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GUIDEBOOK FOR FARMSTEAD DEMAND-SIDE MANAGEMENT (DSM) PROGRAM DESIGN

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ACKNOWLEDGEMENTS

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Synergic Resources Corporation would like to thank all the project participants who made the New York State Farmstead DSM project possible.

This project built on the past efforts of the four upstate New York utilities and Cornell University's Department of Agricultural and Biological Engineering who have compiled a body of agricultural electric energy research that is almost unmatched in any other state in the U.S. This experience made this project possible along with the financial resources of the utilities and the U.S. Department of Energy. We all hope the information will help utilities better serve New York's farmers as well as those elsewhere in the Northeastern U.S. It was a privilege to work with you on this assignment.

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I. INTRODUCTION

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A. BACKGROUND

The acceptance and growth of Demand-Side Management (DSM) continues to increase in the United States. According to latest estimates, total expenditures on electric utility DSM programs now exceed $1.2 billion annually, with these investments ranging from 1 to 5 percent of a utility's gross revenues.[1] In addition, due to increasing environmental concerns and the high cost of new capacity, these expenditure levels are expected to increase. While the vast majority of these DSM programs are directed at the more traditional residential, commercial and industrial market sectors, significant opportunities still exist. One market segment that has not been the focus of attention -- but a critical sector from an economic development perspective for many utilities -- is the agricultural and farmstead market. Although the total number of farms in the United States decreased by approximately 5 percent between 1985 and 1989, the land dedicated to farming still accounts for over 995 million acres.[2] Furthermore, the total value of farm output in the United States has been steadily increasing since 1986. The limited penetration of energy efficiency measures in farmsteads provides an excellent opportunity for utilities to expand their DSM programming efforts to capture this "non-traditional" market segment, and at the same time assist farms in increasing their efficiency and competitiveness. In many states, and, in particular New York State, agriculture plays a major economic role. The importance of farms not only from a utility perspective but also from a state and federal perspective cannot be overstated. As such, utilities are in a unique position to facilitate farmstead DSM

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[1]Nadel, Steven, American Council for an Energy Efficient Economy. "Electric Utility Conservation Programs: A Review of the Lessons Taught By A Decade of Program Experience," 1990.

[2]Statistical Abstract of the United States, 1990.

technology investments in an effort to benefit the farmer (and his profitability), the utility, the state and the country.

This guidebook is designed to provide the necessary framework for agricultural demand planning, including market assessment, technology assessment, market penetration analysis and program design.

B. OBJECTIVE

The New York State DSM Assessment Project was conceived to focus the body of energy research conducted on the development of cost-effective DSM options for farms in New York State. This guidebook is intended as a tool for utility staff members responsible for the development of effective agricultural DSM programs. In particular, this guidebook will address the following:

- The need for market information
- Identification and screening of agricultural technology options
- Analysis of agricultural DSM programs
- Development of program planning.

C. APPROACH

In developing the information used in this guidebook, three major steps were taken, each with a number of separate components. The approach for completing this guidebook is presented in Figure I-1.

Figure I-1

APPROACH FOR COMPLETING THE
FARMSTEAD DSM PROGRAM ANALYSIS GUIDEBOOK

Step 1

- Review of New York State situation
  - DSM plans
  - Public Service Commission
  - Equity
  - Mandatory TOU rates
- Importance of New York State agricultural sector
- Finding common objectives and resources
- Project Design

↓

Step 2

- Data inventory review
  - Farmstead Data Inventory Report
- Screening of agricultural DSM technologies
  - Farmstead Technology Options Report
  - Farmstead Technology Segmentation Report
- Applying existing analysis tools
  - Cornell Farm Load Simulation
  - RELOAD
  - COMPASS

↓

Step 3

- Design and conduct analysis
  - Farmstead Program Design and Analysis Report
- Presentation and dissemination of results
  - New York Farmstead DSM Conference

D. ORGANIZATION

The organizational structure of this guidebook is illustrated in Figure I-2.

Section two of this report provides an overview of the project's processes and procedures. The section details the common objectives of the project co-sponsors, their experiences and overall lessons learned in organizing the project.

Section three details the importance of market information. The elements of conducting a market assessment are discussed, including data identification, development and reconciliation.

The technology option screening assessment is presented in **Section four.** This includes a step-by-step approach to complete the screening exercise and identify applicable agricultural technology options.

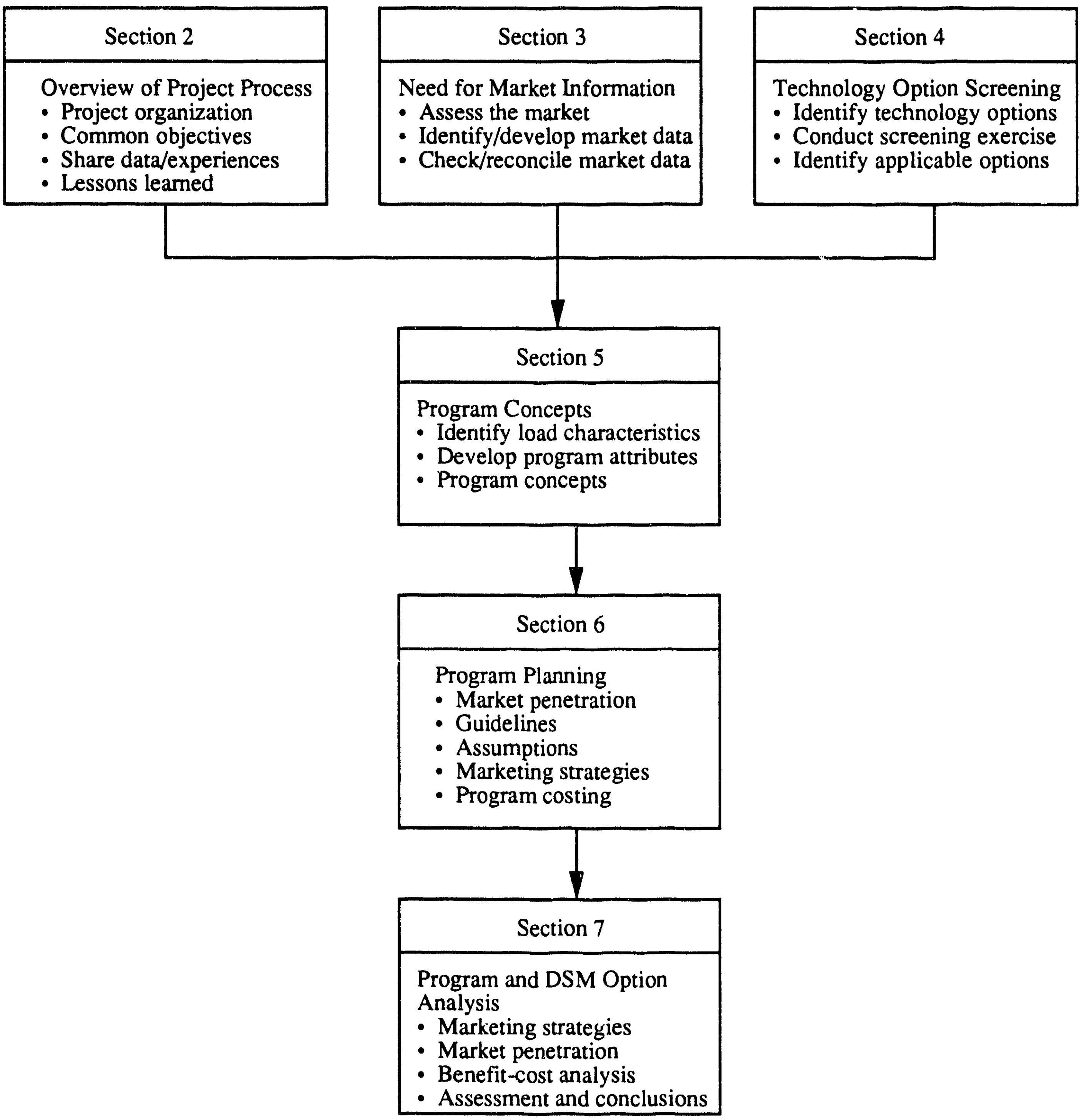
Section five details the development of program elements. This section links technologies identified in the screening exercise to actual program attributes, including program costs, incentive types/levels and market acceptance.

The program planning process is described in **Section six.** Program guidelines and assumptions are listed, marketing strategies identified, and program costs estimated.

Section seven provides the analysis of Farmstead DSM options.

Figure I-2

OVERVIEW OF GUIDEBOOK CONTENTS



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E. USE OF THE GUIDEBOOK

As identified above, this guidebook is comprised of 7 separate sections. The intent of the guidebook is to provide a step-by-step outline of the procedures used to develop cost-effective farmstead DSM programs. We recognize that users of this guidebook possess varying levels of knowledge about and experience with DSM program planning and development. As such, the guidebook format provides a comprehensive review for the novice reader while also allowing for the more sophisticated readers to skip to sections that are of relevance to their specific situation.

II. ORGANIZATIONAL ISSUES IN CONDUCTING A DSM FARMSTEAD PROJECT

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A. THE NEED FOR ORGANIZATION

A project of this scope requires significant structure and organization. There are many stakeholders and participants who may have an interest or can contribute information or data. In the New York situation, the DSM analysis was conducted on a state-wide basis, which initially required input from a number of state investor-owned utilities as well as other related agencies. An example of the range of participants and their associated responsibilities from the New York experience is shown on Table II-1. This amplified the need to ensure a structured, organized approach. This includes many of the detailed issues such as assignment of responsibilities, setting project objectives and meeting deliverable schedules. As an end result, the actual process of the project becomes as important as the results. If this effort is being conducted by a single utility, then the scope of the organizational issues are likely to be more straight forward, still there are a number of significant lessons of experience that can be discerned which could help any utility in their DSM farnmstead efforts. This chapter provides a review of the primary organizational issues including; setting project objectives, developing a project workplan and assigning project responsibilities and schedules.

B. SETTING PROJECT OBJECTIVES

The first step in this effort, either for a single utility or a group of participants, is the need to establish project objectives. Any successful DSM farmstead effort must be grounded on a set of clear, definable project objectives which address overall project goals. A key point

Table II-1

LISTING OF PROJECT PARTICIPANTS AND GENERAL RESPONSIBILITIES

	Overall Project Design	Primary Data Support	Secondary Data Support	Review of Materials	Data Analysis	Funding
New York State						
- Niagara Mohawk	●	●	●	●		●
- NYSEG	●	●	●	●		●
- RG&E	●	●	●	●		●
- CHG&E	●	●	●	●		●
Educational/Institutional Facilities						
- Cornell University			●	●		
- NY State Cooperative Extension			●			
Federal/Governmental Agencies						
- Department of Energy	●					●
- National Food & Energy Council			●			
Others						
- Contractor	●	●		●	●	

to keep in mind is that objectives may vary among the various project participants. For example, a utility objective may focus on developing programs to help build a closer relationship to farmers by identifying energy-efficiency improvements, while the objective of the Department Of Energy (DOE) may focus on developing a transferable datatset so that other utilities can benefit. Even within utilities, the objectives may differ. As a result, it is important to identify and set all project objectives.

The actual process of setting objectives can best be accomplished in a group "brainstorming" setting. This provides an environment whereby participants can identify their unique or individual objectives collectively. This approach becomes increasingly important if there are large numbers of study participants (utilities and others). Once all the objectives are presented, effort should be placed on condensing and refining them into a distinct set of objectives. An example of the identified objectives from the New York study is shown on Table II-2.

In taking this approach, whereby the suggestions and input from all the primary players is reviewed, the various participants can feel more involved in the process and develop a greater sense of "buy in" into the study.

C. DEVELOPING A PROJECT WORKPLAN

Once consensus on project objectives can be reached, effort should be placed on carefully detailing the research design for the study. More specifically, each step of the project should be "mapped out," depicting the major tasks and highlighting the relationships between various activities. In addition to understanding the objectives, this requires review of a number of issues, including:

Table II-2

PROJECT OBJECTIVES FROM THE

NEW YORK STATE FARMSTEAD STUDY

- Establish a methodology to estimate technical, economic and technical potential from agricultural DSM technologies.

- Develop data on agricultural DSM technologies including load impacts (energy/demand), equipment costs, useful lifetimes and performance characteristics.

- Identify optimum approaches for program designs to implement cost-effective technologies. This includes estimating the eligible market, identifying incentive levels and developing program costs (marketing and program administration).

- Develop a method of analyzing farmer purchase decision behavior as it impacts energy-related investm... .

- **Data Availability**- A review of the existing available data, such as results from utility load research studies, may impact the efforts required to modify and/or develop appropriate data. This will also dictate the efforts required for primary research and secondary research, which will impact the approach taken.

- **Project Scheduling**- an important component of the plan, is fitting all the necessary steps within time and scheduling guidelines. These should be stated at the outset by the primary project participants. The sensitivity associated with the scheduling process should also be addressed.

- **Funding**- A final consideration is the available funding from within the utility or in the case of New York, leveraged and aggregated, to conduct the work. The level of detail and extent of data development will, in large part, be dependent on funding levels.

The development of a project plan should be manifest in a project flowchart, which identifies the primary tasks and shows the sequential relationship between the various tasks. An example prepared in the New York situation is provided on Figure II-1. In taking this approach, one can also begin to assign responsibilities to the various participants. These responsibilities may range from collecting existing data or even conducting new surveys or research. An example of the assignment of responsibilities from the New York situation is shown on Table II-3. It is also important that a time component be attached to each of the tasks as responsibilities are given. As an end result, each participant will know three things:

- **What** type of information or data is needed?

- **Who** is responsible for developing this data?

- **When** is this data or information required?

As part of the project plan, emphasis must also be placed on establishing a meeting schedule for all participants. The meeting schedule should be tied to the timing of

Figure II-1

FRAMEWORK FOR THE EVALUATION OF CONSERVATION AND LOAD MANAGEMENT MEASURES

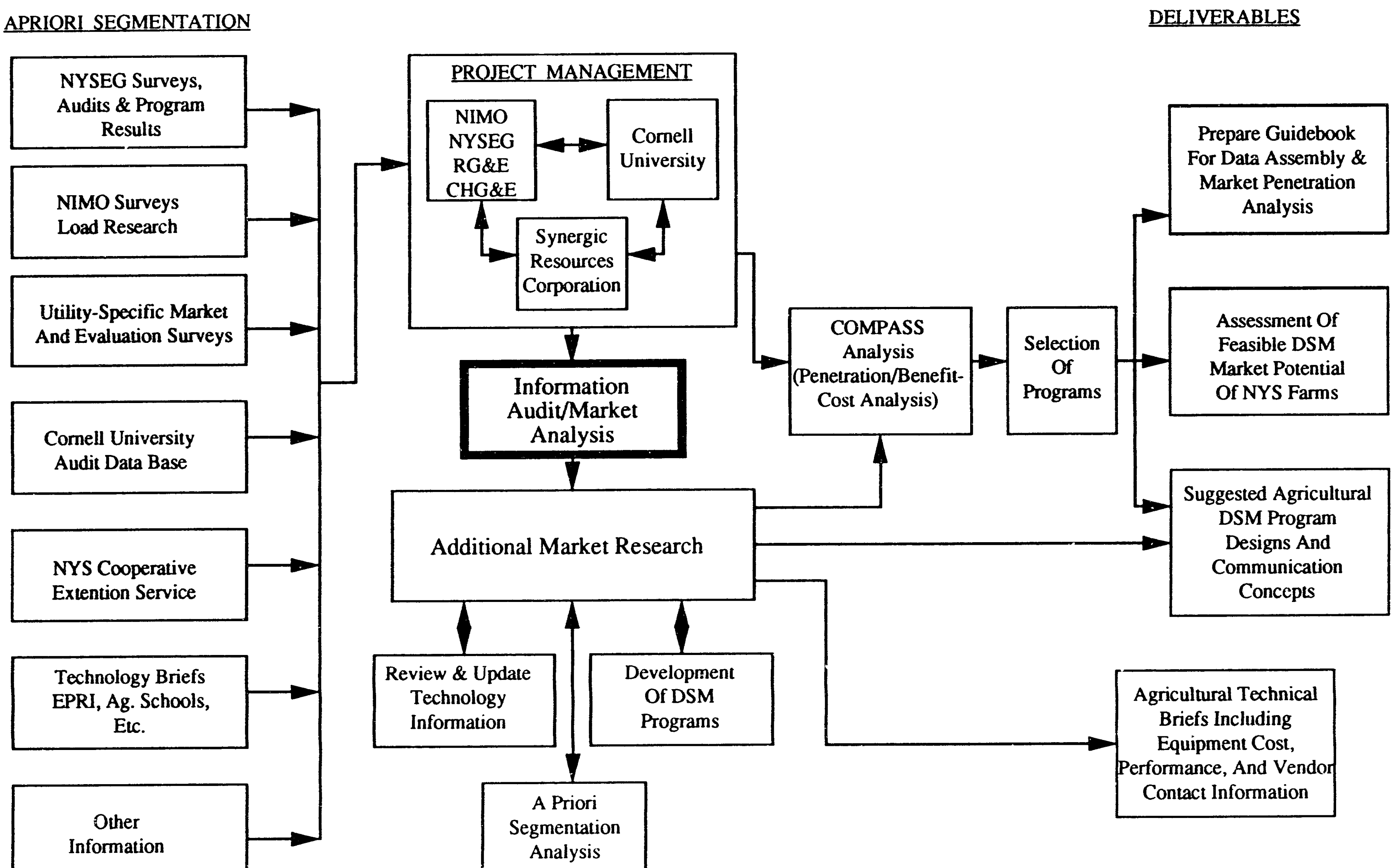

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Table II-3

ASSIGNMENT OF DATA ACQUISITION AND DEVELOPMENT

	Load Research Data	Market Surveys	Energy Audits	Technology Assessment	Investment Research	Data Analysis
Niagara Mohawk	●	●	●	●		
NYSEG	●	●	●	●		
RG&E		●				
CHG&E		●				
Cornell			●	●	●	
SRC					●	●

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delieverables and provide a forum to review results and gain concensus on the status of the project, before undertaking subsequent steps.

D. LESSONS OF EXPERIENCE IN FARMSTEAD PROJECT ORGANIZATION

There are a number of critical success factors regarding project organization that can be discerned from the New York State experience. These are:

- It is important that all key participants contribute to the initial organizational activities of the study. This ensures the opportunity obtain input from all perspectives and take into account any disparate positions that may be taken.
- There needs to be an overall point of focus from an organizational standpoint. One person or utility must take the lead to moderate the discussions, direct the review process and serve as the central point of contact among all participants.
- The organizational approach and project plan should be as detailed as possible to avoid confusion and communications problems. The exactness of the plan can also help throughout the project in providing a means of identifying progress made and any problems or "bottlenecks" which may need to be addressed.
- The collective organizational approach can work well in serving as a means of utility data sharing or trading DSM stories. This serves as a way of looking at the process as a "learning experience", since the emphasis on agricultural DSM planning is generally modest.

III. THE NEED FOR MARKET INFORMATION

III. THE NEED FOR MARKET INFORMATION

A. OVERVIEW

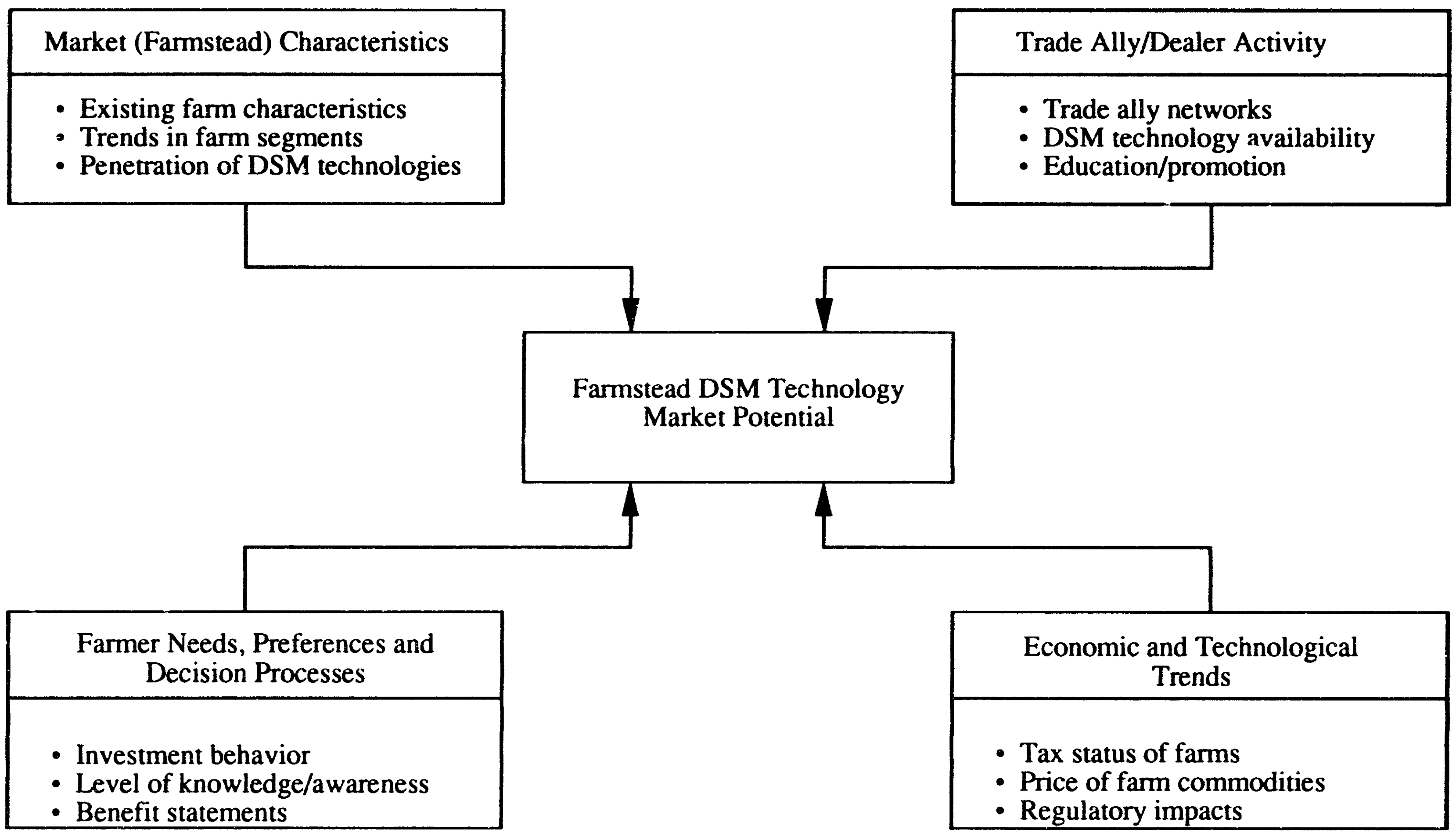
A crucial element in the design and development of a farmstead DSM program is market information. It is in this initial program design phase that the signals from the market must be closely analyzed. Given the diversity in the type, size and composition of farms (i.e., dairy, cattle, poultry, grain, etc.), it is essential for utilities to gather primary market data and information that details farmstead characteristics and assesses farmers' needs, unique to each farm in each service territory. In addition, the farmstead environment is also influenced by more macro-market situations including economic, technological and legal events/trends. As a result, it is in utilities' interests to identify what information is important and which resources can be leveraged to obtain this relevant data. This chapter provides an overview of the elements and steps required to conduct a market assessment of the farm sector.

B. THE NEED TO ASSESS THE MARKET

As indicated above, in order to develop a marketing strategy, data which details the farmstead market environment and assesses customer needs must be collected. As presented in Figure III-1, there are a number of external factors that impact the market potential for farmstead DSM technologies. In the traditional market planning process, the completion of a situation analysis is typically recommended. This initial information gathering is used in subsequent stages of the strategy development process. The key external elements, relevant for the farmstead sector, that should be included as part of such an assessment include the following:

Figure III-1

EXTERNAL FACTORS THAT INFLUENCE MARKET POTENTIAL FOR FARMSTEAD DSM TECHNOLOGIES



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- Market (farmstead) characteristics
- Economic and technological trends
- Farmers' preferences, attitudes and decision criteria
- Trade ally/dealer activity.

It is important to note that the development of comprehensive market data can be costly and time consuming. In reviewing utility farmstead market data, there are likely to be data gaps and areas where information is not conclusive or undeveloped. One of the outcomes of this data assessment is to identify the current status of market information and identify areas where resources should be directed to improve market information. Discussions regarding how to develop data and what types of information are most important will be addressed in greater detail, later in this chapter.

C. ELEMENTS OF A MARKET ASSESSMENT

It is important to note that there are a number of specific elements attached to farmstead market assessment. What follows is a detailed description of these key elements.

1. Market (Farmstead) Characteristics

One of the first elements of data needed is the identification of the characteristics of the farms within a utility's service territory. This effort should focus on a number of considerations including farm types, sizes, equipment use and consumption practices. A more detailed listing in presented in Table III-1.

Table III-1

INFORMATION NEEDS FOR FARMSTEAD CHARACTERISTICS ASSESSMENT

• Account number, name and address
• SIC code/primary farm activities
• Size of farm
  - number of acres
  - number of animals
• Number, type and age of electric farmstead equipment
  - market saturation percentages
  - eligibility percentages
• Prior energy management activities
• Total gross farm receipts
• Age of farm
• Hours of operation/operating characteristics
• Demographic data
  - age
  - education level
  - income level
  - degree of debt (%)

Since opportunities for farmstead DSM technologies are partially based on the type of farm (and its associated technology requirements), it is essential that utility planners monitor and evaluate the saturation of electric farmstead equipment (as well as the penetration of farmstead DSM technologies). More specifically, this examination should focus on the identification of the number of farms (segmented by SIC code), the size of farms and the number/types of electric farmstead technologies. This also includes identifying which farm sectors are growing or declining. Table III-2 provides an example of the breakdown of upstate New York farms by type of farm which have an energy intensity greater than 15,000 kWh/year in electricity consumption.

This type of information can help the utility planner realize market opportunities and assist in strategy development. As an example, if a utility has a large percentage of dairy farms in its service territory, the promotion of well water pre-coolers for milking operations may be a cost-effective DSM strategy for both the farmer and the utility.

In addition to the number/size of farms and farmstead equipment saturation, it is important to identify equipment operating characteristics in order to develop energy and demand profiles of the various end-uses and technologies. Much of this information can be obtained through load research[1] and engineering estimates. A comprehensive assessment of farmstead characteristics also includes a review of the demographic variables of its farm population. Examples of such variables include a farmer's age, education level, and number of years operating a farm.

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[1]Niagara Mohawk Power Corporation has funded a considerable amount of farmstead load research through Cornell University's Department of Agricultural and Biological Engineering.

Table III-2

UPSTATE NEW YORK FARMS BY TYPE OF FARM[1]

SIC Code	SIC Type	#	%
011	Cash Grain	829	5.5
013	Field Crop	964	6.4
016	Vegetable/Melon	621	4.1
017	Fruit/Nuts	984	6.6
118	Horticulture	520	3.5
019	General Crop	249	1.7
021	Livestock	1,317	8.8
024	Dairy	8,998	60.0
025	Poultry	125	0.8
027	Animal Specialties	279	1.9
029	General Farm	112	0.7
TOTAL		15,000	100%

[1]Farms listed include only those targeted with an annual energy consumption of greater than 15,000 kWh.

While there are a number of methods and sources that can be used to gather this information, much of the data can be obtained via primary market research (i.e., surveys, focus groups). Additional sources include the following:

- Audit data
- U.S. Census data
- Load research data
- Pilot program experience (e.g., NYSEG, Northeast Utilities)
- New York State Agricultural Experiment Station (e.g., Cornell University)
- New York State Statistical Service
- U.S. Department of Energy
- The National Food and Energy Council, Inc.

To summarize the discussion of farmstead characteristics, Tables III-3 through III-6 provide examples of farmstead market sizes, eligible percentages and saturation percentages for each of the four upstate New York utilities. In addition, Table III-7 presents eligible market percentages for selected farmstead segments in upstate New York. These tables serve as benchmark illustrations of the specific types of market characteristics data that can be used in future farmstead DSM planning efforts.

2. Economic and Technological Trends

As part of a market assessment of the farmstead sector, it is important to identify and keep abreast of the trends occurring in the economic and technological environments. These external factors have a significant impact on farmers and their ability not only to participate

TABLE III-3

NMPC Farmstead Market Sizes, Eligible Percentages, and Saturation Percentages

Market Segment	# of farms*	End-use	Technology Option	Elig. %**	Market Saturation Percentages***
FARMS	7750	Security Lighting	MV to HPS	37.0%	B=100%, D=0%
		Outdoor Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
POULTRY FARMS	41	Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
		Ventilation	Std. to H.E.	91.0%	B=85%, D=15%
SMALL DAIRY FARMS	4349	T.S. Lighting	Inc. to Fluor.	88.5%	B=86.8%, D=13.1%
		F.S. Lighting	MV to HPS	3.8%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=95%, D=5%
		Water Heating	Timer	84.7%	B=100%, D=0%
			Heat Recovery	60.5%	B=100%, D=0% (Sat. inc. in Elig. %)
		T.S. Ventilation	Std. to H.E.	81.2%	B=85.5%, D=14.5%
LARGE DAIRY FARMS	720	T.S. Lighting	Inc. to Fluor.	33.6%	B=86.8%, D=13.2%
		F.S. Lighting	MV to HPS	25.1%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=62%, D=38%
		T.S. Ventilation	Std. to H.E.	33.2%	B=77.5%, D=22.5%
LARGE DAIRY FARMS W/PARLORS	498	Water Heating	Timers	73.6%	B=100%, D=0%
			Heat Recovery	35.3%	B=100%, D=0% (Sat inc. in Elig. %)
		Milking	Dual Vacuum Pumps	100.0%	B=100%, D=0%
LARGE DAIRY FARMS W/PIPELINES	222	Water Heating	Timers	76.9%	B=100%, D=0%
			Heat Recovery	39.2%	B=100%, D=0% (Sat inc. in Elig. %)

* Estimates of the number of farms by farmtype in the NMPC service area was derived from census data as described in the "Technology Segmentation Report".

** See Table III-7 for notes on eligible percentages.

*** The current year saturation percentages for each DSM option (Base and DSM technology pair) were estimated based on farmstead surveys conducted by the Departments of Agricultural Economics and Agricultural and Biological Engineering at Cornell University, Ithaca, NY, 1987-1989. See the "Technology Segmentation Report" for specific references.

TABLE III-4

NYSEG Farmstead Market Sizes, Eligible Percentages, and Saturation Percentages

Market Segment	# of farms*	End-use	Technology Option	Elig. %**	Market Saturation Percentages***
FARMS	5650	Security Lighting	MV to HPS	37.0%	B=100%, D=0%
		Outdoor Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
POULTRY FARMS	60	Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
		Ventilation	Std. to H.E.	91.0%	B=85%, D=15%
SMALL DAIRY FARMS	2943	T.S. Lighting	Inc. to Fluor.	88.5%	B=86.8%, D=13.1%
		F.S. Lighting	MV to HPS	3.8%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=95%, D=5%
		Water Heating	Timer	59.3%	B=100%, D=0% (Sat. inc. in Elig. %)
			Heat Recovery	60.5%	B=100%, D=0% (Sat. inc. in Elig. %)
		T.S. Ventilation	Std. to H.E.	81.2%	B=85.5%, D=14.5%
LARGE DAIRY FARMS	487	T.S. Lighting	Inc. to Fluor.	33.6%	B=86.8%, D=13.2%
		F.S. Lighting	MV to HPS	25.1%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=62%, D=38%
		T.S. Ventilation	Std. to H.E.	33.2%	B=77.5%, D=22.5%
LARGE DAIRY FARMS W/PARLORS	337	Water Heating	Timers	51.5%	B=100%, D=0% (Sat inc. in Elig. %)
			Heat Recovery	35.3%	B=100%, D=0% (Sat inc. in Elig. %)
		Milking	Dual Vacuum Pumps	100.0%	B=100%, D=0%
LARGE DAIRY FARMS W/PIPELINES	150	Water Heating	Timers	53.8%	B=100%, D=0% (Sat inc. in Elig. %)
			Heat Recovery	39.2%	B=100%, D=0% (Sat inc. in Elig. %)

* Estimates of the number of farms by farmtype in the NYSEG service area was derived from census data as described in the "Technology Segmentation Report".

** See Table III-7 for notes on eligible percentages.

*** The current year saturation percentages for each DSM option (Base and DSM technology pair) were estimated based on farmstead surveys conducted by the Departments of Agricultural Economics and Agricultural and Biological Engineering at Cornell University, Ithaca, NY, 1987-1989. See the "Technology Segmentation Report" for specific references.

TABLE III-5

RG&E Farmstead Market Sizes, Eligible Percentages, and Saturation Percentages

Market Segment	# of farms*	End-use	Technology Option	Elig. %**	Market Saturation Percentages***
FARMS	1000	Security Lighting	MV to HPS	37.0%	B=100%, D=0%
		Outdoor Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
POULTRY FARMS	10	Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
		Ventilation	Std. to H.E.	91.0%	B=85%, D=15%
SMALL DAIRY FARMS	284	T.S. Lighting	Inc. to Fluor.	88.5%	B=86.9%, D=13.1%
		F.S. Lighting	MV to HPS	3.8%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=95%, D=5%
		Water Heating	Timer	84.7%	B=100%, D=0%
			Heat Recovery	60.5%	B=100%, D=0% (Sat. inc. in Elig. %)
		T.S. Ventilation	Std. to H.E.	81.2%	B=85.5%, D=14.5%
LARGE DAIRY FARMS	47	T.S. Lighting	Inc. to Fluor.	33.6%	B=86.8%, D=13.2%
		F.S. Lighting	MV to HPS	25.1%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=62%, D=38%
		T.S. Ventilation	Std. to H.E.	33.2%	B=77.5%, D=22.5%
LARGE DAIRY FARMS W/PARLORS	33	Water Heating	Timers	73.6%	B=100%, D=0%
			Heat Recovery	35.3%	B=100%, D=0% (Sat inc. in Elig. %)
		Milking	Dual Vacuum Pumps	100.0%	B=100%, D=0%
LARGE DAIRY FARMS W/PIPELINES	14	Water Heating	Timers	76.9%	B=100%, D=0%
			Heat Recovery	39.2%	B=100%, D=0% (Sat inc. in Elig. %)

* Estimates of the number of farms by farmtype in the RG&E service area was derived from census data as described in the "Technology Segmentation Report".

** See Table III-7 for notes on eligible percentages.

*** The current year saturation percentages for each DSM option (Base and DSM technology pair) were estimated based on farmstead surveys conducted by the Departments of Agricultural Economics and Agricultural and Biological Engineering at Cornell University, Ithaca, NY, 1987-1989. See the "Technology Segmentation Report" for specific references.

TABLE III-6

CHG&E Farmstead Market Sizes, Eligible Percentages, and Saturation Percentages

Market Segment	# of farms*	End-use	Technology Option	Elig. %**	Market Saturation Percentages***
FARMS	600	Security Lighting	MV to HPS	37.0%	B=100%, D=0%
		Outdoor Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
POULTRY FARMS	14	Lighting	Inc. to Fluor.	100.0%	B=100%, D=0%
		Ventilation	Std. to H.E.	91.0%	B=85%, D=15%
SMALL DAIRY FARMS	145	T.S. Lighting	Inc. to Fluor.	88.5%	B=86.8%, D=13.1%
		F.S. Lighting	MV to HPS	3.8%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=95%, D=5%
		Water Heating	Timer	84.7%	B=100%, D=0%
			Heat Recovery	60.5%	B=100%, D=0% (Sat. inc. in Elig. %)
		T.S. Ventilation	Std. to H.E.	81.2%	B=85.5%, D=14.5%
LARGE DAIRY FARMS	24	T.S. Lighting	Inc. to Fluor.	33.6%	B=86.8%, D=13.2%
		F.S. Lighting	MV to HPS	25.1%	B=100%, D=0%
		Milk Cooling	Pre-Coolers	100.0%	B=62%, D=38%
		T.S. Ventilation	Std. to H.E.	33.2%	B=77.5%, D=22.5%
LARGE DAIRY FARMS W/PARLORS	17	Water Heating	Timers	73.6%	B=100%, D=0%
			Heat Recovery	35.3%	B=100%, D=0% (Sat inc. in Elig. %)
		Milking	Dual Vacuum Pumps	100.0%	B=100%, D=0%
LARGE DAIRY FARMS W/PIPELINES	7	Water Heating	Timers	76.9%	B=100%, D=0%
			Heat Recovery	39.2%	B=100%, D=0% (Sat inc. in Elig. %)

* Estimates of the number of farms by farmtype in the CHG&E service area was derived from census data as described in the "Technology Segmentation Report".

** See Table III-7 for notes on eligible percentages.

*** The current year saturation percentages for each DSM option (Base and DSM technology pair) were estimated based on farmstead surveys conducted by the Departments of Agricultural Economics and Agricultural and Biological Engineering at Cornell University, Ithaca, NY, 1987-1989. See the "Technology Segmentation Report" for specific references.

TABLE III-7

Eligible Percentages for Upstate N.Y. Farmstead Markets

Market Segment	End-use	Technology Option	Elig. %*	Eligibility Notes
FARMS	Security Lighting	MV to HPS	37.0%	Approximately 37% of all farms have MV security lighting.
	Outdoor Lighting	Inc. to Fluor.	100.0%	It is assumed that all farms are eligible for this option.
POULTRY FARMS	Lighting	Inc. to Fluor.	100.0%	It is assumed that all poultry farms are eligible for this option.
	Ventilation	Std. to H.E.	91.0%	Approximately 91.0% of all upstate poultry farms presently use electric-powered ventilation fans.
SMALL DAIRY FARMS	T.S. Lighting	Inc. to Fluor.	88.5%	Approximately 88.5% of small dairy farms have tie stall barns.
	F.S. Lighting	MV to HPS	3.8%	Approximately 10.0% of small dairy farms have free stall barns and 38.3% of free stall barns use MV lighting.
	Milk Cooling	Pre-Coolers	100.0%	It is assumed that all small dairy farms are eligible for this option.
	Water Heating	Timer**	84.7%	Approximately 84.7% of small dairy farms have electric water heaters.
		Heat Recovery	60.5%	Approximately 84.7% of small dairy farms have electric water heaters and 28.6% have heat recovery water heaters.
	T.S. Ventilation	Std. to H.E.	81.2%	Approximately 88.5% of small dairy farms have tie stall barns and 91.8% of small tie stall barns use ventilation fans.
LARGE DAIRY FARMS	T.S. Lighting	Inc. to Fluor.	33.6%	Approximately 33.6% of large dairy farms have tie stall barns.
	F.S. Lighting	MV to HPS	25.1%	Approximately 65.5% of large dairy farms have free stall barns and 38.3% of free stall barns use MV lighting.
	Milk Cooling	Pre-Coolers	100.0%	It is assumed that all large dairy farms are eligible for this option.
	T.S. Ventilation	Std. to H.E.	33.2%	Approximately 33.6% of large dairy farms have tie stall barns and 98.9% of large tie stall barns use ventilation fans.
LARGE DAIRY FARMS W/PARLORS***	Water Heating	Timer**	73.6%	Approximately 73.6% of large dairy farms w/milking parlors have electric water heaters.
		Heat Recovery	35.3%	Approximately 73.6% of large dairy farms w/milking parlors have electric water heaters and 52.1% have heat recovery water heaters.
	Milking	Dual Vacuum Pumps	100.0%	This option is limited to large dairy farms w/milking parlors. It is assumed that all large farms w/milking parlors are eligible.
LARGE DAIRY FARMS W/PIPELINES***	Water Heating	Timer**	76.9%	Approximately 76.9% of large dairy farms w/pipeline milking systems have electric water heaters.
		Heat Recovery	39.2%	Approximately 76.9% of large dairy farms w/pipeline milking systems

* Source: Eligible percentages were estimated based on farmstead surveys conducted by the Departments of Agricultural Economics and Agricultural and Biological Engineering at Cornell University, Ithaca, NY, 1987-1989. See the "Technology Segmentation Report" for specific references.

** The eligible percentages listed for water heating with timer are for the NMPC, RG&E, and CHG&E service areas only. In the NYSEG service area, 30% of the farm customers use controlled electric water heating, and the eligible percentages are: sm. dairy farms - 59.3%, lrg dairy w/parlor - 51.5%, and lrg. dairy w/pipeline - 53.8%.

*** Due to variations in hot water requirements, the eligible market for water heating on large dairy farms was segmented into farms with milking parlors and farms with pipeline milking systems.

in utility farmstead programs and invest in DSM technologies, but to maintain profitability and stay in business. What follows is a brief review of these market forces and their impact on the New York State farmstead sector.

- Economic Forces -- the economic environment is a major influencer in the health and stability of farmsteads. Utility planners must be aware of the economic trends and their consequences to the farming community in order to effectively design DSM programs that target this market sector. The importance of recent economic pressures facing the farmstead market and their effect on these customers is illustrated as follows:

  - An August 1988 State of New York Public Service Commission order directed utilities to develop and implement time-of-use (TOU) rates for their largest residential customers, which, in large part, meant farmers. The implementation of TOU rates starting in 1990 will have a direct impact on farmstead electric costs and their consequences.

  - The State of New York's increased concern about the use of pesticides has increased the expense of pesticide management. This has a direct economic impact on farmers and their ability to upgrade their equipment and invest in DSM technologies.

  - New York farmers pay, on average, $21.80 in taxes per $1,000 of assessed value of land, which is as high as many other states.[2] This situation also affects the economic stability of farmers, and may inhibit future farmstead migration.

  - During the 1980s, prices for many farm commodities were low. For example, milk prices during the 1980s either decreased or remained stagnant while farm expenses increased.[3] For farmsteads in upstate New York this has direct financial consequences, as over 50 percent of these farms are dairy.

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[2]Finger Lakes Times, "Commissioner Disputes Kuhl," State Senator Randy Kuhl, New York State Senate, December 18, 1989, p. 12.

[3]Associated Press, Finger Lake Times, "Farm Economy Looks Better," January 2, 1990, p. 12.

As a result of these economic forces (and others), approximately 4,500 New York farms went out of business between 1982 and 1987.[4] Prior to developing a farmstead DSM program, utilities should have a fundamental understanding of the salient economic forces impacting the farming community. Sources for this information include newspapers, New York Agriculture, New York Agricultural Statistical Service, the New York Public Service Commission, the federal government, and cooperative extensions.

- Technological Forces - In conjunction with economic forces, it is essential that utility maintain up-to-date information about the technological trends that have an impact on the farmstead sector. There are a range of electric end-uses utilized by farmers and, in addition, a range of DSM technologies that can be targeted at these end-uses. Figure III-2 details the major farmstead end-uses and commercially available DSM technologies applicable to each.

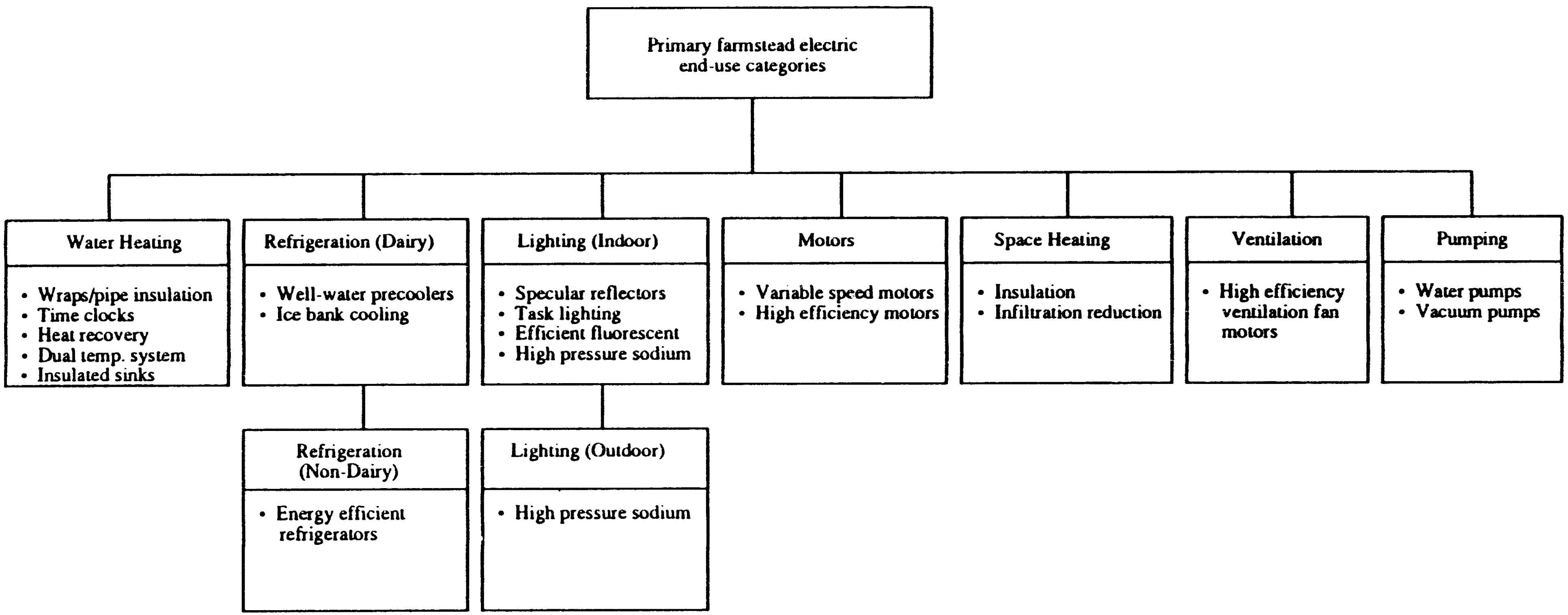
  The degree of DSM technology knowledge that utility representatives demonstrate is one of the most critical factors in the effectiveness of sales persons in the farmstead market. In particular, one should understand the relative benefits of farmstead DSM technology options for each end-use and position those options based on the problems and needs of the farmer. Sources of information for farmstead electric end-uses and DSM technologies include the following:

  - Utility reports (i.e., NYSEG, Northeast Utilities)
  - National Food and Energy Council
  - EPRI
  - EEI
  - Manufacturers' literature.

[4]Bureau of the Census, 1987 Census of Agriculture, Volume 1, Geographic Area Series, Part 32, New York State and County Data, U.S. Department of Commerce, Washington, DC, July 1989.

Figure III-2

FARMSTEAD ELECTRIC END-USE CATEGORIES AND APPLICABLE DSM TECHNOLOGIES



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3. Farmers' Needs, Preferences and Decision Criteria

Utilities that have information about farmers' decision-making processes, perceptions of program benefits and drawbacks, and preferences for programs and information sources, are in a better position to design programs to meet the needs of their farmstead sectors. This results in a greater likelihood of maximizing program participation. Focus groups and in-depth interviews are important marketing research tools to provide information and insight on farmers' needs and preferences. Although results of these qualitative studies are not statistically significant, they do help to identify desirable energy efficiency program design and marketing strategies. Benefits of qualitative market research over quantitative include greater speed, lower cost and better anecdotal information. This last point is particularly important in understanding the unique characteristics and needs of the farmstead market.

In addition to farmers' needs and preferences, it is necessary to discern the economic considerations facing farmers. In particular, a more complete understanding of the investment behavior and decision-making criteria of farmers is essential in gauging farmer interest in utility programs. Several variables are likely to be part of an investment decision including demographic factors (e.g., age, education level, etc.), firmographic descriptors (e.g., farm size, technological intensity, etc.) and psychographic constructs (such as attitudes towards energy management, degree of risk aversion). Not only is it important to identify investment behavior of farmers in general, but also to test investment behavior for each technology and examine if such behavior is actually technology specific. The use of quantitative techniques (such as simple payback analysis, choice modeling, etc.) may be used to verify the exact relationship between farmers' decision-making parameters and their actual investment behavior. This will help utility planners determine how changes in the economic and non-economic environment will affect the outcome of farmers' investment decisions.

4. Trade Ally/Dealer Activity

A critical set of participants in any farm marketing strategy are the relevant trade ally groups. Since local conditions are likely to vary, it is important for a utility to assess the current trade ally networks in their respective service areas. It should also be noted that the magnitude of each trade ally's potential impact varies in accordance with the type of service design (i.e., information, farm equipment sale, audit) and the type of farmstead in question (i.e., dairy, cash grain, etc.). The importance of trade allies -- farm equipment manufacturers and dealers, electrical contractors and engineers -- in the technical assistance and farmstead DSM technology marketing effort cannot be overstated. In the initial program design phase, utility planners must begin to formalize how they can best work with the trade ally community in leveraging resources and promoting energy efficiency.

An excellent method of obtaining both subjective and objective information from trade allies is through the use of primary market research -- focus groups, in-depth interviews (telephone and on-site) and surveys. Examples of the specific types of information utility planners can obtain from these allies are detailed in Table III-8.

As part of the New York State Farmstead Project, several interviews were conducted with area trade allies to discern some of this information.[5] The following illustrates some of the key findings:

- The most important factor influencing farmers' investments in conservation equipment is return on investment, or payback. Other primary factors include:
  - Failed equipment
  - Dollar savings on energy bill

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[5]Trade ally interview summaries can be found in a report completed earlier in this project entitled, New York State Farmstead Project Data Inventory Report.

Table III-8

TRADE ALLY SURVEY INFORMATION NEEDS FOR THE FARMSTEAD SECTOR

TRADE ALLY SURVEY INFORMATION
• Types of farmstead equipment and services provided • Equipment (and installation) costs • Typical size ranges • Typical efficiency levels • Average maintenance costs • Useful life expectancies • Cost premium for energy efficient equipment • Availability of high efficiency technologies • Percentage of customers purchasing energy efficient equipment • Significant industry trends • Farmers' investment criteria • Willingness to participate in utility-sponsored farmstead DSM programs • Suggestions for utility involvement

- Time and labor (productivity) savings.

- Rebates are effective. Trade allies confirm this type of incentive is the best way to entice farmers to replace their old equipment and invest in new equipment.

- There is a general lack of knowledge about conservation equipment, specific equipment energy consumption, and existing utility rebates.

- Farmers must have knowledgeable attention. One-on-one contact is the best way to reach farmers with any program.

- Milk cooling and ventilation systems currently offer the most potential for DSM programs.

Clearly, these are important pieces of information and should be considered in any farmstead DSM program design effort.

D. CHECKING/RECONCILING MARKET DATA

The approach presented above identifies a significant amount of planning and data gathering for program design. A basic response would be -- do I really need to undertake all the activities as stated? Unfortunately, there is no clear-cut answer to this question. Experience has shown that more market information and planning in the design stages results in a more effective marketing program that closely targets the available opportunities in the marketplace.

In amassing the plethora of farmstead market information, it becomes important to step back and take an "outsider's view" of the collected data. As mentioned in this chapter's overview, utility planners must try and identify which information is relevant and applicable to the design and development of a farmstead DSM program.

IV. IDENTIFICATION AND SCREENING OF TECHNOLOGY OPTIONS

IV. IDENTIFICATION AND SCREENING OF TECHNOLOGY OPTIONS

A. OVERVIEW

The inclusion of a technology identification and screening process is a critical element in farmstead DSM planning. The screening process is designed to permit a comprehensive assessment of all available options in a manner which focuses attention and resources only on those measures which are most reasonable and relevant. It is first based on looking at a wide range of DSM measures, then using a formalized judgmental approach, the options are prioritized based on their contributions to a predetermined set of evaluation criteria. This chapter discusses the approach used in identifying the options, and the development of a judgmental screening process.

B. IDENTIFICATION OF TECHNOLOGY OPTIONS

The first step in the screening process is the development of a comprehensive listing of DSM technology options for farmsteads. Given the range of electric end-uses that may be found on farms, the identification of DSM options covers nine end-use categories and a wide number of measures. Table IV-1 identifies the various electric end-uses. Table IV-2 presents a breakdown of specific DSM options for each end-use.

There are a number of sources that can be used to identify electric farm end-uses and related DSM measures. A listing of sources includes:

- Utility experience
- Cooperative extension agencies

Table IV-1

DEFINITION OF MAJOR END USES

- Water Heating - used by most farms, particularly in dairy operations for washing milk stalls, cow udders, and cleaning milk lines. Also used for egg and produce washing, general cleaning operations, and livestock sanitation.

- Refrigeration (Dairy) - used in dairy operations to cool new milk down to 45° as per state regulations.

- Refrigeration (Non-Dairy) - provides general refrigeration needs for non-dairy products including eggs, fruit and vegetables.

- Lighting (Indoors) - provides visibility needs for indoor lighting use in residences, barn and farm structures.

- Lighting (Outdoors) - used for worker and livestock safety and security. Also used to extend hours of farm operation into the nighttime and very early morning hours.

- Motors - electric motors are found on a range of farm equipment including haydryers, silo unloaders, produce sorters, packagers, mixers, elevators and feeders.

- Space Heating - used to keep workers, animals and plants warm to ensure productive capabilities. Includes both farm residences, greenhouses and active barns.

- Ventilation - measures are required to maintain a healthy and comfortable indoor environment including adequate air exchanges and air circulation.

- Pumping - used for dairy milking, water pumping systems, and field irrigation.

Table IV-2

Technologies Used on Farms by Farm Type

Cash Grain 011 **Field Crop 017** **General Crop 019**	**Vegetable 016** **Fruit/Nuts 021** **Horticulture 018**	**Livestock 021** **Animal Spec. 027** **General Animal 029**	**Dairy 024**	**Poultry 025**
Water Heater	Water Heater	Water Heater	Water Heater	Water Heater
Lights	Lights	Lights	Lights	Lights
Ventilation Sys.	Ventilation Sys.	Ventilation Sys.	Ventilation Sys.	Ventilation Sys.
Water Pump	Water Pump	Water Pump	Water Pump	Water Pump
Space Heater	Space Heater	Space Heater	Space Heater	Space Heater
Refrigerator/Cooler	Refrigerator/Cooler	Refrigerator/Cooler	Refrigerator/Cooler	Refrigerator/Cooler
Silo Unloader		Silo Unloader	Silo Unloader	
Silage Blower		Silage Blower	Silage Blower	
Auger/Elevator		Auger/Elevator	Auger/Elevator	
Roller Mill		Roller Mill	Roller Mill	
Hay Dryer		Hay Dryer	Hay Dryer	
Grain Dryer		Grain Dryer	Grain Dryer	
	Sorter		Milking Machine	Egg Gatherer
	Washer		Milk Tank-Cooler	Egg Grader
	Unloader		Vacuum Pump	Egg Washer
	Bagger		Milk Transfer Pump	Egg Cooler
		Gutter Cleaner	Gutter Cleaner	
		Alley Scraper	Alley Scraper	
		Manure Mixer	Manure Mixer	Manure Mixer
		Stacker	Stacker	Stacker
		Ram Pump	Ram Pump	Ram Pump
		Unloading Pump	Unloading Pump	Unloading Pump

- Industry reports including EPRI's report on "Demand-Side Management for Rural Electric Systems."

As part of the New York State study, a total of 50 farmstead DSM options were identified and ultimately screened. The options reflect the local farm environment, and as such there may be additional measures which may apply to farms outside of New York. The listing provided in this study can serve as a starting point for any utility looking to identify farmstead DSM options.

C. DEVELOPING THE SCREENING APPROACH

The screening approach is designed to judgmentally evaluate the universe of DSM farmstead options as a means of prioritizing their impacts and benefits. This approach reflects the finite resources (financial and labor) utilities have and the need to efficiently focus them on those options which are most beneficial. An overview of the process is shown on Table IV-3.

One of the critical steps in the screening process is the identification and ranking of evaluation criteria (steps 3 and 4). This effort requires a collective agreement on the criteria or factors, against which each DSM farmstead option can be evaluated. This is likely to vary among utilities and study teams depending on their distinct objectives. In the case of New York State, the following criteria were used:

- Magnitude of Load Impacts - those options which provide significant annual energy and demand impacts are ranked higher than optional which have seasonal or modest impacts.

- Data Availability - measures which have reliable data detailing their unit impacts are ranked higher than options which have little load data.

Table IV-3

STEPS IN THE JUDGMENTAL SCREENING PROCESS

STEP 1. Identification of Utility Objectives - The first step is the identification of the objectives of the utility and study participants. This will ensure that the DSM options and evaluation approach are "grounded" and consistent with the identified direction of the participants.

STEP 2. Identification of DSM Technology Options - One advantage of the judgmental screening is the ability to intuitively evaluate a large number of options. The development of these options may be based on a number of sources including: utility experience, cooperative extension agencies, trade allies, or secondary data.

STEP 3. Development of Judgmental Screening Evaluation Criteria - In order to evaluate DSM farmstead options, a set of screening criteria must be developed. The criteria typically include both objective and subjective considerations, in an effort to evaluate options using a wide range of factors. The key consideration is the need to be explicit in detailing criteria and how they should be interpreted in the evaluation process. Optimally, each criterion should be posed in a question format regarding its compatibility to the DSM options being evaluated (eg., How consistent is this technology option with load shape objectives?)

STEP 4. Development of Criteria Weights and Scoring Guidelines - Each of the determined evaluation criteria must be given a weighting factor based on its relative importance and/or degree of impact in the evaluation process. Those criterion which are viewed as having a larger impact should be ranked higher than criterion perceived as being less important. This technique provides an additional manner to distinguish technology options. The development of detailed scoring guidelines must also be completed. This may be based on providing a plus or minus symbol (as used in the case of New York) or even actual scores (such as on a scale of 1 (least impact) to 5 (greatest impact). These guidelines should provide the necessary reference for scoring based on its impact to the selected evaluation criteria.

STEP 5. Conduct Judgmental Screening - The actual screening exercise is conducted on a matrix which aligns the evaluation criteria (X axis) with each of the predetermined DSM technology options (Y Axis). This design permits the ability to evaluate each technology option on the basis of its impact on the appropriate criterion objective. The procedure for scoring is based on multiplying the rank score in each cell, by the appropriate criteria weighting factor. This product is summed across the matrix providing a total score for each option.

STEP 6. Development of Prioritized List of DSM Options - The results of the screening exercise will provide a total score for each technology option. This will permit the ranking of technology options based on their score. This prioritized list should serve as input into a subsequent analysis step, once the more formal economic and technical assessments are completed.

- Market Size - options which have greater applicability and can potentially impact a large number of farms is viewed as being more attractive than options which have limited applicability.

- Coincident Peak Impacts - measures which produce significant utility system peak demand reductions are favored over options which result in small or modest peak demand impacts.

It should be noted that a key concern is gaining consensus on a manageable set of criteria to facilitate ease of conducting the screening process and eliminate confusion stemming from too many (and perhaps redundant or conflicting) criteria. It should also be noted that the criteria listing used in the New York State case is not exhaustive. There are numerous additional criteria that may be considered, based on project objectives and the local farmstead environment. For example, additional criteria may include the following:

- Measure lifetime
- Customer lifestyle/business operations impact
- Load shape impact
- Technology cost
- Revenue loss impact
- Free rider potential.

The actual scoring system used in screening technology options may vary. In the case of New York State, a system of pluses (indicating the screening criterion was substantially satisfied by the technology) minuses (reflecting criterion which were not satisfied by the technology) and question marks (reflecting uncertain level of criterion satisfaction) were used. One may also use a number-based scoring scheme; for example, a scoring scheme based on a scale of one (little criterion satisfaction) to five (significant criterion satisfaction). This approach will result in an actual score that can be developed to prioritize options.

D. INTERPRETING AND EXPANDING THE RESULTS OF THE TECHNOLOGY SCREENING PROCESS

Although there is a lot of flexibility in designing the screening process, the end product from any approach must result in prioritizing farmstead options. This permits greater focus only on those measures that make the most sense. The results of the screening in the New York example are shown on Table IV-4.

A review of these results points to a number of salient measures to be considered for more detailed evaluation:

- Lighting - the lighting option that results in replacing incandescent lamps, provides significant, annual load reduction, is commercially available, and provides reliable end use results. In contrast, upgrading existing fluorescent lamps has minimal market impact and low annual energy savings.

- Milk Cooling - the use of pre-cooling milk provides year-round load reductions on dairy farms and is a fairly reliable technology. Lack of data and widespread commercial availability limits the use of thermal storage as a measure for milk cooling.

- Ventilation - the estimated market and load reduction (energy and demand) impact of energy-efficient ventilation fans and motors, in combination with data and availability in the market, results in selecting this measure for more detailed analysis. In contrast, measures such as curtain walls or adjustable speed drives do not appear to have the same data documentation or general applicability.

- Milking - the use of high-efficiency motors and dual vacuum pumps has significant load impact, available data and is commercially available for the largest farm market-dairy farms.

- Water Heating - the impact of water heating measures, particularly time clock and heat recovery options can be significant from a load

FARMSTEAD TECHNOLOGY SELECTION MATRIX

Processes	End-Use	Technology Unit	Base Technology	DSM Technology	CRITERIA #1	#2	#3	#4	#5	Selected Y/N
Lighting	Lighting	Lamp/Luminaire								
		Indoor	Incandescent	Compact Fluorescent	+	+	+	+	+	Y
				Fluorescent	+	+	+	+	+	Y
			Mercury Vapor	HPS	+	+	+	+	+	Y
			Standard Fluorescent	High Efficiency Fluorescent Lamps	+	+	+	-	+	N
				High Efficiency Ballasts	-	-	+	+	+	N
		Outdoor	Incandescent	PL Floods (Fluorescent)	+	+	+	+	-	Y
			Mercury Vapor	HPS	+	+	+	+	-	Y
Process Refrig.	Milk Cooling	Refrig. System	Direct Expansion	Precooling						
				Water Cooled	+	+	+	+	+	Y
				Air Cooled	+	-	-	+	+	N
				Thermal Storage						
				Ice Bank	+	-	+	?	+	N
				Winter Cold	+	-	-	+	+	N
		Condenser	Air Cooled	Water Cooled	+	-	+	+	+	N
	Fruit/Veg. Cooling	Refrig. System	Direct Expansion	Thermal Storage ("Iceberg")	+	-	-	-	+	N
		Condenser	Air Cooled	Water Cooled	-	-	+	-	+	N
		Evaporator Fan/Motor	Continuous Operation	Motor Cycling	+	-	+	-	+	N

The screening criteria are:

#1 - Large energy/load
#2 - Availability of load data
#3 - Commercially available
#4 - Applicable on a large number of farms
#5 - Loads coincident with system peaks

FARMSTEAD TECHNOLOGY SELECTION MATRIX

Processes	End-Use	Technology Unit	Base Technology	DSM Technology	CRITERIA #1	#2	#3	#4	#5	Selected Y/N
Water Htg.	Water Htg.	Water Heater	Standard	Time Clock	+	+	+	+	+	Y
			Electric	Heat Recovery	+	+	+	+	+	Y
			Water Heater	High Efficiency	+	-	+	+	+	N
				Pipe Insulation	-	-	+	+	+	N
				Heat Trap	+	-	+	+	+	N
				Dual Temp. Heaters	+	-	+	+	+	N
				Hot Water Cons.	+	-	+	+	+	N
				Insulated Sinks	+	-	+	+	+	N
Moving Air	Ventilation	Fan/Motor Sys.	Standard	High Eff. Fan Sys.	+	+	+	+	+	Y
				ASD	+	-	-	+	+	N
				Curtain Wall	+	-	+	-	+	N
	Circulation	Fan/Motor Sys.	Standard	High Eff. Fan Sys.	-	+	+	-	+	N
				Curtain Wall	-	+	+	-	+	N
Milking	Milking	Vacuum Pump Motor	Standard	High Eff. Motor	+	+	+	-	+	N
				Dual Vacuum Pumps	+	+	+	-	+	Y
				Dual Vacuum/ASD	+	+	-	+	+	N
		Compressor Motor	Standard	High Efficiency	+	-	+	+	+	N
Space Htg.	Space Htg.	Electric Heaters	Standard	Thermal Storage						
			Electric	Bricks/Stone	+	-	+	-	+	N
			Space Heaters	Sand/Earth	+	-	+	-	+	N
				Water	+	-	+	-	+	N
				Heat Recovery	+	-	+	-	+	N

The screening criteria are:

#1 - Large energy/load
#2 - Availability of load data
#3 - Commercially available
#4 - Applicable on a large number of farms
#5 - Loads coincident with system peaks

FARMSTEAD TECHNOLOGY SELECTION MATRIX

Processes	End-Use	Technology Unit	Base Technology	DSM Technology	CRITERIA #1	#2	#3	#4	#5	Selected Y/N
Feed/Crop Handling	Motor	Silo Unloader Grain elevator	Standard Motor	High Efficiency Motor	+	-	+	+	?	N
		Hammer Mill Roller Mill	Standard Motor	High Efficiency Motor	+	-	+	-	?	N
		Hay Dryer Grain Dryer	Standard Motor	High Efficiency Motor	+	-	+	-	?	N
Manure Handling	Motor	Gutter Cleaner	Standard Motor	High Efficiency Motor	+	-	+	+	?	N
		Manure Mixer Ram Pump Manure Pump	Standard Motor	High Efficiency Motor	+	-	+	-	?	N
Egg Handling	Motor	Egg Gatherer Egg Grader	Standard Motor	High Efficiency Motor	+	-	-	-	?	N
		Sorter Washer	Standard Motor	High Efficiency Motor	+	-	-	-	?	N
Engine Block Heating	Engine Block Heating	Engine Block Heaters	Continuous /On-Demand	Time Clock	-	-	+	+	-	N
				Outdoor Temp. Control	-	-	+	+	-	N
Battery Charging	Battery Charging	Chargers	On-Demand	Time Clock	-	-	+	-	-	N

The screening criteria are:

#1 - Large energy/load
#2 - Availability of load data
#3 - Commercially available
#4 - Applicable on a large number of farms
#5 - Loads coincident with system peaks

shifting and market potential standpoint. In contrast, the lack of reliable load shape data for the remaining water heating options resulted in making some of these options less attractive.

E. TECHNOLOGY BRIEFS

Once the Screening Matrix has been applied and DSM options qualified, the development of Technology Briefs represents an important step in DSM option development. To this stage technology information has been driven by rough approximations and assumptions. As detailed work on the energy and demand impacts of the qualified technologies proceeds the Technology Brief provides the technical specifications and marketing and behavioral issues and factors associated with various DSM options.

Examples of Technology Briefs on farmstead ventilation and outdoor lighting are contained in Appendix A.

V. DEVELOPMENT AND LINKAGE OF PROGRAM ELEMENTS

V. DEVELOPMENT AND LINKAGE OF PROGRAM ELEMENTS

A. OVERVIEW

An inclusive assessment of farmstead DSM technology options involves the development of data and assumptions regarding program concept design. The objective behind the development of program concepts is the need to align program elements to the selected technologies to provide a means of economic comparison. The primary focus of this analysis is the identification of load characteristics, market segment/acceptance data and the accurate costing for each program component. It should be noted that the development of program concepts is part of an iterative process that allows for a realistic comparison of demand-side options to alternative supply-side options (the marginal costs of supply). This chapter presents a framework for developing farmstead DSM program concepts and linking the data elements required for such an analysis. The program concepts completed as part of the New York farmstead project are provided as examples.

B. LINKING TECHNOLOGIES TO PROGRAM ELEMENTS

As a result of the identification and screening of agricultural DSM technology options, the utility planner is in a position to identify those technologies that warrant more detailed analyses. More specifically, it becomes essential to begin to estimate load impact characteristics, eligible market sizes, market acceptance, and strategies. These specifications vary not only across technologies, but also across utilities and, thus, the importance lies in focusing on the unique market situation.

A number of elements must be addressed to link program elements to specific technologies. These include the identification of the following:

- Base and DSM technologies
- Relevant market segments
- Load characteristics (energy, capacity)
- Eligible market acceptance data
- Incentive types and levels
- Fixed and variable program costs.

Figure V-1 presents examples of the above elements specific for the farmstead sector. These types of information facilitate the analysis of farmstead DSM technologies' cost effectiveness and market penetration. The actual analysis techniques of agricultural DSM programs are detailed in Chapter VI. What follows is a review of the various program concept requirements.

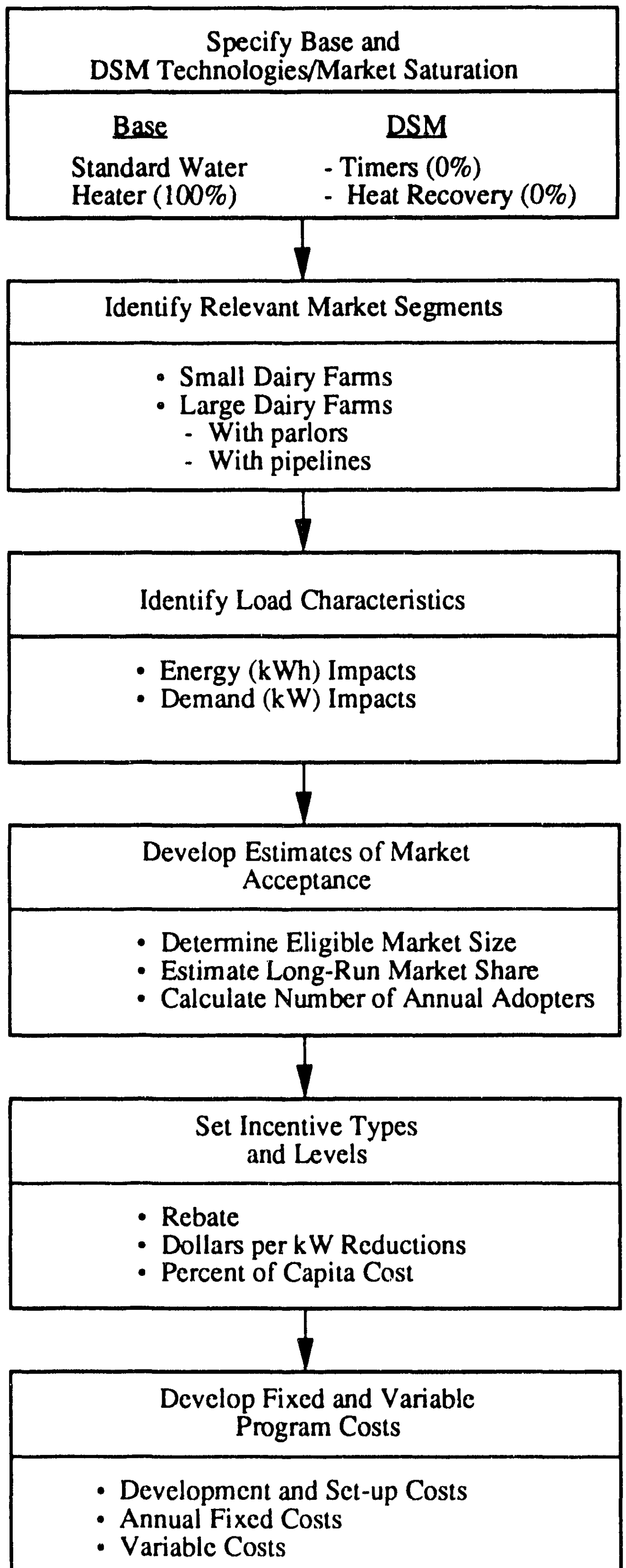
C. MARKET SEGMENTS AND ELIGIBLE MARKET

While market segments presented in Section III and the screening of DSM technologies were presented in Section IV, this is not to imply that the process occurs in this order. Rather, it should be noted that the definition of market segments and the screening of DSM options are most practically completed simultaneously.

The result of these combined tasks are quantified market size estimates of a qualified set of technologies based on market and technological factors focused on important DSM

Figure V-1

FRAMEWORK FOR LINKING FARMSTEAD DSM PROGRAM ELEMENTS



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strategies. From this point, a justification for detailed load shape and technology costing work is established.

Defining the market size involves estimating the number of farmstead customers that will be considering new, replacement, and early retrofit investments in each year. To develop these estimates a stock accounting model can be used. The major data requirements for the stock accounting model include size of farmstead customer base, growth rate, demolition rate, equipment lifetime (or retirement rate) and percent of existing, non-retiring installations where early retrofit will be considered (retrofit fraction). Much of this information can be obtained through market research and/or program evaluation data. In cases where such data is unavailable an explicit judgmental assumption should be used.

D. IDENTIFICATION OF LOAD CHARACTERISTICS

A key component in the development of farmstead program concepts is the need to estimate the energy and demand profiles for each pair of base and DSM technologies. This information should be identified for each season (i.e., summer, winter) and period (i.e., on-peak, off-peak, partial-peak). Energy use is defined by kWh/unit for each season and period, while demand should be the maximum diversified demand during those times. With these estimates, the utility planner is in a position to quantify the load impacts associated with the adoption of each farmstead DSM technology.

1. Energy and Demand Impact Data

Impact data can be derived by any of a number of techniques:

- Engineering estimation

- Engineering simulation
- Billing analysis
- Load research.

Each approach has its advantages, but are frequently used in combination with another to compensate for the weakness of a pure approach. Each technique is briefly described below:

- Engineering estimation use algorithms derived from scientific equations. Simplifications of formula developed by ASHRAE[1] and other research and professional societies are sources often used by the utility industry.
- Engineering simulation also use engineering algorithms but attempt to represent a building or energy system in a comprehensive way that recognizes all the interactive and/or feedback effects of an energy conservation action.
- Billing analysis is a statistical approach to energy and demand estimation which attempts to explain an observed impact or change in customer bills while accounting for extraneous changes in customer facilities, behavior, etc., which may obscure the estimate.
- Load research is an activity which involves the collection of metered data from a sample of program participants before and after a measure is installed.

2. Load Shapes

As documented in the Farmstead DSM Technologies Report, the energy and demand impacts of farmstead technologies were either derived in one of four ways:

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[1]ASHRAE stands for the American Society of Heating, Refrigeration, and Air Conditioning Engineers, Atlanta, Georgia.

- Load research

- Engineering simulations

- A combination of engineering estimates used to adjust load shapes developed from load research

- A combination of engineering simulations used to adjust load shapes developed from load research.

All energy and demand impacts were expressed in terms of base and DSM 36-day load shapes. Figure V-2 illustrates how the load shapes were developed in setting up the analysis of DSM options. As an example, Tables V-1 and V-2 provide the specifications for a poultry farm lighting DSM option which replaces incandescent lighting in a poultry house with compact fluorescent bulbs. Figure V-3 shows the base and DSM (fluorescent) lighting technologies (incandescent) superimposed on one another for an average weekday in July.

E. THE COST OF DSM OPTIONS

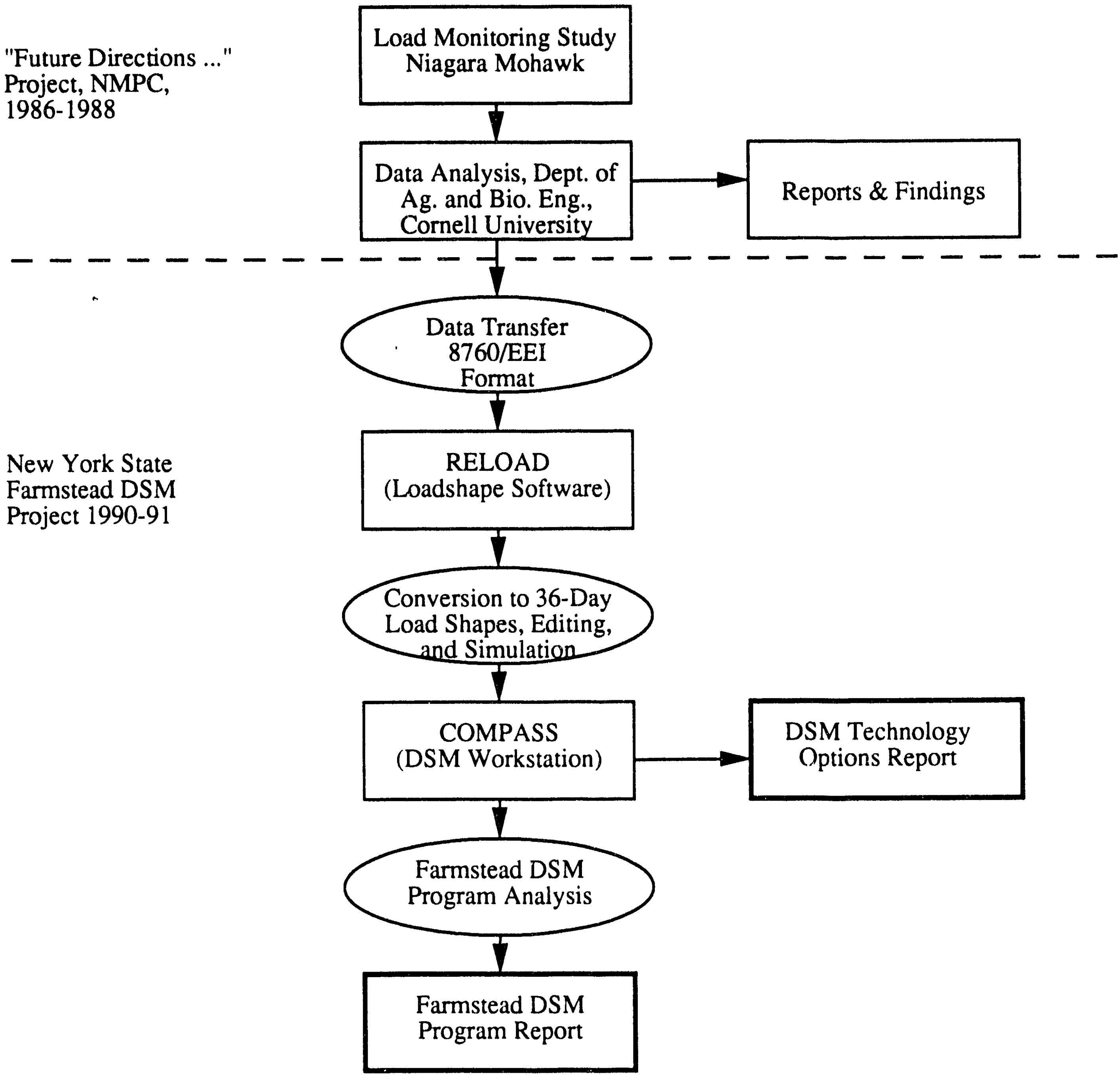
1. Types of Costs

The cost of DSM options are the costs incurred by farmers for the purchase, installation and maintenance of standard (base) and high efficiency (DSM) technologies. These costs were estimated for all options using product literature and catalogues, and discussions with equipment suppliers and agricultural engineering specialists. Technology costs are comprised of the following components:

- **Capital Costs** — Costs incurred by the farmer if they were to purchase the technology at the retail level.

Figure V-2

PROCEDURE FOR DEVELOPMENT OF FARMSTEAD LOAD SHAPES



[1] Niagara Mohawk Power Corporation, "Future Directions ...", Syracuse, NY 1986-88
[2] Dept. of Agricultural and Biological Engineering, "Future Directions ...", Cornell University, Ithaca, NY
[3] Electric Power Research Institute, RELOAD, developed for EPRI by Synergic Resources Corp., Palo Alto, CA 1987-88
[4] Synergic Resources Corporation, COMPASS , Version 1.3, Bala Cynwyd, PA 1991

Table V-1

Agriculture Poultry Farms, Niagara Mohawk Power Corp
End use: Lighting, Vintage: Existing
Technology Option: Pltry Barn Lighting, Inc

Season	Demand (KW) On	Demand (KW) Off	Demand (KW) Partial	Energy (MWh) On	Energy (MWh) Off	Energy (MWh) Partial
WINTER	3.74	3.47	3.59	3.48	1.86	1.10
SUMMER	4.95	3.15	3.82	2.62	1.23	0.47
SPRING	3.79	3.44	3.56	1.43	0.63	0.34
FALL	3.51	3.24	3.43	0.81	0.33	0.22

Month	Demand (KW) On	Demand (KW) Off	Demand (KW) Partial	Maximum Demand	Energy (MWh) On	Energy (MWh) Off	Energy (MWh) Partial	Total Energy
January	3.74	3.25	3.49	3.74	0.76	0.34	0.25	1.36
February	3.62	3.40	3.59	3.62	0.68	0.36	0.23	1.26
March	3.72	3.47	3.45	3.72	0.72	0.44	0.20	1.36
April	3.79	3.44	3.56	3.79	0.76	0.34	0.20	1.29
May	3.29	3.17	2.36	3.29	0.67	0.29	0.14	1.10
June	3.40	3.11	1.34	3.40	0.50	0.29	0.09	0.87
July	3.40	2.96	1.34	3.40	0.60	0.27	0.12	0.98
August	4.95	2.97	1.79	4.95	0.80	0.30	0.11	1.22
September	3.35	3.15	3.82	3.82	0.73	0.38	0.16	1.26
October	3.51	3.24	3.43	3.51	0.81	0.33	0.22	1.36
November	3.05	3.05	3.05	3.05	0.64	0.36	0.20	1.20
December	3.05	3.05	3.05	3.05	0.68	0.36	0.21	1.25
Annual	4.95	3.47	3.82	4.95	8.33	4.05	2.13	14.51

Month	System Peak Hour	Coincidence Factors	Load Factors
January	18	0.3896	0.4870
February	18	0.3043	0.5180
March	18	0.2920	0.4921
April	14	0.2781	0.4736
May	14	0.2801	0.4478
June	14	0.2844	0.3574
July	15	0.2832	0.3887
August	14	1.0000	0.3302
September	14	0.8643	0.4582
October	15	0.2798	0.5216
November	18	0.3750	0.5488
December	18	0.5000	0.5521
Annual	-----	0.2948	0.3350

Table V-2

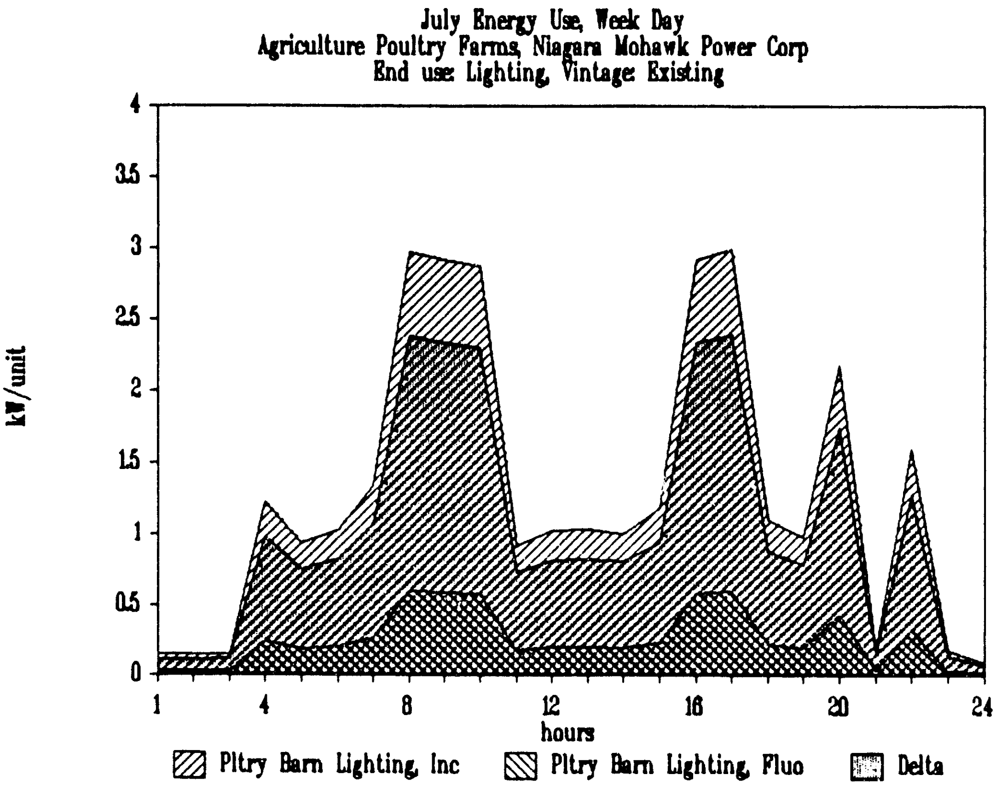
Agriculture Poultry Farms, Niagara Mohawk Power Corp
End use: Lighting, Vintage: Existing
Technology Option: Pltry Barn Lighting, Fluo

Season	Demand (KW) On	Demand (KW) Off	Demand (KW) Partial	Energy (KWh) On	Energy (KWh) Off	Energy (KWh) Partial
WINTER	0.75	0.69	0.72	694.34	371.38	218.96
SUMMER	0.99	0.63	0.76	524.32	246.39	94.69
SPRING	0.76	0.69	0.71	284.79	125.26	67.24
FALL	0.70	0.65	0.69	161.02	66.71	44.40

Month	Demand (KW) On	Demand (KW) Off	Demand (KW) Partial	Maximum Demand	Energy (KWh) On	Energy (KWh) Off	Energy (KWh) Partial	Total Energy
January	0.75	0.65	0.70	0.75	151.81	68.39	50.75	270.95
February	0.72	0.68	0.72	0.72	135.33	71.01	45.23	251.57
March	0.74	0.69	0.69	0.74	143.26	87.62	40.92	271.80
April	0.76	0.69	0.71	0.76	151.37	68.00	38.96	258.33
May	0.66	0.63	0.47	0.66	133.43	57.25	28.28	218.96
June	0.68	0.62	0.27	0.68	99.79	57.57	17.42	174.78
July	0.68	0.59	0.27	0.68	119.16	53.40	23.89	196.45
August	0.99	0.59	0.36	0.99	160.01	60.43	22.31	242.76
September	0.67	0.63	0.76	0.76	145.36	74.98	31.07	251.41
October	0.70	0.65	0.69	0.70	161.02	66.71	44.40	272.13
November	0.61	0.61	0.61	0.61	128.40	71.79	40.23	240.42
December	0.61	0.61	0.61	0.61	135.54	72.56	41.83	249.94
Annual	0.99	0.69	0.76	0.99	1664.4	809.74	425.29	2899.5

Month	System Peak Hour	Coincidence Factors	Load Factors
January	18	0.3896	0.4870
February	18	0.3043	0.5180
March	18	0.2920	0.4921
April	14	0.2781	0.4736
May	14	0.2801	0.4478
June	14	0.2844	0.3574
July	15	0.2832	0.3887
August	14	1.0000	0.3302
September	14	0.8643	0.4582
October	15	0.2798	0.5216
November	18	0.3750	0.5488
December	18	0.5000	0.5521
Annual	-----	0.2948	0.3350

Figure V-3



July Energy Use, Week Day
Agriculture Poultry Farms, Niagara Mohawk Power Corp
End use: Lighting, Vintage: Existing
kW/unit
4
3.5
3
2.5
2
1.5
1
0.5
0
1
4
8
12
16
20
24
hours
Pltry Barn Lighting, Inc
Pltry Barn Lighting, Fluo
Delta

- **Installation Labor Costs** — Out-of-pocket expenses incurred by the farmer when the technology is installed by a contractor. Technologies that are installed by the farmer were assumed to have no installation costs.

- **Maintenance Costs** — Maintenance costs were estimated for all lighting options. These costs reflect the annual cost of replacing lamps and ballasts over the useful life of the light fixture[2]. Maintenance cost estimates were not developed for milk cooling, water heating, ventilation and milking technology options. For these options, it was assumed that maintenance is an aspect of a farmer's daily work routine which does not require significant and/or quantifiable annual out-of-pocket expenditures.

All cost estimates were developed on a per farm basis. For instance, the analysis for indoor lighting on poultry farms was based on the assumption that there are 200, 40-watt incandescent light bulbs in the average poultry house in upstate New York[3]. The per bulb cost estimates for both base (existing incandescent bulbs) and DSM (compact fluorescent screw-in bulbs) lighting technologies were multiplied by 200 to estimate the total capital cost of the measure for the average poultry farm.

2. Type of Market - Retrofit vs. Replacement

The farmstead DSM analysis identified 19 technology options for promotion to farmstead customers. The DSM programs selected for implementation by the utilities can apply to new or existing customers, and address either the replacement or the retrofit market. When a DSM program is run as a **replacement** program, only that equipment which is due for retirement on a normal replacement cycle (with or without the utility-sponsored program in place) is eligible for participation in the program. In this situation, the DSM technology is being substituted for the base technology and, as a result, the difference in cost between

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[2]A 20-year useful life was assumed for all light fixtures.

[3]The average size poultry farm was assumed to have approximately 27,000 layers. New York State Agricultural Statistics Service, et.al., New York State Agricultural Statistics, 1988-1989, Albany, NY, July 1989.

the base and DSM technologies (the incremental cost of the DSM technology) is included in the analysis. The replacement market includes all lighting, ventilation, and milking options.

In a **retrofit** program, all customer equipment is considered eligible for participation in the program. In the retrofit case, the customer is either adding a measure or technology to the existing base technology, or replacing the existing equipment before that equipment has reached the end of its expected service life (early retirement). In this case, the analysis includes the entire capital and installation costs of the DSM measure that is borne by the customer. The retrofit market includes milk cooling and water heating options.

3. Documentation of Technology Costs

- **Farmstead Lighting**

Seven lighting options were selected for evaluation including: general outdoor and security lighting, indoor lighting on poultry farms, and indoor lighting on small and large dairy farms with tie stall barns and on small and large dairy farms with free stall barns. With one exception, capital costs were taken directly from the Granger General Catalog[4]. All lighting installation labor costs were provided by an upstate New York farm equipment

[4]W.W. Granger, Inc., Granger General Catalog, No. 379, 1991. The capital cost of the 13 watt compact fluorescent floodlight was obtained from Mr. James Flood, Sales Representative, Empire Agri Systems, Inc., Auburn, NY. Telephone communication 4/91.

dealer[5] and maintenance costs were estimated based on the annual cost of replacing lamps and ballasts at the end of their rated life.

- **Milk Cooling**

Milk pre-coolers are installed in the pipeline of an existing bulk tank milk cooling system. Because milk pre-cooling is a retrofit application, the base technology costs are zero and the entire capital and installation labor costs of the DSM measure are included in the analysis. The cost of milk pre-cooling on small and large dairy farms were obtained from agricultural researchers at Cornell University and by consulting with two large upstate farm equipment dealers[6].

- **Water Heating**

For the farmstead water heating option, the base technology was assumed to be an existing 80 or 120 gallon electric water heater, and the retrofit DSM technologies are controlled electric water heating and heat recovery water heating. Capital and installation labor costs were estimated using data obtained from the Agricultural DSM Water Heating Program at NYSEG[7]. A summary of the cost data for controlled water heating and heat

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[5]Fixture installation was assumed to cost $75 per fixture for one fixture, $62.50 per fixture for two and ten fixtures, and $50 per fixture for eleven or more. These costs were based on a telephone communication with Ross Primer, C&R Electric, Inc., Earlville, NY., 4/91. The relamping of incandescent lights with compact fluorescent screw-in type bulbs was assumed to be self-installed.

[6]The cost estimates were provided by Roger Pellerin and Ginny Farmer, Department of Agricultural and Biological Engineering, Cornell University, Ithaca, NY, 4/91 and were confirmed in telephone communications with Chuck Olin, Partner, Charles Olin & Sons, Elmira, NY., and Rick Beck, Manager, Don Beck, Inc., Corfu, NY, 4/91.

[7]New York State Electric & Gas Corporation, Agricultural DSM Water Heating Program, Binghamton, NY, 3/91.

recovery water heating are shown in Appendix B. The heat recovery cost estimates were compared to estimates provided by two large upstate farm equipment dealers to verify their accuracy.[8]

- **Ventilation**

The DSM option for ventilation on farms consists of replacing standard ventilation fans with high efficiency ventilation fans. Installation labor costs were assumed to be the same for both the standard fan and the high efficiency unit. The base technology's capital cost reflects the cost of a standard efficiency fan system obtained from the 1990 Grangers Catalog[9]. The capital costs for the DSM technology were estimated using data obtained from the Agricultural DSM Ventilation Program at NYSEG[10]. A summary of the cost data for 42 high efficiency fans installed on 7 upstate farms in 1990 are shown in Appendix C. The estimated cost per fan for the DSM technology was multiplied by a smaller number of fans per farm because in installations with multiple fans fewer high efficiency fans are required to provide the same amount of ventilation as standard fans.

- **Milking**

The application of dual vacuum pump milking systems is limited to large dairy farms that use milking parlors. Installation of a dual vacuum pump milking system in place of a single vacuum pump system is a replacement option. The estimated capital and installation

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[8]Confirmation of the reasonableness of the cost estimates were obtained in telephone communications with Chuck Olin, Partner, Charles Olin & Sons, Elmira, NY, and Rick Beck, Manager, Don Beck, Inc., Corfu, NY, 4/91.

[9]W.W. Grainger, Inc., Grainger General Catalog, No. 379, p. 1963, 1991.

[10]New York State Electric & Gas Corporation, Agricultural DSM Ventilation Program, Binghamton, NY, 3/91.

labor costs of the base and DSM technologies were provided by Dr. Stan Weeks and an upstate farm equipment sales representative[11].

F. PROGRAM COSTS AND INCENTIVES

1. Program Costs

There are several types of costs that should be identified and estimated as part of DSM program concept development and analysis. The first concern is the need to develop costs of designing, implementing and evaluating each program. It should be noted that although this procedure requires estimates and assumptions regarding staffing requirements, equipment costs, marketing costs, etc., the importance lies in providing benchmarks against which the benefits of the concepts can be evaluated. A review of the various cost categories follows:

- Development and setup cost is a one-time expense to the utility, which occurs in the first year of the program. Examples of this cost category include staff labor for program design, establishing trade ally roles and initial advertising design expenses.
- Annual fixed cost is considered a cost to the utility for each year of the program (including the first year). This includes expenses such as full-time staff devoted to on-going implementation of the program or part-time spent by regular employees.
- One-time variable costs are those incurred for each number of farms, unit of program adoption. For example, if the unit being used is this

[11]Dr. Weeks, Director of Farm Systems Research and Applied Technology, Agway, Inc., Syracuse, NY, has performed extensive research on the dual vacuum pump milking system at Agway's Experimental Farm in Tully, NY. Base and DSM equipment and labor cost estimates were provided by Mr. Gary Hatfie'd, Farm Systems Sales Representative, Agway, Inc., Auburn, NY, 4/91.

expense should be specified per unit. An example of a one-time variable cost is the time necessary to process a rebate or install a new device or inspect an qualifying installation.

These cost categories should have escalators applied to facilitate projections of costs into the future. This may be difficult to develop but is necessary to assess the total costs and benefits of DSM over the span of a planning horizon.

2. Incentive Types/Levels

In designing farmstead DSM program concepts, a variety of incentive structures are available. A description of each follows:

- Rebate - This is a fixed, one-time rebate to a new adopter (per unit). This value is subtracted from the customer's incremental first-year cost.
- $/kW - This is a one-time rebate to new adopters based on the peak demand reduction in the first year.
- Percent of Capital Cost - This is a one-time rebate based on the incremental first-year cost to the customer. For retrofit market types, the entire cost of the DSM technology is used; for replacement markets, only the difference in the cost of the two technologies is used.
- Cents/kWh - This is an annual payment to the customer based on the energy savings in that year.
- Bill Credit - This is a fixed annual payment to the customer (per unit).
- Payback - This is a one-time, first-year rebate designed to equate to a pre-specified payback.

The development of incentive levels to help in marketing farmstead DSM technologies should take into consideration short-run net marginal supply costs, market experience, equity in the distribution of benefits and benefit-cost results. It should be noted that, as with program costs, incentive types should have an escalator associated with them, in order to account for inflationary effects.

G. MARKET PENETRATION

Once detailed energy and demand impact estimates are available for the DSM options identified, technology costs estimated, and the size of each market quantified, the development of an estimation of the market penetration of the technologies can be attempted. More specifically, this can involve using market penetration (diffusion of the technology options) to estimate participation. Although there is a significant amount of uncertainty surrounding this type of analysis, the inclusion of primary market research[12] with farmstead customers can help to assess realistic market acceptance of farmstead DSM programs.

Although there are many techniques used for forecasting market penetration or diffusion the description of one approach will provide some insight into the technique and the challenging market research problem it presents. The approach used in this project and perfected in DSM applications by SRC decomposes the problem into two major steps:

- Estimation of the long-run market share (LRMS)
- Development of a time path for market penetration toward the LRMS.

[12]A review of the importance and benefits of market research is detailed in Chapter III, "The Need for Market Information," of this Guidebook.

This approach has been adapted and incorporated in the COMPASS[13] Model which was used to conduct the analysis for this project.

Figure V-4 provides a general framework for forecasting the market penetration of farmstead DSM technologies once the market sizes and specifications have been quantified. A discussion of the two step process is presented in the next sections.

1. Long-Run Market Share

The long-run market share for a DSM measure can be regarded as a function of the attractiveness of the technology to utility customers and customers willingness to invest in the technology. This is dependent on many factors, a number of which cannot be easily captured in a model. Methods of estimating these parameters range from simple analogy to complex multi-attribute models. The Farmstead project estimated long-run market share using payback acceptance curves developed from the market research described in the Farmstead Investment Behavior Report (Report No. 4).

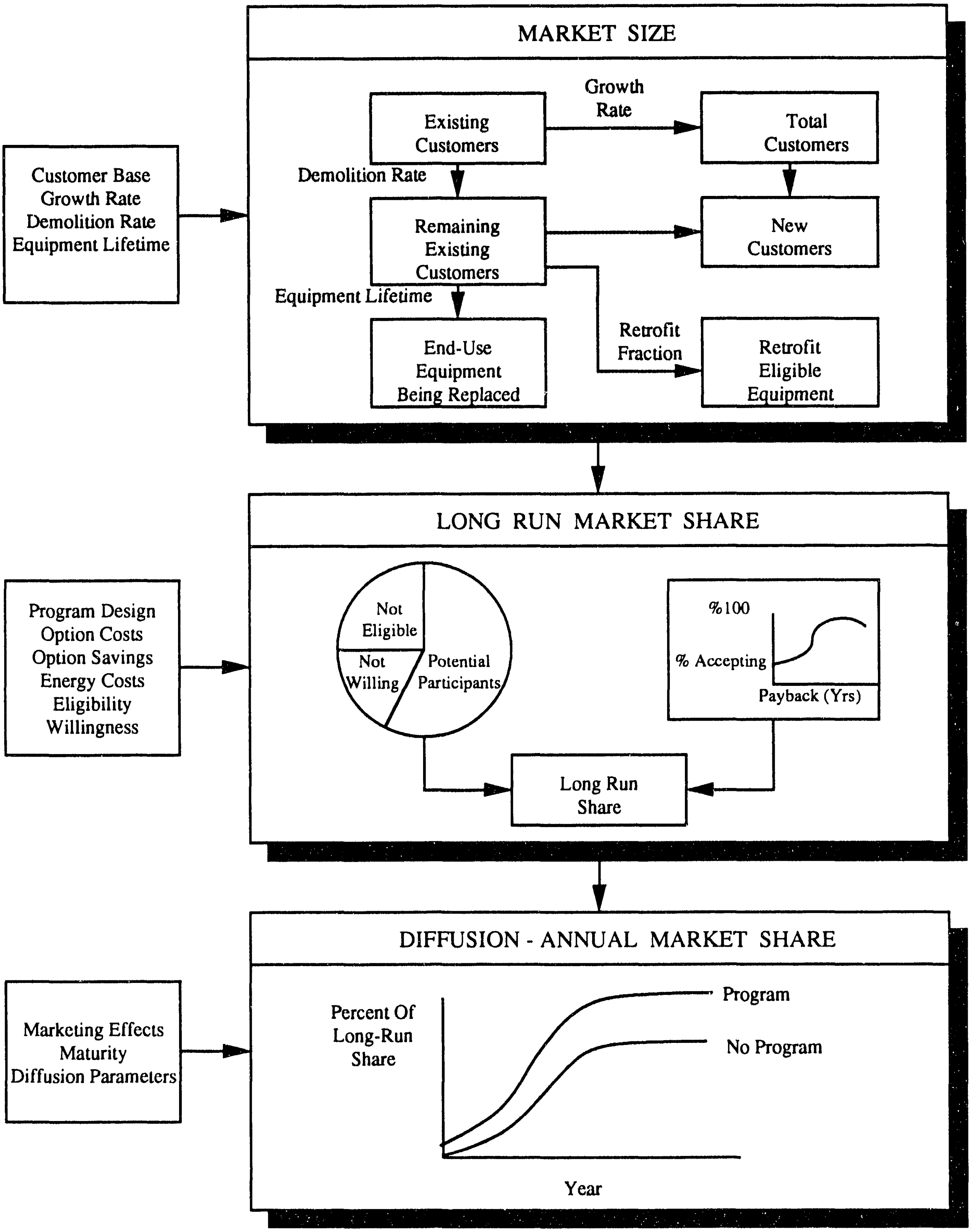
The CABEAS audit and follow-up survey information provided by NYSEG best supports the use of the payback acceptance approach. In addition, SRC's review of case studies in trade publications indicates that the payback acceptance methodology has good predictive performance when studying investment behavior in the light of cost savings.[14] The payback acceptance quantifies the willingness to invest for a farmer in the light of the

[13]Synergic Resources Corporation, Comprehensive Market Planning and Analysis System, Version 1.3 User Guide, Bala Cynwyd, PA, 1990.

[14]Synergic Resources Corporation, "Tabulation of Payback Acceptance data from 621 Case Studies," *Energy Users News* articles from 1983 to 1987, Chilton Business Magazine, New York, NY.

Figure V-4

FRAMEWORK FOR MARKET PENETRATION FORECASTING



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savings that can be recovered. The underlying assumptions of the Payback-Acceptance method in COMPASS are:

- Most commercial decision-makers use simple payback (initial investment divided by energy savings in the first year) as the economic decision criterion for making investment decisions.

- Different decision-makers use different threshold values for the desired payback

- If the probability distribution of desired paybacks can be estimated, it can be used to estimate the probability that a decision-maker selected at random will accept a given payback, which in turn can be used to estimate the fraction or percentage of decision-makers who will accept a specified payback. [15]

Figure V-5 provides an example of a payback acceptance schedule for heat recovery water heaters generated in this project. Table V-3 provides payback acceptance schedules in tabular form for several major farmstead technologies analyzed in this project.

2. Market Diffusion

A diffusion function describes the time pattern of adoption or awareness of new technologies using a logit or S-shaped curve which has been observed to best represent the diffusion of information about a technology in the marketplace over time.[16]

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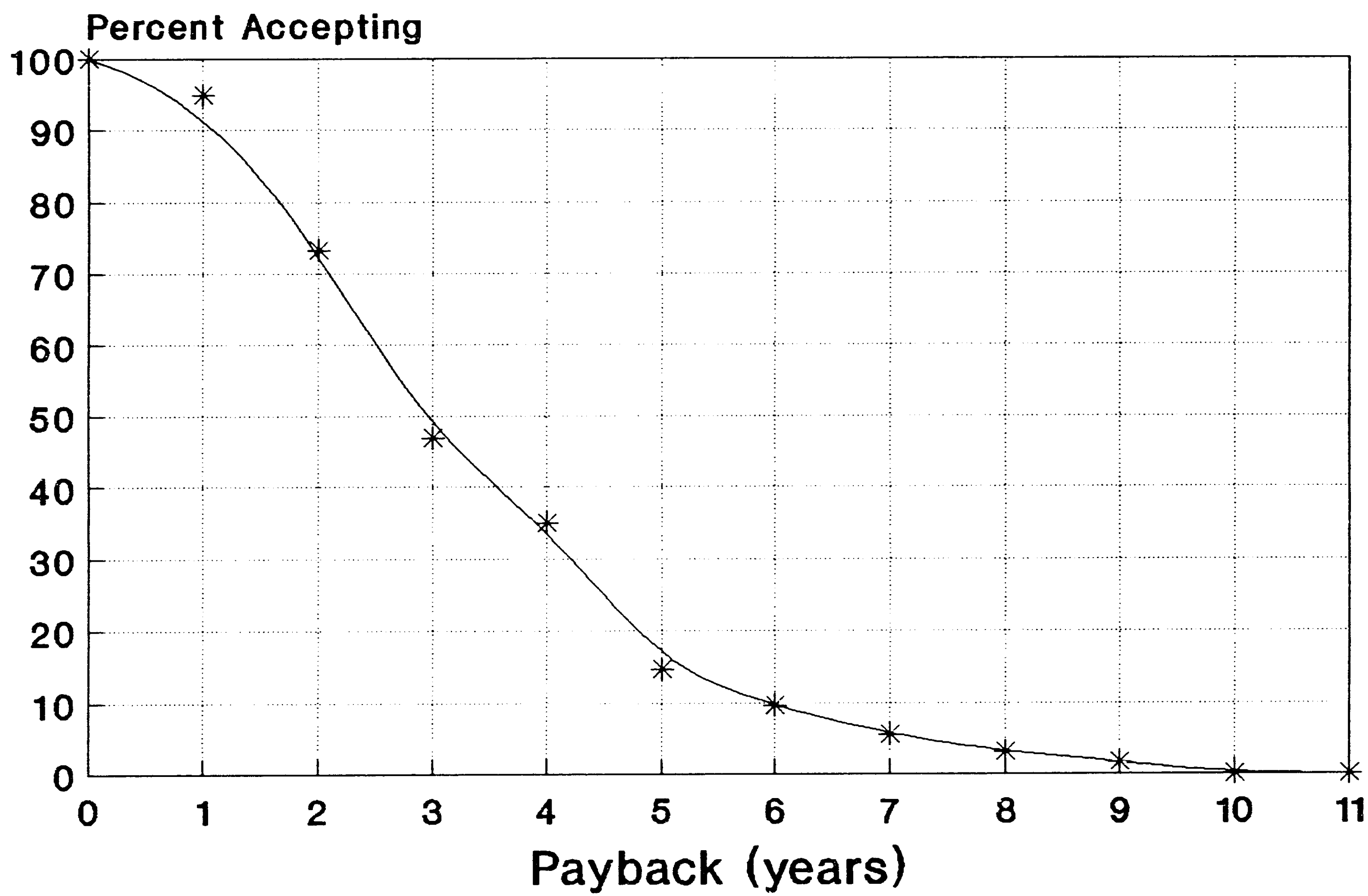
[15]Synergic Resources Corporation, Comprehensive Market Planning And Analysis System, Version 1.2 User Guide, Bala Cynwyd, Pa., 1990

[16]The inherent S-shape of the farmstead diffusion curve is due to: (1) the cumulative curve approaches a limiting penetration level of less than 100% of all farms (frequently far less), and (2) the successive increments of adoptions decline as a function of time.

Figure V-5

PAYBACK ACCEPTANCE SCHEDULE FOR HEAT RECOVERY WATER HEATERS



(Based on 32 reported installations)

Table V-3

PAYBACK ACCEPTANCE SCHEDULES FOR FARMSTEAD DSM TECHNOLOGIES

	ACCEPTANCE (%)			
PAYBACK (years)	HEAT RECOVERY WATER HTRS. (n=32)	WELL WATER PRECOOLERS (n=33)	CONTROLLED WATER HEATERS (n=136)	LIGHTING (n=343)
0	100.0	100.0	100.0	100.0
1	94.9	76.5	98.5	97.5
2	73.3	76.5	68.4	72.3
3	46.9	64.7	43.4	56.4
4	35.0	52.9	33.1	36.6
5	14.7	47.1	17.7	22.5
6	9.6	29.4	14.8	10.3
7	5.5	23.5	11.9	3.3
8	3.1	17.6	11.2	0.6
9	1.7	11.8	8.3	0.0
10	0.0	11.8	6.8	0.0
11	0.0	0.0	0.0	0.0

The approach employed in the Farmstead project is based on a diffusion model developed by Lawrence and Lawton[17] and incorporated in COMPASS. The market research, model specifications, and the application of the model is explained in detail in the Farmstead Investment Behavior Report.

The Lawrence-Lawton diffusion curve was chosen for COMPASS for two reasons: because it has been shown in the literature that all other diffusion models are extensions of the Lawrence-Lawton model; and secondly, the Lawrence-Lawton specification uses the minimum number of parameters, so that it can be easily calibrated.

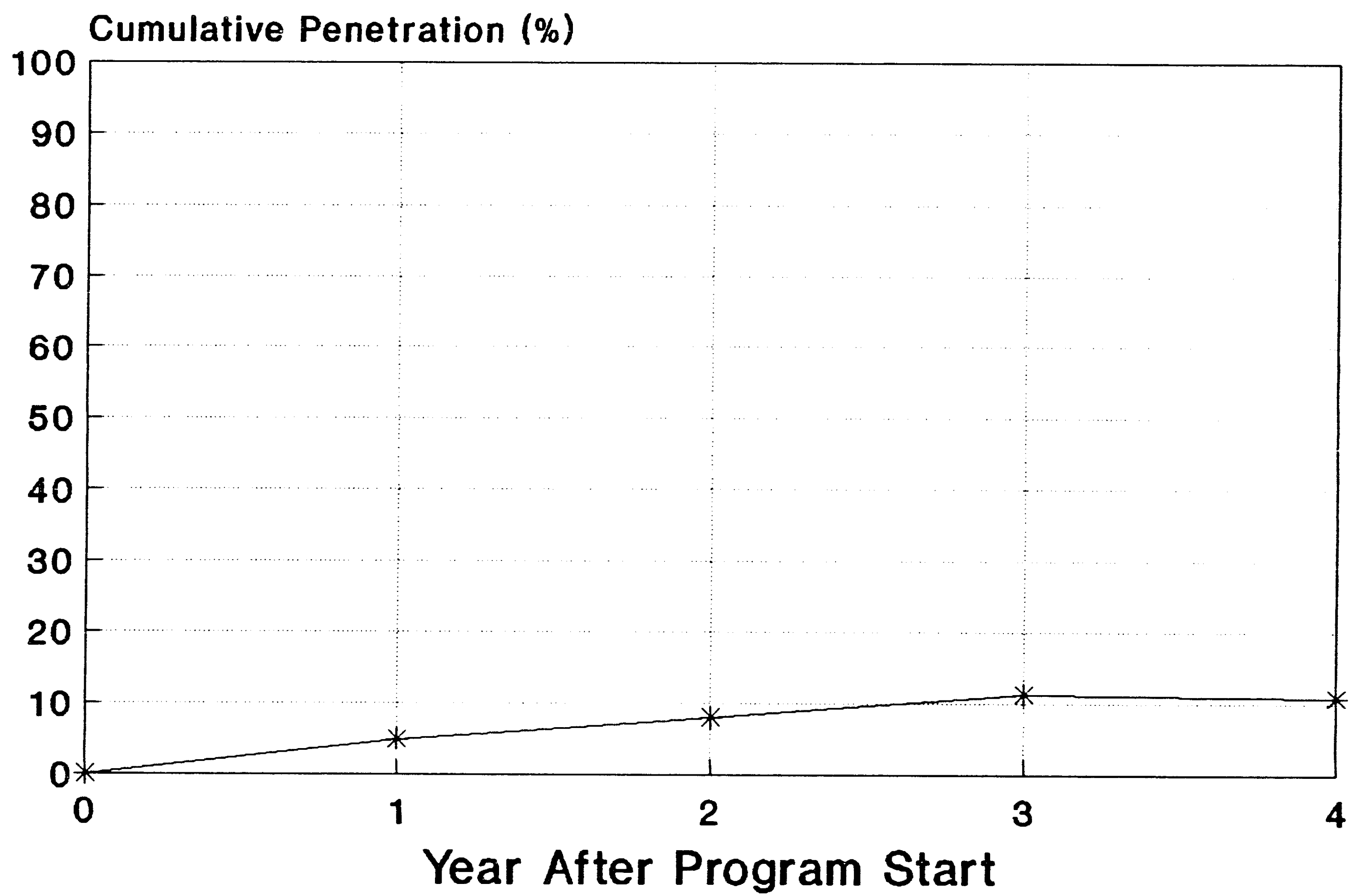
The Lawrence-Lawton diffusion approach has been modified to include an information effect parameter which assumes that a percentage of the market which is not informed through other channels will be informed by the utility information program each year. The information effect is defined as the percent of the remaining uniformed population that is informed in any given year. The diffusion effect is expressed in COMPASS as a cumulative percentage of the long-run market share. The cumulative penetration in any one year is obtained by taking the product of long-run market share and the diffusion rate and accounting for eligible market percentage and willing population fraction.

The diffusion rates for various farmstead DSM options were adjusted using the results of the market research which plotted their historical penetrations. Figure V-6 shows a graph of penetration of heat recovery water heaters over time from NYSEG audit data. Table V-4 provides penetration schedules for four major types of farmstead DSM options.

[17]Lawrence, K.D. and Lawton, W.H., "Applications of a Diffusion Model: Some Empirical Results," New Product Forecasting, Lexington Books, Lexington, Ma., 1981

Figure V-6

CUMULATIVE PENETRATION SCHEDULE FOR HEAT RECOVERY WATER HEATERS



(Based on 32 reported Installations)

Table V-4

CUMULATIVE PENETRATION SCHEDULES FOR FARMSTEAD DSM TECHNOLOGIES

YEAR AFTER INTRO.	HEAT RECOVERY WATER HEATERS		WELL WATER PRECOOLERS		CONTROLLED WATER HEATERS		LIGHTING	
	Number of Installations	Cumulative Penetration (%)	Number of Installations	Cumulative Penetration (%)	Number of Installations	Cumulative Penetration (%)	Number of Installations	Cumulative Penetration (%)
0	0	-	0	-	0	-	0	-
1	4	4.9	3	1.7	5	4.0	29	4.1
2	3	7.9	7	3.4	4	6.2	36	7.9
3	13	11.2	7	4.1	37	18.6	80	9.1
4	12	10.8	16	6.6	15	33.7	198	18.3

VI. FARMSTEAD DSM PROGRAM DESIGN

VI. FARMSTEAD DSM PROGRAM DESIGN

A. INTRODUCTION

Through Section V, the discussion has presented various constructs based on this project's experience with the assembly and analysis of Farmstead DSM data. In this section the process of DSM program design is presented analytically using the COMPASS market planning and analysis system and all the data sources reviewed. The emphasis is on the systemmatic development of assumptions for program design and the application of a procedure for estimating program costs.

In the final section of the guidebook (Section VII), the program design is tested based on basic assumptions and various marketing strategies. The conclusions of the program analysis are also documented.

B. DSM PROGRAMS AS ENERGY (KWH) AND CAPACITY (KW) RESOURCES

The purpose of New York State Farmstead DSM project was to develop an assessment of various options for consideration by New York's Upstate utilities. To provide an accurate and balanced analysis of the options, the procedure must combine data and assumptions regarding program design to create the most realistic assessment that is possible. A central focus of the realism being attempted is the achievement of an accurate costing of all program components because these costs will be compared to alternative supply side options (the marginal costs of supply) in evaluating the DSM options.

This realism must satisfy two requirements:

- From a program perspective, DSM programs are a combination of multiple DSM options offered through a multi-faceted marketing strategy.

- From a technology perspective, the most cost-effective options must be selected for promotion under the DSM program.

The major problem with these requirements is developing an appropriate resource costing methodology which results in the selection of the most cost effective options which when combined provide a program budget which is realistic from a marketing and implementation perspective. This methodology requires the establishment of program design/costing guidelines.

In addition, by considering alternative marketing strategies in the analysis, the decision-making perspective can be expanded. This section discusses the application of two program design formula's in the analysis of DSM options - a high intensity and a low intensity marketing strategy.

C. GENERAL DSM PROGRAM PLANNING GUIDELINES AND ASSUMPTIONS

To realistically estimate the cost of DSM program options, they must be considered in the context of the final program design. A review of U.S. DSM program implementation efforts, provides some basic guidelines:

- Many utilities have found that DSM programs which promote multiple options tend to reduce marketing expenses as compared to the combination of individual promotion efforts.

- The diffusion of any product in the market place whether VCRs or heat recovery water heaters observes a pattern from the time of introduction to market maturity similar to an S-shaped (logistics) curve.

The S-shaped curve reflects an initially slow period of adoption increasing gradually to a point where annual increases in adoption accelerate until a point of market maturity is reached where annual increases in adoption begin to decline from the year before.

- To capture all benefits of DSM options, DSM planning must account for both the years in which a product is promoted, through the years after the promotion has ended but during which the product remains in operation producing energy and demand savings at the customer's residence or business.

- All program costs including administration and marketing labor, overhead, and marketing costs must be included in DSM program costs.

- The intensity with which a product is promoted (marketing intensity[1]) influences to a great extent the degree to which customers adopt the product.

- The presence of incentives influences the market penetration of DSM options, however, this influence does not necessarily correlate with the level of the incentive. That is, the presence of an incentive at some threshold might produce a larger incremental effect than the added effect of raising the incentive above the threshold level.

- Together, the presence of an incentive in the DSM program design coupled with a certain level of marketing including technical assistance, training, and education produces a larger market response than just incentives alone.[2]

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[1]The marketing intensity refers to range and level to which various marketing methods are employed to promote a concept and/or a product to reach customers who are in a position to make a purchase decision.

[2]Berry, Linda, **The Market Penetration of Energy-Efficiency Programs**, prepared for the Office of Energy Resources, Bonneville Power Administration, U.S. DOE Contract DE-AC05-840R21400, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1990, pp. 35-36

- Commercial decision makers, including farmers, understand and respond to the concept of simple payback.[3]

D. NEW YORK STATE FARMSTEAD PROGRAM DESIGN ASSUMPTIONS

Coupling the general guidelines with the information sources synthesized during this project, the following constructs for realistic program design and accurate costing of DSM options as resources are offered:

- The Farmstead DSM program design featured the promotion of at least ten DSM options over which program costs were distributed. This results in an allocation of no more than 1/10 of overhead, fixed labor and material costs to each option.

- The general marketing costs were allocated over no less than ten DSM options.

- The Farmstead DSM program analysis was run for five years so that fixed administrative and marketing costs would be distributed over a period of time which allows for the adoption rate to increase substantially from the low levels normally encountered at the beginning of a DSM program.

- The Farmstead DSM program combined both incentives and marketing strategies to encourage the adoption of DSM options. The incentives were at least 50% and less than 100% of the incremental capital and installation cost.

- The farmstead market in upstate New York is sufficiently small (< 15,000) that utilities should consider one marketing effort which promotes all types of farmstead options.

- The willingness of customers to participate in electric utility DSM programs is a key to their success. This phenomenon has been

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[3]See the **Farmstead Investment Behavior Report**, New York State Farmstead Assessment Project, Report No. 4, May 1991, p. IV-8

observed to vary between 15% and 25% in more traditional utility sectors such as residential and commercial, but may be even higher in the farm sector.

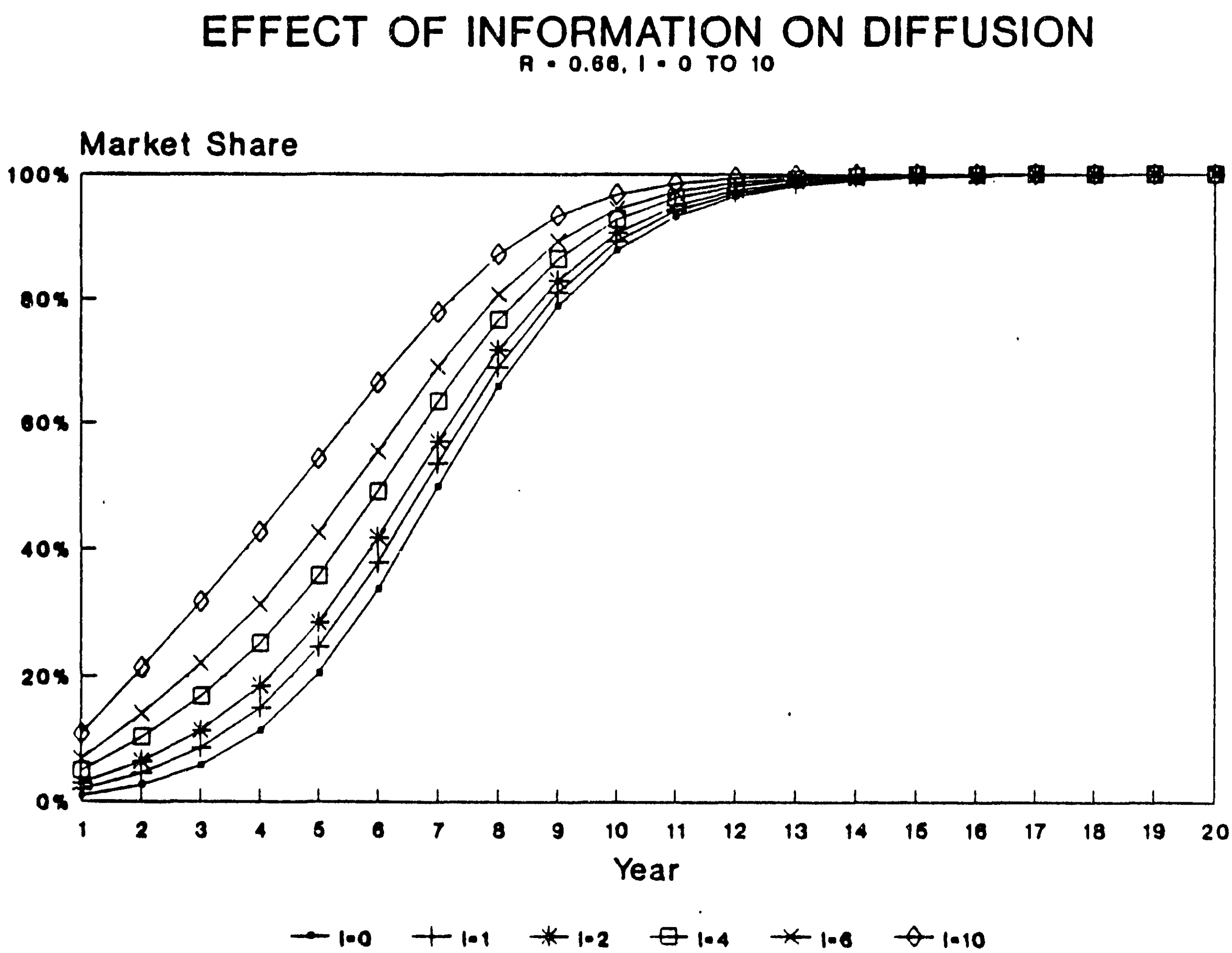
E. DSM PROGRAM MARKETING STRATEGIES - VARIOUS SCENARIOS

Before the costing of DSM options can be attempted, the marketing strategy must be considered first. In fact, several strategies or approaches can be considered, but should be assembled before the actual costing begins in order to provide the most balanced set of alternatives. This section discusses the relationship between the magnitude of the marketing effort and the impact it has on the public awareness of the program and eventual participation forecasted by a market planning and analysis model.

The COMPASS model decomposes the market penetration problem into two parts: the long-run market share and the annual diffusion of the option. The long-run market share can be regarded as the portion of the market that will eventually adopt the option once everyone is aware of the option and has an opportunity to purchase it. The market diffusion refers to the rate at which information about a DSM option disperses in the market and is described as the fraction of the long-run market share that is attained in any given year.

A component of the diffusion model adapted for COMPASS is what is called the information effect. The information effect was originally added to the diffusion model to account for the assumption that some percentage of the market that is not informed through utility channels will be informed by the utility DSM program. This factor was used to adjust the diffusion curve for various levels of marketing. As can be seen in Figure VI-1, by varying the information percentage, the slope or penetration rate is affected especially early in the life of the program. The higher the value, the higher the penetration. Because research on the correlation between the information effect and the marketing intensity applied to DSM

Figure VI-1


EFFECT OF INFORMATION ON DIFFUSION
R = 0.66, I = 0 TO 10
Market Share
100%
80%
60%
40%
20%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Year
I=0
I=1
I=2
I=4
I=6
I=10

programs is very limited, these adjustments were applied judgmentally to reflect as much as possible the trends or propensities found to exist in the New York State farmstead market.

The Computerized Agribusiness Energy Analysis System (CABEAS) developed by New York State Electric & Gas Corporation (NYSEG) provides some experience with an approach that represents the high penetration/high cost end of the scale of DSM program marketing. The CABEAS energy analysis is administered by NYSEG under the Agricultural Energy Analysis program which combines the range of information services including print media (ie. bill stuffers, direct mail, etc...), person-to-person contact, conferences, trade allies seminars, point of purchase, etc.... The program has been in existence for over five years and achieved a cumulative participation of over 1700 farms in that time. It is assumed that a low intensity marketing scenario will achieve lower participation levels at lower cost.

For each of the 19 DSM options defined two marketing strategies were evaluated:

- Low Intensity Marketing (LIM): Direct Mail, Bill stuffers, point of purchase, seminars to trade allies
- High Marketing Intensity (HIM): LIM + Person-to-person, Audit, Trade Shows and Seminars, and some Media Promotion.

The components of each marketing strategy are presented in Figure VI-2. Each marketing scenario is described in more detail below:

Figure VI-2

ALTERNATVIE MARKETING STRATEGIES FOR FARMS

	LOW	HIGH
Direct Mail Brochure	X	X
Bill Stuffers	X	
Major Program Brochure	X	X
Minor Program Brochure		X
Trade Ally Seminars	5	10
Training Seminars		5
Point of Purchase	X	X
Telemarketing		
Person-to-person Marketing		
Energy Survey/Analysis/Audit		X
Radio		X
Magazine		X
Television		
Conferences		X
Off-Season Seminars		5
Incentives		
Rebates	X	X
Low Interest Loans		

1. **Low Intensity Marketing**

Low Intensity Marketing (LIM) is centered around low cost print media and mailings to farmstead customers. This marketing strategy emphasizes the use of printed letters and bill stuffers to communicate the energy efficiency concepts and opportunities of the program. A minor brochure is printed that may serve as part of the direct mail package and also set up in point-of-purchase situations as appropriate. The LIM strategy also features limited trade ally seminars which are designed to introduce the DSM program options to the suppliers and installers of energy efficient equipment. This strategy can essentially inform the target market about the options and establish a limited buy-in from equipment suppliers and dealers. It does not provide any direct utility contact with customers or go a long way in adding to the customers perception of the utility's credibility or a demonstration of the benefits of the technology.

2. High Intensity Marketing

The high intensity marketing (HIM) strategy combines the elements of the LIM strategy with person-to-person marketing and technical assistance (energy analysis/audits), radio and magazine advertising, conferences, customer seminars, etc... The LIM strategies are also intensified by providing more detailed brochures and printed material, increasing the number of trade ally seminars from 5 per year to 20 per year. The HIM strategy also features 5 additional off-season seminars with farmers. The HIM strategy is designed to not only increase the presence of the utility in the market place but also to address the concerns of customers regarding the economic payback, risk, and disruption of making investments in energy efficiency improvements. The technical assistance in the form of audits and utility representative expertise is specifically designed to address farmer's aversions to risk and their uncertainty and skepticism about the reliability and performance of DSM technologies.

F. TYPES OF PROGRAM COSTS

Program costs include administrative, marketing, and incentive costs.

1. Administrative Costs

Although the definition of administrative costs varies to some degree among utilities, it is generally understood to include the following cost elements in DSM programs: labor costs of planning and implementation, processing costs, marketing, equipment, outside contractors, material and overhead costs. The fixed cost component of administrative costs do not vary with the number of participants. The variable cost component varies according to the number of participants. Both utilities and regulatory commissions observe conventions regarding the various components of administrative costs. For example, many organizations separate administration costs into direct and indirect costs. Those costs that can be assigned to specific DSM programs are called direct.

Another reasonable distinction that can be made is between marketing costs and other administration costs. In this program design exercise, it is preferable that this distinction be observed in order to compare alternative marketing strategies. We feel that this approach will become the rule in the future because utilities will increasingly want to examine the linkage between the marketing intensity of various DSM efforts and the market penetration results achieved.

2. Marketing Costs

Marketing costs refer to the labor, processing, materials, and advertising costs required to generate participants in a DSM program. While, in a sense, financial incentive costs represent a form of marketing, the special nature of this inducement and its large impact on participants warrants a separate category. In addition, incentive costs are more often linked to the specific technologies under promotion and the precise effect they have on lowering the customer's initial costs of making the investment.

3. Incentive Costs

Financial incentive offerings can take various forms including low interest loans, cash grants, rebates, or bill credits. Low interest loans are usually offered directly to utility customers while rebates can be offered to either customers or trade allies. In the case of the

Farmstead Program analysis, it was assumed that rebates would be offered directly to customers. This ties in with the use of payback acceptance to determine the long-run market share in the COMPASS model. Payback acceptance attempts to quantify the willingness of a commercial decision-maker to invest in a DSM technology or measure in the light of its capital and installation cost, annual savings potential, and the value of the incentive provided by the utility.

G. ESTIMATING THE COST OF DSM OPTIONS

The goal in utility DSM planning is to discriminate between those DSM options which are of marginal or no benefit and those which represent the most cost-effective resources from the resource and societal perspectives and then package them in a DSM Program. The problem is that the utility may, initially, consider many options for evaluation and needs to price the various resources as accurately as possible to produce a balanced differentiation of DSM options. The only way to do this was to develop and allocate costs within the context of a DSM program approach. The following definitions were kept in mind as this process was undertaken:

- **DSM Options** - A DSM option is a specific strategy in which utility customers adopt a high efficiency or demand reduction technology or measure in place of a standard or existing technology measure. The option represents the pair of technologies, the one that is replacing or being added and the standard or existing technology or measure that is being replaced or supplemented.

- **DSM Program** - A DSM program is a management and marketing structure which provides for the promotion and delivery of program services or financial resources to electric utility customers who are interested in energy efficiency and demand reduction technologies and measures. DSM programs can be composed of one or more DSM options.

To increase the cost-effectiveness on a per option basis, the basic DSM program design assumes that at least ten DSM options will be included in the base program design. This approach decreases the unit cost of each option because of some economies that are derived from some management and marketing activities. The approach of specifying multiple options per DSM program is not as important with programs which are light on direct contact with customers.[4] In these types of programs, the economies are significant if utility contact personnel costs are allocated across several DSM options. By allocating the costs to each individual option, the analysis provides the building blocks for design of a cost-effective program.

The most realistic approach for costing DSM programs was to start with the following approach:

- Assume that each DSM option will be a component part of an umbrella DSM program containing a minimum of 10 DSM options
- Specify and cost the elements of the umbrella program tailored to the marketing strategy desired and the estimated size of the market (in this case larger than 5000 farms)
- Allocate the fixed program costs (overhead, management, marketing) over each of the total number of DSM options under consideration
- Specify the specific costs associated with each DSM option
- Total the costs associated with each DSM option and analyze separately
- Assemble the most cost-effective options in the final DSM program design.

[4]According to the marketing strategies specified in Section D the LIM strategy had no direct person-to-person contact with customers and the HIM featured personal contact with customers in the form of the energy survey/audit vehicles.

In Tables VI-1 and VI-2, the program costs are specified for administration, marketing, and evaluation costs of a typical option under the two different marketing strategies discussed in Section VI.D. - HIM and LIM. In Table VI-3, an adjustment was made to program costs for the HIM scenario to account for anticipated lower fixed costs to manage the smaller service territories of Rochester Gas and Electric and Central Hudson Gas and Electric Corporations. This involved reducing the variable cost of a program engineer from full to half-time and reducing the number of training and information seminars from 20 to 5 per year. Incentive costs are varied independently of these program costs in COMPASS and do not appear in these exhibits. From this quasi-realistic starting point, the most appropriate pricing of the DSM option was facilitated.

The program elements are defined in the left hand column. The "Unit Cost" represents the cost of each program element. The "First Year Allocation Factor" shows how much of the Unit Cost is allocated to the first year of the program. The "Recurring Year Allocation Factor" allocates the unit cost for successive years after the initial start-up year. "Notes" references the assumptions and estimates used to develop the unit costs and allocation factors for the analysis.

The costs developed in Tables VI-1, VI-2, and VI-3 were summarized in Table VI-4 and entered in the COMPASS model. Along with incentives, the program costs were used to determine the final value of the DSM options with respect to supply-side resources.

Table VI-1

ADMINISTRATION, EVALUATION, AND PROMOTION COST GUIDELINES

PROGRAM: New York State Farmstead Program
SCENARIO: High Marketing Intensity - Large Market HIMCOST1

COST CATEGORY	UNIT COST ($)	1ST YEAR ALLOCATION FACTOR	1ST YEAR COST ($)	RECURRING YEAR ALLOCATION FACTOR	RECURRING ANNUAL COSTS ($)	NOTES
FIXED ADMIN. & IMPLEMENT:						
Program Manager	$85,050	0.25	$21,263	0.1	$8,505	a
Program Engineer	$75,600	0.5	$37,800	0	$0	b
Program Support	$35,100	0.1	$3,510	0.1	$3,510	c
Miscellaneous	$10,000	1	$10,000	1	$10,000	d
VARIABLE MKTG. & IMPLEMENT:						
Program Engineer	$75,600	1	$75,600	1	$75,600	e
Program Support	$35,100	0	$0	0	$0	
Customer Reps	$64,800	0	$0	0	$0	
FIXED MARKETING EXPENSES:						
Major Brochure	$12,000	1	$12,000	0	$0	f
Minor Brochure	$5,000	1	$5,000	1	$5,000	g
Bill Stuffer	$2,000	0	$0	0	$0	
Direct Mail	$2,000	1	$2,000	1	$2,000	h
Point of Purchase	$6,000	1	$6,000	1	$6,000	i
Seminars	$2,000	20	$40,000	20	$40,000	j
Other Communication	$10,000	1	$10,000	1	$10,000	k
Travel & Expenses	$2,500	1	$2,500	1	$2,500	l
VARIABLE ADMIN. EXPENSES:						
Processing Cost	$9.00	188	$1,692	375	$3,375	m
Audit Analysis Cost	$66.00	150	$9,900	300	$19,800	n
Verification Cost	$6.60	188	$1,241	375	$2,475	o
SUMMARY COSTS:						
Admin. Fixed			$72,573		$22,015	
Mktg. Variable			$75,600		$75,600	
Marketing Fixed			$77,500		$65,500	
Admin. Variable			$12,833		$25,650	
SUBTOTAL			$238,505		$188,765	
Evaluation (@ 10%)			$23,851		$18,877	
TOTAL			$262,356		$207,642	

Table VI-1

ADMINISTRATION, EVALUATION, AND PROMOTION BUDGETS

PROGRAM: New York State Farmstead Program
UTILITY: High Marketing Intensity - Large Market

NOTES

a. 1/4 time in first year, 1/10 time recurring for program design and implementation.

b. 1/2 time in engineering support and design assistance in first year.

c. 1/10 time in annual secretarial/technician support.

d. Initial startup and, then, recurring annual costs for office equipment and supplies.

e. Full time for engineering/marketing implementation support in the first year and recurring annual implementation support. Assumes that 1 full time engineer is required to supervise audit and field contact personnel.

f. Design and production of major brochure for farm customers.

g. Minor brochure for direct mail.

h. Direct mail to farm customers.

i. Point of purchase display with major and/or minor brochures.

j. 20 seminars & training sessions for trade allies, utility personnel, and customers.

k. Other media advertising (ie., radio, magazines, etc...) and conferences.

l. Travel time for seminars and training.

m. Program support cost is divided by 1960 hours/yr = $17.90/hr.. Assumed that 2 rebate applications can be processed per hour or $9/participant. Allocation factors are shown for illustrative purposes. Actual admin. variable costs determined by COMPASS.

n. Customer rep cost is divided by 1960 hours/yr = $33.00/hr.. Assumed 2 hours per on-site analysis and marketing contact or $66.00/audit. Also assumed that every four audits produced 1 additional program participant. Allocation factors are illustrative only.

o. Assumed customer reps perform verifications on 10% of installations. Assumed 2 hours per audit x 10% = $66.00/audit x 10% = $6.60/participant.

Table VI-2

ADMINISTRATION, EVALUATION, AND PROMOTION COST GUIDELINES

PROGRAM: New York State Farmstead Program
SCENARIO: Low Marketing Intensity LIMCOST

COST CATEGORY	UNIT COST ($)	1ST YEAR ALLOCATION FACTOR	1ST YEAR COST ($)	RECURRING YEAR ALLOCATION FACTOR	RECURRING ANNUAL COSTS ($)	NOTES
FIXED ADMIN. & IMPLEMENT:						
Program Manager	$85,050	0.25	$21,263	0.1	$8,505	a
Program Engineer	$75,600	0.5	$37,800	0.1	$7,560	b
Program Support	$35,100	0.1	$3,510	0.1	$3,510	c
Miscellaneous	$10,000	0.5	$5,000	0.5	$5,000	d
VARIABLE MKTG. & IMPLEMENT:						
Program Engineer	$75,600	0	$0	0	$0	
Program Support	$35,100	0	$0	0	$0	
Customer Reps	$64,800	0	$0	0	$0	
FIXED MARKETING EXPENSES:						
Major Brochure	$12,000	1	$12,000	0	$0	e
Minor Brochure	$5,000	0	$0	1	$5,000	f
Bill Stuffer	$2,000	1	$2,000	1	$2,000	g
Direct Mail	$2,000	1	$2,000	1	$2,000	h
Point of Purchase	$6,000	1	$6,000	1	$6,000	i
Seminars	$2,000	5	$10,000	5	$10,000	j
Other Communication	$10,000	0	$0	0	$0	
Travel & Expenses	$2,500	1	$2,500	1	$2,500	k
VARIABLE ADMIN. EXPENSES:						
Processing Cost	$9.00	150	$1,350	375	$3,375	l
Audit Analysis Cost	$66.00	0	$0	0	$0	m
Verification Cost	$6.60	150	$990	375	$2,475	n
SUMMARY COSTS:						
Admin. Fixed			$67,573		$24,575	
Mktg. Variable			$0		$0	
Marketing Fixed			$34,500		$27,500	
Admin. Variable			$2,340		$5,850	
SUBTOTAL			$104,413		$57,925	
Evaluation (@ 10%)			$10,441		$5,793	
TOTAL			$114,854		$63,718	

Table VI-2

ADMINISTRATION, EVALUATION, AND PROMOTION BUDGETS

PROGRAM: New York State Farmstead Program
UTILITY: Low Marketing Intensity

NOTES

a. 1/4 time in first year, 1/10 time recurring for program design and implementation.

b. 1/2 time for engineer for program development in first year and 1/10 time in recurring costs to oversea annual implementation.

c. 1/10 time in annual secretarial/technician support.

d. Initial startup and, then, recurring annual costs for office equipment and supplies.

e. Design and production of major brochure for farm customers.

f. Minor brochure for direct mail in 2nd, 3rd, 4th, and 5th years.

g. Annual bill stuffers.

h. Direct mail to farm customers.

i. Point of purchase display with major and/or minor brochures.

j. 5 seminars & training sessions for trade allies and utility personnel.

k. Travel time for seminars and training.

l. Program support cost is divided by 1960 hours/yr = $17.90/hr.. Assumed that 2 rebate applications can be processed per hour or $9/participant. Allocation factors are shown for illustrative purposes. Actual admin. variable costs determined by COMPASS.

m. Customer rep cost is divided by 1960 hours/yr = $33.00/hr.. Assumed 2 hours per on-site analysis and marketing contact or $66.00/audit. Also assumed that every four audits produced 1 additional program participant. Allocation factors are illustrative only.

n. Assumed customer reps perform verifications on 10% of installations.
Assumed 2 hours per audit x 10% = $66.00/audit x 10% = $6.60/participant.

Table VI-3

ADMINISTRATION, EVALUATION, AND PROMOTION COST GUIDELINES

PROGRAM: New York State Farmstead Program
SCENARIO: High Marketing Intensity - Small Market HIMCOST2

COST CATEGORY	UNIT COST ($)	1ST YEAR ALLOCATION FACTOR	1ST YEAR COST ($)	RECURRING YEAR ALLOCATION FACTOR	RECURRING ANNUAL COSTS ($)	NOTES
FIXED ADMIN. & IMPLEMENT:						
Program Manager	$85,050	0.25	$21,263	0.1	$8,505	a
Program Engineer	$75,600	0.5	$37,800	0	$0	b
Program Support	$35,100	0.1	$3,510	0.1	$3,510	c
Miscellaneous	$10,000	1	$10,000	1	$10,000	d
VARIABLE MKTG. & IMPLEMENT:						
Program Engineer	$75,600	0.5	$37,800	0.5	$37,800	e
Program Support	$35,100	0	$0	0	$0	
Customer Reps	$64,800	0	$0	0	$0	
FIXED MARKETING EXPENSES:						
Major Brochure	$12,000	1	$12,000	0	$0	f
Minor Brochure	$5,000	1	$5,000	1	$5,000	g
Bill Stuffer	$2,000	0	$0	0	$0	
Direct Mail	$2,000	1	$2,000	1	$2,000	h
Point of Purchase	$6,000	1	$6,000	1	$6,000	i
Seminars	$2,000	5	$10,000	5	$10,000	j
Other Communication	$10,000	1	$10,000	1	$10,000	k
Travel & Expenses	$2,500	1	$2,500	1	$2,500	l
VARIABLE ADMIN. EXPENSES:						
Processing Cost	$9.00	188	$1,692	375	$3,375	m
Audit Analysis Cost	$66.00	150	$9,900	300	$19,800	n
Verification Cost	$6.60	188	$1,241	375	$2,475	o
SUMMARY COSTS:						
Admin. Fixed			$72,573		$22,015	
Mktg. Variable			$37,800		$37,800	
Marketing Fixed			$47,500		$35,500	
Admin. Variable			$12,833		$25,650	
SUBTOTAL			$170,705		$120,965	
Evaluation (@ 10%)			$17,071		$12,097	
TOTAL			$187,776		$133,062	

Table VI-3

ADMINISTRATION, EVALUATION, AND PROMOTION BUDGETS

PROGRAM: New York State Farmstead Program
UTILITY: High Marketing Intensity - Small Market

NOTES

a. 1/4 time in first year, 1/10 time recurring for program design and implementation.

b. 1/2 time for engineer for program development in first year and 1/10 time in recurring costs to oversee annual implementation.

c. 1/2 time in annual secretarial/technician support.

d. Initial startup and, then, recurring annual costs for office equipment and supplies.

e. 1/2 time for engineering/marketing implementation support in the first year. Recurring 1/2 time annual implementation support.

f. Design and production of major brochure for farm customers.

g. Minor brochure for direct mail.

h. Direct mail to farm customers.

i. Point of purchase display with major and/or minor brochures.

j. 5 seminars & training sessions for trade allies and utility personnel.

k. Other media advertising (ie., radio, magazines, etc...) and conferences.

l. Travel time for seminars and training.

m. Program support cost is divided by 1960 hours/yr = $17.90/hr.. Assumed that 2 rebate applications can be processed per hour or $9/participant. Allocation factors are shown for illustrative purposes. Actual admin. variable costs determined by COMPASS.

n. Customer rep cost is divided by 1960 hours/yr = $33.00/hr.. Assumed 2 hours per on-site analysis and marketing contact or $66.00/audit. Also assumed that every four audits produced 1 additional program participant. Allocation factors are illustrative only.

o. Assumed customer reps perform verifications on 10% of installations. Assumed 2 hours per audit x 10% = $66.00/audit x 10% = $6.60/participant.

Table VI-4

NEW YORK FARMSTEAD DSM ASSESSMENT
SUMMARY OF PROGRAM COST INPUTS FOR BENEFIT ANALYSIS OF DSM OPTIONS *

	LOW INTENSITY MARKETING		HIGH INTENSITY MARKETING Large Market		HIGH INTENSITY MARKETING Small Market	
	1st Year	2nd - 5th Year	1st Year	2nd - 5th Year	1st Year	2nd - 5th Year
Development Cost ($/Yr.)	$43,000	$0	$50,600	$0	$50,600	$0
Fixed Costs						
Administrative ($/Yr.)	$24,600	$24,600	$20,000	$20,000	$20,000	$20,000
Marketing ($/Yr.)	$34,500	$27,500	$77,500	$65,500	$47,500	$35,500
Evaluation ($/Yr.)	$11,000	$6,000	$24,000	$19,000	$17,000	$12,100
Variable Costs						
Marketing P-to-P ($/Yr.)	$0	$0	$75,600	$75,600	$37,800	$37,800
Marketing ($/Participant)	$0	$0	$66	$66	$66	$66
Processing ($/Participant)	$9	$9	$9	$9	$9	$9
Inspection/Verification ($/Participant)	$7	$7	$7	$7	$7	$7

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* The estimates are for a final Farmstead DSM Program design which contains a minumum of 10 DSM options.

For analyzing individual DSM options Development, Fixed, and Variable Person-to-person Marketing costs (all annual costs) were divided by 10 and entered into COMPASS.
Per participant costs were summed and entered into COMPASS directly as one-time variable costs.

VII. FARMSTEAD DSM PROGRAM ANALYSIS AND RESULTS

VII. FARMSTEAD DSM PROGRAM ANALYSIS AND RESULTS

A. BASIC ASSUMPTIONS AND PARAMETERS

The analysis and presentation of results represents the final stage of the DSM program design process. At this stage, the following major elements of DSM program design have been completed for all four upstate New York utilities:

- Data collection and development including:
  - farmstead technology inventory
  - market size research
  - specification of farmstead DSM options
  - screening of farmstead DSM options
  - estimation of cost of DSM options
- Development of load shapes for DSM options
- Research on the investment behavior of farmers
- Development of DSM program design guidelines and assumptions.

Because the original objective of the New York State Farmstead DSM Assessment Project remains to analyze and, then, identify the most effective DSM technologies, the analysis adhered to a number of guidelines to assure that the overall objective was achieved. The following analytical guidelines were used during the analysis of program strategies and farmsteadDSM options:

- The approach used to estimate market penetration and long run market share of DSM technologies relied on simple payback and cumulative penetration analysis.[1] The indices for market acceptance and diffusion of DSM technologies were developed using energy audit data of agricultural customers collected over a four year period and a follow-up survey of farmers who had received an audit.[2] A summary of the market penetration parameters and payback schedules used in the analysis is presented in Table VII-1.

- The most important test for cost effectiveness is the societal test which counts benefits as avoided energy and capacity costs and environmental damages from power generation that can be reduced and costs as utility program administrative and marketing costs, plus the incremental cost of the DSM option. DSM options which pass the societal test have qualified as economically efficient investments for society to make through the compact between a utility and its customer.

- Due to the economic importance of farms, another analysis objective is to define a DSM program which achieves the most energy and demand savings possible. As a proxy for participation by farmers in the DSM program, energy savings is a barometer of the degree to which farmers participated and were able to increase the efficiency of their operations due to adoption of DSM options promoted by the electric utility.

- While DSM programs have historically tended to be designed around a group of technologies involving one end-use (ie. residential AC rebate for window and central AC and heat pumps), increasingly, electric utilities are designing programs which encompass under one marketing strategy a large array of DSM options. As a result, DSM program design has evolved into a "one stop" promotion of the range of DSM services and incentives available from a utility while achieving significant administrative and marketing economies. The analysis therefore will look at both the package of DSM options as one DSM program as well as the individual DSM options and identify the most cost-effective ones from a societal perspective.

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[1] The market penetration analysis is presented in Synergic Resources Corporation, **The New York State Farmstead Assessment Project — Investment Behavior Report**, Bala Cynwyd, PA., June 1991.

[2] The energy audits were conducted as part of the **CABEAS** analysis. The follow-up survey was conducted in 1990 to gauge the effectiveness of CABEAS over the previous four years. New York State Electric & Gas Corporation, **Computerized AgriBusiness Energy Analysis System (CABEAS)**, and **CABEAS — Follow Survey Statistics**, Agricultural Market Services, NYSEG, Binghamton, NY, 1990.

Table VII-1

MARKET PENETRATION PARAMETERS FOR FARMSTEAD DSM ANALYSIS[1]

END-USE	RATE PARAMETERS[2] (R =)	INFORMATION (%)[3]				TYPE OF PAYBACK SCHEDULES[4]
		Effect w/ Program		Effect w/o Program		
		Low	High	Low	High	
WW Pre-Cooler	.50	2	10	0	0	WW Pre-Cooler
HR Water Htg.	.53	2	10	0	0	Heat Recovery
Lighting	.55	2	10	0	0	Lighting
Ventilation	.55	2	10	0	0	Lighting
Water Htg. Ctrl.	.60	2	10	0	0	Wtr. Htg. Ctrl.

1 Synergic Resources Corporation, **The New York State Farmstead Assessment Project — Investment Behavior Report**, Bala Cynwyd, PA., June 1991.

2 The rate parameter (R) is a measure of the rate at which a new product gets disseminated into the market.

3 The information effect accounts for the fact that some percentage of the market that is not informed through other channels will be informed by the utility DSM program.

4 Payback acceptance schedules were developed for four DSM technologies using recommended savings and estimated cost data from CABEAS audits and follow-up survey information.

B. RESULTS

The results of the analysis are presented in two stages. Because of the importance of achieving the largest adoption rate possible among farmers, the complete package of 19 DSM options were analyzed first in either the High Intensity Marketing (HIM) or the Low Intensity Marketing (LIM) scenario for each utility. The full complement of measures were analyzed assuming that all farmers were willing to participate in a Farmstead program (unwillingness factor was zero).

This analysis was designed to compare the difference in the economic potential of the 19 DSM options (packaged in one DSM program) tested for variations in the intensity of the marketing used in the implementation strategy. The results of this analysis, presented in Table VII-2, indicate that the HIM scenario, while slightly less cost effective, produced almost twice the impacts (GWhs, kWs,) of the LIM scenario. The results of the COMPASS analyses for each utility are contained in Appendix H.

A second simulation of the full complement of 19 programs for the HIM scenario was conducted to examine how great the influence of farmers unwillingness to participate in utility sponsored investments might affect the economic potential of the DSM program. These results are presented in Table VII-3 and clearly indicate that even with 40% of farmers unwilling to participate, the cost-effectiveness of the full program is sufficient to pass the societal test.

Table VII-4 presents the individual societal benefit cost ratios for each DSM options for the analysis with 0% unwillingness. This table shows the relative cost-effectiveness of the DSM options analyzed in this study. Two options pass for all four utility markets -- Small Dairy Milk Pre-Coolers and Small Dairy Heat Recovery Water Heaters.

Table VII-2

PARAMETERS OF ANALYSIS OF ALTERNATIVE DSM PROGRAMS AND RESULTS[1]

(DSM Programs Containing 19 DSM Options)

SCENARIO PARAMETERS							B/C RESULTS AND IMPACTS[2]				
							B/C RATIOS				
NAME	DESCRIPTION	MKT. SIZE	MKT. INT.	INC. LEVEL	PROGRAM COSTS[3]	UTIL.	SOC.	PART.	GWh IN 2000	kW WTR.	kW SUM.
HIM COST1	Unit Cost All Options And Add Together	LRG	HIGH	100%	D: $50,600 F: $200,000 V: $82/Part	NMPC	2.01	4.04	29.9	2418	453
						NYSEG	1.81	4.85	18.8	1494	689
HIM COST2	Unit Cost All Options And Add Together	SML	HIGH	100%	D: $50,600 F: $124,000 V: $82/Part	RG&E	0.67	4.71	1.8	142	70
						CHG&E	0.39	5.60	0.9	42	83
LIM COST1	Unit Cost All Options And Add Together	LRG	LOW	100%	D: $43,000 F: $70,100 V: $16/Part	NMPC	2.02	4.66	10.4	786	141
						NYSEG	1.77	5.28	5.9	449	243
LIM COST2	Unit Cost All Options And Add Together	SML	LOW	100%	D: $43,000 F: $70,100 V: $16/Part	RG&E	0.41	5.13	0.5	40	24
						CHG&E	0.25	6.05	0.3	26	15

[1] MARKET POTENTIAL OF DSM PROGRAMS, Unwillingness: No Program = 0%, with Program = 0%.

[2] Benefit/Cost results are societal and participant. Impacts are energy savings and coincident demand reductions in the year 2000.

[3] D = One time development costs; F = Annual fixed costs; V = One time variable cost per participant.

Table VII-3

PARAMETERS OF ANALYSIS OF ALTERNATIVE DSM PROGRAMS AND RESULTS[1]
(DSM Programs Containing 19 DSM Options)

SCENARIO PARAMETERS							B/C RESULTS AND IMPACTS[2]				
							B/C RATIOS		GWh in 2000	kW WTR.	kW SUM.
NAME	DESCRIPTION	MKT. SIZE	MKT. INT.	INC. LEVEL	PROGRAM COSTS[3]	UTIL.	SOC.	PART.			
HIM COST1	Unit Cost All Options And Add Together	LRG	HIGH	100%	D: $50,600 F: $200,000 V: $82/Part	NMPC	1.79	3.94	18.2	1480	279
						NYSEG	1.54	4.77	11.5	920	423
HIM COST2	Unit Cost All Options And Add Together	SML	LOW	100%	D: $50,600 F: $124,000 V: $82/Part	RG&E	0.45	4.60	1.1	82	42
						CHG&E	0.26	5.48	0.6	26	51

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[1] MARKET POTENTIAL OF DSM PROGRAMS, Unwillingness: No Program = 50%, with Program = 40%.

[2] Benefit/Cost results are societal and participant. Impacts are energy savings and coincident demand reductions in the year 2000.

[3] D = One time development costs; F = Annual fixed costs; V = One time variable cost per participant.

Table VII-4

Results of Individual DSM Options Assessment:

HIGH INTENSITY MARKETING SCENARIO

	SOCIETAL BENEFIT/COST RATIOS			
Name of DSM Option	NMPC	NYSEG	RG&E	CHG&E
L. Free Stall Light	0.3	0.2	0.1	0.0
L. Milk Pre-Cool	2.1	1.8	0.8	0.4
L.D. Pipe H_2O Ctrl.	0.6	0.9	0.1	0.1
L.D. Pipe H_2O H.R.	2.5	1.8	0.3	0.2
L.D. Parlor H_2O Ctrl.	0.7	1.2	0.2	0.1
L.D. Parlor H_2O H.R.	1.9	1.5	0.3	0.3
L. T.S. Light	1.7	1.1	0.2	0.0
L. T.S. Vent	1.6	1.1	0.2	0.1
L. Dual Vac. Milk	4.3	4.0	1.1	0.7
Poultry House Light	0.2	0.3	0.1	0.1
Poultry House Vent.	0.3	0.4	0.1	0.1
Outside Area Light	1.3	1.0	0.3	0.2
S.D Free Stall Light	0.1	0.1	0.0	0.0
S.D. Milk Pre-Cool	1.8	1.6	1.3	1.0
S. Tie Stall Light	4.2	3.2	0.5	0.3
S. Tie Stall Vent.	6.9	5.1	0.9	0.5
S.D. H_2O Ctrl.	1.8	2.8	0.8	0.4
S.D. H_2O H.R.	2.2	2.1	1.5	1.1
Security Light	0.5	0.4	0.2	0.1
No. Options Passing	12	13	3	2

Finally, Table VII-5 presents the individual average customer impacts in energy (kWh) and demand (kW) and the estimated annual bill savings for each DSM option by utility. It should be noted that no one farm will implement even half of these measures for reasons for incompatible or redundant applications. However, some farms will be able to take advantage of security lighting, free stall barn lighting, water heater controls, and dual vacuum milking technology which could amount to as much as $1250 per year in reduced bills on a large farm in the NMPC service area. A small farm which installs high efficiency security lighting, tie stall barn lighting, water heater controls, and milk pre-cooling could save as much as $700 per year.

The individual technology analysis files are presented in Appendix I.

C. CONCLUSIONS

The analysis presented in Section B provides an indication of the most appropriate strategy for upstate New York's electric utilities.

- Utilities with farm markets of 5000 or larger will tend to be able to implement a range of DSM options in a stand-alone program for farms. (ie. NMPC and NYSEG)
- Utilities with farm markets of 1000 or less will not be able to implement a cost effective stand-alone DSM program for farms. (ie. RG&E and CHG&E)
- Low intensity marketing (LIM) and high intensity marketing (HIM) can potentially achieve approximately the same levels of cost effectiveness, however, the HIM strategy which features person-to-person contact with farmers and provides free energy audits/surveys will achieve substantially more participation from farmers.
- While it is possible for NMPC and NYSEG to implement cost effective stand-alone Farmstead DSM programs, it is highly likely that their programs could become more cost effective if they were to conduct joint marketing support

Table VII-5
DSM OPTIONS ANALYSIS -- FARMSTEAD PERSPECTIVE

Name of DSM Option	Annual Energy Savings (kWh/yr)	Average Demand Reduction (kW)	Annual Bill Savings ($/Farm)			
			NMPC	NYSEG	RG&E	CHG&E
L. Free Stall Light	2,729	0.5	159	189	168	200
L. Milk Pre-Cool	9,983	0.0	625	933	805	1,018
L.D. Pipe H_2O Ctrl.	0	0.7	380	625	667	732
L.D. Pipe H_2O H.R.	20,983	0.5	1,336	1,850	1,635	1,883
L.D. Parlor H_2O Ctrl.	11	0.3	267	333	425	634
L.D. Parlor H_2O H.R.	11,217	0.7	729	930	898	1,041
L. T.S. Light	11,801	4.1	797	884	907	1,047
L. T.S. Vent	7,294	1.1	470	559	550	645
L. Dual Vac. Milk	11,620	3.6	799	922	910	1,116
Poultry House Light	11,615	3.2	816	970	974	1,206
Poultry House Vent.	5,217	1.2	351	399	411	467
Outside Area Light	285	0.1	17	20	17	20
S.D Free Stall Light	910	0.2	53	63	56	67
S.D. Milk Pre-Cool	4,562	0.0	294	426	385	466
S. Tie Stall Light	3,559	1.6	239	245	265	316
S. Tie Stall Vent.	2,917	0.5	188	224	220	258
S.D. H_2O Ctrl.	0	0.1	159	344	273	382
S.D. H_2O H.R.	7,600	0.8	496	674	624	731
Security Light	393	0.1	23	27	24	28

DSM options are developed on a per farm basis.
Annual Energy and Annual Bill savings are estimated average savings per DSM option per farm.
The prefix "L" stands for an average large dairy farm (approx. 175 cows) and the prefix "S" stands for an average small dairy farm (approx. 70 cows).

functions with each other and their smaller neighbors -- RG&E and CHG&E. Marketing support activities include the establishment of an 800 information number, conducting joint seminars for trade allies and marketing personnel, and developing technical br.chures.

- Utilities in small farm markets can still provide DSM incentives and services by conducting some marketing, trade ally seminars, and training together rather than individually.

- The results of the individual benefit cost analysis of DSM options using allocated program costs revealed the following:

  - The most cost-effective DSM options for all utilities were Small Dairy Heat Recovery Water Heating and Milk Pre-coolers
  - The least cost-effective DSM options were Free Stall Lighting for Large Farms, Water Heater Control for Large Farms (Pipe and Parlor), Poultry House Lighting and Ventilation, Small Dairy Free Stall Lighting, and Security Lighting.

- In general, the most important factors in determining the cost-effectiveness of the DSM reviewed were: incremental cost, size of the market, and magnitude of the energy and demand reduction. Some DSM options such as Poultry House Ventilation and Lighting were not cost-effective because of the small number of poultry farms in upstate New York. Outside and security lights were not generally cost-effective as stand-alone options because they produced energy and demand reductions in the off-peak period. The cost-effectiveness of most other measures were influenced by a more balanced combination of the three factors.

- The average large dairy farm replacing existing lighting systems with high efficiency security lighting and free stall barn lighting, adding water heater time clocks and installing dual vacuum pump milking systems will save approximately $1250/year on their total electric bill.

- The average small farm replacing existing lighting systems with high efficiency security and tie stall barn lighting and adding water heater time clocks will save approximately $421/year on their total electric bill. If the average small farm installs a milk pre-cooling system, it can expect to save an additional $295/year.

D. RECOMMENDATIONS

- The complete package of 19 DSM measures should be promoted by the large utilities -- NMPC and NYSEG through a comprehensive high intensity marketing approach for farms.

- Small utilities should investigate the development of limited but distinguishable promotion materials for farms and consider appending them to existing residential or commercial programs

- All four upstate utilities should investigate ways that they can combine marketing support activities to reduce the fixed costs of promoting agricultural DSM and extending the benefits to all upstate New York's farmsteads. NMPC and NYSEG could reduce program costs by jointly conducting some support activities together and inviting RG&E and CHG&E to participate.

- DSM groups at each upstate utility should inform their economic development offices of the condition of farming in their areas, the statewide concern regarding farms, and the importance of this sector over and above its direct electric energy purchases. In addition, at each utility DSM should investigate with economic development what additional activities could be undertaken to support this sector.

Appendix A

SAMPLE TECHNOLOGY BRIEFS

1. Efficient Outdoor Lighting
2. Choosing and Maintaining Energy Efficient Ventilation Fans

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EFFICIENT OUTDOOR LIGHTING

LIGHTING TYPES

Efficient lighting types are those which provide more light for the same or less electricity. Light output is measured in lumens while the rate of electricity used by the light is measured in watts. The efficiency of a lamp is measured in lumens per Watt (lm/W). Although the more efficient types of lamps initially cost more, they last longer and save money on replacement costs. So coupled with the savings in energy cost, some lamp types offer substantial savings.

There are other factors to be considered when deciding what type of lighting to use. When choosing a lamp type, the most efficient lamp with the desired characteristics should be used. Table 1 lists various light types and their approximate efficiency along with an estimate of the average life. Following is a discussion of the various lamp types.

Table 1: COMPARISON OF ELECTRIC LAMP PERFORMANCES FOR OUTDOOR LIGHT SOURCES

Type	Watts	Initial Lumens	Efficiency*	Lamp Life (hours)	Color
Incandescent	100	1,710	17	750	White
	150	1,900	13	2,000	
	1,000	23,000	23	1,000	
Compact Fluorescent	13	900	60	10,000	Cool or Warm White
	22	1,200	48	10,000	
Mercury Vapor	175	8,500	41	24,000	Pinkish White
	250	13,000	44	24,000	
	400	23,000	50	24,000	
Metal Halide	175	14,000	62	7,500	White
	400	34,000	73	20,000	
High Pressure Sodium	35	2,250	51	16,000	Pink/ Yellow
	70	6,300	71	24,000	
	100	9,500	75	24,000	
	250	27,500	94	24,000	
Low Pressure Sodium	90	13,500	108	18,000	Deep Orange

*Approximate Lumens/Watt (Including ballast losses)

This technical brief was prepared for New York State Utilities by: The Agricultural Energy Information Program, Department of Agricultural and Biological Engineering, Cornell University as part of the NYS Farmstead Demand-Side Management Assessment Project funded by the U.S. Department of Energy, Niagara Mohawk Power Corp., New York State Electric and Gas Corp., Rochester Gas and Electric Corp., and Central Hudson Gas and Electric Corp.

type of ballast and socket in which they are used. There is now also an HPS retrofit which can be screwed directly into incandescent sockets. These lamps are not as readily available as others but can be specially ordered. There are also special HPS bulbs available which have a white light.

Another advantage of HPS lighting over mercury vapor is in the characteristic of lamp lumen depreciation. Light output decreases during the life of all lighting types but at different rates. HPS lamps produce about 90% of their initial lumens at 50% of their rated life compared to only 75% for mercury vapor. Therefore, HPS lamps maintain a higher level of illumination than mercury vapor.

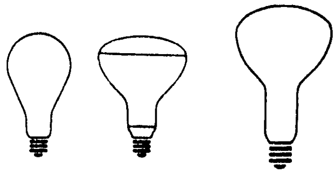
The most efficient type of HID lighting is the low pressure sodium. However, the lamps are expensive and not readily available. Their biggest drawback is the type of light produced. The light is golden or orange with very poor color rendering properties.

SECURITY LIGHTING ON FARMS

Farm workers often start work before dawn and/or finish work after dusk. Many outdoor tasks such as refueling tractors or unhooking equipment are done during non-daylight hours. Outside lighting is important to the safety of these workers and the protection of the property and animals. A few well located automatic dusk-to-dawn lights will provide personal security for these workers and deter thieves and/or vandals. An illumination level of 0.2 to 3 footcandles is recommended for areas where night-time chores such as refueling tractors are performed.

Despite the importance of security lighting many farms in New York do not have any. A Cornell University survey of New York farms found that only half of the farms in the state reported having security lighting on their farm. Of those farms with security lighting mercury vapor lighting was the most common. This is probably because it is the most readily available and cheapest of the HID lights. However, as HPS has grown in acceptance over the past few years, it has become more readily available but is still more expensive than mercury vapor. The savings on energy, however, make HPS more economical than mercury vapor. Table 2 compares the cost of incandescent, fluorescent, mercury vapor and HPS lighting. The costs were calculated for 5 year to show the effect of the longer life of some of the types. Depending upon the specific application, the HPS or compact fluorescent are the preferred options. For those applications requiring higher light levels, HPS is less expensive because it may require several fluorescent fixtures to do the job. The example in the table was based on the typical yard that uses a 175 watt mercury vapor bulb. To achieve the same level of lighting would require only one HPS light but three fluorescent floods. On the other hand, an area that would only require a 150 watt incandescent bulb could use either a 35 watt HPS or a 22 watt fluorescent. In this case, the compact fluorescent could be less expensive because one fixture of either type would be used. Fluorescent light has the advantage of more natural color rendition and faster starting. In checking with dealers we found quite a variation in the prices of the fluorescent floods so it will pay to shop around.

Incandescent



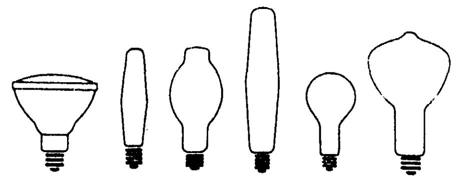
Although incandescent lamps are the least efficient, they are the most commonly found. These bulbs are initially the least expensive and are readily available. They can be easily interchanged so that lighting intensity can be changed without changing the fixture. Because of the low efficiency of the bulbs, much energy is wasted in the form of heat. However, energy efficient krypton or halogen filled incandescent bulbs are available which use 10-15% less energy and last longer. Although the initial cost of the more efficient bulbs is higher, they pay for themselves in a relatively short time in energy savings and replacement costs.

Compact Fluorescent

Fluorescent lamps provide about four times as much light as incandescent per watt of electricity used and last many times longer. However, conventinal fluorescents require a ballast for starting and do not start reliably at temperatures below 50°F. Furthermore, light output decreases approximately 1% for every degree below 65°F.

Conventional fluorescent lamps are not recommended for outdoor applications. However, new compact fluorescent retrofits with self-contained electronic ballasts are available that will start at temperatures down to 0°F. These units can be screwed into standard incandescent outlets and some can be used outdoors. The compact lamps are available in wattages ranging from 5 to 22. The 22 watt bulb starts at temperatures down to -32°F. The ballast lasts 24,000 and the lamp lasts 10,000 hours and can be replaced independently. Fixtures with special mirrored reflectors that take advantage of the design and distribution of this type of lamp are also available. Alone, the 22 watt bulb has a lumen output comparable to a 75-100 watt incandescent but when used in the mirrored fixtures, it can replace a 150 watt incandescent flood light.

High Intensity Discharge (HID)



High Intensity Discharge lamps include mercury vapor, metal halide, high pressure sodium and low pressure sodium. HID lamps are very efficient but because of the intense light, they require mounting heights of 10 to 20 feet for proper utilization. HID lamps are not affected by cold temperatures but do require one to ten minutes of warmup time to reach full output. An additional one to five minutes is required for restarting if the lights are shut off. This should not be a limitation for most outdoor lighting applications.

Mercury vapor are the most commonly used and least expensive to buy of the various types of HID lamps. They are twice as efficient as incandescent and have a longer life than fluorescent. Mercury vapor lamps are widely used for outdoor lighting and in free stall barns. Although the standard globes have relatively poor color renderings, phosphor coated globes are available which produce a more suitable light.

Metal halide lamps provide the whitest light of the HID lamps and are thus used where color rendering is important. They are about four times more efficient than incandescent but are more expensive and have a shorter life than mercury vapor.

High pressure sodium (HPS) lamps are up to five times more efficient than incandescent but are more expensive to purchase than mercury vapor and metal halide. They have a life span similar to mercury vapor. The light produced is yellow with a fair color rendering. Many applications that are currently using mercury vapor lamps could save money by replacing them with high pressure sodium. There are replacements available for existing mercury vapor fixtures but these replacements must be carefully selected since they are specific with regard to the

FREESTALL LIGHTING

Most of the free stall barns in New York utilize mercury vapor lighting but many still use incandescent. Replacement of either type with HPS lighting could result in a significant decrease in energy costs.

Some freestall barns which have no natural light have lamps which are on twenty-four hours a day. Or, lamps with photocontrol are often on all day because of dirt or failure of the sensor. The bottom part of Table 2 compares the 24 hour day cost of various lights. Notice that although the security lighting is on for approximately half as long as the all day lighting, the energy cost is much less than half because of the lower night-time rates.

ADDITIONAL LIGHTING BRIEFS

Tech briefs on dairy and poultry lighting applications are also available.

Table 2. COMPARISON OF OUTDOOR LIGHTING COSTS[1] FOR FOUR LIGHTING TYPES

Light Type	Incandescent	Mercury Vapor	High Pressure Sodium	Compact Fluorescent
Wattage (including ballasts where applicable)	450 (3 150 watt bulbs)	200 (one 175 watt bulb plus ballast)	115 (one 100 watt bulb plus ballast)	75 (three 22 watt bulbs plus ballast)
Approximate Initial Lumen Output	6000	7500	8500	3600[2]
DUSK-TO-DAWN LIGHTING				
$/yr electricity cost	$101	$45	$26	$17
Approximate 5 year cost for fixtures and lamps	$230	$30	$70	$190
Total 5 year cost (bulbs, special fixtures, energy)	$735	$255	$200	$275
ALL DAY LIGHTING				
$/yr electricity cost	$233	$103	$59	$39
Approximate 5 year cost for fixtures and lamps	$460	$60	$140	$260
Total 5 year cost	$1623	$577	$437	$452

[1] Based on NMPC's residential time-of-use rates in effect on 1/91 and dusk-to-dawn lights on from sunset to sunrise.
[2] Although lumen output is lower for this choice than others, fixture design with mirrored reflectors provides more effective light distribution.

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CHOOSING AND MAINTAINING ENERGY EFFICIENT VENTILATION FANS

VENTILATION TYPES

Adequate ventilation is essential to the health of animals and the preservation of other commodities as well as protection of farm structures. There are two types of ventilation systems, mechanical and natural. Some buildings may use a combination of both.

Natural ventilation systems rely on natural airflow, curtains and circulation or paddle fans and are most appropriate for "cold" livestock housing.

Mechanical ventilation systems use fans, controls, inlet/outlet ducts, and other equipment to maintain a warm environment with:

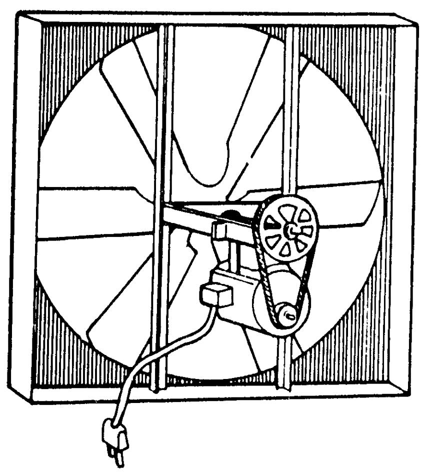
- dry floor and/or litter
- uniform temperatures throughout the area
- a minimum of rapid changes and wide fluctuations in temperature
- prevention of cold air movement over livestock.

This brief will focus on mechanical ventilation systems. Information on natural ventilation systems can be found in a number of sources listed at the end of this publication.

Fans represent one of the largest uses of electricity in agriculture. Dairy, poultry and other livestock operations as well as greenhouse and fruit and vegetable storage use large numbers of fans that run much of the time. For example, on dairy farms ventilation accounts for 16% of the electricity costs on New York dairy farms. On some farms this percentage is much higher.

FAN EFFICIENCY

The use of energy efficient ventilation fans can cut electricity costs significantly. The variation in energy efficiencies for commercially available fans typically vary by a factor of 2. Annual savings can exceed $300/yr/fan even for fans operating one third of the time.



When selecting a fan consider energy efficiency data. The most reliable data includes motor, shutter and guard losses and comes from an impartial source.

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Fan efficiency is expressed as "cfm per watt ratio" which is a measure of the number of cubic feet of air moved per minute (cfm) per watt of input. This is also known as Ventilating Efficiency Ratio (VER). This term was chosen to parallel the Energy Efficiency Ratio (EER), the rating system for air conditioners. VER ratings for fans range from about 10 to 20, with most around 12 to 13.

VER decreases as the static pressure that the fan must operate against increases. Fans in most livestock buildings operate against a static pressure of 0.05 to 0.125 inches of water. Operating pressure can range from 0.2 to 0.5 inches when evaporator pads are used or when fans must move air through other high resistance materials.

Although the fans with a higher VER ratio will cost more initially, they will soon pay for themselves in energy savings. Furthermore, the more efficient fans are usually of higher quality construction and will last longer. When buying new fans, it makes sense to buy the most energy efficient ones. Replacing existing fans with high efficiency ones may also be a good investment.

Here's an example of the savings which can be realized by using energy efficient fans: assume that a barn needs 30,000 cfm for adequate ventilation. The barn currently uses three 1 hp fans with a VER of 10 cfm/watt. Assuming the fans run 50% of the time at an average cost of 8¢/kWh, energy costs for a year are $1050. These fans can be replaced with three 1/2 hp fans with a VER of 20 cfm/watt. The new fans which are twice as efficient will use half the electricity and save $525 in a year.

Table 1 presents yearly operating costs for various efficiency fans at several different electricity rates.

Table 1: Yearly operating costs to supply 100,000 cfm for 100% of the year[1]

Model	VER cfm/watt	HP	no. of fans needed for 100,000 cfm	Yearly operating cost at a kWh cost of electricity			
				8¢	10¢	12¢	14¢
A	12.6	1	8	$5600	$7000	$8400	$9800
B	16.4	1	6	$4200	$5300	$6300	$7300
C	21	1	5	$3500	$4300	$5300	$6100

[1] Greenhouses typically operate an average of 35% of the year and poultry houses 60%, so fan operating costs are 35% for greenhouses and 60% for poultry. Dairy operating time varies considerably. Fans on a dairy farm that keeps cows stabled year round run about 70% of the time.

FINDING THE EFFICIENT FAN

Fan efficiency ratings are not always easy to obtain. However, most commercially available fans in the larger sizes have been tested by the University of Illinois Bioenvironmental and Structural Systems (BESS) Lab and those data are available in the "Agricultural Fan Performance Directory". If manufacturers do not have performance data from an objective source, you should contact the manufacturers and ask for these published ratings. You will not only be helping yourself choose the best fan, but it will alert the manufacturer that consumers are concerned about energy efficiency.

Following are some pointers on the efficiency of fans in general:

- A larger fan is usually more efficient that a small one. The larger blades can move more air per unit of input power.
- A few larger fans are usually more efficient than many small ones. However, it is important to have at last two fans/room as back-up protection in case of failure.

CERTIFIED RATINGS

Since the main purpose of a fan is to move air, it is important to know how much air a selected fan will deliver. The most reliable test of fan performance is by an unbiased source and as realistically installed with shutters, guards and motors. The combined effects of motors, shutters and guards typically reduce efficiency by 30 to 50 per cent compared to tests without them. Most manufacturer's test data are not from an impartial source and are usually performed without the shutters, guards and motors.

MAINTENANCE

Keeping a fan in good repair is as important in reducing energy costs as buying the most efficient model. Poor maintenance can reduce a fan's efficiency by 50 percent or more.

Belt adjustment is an important maintenance problem with belt-driven fans. Belt adjustment must be performed regularly for full air movement. When a new fan or a new belt has been installed, readjustment is recommended after two weeks in order to take up the initial stretch.

Cleaning the fan periodically is also critical. Fine dust and dirt accumulate on the components, especially during cold winter months when more condensation usually occurs.

Following is a cleaning and maintenance procedure recommended by the National Food and Energy Council:

CLEANING

- make sure the power is OFF;
- remove the safety guard and wash it thoroughly;
- remove all loose dust and dirt from the motor using a vacuum or blower, making sure electrical connections and switch cover plates are replaced and securely fastened;
- clean fan blades and louvers with soapy water then rinse with clean water and dry or use a high pressure washer then allow to dry.

MAINTENANCE

- lubricate louver pivot points with light oil so they completely close when fan is OFF, and are fully open when fan is ON;
- for belt-driven fans, check belt tension seasonally and adjust accordingly. Also, oil fan shaft bearings;

- if motor shafts don't have sealed, lubricated bearings, add one or two drops of lightweight machine oil twice a year;
- maintain proper adjustment of air inlet controls to achieve most effective circulation within the building while considering season and building capacity used;

RESTARTING

- remove excess dust from thermostats and be sure that thermostats are set at desired temperature;
- when all fan maintenance procedures are complete, and proper motor protective devices are in place, replace protective guards and secure in original place.

FAN LOUVERS

Louvers should shut tightly when a fan is not operating. In a greenhouse, a single louver panel that will not close can waste up to $200 a year in heating fuel costs.

When the fan is on, louvers must be fully open. Otherwise they will restrict the flow of air from the building. A restricted fan operates longer and bears a heavier load to achieve the desired amount of cooling, which costs more in electricity. In many cases, you can fix louvers that are sticking open or shut just by cleaning them and applying oil and a rust solvent to the hinges. "Fully open" does not necessarily mean that the louvers stick out horizontally. Some foil shaped louvers may appear as not fully open but can offer superior performance.

CONTROLS

Fans can be controlled in a number of ways. The most common are on-off thermostats, variable speed thermostats and/or interval-timers. A thermostat measures the air temperature and turns the fan on or off when the specified temperature is reached. Ventilation requirements generally vary by a factor of ten so staging of fans and the use of variable speed or timer controls is typically needed.

Humidistats which sense humidity rather than temperature are less commonly used to control ventilation. The accuracy and reliability of humidistats are more sensitive to a dirty environment so they are not recommended for most farm applications.

ADDITIONAL PUBLICATIONS ON FARM VENTILATION

"Agricultural Ventilation Fans Performance and Efficiencies", from BESS (University of Illinois, Urbana-Champaign, IL), "Mechanical Ventilation Systems for Livestock Housing" and "Natural Ventilating Systems for Livestock Housing", from the Midwest Planning Service (Iowa State University, Ames, Iowa 50011) or NRAES; and "Ventilation with Curtains and Paddle Fans for Freestall Housing", an Agricultural Engineering Fact Sheet from the Cornell Cooperative Extension (EF-3).

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