Appendix H – GPRA06 Industrial Technologies Program Documentation

1 Introduction

The information provided in this appendix is based on the Industrial Technologies Program (ITP) report of the GPRA06 process, "GPRA06 Quality Metrics – Methodology and Results," Energetics Inc., October 25, 2004. The report includes additional methodological details and the actual off-line energy savings results submitted to the Office of Energy Efficiency and Renewable Energy (EERE).

The GPRA06 calculation of future program impacts was performed separately for each planning unit and summed to produce the total ITP program impact. Within planning units, impacts were calculated differently for R&D planning units than for Technology Delivery planning units. Impacts for R&D planning units were calculated at the project level using a uniform methodology embodied in a spreadsheet-based computer tool called the Technology Impact Projections Model. Impacts for Industrial Assessment Center (IAC) and Best Practices planning units were calculated for subprogram element activities using historical data, estimates, and assumptions documented in tabular format; and summed to produce the planning unit impacts. ITP's subprogram structure includes:

R&D Planning Units

1. Aluminum Industry Vision
2. Chemicals Industry Vision
3. Forest Products Industry Vision
4. Glass Industry Vision
5. Metal-Casting Industry Vision
6. Steel Industry Vision
7. Mining Industry Vision
8. Supporting Industry Vision
9. Industrial Materials Crosscut
10. Sensors and Automation Crosscut
11. Combustion Crosscut

Technology Delivery Planning Units

1. Industrial Assessment Center (IAC) Program
2. Best Practices Program

1.1 Target Markets (The Baseline Case)

- **Target Market Description**

Advanced industrial energy efficiency technologies under development with program support will enter a variety of specialized markets for production equipment, plant energy conversion, distribution, heat recovery, and waste-reduction equipment. Underlying fuel prices, the electricity generation and distribution fuel mix and heat rates, and sector economic growth rates —which were used in the NEMS-GPRA06 runs that produced the ultimate results from ITP's energy-savings inputs—were consistent with the reference case in the Department of Energy's (DOE/EIA) *Annual Energy Outlook 2004*. ITP's off-line calculation of fuel and electricity savings for individual projects and program-element activities did not refer explicitly to macro-baseline quantities, except that a unique market growth rate was specified in each of the 163 Technology Impact Projections Model runs. This permitted the analysts to differentiate among highly varied market outlooks in the various industries. Except for several chemicals industry market targets with short-term growth rates of more than 3.0%, the range of these annual market growth rates was from -1.0% to 2.5%, with an average close to 1.5%.

Due to differences in the analytical framework of the NEMS-GPRA06 model and ITP's bottom-up energy-savings projection methodology, it was not possible to definitively match those models' base-case assumptions with the implicit base case in the GPRA study. NEMS-GPRA06 addresses the entire industry group in a top-down manner, assigning energy intensities to a comprehensive set of activities to project total industry energy use under alternative assumptions. The bottom-up ITP GPRA study specified the unit energy savings of a particular set of 163 advanced technologies, each in comparison to a best-available commercial technology alternative. ITP GPRA savings are only those savings attributable to these technologies in their primary intended markets.

The target market for each of 163 R&D technologies included in the ITP study was described qualitatively and quantitatively in a spreadsheet-based Technology Impact Projections Model run. The technologies were grouped based on common production activity Impact Targets. This was done to facilitate the identification of potentially overlapping markets; where potentially overlapping markets were found, either the market was split between the two competing technologies or only one spreadsheet model run was used to represent both technologies. Markets were defined in terms of the total number of technology units potentially in use at the year of introduction. This number was reduced to the fraction of those units considered technically and economically accessible, and further reduced to the likely achievable technology market share accessible to the technology as compared to other advanced technologies. And, finally, it was reduced to the savings potential attributable to the program. The market size was adjusted annually by the spreadsheet logic, based on the specified annual percentage growth rate.

- **Baseline Technology Improvements**

Continued baseline improvement in energy productivity was accounted for in the ITP methodology. ITP's method essentially subtracted a fixed "next best" baseline technology from a fixed advanced technology to obtain unit technology savings. However, the energy savings of a new technology were determined by the number of years the technology's market introduction is accelerated by the Federal program involvement. In particular, the energy savings associated with the program were explicitly projected to occur without the EERE R&D after a period of years known as the "acceleration period." Only the slice of energy savings attributable to the program's effort to accelerate technology development was counted as GPRA savings. In this way, the methodology incorporated an assumption that the energy intensity of industrial production will steadily improve, and that specific Federal interventions in cofunding R&D only temporarily accelerate the rate of improvement in the targeted production activities. Acceleration periods varying from two years to 42 years were found in the GPRA06 runs, with an average close to 10 years.

Likewise, in the ITP off-line study, the conventional technology with which each new technology was compared, was generally the best currently available technology—not a projected technology that might exist at the time of market introduction or future sales of the new technology, nor the average technology in use. While the industry-level rate of improvement in production energy intensity tends to follow fairly smooth curves of monotonic improvement, it is very difficult to predict the future energy performance of as-yet unidentified technologies to perform specific functions. In addition, the best currently available technology is often not yet widely adopted in the market, so that when the ITP technology enters the market, the current best-available technology may still represent the next-best decision alternative for many cases. Again, taking credit for only that slice of savings due to the presumed acceleration of the new technology's market introduction date was intended to minimize any overestimation of savings due to the underlying rate of technology improvement.

The commercial introduction of a technology normally occurs after a significant demonstration or using an operating prototype, and after an adequate test and evaluation period along with allowances for the beginnings of production, dissemination of information, initial marketing and sales, or other "start-up" factors. To capture this lengthy process, users of the Technology Impact Projections Model were asked to indicate the timeline for developing and introducing the technology into the market. This includes the years for when an initial prototype, refined prototype, and commercial prototype of the technology has or will be completed; and the year when the technology will be commercially introduced. An initial prototype is the first prototype of the technology. A refined prototype represents changes to the initial prototype but not a commercially scaled-up version. A commercial prototype is a commercial-scale version of the technology. Commercial introduction is when the first unit beyond the commercial prototype is operating. Prototype and commercial introduction years were to be consistent with the technology development program plans, and two values for a commercial introduction year were requested. One reflects when the technology is projected to be introduced, if the program proceeds as expected ("With ITP" case). The other reflects when the technology would have entered the market, if the program had not been involved ("Without ITP" case). The difference in commercial introduction years for the "With ITP" and "Without ITP" cases is referred to as the "acceleration period."

- **Baseline Market Acceptance**

The rate of market penetration of novel technologies in industrial production markets was captured explicitly in the methodology.

Based on historical data, new technologies normally penetrate a market following a familiar S-curve—the lower end representing the uncertainties overcome by "early adopters." The curve tails off at the far future, where some may never adopt the new technology. The steepest portion of the S-curve is where the new technology is most rapidly penetrating the market and producing new savings. The rate at which technologies penetrate their markets varies significantly. Penetrations of heavy industrial technologies generally occur over decades, while simple process or control changes can penetrate much more rapidly. The actual penetration rate varies due to economic, environmental, competitive, productivity, regulatory, and other factors.

In a 1998 study by Arthur D. Little Inc. ("Streamlining of OIT's GPRA Process (Draft)," Arthur D. Little Inc. Reference 33550-01, May 27, 1998), data was presented on a number of actual penetration rates of past and present technologies. These penetration rates were analyzed, normalized, and grouped into five classes based on a number of characteristics and criteria. Users of the ITP Technology Impact Projections Model were asked to complete **Table 1** for each project by adding the project title in the top row and either a, b, c, d, or e in the right-hand column for those characteristics for which they could make a judgment. Based on the strength of these characteristic scores, the overall technology market-penetration curve selection was entered in the first row at the right under "Score." The table was copied onto the spreadsheet model run at the "Background" tab. Note that the characteristics (rows) are relatively independent, and a given technology will likely fit best in different classes for different characteristics. By examining the pattern, however, it is possible (based on best judgment and experience) to select the most likely class (rate) at which the new technology may penetrate the market. This may be a "subjective average" of the characteristics, or it is possible that one or two characteristics are expected to dominate future adoption decisions that a particular class of penetration rate is justified. There also may be "windows of opportunity," where significant replacements of existing equipment may be expected to occur in the future for other reasons. The user was asked to insert into the spreadsheet the class of penetration rate believed most likely—all things considered—and provide a narrative of the rationale for selection if not obvious from **Table 1.**

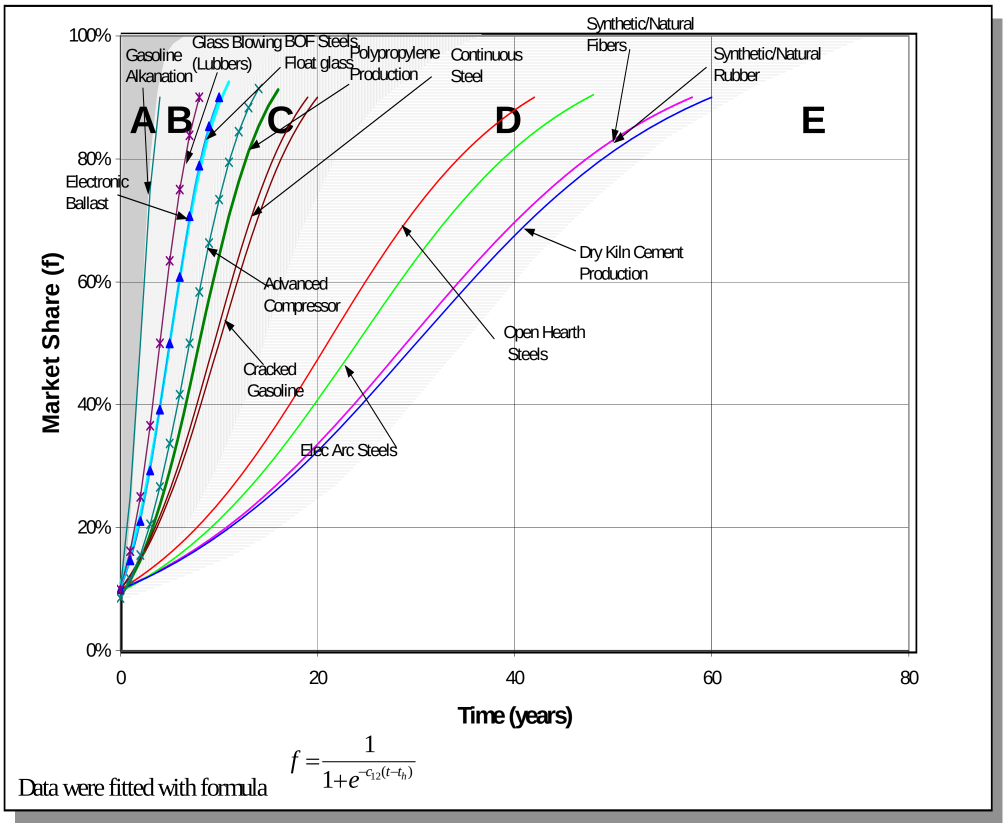
For additional context, **Table 2** shows actual technologies and the class of their historical penetration rates. Comparison of the new technology, by analogy or similarity, with these examples provided additional insight into selecting the appropriate penetration rate that might be expected for the new technology. The actual technologies' historical market penetrations are shown graphically in **Figure 1,** falling within the market-penetration rate classes used by the model.

Table 1. Selecting the Market-Penetration Rate Class

Technology/project						**Score (a,b,c,d,e)**
Characteristic	**a**	**b**	**c**	**d**	**e**	
Time to saturation	5 yrs	10 yrs	20 yrs	40 yrs	>40 yrs	
Technology factors						
Payback discretionary	<<1 yrs	<1 yr	1-3 yrs	3-5 yrs	>5 yrs	
Payback non-discretionary	<<1 yr	<1 yr	1-2 yrs	2-3 yrs	>3 yrs	
Equipment life	<5 yrs	5-15 yrs	15-25 yrs	25-40 yrs	>40 yrs	
Equipment replacement	none	minor	unit operation	plant section	entire plant	
Impact on product quality	$$	$$	$$	$	0/-	
Impact on plant productivity	$$	$$	$$	$	0/-	
Technology experience	new to U.S. only	new to U.S. only	new to industry	new	new	
Industry factors						
Growth (% per annum)	>5%	>5%	2-5%	1-2%	<1%	
Attitude to risk	open	open	cautious	conserv-ative	averse	
External factors	forcing	forcing	driving	none	none	
Gov't regulation						
Other						

Table 2. Examples of Technologies

Class	A	B	C	D	E
Aluminum		Treatment of used cathode liners	Strip casting, VOC incinerators		
Chemicals	New series of dehydrogenation catalyst (incremental change)	CFCs -> HCFCs, incrementally improved catalysts, membrane-baed chlor-alkali	Polypropylene catalysts, solvent to water-based paints, PPE-based AN	Synthetic rubber and fibers	
Forest Products			Impulse drying, de-inking of waste newspaper	Kraft pulping, continuous paper machines	
Glass		Lubbers glass blowing, Pilkington float glass	Particulate control, regenerative melters, oxygenase in glass furnaces		
Metals Casting	New shop floor practice				
Petroleum	New series HDS catalysts	Alkylation gasoline	Thermal cracking, catalytic cracking	Residue gasification, flexicoking	
Steel	Improved EAF operating practice (e.g. modify electric/ burner heating cycle to minimize dust generation)	BOF steel making	Oxyfuel burners for steel, Level II reheat furnace controls, continuous casting, particulate control on EAF, high-top pressure blast furnace	Open-hearth technology, EAF technology	
Other		Advanced refrigerator compressors, oxygen flash copper smelting, solvent extraction with liquid ion exchange	Fluegas desulfurization (coal-fired utilities), low Nox industrial burners, industrial gas turbines, ore beneficiation		Dry-kiln cement, industrial ceramic recuperators Industrial heat pumps



$$f = \frac{1}{1+e^{-c_{12}(t-t_h)}}$$

Figure 1. Market Penetration Rate Classes

1.2 Key Factors in Shaping Market Adoption of EERE Technologies

- **Price**

ITP methodology places little emphasis on cost-based estimation of market penetration, because useful cost information on industrial technologies in the R&D stage of development is, in nearly all cases, impossible to obtain. Instead, relative costs in the form of the expected payback period were one of numerous market-driving factors considered in selecting the market-penetration schedule best matching each innovative technology (see previous section). These market-penetration schedules are typical of historical industrial-sector technology innovations, whose characteristic payback period, scale, equipment lifetime, impact on product quality, relevant experience level, market growth rate, attitude to risk, and other factors were matched to each innovative technology to select the best market-penetration schedule.

- **Non-price Factors**

- Key Consumer Preferences/Values.

Several consumer preference/value issues were incorporated in the ITP market-penetration curve selection technique. These include factors such as technology scale, equipment lifetime, impact on product quality, etc. listed above.

- Manufacturing Factors.

The benefits-estimation approach requested the analyst to estimate the year in which the technology is expected to be successfully developed at the successive stages of (1) completion of initial R&D, (2) initial system prototype, (3) refined prototype, (4) commercial prototype, and finally (5) commercial introduction, given the push provided by the ITP program support. These estimates were documented as part of each spreadsheet model run.

- Policy Factors.

In the great majority of cases, no policy factors were considered significant to the market introduction and acceptance of ITP technologies. However, for cases where a regulation or other policy will drive the market to accept a new technology solution, the market-penetration curve selection procedure was set up to accept this information and allow it to play a role in the analysis. Any such influence was discussed in documentation provided in the spreadsheet model run.

1.3 Methodology and Calculations

- **Changes in Inputs to Base Case**

ITP did not provide inputs that changed the base case assumptions for the industrial markets.

- **Technical Characteristics of the Program Case**

ITP did not provide specific changes to the NEMS-GPRA06 industrial-sector characteristics.

ITP's estimates of the energy savings of its advanced technologies were based on information provided to the analysts through the proposal review and contracting process, which includes industry participation and review, followed by program review of these estimates. ITP analysis by sector has focused on assessing where energy is actually consumed and understanding current and best practices for each proposed technology. The participation of industry experts in this process has been critical to helping refine the estimates.

- **Expected Market Uptake**

- **R&D Planning Units**

GPRA06 energy savings in the ITP off-line study were projected for individual projects within planning units and summed to total results for planning units and for ITP as a whole. Active projects were selected by the ITP program managers for GPRA06; thus, the FY 2005 program portfolio was used as a surrogate for the (as-yet unknown) FY 2006 portfolio. The number of study projects in each planning unit was controlled to represent an aggregate nominal funding level not greater than 100% of the FY 2005 budget request.

This prospective assessment was carried out with the aid of an experience-based market-penetration model designed to estimate the national energy, economic, and environmental impacts of innovative industrial technologies. ITP's off-line calculations for GPRA06 did not utilize the model's capabilities to project environmental and cost impacts, so the results will focus only on energy savings. EERE guidance for GPRA06 was to project the energy impacts of the FY 2006 program, which subsequently were used by others to specify scenario projections by the NEMS-GPRA06. The resulting NEMS-GPRA06 runs (reported elsewhere) produce environmental and cost results using integrated demand and supply assumptions consistent across the demand sectors.

The Technology Impact Projections Model was used to estimate the potential energy savings resulting from research, development, and demonstration projects funded by the Industrial Technologies Program (ITP). Benefit estimates are critical for evaluating projects and presenting the merits of both individual projects and the overall RD&D portfolio.

Proposers responding to a Solicitation or Request for Proposals were asked to use the Technology Impact Projections Model to estimate program impacts. Where not provided in proposals, principal investigators were asked to provide inputs for their active projects. Use of the model across all projects allows ITP to estimate the impacts of its projects in a consistent manner.

Users were asked to provide their best estimate for each piece of information required for the spreadsheet model. A description of the advanced technology was required to provide an overview of the project/technology. This includes the project name, project number (once project is funded), estimates preparer, program manager, planning unit, lab and industry contacts, and data sources. A narrative summary of the technology on which benefit estimates are based was required. This described what constitutes a typical process unit for the technology, in terms of annual output (production capacity times duty factor). For simplicity, the analysis assumed that all units in the industry have the same capacity. An average, or typical, unit capacity was chosen, particularly for situations where the unit size may vary in different installations. By convention and to enable comparisons, units for the new technology and the current state-of-the-art were equal in output capacity; even if, in reality, the new technology might have a different unit capacity for various reasons.

The new technology also might not be a physical item of hardware. Rather, it could be a process change, a computer model or control system, operational change, or other nonphysical technique. In such cases, a unit was defined as the typical or average process or plant that would utilize the new technique. The annual energy inputs, based on the expected energy consumption of the process or plant with the new technique, were then compared with annual energy consumption required by existing techniques.

Key information was provided on the performance of single installed units or applications of the advanced technology. For comparison, information was required on the performance of the best-available technology for the application, not the average of all in-place technology units.

Users were required to provide energy use per year for the new and conventional units, by fuel:

- **Electricity** - Includes direct electricity.
- **Natural Gas** - Includes pipeline fuel natural gas and compressed natural gas.
- **Petroleum** - Includes residual fuel, distillate fuel, and liquid petroleum gas.
- **Coal** - Includes metallurgical coal, steam coal, and net coal coke imports.
- **Feedstock** - Includes fossil fuels consumed in nonenergy uses such as process feedstocks.
- **Biomass** - Includes the use of biomass (for energy or as feedstock).
- **Wastes** - Includes the use of fuels that are generated as wastes or process byproducts. Examples of such fuels are refinery fuel gas, blast furnace gas, hog and bark fuel, and sewage sludge.
- **Other** - Includes any fuels that may not be included in those listed above.
- **Total Primary Energy** - Is calculated from individual energy inputs. The primary equivalent of direct electricity consumption includes losses in electricity generation and distribution. For GPRA06, fuel and electricity savings were used as inputs to specify NEMS-GPRA06 runs that themselves applied heat rates, etc. varying over time to produce primary energy savings.

Energy use was entered in physical units (e.g., billion cubic feet of natural gas) or primary units (trillion Btu). The exception was electricity use, which has to be entered as site energy consumption (either in billion kWh or trillion Btu).

To determine the potential impact of the new technology as it becomes adopted, it was necessary to estimate the total market for the technology, reduce that to the likely actual market, and estimate when—and the rate at which—the new technology will penetrate the market.

Users were required to estimate the number of installed units in the U.S. market in a specified year. That market was defined as narrowly as possible: The smallest group of applications that covers all potential applications for which the user may have some data. Users could apply their own data on energy use of the state-of-the-art technology. Other potential data sources include ITP's Energy and Environmental Profile for the relevant industry, EIA's MECS data, or industry sources.

The annual market growth rate was specified by the model user, based on an EIA or industry growth projection for the relevant industry and process. A source for the growth rate was called for in the comments section.

Market share was specified as a function of the potential accessible market share and the likely market share. The Potential Accessible Market Share was defined as the market that the new technology could reasonably access given technical, cost, and other limitations of the technology. For example, certain technologies may be applicable only to a certain scale of plant, certain temperature-range processes, certain types of existing equipment or subsystems, or only certain segments of the industry. A further delimiting fraction was called the Likely Market Share. In some instances, in addition to technical and cost factors, the technology may compete with other new technology approaches (or with other companies) for the market. The user was asked to use current market-share information or base their estimated market share on the number of competitors in the market, assuming they are using different technologies not resulting from this project. This is different than the possibility of "copycats," which should not be considered as competing. That is, if others adopt essentially the same (or slightly modified) technology due to this new technology, that adoption was triggered by the project being described and that project should be "credited" with causing that trend. This is potentially the case for techniques where the intellectual property cannot be, or is not, protected and becomes general knowledge throughout the industry.

In some instances, a program may be developing a technology in conjunction with another ITP, EERE, or DOE program. The analysts were asked in these cases to provide an estimate of the percentage of savings that is attributed to the program. The attribution percentage should be similar to the percentage of Federal funds provided to the project by the program. A default value of 100% was entered in the model.

To understand how rapidly the potential impact of the technology may be felt, the market penetration of the technology must be projected. This is based on two estimates: the technology development and commercialization timeline, and the market-penetration curve.

The technology development and commercialization timeline was first determined. The commercial introduction of a technology normally occurs after a significant demonstration or operating prototype and after an adequate test-and-evaluation period, along with allowances for the beginnings of production, dissemination of information, initial marketing and sales, or other "start-up" factors. To capture this lengthy process, the analyst indicated the timeline for developing and introducing the technology into the market. This includes the years for when an initial prototype, refined prototype, and commercial prototype of the technology has or will be completed, as well as the year when the technology will be commercially introduced. An initial prototype is the first prototype of the technology. A refined prototype represents changes to the initial prototype but not a commercially scaled-up version. A commercial prototype is a commercial-scale version of the technology. Commercial introduction is when the first unit beyond the commercial prototype is operating. Prototype and commercial-introduction years were to be consistent with the technology-development program plans. Two values for a commercial introduction year were requested. One reflected when the technology is projected to be introduced, if the program proceeds as expected ("With ITP" case). The other reflected when the technology would have entered the market if the program had not been involved ("Without ITP" case). If the technology would not have been commercially introduced without the program, then a year of 2050 for the "Without ITP" case was entered. The difference in commercial introduction years for the "With ITP" and "Without ITP" cases is referred to as the acceleration period. Only the slice of energy savings attributable to the program's effort to accelerate technology development was counted as GPRA savings.

New technologies normally penetrate a market following a familiar S-curve, the lower end representing the above uncertainties overcome by "early adopters." The curve tails off where some may never adopt the new technology. The major portion of the S-curve, where the new technology is penetrating the market and benefits are being reaped, is most important. The rate at which technologies penetrate their markets varies significantly. Penetrations of heavy industrial technologies generally take place over decades, while simple process or control changes can penetrate much more rapidly. The actual penetration rate varies due to economic, environmental, competitive, productivity, regulatory, and other factors.

Technology impact projections-model runs for individual R&D projects receiving R&D support were aggregated to obtain energy savings associated with each R&D planning unit. In aggregating the savings, market targets were examined explicitly to avoid double-counting the same potential savings in the infrequent instances when the same energy efficiency market is clearly addressed by multiple projects. Where possible market overlaps were found, the markets were either assigned to only one technology or divided among the competing technologies under development. This process increases confidence that any systemic double-counting within planning units has been minimized. Nevertheless, some double-counting across planning units within ITP or with other EERE programs is assumed to remain.

The approximate portion of the FY 2005 budget represented by the analysis for each planning unit was noted, but the results were not scaled to 100% of the FY 2005 budget. Typically, the projects analyzed represented 80% to 99% of the FY 2005 budget for the various planning units. Projected benefits for these planning units do not include the effects of R&D projects completed prior to the current year.

The justification for assuming that all of the projects analyzed will succeed is twofold. First, projects that fail will likely be replaced with new projects using different technical approaches to achieve similar goals. Using this theory, the basic goals will be met by the program in the long run and continuously funded. Second, the projects analyzed do not comprise 100% of the FY 2005 budget, which in itself discounts the aggregated results, equivalent to incorporating some risk of failure into the overall process. In addition, the knowledge benefits of ITP's R&D portfolio are not assessed here; this scientific and technical knowledge can help to underpin additional production technology innovations in the future, and spin-off applications in both the near and longer terms.

- Technology Delivery Planning Units

The Industrial Analysis Center program and the Best Practices program were assessed, based on retrospective analysis of performance data accumulated over a period of years. ITP's off-line Quality Metrics study for these planning units is based on the premise that continuation of the programs will result in beneficial impacts proportional to documented experience at historical budget levels. These analyses did not count as savings any continuing contributions from prior program expenditures, but only assumed that future expenditures will produce results proportionate to those reported for past expenditures.

The approaches for calculating the impacts of the IAC and best-practices planning units were similar. In each case, those program activities associated historically with documented energy savings were projected into the future based on assumed continuation at the FY 2006 budget level. The numbers of assessments, Web site visitors, trained individuals, etc. performed in each future year were used to logically arrive at the future energy savings attributable to the activity, given continued performance at historical levels of effectiveness. Each quantity and assumption was explicitly shown in a tabular format intended to show the contribution of each step of the calculation to the final result and to make the entire analytical process repeatable.

The IAC program benefits were supported by 25 years of actual assessment and implementation data. Among other assumptions, the effects of assessments were projected to last for seven years. The effects of student training were projected to persist for 11 years. The effects of the Web site information activity were projected to last for seven years.

Best Practices program benefits were based on findings of an Oak Ridge National Laboratory study of program effects, and on a FY 2004 peer review that focused on ORNL's outcome evaluation study. The basic methodology used in each of four best-practices activity areas was very similar. First, the activity reach was estimated by calculating the number of individuals touched by best-practices information. This number was then scaled back to calculate the number of plants taking action, due to this information dissemination. The scale-back factors included accounting for duplicate "touches" within the same company, the percentage of companies actually taking action, and a reduction factor to discount program credit due to it being but one of multiple sources of influence. To obtain the total program energy savings, reported rates of energy savings were applied to the number of plants estimated to be affected by best-practices activities in each future year.

Best Practices activity areas evaluated for GPRA06 were: Plant-wide Assessments, Training, Software Tools Distribution, and Qualified Specialists. Total annual energy savings attributed to Best Practices were the sum of the subtotals estimated for these four delivery channels.

1.4 Sources

“GPRA06 Quality Metrics – Methodology and Results,” Energetics Inc., October 25, 2004.

DOE/EIA, *Annual Energy Outlook 2004.*

“Streamlining of OIT’s GPRA Process (Draft),”Arthur D. Little Inc. Reference 33550-01, May 27, 1998.