Summary of Findings – Peer Review of the FY2001 GPRA Assumptions

Report to
National Renewable Energy Laboratory

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Introduction

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

Approach

Arthur D. Little worked with DOE staff to review the estimates and assumptions for selected Planning Units within five sectors of EERE. The review process is an interactive, iterative process between the individual Planning Unit managers and Arthur D. Little experts, in each case leading to a consensus regarding the final submissions. Arthur D. Little evaluated two primary metrics for the FY2001 data call:

- The energy and carbon emission savings of each technology projected for the years 2001 through 2030, which depend on estimates of market penetration, cost, and performance assumptions for each technology.
- The performance measurements of each Planning Unit, which include near-term goals and milestones for the next five years designed to achieve the market penetration, cost, and performance objectives underlying the energy savings metrics.

In addition to the above, Arthur D. Little focused on sector-level Performance Measures (PMs) as well as sector-level accomplishments. We provided feedback on whether DOE was measuring the most important things at the Sector level and recommended other PMs when appropriate. For the sector accomplishments, we reviewed and commented on the cumulative benefits presented for the sector.

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

The 14 Planning Units reviewed for GPRA FY2001 include:

Office of Power Technologies (OPT)

- Hydrogen Research and Development
- Power System Integration – Transmission Reliability
- Solar Buildings
- Energy Storage Systems

Office of Industrial Technologies (OIT)
- Steel Vision
- Industrial Assessment Center
- Inventions & Innovations

Office of Building Technologies, State and Community Programs (BTS)
- Community Partnerships
- Technology Roadmaps and Competitive Research and Development
- Weatherization

Office of Transportation Technologies (OTT)
- Materials Technologies
- Technology Deployment
- Heavy Vehicle Systems

FEMP

The majority of the Planning Units were selected based on the following criteria:

- large expected energy savings
- large program visibility
- significant variables impacting the Planning Units from last years analysis
- desire to review all Planning Units every four years

The following tables summarize the results of the GPRA FY2001 analysis. In general, Arthur D. Little has seen improvement in the credibility of the GPRA information while working with DOE on this effort since 1994. Arthur D. Little has worked with the DOE staff to develop credible estimates/assumptions impacting energy saving and emission reduction estimates. Our overall findings are provided in Tables 1 through 10.

Table 11 shows the final energy savings estimates for all of the Planning Units for EERE. There may be some slight differences between Tables 1 through 10 and Table 11 due to revisions to estimates based on increased funding levels that occurred after the review.

Table 1. OPT Sector Summary

OPT Sector Level PMs/Accomplishments
MAJOR FINDINGS FOR SECTOR LEVEL PM • The goal of tripling installed U.S. renewable generation capacity by 2010 is an appropriate Performance Measure (PM). • OPT needs to develop additional quantitative sector-level PMs that reflect more than one program and that reflect OPT goals that are not directly related to energy and emissions savings. **MAJOR FINDINGS FOR SECTOR ACCOMPLISHMENTS** • OPT did not develop sector-level accomplishments for the FY2001 GPRA submission. They will need to be developed for FY2002.

Table 2. OPT Planning Unit Summaries

Planning Unit							
Hydrogen Research and Development							
	Total Primary Energy Displaced (Trillion Btu)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	0	45	165	363	588	Not avail.	Not avail.
Final Submission	0	1	43	143	303	460	620
	MAJOR FINDINGS FOR QM • Market size estimates were initially too high and occurred too soon for the applications considered given current product status and the timing of planned demonstrations. • Fuel cell mini-grids require more detailed analysis to strengthen the rationale and the benefits calculation. **MAJOR FINDINGS FOR PLANNING UNIT PM** • OPT has presented several useful trended PMs. Several additional, complementary PMs may be beneficial. • The links between the QM, PM and Planned Accomplishments need to be strengthened within the GPRA documentation. • A single, self-contained GPRA document needs to be developed that includes QM, PM and Planned Accomplishments. This document would draw upon, and be consistent with, other Hydrogen program documentation. **DOE RESPONSES AND ACTIONS** • OPT has appropriately modified the FY2001 QM analysis, and has agreed to several other recommendations for future GPRA analyses. • OPT provided information showing the link between the PM, QM and Planned Accomplishments, and agreed that a self-contained GPRA document needs to be developed.						

Table 2. OPT Planning Unit Summaries (continued)

Planning Unit							
Transmission Reliability							
	Total Primary Energy Displaced (Trillion BTUs)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft							
Trans. Reliability		119	124	129	132		
Distributed Power		40	90	150	210	250	290
Trans. Reliability		24	70	130	130	130	130
Distributed Power		41	90	150	210	250	290
Final Submission		65	160	280	340	380	420

MAJOR FINDINGS FOR QM

- Energy savings from Transmission Reliability come from reductions in spinning reserve in the United States. ADL supports the concept, but believes that savings in the early years are too optimistic and should be adjusted downward.
- Distributed Power produces savings by increasing the amount of renewable generation sources, and by decreasing energy losses in the T&D system. ADL supports these concepts, and believes that the stated savings are defendable, although possibly overstated. More detailed analysis is needed by OPT to refine these estimates.

MAJOR FINDINGS FOR PLANNING UNIT PM

- Energy savings and carbon displacement are inappropriate metrics for measuring the primary value of this program.
- Current PM are not graphable and are more appropriate as Planned Accomplishments.
- White Papers offer good insight into the Transmission Reliability issues currently faced by the US power industry.

DOE RESPONSES AND ACTIONS

- DOE has made the recommended changes to the QM estimates.

Table 2. OPT Planning Unit Summaries (continued)

Planning Unit						
Solar Buildings						
	Total Primary Energy Displaced (Trillion Btus)					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	56	104	169	256	371	515
Final Submission	34	64	104	164	251	363

MAJOR FINDINGS FOR QM SDHW and SPH

- The GPRA analysis assumes the introduction of a low cost, polyethylene solar domestic hot water (SDHW) collector by 2005. Discussions with NREL, however, indicate that this type of collector is not likely to be introduced into the market until 2008 – 2010 given current funding levels.
- There was no economic analysis conducted for the market penetration of SDHW. The analysis took the annual installations of approximately 7,700/yr in 1998 and applied market growth rates. There was no convincing explanation in the original analysis that would justify the significant increases in market penetration prior to 2005.
- ADL suggests that the solar pool heating (SPH) analysis use a savings per pool heating system of 1,600 therms rather than 2,700 therms.
- A high level issue that needs to be addressed is whether the DOE program should be taking credit for solar pool heating savings when the primary focus of the program is SDHW.

MAJOR FINDINGS FOR PLANNING UNIT PM

- PMs are only shown for SDHW and not for SPH.
- A graphed PM is shown for $/kWh of projected delivered energy cost. A better and clearer metric might be the installed cost of a SDHW system and clear pathways of how these cost reductions will be achieved.
- A convincing story has not been presented as to how the PM shown for SDHW will achieve the QM energy saving targets.
- The PM cost reduction target for the period 2002 – 2006 is too aggressive. In addition, there should be annual targets shown for 2002, 2003, 2004, and 2005.

DOE RESPONSES AND ACTIONS

- DOE has agreed to the above adjustments.
- In FY00, Congress appropriated only $1.97 million of the $5.5 million DOE requested for SDHW development. DOE has requested $3.0 million for SDHW in the FY01 request (plus another $1.5 million for other solar R&D related to the zero energy building concept). The new low-cost technology could be introduced by 2005 if Congress were to fully fund the program.
- Although pool heating is not the focus of the program, it still maintains support of the solar pool industry. In addition, the pool heating industry is heavily involved in the program's low-cost SDHW activity, which devotes considerable effort to the use of polymers in the collector. Solar pool heaters are made of polymers, and the pool heating industry can be expected to benefit from the program's polymer R&D. The program should, therefore, be given credit for solar pool metrics.

Planning Unit	
Solar Buildings	
	• Pool heating is not the focus of the solar buildings program, so DOE felt the PM's should reflect the major effort in SDHW. • In future background analyses, DOE will ask that installed cost also be used as a graphed PM.

Table 2. OPT Planning Unit Summaries

Planning Unit			
Energy Storage Systems			
	2001	**2010**	**2020**
<u>Preliminary Draft</u>: Displaced Carbon from Integrating Renewables and Peak Shaving (MMTCE)	0.4	0.8	1.5
<u>Arthur D. Little recommendation:</u> "Displaced Carbon from Integrating Renewables" (MMTCE)	0.01	0.018	0.072
<u>Preliminary Draft:</u> Non-Energy Cost Savings ($billions)	1.7	3.5	5.5
<u>Arthur D. Little recommendation</u> "Non-Energy Cost Savings from PQ and Peak Shaving" ($billions)	0.1	1.8	3.8

MAJOR FINDINGS FOR QM

- ADL and DOE agree that traditional GPRA metrics of energy savings and carbon displacement do not adequately convey the importance of the energy storage program.
- DOE estimates of carbon displacement include increased use of renewables, peak shaving, and a conversion of all non-energy cost savings (industry productivity) into carbon savings, based on a 4kWh/$GNP. ADL agrees that carbon displacement is achieved when storage is combined with renewables, but not through peak shaving. We also disagree with converting non-energy cost savings to carbon. ADL, therefore, recommends adjusting displaced carbon to reflect increased use of renewable energy only (photovoltaics specifically).
- DOE estimates of non-energy cost savings suggest that the ESS program will eliminate 1% of the power quality (PQ) problems affecting US industry by 2000. This number has been adjusted to more closely reflect the existing 12 storage systems in place. Year 2010 benefits have been adjusted to $1.8 billion (from $3.5 billion) based on a 1% (rather than 2%) improvement in PQ and 1% penetration of customer sited peak shaving applications. Year 2020 benefits now assume a 2% (rather than 3%) improvement in PQ and a 2% penetration of customer-sited peak shaving.

MAJOR FINDINGS FOR PLANNING UNIT PM

- PMs as currently stated reflect targets for FY2001 only. It is not clear from the available material that the PMs will help achieve cost and power density goals stated for 2003.

DOE RESPONSES AND ACTIONS

- DOE agrees with the ADL recommendations.

Table 3. OIT Sector Summary

OIT Sector Level PMs/Accomplishments							
	Total Primary Energy Displaced (Trillion BTUs)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	221	800	1585	2977	4933	7398	9889
Final Submission	177	736	1516	2875	4827	7287	9772

MAJOR FINDINGS FOR QM

- Overall the QM numbers at the sector level are reasonable and are based on a bottom-up calculation of Planning Unit program benefits.
  - The extrapolated savings for the Chemicals Vision Planning Unit was aggressive with a savings of 0.9 quads in 2020 and 2.3 quads in 2030. These energy savings included feedstock plus fuel energy savings. The Planning Unit assumed that all projects reached commercialization. Any market overlap for the technologies was not taken into account. This translated into 10% and 20% of projected chemicals energy use (fuel plus feedstock) using a projected growth of 2% per year.
  - The extrapolated savings for the Forest and Paper Products Vision Planning Unit was aggressive with a savings of 1.5 quads in 2020 and 3.9 quads in 2030 (30% of projected paper and lumber energy use for fuel in 2020 [projected growth of 2% a year]). The bulk of the savings for the Forest and Paper Products Vision Planning Unit is derived from savings gained from black liquor gasification projects. A large portion of the funding of these programs, however, has been transferred to another office within DOE.
- OIT also projects energy savings using a calibrated data point from the IMPACT books (for energy savings from OIT-commercialized technologies) and then takes a common growth rate for all Planning Units to project energy savings into the future. ADL strongly recommends that the sector-level projections be related to individual Planning Unit projections for each of the years so that the sector level can use the GPRA numbers as a portfolio management tool.
- It is recommended that OIT standardize commercialization rates (success rates) used to project energy savings from technologies introduced as a result of OIT funding. It is also recommended that the OIT sector level estimate the level of market overlap that might occur with the technologies being commercialized when projecting energy savings due to technology commercialization.

MAJOR FINDINGS FOR SECTOR LEVEL PM

- **Industrial delivered energy intensity or energy intensity per unit output. The goal is a reduction of 25% from 1990 levels by 2010.**
  - OIT's approach focuses on the integrated delivery of R&D results, cross-cutting technology, financial and technical assistance to industry partners, and leveraging industry partner efforts to achieve the 25% reduction goal for energy intensity.
  - A main issue is tracking of progress in energy reduction with calibration points during the period between Manufacturing Energy Consumption Survey (MECS) measurements, which occur every four years. OIT is collaborating with the Energy Information Administration (EIA) to develop methodologies to extrapolate energy consumption data during the period between MECS measurement years.

OIT Sector Level PMs/Accomplishments

- The sector level should also include a PM to track energy savings directly associated with program investment, in addition to the MECS-based numbers, which are based on total energy savings. The sector level acknowledges the limited scope of OIT's investment compared with that made by industry, and that a large part of the savings in energy intensity will be achieved by investment made by industry. It is recommended that the sector track the energy saved attributed to sector programs per investment dollar for use in overall internal planning, in addition to the overall numbers.

- **BTUs of energy saved through the deployment of OIT-sponsored technologies and programs**
  - The energy saved is derived through commercialization of OIT-sponsored technologies and from technology access programs such as the Industrial Assessment Centers and Best Practices Programs.
  - The key issue is tracking the OIT investment dollar portion of the benefit gained through the technology introductions and program implementations. Most of the Industry of the Future technology programs entail cost sharing and leveraging of industry efforts. The metric should indicate what that portion is. If the DOE activities are enabling or accelerating, it should highlight how this enabling/accelerating works.
- **Number of technologies successfully commercialized per year**
  - The target value for 1998 was based upon historical success rates achieved with an average of 6 technologies a year being successfully commercialized. With the industries of the future (IOF) program, and the shift in focus of the Inventions & Innovations program toward IOF applications, the goal is that an average of 10 technologies a year would be commercialized through 2009.
  - The current definition of "successfully" commercialized is one sale after prototype introduction. The definition of success should be standardized across Planning Units. "Successful" commercialization should be defined in terms of market share achieved. The measures of success should also include a dimension that incorporates energy savings, environmental benefit or productivity gains. Possible measures of success are the number of installations of a technology and energy saved per installation. An additional measure of success could be R&D 100 awards.
  - For the IOF technology introductions, a metric should be made to track which Planning Unit(s) has the greater success rate for technology introduction.
  - The assumption of using historical success rates to predict future introduction rates should be calibrated with yearly sales data. A possible source of calibration data could be introduction rates of technology in mature industries such as the chemical, aluminum, or steel industries.
  - In order to sustain the technology introductions, the overall sector program management will also have to manage the quality and quantity of programs "in the pipeline" on the path to commercialization. At the Planning Unit level, the use of milestones tied to go/no-go decision points will have to be increased to ensure that the limited amount of investment available is made in the most promising technology programs.

A general comment on the PMs is the weakness of PMs aimed at tracking success in environmental impact of sector program funds. ADL understands that there is some controversy over which environmental metric to use, whether CO_2 displaced, sulfur, or NO_x and how to calibrate it in ways other than derived from fuel use.

PMs should also eventually be developed that track non-energy savings such as the improvement of labor and capital productivity and/or waste reduction, which is also in the mission statement of the OIT.

OIT Sector Level PMs/Accomplishments
MAJOR FINDINGS FOR SECTOR ACCOMPLISHMENTS • In general, the accumulated energy benefits from the aggregate OIT programs are credible and the methodology is reasonable, representing 2% of projected total consumption of off-site produced energy for heat and power for IOF industries. • The demonstrated impact of the OIT programs is promising in that OIT is leveraging industry efforts with the IOF program with cross-industry programs, such as the cross-cutting technologies and Best Practices programs. ADL agrees that the use of the Integrated Delivery program will hasten the introduction of OIT technologies and generated knowledge across the focused industries. • Accomplishments should be as quantitative as possible, highlighting technical or market progress resulting from program activity, in addition to or instead of administrative accomplishments. • The definition of technology commercialization should be standardized across planning units (in terms of a market share.) The growth rate used for benefits projections should be tied to the industry growth rates within each planning unit instead of a common growth rate across all of OIT. **DOE RESPONSES AND ACTIONS** • OIT sector level will have an environmental PM next year that will be derived from fuel use.

Table 4. OIT Planning Unit Summariess

Planning Unit						
Steel Industry Vision (Industries of the Future Specific)						
	Total Primary Energy Displaced (Trillion BTUs)					
	2005	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	27	79	158	238	302	350
Final Submission	27	79	158	238	302	350
	MAJOR FINDINGS FOR QM • Overall the QM numbers for the steel industry are reasonable. The extrapolated savings for the steel industry are 0.35 quad of energy savings per year in 2030 (12% of projected fuel use for primary metals [projected growth of 2% per year). • Energy savings should be tied to activities in steel vision programs. The PM of reducing the unit energy use for steel manufacture is accomplished by a combination of industry efforts, steel vision programs, and other cross cutting programs. The steel team acknowledged that the percentage of actual savings derived from steel programs directly is a portion of the efforts to reduce MMBTU/ton of steel manufactured. The metrics should indicate what that portion is. If the DOE activities are enabling or accelerating, it should highlight how this enabling/accelerating works. • The metrics should be expressed in terms of total absolute energy saved, not as a number relative to production (i.e. in MMBTUs instead of MMBTU/ton). OIT/ADL have made a simple projection of US steel production based on consumption growth rates and typical production numbers for the past five years					

Planning Unit	
Steel Industry Vision (Industries of the Future Specific)	
	(zero growth, 100 MM ton/yr. production). Import/export swings could not be taken into account, despite the fact that they could strongly impact annual fluctuations in production. **MAJOR FINDINGS FOR PLANNING UNIT PM** • The current PM in the Steel Vision program is energy consumption for manufacturing, MMBTU/ton steel. The goal for the industry vision roadmap is to reduce energy consumption from 18.5 MMBTU/ton in 1997 to 15 MMBTU/ton in 2010. It is important that the BTU/ton steel metric is used in the context of benefits derived from steel program efforts. It is understood that Steel Vision program efforts alone will not achieve the 3.5 MMBTU/ton reduction. It is important, however, to quantify the benefits that steel programs contribute to achieving the overall reduction. • Another suitable metric could be cost of energy savings (capital and operating) per MMBTU saved for each of the program technologies. A metric of this type will help to rank programs in terms of cost effectiveness in reducing energy consumption for the steel industry. • An important metric of interest to the steel industry is capital productivity. Programs that save energy also may have more impact in terms of capital productivity such as the use of nickel aluminide in rolls in a pre-heating furnace (longer run lengths in between roll change-outs). A metric for productivity could be defined in terms of a payback concept. • Additional metrics of use could be the number of patents, patent applications, and other general industry knowledge generated as a result of the steel programs. • Additional PMs should be formulated to address the environmental benefits of Steel Vision programs in the area of NO_x, C-emissions, metal waste generation, etc. • The planned accomplishments or milestones should be expanded so it is clearer what and when milestones have to be, to meet the goal of reducing energy consumption to 15 MMBTU/ton. • The current steel industry portfolio contains technologies that could be leveraged across other industries, in particular the development of high temperature/severe condition sensor and controls, and improved lower CO_2, and low NO_x burner development. **DOE RESPONSES AND ACTIONS** • No action was required with respect to energy saving QM. The steel team is working on establishing additional PMs, and on linking energy savings more directly to DOE activities.

Table 4. OIT Planning Units Summaries (continued)

Planning Unit							
Industrial Assessment Centers (IAC)							
	Total Primary Energy Displaced (Trillion BTUs)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	76.6	91.4	100	104	107	109	112
Final Submission	7.2	28.0	42.6	51.2	55.1	55.1	55.1
	MAJOR FINDINGS FOR QM • The preliminary QM results reflected the effect of a cumulative impact of students in the marketplace as a result of past year efforts. The resubmitted QM numbers reflect the changes detailed in the DOE response, mainly changing the impact of graduated students and revising the impact of replication effects. • There is real value to training students in the IAC program, but attributing energy savings to student's activities is difficult to quantify. ADL recommends that the QM extrapolations be revised to reflect a smaller realized impact of student-derived savings. The energy impacts derived from audits can be calibrated; the effect of student efforts are not easily quantified. ADL recommends that the effect of graduated students, since it is not easily calibrated, be reduced further to a 7-10 year career impact to reflect an average time in a particular job function. ADL also recommends that a minimum participation level be defined in order to standardize the definition of a "graduated student" from the IAC program. **MAJOR FINDINGS FOR PLANNING UNIT PM** • The PM of energy cost savings from audits should be augmented with follow-up interviews with plant participants to provide a calibration point on actual savings incurred. This would also provide a possible check on intra-company replication rates. The energy cost savings should also be supplemented with the equivalent savings in BTUs to decouple the effects of fuel price fluctuations. • The use of a non-energy savings performance metric is appropriate. If possible, it would be useful to specify the waste savings from the productivity savings. • The number of audits is a reasonable metric. • The focus of audits in the past has been on operational issues, so-called "low hanging fruit". ADL recommends that the focus be placed on more long term savings so that energy and productivity savings can be replicated in subsequent audits. There is a concern as to how many times an audit can realize savings if only "low hanging fruit" options are recommended. • Additional emphasis should be placed on identifying investment options for future retrofit opportunities (both for energy and productivity savings and waste minimization). Through the post-audit interview program, recommendations could be tracked for implementation information. The post-interview program could also be used to track the implementation of state-of-the-art technologies in industry. For example, data on the convergence of technologies (time it takes until "a large fraction" is using a particular energy or productivity saving						

Planning Unit	
Industrial Assessment Centers (IAC)	
	technology) could be useful for technology introduction projections across OIT programs. • The student's trained metric should be made with a defined minimum participation level to avoid multiple counting of students. • Discussions with the IAC program mention the presence of "stars" of the program who have since founded firms that specialize in audit activities. The number and effect of such firms could be a PM. • There is a question on including the energy effects due to information disseminated via the internet and other electronic media. The IAC program has set up a web site that includes manuals on the use of databases that document historical audit results and self-audit manuals and other energy savings documents. It is difficult to attribute and verify possible energy savings gained from electronic media. • The use of the database of past audit recommendations and results should be linked to IOF program developments where feasible. The database could be rationalized by industry segment, highlighting past recommendations that resulted in significant energy and productivity savings. • ADL recommends that energy savings and productivity gains that are viewed as cross-cutting be identified for possible inclusion in Best Practices demonstrations. **DOE RESPONSES AND ACTIONS** • The resubmitted QM numbers reflect the following assumption changes: ➢ The extrapolated energy savings are a summation of original plant audit savings, plant replication effects, and secondary effects of graduated students in industry. A place holder for derived savings from web site information was made at 0.5 trillion BTU in 2000 and increased to 1 trillion BTU in 2001. ➢ The estimated savings for a plant audit are based on historical data (16 years of experience) incorporating savings from energy savings, productivity gains, and waste reduction. The historical savings from an audit should be updated as data becomes available. ➢ Savings from student alumni were reduced. Initially the student alumni estimates were for the number of students participating in the program (student-years of participation) which did not take into account a student's participation for more than one year (resulting in double counting of students). The impact for student alumni was taken as 25% of the graduating year students having an impact equivalent to 2 audits worth of energy savings per year for a 15 year career impact (from 25 year career with ½ audit savings per year). ➢ Intra-company replication effects were scaled back to provide additional energy savings of 30% from the previous value of 80% additional savings. ADL feels the assumptions for audit savings are reasonable, but should be calibrated with data (see performance metric notes). ➢ Savings continue for 7 years.

Table 4. OIT Planning Unit Summaries (continued)

Planning Unit							
Inventions & Innovations (I&I) (Industries of the Future Cross Cutting)							
	Total Primary Energy Displaced (Trillion BTUs)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	111	103	107	117	117	117	117
Final Submission	0	3.0	42.5	108	108	108	108
	MAJOR FINDINGS FOR QM • The preliminary QM results reflected the effect of a cumulative impact of total number of program sponsored inventions in the marketplace as a result of past year funding. The resubmitted QM numbers reflect the impact of inventions of the "class of 2001" funding, a "sliced" QM. • ADL thinks it is reasonable that a "sliced" single year savings QM be used in order for the savings from I&I programs to be compared with other DOE program efforts on a yearly basis. • The extrapolated energy savings for the I&I program assumes that 25% of those inventions receiving funding ultimately are commercialized. The 25% success rate was based on historical data. ADL questions whether the historical success rate of 25% will be translated into the future where emphasis is placed more on inventions resulting in energy savings and focused on applications in the industries of the future programs. • The definition of commercially "successful" was one sale in addition to a sale of a prototype. ADL recommends that "successful" commercialization also be defined in terms of market share achieved. • In the past, the I&I program did not necessarily involve programs that resulted in energy savings. The new focus on energy savings in the proposal evaluation criteria and emphasis on the energy-intensive industry of the future program will probably result in more energy savings than achieved in the past. **MAJOR FINDINGS FOR PLANNING UNIT PM** • A current measure in use is to track the cumulative number of inventions that were supported currently in the marketplace. ADL recommends that this be supplemented with a metric that tracks "slices" of program years for example 5-year periods, i.e. 1997-2001 program awardees. • The Planning Unit also uses annual energy cost savings from I&I inventions in the marketplace. ADL recommends that the actual BTUs saved be tracked in order to decouple the effect of energy cost fluctuations. • ADL recommends that the definition of "successful" include a dimension that reflects the cost effectiveness of energy reduction and/or productivity gains, and market share or number of installations. • The I&I program should also track the number of proposals received and the number of proposals that were "suitable" for funding and did not receive funding due to unavailability. By tracking "suitable" proposals in addition to proposals							

Planning Unit	
Inventions & Innovations (I&I) (Industries of the Future Cross Cutting)	
	awarded, the program management could track the success of the program in fostering an increasing number of potential inventions that could be commercialized. • It is recommended that a PM be used that also tracks the capital efficiency of the programs in achieving energy savings. A suitable metric could be dollars invested per trillion BTU saved. • A metric should be instituted that measures productivity gains that do not necessarily translate into energy savings. One metric could be yield improvements for feedstock use, for example. • A program management tool to track the success rate of programs could be to track patent applications and the generation of intellectual property. **DOE RESPONSES AND ACTIONS** • DOE resubmitted the QM numbers to reflect the energy savings as a result of technologies commercialized for the budget year only.

Table 5. BTS Sector Summary

Sector Level PMs/Accomplishments
MAJOR FINDINGS FOR SECTOR LEVEL PM • BTS has developed PM for residential buildings, commercial buildings, and equipment, incorporating all programs. • The baseline could be more clearly stated by saying that the energy savings are being measured from the beginning of the year 2000 and include savings generated from BTS programs and technologies funded since FY2000. • The sample of technologies used in developing the PMs needs to be stated. • Additional measures need to be developed, including: - Technologies commercialized or square footage retrofitted - Energy consumption/intensity in commercial and residential buildings - Emissions avoided **MAJOR FINDINGS FOR SECTOR ACCOMPLISHMENTS** • Sector accomplishments do not appear to be in line with the QM submission. For example, a comparison between the expected energy savings for 2001 versus the stated actual energy savings for 1999 shows a large disparity between the two estimates. While the sector accomplishments may be correct, it is not possible to discern why there is a difference.

Table 6. BTS Planning Unit Summaries

Planning Unit							
Community Partnerships							
	Total Primary Energy Displaced (Trillion Btus)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	23	126	333	549	664	788	905
Final Submission	21	113	293	478	575	686	794

MAJOR FINDINGS FOR QM

- Overall, the DOE/BTS numbers seem reasonable. Decreases from the preliminary draft to the final submission represent decreases in the level of funding for this Planning Unit.
- Savings are a combination of various programs.
- The market penetrations assumed for the various programs appear to be reasonable.
- For competitively selected community projects, ADL suggests basing savings on the project applicant claims.
- More work is needed to support information outreach. ADL suggests viewing this program as a necessary overhead, and attributing a percentage of savings from other programs to this activity.
- For codes training and assistance, more documentation is needed to support the assumptions behind the analysis. Specifically, more documentation is needed to support the long-term impact of DOE's assistance to code activities, as well as the potential available market impact.

MAJOR FINDINGS FOR PLANNING UNIT PM

- Additional milestones should be added to verify the energy savings projected. Also, some consideration should be given to the costs to achieve each milestone. Additional information is recommended, including:
  - Number of new residential homes being built to Building America standards
  - Number of square feet retrofitted under Rebuild America
  - Cost of achieving the energy savings associated with upgraded/improved residential and commercial buildings
  - States adopting ASHRAE/IESNA Standard 90.1
  - States updating their residential energy code to meet the 1999 International Energy Conservation Code
- These additional PM would support and enhance BTS's discussion relating to the benefits of the Community Energy Program.
- While the stated PM are reasonable considering the goals of each of the programs, greater consideration needs to be given by BTS in connecting the QM energy savings calculations to the PM.

DOE RESPONSES AND ACTIONS

- DOE agrees with ADL's findings.

Table 6. BTS Planning Unit Summaries (continued)

Planning Unit							
Technology Roadmaps and Competitive Research and Development							
	Total Primary Energy Displaced (Trillion Btus)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	7	32	59	87	110	137	165
Final Submission	10	47	88	128	162	202	243

MAJOR FINDINGS FOR QM

- Overall, the DOE/BTS numbers seem reasonable. Increases from the preliminary draft to the final submission represent increases in the level of funding for this Planning Unit.
- A potentially better alternative methodology would be to assume the investment in technology roadmaps would lead to a better effectiveness of DOE's other research and development programs. Effectiveness could be characterized in Btu/$ invested. The additional savings would then be attributed to the Technology and Competitive Research and Development Planning Unit, potentially based on a target rate of return (i.e., 10%).

MAJOR FINDINGS FOR PLANNING UNIT PM

- Additional milestones should be added to verify the energy savings achieved. Also, some consideration should be given to including the costs to achieve each milestone. Additional information is recommended, including:
  - Technology Roadmaps published
  - Savings expected in Btu/$ invested
  - Additional technologies commercialized due to adoption of the Technology Roadmaps and Competitive Research and Development
  - Increased market acceptance of BTS technologies due to adoption of Technology Roadmaps and Competitive Research and Development
- These additional PM would support and enhance BTS's discussion relating to the benefits of Technology Roadmaps and Competitive Research and Development.
- While the stated PM are reasonable considering the goals of each of the programs, greater consideration needs to be given by BTS in connecting the QM energy savings calculations to the PM.

DOE RESPONSES AND ACTIONS

- DOE agrees with ADL's findings.

Table 6. BTS Planning Unit Summaries (continued)

Planning Unit							
Weatherization							
	Total Primary Energy Displaced (Trillion Btus)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	9	44	85	122	117	117	117
Final Submission	6	32	63	93	92	92	92
	MAJOR FINDINGS FOR QM • Overall, the DOE/BTS numbers seem reasonable. Decreases from the preliminary draft to the final submission represent decreases in the level of funding for this Planning Unit. **MAJOR FINDINGS FOR PLANNING UNIT PM** • Additional milestones should be added to verify the energy savings achieved. Also, some consideration should given to including the costs to achieve each milestone. Additional information is recommended, including: - Number of homes/year weatherized - Consumer savings attributable to the Weatherization Program - Cost/year to achieve savings in weatherized homes - Additional resources identified to leverage federal funding for Weatherization - Technologies successfully deployed in the Weatherization Program • These additional PM would support and enhance BTS's discussion relating to the benefits of the Weatherization Program **DOE RESPONSES AND ACTIONS** • DOE agrees with ADL's findings.							

Table 7. OTT Sector Summary

OTT Sector Level PMs/Accomplishments
MAJOR FINDINGS FOR SECTOR LEVEL PM • No explicit sector-level Performance Measures were previously defined. OTT and Arthur D. Little are working to define appropriate sector-level PMs. • Fleet-wide PMs are somewhat difficult to define since the key indices of fleet-average emissions and fuel economy are driven by regulations and automakers are expected to meet, but not exceed these regulations. • Sector-level PMs should therefore focus on the new vehicle fleet and on measures that are relatively independent of government standards. **MAJOR FINDINGS FOR SECTOR ACCOMPLISHMENTS** • The cumulative benefits presented for the Sector are plausible and reasonable. No changes have been suggested.

Table 8. OTT Planning Unit Summaries

Planning Unit							
Materials Technologies							
	Total Primary Energy Displaced (Trillion Btus)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	0**	2	11	29	53	Not avail.	Not avail.
Final Submission	0**	1	9	24	43	Not avail.	Not avail.
	Total Primary Oil Displaced (Trillion Btus[a])						
Preliminary Draft	0**	2	14	36	62	Not avail.	Not avail.
Final Submission	0**	5	19	39	62	Not avail.	Not avail.

** Data for 2000

MAJOR FINDINGS FOR QM

- The OTT analysis is based on reasonable methodologies and assumptions.
- The relationship between fuel economy and gross vehicle weight used by OTT is somewhat conservative with respect to other published data, which leads to a conservative estimate of this program's impact.
- The projections assume that the benefits of the Materials Technologies Program will only be realized in alternative vehicles (i.e., electric, hybrid, and fuel cell vehicles). This assumption is also somewhat conservative, but fundamentally sound.

MAJOR FINDINGS FOR PLANNING UNIT PM

- Definition of independent PM for the Propulsion Materials Program is not practical. However, the Planned Accomplishments for the program follow a logical and realistic timeline, which supports the achievement of the more general PM for Vehicle Technologies R&D.
- The PM for the Lightweight Materials Program (number of lightweight material vehicles on the road, and cost of carbon fiber and aluminum sheet) provide useful measures for assessing the success of the program.
- Since manufacturing costs are also an integral part of the Lightweight Materials Program and ultimately impact consumer vehicle choice, an additional PM related to both the material and manufacturing costs is recommended.

DOE RESPONSES AND ACTIONS

- All issues and suggestions have been discussed with and agreed to by OTT staff. They are now working to address the recommendations.

Table 8. OTT Planning Unit Summaries (continued)

Planning Unit							
Technology Deployment[1]							
	Total Primary Energy Displaced (Trillion Btus)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	0	0	0	0	0	0	0
Final Submission	0	0	0	0	0	0	0
	Total Primary Oil Displaced (Trillion Btus)						
Preliminary Draft	70**	272	394	449	450	Not avail.	Not avail.
Final Submission[2]	70**	278	414	484	498	502	509
** Data for 2000	**MAJOR FINDINGS FOR QM** • OTT needs to review the various aspects of the DOE/EIA EPAct fleet projections, which form part of the Technology Deployment QM. Specifically, OTT needs to ensure that the near-term projections for alternative fuel use (e.g., fuel mix, market size) are consistent with current conditions and trends. • QM estimates of private use of CNG vehicles appears reasonable. **MAJOR FINDINGS FOR PLANNING UNIT PM** • OTT needs to develop appropriate trended PMs for Technology Deployment as a whole. • Programs appear to cover the range of necessary activities to meet QM targets, but OTT should clarify the linkages between the various activities within Technology Deployment. • Additional detail is needed in some areas for the Planned Accomplishments **DOE RESPONSES AND ACTIONS** • All issues and suggestions have been discussed with and agreed to by OTT staff. They are now working to address the recommendations.						

1 This planning unit is not expected to reduce energy consumption, but rather to displace petroleum. Thus, this second metric has been reported here.

2 TBD = To be determined following additional OTT review of near-term impacts.

Table 8. OTT Planning Unit Summaries (continued)

Planning Unit							
Heavy Vehicle Systems							
	Total Primary Energy Displaced (Trillion Btus)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft[a]	7**	42	82	123	187	Not avail.	Not avail.
Final Submission	9**	75	229	351	451	Not avail.	Not avail.
	Total Primary Oil Displaced (Trillion Btus)						
Preliminary Draft[a]	9**	44	83	124	187	Not avail.	Not avail.
Final Submission	9**	75	229	351	451	Not avail.	Not avail.

** Data for 2000

MAJOR FINDINGS FOR QM

- The projected QMs associated with Heavy Vehicle Systems R&D program represent a plausible progression and are consistent with the achievement of the goals of this program.
- For next year, OTT needs to define a consistent policy for how to allocate benefits from research performed as part of the Advanced Heavy Duty Diesel Engine R&D Program.

MAJOR FINDINGS FOR PLANNING UNIT PM

- OTT has defined three effective and suitable PM for tracking progress: (1) increased efficiency of Heavy Duty Diesel Engines, (2) market penetration of advanced diesel technology, and (3) aerodynamic reduction of drag.
- The defined PMs need to be complemented to cover all key aspects of achieving the overall program goal. Specifically, there is no explicit PM addressing the cost-effective reduction of rolling resistance.
- ADL recommends the use of additional PMs to address the cost-effectiveness of new technologies.

DOE RESPONSES AND ACTIONS

- All issues and suggestions have been discussed with and agreed to by OTT staff. They are now working to address the recommendations.

Table 9. FEMP Sector Summary

FEMP Sector Level PMs/Accomplishments
MAJOR FINDINGS FOR SECTOR LEVEL PM • FEMP has developed several useful trended PMs that are consistent with the QM analysis. ADL believes they are sufficient for tracking the overall progress of FEMP. • FEMP is developing additional PMs to track its new responsibilities in renewable energy use and agency reporting. • FEMP should increase the use of graphs and tables to display its PMs. **MAJOR FINDINGS FOR SECTOR ACCOMPLISHMENTS** • FEMP sector-level accomplishments to date are consistent with historical changes in federal energy use and appear reasonable.

Table 10. FEMP Planning Unit Summary

Planning Unit							
FEMP (all programs)							
	Total Primary Energy Displaced (Trillion Btus)						
	2001	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
Preliminary Draft	26	52	66	68	66	67	67
Final Submission	26	52	66	68	66	67	67
	MAJOR FINDINGS FOR QM • QM estimates are reasonable and no changes are needed. • Slight discrepancies were found between the information contained within FY2001 Draft OBM Budget Request and the latest QM analysis provided by PNNL staff. • After appropriate PMs are developed, future QM analyses should include the impacts of renewable energy use in Federal buildings. **MAJOR FINDINGS FOR PLANNING UNIT PM** • FEMP has developed several useful trended PMs that are consistent with the QM analysis. ADL believes they are sufficient for tracking the overall progress of FEMP. • FEMP is developing additional PMs to track its new responsibilities in renewable energy use and agency reporting. • FEMP should increase the use of graphs and tables to describe its PMs. • FEMP should develop appropriate Planned Accomplishments for the period FY2002 – 2005. **DOE RESPONSES AND ACTIONS** • All issues have been discussed with FEMP and they agree with ADL's recommendations. FEMP is implementing the recommendations.						

Table 11. Final Planning Unit Submissions

Sector/Planning Unit	Total Primary Energy Displaced (Trillion Btus)		
	2005	2010	2020
BTS			
Commercial Buildings Integration	8	42	159
Community Energy Program	113	293	575
Energy Star	92	219	279
Equipment, Materials & Tools	177	532	1,236
Residential Buildings Integration	3	20	110
State Energy Program	27	51	97
Technology Roadmaps and Competitive R&D	47	88	162
Weatherization Assistance Program	32	63	92
OIT			
Advanced Industrial Materials (AIM)	7	22	86
Agriculture Vision	1	4	45
Aluminum Vision	16	40	148
Best Practices	79	163	336
CFCCs/Engineered Ceramics	21	58	153
Chemicals Vision	81	196	876
Distributed Generation	86	163	541
Forest & Paper Products Vision	111	259	1,510
Glass Vision	24	43	77
Industrial Assessment Centers (IAC)	20	39	54
Inventions & Innovations	3	43	108
Metals Casting Vision	10	25	96
Mining Vision	3	9	39
NICE-3	1	16	98
Petroleum Refining Vision	74	206	417
Sensors and Controls	2	2	5
Steel Vision	27	79	238
OPT			
Biomass Power R&D	186	503	826
Competitive Solicitation	3	3	3
Concentrating Solar Power	3	12	43
Energy Storage	0	1	4
Geothermal Energy R&D	23	94	307
High Temperature Superconductivity	5	85	343
Hydrogen	1	43	303
Photovoltaic Systems R&D	6	21	98
Solar Buildings	34	64	164
Transmission Reliability	65	164	339
Transmission Reliability	*24*	*74*	*132*
Distributed Power	*41*	*89*	*207*
Wind Energy R&D	246	585	1,231
OTT			
Biofuels	23	182	683
Fuel Utilization (1)	0	0	0
Materials Technology	1	9	43
Technology Deployment (2)	0	0	0
Vehicle Technologies	154	742	1,768
FEMP	52	67	66

(1) Benefits for Fuels Utilization are included in the benefits for Vehicle Technologies

(2) There is no net energy displaced for OTT Technology Deployment because petroleum based fuels are being replaced by alternative fuels. However, since the alternative fuels are less costly and produce less carbon, there are energy cost savings and carbon reduction.