ENERGY DIVISION

**U.S. DEPARTMENT OF ENERGY
INTEGRATED RESOURCE PLANNING PROGRAM:
ACCOMPLISHMENTS AND OPPORTUNITIES**

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ABSTRACT

The U. S. Department of Energy Integrated Resource Planning Program supports many activities and projects that enhance the process by which utilities assess demand and supply options and, subsequently, evaluate and select resources. The U. S. Department of Energy program coordinates integrated resource planning in risk and regulatory analysis; utility and regional planning; evaluation and verification; information transfer/technological assistance; and demand-side management.

Professional staff from the National Renewable Energy Laboratory, Oak Ridge National Laboratory, Lawrence Berkeley Laboratory, and Pacific Northwest Laboratories collaborate with peers and stakeholders, in particular, the National Association of Regulatory Utility Commissioners, and conduct research and activities for the U. S. Department of Energy.

Twelve integrated resource planning activities and projects are summarized in this report. The summaries reflect the diversity of planning and research activities supported by the Department. The summaries also reflect the high levels of collaboration and teaming that are required by the Program and practiced by the researchers. It is concluded that the Program is achieving its objectives by encouraging innovation and improving planning and decision making. Furthermore, as the Department continues to implement planned improvements in the Program, the Department is effectively positioned to attain its ambitious goals.

EXECUTIVE SUMMARY

The U. S. Department of Energy (DOE) Integrated Resource Planning (IRP) Program supports many activities and projects that enhance the process by which utilities assess demand and supply options and, subsequently, evaluate and select resources. The early emphases of the U. S. DOE IRP program, which began as the least-cost utility planning (LCUP) program in 1986, were demand-side management and information transfer. As the IRP program matured, the U. S. DOE began to focus more on the planning process itself, while continuing to stress information exchange and training. By 1991, the U. S. DOE IRP effort began to shift toward more comprehensive analysis and evaluation activities. This expanded meaning of "integrated" also included the gas utility sector. Although some of the most recent activities have focused on planning, primarily as a response to a growth in collaboratives, the U. S. DOE IRP program is now diverse in the research it supports.

The U. S. DOE IRP program coordinates integrated resource planning in risk and regulatory analysis; utility and regional planning; evaluation and verification; information transfer/technological assistance; and demand-side management. Professional staff from the National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory (ORNL), Lawrence Berkeley Laboratory (LBL), and Pacific Northwest Laboratories (PNL) collaborate with peers and stakeholders, in particular, the National Association of Regulatory Utility Commissioners (NARUC), and conduct research and activities for the U. S. DOE.

Twelve IRP activities and projects are summarized in this report. The summaries include a description of the work, discussion on project status and related activities, and a statement on the contributions that the project has made to the advancement of IRP. This report contains summaries of the projects listed below.

- The NARUC Project
- Gas IRP
- Advancement of IRP in Public Power
- DIAMOND
- IRP and Renewables
- Fuel Cycle Analysis
- Environmental Externalities
- Database on Energy Efficiency Programs (DEEP)
- Handbook of Evaluation of DSM Programs
- DSM Terminology Handbook
- Advanced IRP Seminar
- Regulatory Assistance Project (RAP)

The summaries reflect the diversity of planning and research activities supported by the U. S. DOE. The summaries also reflect the high levels of collaboration and teaming that are required by the IRP program and practiced by the researchers.

IRP is a dynamic process. Although it is important to conduct IRP in an *orderly* manner, it is *not* imperative to conduct IRP *in* some pre-arranged *order*. In other words, IRP will work best when it is tailored for specific circumstances.

In view of the complexity with which energy and environmental issues are developing (at least, solutions to problems are becoming more complex), the U. S. DOE IRP program is effectively establishing networks that promote continuity and confidence in the way that IRP activities are defined and funded. Moreover, with the utility industry in transition at the same time, the U. S. DOE IRP program is also evolving, so that IRP can continue to be meaningful and useful to utilities and other stakeholders.

IRP as a process is an important contribution, in and of itself, that DOE has made to resource management. Perhaps just as importantly, the U. S. DOE IRP program is achieving its objectives by encouraging innovation and improving planning and decision making. As the U. S. DOE continues to implement planned improvements in its IRP program, it advances towards successful attainment of its ambitious goals.

1. INTRODUCTION

Integrated Resource Planning (IRP) is the process by which utilities evaluate and select resources from supply-side and demand-side options. The federal role in IRP emphasizes research and information transfer. In establishing the IRP program, the U.S. Department of Energy (DOE) has had extensive consultation with IRP stakeholders to determine the best opportunities for federal involvement. This is an evolving process that requires stakeholders and DOE to reevaluate the requirements of the process continuously.

DOE involvement in IRP began in 1986 with the inception of DOE's Least Cost Utility Planning (LCUP) Program. Following an extensive survey of utility planning practitioners, the LCUP program's initial research plan introduced demand-side management (DSM) to DOE's utility program activities. In 1990, the program evolved further when a series of public hearings held as part of the development of the National Energy Strategy (NES) generated strong support for an expanded DOE role in research and technology transfer involving integrated utility planning methods, data, and processes. The NES transformed the LCUP program into the IRP program with an emphasis on both demand-side and supply-side utility planning issues.

The LCUP/IRP program has been growing in recent years, but is still a relatively small DOE program. The program's funding was initially less than \$1 million in fiscal year 1985, and has increased to approximately \$5 million in fiscal year 1993.

A recent paper (Bauer, 1993) has analyzed the history of DOE's IRP Program. The early emphasis of DOE's IRP activities was DSM and, to a lesser extent, information transfer. In 1990 and 1991 the emphasis shifted toward planning and development of analytical tools, and evaluation to account for the large growth in utility DSM activities. Publications in the 1985-86 era of the IRP Program reflected the following program emphases:

- technical potential for residential conservation
- energy savings in retrofitted multi-family buildings
- technical, institutional, and research issues surrounding conservation in public housing
- electric utility conservation and load management programs at various utilities
- commercial building energy conservation
- commercial office lighting programs
- Hood River conservation project impact evaluations [not funded by LCUP]
- residential retrofit conservation

By 1988, though there were still many research projects and publications addressing various DSM issues, DOE-sponsored research began to reflect increased emphasis on the planning process itself. The following publications exemplify this shifting emphasis:

- Eto, J., *et al*, *Statistical Indicators of Potential for Electric Utility Least-Cost Planning Programs*, LBL-25473, Lawrence Berkeley Laboratory, 1988.

- Hirst, E.A., *Developing an Integrated Planning Process: An Electric Utility Case Study*, ORNL/CON-247, Oak Ridge National Laboratory, Oak Ridge, Tenn., C. Knutsen, Puget Sound Power and Light Co., Bellevue Wash., January 1988.
- Hirst, E., *Regulatory Responsibility for Utility Integrated Resource Planning*, ORNL/CON-249, Oak Ridge National Laboratory, Oak Ridge, Tenn., January 1988.
- Krause, F. and J. Eto, "Conceptual and Methodological Issues for Least-Cost Utility Planning," Volume 2 of *NARUC/LCUP Primer*, LBL-25472, Lawrence Berkeley Laboratory, 1988.
- National Association of Regulatory Utility Commissioners, Washington, D.C., *Least Cost Utility Planning: A Handbook for Public Utility Commissioners*, Volume I, October 1988.

Concurrently, DOE-sponsored IRP activities stressed information exchange and training, particularly with the National Association of Regulatory Utility Commissioners (NARUC) and its Energy Conservation Committee (ECC), which conducted the first national IRP Conference (then called the LCUP Conference) in April 1988. Several evaluation activities were also initiated.

A significant new development in 1989 was the work undertaken by the NARUC ECC to address utility DSM incentives and to begin to define processes for decoupling utility profitability from kilowatt-hour sales.

By 1991, the DOE-sponsored IRP effort had shifted toward analysis and evaluation activities. Activities also began to address environmental externality issues which were confronting public service commissions. Analysis was undertaken on various bidding approaches for acquiring supply and demand-side resources. The DOE IRP program also initiated in 1991 an inquiry into applying IRP principles to gas utilities. The applicability of IRP principles to the gas utility sector was, itself, a complex subject. There are significant differences between gas and electric utilities in industry structure, technology, underlying economics, the distribution of federal and state regulatory authorities, and in the history of government policy.

By 1991, based upon a growing body of state regulatory experience, interest began to focus on the IRP process itself. Several collaborative efforts had begun to form between traditional utility and environmental/consumer adversaries. Collaboratives were seen as preferable to protracted litigation by companies and other parties. By 1992, there was enough experience with collaboratives, particularly in New England, to analyze the DSM process itself (Raab and Schweitzer, 1992; Schweitzer, English, Yourstone, and Altman, 1993).

The DOE IRP program has largely focused on research and information transfer activities. Recently the program conducted a comprehensive survey throughout the DOE and identified over

100 specific projects which related in some manner to integrated resource planning.¹ Many of these projects were funded directly by the IRP program. Others were funded by other DOE program offices.

Several specific projects illustrate the comprehensiveness and evolution of DOE's IRP program activities. An early accomplishment of the program, for example, was DOE's involvement in the NORtheast Demand-Side Management DAta EXchange (NORDAX). The NORDAX project grew out of the recognition by many of the Northeast region's electric utilities that data and information on DSM program experiences was widely scattered, difficult to access, and highly variable in format, completeness, and quality. DOE's LCUP program, in response to this need, provided seed funding for the development of the NORDAX database (NORDAX, 1991). Other participants in the effort included all of New York state's utilities, a number of other Northeastern utilities, the New York Public Service Commission, several national laboratories, the Alliance to Save Energy (ASE), the Edison Electric Institute (EEI), the Electric Power Research Institute (EPRI), state and city energy agencies, and other groups. The principal accomplishment of this effort was not only the development of the NORDAX database, but the collaborative effort to bring many disparate parties together to address DSM data related requirements.

Another effort sponsored by the program involved the identification of key issues in IRP based on a survey of resource plans and related documents from 29 utilities and five non-utility government agencies throughout the United States. This study identified six key issues which were identified as likely to influence an integrated resource plan's societal value (Schweitzer, Yourstone, and Hirst, 1990).

Another accomplishment of the DOE program was support of the Rhode Island Least Cost Planning Committee to formulate and analyze a state-wide lighting program for commercial and industrial utility customers. This state-wide effort was an early experiment to bring together representatives from several electric utilities, the state government, and the public service commission to analyze the effectiveness of state-wide approaches to DSM (Aspen Systems Corporation, 1991). The value of this effort was in large part to bring people together in a pre-collaborative undertaking that helped to build trust in subsequent resource planning and DSM activities.

The DOE IRP program also recognized early on the critical need for data on utility demand-side activities and programs in order to promote IRP analysis and methodology development. Through the efforts of the program, the Energy Information Administration (EIA) initiated a supplemental form (Schedule V to the EIA 861) that collects information from utilities on peak demand reduction, energy reduction, and costs of utility DSM programs. These data have proven of

¹ The results of the survey were not published. However, the DOE IRP program compiled a bibliography for the period 1989-1992. It is anticipated that similar efforts in the future will yield documents for wide distribution to IRP stakeholders and students.

significant value to the IRP community in expanding the role of IRP in U.S. utilities (see for example, Hirst, 1992).

In 1989, the DOE program produced a report surveying the then recent accomplishments and contributions of the LCUP program (Berry and Hirst, 1989). The purpose of the present report is to provide an update on selected accomplishments and new directions of DOE's IRP program. Therefore, this report largely focuses on activities sponsored by the DOE IRP program over the period from 1989 through 1993.

In 1993, DOE developed a multi-year program plan for the IRP program for the period FY 1994 through FY 1998 (DOE, 1993). The evolution of this multi-year plan is discussed in greater detail in Chapter 2. The multi-year program plan developed 12 areas of research activity for the IRP program.

The recent accomplishments of the DOE IRP program, as highlighted in this report, are reported in five chapters. The activity areas described in the 1993 multi-year program plan reflect a planner's orientation. The titles of the five chapters reflect a reference librarian's or indexer's approach to organizing multidisciplinary research. The relationships between IRP program planning and the organization of this report are shown in Figures 1.1 and 1.2.

During the period covered by this report, there were over 100 projects sponsored, in whole or in part, by the DOE IRP program. Several projects in each of the above areas were selected for inclusion in this report and are summarized with emphasis on their contribution to the advancement of IRP in the United States. The projects which were selected for inclusion are a subset of activities sponsored by the DOE IRP program. They were selected to represent a cross section of the types of projects and activities, as well as subject matter, being covered by the program.

Stakeholders and IRP researchers were interviewed to determine which DOE-sponsored IRP projects were particularly important to the advancement of IRP. The projects suggested from these interviews were combined with a listing of recently conducted projects. Using the following criteria, projects were then selected that

- were rated important by stakeholders and researchers who were interviewed,
- covered a range of subject areas, including planning practices, regulatory approaches, information transfer, technological and environmental issues,
- represented a cross section of research organizations, and
- were felt to have contributed significantly to the advancement of IRP principles.

The projects selected for discussion are summarized in Chapters 3 through 7.

Figure 1.1 Projects and Activity Areas Highlighted in this Report

Chapter	Title	Project	IRP Multi-Year Program Plan Activity Area
3	Regulatory Approaches and Methods	1. The NARUC Project	Expand the Application of IRP
		2. Gas IRP	Natural Gas
4	Planning Approaches and Methods	1. Advancement of IRP in Public Power	Modify the IRP Process
		2. DIAMOND: A Model of Incremental Decision Making for Resource Acquisition by Electric Utilities	Risk and Uncertainty
5.	Technological and Environmental Issues	1. IRP and Renewables	Non-Traditional Resource Options
		2. Fuel Cycle Analysis	Environmental, Economic, and Other Externalities
		3. Environmental Externalities	Environmental, Economic and Other Externalities
6.	DSM Resource Characterization	1. Database on Energy-Efficiency Programs (DEEP)	Expand the Application of IRP
		2. Handbook of Evaluation of DSM Programs	National Impacts of IRP
		3. DSM Terminology Handbook	National Impacts of IRP
7.	Training and Information Transfer	1. Advanced IRP Seminar	Expand the Application of IRP
		2. Regulatory Assistance Project	Expand the Application of IRP

Figure 1.2 Correspondence Between Report and Program Planning Categories

Report Categories	Multi-Year Plan
Regulatory Approaches and Methods	Risk and Regulatory Analysis
Planning Approaches and Methods	Utility and Regional Planning
Technological and Environmental Issues	Risk and Regulatory Analysis
DSM Resources	DSM: Evaluation and Verification
Training and Information Transfer	Information Transfer/Technological Assistance

Finally, Chapter 8 of this report presents conclusions and future directions for the DOE IRP program. Highlights of the multi-year program plan include the program goals, program activity areas, and program budget for the DOE IRP program for the years FY 1993 through FY 1998. Thus, this report presents recent historical highlights of the DOE IRP program and provides a look into the program's future.

2. CURRENT STATUS OF THE DOE IRP PROGRAM

In 1990, a series of public hearings held as part of the development of the NES generated strong support for an expanded DOE role in research and technology transfer involving integrated utility planning methods, data, and processes. The NES transformed the then LCUP Program at DOE into the IRP program with an emphasis on both demand-side and supply-side utility planning issues.

Since 1990, the DOE IRP program has had several major accomplishments, many of which are highlighted in this report. These include development of DSM terminology and reporting guidelines, and advanced IRP seminars for state utility regulators.

In 1992, DOE held an Executive Dialogue, an IRP Practitioners Meeting, and an Internal Program Review to further understand stakeholder needs and opportunities for DOE involvement in IRP and, thus, further refine the role and priorities of the IRP program. From these meetings, DOE produced a draft strategic plan for the IRP program, which provided an overview of the federal role, technical directions, and overall priorities guiding DOE's efforts in IRP development.

Soon after the draft strategic plan was published (DOE, 1992) the Energy Policy Act of 1992 (EPAct) was enacted. According to Section 111 of the EPAct, the term integrated resource planning means a planning and selection process for new energy resources that evaluates the full range of alternatives, including new generating capacity, power purchases, energy conservation and efficiency, cogeneration and district heating and cooling applications, and renewable energy resources, in order to provide adequate and reliable service to customers at the lowest system cost. The process shall take into account necessary features for system operation, such as diversity, reliability, dispatchability, and other factors of risk; shall take into account the ability to verify energy savings achieved through energy conservation and efficiency and the projected durability of such savings measured over time; shall treat demand and supply resources on a consistent and integrated basis.

According to Section 115, the term integrated resource planning means, in the case of a gas utility, planning by the use of any standard, regulation, practice or policy to undertake a systematic comparison between demand-side management measures and the supply of gas by a gas utility to minimize lifecycle costs of adequate and reliable utility services to gas consumers. Integrated resource planning shall take into account necessary features for system operation such as diversity, reliability, dispatchability, and other factors of risk and shall treat demand and supply to gas consumers on a consistent and integrated basis.

EPAct required the IRP program to absorb additional responsibilities in facilitating IRP development and evaluating its results. From the draft strategic plan, DOE developed a multi-year program plan (DOE, 1993) to incorporate new thrusts required by EPAct and provide additional detail about specific goals and activities which the IRP program expects to undertake.

The DOE IRP program coordinates research at national laboratories and consulting firms. The DOE Office of Utility Technologies (OUT), Lawrence Berkeley Laboratory (LBL), the National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest Laboratory (PNL), conduct research and consulting support for the DOE IRP program along with BCS, Inc., Energetics, and Meridian, Inc. These organizations have also contributed to DOE-sponsored forums like the following training meetings and conferences, which have been recently completed or scheduled for the near future:

- NARUC Renewable Energy for Regulators Conference, October 1993
- NARUC Annual Meeting November 1993
- American Gas Association, Gas IRP Conference, December 1993
- NARUC Winter Meeting February 1994
- NARUC IRP Conference May 1994
- NARUC Summer Meeting July 1994
- EPRI/DOE National DSM Conference March 1995

A summary of current DOE IRP project activities is displayed in Figure 2.1. A bibliography of recent research reports prepared for the DOE IRP program is attached at the Appendix.

At the time of this writing, the DOE IRP program is refining its program plan for the period FY 1994 through FY 1998 in response to EPAct mandates and initiatives of the current administration. Chapter 8 of this report summarizes the new directions of the DOE IRP Program to be undertaken as a result of this multi-year planning process.

Figure 2.1 Current DOE IRP Project Activities, by Contractor

LABORATORY SUPPORT	
THE NATIONAL RENEWABLE ENERGY LABORATORY	OAK RIDGE NATIONAL LABORATORY
<ul style="list-style-type: none"> • MIT-AGREA model • Wheeling authority and PUHCA reform • Evaluation of renewables in IRP • NES-EPAAct evaluation • Transmission utilization • Impact of ratemaking on renewable energy • State renewable energy news • Public Power project • Transmission capacity availability • Utility incentives for renewable energy • DSM technology strategy • Assessment of regional IRP • Fuel cycle analysis • Utility modeling of renewable energy 	<ul style="list-style-type: none"> • DSM evaluation and verification • Electricity pricing as a DSM strategy • DSM program evaluation • DSM in CAAA compliance • DOE IRP planning and DSM accomplishments • IRP/DSM in consumer-owned utilities • State regulatory activities • Uncertainty analysis and methods • The utility of the 21st century • IRP in the Rocky Mountain region
LAWRENCE BERKELEY LABORATORY	PACIFIC NORTHWEST LABORATORIES
<ul style="list-style-type: none"> • Data for Energy Efficient Programs (DEEP) • Competitive resource acquisition • Ratemaking to stimulate utility DSM • Gas IRP • The role of T & D in IRP • Technical assistance to PMAs • LBL advanced IRP seminar 	<ul style="list-style-type: none"> • Center for Electric End-Use Data (CEED) • Load shape transferability • Industrial DSM: A Status Report • Long-term impacts of DSM on electricity pricing • Industry-DOE IRP dialogue
NARUC	OTHER
<ul style="list-style-type: none"> • Conference on IRP • Conference on Renewable Energy • Research on DSM measures • Study of gas IRP • National database on IRP • Research on the quantification of externalities • Study of regulatory incentive mechanisms 	<ul style="list-style-type: none"> • National Conference of State Legislators - identifying successful state IRP legislation • Alliance to Save Energy - DSM behavior • Regulatory Assistance Project • EOP - Policy analysis, database development • International (conferences and studies) • Net income neutrality

REGIONAL PROJECTS
<ul style="list-style-type: none"> • New England Governors Conference • Rocky Mountain Regional Project • Southern States Energy Board

3. REGULATORY APPROACHES AND METHODS

IRP encompasses the planning needs of public power and regulated utilities. Traditional utility regulation relies on a cost-of-service formulation so that utilities equitably allocate costs for bringing service to different customer classes. Utilities are permitted to recover such costs and earn a reasonable return on investment from the rates that they charge these customer classes. Since IRP brings new concepts and approaches to traditional cost-of-service rate regulation, the DOE IRP program has emphasized the development of innovative regulatory approaches and methods in the advancement of IRP.

NARUC is the leading organization representing state utility regulators. These utility regulators are integrally involved in the advancement of IRP principles through the NARUC ECC. The DOE IRP program and NARUC work together closely to improve regulatory approaches and methods leading toward the advancement of IRP in the states. This chapter describes highlights of NARUC IRP efforts sponsored by the DOE IRP program.

A specialized component of utility regulation is the treatment of gas utilities from the perspective of integrated resource planning. Gas utilities face significantly different planning parameters and frameworks than electric utilities. The DOE IRP program recognizes these differences and has sponsored work to examine alternative regulatory approaches and IRP methods specifically tailored to the gas industry. This chapter also highlights the DOE IRP program-sponsored gas IRP efforts.

3.1 THE NARUC PROJECTS

Project Summary

Early in the formulation of the DOE IRP program, the importance of involving the regulatory community was recognized. As a result, DOE established a working relationship with NARUC. The basic concept was to use resources (i.e., the NARUC infrastructure and commissioners and staff) already in place to advance IRP principles and methods in utility regulation. It was perceived that NARUC offered an excellent vehicle for the training, technical research, and communications tasks necessary to effectively promote IRP adoption by state regulators. Further, it was perceived that NARUC would add credibility to the regulatory community for advancing IRP principles. As a result, the DOE made an initial grant to NARUC to assist in DOE IRP program activities.

From the NARUC perspective, IRP projects under the grant are managed by NARUC's ECC. Moreover, LBL, NREL, and ORNL provide support for NARUC/ECC. The ECC consults regularly with DOE IRP program staff on developing and implementing an appropriate agenda for NARUC

activities to advance IRP principles. The original grant calls for NARUC to undertake seven specific projects. These seven projects are briefly described in the following paragraphs.

Financial and Regulatory Incentive Mechanisms. Under this project, NARUC monitors and analyzes financial and regulatory incentive mechanisms being adopted by state regulatory commissions. LBL has been preparing a comprehensive evaluation of the incentive programs implemented by utilities in various state jurisdictions. To date, LBL has completed major studies on shared savings and decoupling. The effort is designed to determine the effects of incentives on utility performance, the cost of regulation, and rates and bills of customers as well as customer usage. NARUC, through the Tellus Institute, has prepared and updated a white paper which examines the relationship between integrated resource planning and utility rate design (Stutz, 1993). This paper specifically focuses on how certain types of utility rate structures may be inconsistent with the goals of integrated resource planning while others appear to further IRP goals. The white paper will be coupled with a survey or case studies to analyze specific rate designs and their relationship to IRP goals. This project led to the Science Applications International Corporation's (SAIC's) examination of methods for cost allocation of conservation and load management programs (NARUC, 1993b). A key component of the cost allocation question is methods for evaluating and measuring the impact of conservation and load management programs, specifically with respect to demand and energy savings. NARUC has examined approaches to measure impact savings.

Fourth National Conference on IRP. Under DOE IRP program sponsorship, NARUC has conducted four national conferences on integrated resource planning. The most recent conference was held in Burlington, Vermont in September, 1992. This conference featured fifty speakers, representing state Public Service Commissions, utility staff, DOE, trade associations such as EPRI, DOE laboratory personnel, and consultants speaking on a variety of issues. The NARUC IRP conference has become the flagship conference to bring together practitioners, researchers, regulators, utilities, and other stakeholders for open exchange of information and discussion of issues relating to IRP. The fifth NARUC IRP Conference is scheduled for May of 1994 in Kalispell, Montana.

IRP Regulatory Database. Under the DOE IRP program grant, NARUC is overseeing the assembly of a comprehensive collection of state commission rate orders, reports, testimony, and other materials relating to the practice of integrated resource planning. These documents are being abstracted and key word indexed so that they can be compiled into a computerized database. The database provides up-to-date information on emerging regulatory trends in the IRP field.

Application of Renewable Energy Technologies. In 1990, NARUC conducted a seminar on the current state of Renewable Energy Technologies and produced a report entitled "Renewable Energy and Utility Regulation" (NARUC, 1990a). Under the DOE IRP program grant, NARUC is continuing efforts to assist regulators by beginning to implement appropriate portions of the Renewable Energy Agenda developed as part of the earlier effort. The objective of this work is to assist state utility regulators in creating a levelized playing field for the selection of new resources, including renewables, for meeting energy requirements. Under DOE IRP program sponsorship, NARUC conducted a national conference on renewable energy in Savannah, Georgia in October, 1993 (NARUC, 1993a). In addition to updates on renewable energy technology, the

conference focused on models for state legislative and regulatory commission treatment of renewables and associated planning issues encompassing renewables.

Externalities. DOE and NARUC have both recognized that regulators are now grappling with difficult questions relating to the proper inclusion of environmental and other externalities when considering the costs of resource options available to utilities. With DOE sponsorship, NARUC held a national conference on environmental externalities in October of 1990 (NARUC, 1990b). As a follow-on effort, NARUC published a resource handbook on methods for quantifying environmental externalities. The handbook describes various methods for evaluating, qualifying, and quantifying environmental externalities and will consider how they can effectively be included in the power planning process.

Definitions of DSM Program Terms. NARUC played a key role in supporting a DOE IRP program and EPRI sponsored effort by Oak Ridge National Laboratory (Hirst and Sabo, 1991) to define the key DSM terms needed to quantify the performance and costs of utility DSM programs. Although ORNL compiled, assembled, and produced the DSM glossary directly for DOE, NARUC participated in this effort by reviewing the ORNL work and offering advice on scope and objectives of the project.

Natural Gas IRP. NARUC has played a key role in transferring the experience of IRP from the electric side appropriately to natural gas utilities. In furthering this effort, NARUC has been involved in working closely with DOE IRP researchers at LBL to review the status of gas IRP and to develop a primer which would explain and compare the methodologies for IRP that could be used for natural gas to those methods currently used by electric utilities (Goldman *et al.*, 1993).

From a management perspective, NARUC's project manager, with guidance from the NARUC ECC, works in close conjunction with DOE IRP program staff and laboratory staff to develop the NARUC research and program agenda. NARUC then is responsible for implementing the research agenda, including, as appropriate, issuing requests for proposal for expert consultant or contractor support to undertake certain efforts.

Contributions to the Advancement of IRP

NARUC and its members are key stakeholders in the advancement of integrated resource planning. Representing the nation's state utility regulators, NARUC provides the infrastructure for the DOE IRP program to directly reach key regulatory staff involved in IRP within their states. Through this mechanism, the DOE IRP program can provide training and technology transfer assistance and state-of-the-art methods for state regulators so that they may understand and implement IRP principles within their state environment. This has been particularly valuable for smaller states which typically do not have the financial resources and expertise to implement IRP principles without such assistance. Such states typically turn to NARUC for assistance since NARUC offers the credibility of a nationwide association representing utility regulators. One key public utility commission staffer

says, "DOE funding provided to NARUC has been used very successfully to spread the word to states on IRP" (Wolfson, 1993).

3.2 GAS IRP

Project Summary

The DOE IRP program has sponsored a series of projects to investigate the requirements for advancing IRP principles within the natural gas industry. Public service commissions were beginning to look more closely at the planning processes of local gas distribution companies (LDCs) in part because of the increased control and responsibilities that LDCs have for their purchased gas costs and because of questions surrounding the potential role for gas end-use efficiency options. An IRP program-sponsored survey (Goldman and Hopkins, 1991) of state commissions identified fifteen Public Utility Commissions (PUCs) that were actively developing or considering IRP for gas utilities. However, the LBL study concluded that gas IRP still appeared to be in its infancy since gas utilities in only five states (the District of Columbia, Illinois, Nevada, Oregon, and Washington) had filed initial integrated resource plans in response to formal regulations. A survey of gas utilities (American Gas Association, 1992) determined that 41 out of the 85 gas companies surveyed expect to have IRP requirements within the next two years.

In a follow-on to these initial efforts, the DOE IRP program sponsored research to further investigate the state-of-the-art of gas utility IRP and to develop approaches and methods for advancing IRP in the gas utility sector (Goldman and Hopkins, 1992). In this project, LBL reviewed the IRP plans prepared by four gas utilities:

- Washington Gas Light (District of Columbia);
- People's Gas Light and Coke Company;
- Southwest Gas Corporation; and
- Washington Water Power Company.

The objectives of this review were to (1) assess progress among gas utilities in responding to the challenges posed by state regulators; (2) examine how the regulatory and market context affects plan objectives, development, and emphasis; and (3) identify key technical, analytical, and institutional issues that arise in a comparative assessment of these first generation gas IRP plans.

As an initial effort, the research team examined the objectives of each of the four utility IRP plans. These objectives are summarized in Figure 3.1. It was noted in this review that recent changes associated with deregulation in the gas industry have had a profound effect on the planning horizons of LDCs. Several of the utilities noted that their planning environment was dominated by the need for "transition" strategies to cope with fast paced changes brought about by industry restructuring and new regulatory requirements.

Figure 3.1 Objectives of Gas Utility IRP Plans

Gas Utility Plan Objectives		
	IRP	DSM
Washington Gas Light	<ul style="list-style-type: none"> • Meet quantitative & qualitative planning criteria • Quantitative criteria: <ul style="list-style-type: none"> - design day & sales requirements - operational integrity - meet PSC DSM goals - least cost (typical bills) - feasibility of implementation 	<ul style="list-style-type: none"> • Implement pilot programs to determine if, on a full scale basis, they produce reductions in gas use equivalent to conservation targets specified by PSC
People's Gas	<ul style="list-style-type: none"> • Comply fully with Illinois statewide Gas Utility Plan & requirements of ICC least cost planning regulations • Provide gas supplies sufficient to meet design peak day, peak season & annual requirements of all customers, at lowest cost consistent with short & long-term reliability & safety requirements 	<ul style="list-style-type: none"> • Increase capability to deliver viable DSM programs • Provide all customer classes with cost-effective DSM options • Increase company's understanding of DSM-related uncertainties • Pursue other DSM activities that will reduce system-wide average unit costs of gas
Southwest Gas	<ul style="list-style-type: none"> • Pursue best available courses of action that will balance customer service obligations with interests of shareholders, while retaining its position as a leader in energy marketplace 	<ul style="list-style-type: none"> • Respond to Nevada resource planning regulations • Provide all customers classes with cost-effective DSM options
Washington Water Power	<ul style="list-style-type: none"> • Comply with commission mandate; illustrate WWP gas resource planning process 	<ul style="list-style-type: none"> • Identify and quantify DSM resources in its territory • Develop a planning level assessment, not to develop specific DSM savings and expenditures at this time

Source: C.A. Goldman and M.E. Hopkins, 1992, "Integrated Resource Planning at Gas Utilities: A Review of Initial Efforts," *Proceedings ACEEE 1992 Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Washington, September, page 8.71.

The project team also examined the technical and analytical issues associated with gas IRP. It found that gas utilities rely on a series of linked models for IRP analysis. This was due primarily to the fact that for the gas utilities reviewed, existing tools and models were bootstrapped and integrated into an analysis procedure. The researchers also felt that the apparent lack of stand-alone integrated planning models might be a by-product of the gas industry structure, which is vertically disintegrated (as opposed to the vertically integrated electric utility structure). Figure 3.2 summarizes the IRP

analytic framework developed by People's Gas Company. Prior to implementing IRP, People's Gas did not consider DSM programs as a resource option in developing a least-cost supply portfolio. The requirement for IRP expedited the complete integration of People's Gas existing approaches to demand forecasting, demand-side planning, and supply-side planning.

Figure 3.2 People's Gas IRP Analysis Framework

Source: Goldman and Hopkins, 1992, p. 8.73.

The review also determined that among the four utilities, experience in implementing large scale gas DSM programs was limited. The gas industry has raised practical and methodological concerns from the standpoint of estimating long-term benefits of gas DSM programs and the particular problem of approaches to develop gas avoided costs. Specific difficulties in estimating gas

commodity costs over the planning horizon, and disagreements regarding the extent to which pipeline demand or capacity related costs can be avoided by DSM, were identified.

This DOE IRP project found that gas utilities face institutional and financial barriers to DSM. A significant barrier is that well accepted and standardized procedures for cost recovery have not been developed. Moreover, gas utilities have limited experience in documenting gas savings and corresponding lost revenues.

This project concluded that in establishing a gas IRP process, explicit policy guidance from regulators was most needed in the following areas:

- Balancing among various economic tests;
- Ensuring comparable earnings opportunities for DSM; and
- Interfuel competition and promotional practices.

LBL is continuing its gas IRP project efforts under the DOE IRP program. In particular, LBL has worked closely with the NARUC ECC and Gas Committee to develop a primer on gas IRP. Among the topics covered are:

- Gas resource planning (including supply and reliability) (Goldman *et al.*, 1993);
- Integration of gas efficiency options in existing gas supply planning tools;
- Methods used to evaluate DSM program options; and
- Fuel substitution policies and technical issues.

In addition, LBL is undertaking a follow-on comparative analysis of gas IRP plans submitted by nine gas utilities. The study will compare gas planning processes, utility assessments of DSM technical and market potential, and will analyze key technical issues that arise in preparation of gas IRP plans.

Contributions to the Advancement of IRP

While there is substantial interest in applying IRP to the gas utility industry, most observers realize that IRP methods for gas lag those for electricity. Further, significant infrastructure, institutional, and regulatory differences exist between electricity and gas. Therefore, a major contribution of the gas IRP project is to appropriately adapt IRP principles to the gas industry and, in particular, local distribution companies. These adapted techniques recognize the particular issues, planning methods, and barriers associated with advancement of IRP in the gas utility sector. In this sense, the gas IRP work sponsored by the DOE IRP program contributes significantly to expanding and adapting IRP principles to the gas utility sector.

4. PLANNING APPROACHES AND METHODS

In this chapter, two IRP projects dealing with planning approaches and methods are described. The first project represents work conducted by the NREL dealing with IRP needs in the public utility sector. The second project, managed by ORNL, describes the development of DIAMOND, a computer model of incremental decision making for resource acquisition by electric utilities.

4.1 ADVANCEMENT OF IRP IN PUBLIC POWER

Project Summary

Much initial work in IRP has been focused on investor-owned utilities (IOUs) under PUC regulation. During 1992, DOE sponsored a scoping study (NREL, 1993) on integrated resource planning practices in the public utility sector, recognizing the existence of potentially significant differences in planning parameters. Public utilities were defined as not-for-profit utilities that include federal, state, municipal, and co-operative utilities. The DOE IRP sponsored scoping study indicated significant opportunity to advance IRP practice in the public utility sector, which accounts for approximately 25% of the nation's electricity sales.

Figure 4.1 from the scoping study provides an organization chart of U.S. electric utilities and highlights the various entities comprising the public utility sector. Figure 4.1 indicates the diversity of the public utility sector as compared to IOUs. The scoping study identified several drivers behind public utility IRP activity as well as eight specific barriers to greater IRP implementation in the public utility sector. Figure 4.2 lists the barriers to IRP defined by the scoping study and suggests several advancement strategies for promoting IRP in the public utility sector.

A significant finding of the scoping study is that most public utilities are not regulated by state PUCs and many public utility transactions fall outside of federal jurisdiction. It was further determined, particularly in the light of EPAct, that DOE itself has a direct stake in promoting IRP in the public utility sector. Specifically, the power marketing administrations (PMAs) (Alaska, Bonneville, Western Area, Southeastern, and Southwestern), report to the Deputy Secretary who reviews implementation of IRP practices in the PMAs.

Figure 4.1 Organization of U.S. Electric Utilities

Source: National Renewable Energy Laboratory (NREL), 1993, *Scoping Study of Integrated Resource Planning Needs in the Public Utility Sector*, NREL-TP-463-5473, Golden, Colo., June, p. 6.

Figure 4.2 Applicability of IRP Advancement Strategies to Overcome Barriers to IRP Implementation

IRP Advancement Strategies	Barriers to IRP							
	Non-Integrated Organizational Structures	Lack of Knowledge/Experience	Surplus Electricity	Limited Financial and Personnel Resources	Conservative Boards and Managers	Unavailable/Unreliable Data	Overlapping/Conflicting Regulations	Mixed Pricing Signals
Applied Research	•	•	•	•	•	•	•	•
Education and Information Dissemination Services	•	•	•		•		•	•
Technical Assistance	•	•		•	•		•	
Methods and Tools Development	•	•		•				
Data Development and Transfer		•				•		
Financial Assistance/Incentives			•	•	•			
Regulatory Mandates	•				•			

Note: Column headings refer to barriers to adoption of IRP in the public power sector, as identified in the scoping study (NREL, 1993). Row headings identify selected strategies that can be used in overcoming the identified barriers. Dot indicates the strategy that applies to the appropriate barrier.

Source: NREL, 1993, p. 30.

The scoping study concluded that a comprehensive strategy is needed to further define the potential for IRP advancement in the public utility sector, and that several major public utility groups, including the American Public Power Association (APPA), the National Rural Electric Cooperative Association (NRECA), the Western Area Power Administration (WAPA), the Southeastern Power Administration (SEPA), and the Southwestern Power Administration (SWPA) had indicated both the need for IRP advancement in the public utility sector, and the desire to work cooperatively with DOE on this effort.

As an outgrowth of the scoping study, the DOE IRP program is currently sponsoring a project on advancement of IRP in public power, which is specifically designed to develop a comprehensive strategy for DOE to advance integrated resource planning practice in the public utility sector. The project, which is being managed by the NREL, is actively involving key public utility organizations in the development of an IRP advancement strategy to ensure that the strategy is responsive to the needs of the various public utility constituents. The project involves two distinct tasks:

- Assessment of common and special needs of key stakeholders; and
- Strategy development.

This key participant involvement task actively involves several key public utility organizations and their constituents in the development of DOE's IRP advancement strategy. The Steering Committee consists of representation from APPA, NRECA, WAPA, REA, SEPA, and SWPA.

Also included on the Steering Committee are the Tennessee Valley Authority (TVA) and the Bonneville Power Administration (BPA). These public power agencies are pursuing their own IRP initiatives. Their involvement on the Steering Committee will ensure that public utility IRP approaches are being examined in a consistent manner across both government owned and cooperatively owned organizations. This activity also involves an assessment to identify and assess the needs, expectations, common interests, and divergences that must be addressed by the IRP in public power project.

The strategy development task will focus on the design of a comprehensive strategy that will have the best potential for advancing public utility sector IRP practice. The strategy development will include four work elements as described below:

- Approach Definition: This effort will delineate the particular strategy development approach, methods, and data requirements.
- Public Power Profile: This effort is focused on obtaining data to characterize factors influencing IRP advancement and assess the current and achievable levels of IRP.

- Market Characterization and Analysis: This effort will be coordinated closely with the Public Power Profile in order to assess the "market" for IRP advancement in the public utility sector.
- Strategy Presentation: This work effort will consolidate the results of the preceding efforts and produce a comprehensive IRP advancement strategy for DOE to pursue in the public utility sector.

Contributions to the Advancement of IRP

The scoping study and the follow-on projects will define the critical needs of IRP in the public utility sector. Insofar as this sector provides 25% of all U.S. electricity sales, it is a key component of the U.S. electricity infrastructure. Since most IRP efforts have been focused on regulated IOUs, this set of projects fills a key gap and ensures that IRP approaches and methods can be extended to the public power sector. Public utilities are not subject to regulation like IOUs are regulated. At the same time, the projects emphasize consensus building; all components of the public utility sector combine to ensure that IRP strategies are tailored to the specific needs of public utilities. Further, since many public utilities do not fall within traditional state level regulation, this project provides a context for determining alternative approaches to capture the benefits of IRP outside of the traditional regulatory framework. This sequence of projects, therefore, ensures that the critical public power sector will not be excluded from IRP advancements and benefits.

4.2 DIAMOND: A MODEL OF INCREMENTAL DECISION MAKING FOR RESOURCE ACQUISITIONS BY ELECTRIC UTILITIES

Project Summary

A major issue facing electric utility planning and, therefore, IRP, is uncertainty. Substantial uncertainty exists in such important planning parameters as future load growth, lifetime of existing power plants, and construction times and costs. In recent years, the industry has developed a variety of analytical approaches to address the issue of uncertainty in the planning function. These methods include sensitivity analysis, scenario analysis, and portfolio analysis, and, in many cases, assume probabilistic treatment of various outcomes.

In this project, DOE IRP program sponsored researchers recognized that current planning approaches typically rely on simulation of utility operations over a 20- to 30-year time period. Because all of the inputs for these simulations are required to be specified at the outset, the approaches do not reflect the realities of incremental decision making, that is, modified decisions with the addition of new information.

The integrated resource planning process must address the issue of uncertainty in utility planning decisions. However, it was felt that a planning framework with more flexibility and realism in capturing incremental decision making was required. To respond to this requirement, the DOE

IRP program commissioned ORNL to investigate a methodology for use in incremental decision making by electric utilities (Gettings, Hirst, and Yourstone, 1991). The ORNL project developed a new planning model specifically designed to train electric utility analysts in making resource acquisition decisions. The model is called DIAMOND, Decision Impact Assessment Model.

DIAMOND explicitly treats uncertainty and provides for frequent user interaction and the ability to change prior decisions based on intermediate information outputs. It is believed that DIAMOND is a more accurate representation of the planning and decision making environment that utility planners and executives face. This realism is effectuated because utility planners interact with the model after every year or two of simulation, which provides an opportunity to modify past decisions as well as make new decisions. This concept is illustrated in Figure 4.3, where the traditional planning formulation is shown at the top of the exhibit, based on a fixed thirty-year planning horizon. The DIAMOND approach, represented in the bottom portion of Figure 4.3, shows the interactive nature of the output allowing for yearly adjustments to decisions.

The **DIAMOND** model consists of four submodels:

- **FUTURES**;
- **FORECASTS**;
- **SIMULATION**; and
- **DECISION**.

The model structure is illustrated conceptually in Figure 4.4.

The **FUTURES** submodel defines the planning future in which a utility must plan and operate its system. The analyst does not directly control this submodel, which is run once for each simulation. The **FUTURE** submodel outputs are exogenous variables such as economic growth, inflation rate, and fossil fuel prices.

The **FORECASTS** submodel uses "historical" information from **FUTURES** and from the **SIMULATION** submodel to produce simplified forecasts of key variables such as fuel price and economic growth and electricity demand. The model user employs these forecasts during each decision cycle to determine whether and when to acquire new resources.

The **DECISION** submodel is the heart of **DIAMOND**. In this submodel, the user interacts with the model to select demand and supply resources to meet future load growth. The analyst sees combined information from **FUTURES** and **SIMULATION** on historical trends and also sees forecasts of future loads, prices, and other factors from **FORECASTS**. When this information is combined with estimates of construction times for generating resources and the operating costs of alternative resources, the analyst can modify prior decisions on resource acquisition.

Figure 4.3 Typical Modeling Approach Versus Proposed Approach

Source: M. Gettings, E. Hirst, and E. Yourstone, 1991, *DIAMOND: A Model of Incremental Decision Making for Resource Acquisition by Electric Utilities*, ORNL/CON-315, Oak Ridge National Laboratory, Oak Ridge, Tenn., February, p. 3.

The **SIMULATION** submodel calculates electrical consumption and peak load for the current year on the basis of electricity prices, gas prices, income, and the performance of the utility's demand-side programs. User decisions from the **DECISION** submodel affect construction budgets and the amount and costs of power supply resources. **SIMULATION** then assigns these resources in order of increased variable cost to meet forecasted load. The results from this production costing algorithm are passed to the financial and regulatory parts of **SIMULATION**, which computes simple income statements and balance sheets and determines the size and timing of any rate increases.

Figure 4.4 Structure and Submodels of DIAMOND

Source: Gettings, Hirst, and Yourstone, 1991, p. 3.

Contributions to the Advancement of IRP

DIAMOND offers utility planners a realistic decision making framework to consider alternative resource acquisition decisions and associated uncertainties. The model is interactive on an annual basis so that utility planners can change decisions periodically in the planning cycle. For example, construction of a power plant can be started one year and, if model outputs indicate a change in circumstances, the plant can be accelerated, mothballed, canceled, or continued as originally planned. Similarly, utility planners can adjust marketing and financial incentives for demand-side management programs from year to year to determine the effects of these resources. DIAMOND developers are hopeful that this frequent user interaction with the model, which in effect is an operational game, will build greater understanding and insights among utility planners

concerning the risks associated with different types of resources, including traditional generation and demand-side resources.

Further, DIAMOND can be used to explore the effects of forecast error on decisions. A greater understanding of such error could guide utility decisions on whether to devote more effort to monitoring and forecasting key variables that affect resource acquisition. Finally, from the IRP program perspective, it is felt that the model has excellent application as a training device. Because of the interactive nature of the model, it can serve as "an educational device providing both ideas and insights to the participants . . . an excellent framework in which people may interact." (Quade, 1975).

5. TECHNOLOGICAL AND ENVIRONMENTAL ISSUES

Much of utility planning is connected with specific technologies. Planners must make assumptions about technology in the integrated planning function. Specifically, issues related to technology costs, efficiencies, reliability, and overall performance are subsumed in utility planning. This pertains to both supply-side technologies and demand-side technologies.

Technology also relates to environmental performance. For example, valuing DSM environmental externalities directly relates to the supply-side technology that is being displaced or deferred. Using renewables, for example, to displace fossil fuel combustion technologies can have direct environmental benefits. Utility planners are, therefore, increasingly concerned with emissions properties of selected technologies just as they are concerned with meeting energy service requirements.

The DOE IRP program has recognized the importance of technology issues in IRP and has sponsored several project activities in this area. In this chapter, three IRP projects are summarized. These include a project addressing IRP and renewable energy technologies, a project addressing fuel cycle analysis, and research on the subject of environmental externalities and their relationship to IRP approaches.

5.1 IRP AND RENEWABLES

Project Summary

Integrated resource planning is a process for considering the relative costs and benefits of all energy resources and technologies commensurately in the resource planning and procurement process. However, a number of technical, market, and institutional barriers currently hinder a full consideration of both conventional and emerging renewable energy technologies under IRP. For example, many utility sector decision makers lack a firm understanding of renewable energy resources and technologies and the key attributes and values they offer to utility system planning and operations. Further, many utilities and regulators lack adequate tools and methods with which to incorporate the many different attributes and characteristics of renewable energy technologies into existing planning models and frameworks.

In this project, NREL is working to identify key issues and opportunities related to greater consideration and deployment of renewables under IRP. NREL is working with key IRP stakeholders to develop appropriate vehicles for disseminating this information. This work contributes to the development of analytical methods and processes in support of a more robust IRP process.

In undertaking this project, NREL has established close working relationships with a variety of stakeholder organizations associated with IRP. These include the Subcommittee on Renewable Energy of NARUC, the Utility Renewable Resources Association (URRA), and EPRI.

NREL has worked closely with NARUC's Subcommittee on Renewable Energy on the development of a white paper on renewable energy in state regulatory processes (Hamrin and Rader, 1993), the development of workshops on renewable energy for state regulators, and the development of a national regulatory conference on renewable energy (NARUC, 1993a).

The national conference, co-sponsored by NARUC and DOE under IRP program auspices, involved several hundred state and federal utility regulators, regulatory staff, utility executives, representatives from renewable industries and consumer and environmental advocates (NARUC, 1993a). The topics covered at the conference included:

- the case for renewables,
- leading edge renewable technologies,
- models for success, including state, legislative, and regulatory commission models,
- planning issues,
- economics, finance, and renewables, and
- developing renewable energy regulatory strategies.

Under this project, NREL is also working closely with EPRI to identify planning and modeling needs related to renewable energy analysis under IRP. NREL staff are beginning to develop improved tools and methods that assist in characterizing and evaluating renewable energy technologies in utility planning. Other efforts underway in the renewables area include reviewing the renewables assessment capabilities of utility planning models, assessing the role of rate making and utility incentives in renewable energy development, evaluating the consideration of risk and uncertainty in utility planning, and assessing the potential implications for renewables.

The project has produced several important work products, including the following:

- *State Renewable Energy News*, a newsletter developed to promote the sharing of information on state level renewable energy activities. The newsletter is published three times annually to coincide with NARUC committee meetings;
- *Investing in the Future: a Regulator's Guide to Renewables*, a regulatory primer on renewable energy, published by NARUC (Hamrin and Rader, 1993);
- *Status Report on Renewable Energy in the States*, an NREL report which assesses the state of knowledge and awareness about renewables among state regulators and also catalogs existing state policies toward renewables (Swezey and Sinclair, 1992); and
- The development of a "Workshop on Renewable Energy for State Regulators." One workshop was held in May 1993 for state regulators from the Rocky Mountain region, and another was held in Boston in December 1993 for New England regulators. The workshop schedule was an agenda item in Boston.

Contributions to the Advancement of IRP

Renewable technologies often face significant barriers in utility planning, owing to their non-conventional performance characteristics and in some cases, their higher capital costs. However, renewable energy can represent an important component of the nation's energy future and should be considered on a common basis with other technologies on both the supply and demand sides in utility integrated planning. This project will provide the methods and data necessary to ensure the balanced consideration of renewables along with other more conventional technologies in IRP planning processes. This will ensure that the full potential of renewables can be realized by utilities and incorporated into their planning processes as a viable resource option.

5.2 FUEL CYCLE ANALYSIS

Project Summary

Utility and state regulators need reliable methodologies to evaluate technology options within an integrated resource planning framework. One approach to providing value added information to IRP is fuel cycle assessment. There are several different public and private organizations that are attempting to define and develop frameworks that are useful to utility and state decision makers. The DOE IRP program is sponsoring a project to identify and develop a framework for developing a fuel cycle analysis for input to IRP. The objectives of this project are to:

- Assess the usefulness of a fuel cycle assessment "guide" in providing a framework to establish data and research parameters for performing a fuel cycle assessment;
- Refine the guide based on the results of the research and analysis; and
- Assess the notion of regionally appropriate fuel cycle assessments.

Fuel cycle assessment involves a comprehensive assessment of the costs and benefits of a given energy technology. These include the social, economic, and environmental costs and benefits throughout the technology's life cycle. Net energy analysis forms a component of the fuel cycle assessment process with the addition of social, economic, and environmental costs and benefits. A **preliminary** illustration of the fuel cycle is illustrated in Figure 5.1.

Under this project, which is being managed by the NREL, researchers are working closely with the state of Maryland to develop and test the Fuel Cycle Assessment Guide. Several Maryland state practitioners and participants from industry organizations have formed a working group.

Figure 5.1 The Total Fuel Cycle

Source: BCS, Inc., November 1993.

In conjunction with the Working Group, the NREL research team has identified:

- Fuel cycle stages for particular technologies;
- Impacts that should be addressed in each stage;
- Data resources and gaps for impact measures; and
- Methods for applying fuel cycle assessment results as input to IRP processes.

To test the guide and conduct the assessment, four case example were selected:

- Combined cycled gas turbine system;
- Pulverized coal co-generation system;
- Energy efficient lighting; and
- Photovoltaics in aquaculture application.

Following the selection of the case examples, an intensive data collection and interviewing process ensued, utilizing the Fuel Cycle Assessment Guide. The Working Group met on several

occasions to monitor the results of the information collection process. Using this information, the group reviewed the fuel cycle assessment concept and revised the Guide. In addition, the group determined how the guide could be used specifically in the IRP process. Presently, the guide is being technically reviewed (Humphries, 1993).

Contribution to the Advancement of IRP

Preliminary results of this project show that the Fuel Cycle Assessment Guide is extremely useful in framing a fuel cycle assessment and its relevant parameters for a set of technologies. Also, it was determined that quantitative data should be collected for economic, environmental, and social consequences of using a given technology. However, where quantitative data are not available, qualitative measures would prove insightful and should be considered for use.

The fuel cycle assessment process advances IRP by providing a tool to examine the more limited set of options after an initial screening of options has been accomplished. For instance, in the initial screening, the IRP process selects alternative cost-effective resources. Then the fuel cycle assessment process assists in the determination of the best options.

The project has determined that the body of information collected and available can augment traditional planning in terms of the type of data collected and the application of this information by both utility and state planners. Fuel cycle assessment provides for consideration of a broad range of externalities in the IRP process. It incorporates risk measures in the assessment and it is adaptive to the utility industry structure as well as changing relations between regulators and utilities.

5.3 ENVIRONMENTAL EXTERNALITIES

Project Summary

It has long been recognized that the environmental effects that accompany operation of electric generating plants have significant impacts on society. In 1985, electricity production from fossil fuel fired generating plants accounted for about two-thirds of the sulphur dioxide and about one-third of the nitrogen oxides and carbon dioxide emitted in the United States. Sulphur dioxide and nitrogen oxides are precursors to acid precipitation. Under the Clean Air Act Amendments of 1990, electric utilities are being required to directly incorporate emission standards and financial costs of compliance into their planning functions. As a result, environmental compliance costs must be considered by electric utilities when considering the full range of resource options.

Partly in response to increased public concern about the impacts of acid precipitation and global climate change, state regulatory commissions in many states are now addressing the difficult questions of how to include environmental externalities in utility resource planning. Environmental costs are also one of the driving forces for many PUCs to place increased emphasis on demand

reduction alternatives for utilities, since avoided generation of electricity can lead to emissions reduction.

Within the field of integrated resource planning, both utility planners and regulators have been confronting the issue of how to explicitly treat environmental externalities in the IRP process. To meet this critical need, the DOE IRP program sponsored several related projects dealing with the incorporation of environmental externalities into IRP processes.

Working under DOE IRP program sponsorship, LBL joined with the NARUC ECC and the Michigan Public Service Commission to design and conduct a telephone and mail survey of PUCs to investigate the role of environmental externalities in utility resource planning and rate making (Cohen *et al.*, 1990). The survey focused on PUC activities as well as the role and efforts of other state agencies. PUC staff were also asked to identify and prioritize important research needs in this area.

The survey was conducted in three phases. Telephone interviews were conducted based on a list of PUC contacts provided by the NARUC ECC. This led to contacts with 49 PUCs. The results of these interviews were summarized and sent back to the respondents for confirmation, expansion, and correction. Written reviews or summaries were received from 35 PUCs.

Figure 5.2 summarizes the survey results with respect to the particular approaches used to incorporate environmental externalities. Several states employed a qualitative treatment of environmental externalities during the resource planning process. Only two states, at that time, provided for direct quantification of environmental costs and impacts as part of integrated planning. Some states employed a bid evaluation process from independent power producers where a weight was assigned to environmental considerations in the bid scoring system. Some states used a percentage adder that increases the cost of supply-side resources or decreases the cost of demand-side resources in the utility's planning process. In Wisconsin, for example, demand-side resources can cost 15% more than a combustion source and still be considered comparable in terms of overall societal cost.

Overall, 17 PUCs have adopted explicit rules directing that environmental externalities be incorporated in the utility planning process. Among this group of states, specific approaches were not mutually exclusive as several states had adopted several of the methods.

During the survey, PUCs were also asked to identify leading research needs in the area of incorporation of environmental externalities. Three major findings resulted from this area of inquiry:

- PUCs expressed great interest in obtaining information that would allow for quantification of environmental externalities.

**Figure 5.2 State Approaches to Incorporating Environmental Externalities
(ca. 1990)**

Source: S.D. Cohen, et. al., 1990, *A Survey of State PUC Activities to Incorporate Environmental Externalities into Electric Utility Planning and Regulation*, LBL-28616, UC-224, Lawrence Berkeley Laboratory, Berkeley, Calif., May, p. 9.

- PUCs were very interested in participating in regional workshops to find out what other states were doing and to discuss approaches for treating environmental externalities.
- Finally, PUCs expressed interest in local or regional studies to better understand the impact of various approaches in terms of their regional characteristics and resource mix.

Overall, the study team found widely varying PUC levels of activity. With the advent of competitive bidding processes, some PUCs and utilities have begun to incorporate environmental factors explicitly in the resource bid selection process. Lee and Drummer (1994) are completing a follow-on study.

A related DOE IRP sponsored project investigated incorporating global warming risks into power sector planning (Krause, Busch, and Koomey, 1992). This study examined the potential for reduced carbon emissions in the New England power sector, as well as the cost and rate impacts of two policy approaches: environmental externalities surcharges and a target based approach. The study addressed several research questions:

- Does New England have sufficient low carbon resources to achieve significant reductions (10% to 20% below current levels) in fossil carbon emissions in its utility sector?
- What reductions could be achieved at a maximum?
- What is the expected cost of carbon reductions as a function of the reduction goal?
- How would carbon reduction strategies affect electricity rates?
- How effective are environmental externalities surcharges as an instrument in bringing about carbon reductions?
- To what extent could the minimization of total electricity costs alone result in carbon reductions relative to conventional resource plans?

In order to address these questions, the study team developed a comprehensive menu of low carbon resource options. These included supply-side resources, demand-side resources, fuel switching, and co-generation. For various resource mixes, emissions and annual electricity costs were calculated.

New England's pooled utility system (NEPOOL) was simulated as though it were a single utility. The simulation covered the time period 1990 to 2010. The simulation incorporated four dimensions of uncertainty. First, high and low capital costs were defined for different low carbon resources. Second, the amount of low carbon resources was varied to capture implementation uncertainties. Third, sensitivity analysis was performed on fuel price escalation. Finally, the study team examined the effect of alternative assumptions about existing power plants retirements.

Based on the analysis, a supply curve of low carbon resource potentials was developed (see Figure 5.3). The analysis showed that the most economically attractive low carbon resources in New England are demand-side efficiency improvements, fuel switching at the point of end-use and gas fired co-generation. The study concluded that the mobilization of these resources, however, would require specific policies and utility efforts to overcome market failures affecting the efficiency of energy use as well as programs to promote the development and use of selected renewable resources.

Specific initiatives to promote these low carbon resources would include appliance efficiency standards, DSM programs, and modification of PURPA efficiency requirements for co-generators.

Figure 5.3 Supply Curve of Low Carbon Resource Potentials in New England

Source: F. Krause, J. Busch, and J. Koomey, 1992, *Incorporating Global Warming Risks in Power Sector Planning: A Case Study of the New England Region*, Volume I, LBL-30797 v.2, UC-350, Lawrence Berkeley Laboratory, Berkeley, Calif., November, p. 43.

The basic analysis was supplemented by a target based analysis to determine what reductions in carbon emissions could be achieved with low carbon resources relative to 1990 levels while meeting projected demand for electricity services in the 2005/2010 timeframe. Several scenarios were developed to analyze this issue. The target based scenario analysis concluded that New England

could realize carbon reductions relative to 1990 so long as about 50% of the low carbon resource potentials could be mobilized. If less than 50% of the carbon reduction potentials were mobilized, carbon reductions relative to 1990 levels dropped significantly.

The analysis also addressed rate impacts and utility bills. With respect to total utility bills, the analysis indicated that some carbon reductions are likely to be achievable at zero or even negative net cost. However, the analysis showed that since the carbon reduction portfolios relied heavily on demand-side resources, they would result in rate impacts even though total utility bills would be reduced. Rate impacts from the demand-side resources are caused by spreading the system's fixed cost (of existing generation, new generation, customer costs, administration costs, and T&D requirements) over a smaller number of kWh sold. Keeping carbon emissions constant at 1990 levels in the low cost scenario would cause rate impacts of from one percent to six percent in the year 2010. The low carbon scenario yields the larger carbon reductions with somewhat smaller rate impacts since under the low carbon scenario there would be less reliance on DSM and greater reliance on low carbon generation technologies. The study team concluded that in view of these rate impact uncertainties, regulators could approach carbon reduction goals based on a given maximum tolerable rate impact. The study team felt that freezing emissions at 1990 levels would be a safe target if limiting rate impacts to about five percent or less were the principal policy objective.

The "Least Cost" supply curve shows DSM, fuel switching, and cogeneration costs to be below gas-fired ACC, while biomass and wind costs would be greater than gas-fired ACC in New England.

Contributions to the Advancement of IRP

From a societal perspective, environmental considerations have assumed increased importance and visibility. Those concerned with IRP are being forced to confront and integrate environmental externalities directly into IRP planning processes. These projects sponsored by the DOE IRP program provide regulators, utility planners and other interested stakeholders with information on specific methodologies and procedures for incorporating environmental externalities into the IRP process. As these methods are integrated into IRP, the result can lead to not only a resource plan optimized from an energy cost perspective, but a resource plan which is truly globally optimized from both an energy and environmental cost perspective.

6. DSM RESOURCE CHARACTERIZATION

Integrated resource planning includes comparable treatment of both supply-side and demand-side resources in the utility planning function. Historically, supply-side resources are more or less directly measurable. For example, it is possible to directly instrument and measure the MW and MWh output of a fossil fired power plant. Demand-side resources on the other hand have proven much more difficult to accurately measure because of their highly dispersed nature. DSM program evaluation is concerned with methodologies to accurately measure savings (both energy and demand) from demand-side management programs. While much evaluation of DSM programs is keyed toward confirmation of whether utilities meet regulated mandates or earn incentives for their DSM programs, a key component of DSM evaluation is to accurately measure the demand-side resource for purposes of integrated resource planning.

Recognizing this critical relationship between DSM and IRP, and the importance of DSM to the implementation of integrated resource plans, the DOE IRP program has sponsored several projects relating to DSM evaluation. In this chapter, three such projects are highlighted: the development of a national database on energy efficiency programs (DEEP), a handbook on evaluation of utility DSM programs, and a DSM terminology handbook. These projects are discussed in the following sections.

6.1 DATABASE ON ENERGY EFFICIENCY PROGRAMS (DEEP)

Project Summary

With the advent of IRP and DSM, regulators, utility planners, and other interested stakeholders have recognized a critical need for the exchange of information. This includes information on programs, technologies, evaluation methods, costs, program performance, and a host of related parameters. The DOE LCUP/IRP Program recognized this critical need in the late 1980's. DOE then provided funding support for NORDAX. NORDAX became a valuable tool for storing and sharing valuable information on utility DSM programs (NORDAX, 1991).

Building on the NORDAX experience, the DOE IRP program sponsored the development of a national Database on Energy Efficiency Programs, known as DEEP. DEEP is designed to contain information on electric and gas utility DSM programs as well as those carried out by non-utility players such as government agencies. The database will consist mostly of North American programs. DEEP will provide program descriptions and key summary data on program costs, participation rates, total eligible customer base, energy and demand savings, cost effectiveness, and evaluation methodologies.

The primary source of the data entering DEEP is evaluation reports prepared by utilities and state and regional organizations. DEEP is, thus, actively engaged in soliciting and collecting evaluation reports for utility DSM programs throughout North America. To date, several hundred such reports have been collected.

These evaluation reports will yield practical information to be included in the database itself. Analyses and summaries of pertinent data will be provided periodically to present lessons learned from particular types of programs (e.g., lighting programs in commercial buildings, appliance rebate programs, programs for energy-efficient refrigerators, etc.). Experience from additional energy-efficiency programs will be transferred to the database as available.

The information in DEEP will be accessible to all interested parties. Current efforts focus on developing a final approach for this accessibility. One concept which is being examined is to provide DEEP as an on-line database which could be accessible through a toll-free number with a computer and modem. The user would interact with DEEP through a series of menus that would allow key word searching. Information could be viewed on-screen or downloaded to the user's computer.

DEEP is being developed and managed at LBL. Recognizing the critical importance of involving a wide variety of stakeholders in the IRP and DSM areas, LBL and the DOE IRP program have obtained co-funding from several organizations, including the:

- New York State Energy Research and Development Authority (NYSERDA),
- Bonneville Power Administration (BPA),
- Electric Power Research Institute (EPRI),
- Rockefeller Family and Associates, and
- the Energy Foundation.

In addition, two advisory groups provide guidance to DEEP activities. The DEEP Management Board, composed of representatives of DEEP's participating organizations, assists in the management of the project and provides advice at critical junctures during the process of designing and implementing the database. The DEEP Technical Advisory Group (TAG) includes utility representatives, database specialists and DSM professionals. The TAG provides advice on the development of the database and on data collection and analysis activities.

LBL is examining total resource costs (including customer costs) of approximately 20 commercial lighting programs. Currently, a market research study is being performed to define the information needs of the DSM and IRP audience and to assess how DEEP can be configured to best meet these information needs. A working draft report is in progress.

Contributions to the Advancement of IRP

DEEP serves as a repository of evaluation results of DSM programs. In this regard, DEEP serves as a comprehensive inventory of measurements of DSM program performance throughout North America. These measurement data can serve as critical inputs to IRP planning functions to fine tune estimates of demand-side resource quantities and costs.

DEEP also provides an objective synthesis of what has been learned through the implementation of DSM programs throughout North America as well as the full range of data available from evaluation efforts. DEEP staff can provide objective estimates and synthesis of DSM program costs and savings.

Finally, DEEP serves as a clearinghouse of evaluation methodologies currently being employed in the DSM community. The DEEP database and document collection provides a library of the current state of practice in DSM measurement and impact evaluation.

DOE's support of DEEP has attracted and involved the international community. While this report was being completed, LBL was beginning to administer the International Database on Energy Efficiency Programmes (INDEEP). INDEEP will be funded by the International Energy Agency (IEA) and 24 of IEA's industrialized member countries.

6.2 HANDBOOK OF EVALUATION OF UTILITY DSM PROGRAMS

Project Summary

Evaluation of DSM programs has become a central issue in the world of IRP. DSM is being considered as an important resource in a utility's portfolio of options. In recent years, the amount of money that utilities have invested in DSM has grown rapidly in most regulatory jurisdictions.

Further, the introduction of regulatory incentives for utilities to implement DSM programs has really focused the need for precise impact evaluation. Many regulators have embraced the importance of aligning a utility's profitability with IRP goals and have opted for incentive regulation. Since incentives are typically based on the amount of energy saved, evaluation methods which attempt to estimate these savings have become critical.

Recognizing this critical need, the DOE IRP program, in conjunction with NYSERDA, sponsored the development of a *Handbook of Evaluation of Utility DSM Programs* (Hirst and Reed, 1991). In the handbook, the editors define evaluation as "the systematic measurement of the operation and performance of programs." Further, the editors point out that evaluations depend on objective measurements rather than anecdotal evidence and that evaluations use social science research methods and technical data to produce valid and reliable results. The handbook also notes that evaluations are not just academic exercises but are intended to affect future decisions regarding DSM programs.

The handbook illustrates the analysis of the effects of a DSM program (see Figure 6.1). Impact evaluations provide quantitative documentation of program benefits and costs. They compare what happened to program participants with what would have happened if the program had not existed. Figure 6.2 illustrates this concept. The figure also addresses the concept of total savings achieved by a DSM program and the issue of attribution, or net savings, which is the portion of total savings that can be directly attributed to the utility program. The editors also define the sequence of activities associated with evaluation of DSM programs. These are illustrated in Figure 6.3. Additionally, the introduction to the handbook clarified several challenges that DSM program evaluators are likely to face in the 1990's. These include:

- role of evaluation in contested PUC hearings,
- integration of evaluation with other customer analysis activities,
- measurement of long term durability of energy savings,
- definition of key DSM program terms,
- development of standard approaches for evaluation,
- evaluation of the performance of DSM technologies,
- measurement of the savings from DSM bidding programs, and
- evaluation of DSM programs that aim to transform the market.

Figure 6.1 Relationships Between a DSM Program, Its Inputs and Outputs

Source: E. Hirst and J. Reed, eds., 1991, *Handbook of Evaluation of Utility DSM Programs*, ORNL/CON-336, Oak Ridge National Laboratory, Oak Ridge, Tenn., December, p. 4.

In the area of evaluation planning, key activities revolve around identification of the goals of the evaluation and obtaining agreement on the goals from all relevant stakeholders. Clear evaluation goals are essential to ensure that appropriate data are collected and available for analysis when needed. The handbook further points out that the choice of a particular evaluation approach depends upon the type of program, its size, customer segment, and the ultimate use of the evaluation results. The handbook notes that a good research design is also critical to guiding data collection and ensuring that the results of the evaluation can withstand critical review.

Figure 6.2 Schematic of Electricity Use

Source: Hirst and Reed, eds., 1991, p. 4.

In the chapter on monitoring the impacts of DSM programs, the handbook asserts that monitoring is not conducted in a vacuum, but is interrelated with evaluation planning and analysis. Not all data sources suit all analytical objectives and methods. Selecting data sources is noted as a key decision which can dramatically impact budget requirements. Measurement accuracy and sample size can be traded off in order to optimize precision and costs.

Data quality is a critical issue in evaluation data collection and begins with adequate training and quality data collection instruments and materials. Data quality can also be assured through validation checks and data collection oversight.

Figure 6.3 Sequence of Activities in Evaluating DSM Programs

Plan evaluation
Identify program goals and future decisions
Determine purposes of evaluation and questions to address
Identify evaluation resources (budget, staff, time, data, and analytical methods)

Implement evaluation
Define populations to sample
Collect data (program records, weather data, monthly electricity bills, customer surveys, interviews with program staff, and end-use load monitoring)

Analyze data

Present evaluation results
Review results with program implementation and planning staffs
Report results to utility executives and to the PUC
Prepare final report and briefings
Act on findings

Source: Hirst and Reed, eds., 1991, p. 5.

The chapter on data analysis encompasses several critical subjects in DSM impact evaluation. The handbook covers statistical comparison approaches, the use of paired data to enhance precision, multi-variate savings models, and the treatment of self-selection bias and free riders. The analysis chapter concludes that increased emphasis will be placed on discrete choice modeling in DSM evaluations and, further, that more end-use and whole premise metering will be incorporated into DSM evaluation. However, nearly universal analysis of electricity billing data will continue, even with the advent of additional methods. Finally, the use of hybrid techniques or multiple approaches will continue to evolve. These include difference estimators, ratio estimators, and statistically adjusted engineering estimates.

The handbook includes a chapter on load research in evaluation and specifically addresses premise level and end-use metering activities. The chapter includes treatment of costs of load research as well as application of load research to DSM evaluation.

A chapter on free riders and other factors that affect net program impacts is also included in the handbook. This chapter includes techniques for estimating free ridership such as surveys, market data, comparison groups, and statistical modeling. The chapter also includes a discussion of free drivers.

One handbook chapter treats the issue of the persistence of energy savings and describes several methodologies and issues associated with estimating persistence of savings.

The handbook devotes a chapter to process evaluation, which examines the operational efficiency and effectiveness of the program. This chapter also discusses the critical links between

process and impact evaluations and how overall evaluation results can be used and factored into program improvements. The handbook is thoroughly referenced and contains a comprehensive, annotated bibliography. The authors developed the handbook based upon the lessons learned from the best of the best DSM program evaluations in the U.S.

Contributions to the Advancement of IRP

The *Handbook of Evaluation of Utility DSM Programs* offers a comprehensive reference tool for practitioners in the DSM evaluation field. Employment of the techniques and methods contained in the handbook can result in more rigorous and more precise measurement of demand-side resources. To the extent that such demand-side resources can be more precisely estimated, they will assume increased importance in utility planning. As the reliability and availability of these resources become better defined, utility planners will be more willing to include them on an equal footing with supply resources, which is a key goal of IRP. Therefore, the handbook provides a valuable link in the art and science of more precise measurement of demand-side program impacts and demand-side resources.

6.3 DSM TERMINOLOGY HANDBOOK

Project Summary

As utility DSM programs expand, the need to describe them, analyze them, and compare them also expands. DSM practitioners across the country sometimes use different terminology to describe similar concepts. Also, certain practitioners developed additional terminology to describe newly observed phenomena (e.g., free drivers). In recognition of the need to develop a basis for common terminology and reporting formats in the field of DSM, the DOE IRP program, in conjunction with EPRI, sponsored a project to develop a report on *Electric Utility DSM Programs: Terminology and Reporting Formats* (Hirst and Sabo, 1991).

The handbook addresses the need for additional and better information in two important ways. First, the handbook presents key concepts associated with DSM program types, participation, energy and load impacts, and costs. Second, the handbook presents definitions and a sample reporting form for utility DSM programs. The primary objective in developing these definitions and reporting form is to encourage consistency in the collection and reporting of data and information on DSM programs.

The handbook recognizes that data on DSM programs are useful within the utility, for other utilities planning similar programs, for regional power pools, for state regulatory commissions, for state and federal energy planners, and for other groups interested in energy issues. The concept is illustrated in Figure 6.4. Data on DSM programs crosscut several activities and functions within utilities in addition to IRP. These include DSM program planning and design, market research, load

research, load forecasting, and evaluation. Such data are also essential for reporting results of DSM programs to state regulatory commissions.

Figure 6.4 Data on DSM Programs

Source: E. Hirst and C. Sabo, 1991, *Electric Utility DSM Programs: Terminology and Reporting Formats*, ORNL/CON-337, Oak Ridge National Laboratory, Oak Ridge, Tenn., October, p. 6.

The handbook provides definitions in several important categories of DSM. Definitions are also provided for customer class and market segment for DSM program type and for program life cycle stage.

In addition to definitions of utility DSM program type, the handbook contains sections on terminology associated with program participation, including participating units, market definitions, and terminology associated with participation rates.

Owing to the critical importance of DSM impact evaluation, the handbook provides coverage of terminology associated with energy and load effects, including gross versus net effects, temporal dimensions of effects, and data and analysis methods.

Since ultimately all DSM programs must pass benefit-cost analysis, there has been significant debate on what comprises DSM program costs. The handbook covers this issue at length and treats a wide variety of cost elements, including costs related to administration, marketing, monitoring and evaluation, equipment, incentives, demand-side bidding, and regulatory incentives.

The handbook provides a chapter on cost benefit calculations and program performance measurement (Hirst and Sabo, 1991). In addition to a comprehensive reference list, the handbook also contains a glossary of key DSM program terms. A sample from the glossary is presented in Figure 6.5. Another appendix to the handbook contains the authors' suggested uniform DSM program data reporting form.

Contributions to the Advancement of IRP

Supply-side planning has been in place for 100 years. Over this period, the terminology, methods, and approaches have been well detailed. Demand-side planning programs and analysis, on the other hand, are relatively recent additions to the electric utility planning environment. Further, demand-side planning and analysis are continually evolving. The need for a common framework of reference and terminology associated with demand-side planning is critical to allow for common understanding among DSM and IRP practitioners and regulators. This handbook provides a starting point for developing a common framework of reference, which is essential to the advancement of IRP. To the extent that IRP involves comparisons (e.g., of demand-side and supply-side resource, costs and benefits, and DSM programs) a common framework is essential to engender confidence in making these comparisons. The handbook is a start in providing a common basis of communication on important demand-side principles.

Figure 6.5 Extract of Glossary of Key DSM-Program Terms

Achievable potential is an estimate of the amount of energy savings that would occur if all cost-effective, energy-efficient options promoted through utility DSM programs were adopted.

Add-ons are purchases of new or additional equipment of a type previously not present in an existing facility, such as the purchase of a food freezer for a home that previously had none or the purchase of a second room air-conditioner.

Administrative costs are expenses incurred by the utility for program planning, design, management, and administration. They include labor, office supplies, data processing, and other such costs. They exclude the costs of marketing, purchase of equipment for programs, incentives, and monitoring and evaluation.

Agricultural sector is the group of nonresidential customers engaged in the production of crops or livestock, forestry, fishing, hunting, or trapping.

Alternative-rate programs offer special rate structures or discounts on the customer's monthly electric bill, often in return for participation in programs aimed at cutting peak demands or changing load shape.

Annual effects are the changes in customer electricity use and demand caused by a program's activities during a given year.

Annual participation is the number of customers enrolled in a particular program for a given year.

Annual participation rate is the ratio of the number of participating units in a particular year to the number of eligible units.

Base market is the set of customers or technologies against which participation in a program is measures.

Bill credit is a payment in the form of a reduction in a customer's electricity bill.

Capitalized refers to equipment or other utility investments to be used over a multiyear period and therefore eligible for inclusion in the utility's ratebase.

Cash incentive is a monetary award or inducement in the form of a rebate or payment.

Source: Hirst and Sabo, 1991, p.67.

7. TRAINING AND INFORMATION TRANSFER

As IRP has evolved, the need for training and information transfer has become more pronounced. This training requirement has occurred in several dimensions. For example, one requirement is to transfer expertise from states with experience in IRP to those (typically smaller) states who are just getting started in IRP and who lack experience and staff expertise. Further, as IRP itself has advanced and become more sophisticated, there is a need for on-going training on new state-of-the-art techniques and principles of integrated resource planning. As an increasing number of state Public Service Commission staffs and utility planners become knowledgeable about the principles and techniques of IRP, it can be expected that IRP will become increasingly widespread.

Therefore, the DOE IRP program has sponsored several activities to meet training and information transfer needs in the IRP field. In this chapter, two such activities are summarized. Periodic IRP training seminars conducted by staff at LBL are presented. A complementary training program conducted by the Regulatory Assistance Project (RAP) with partial funding support from the DOE IRP program is also summarized.

A key feature of DOE-supported training is the diversity among speakers and trainers. A substantial majority of IRP perspectives are represented, thereby enhancing IRP's comprehensiveness.

7.1 LBL ADVANCED IRP SEMINAR

Project Summary

Staff at LBL have developed a seminar on advanced IRP. In January of 1990, the first seminar on advanced LCUP was organized and presented by LBL. The 1990 LCUP seminar encompassed five days of intensive coverage of a range of subjects relevant to IRP. Major topics of the 1990 seminar included:

- What are demand-side technologies for buildings?
- Energy demand forecasting: the link to supply planning;
- Putting it all together: integrated resource planning;
- The importance of program evaluation;
- Decoupling of profits from sales;
- Regulatory review of IRP filings; and
- Treatment of environmental externalities.

Presenters at the 1990 seminar, in addition to LBL staff, included experts from the American Council for an Energy Efficiency Economy (ACEEE), the California Energy Commission (CEC), the Northwest Power Planning Council (NPPC), the Massachusetts Department of Public Utilities, ORNL, the BPA, Pace University, and the California Public Utilities Commission.

Based on the results of the 1990 LCUP seminar, improvements and enhancements were made to the course materials and agenda and a second advanced IRP seminar was held by LBL staff in June of 1991.

The most recent advanced IRP seminar was held by LBL in January of 1993. The seminar featured a week of in-depth lectures, hands-on demonstrations, and informal discussions of leading technical issues. The seminar was designed for state regulatory staff that review integrated resource plans submitted by utilities. The 1993 advanced IRP seminar was limited to 20 participating commission staffers; advance preparation was mandatory. Selection criteria for applicants included:

- Current role in review of utility IRP filings;
- Potential for leveraging information gained from the seminar;
- Familiarity with IRP issues and techniques;
- Existence of upcoming proceedings for which attendance at the seminar would be valuable; and
- Prior representation from the same state.

Final selection of applicants was made by a joint LBL/NARUC review panel. Figure 7.1 summarizes the agenda for the 1993 LBL Advanced IRP Seminar. Each session contained

Figure 7.1 Summary of Topics Covered in 1993 LBL Advanced IRP Seminar

UNDERSTANDING THE DEMAND-SIDE RESOURCE

- Reviewing Utility Integrated Resource Plans
- The Rationale for Utility Involvement in Customer Energy Efficiency Programs
- Developing a Micro-Supply Curve of Conserved Energy

ACQUIRING DEMAND-SIDE RESOURCES COST EFFECTIVELY

- Lessons Learned: A Review of Utility Commercial and Residential DSM Programs
- DSM Program Evaluation: Did You Get What You Paid For
- Designing a Successful Utility DSM Program

PUTTING IT ALL TOGETHER: INTEGRATED RESOURCE PLANNING

- Integrating Supply and Demand
- Methods and Models for Calculating Electricity Avoided Costs
- Regulation by Computer Simulation: Production Cost Modeling in a Regulatory Setting
- Deferring Power Plants with Demand-Side Resources

STIMULATING UTILITY PARTICIPATION IN DEMAND-SIDE MARKETS AND EXPANDING THE ISSUES CONSIDERED IN IRP

- Ratemaking for Utility Customer Energy Efficiency Programs
- DSM Incentives and Program Evaluation
- Clean Air Act Compliance and IRP
- Transmission Planning and IRP: Are They Compatible
- The Role of Renewables in IRP: Regulatory Issues

COMPETITION: A NEW PLANNING PARADIGM

- Links Between Competition and IRP
 - Gas Integrated Resource Planning
-

appropriate reading materials and represented the state-of-the-art in addressing relevant topics associated with IRP.

All of the LBL training seminars were evaluated by participants to provide a means of feedback and improvement of course materials and presentation. The 1993 Advanced IRP Seminar was attended by 22 utility regulatory staff, representing 20 state commissions, and included staff from six state commissions that had not participated in previous LBL seminars.

The 1993 seminar was divided into four types of activities: (1) morning lectures by IRP experts on core IRP issues; (2) afternoon software exercises; (3) topical lectures on emerging IRP issues; and (4) evening informal sessions. At the end of the week, each participant was asked to complete an evaluation form rating each component of the seminar. A scale of one to four was used, with four being the top rating.

As in previous years, the overall seminar was rated significantly higher (3.9) than any individual component of the seminar.² Among the highest rated core IRP issues were the sections on descriptions of DSM program design, guidelines for good IRP, and integration methods. Results of the complete rating of the 1993 seminar are indicated in Figure 7.2.

Contributions to the Advancement of IRP

In three offerings, 67 state utility commission staff from 37 states have participated in the advanced seminar. The seminars are playing an important role in advancing IRP principles to states that would not otherwise have access to the training necessary to implement IRP. Further, as IRP techniques and methods advance, seminar content is continuously reviewed and updated to feature the latest state-of-the-art approaches. This serves to maintain currency, even amongst practitioners with experience in IRP.

The initial LBL seminars were offered at a time when there was no routine channel of communication for prompt dissemination of IRP information. The seminars provided a vehicle for PUC staff, especially those from smaller, less active commissions, to quickly acquire knowledge of IRP principles. The format of lectures, discussions, and hands-on software experiments provided a comprehensive, high quality IRP learning experience. Thus, in terms of both expanding the coverage of IRP geographically and continuously improving the state of practice, the advanced IRP seminar series appears to be playing a key role in advancement of IRP.

² In this case, the teaching of IRP served as a good example for the way IRP should be practiced. From gestalt theory--the whole is greater than the sum of its parts, i.e., the seminar was highly integrative. The higher overall rating suggests that seminar participants are learning the significance of *integrated resource planning*.

Figure 7.2 Rating of 1993 LBL Advanced IRP Seminar
(Scale of 1 to 4, with 4 the top rating)

"CORE" LECTURES	
Reality vs. Rhetoric: Reviewing Utility Integrated Resource Plans	3.55
Rationale for Utility Involvement in Customer Energy Efficiency Programs	2.93
Lessons Learned: A Review of Utility Commercial and Residential DSM Programs	3.61
DSM Program Evaluation: Did You Get What You Paid For?	3.36
Integrating Supply and Demand	3.48
Methods and Models for Calculating Electricity Avoided Costs	3.18
Regulation by Computer Simulation: Production Cost Modeling in a Regulatory Setting	3.14
SOFTWARE EXERCISES	
Developing a Micro-Supply Curve of Conserved Energy	3.33
Designing a Successful Utility DSM Program	3.21
Deferring Power Plants with Demand-Side Resources	3.21
TOPICAL ISSUES	
Ratemaking for Utility Customer Energy Efficiency Programs	3.50
DSM Incentives and Program Evaluation	3.50
Clean Air Act Compliance and IRP	3.50
Transmission Planning and IRP: Are They Compatible?	3.00
The Role of Renewables in IRP: Regulatory Issues	2.62
Links Between Competition and Integrated Resource Planning	3.37
Gas Integrated Resource Planning	3.50
EVENING SESSIONS	
The Threat of Global Warming and Strategies for Coping	2.92
Energy Efficient Technologies Demonstration: Evening Reception at PG&E's Pacific Energy Center	3.56
An Informal, Participatory Discussion on Regulatory Strategies for IRP	2.89
SEMINAR MATERIAL AND LOGISTICS	
Course Reader and Reference Materials	3.81
Seminar Room and Meals	2.47
Housing Accommodations	2.87
Seminar Location	3.74
OVERALL ASSESSMENT OF THE SEMINAR	3.92

7.2 REGULATORY ASSISTANCE PROJECT

Project Description

The Regulatory Assistance Project (RAP) is a non-profit organization funded in part by the DOE IRP program. RAP designs and implements training and workshops for PUC staff and commissioners in conjunction with a range of nationally recognized IRP experts. The RAP training programs are coordinating closely with training and experts from LBL, ORNL, and other DOE and energy organizations.

The fundamental difference between the LBL Advanced IRP Seminar and the RAP approach is that RAP provides intensive **on-site** educational programs to state PUCs on all aspects of IRP. This, in effect, increases the range and coverage of IRP program training initiatives since RAP can schedule several training seminars in the course of the year, traveling to the PUC location.

Further, RAP attempts to customize the workshops, based on the needs and interests of each individual state commission. The RAP workshop covers the full range of relevant IRP issues, including:

- integration and optimization of supply-side and demand-side resources;
- energy conservation program design, measurement, and evaluation;
- DSM cost recovery;
- avoided cost methodologies;
- renewable resources;
- rate design;
- competitive bidding;
- IRP profitability and incentives;
- Clean Air Act compliance; and
- consideration of externalities.

RAP workshops are provided free of charge, although state commissions are asked to provide the local training facility and copies of workshop materials. States are selected to receive the workshop based upon their interest, their current level of IRP activity, and the relative size of the emission reduction obligations faced by the utilities under the Clean Air Act Amendments of 1990.

In addition to the traveling workshop series on IRP, RAP also conducts workshops on the EPCA of 1992 and its implications for state public utility regulators, and on renewable resources.

Contributions to the Advancement of IRP

Training on principles is considered essential to further the adoption and implementation of IRP throughout the United States. In addition, different states face different local issues and requirements. For example, some states have significant excess generation capacity, while others face capacity shortfalls. Some states face difficult issues associated with Clean Air Act compliance, while others are not similarly constrained. RAP, through its tailored approach, customizes training issues

for the particular state commissions, helping to overcome what might otherwise be localized barriers to adoption.

The RAP approach complements the LBL seminar series by providing the ability to reach more commissions and commission staff who require training on IRP. Further, the RAP approach complements the LBL seminar in its ability to present generalized instruction contained in the LBL seminar and adapt it to the particular needs of individual state regulatory bodies.

8. CONCLUSIONS AND PROSPECTS

8.1 CONCLUSIONS

The DOE program has evolved significantly in recent years and continues to evolve to meet national energy policy mandates and stakeholder needs. The program has contributed significantly to the promotion of integrated planning principles and processes throughout the country. Program activities have fostered the transfer of knowledge and information, the development of advanced methods and analytical tools, and the analysis of specific barriers and topical issues which relate to state and local jurisdictions' ability to adopt and implement principles.

Efforts of NARUC, under DOE sponsorship, have contributed significantly to advancing principles throughout the utility regulatory community. In addition to providing a credible vehicle for transferring the knowledge of principles from more advanced states, the NARUC project has led the way in exploration of key regulatory issues and constraints. The DOE program sponsored work on gas has also contributed to regulatory approaches, by providing the tools and techniques necessary to transfer principles from the electricity to the gas sector, and from the IOU industry to the public power sector.

IRP relies on a sound understanding of the performance of energy technologies, whether they be on the supply side or the demand side. The Renewables project has been instrumental in transferring sound technical knowledge of renewable energy technologies to the community.

IRP is inextricably linked to environmental issues, since energy production in general, and electricity generation in particular, are major pollutant sources. The project on Fuel Cycle Analysis helps practitioners to understand the complete implications of fuel choices both from an energy and environmental perspective. The project on Environmental Externalities provides a sound basis for utility planners and regulators to systematically incorporate the environmental costs and benefits of alternative supply and demand-side resources into practice.

Finally, the DOE program has supported the development of a sound knowledge base and effective information transfer mechanisms. The handbooks on DSM Terminology and DSM Program Evaluation have become standards. They provide comprehensive reference resources for both experienced and novice practitioners relative to these complex subjects. The DOE program sponsored training seminars organized by LBL and RAP have been widely acclaimed as a mechanism to expand knowledge of principles throughout the states while at the same time capturing and transferring the latest developments in practice.

The issues underlying IRP are complex and involve a large array of professional disciplines. Issues of economics, regulation, policy, energy technology, and environmental compliance are not easily resolved. In its recent accomplishments, the DOE IRP program has attempted to incorporate and respond to the needs of various stakeholders for support in tackling these many complex issues.

A small set of DOE-sponsored projects summarized in this report illustrate both the complexity of the issues and the DOE program approach to developing better understanding of these issues. Papers, conferences, training seminars, models, databases, and handbooks developed by the DOE IRP program have proven highly successful in advancing both the state of practice and the adoption of principles in an ever increasing number of jurisdictions throughout the country.

8.2 FUTURE DIRECTIONS

As discussed in Chapters 1 and 2 of this report, the DOE IRP program continues to evolve in response to national energy policy initiatives. The DOE program agenda in future years will be defined by a combination of mandates under EPCA, policy initiatives of the current administration, and stakeholder needs.

EPCA has underscored the potential importance of IRP by calling for the widespread adoption of a method for the nation's electric and gas utilities and their stakeholders to improve the economic efficiency of utility systems and the energy efficiency of utility end-uses. EPCA amends the Public Utility Regulatory Policies Act of 1978 (PURPA) to require PUCs to consider adopting the process of integrated resource planning within the next two years. This requirement encourages the development of IRP practices by those investor-owned and public utilities and rural electric cooperatives throughout the nation that have yet to adopt principles and processes. EPCA also calls for the WAPA to require its customers to use IRP in their planning and for the TVA to consult with its customers to prepare an IRP.

EPCA has mandated several specific actions to be accomplished by DOE. The act requires DOE, for example, to monitor, evaluate, and report to Congress within two years on the status and impact of IRP development nationwide. In response, DOE plans to survey the rules and regulations governing electric and gas utility planning in each state. As called for by EPCA, DOE plans to work with the Federal Trade Commission (FTC) to evaluate the impact of electric and gas utility sponsored DSM programs on small businesses that provide energy services to customers. Section 111 of EPCA further requires DOE to survey the status of development among the nation's rural electric cooperatives. This section also requires DOE to conduct a national evaluation of the impact of electric utility programs on rates, reliability, and fuel diversity. Section 112 calls for DOE to provide grants to the states for energy efficiency. In addition, Title VI, "Global Climate Change," requires DOE to develop a least cost energy strategy for the nation. To meet this requirement, DOE expects to apply IRP techniques in developing such a strategy.

The DOE program has determined that federal assistance can best be applied in several distinct areas to promote the advancement of IRP. These include:

- Transferring knowledge about lessons learned by leading-edge practitioners to less experienced utilities and states;

- Developing advanced methods, analytical tools, and data in which utilities and states have interest but lack the capabilities or resources to develop on their own;
- Analyzing barriers to the adoption of IRP and identifying new approaches to facilitate implementation of locally appropriate processes on a broader scale; and
- Analyzing the implications of IRP development as they relate to EPAct and achievement of critical energy, economic, and environmental policy goals.

This range of activities is based on the premise that DOE is uniquely positioned to provide independent and unbiased information about IRP to all stakeholders, particularly those facing a resource constraint in developing the tools and talents needed to implement IRP properly. However, the DOE program recognizes that the federal role does not involve developing standards. The DOE program recognizes that there is no single way to do IRP and that the best processes are those that have been custom designed to suit local opportunities, resources, and needs.

In recognition of EPAct requirements and stakeholder needs, the DOE program has established five program goals to drive future program activities. These goals are summarized in Figure 8.1. To support these goals, the DOE program envisions 11 areas of program activity over the next several years. These activity areas/objectives are described in Figure 8.2. The projected DOE program budget to accomplish these goals and activities is shown in Figure 8.3.

Figure 8.1 Program Goals

Source: Department of Energy (DOE), 1993, *Integrated Resource Planning Program Plan, FY1994 - FY1998, Draft #7*, Washington. November 12 p. 9.

Figure 8.2 Program Activities

Source: DOE, 1993, p. 10.

Given the evolution of needs nationwide and on a state level, the DOE program has defined its future mission as follows:

To develop and promote sound planning principles and processes through the use of integrated resource planning and other techniques to improve economic efficiency, environmental quality, and energy security while recognizing the evolving nature of the electric and natural gas utility sectors.

Based on its record of accomplishments, DOE is well positioned to meet future challenges.

Figure 8.3 DOE Program Budget
(FY 1994 through FY 1998)

Source: DOE, 1993, p. B-1.

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