to the entire BTS budget.
(b) Reflects energy savings per million dollars.
(c) Indicates the primary energy savings per million dollars of requested budget not funded in the appropriation.

Acronyms and Abbreviations

AEO	Annual Energy Outlook
BESET	Building Energy Savings Estimation Tool
BT	Buildings Technology Program
BTS	Office of Building Technology, State, and Community Programs
COP	Coefficient of performance (unitless)
DOE	U.S. Department of Energy
EERE	Office of Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
FEDS	Facility Energy Decision System
FY	fiscal year
GPRA	Government Performance and Results Act
kWh	kilowatt hour
l	lumens
l/w	lumens/watt
LPSL	low-pressure sodium lamps
NEMS	National Energy Modeling System
NRC	National Research Council
OPT	Office of Power Technologies
PBFA	Office of Policy, Budget Formulation and Analysis
PNNL	Pacific Northwest National Laboratory
QBtu	quadrillion British thermal units
R&D	research and development
TBtu	trillion British thermal unit
W	watt
WIP	Weatherization and Intergovernmental Program

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1.0 Background

The information generated by the annual Office of Energy Efficiency and Renewable Energy (EERE) benefits estimation effort is used to meet the Government Performance and Results Act (GPRA) of 1993 requirements for the U.S. Department of Energy (DOE), which include the development of a strategic plan, and, eventually, the development of annual performance reports and annual performance plans. The EERE GPRA metrics effort is a systematic process to estimate the benefits of EERE's programs and technologies and to relate the benefits to departmental and EERE strategic goals and objectives. The Office of Building Technology, State, and Community Programs (BTS) was the predecessor to the current Buildings Technology (BT) program and portions of the current Weatherization/ Intergovernmental Program (WIP). BTS used the EERE GPRA process for the fiscal year (FY) 2000 budget request to develop and validate the strategic plan goal of saving 2 QBtu of energy per year by 2010, rising to 5 QBtu per year by 2020.

This is one of two of papers reanalyzing the approach and results of the GPRA estimates and the 2 and 5 QBtu goals. This paper analyzes the FY2000 budget request with the benefit of hindsight to determine how reasonable the 2 and 5 QBtu goals are. It also analyzes the FY2000 budget appropriation, as opposed to the request, using this same context. The companion paper to this report, *FY 2000 Buildings Energy Savings Estimates under Risk: Developing Approaches for Incorporating Risk into Buildings Program Energy Efficiency Estimates* (Anderson 2002), develops a potential method for allowing inherent risk to affect the benefits analysis.

For the FY2000 budget request, Pacific Northwest National Laboratory (PNNL) used the internally developed Building Energy Savings Estimation Tool (BESET) to calculate the GPRA estimates for BTS programs. This assumed subsequent (flat) budget requests over a 20- to 30-year time horizon, as specified in the GPRA guidance. Primary energy savings of roughly 2 and 5 QBtu in 2010 and 2020 were estimated using BESET by analyzing the FY2000 project inputs for the GPRA metrics analysis. These estimations helped BTS set the goals of 2 QBtu of annual primary energy savings in 2010 and 5 QBtu annually by 2020.

Beginning with the FY2001 request, PNNL adopted the National Energy Modeling System (NEMS) and used it in conjunction with BESET to analyze some programs in the BTS portfolio. PNNL developed its variant of NEMS to improve the precision and accuracy of the annual project-benefits estimates. NEMS was developed and is used by the Energy Information Administration (EIA) to develop the baseline energy scenarios for the annual energy outlook, among many other applications. NEMS enables the introduction of macroeconomic interactions of supply and demand to influence the adoption and deployment of technologies under market conditions over time. Essentially, technologies compete in a simulated market based on price and performance. The results represent market-clearing levels of technology adoption. In this report, a NEMS variant (here, called NEMS-PNNL) was used to estimate some programs originally analyzed using BESET (Anderson et al. 2003).

2.0 Analysis

2.1 Hindsight

As more effort and attention becomes devoted to improving the realism of project-benefits modeling, estimates of future savings would become more robust and plausible. By incorporating, in hindsight, what we know currently about the BT/WIP portfolio and the economy, we find the estimated effects of the FY2000 budget request are lower than results estimated originally. Some of the decrease is directly attributable to the use of NEMS-PNNL to analyze programs originally modeled with BESET. NEMS-PNNL has added market-clearing behavior to the adoption of new technologies by explicitly competing technologies based on price and performance in a model. The application of NEMS-PNNL is fully documented in Anderson et al. (2003). These market conditions are also reflected in the baseline levels of equipment performance, penetration, and the mix of technologies in competition provided in NEMS. The BESET methodology relies more heavily on expert (project manager) assumptions about the eventual level of market penetration and the amount of time needed to achieve it. These market penetration estimates are the other principal source of change from the original estimates, as this parameter is perhaps the most subject to revision over time. Analyzing the merits of these approaches falls outside the scope of this study. The paper provides more detailed discussion of the specific inputs that have changed since the initial FY2000 GPRA process that ultimately resulted in the 2 and 5 QBtu goals.

Looking retrospectively at the energy-savings analysis and other benefits arising from BT and WIP projects exposes measurement and evaluation risks inherent in the estimates. The report (Anderson 2002), introduces the many types of risks facing the buildings-related portfolio of projects. With the ability to look back and observe the degree of change to project benefit estimates over several years, we gain insight into the degree of risk associated with any year's estimates. Consequently, having that understanding should lead to improved characterization and accounting of BT and WIP projects with time. We amplify our discussion of measurement and evaluation risks in the Discussion section.

3.0 Methodology

This reanalysis of the FY2000 budget request attempted to isolate the effects of changing BT/WIP project inputs over time and to isolate the effects of changing the baseline data common to all programs. We combined this information to account for, or to suggest lower out-year energy-savings estimates in 2010 and 2020. For purposes of this report, we considered only primary energy savings (including electricity losses).

The original FY2000 GPRA estimates were completed in early 1999. Since that time, energy-savings estimates also have been calculated for the subsequent budget requests of FY2001, FY2002, and FY2003 (Belzer et al. 2002). The estimation process for the FY2000 budget request implicitly included project activities for FY2001 through FY2003. With each subsequent year, presumably more accurate and specific project information will become available on project activities than was available two or three years prior. This later, superceding information was applied in this analysis by overlaying it onto FY2000 model inputs, as Figure 1 depicts.

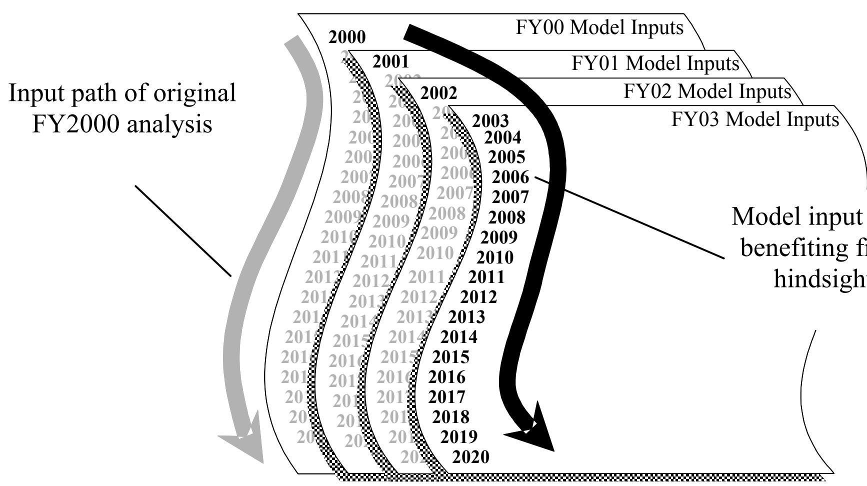

Figure 1. Evaluation Modeling Approach Taking Advantage of Hindsight

The 2- and 5-QBtu goals were developed from a program trajectory resulting from the FY2000 budget. Each subsequent year's budget process changes the trajectory toward those goals by refining and improving the energy-savings estimates for existing programs, introducing new programs that need savings estimates, revising underlying baseline model assumptions, and assessing effects of budget adjustments. The analysis simply follows this annually updating trajectory by imposing the FY2001, FY2002, and FY2003 project inputs onto the original FY2000 budget. This serves to adjust and refine the original trajectory and lead to revised 2010 and 2020 savings goals, while being careful to only include those programs that were part of the FY2000 budget. The specific aims of the individual programs are not expected to materially change from year to year. In other words, goals and objectives articulated for programs in the FY2000 budget are not expected to change significantly over a relatively short (3–5 year) intervening period, which provides a good time frame for looking back at modeling assumptions and inputs.

As noted, major changes in modeling approach, such as moving the analysis of some programs to NEMS beginning with FY2001, are also part of this changing trajectory. Beginning with the FY2001 request, NEMS-PNNL was used instead of BESET for specific programs conducive to the capabilities available with NEMS-PNNL (typically equipment programs featuring a relatively well-defined consumer good). The cumulative affect of these changes in approach and data were applied to the FY2000 portfolio of programs and modeled based on the FY2000 budget request to arrive at estimates that would be consistent with current GPRA estimation practice.

To handle the variety of types of buildings-related programs, PNNL uses a variety of approaches to model the varied programs spanning the BT/WIP portfolio. These range from simple spreadsheets to building simulation models like Facility Energy Decision System (FEDS), to accounting models like BESET, to integrated models of the economy like NEMS. Each has strong suits for application to specific aspects of the portfolio. The approach has been peer reviewed over the years and refinements continue. BESET captures all of the impacts from the various modeling tools to provide a consistent set of modeling output. For more comprehensive discussion of how PNNL develops annual GPRA estimates, see Anderson et al. (2003).

Each key parameter in the project benefits analysis was analyzed in isolation from the rest of the model to estimate the sensitivity of each to the hindsight approach. This was done by holding constant all of the model parameters except the one of interest. The revised input values for the selected parameter were then applied to represent the effect of hindsight. Then, by rerunning the model with this change, the revised savings estimates generated would reflect only the effect of the changed parameter. This was done for each in the following set of parameters:

- building stock
- baseline end-use loads
- performance
- penetration
- electric conversion factors
- baseline equipment
- spreadsheet model results
- NEMS-PNNL model results.

For example, consider electric conversion factors. Each year, electric conversion factors are provided in the EERE GPRA data call. These factors reflect increasing electric energy efficiency (reduced losses in production of electricity) over time that is built into each year's EIA baseline. To estimate the effects of hindsight on this parameter, we updated the out-year parameter values for the FY2000 GPRA effort based on the information available from the FY2003 GPRA effort, while holding the rest of the parameters at their FY2000 levels in the out years. Recalculating the impacts with these changes in place provides a measure of the effect of hindsight on the overall benefits estimates for FY2000 in terms of electric conversion factors. This approach was carried out individually for each of the above listed parameters.

To generate portfolio-level estimates of energy savings under this approach, all of the above parameters were revised based on hindsight and run together as a new scenario.

With the set of model parameters revised based on hindsight, the same approach was applied to the FY2000 appropriation. Adjusting the budget values of the request to reflect those of the appropriation causes the model to adjust savings estimates to the changed funding levels.

4.0 Results

Portfolio-level results appear in Table 1. Apart from switching some programs to being modeled under the NEMS-PNNL approach, the greatest difference in the two sets of estimates comes from revised estimates in market penetration of the programs. This section goes into more detail about the effects of individual parameters on the resulting energy savings estimates.

Table 1. Summary of FY2000 Budget Request Re-estimation

FY2000 Budget	FY2000	2010		2020	
	Budget[(a)]	*TBtu*	*TBtu/ $MM*[(b)]	*TBtu*	*TBtu/ $MM*
Final Request as Reported	295.1	2,146	7.3	4,448	15.1
Final Request Re-Estimated	279.8	1,782	6.4	3,474	12.4
Difference	-15.3	-364	-0.9	-975	-2.7
Percentage Difference	-5.2%	-17.0%		-22.0%	

(a) Reflects BTS budget request for programs actually modeled for energy savings, as opposed to the entire BTS budget. The budget number used in re-estimation reflects a $3.3 million net change between the actual budget request and the version used for the original estimation.
(b) Reflects energy savings per million dollars.

Figure 2 depicts the effects of employing the hindsight approach to key modeling inputs individually, holding constant the original inputs of the other key parameters. For example, the annual impact of revised EIA estimates of higher levels of building stock (third bar from top) results in increased energy savings over the original forecast. This is because both energy consumption and the potential for savings increase as the forecasted stock increases. This is an important subtlety with using absolute energy savings as a goal. While the impact of the portfolio can produce significant energy savings, revised baseline data affect those savings estimates, and overall energy consumption actually can increase. The effect of revised market penetration estimates over time can be seen in the marked decrease in the savings estimates (6th bar from the top). The two most significant impacts on the estimates stem from downward revisions in market penetration estimates over successive years of analysis and moving many equipment programs to the NEMS-PNNL model for analysis as opposed to previous methods.

Figures 3 and 4 break these results down further, showing the effects of re-estimation at the individual FY2000 project level. For example, in Figure 4, original savings estimates were much higher for the commercial and residential codes projects. At the time of the original estimates, the outreach and training functions of the codes projects were being counted under each sector's code project. After FY2000, these activities were counted under the new Training and Assistance for Codes project. The principal changes are summarized within the major model parameters or levers available to model the programs.

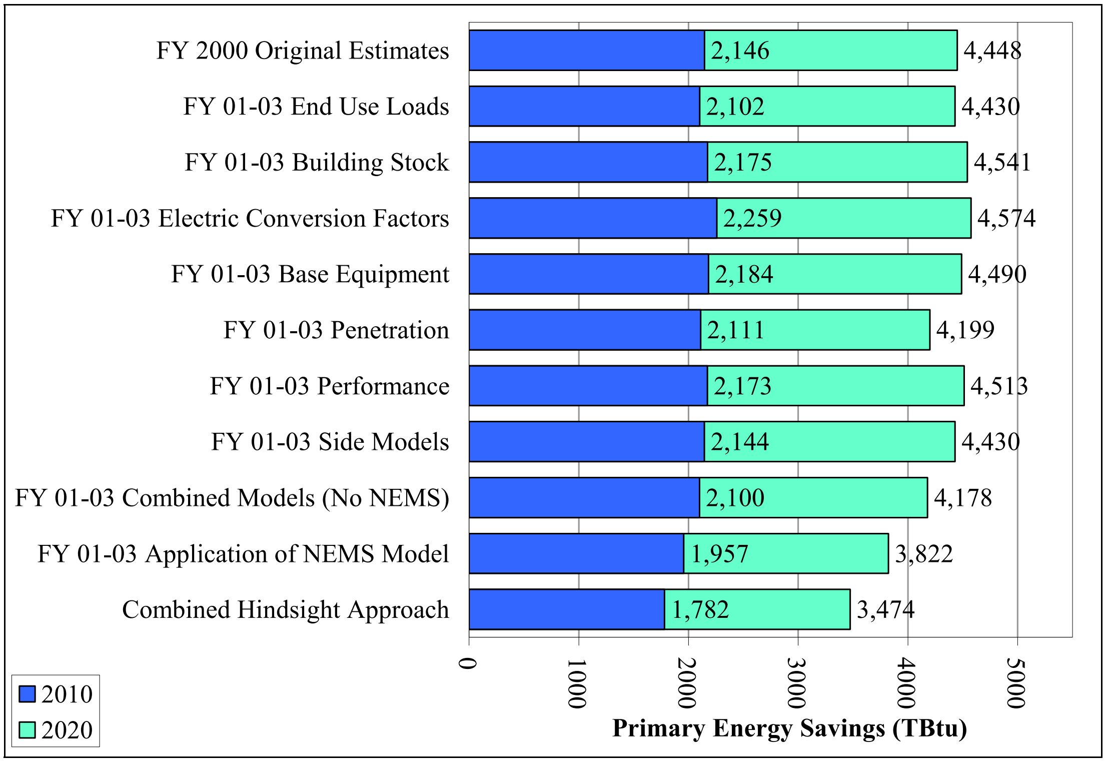

Figure 2. Effects of Selected Model Parameters under Hindsight on Annual Portfolio Savings

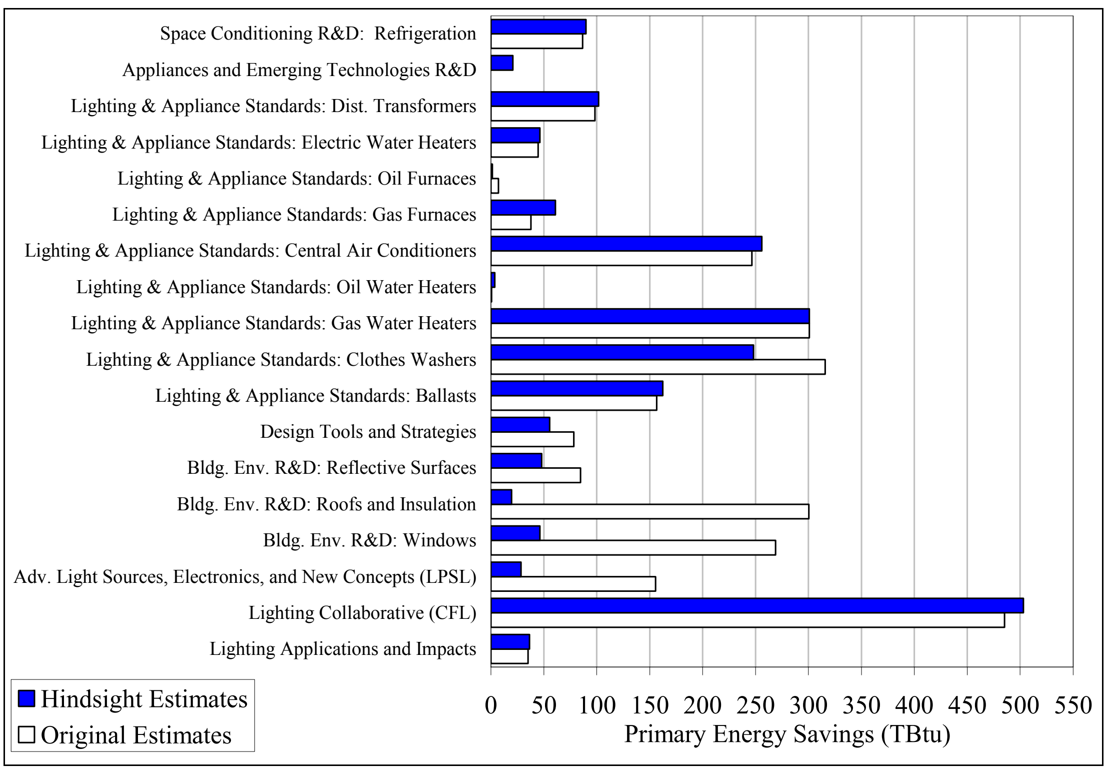

Figure 3. Difference in Equipment Programs' 2020 Energy Savings after FY2000 Re-estimation

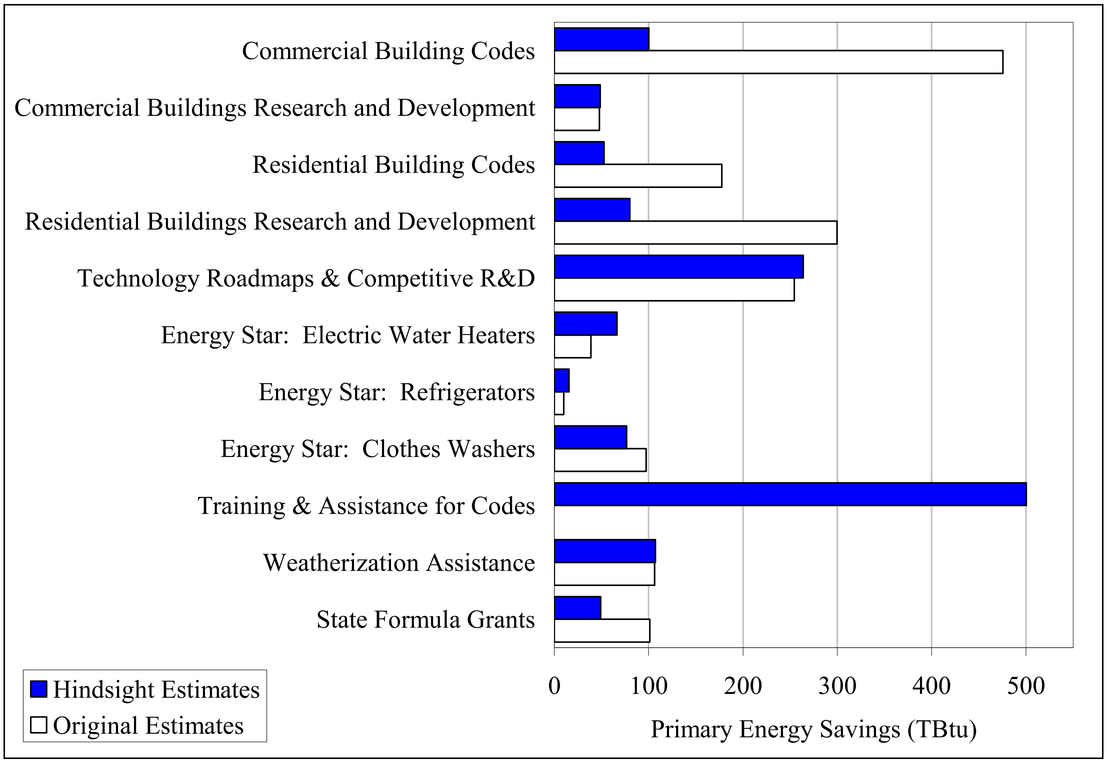

Figure 4. Differences in Other Programs' 2020 Energy Savings after FY2000 Re-estimation

Table 2 summarizes the evolution of the savings estimates from originally reported estimates to what the estimates of the FY2000 budget request would be after employing hindsight. The individual influences shown in Figure 2 are summarized in Table 2. In FY2000, BTS was still credited with the benefits for projects that later moved to the former Office of Power Technologies, as noted in the table. In hindsight, we would not count those projects for BTS. Since FY2000, several equipment programs have been moved to analysis using the NEMS-PNNL model, as noted in Figure 2. The other combined effects of modeling with hindsight show as the "all other modeling" line in the table and correspond to the summation of the individual effects shown in Figure 2, apart from the use of NEMS-PNNL.

Table 2. Individual Influences of Hindsight on Energy Savings (TBtu)

Program Influence	2010	2020
Reported energy savings (FY2000 GPRA)	2,146.4	4,447.8
Programs transferred to OPT*	-35.7	-51.2
Application of NEMS-PNNL	-189.7	-625.9
All other modeling (BESET and Spreadsheets)	-139.1	-297.0
FY2000 estimated with hindsight	1,781.9	3,473.7

*Funding for several programs (cogeneration, fuel cells, combustion research, etc.) was moved to the Office of Power Technologies in the FY2000 budget.

4.1 Results Attributable to Changing End-Use Loads

Before FY2002, the end-use loads (e.g., lighting, heating, and air conditioning, shown collectively in the second bar of Figure 2) were the same across building types, differing only by vintage (year constructed) and region (northeast, southeast, northwest, and southwest). Beginning with the FY2002 effort, PNNL increased the resolution of the modeling efforts by allowing end-use loads to vary by building type. This allowed PNNL to more accurately relate BTS projects to their intended target markets. Table 3 illustrates the effects by project.

In the commercial building sector the following resulted:

- Commercial cooling loads decreased in all vintage/region categories.
- Commercial heating loads decreased significantly in all vintage/region categories.
- Commercial lighting loads increased significantly in all vintage/region categories.
- Commercial water heating loads increased significantly in all vintage/region categories.

Table 3. Change in Energy Savings (TBtu) by Project Attributed to Changing Baseline Base Loads in BESET between FY2000 Analysis and FY2003 Analysis

Affected FY2000 Project	**Original Savings Estimate (Revised)**		**Savings Estimate in Hindsight**		**Percentage Difference (%)**	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
Com. Part. Prog.: Rebuild America	146.2	165.5	82.1	92.7	-43.8	-44.0
Energy Star: Electric Water Heaters	43.6	44.4	65.2	65.9	+49.5	+48.4
Residential Buildings Research and Development	52.7	299.6	70.8	398.5	+34.3	+33.0
Bldg. Env. R&D: Roofs and Insulation	117.9	300.3	106.2	260.3	-9.9	-13.3
Bldg. Env. R&D: Reflective Surfaces	62.4	84.7	46.3	56.7	-25.8	-33.1
Design Tools and Strategies	47.0	78.4	26.8	45.7	-43.0	-41.7
Total of Affected Projects	469.8	972.9	397.4	919.8	-15.4	-5.5

In the residential building sector the following resulted:

- Residential cooling loads increased slightly in the north region and significantly in the south region.
- Residential heating loads increased slightly in the north region and decreased slightly in the south region.

- Residential lighting loads increased significantly in all vintage/region categories
- Residential water heating loads increased significantly in all vintage/region categories.

Although the effects of changes to the base loads are negligible, we can provide some background on changes to specific projects since FY2000. For example, the Residential Buildings research and development (R&D) project was modeled to target new residential building cooling, heating, and water heating loads. The overall impact would increase savings across the end uses. The Building Envelope R&D: Roofs and Insulation project was modeled to target space heating and space cooling end uses in all buildings. Because commercial heating and cooling loads and northern residential heating loads decreased while other residential space heating and cooling loads and both residential and commercial water heating end-use loads increased, an overall decrease in the level of savings would be expected.

4.2 Results Attributable to Changing Building Stock

Each year, the building stock forecast is updated to reflect the most recent EIA forecast published in the Annual Energy Outlook (AEO). For the FY2000 GPRA effort, the building stock was based on AEO 1998 forecast (EIA 1997); for the FY2003 GPRA effort, the building stock was based on the 2001 forecast (EIA 2000). In addition, the stock split by region was revised by PNNL so the FY2002 effort better reflected the location of existing buildings and current construction patterns. Impacts on energy savings estimates are shown in Table 4.

Before the FY2002 effort, existing building stock for residential and commercial was assumed to be divided as 60% in the north and 40% in the south; and new stock was assumed to be divided as 50% in the north and 50% in the south. Beginning with the FY2002 effort, the following assumptions were made regarding stock allocation:

- Residential single family and multifamily: 60% of existing is in the north, and 40% is in the south; new buildings are divided evenly across regions.
- Residential manufactured housing: 48% of existing is in the north, and 52% is in the south; new buildings are assumed to be 45% in the north and 55% in the south.
- Commercial buildings: 59% of existing is in the north and 41% is in the south; new buildings are assumed to be 55% in the north and 45% in the south.

The impacts of the AEO building stock changes are shown in Table 5. The additional impacts of the stock split, listed by region, are illustrated in Table 6. Because the variations in stock forecast changes are not constant throughout the period, data for the years 2003 and 2020 are presented in both tables, along with the annual average change for the 2003 to 2020 period. The average annual change is equal to the sum of the building stock changes for each year divided by the total number of years (18 years).

As illustrated in Table 5, the commercial new-building stock forecast was most impacted by changes in the AEO. The difference between AEO forecasts was intensified by the modifications to the regional stock split, as shown in Table 6. Table 4 provides a summary of the effects on individual programs of annual revisions to the baseline building stock as described above.

Table 4. Change in Energy Savings (TBtu) by Project Attributed to Changing Baseline Building Stock in BESET between the FY2000 and FY2003 Analyses

Affected Project	Original Savings Estimate (Revised)		Savings Estimate in Hindsight		Percentage Difference (%)	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
Com. Part. Prog.: Rebuild America	146.2	165.5	140.7	166.6	-3.9	+0.6
Energy Star: Electric Water Heaters	43.6	44.4	46.2	47.2	+6.0	+6.3
Residential Buildings Research and Development	52.7	299.6	57.4	330.2	+8.9	+10.2
Bldg. Env. R&D: Roofs and Insulation	117.9	300.3	129.5	335.9	+9.8	+11.9
Bldg. Env. R&D: Reflective Surfaces	62.4	84.7	49.0	67.7	-21.5	-20.1
Design Tools and Strategies	47.0	78.4	47.6	83.7	+1.3	+6.8
Total of Affected Programs	469.8	972.9	470.4	1031.3	+0.1	+6.0

Table 5. Changes in Building Stock Estimates Based on Differences in AEO Forecasts (AEO 1998 Versus AEO 2001)

Sector and Vintage	Year	Units	AEO 1998	AEO 2001	Change	Average Annual Change for the period 2003-2020
Commercial Existing (All)	2003	Billion SF	70.48	66.69	-3.79 (-5%)	-2.78 (-4%)
	2020	Billion SF	53.62	51.96	-1.66 (-3%)	
Commercial New (All)	2003	Billion SF	1.69	2.05	0.36 (21%)	0.12 (8%)
	2020	Billion SF	1.14	1.26	0.12 (11%)	
Residential Existing (All)	2003	Million HH	101.90	107.05	5.15 (5%)	5.50 (6%)
	2020	Million HH	90.96	97.46	6.50 (7%)	
Residential New (All)	2003	Million HH	1.71	1.91	0.20 (12%)	-0.04 (-2%)
	2020	Million HH	1.81	1.72	-0.09 (-5%)	

Table 6. Changes to Building Stock Estimates Due to Both Changes in AEO Forecasts and Revisions in Stock Split by Region Assumptions

Sector, Vintage, and Region	Year	Units	FY00 GPRA	FY03 GPRA	Change	Average Annual Change for the period 2003-2020
Commercial Exist North	2003	Billion SF	35.24	39.34	4.10 (12%)	3.97 (13%)
	2020	Billion SF	26.81	30.67	3.86 (14%)	
Commercial Exist South	2003	Billion SF	35.24	27.35	-7.89 (-22%)	-6.75 (-22%)
	2020	Billion SF	26.81	21.29	-5.52 (-21%)	
Commercial New North	2003	Billion SF	0.67	1.13	0.46 (69%)	0.30 (48%)
	2020	Billion SF	0.45	0.69	0.24 (53%)	
Commercial New South	2003	Billion SF	1.02	0.92	-0.10 (-10%)	-0.18 (-19%)
	2020	Billion SF	0.69	0.57	-0.12 (-17%)	
Residential Existing North	2003	Million HH	50.95	63.44	12.49 (25%)	12.37 (26%)
	2020	Million HH	45.48	58.05	12.57 (28%)	
Residential Existing South	2003	Million HH	50.95	43.61	-7.34 (-14%)	-6.87 (-14%)
	2020	Million HH	45.48	39.41	-6.07 (-13%)	
Residential New North	2003	Million HH	0.68	0.94	0.26 (38%)	0.15 (21%)
	2020	Million HH	0.72	0.85	0.13 (18%)	
Residential New South	2003	Million HH	1.03	0.97	-0.06 (-6%)	-0.19 (-17%)
	2020	Million HH	1.09	0.87	-0.22 (-20%)	

4.3 Results Attributable to Changing Electric Conversion Factors

Each year, electric conversion factors are provided in the EERE GPRA data call. These factors reflect increasing electric energy efficiency (reduced losses in production of electricity) over time that is built into each year's EIA baseline. The impact to individual programs is dependent on the percentage of primary savings that come from electricity. Total site energy savings do not change. Table 7 provides a summary of the effects on individual programs of annual revisions to the electric conversion factors. As can be seen in the fourth bar of Figure 2, annual updates to these factors have resulted in a slightly positive impact on energy savings. The more an individual project affects electricity consumption, the greater the percentage impact in any year. Because BT and WIP projects affect end uses of energy, rather than energy production and transmission, savings impacts estimated for these projects are assumed to be in addition to improvements in baseline electrical efficiency.

Table 7. Change in Energy Savings (TBtu) Project Attributed to Changing Baseline Electric Conversion Factors in BESET between FY2000 Analysis and FY2003 Analysis

Affected Project	**Original Savings Estimate (Revised)**		**Savings Estimate in Hindsight**		**Percentage Difference (%)**	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
State Formula Grants	56.0	101.1	58.2	103.0	3.9	1.9
Weatherization Assistance	76.8	106.2	77.9	107.0	1.4	0.8
Com. Part. Prog.: Rebuild America	146.2	165.5	151.2	168.3	3.4	1.7
Energy Star: Clothes Washers	49.9	97.2	51.3	98.5	2.8	1.3
Energy Star: Refrigerators	6.8	10.0	7.3	10.3	7.4	3.0
Energy Star: Electric Water Heaters	43.6	44.4	46.6	46.0	6.9	3.6
Technology Roadmaps & Competitive R&D	79.6	254.4	85.9	263.8	7.9	3.7
Residential Buildings Research and Development	52.7	299.6	54.3	304.3	3.0	1.6
Residential Building Codes	76.4	177.6	80.0	181.9	4.7	2.4
Commercial Buildings Research and Development	35.7	47.8	36.8	48.6	3.1	1.7
Commercial Building Codes	164.5	475.6	176.0	492.7	7.0	3.6
Lighting Applications and Impacts	8.2	35.2	8.8	36.4	7.3	3.4
Lighting Collaborative (CFL)	110.8	485.1	118.6	503.1	7.0	3.7
Adv. Light Sources, Electronics, and New Concepts (LPSL)	34.5	155.6	37.0	161.4	7.2	3.7
Bldg. Env. R&D: Windows	62.8	269.0	65.9	276.0	4.9	2.6
Bldg. Env. R&D: Roofs and Insulation	117.9	300.3	121.7	305.3	3.2	1.7
Bldg. Env. R&D: Reflective Surfaces	62.4	84.7	65.5	86.9	5.0	2.6
Design Tools and Strategies	47.0	78.4	48.7	79.9	3.6	1.9
Lighting & Appliance Standards: Ballasts	166.0	156.7	177.7	162.4	7.0	3.6
Lighting & Appliance Standards: Clothes Washers	140.0	315.8	144.0	320.2	2.9	1.4
Lighting & Appliance Standards: Central Air Conditioners	175.0	246.5	187.1	255.3	6.9	3.6
Lighting & Appliance Standards: Electric Water Heaters	43.2	44.7	46.2	46.3	6.9	3.6

Affected Project	Original Savings Estimate (Revised)		Savings Estimate in Hindsight		Percentage Difference (%)	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
Lighting & Appliance Standards: Dist. Transformers	75.8	98.3	81.0	101.8	6.9	3.6
Space Conditioning R&D: Refrigeration	54.3	86.7	57.9	89.7	6.6	3.5
Total of Affected Programs	1886.1	4146.4	1985.6	4259.1	5.3	2.7

4.4 Results Attributable to Changing Baseline Equipment

For the FY2002 effort, some baseline equipment efficiencies were adjusted. Compact fluorescent lamp efficacies were reduced from 70 lumens/watt (l/w) to 55 l/w (rising to 60 l/w in out years); The coefficient of performance (COP) for electric heat pumps was increased in residential existing households from 1.99 to 2.11; and refrigerator energy use was modified from a flat 450 kWh throughout the analysis period to an initial 822 kWh/year, falling to 343 kWh/year by 2020. Effects of these changes are highlighted in Table 8.

The change in base refrigerator efficiency caused a significant impact on the estimated savings for that project, relative to other baseline changes for other programs. Because the other equipment changes were small, they would be expected to have the negligible impact shown on projects targeting either the building envelope or the whole building.

Table 8. Change in Energy Savings (TBtu) by Project Attributed to Changing Baseline Equipment in BESET between FY2000 Analysis and FY2003 Analysis

Affected FY2000 Project	Original Savings Estimate (Revised)		Savings Estimate in Hindsight		Percentage Difference (%)	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
Com. Part. Prog.: Rebuild America	146.2	165.5	146.5	165.5	+0.2	+0.0
Energy Star: Refrigerators	6.8	10.0	14.7	16.1	+116.2	+61.0
Bldg. Env. R&D: Roofs and Insulation	117.9	300.3	118.7	300.5	+0.7	+0.1
Bldg. Env. R&D: Reflective Surfaces	62.4	84.7	62.9	84.9	+0.8	+0.2
Design Tools and Strategies	47.0	78.4	47.2	78.4	+0.4	+0.0
Total of Affected Projects	380.3	638.9	390.0	645.4	+2.6	+1.0

4.5 Results Attributable to Changing Project Penetration

Each year, the project characterizations are reviewed by both PNNL GPRA analysts and the BT/WIP project managers. As projects change focus, or as better information becomes available, the project penetration rates are adjusted. Both Design Tools And Strategies and Commercial Buildings R&D have very ambitious penetration and performance goals. In FY2000, these were modeled with the goals that the project manager specified, but it became apparent that the Commercial Buildings R&D was relying on all potential results from Design Tools and Strategies to achieve the savings with their high-performance buildings. Thus, these penetration and performance goals are now modeled in combination with one another. Design Tools and Strategies decreased because the assumed penetration into new buildings was adjusted downward to remove overlap with commercial building codes.

The significant change in the Residential Buildings R&D project resulted from correcting the number of households penetrated from a cumulative number to an annual number. For FY2000, the series of cumulative households had been mistaken for annual numbers, based on a definitional misunderstanding. This was corrected for the FY2001 and subsequent analyses. Table 9 highlights those programs with changes in penetration estimates.

Table 9. Change in Energy Savings (TBtu) by Project Attributed to Changing Project Penetration in BESET between FY2000 Analysis and FY2003 Analysis

Affected FY2000 Project	Original Savings Estimate (Revised)		Savings Estimate in Hindsight		Percentage Difference (%)	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
Com. Part. Prog.: Rebuild America	146.2	165.5	127.9	141.0	-12.5	-14.8
Residential Buildings Research and Dev.	52.7	299.6	11.4	66.9	-78.4	-77.7
Bldg. Env. R&D: Roofs and Insulation	117.9	300.3	117.0	294.2	-0.8	-2.0
Design Tools and Strategies	47.0	78.4	43.8	58.0	-6.8	-26.0
Total of Affected Projects	363.8	843.8	300.1	560.1	-17.5	-33.6

4.6 Results Attributable to Changing Project Performance

Characteristics of project performance include such measures as lifetime, percent load reduction, lumens per watt, energy factor, etc., depending on the specific technologies impacted by each project. Table 10 highlights the projects with revised estimates of performance. These projects measure performance in terms of percentage load reductions over time. The significant change in the Design Tools and Strategies project resulted from correcting this project's estimated percentage load reduction across building types and vintages from a constant level to an increasing level over time to be congruent with the Commercial Buildings R&D project goals.

Table 10. Change in Energy Savings (TBtu) by Project Attributed to Changing Project Performance in BESET between FY2000 Analysis and FY2003 Analyses

Affected FY2000 Project	Original Savings Estimate (Revised)		Savings Estimate in Hindsight		Percentage Difference (%)	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
Com. Part. Prog.: Rebuild America	146.2	165.5	142.1	163.5	-2.8	-1.2
Residential Buildings Research and Development	52.7	299.6	43.6	282.9	-17.3	-5.6
Design Tools and Strategies	47.0	78.4	59.0	126.6	25.5	61.5
Total of Affected Projects	245.9	543.5	244.7	573.0	-0.5	5.4

4.7 Results Attributable to Updating Spreadsheet Models

Each year, the BT/WIP project characterizations are reviewed by both the PNNL analysts and the project managers within BT and WIP. As projects change focus, or as better information becomes available, the project penetration rates are adjusted. For example, since FY2000, the building codes projects have been revisited and reanalyzed, resulting in changes to the estimated project savings. Also, the State Energy project was subjected to external peer review as part of the FY2002 GPRA effort. As a result, changes were made to the historical mix of savings as they were applied to the forecasted future mix.

The major change reflected in Table 11 results from the allocation of the bulk of the savings formerly attributable to the residential and commercial codes projects to the newly created Training & Assistance for Codes project. In FY2001, the current Building Codes Training and Assistance project was modeled for GPRA benefits. That year, significant portions of the codes-related energy savings were reallocated from the individual residential and commercial codes projects to this new project because the new project would be responsible for achieving most of the code compliance through training and technical assistance activities. Hence, the significant reductions in energy savings from the codes development projects are largely made up in the savings appearing under Training and Assistance for Codes in Table 11.

Table 11. Change in Energy Savings (TBtu) by Project Attributed to Switching Savings Spreadsheets between FY2000 Analysis and FY2003 Analysis

Affected FY2000 Project	Original Savings Estimate (Revised)		Savings Estimate in Hindsight		Percentage Difference (%)	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
State Formula Grants	56.0	101.1	25.6	48.3	-54.3	-52.2
Training & Assistance for Codes	0.0	0.0	229.1	504.5	+100	+100
Residential Building Codes	76.4	177.6	3.4	52.0	-95.5	-70.7
Commercial Building Codes	164.5	475.6	8.4	96.7	-94.9	-79.7
Total of Affected Projects	296.9	754.3	266.5	701.5	-10.2	-7.0

4.8 Results Attributable to NEMS-PNNL

Beginning with the FY2001 GPRA effort, NEMS was brought into the estimation process for consistency with the integrated analysis methods used by EERE. Each office under EERE analyzes the GPRA benefits attributable to their portfolio of projects in isolation from the other offices. EERE performs an integrated analysis using a version of NEMS. EERE's analysis attempts to account for the various interactions among EERE projects and minimize double counting that might occur when programs are analyzed in isolation from each other. PNNL tailors its analysis methods to the specific project being evaluated. This includes the use of BESET, spreadsheet models, and NEMS-PNNL, as outlined earlier.

For projects not modeled in NEMS-PNNL, BESET and spreadsheet models estimate the difference between the new technology or practice against the appropriate/next-best/average technology in the marketplace. In NEMS, the model selects the most cost effective technology among an array of choices to satisfy demand for an energy service, like lighting, based on cost and performance. Therefore, NEMS-PNNL lends itself well to projects where products can be specified clearly in terms of cost and performance—like equipment-related programs. PNNL currently maintains a version of NEMS for modeling equipment-related programs. Table 12 documents the programs where estimates changed in response to moving to the NEMS-PNNL from the accounting model framework. The net effect on the projects that were selected for modeling under NEMS-PNNL was to reduced energy-savings estimates for those projects by one-third in 2010 to nearly half by 2020.

Table 12. Change in Energy savings (TBtu) by Project Attributed to Switching to NEMS-PNNL to Model Some Programs between FY2000 Analysis and FY2003 Analysis

Affected Project	Original Savings Estimate (Revised)		Savings Estimate in Hindsight		Percentage Difference (%)	
	2010	*2020*	*2010*	*2020*	*2010*	*2020*
Energy Star: Clothes Washers	49.9	97.2	43.8	75.3	-12.2	-22.5
Energy Star: Refrigerators	6.8	10.0	6.5	15.1	-4.4	51.0
Energy Star: Electric Water Heaters	43.6	44.4	14.5	64.1	-66.7	44.4
Adv. Light Sources, Electronics, and New Concepts (LPSL)	34.5	155.6	12	27.4	-65.2	-82.4
Bldg. Env. R&D: Windows	62.8	269.0	18.2	44.5	-71.0	-83.5
Bldg. Env. R&D: Roofs and Insulation	117.9	300.3	1.2	19.4	-99.0	-93.5
Lighting & Appliance Standards: Clothes Washers	140.0	315.8	122.9	244.7	-12.2	-22.5
Lighting & Appliance Standards: Oil Water Heaters	1.1	0.7	2.4	3.6	118.2	414.3
Lighting & Appliance Standards: Central Air Conditioners	175.0	246.5	172.5	246.7	-1.4	0.1
Lighting & Appliance Standards: Gas Furnaces	24.0	37.9	33.4	61.1	39.2	61.2
Lighting & Appliance Standards: Oil Furnaces	4.3	7.1	1.5	1.5	-65.1	-78.9
Appliances and Emerging Technologies R&D	0.0	0.0	13.4	20.0	+100	+100
Total of Affected Programs	659.9	1494.5	442.3	833.4	-33.0	-44.5

Several factors contribute to the wide variances seen in the estimates as a result of changing to the NEMS-PNNL model. The AEO reference cases (EIA 1997, 1998, 1999) typically account for the assumption of increasing energy efficiency over time as a product of technological evolution. This means that before any BT or WIP projects are counted, general energy efficiency is assumed to increase with time and is reflected in the baseline efficiencies of all technologies available to consumers in the NEMS-PNNL model. Before adopting NEMS-PNNL, baseline efficiency was held constant over the analysis period. This lead to high estimates of energy savings in the past, as the relative difference from the baseline widened over time. However, this has since been remedied across the PNNL framework so that increasing baseline efficiency is reflected. The baseline efficiency issue impacts several projects:

- all Lighting and Appliance Standards projects
- lighting R&D: Advanced Light Sources, Electronics, and New Concepts (LPSL)
- all Energy Star projects.

Characteristics have changed for a few of the projects now modeled using NEMS-PNNL. The combination of changes in characteristics and the move to NEMS-PNNL happening simultaneously makes it very difficult to separate the effects of one change or another for these projects. We consider these changes in the NEMS category simply because there is no way to separate the effects. The Building Envelope R&D: Roofs and Insulation project decreased significantly primarily due to the change in technology mix modeled between FY2000 and FY2002. The characterization of this project has been significantly refined with time. Building Envelope R&D: Windows decreased primarily because some of the savings originally attributable to this project were allocated to the Energy Star Windows project beginning in FY2002. The Energy Star Windows project did not exist in FY2000. The Appliances and Emerging Technology project was not originally modeled when the FY2000 estimates were produced, but it was part of the FY2000 budget request and has since been modeled. Characterizations of all projects are evaluated annually. Moving to NEMS-PNNL required that more attention be paid to characterizing specific products for the model that would reflect the likely efforts of equipment research and development projects over time.

4.9 FY2000 Budget Appropriation

The information and approaches used in the re-estimation of the budget request were also used to estimate the savings in the actual appropriation. The appropriated FY2000 budget for the projects modeled amounted to roughly a 14% cut from what was requested. The appropriated budget was assumed to not fundamentally alter the characteristics of projects affected. The projects were assumed to continue with the same energy-savings goals, but likely be delayed in achieving those goals based on the severity of the budget reduction. In reality, project managers would be expected to employ varying strategies to manage their projects based on the appropriated budget. For this analysis, the characteristics of the projects affected by the appropriation remained constant, while the budget assigned to each was reduced to match the appropriation. The resulting effects are shown in Table 13.

Table 13. Summary of FY2000 Budget Request Re-estimation Versus the FY2000 Appropriation for Projects Modeled

FY2000 Budget	FY2000	2010		2020	
	Budget[(a)]	*TBtu*	*TBtu/ $MM*[(b)]	*TBtu*	*TBtu /$MM*
Final Request Re-Estimated	279.8	1,782	6.4	3,474	12.4
Appropriation	240.1	1,434	6.0	2,829	11.8
Difference or Differential	-39.7	-348	8.8[1]	-645	16.2[(c)]
Percentage Difference	-14.2%	-19.5%	-6.3%	-18.6%	-4.8%

(a) Reflects BTS budget request/appropriation for programs actually modeled for energy savings, as opposed to the entire BTS budget.
(b) Reflects energy savings per million dollars.
(c) Indicates the primary energy savings per million dollars of requested budget not funded in the appropriation.

As shown in Table 13, the budget reduction implied by the appropriation results in a disproportional effect on the estimated energy savings. This may vary from year to year, but in FY2000, the appropriation reduced the budgets slightly more for projects having higher estimated energy-savings benefits. Therefore a 14% budget reduction in FY2000 results in out-year energy savings that are 18–20% below those generated for the budget request. Also of note, the table explicitly shows that the effectiveness of project budgets increases over the analysis period, as the savings per million dollars of budget double between 2010 and 2020. However, the effect of reducing requested budgets in the appropriation also affects project effectiveness measured by energy savings per million dollars (TBtu/$MM columns of Table 13). The appropriation reduced the effectiveness of each budget dollar by 6.3% in 2010 and 4.8% in 2020. This results because the projects affected by reduced budgets in the appropriation had estimated energy savings per budget dollar that were significantly higher than the portfolio average—otherwise the effects would be directly proportional.

Figures 5 and 6 below break these results down to the project level. The effects shown simply reflect the assumed delay in achieving project goals imposed by the appropriation. Theoretically, programs facing significant budget reductions resulting from the appropriation should be recharacterized to reflect the need to amend goals and objectives based on the changed funding picture. For this analysis, we simply demonstrate the effect of budget adjusting the projected outcomes of the projects—thus maintaining the original project characteristics. The Training and Assistance for Codes project shows the greatest impact as energy-savings estimates fall in proportion to the percentage difference reduction in budget between the requested and appropriated budget.

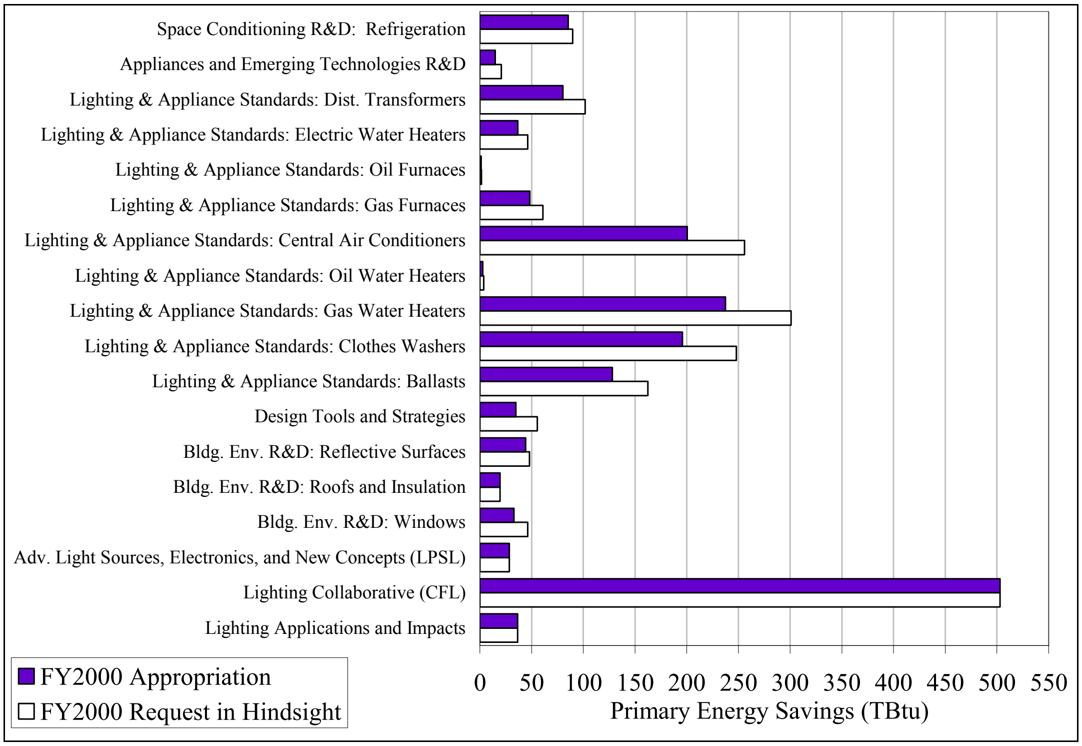

Figure 5. Differences in Equipment Projects' 2020 Energy Savings Based on Appropriation

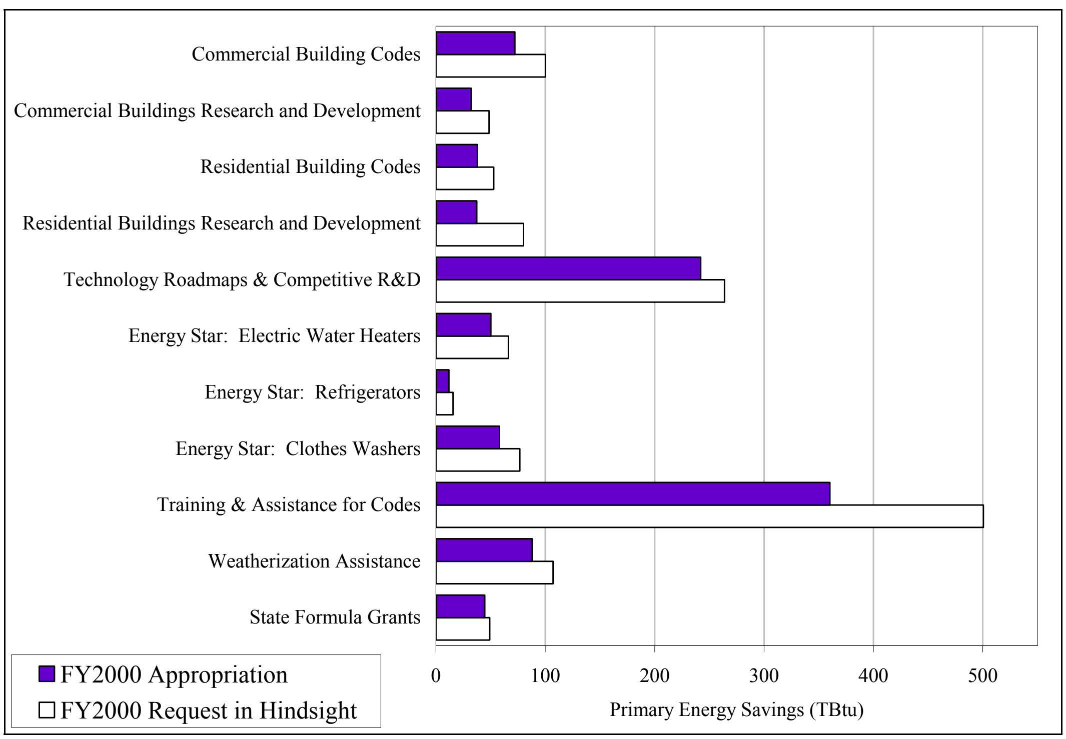

Figure 6. Differences in Other Projects' 2020 Energy Savings Based on Appropriation

In summary, to illustrate the effects of budget appropriations, depending on the relative difference between the request and the appropriation, projects may need to be recharacterized. GPRA analysis focuses on the budget request, and resources are allocated to characterizing projects, as reflected in the requested budget. No such effort is made in response to the appropriation, as this would be beyond the scope of the GPRA legislation. However, a simple factor relating estimated energy savings to requested budget provides a crude method for gauging the effects of the appropriation. This can be valid for relatively insignificant changes in budget between request and appropriation. This implies that budgets reduced in the appropriation would result in delayed achievement of objectives outlined in the budget request.

5.0 Discussion

Of course, we do not have the benefit of hindsight at the time of each annual analysis of the budget request. This paper shows that later reanalysis of the estimates using subsequent-year inputs can result in significant changes to the original estimates. This suggests that the original estimates should have been banded (a range of estimates) or otherwise qualified to denote the uncertain nature of such estimates.

These results indicate that at least two sources of risk or uncertainty, which we are calling "measurement risk" and "evaluation risk," affect the estimation of GPRA benefits. Measurement risk affects the analysis through the calculation methodologies used to derive project-benefits estimates. The calculations are subject to information and various factors that may improve or change with time. For example, performing annual updates to baseline variables, like electric conversion factors or baseline end-use loads, contributes to measurement risk. Evaluation risks arise from annual changes in project assumptions or the analytical frame of reference. For example, the move of several equipment projects to the NEMS modeling framework provided a manifestation of evaluation risk. Project managers' ability to revise or temper their estimates of market penetration over time, based on factors such as variances, between requested and appropriated budgets, new information and research, organizational realignment, or other unforeseen factors, also pose evaluation risks to estimates developed for any specific year. In the absence of perfect information, both issues of measurement and evaluation risk should be accounted for in some fashion.

The adoption of the NEMS modeling system caused a one-time exaggeration of what these measurement and evaluation uncertainties likely would be. Had NEMS not been adopted for modeling project benefits, the differences between the original FY2000 estimates and the hindsight estimates would be much smaller. However, it is not unreasonable to believe that periodic innovations to the GPRA benefits estimation framework, like the adoption of NEMS, might significantly alter projected energy-savings estimates. For example, EERE's use of the MARKAL model to perform integrated analysis of the EERE portfolio is known to yield results that differ from analysis using NEMS. The adoption of the "5-year rule" suggested in the National Academy of Sciences approach to estimating the benefits attributable to Federal investment also leads to benefits estimates for projects that differ compared to historical approaches (NRC 2001). If we were to quantify evaluation risk, in the absence of major methodological changes, year-over-year relative differences in project characteristics (performance, market segmentation, market penetration, etc.) form a more consistent bound for these risks. It also should be noted that evaluation risks swamp measurement risks in terms of their effect on project-benefits analysis.

Measurement risk has been fairly well illustrated in this report using the hindsight approach. We can loosely define the sources of these risks as those annual differences in baseline information used for project modeling (conversion factors, baseline end-use load forecasts, equipment efficiencies, performance, penetration, etc.). Taken together, these variables accounted for an average annual reduction in the 2020 projected energy savings of the buildings-related portfolio of about 100 TBtu from FY2000 to FY2003.

Finally, an "appropriation legacy" effect on the results exists. The GPRA process assesses the trajectory of project benefits originating with the FY2000 budget request. That process assumes that requested budgets will remain constant or follow their planned levels throughout the analysis period. In reality, project results are ultimately constrained to outcomes possible under the budget appropriation. Thus, by estimating benefits in response to the budget request and not factoring in the appropriation, the benefits estimates will always overstate the likely outcomes of the programs (assuming appropriations are typically lower than requests). Further, this analysis shows that for FY2000 the effect of reducing the portfolio budget in the appropriation caused a disproportionate response in projected energy savings. The disproportionate effect resulted from appropriating less than requested for programs estimated to result in higher-than-average energy savings per budget dollar in the long run.

6.0 Conclusion

The message here is three fold. First, expected year-to-year changes in baseline conditions have a minimal to moderate effect on out-year estimates of portfolio energy savings, depending on the project, but as a whole, these effects are insignificant. Second, adjustments to project-specific modeling inputs have a significant effect on energy-savings estimates. This includes strategic decisions to adopt advances in energy-savings modeling, such as NEMS, or to embrace suggested improvements in methodology, such as the NAS approach. If a reanalysis of the FY2002 request takes place two or three years from now, the resulting differences are likely to be much less pronounced, simply because the NEMS results would already be part of the baseline against which we estimate. Finally, in the case of FY2000, the projected response to the appropriation generally reallocated energy savings from potentially higher energy-saving programs to programs having lower or perhaps more certain potential.

Those programs not moved to the NEMS-PNNL analysis framework also had sometimes significant changes to the energy-savings estimates. These changes are mostly attributable to changes in the assumed market penetration resulting from revisions to the project characterizations in discussion with project managers. These revisions include revised penetration rates, updated calculation methodologies, changes in project scope and timing, and updated expectations for future building and equipment code changes.

We have defined how risk affects GPRA benefits analysis. Although the modeling approach for the BT and WIP program portfolios is deterministic, and therefore not able to explicitly estimate risk, users of the benefits estimates must be aware that measurement and evaluation risks affect the results from year to year. We have suggested that evaluation risks greatly overshadow measurement risks. It is important to acknowledge that baseline information gets revised each year, which affects the annual benefits estimates of BT and WIP projects by implying measurement risk. However, when considered in contrast to factors such as methodology changes, project characterization, funding reprioritization, and other more fundamental evaluation risks, measurement risks appear insignificant.

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