

Energy Efficiency in Manufactured Housing

Final Report

September 22, 1991

Submitted to:

The Florida State Energy Office

Submitted by:

Sanford V. Berg, Project Director and Co-Principal Investigator

Barney L. Capehart, Co-Principal Investigator

Lynne C. Capehart, Project Coordinator

Public Utility Research Center

University of Florida

Gainesville, FL 32611

(904) 392-6148

Energy Efficiency in Manufactured Housing

Executive Summary

Manufactured housing in Florida has a mixed record when it comes to energy efficiency. The existing housing stock reflects underinvestment in energy conservation, given current and projected energy prices. We did not address retrofit programs, but were asked by the State Energy Office to develop initiatives for new manufactured homes. We found that the industry is quite diverse. Many purchasers of manufactured homes have chosen those homes because they are affordable. By taking a life cycle approach to purchases, buyers could achieve much more affordable housing. At the high end of the market, new buyers could also benefit from improved information and programs that draw attention to energy conservation opportunities.

We conclude that energy efficiency of manufactured housing could be significantly improved in three areas: the level of insulation in the home, the integrity of the duct system, and the energy efficiency of the major appliances--particularly the HVAC system. Project guidelines constrained the strategies which we could propose for making progress in these areas to be *voluntary* and *inexpensive*. So we tried to identify points of leverage in the decision-process.

Manufactured housing standards are set by the federal government through the Department of Housing and Urban Development, and the states are precluded from setting their own standards. Current HUD insulation standards which apply to Florida manufactured homes are low because insulation standards are targeted at winter heating needs, not summer air conditioning needs. Although HUD is in the process of revising these standards, the revisions may not improve the situation much for Florida, whose summer insulation requirements are comparable to the winter insulation requirements of the colder states. Florida residents who buy a HUD minimum-standard manufactured home could save about 30 percent on their heating bills and about 23 percent on their air conditioning bills if their manufactured homes were insulated at the highest practicable level. Assuming that a new HUD minimum-standard manufactured home is constructed and installed correctly, increasing the amount of insulation in the ceiling, walls and floors can be a cost effective action by new manufactured home buyers.

HUD also sets construction standards relating to duct installation in the air handling system. Leaks in the duct and air handling system represent a major energy loss in manufactured housing. According to a study by the Florida Solar Energy Center, when duct system is not leaking, manufactured homes use on the average of 17.2 percent less energy for cooling. Integrity of the duct system is critical if manufactured home owners are to receive the true energy value in their home.

Energy efficient appliances are the third area in which manufactured home owners can realize dollar savings on their energy bills. Fortunately, the federal government has enacted fairly stringent standards for the major energy-consuming appliances so that the cost-effectiveness of a program designed to convince people to upgrade may be small at the present time. The federal standards go into effect in January 1992.

Even if high efficiency units are purchased, buyers may be paying for oversized air conditioning units for manufactured homes. Not only does this increase the cost of housing, but it also places excessively high electricity demands during peak periods--requiring additional investment in electricity generating capacity. Utility analysts report that units can be oversized by as much as two tons. Procedures followed by manufacturers tend to size air conditioners for the worst-case orientation (a home facing East-West); the result may be to oversize the unit by a half ton if a more energy efficient North-South orientation is utilized. Such oversizing places a burden on the state's utility system and ratepayers. Furthermore, dealers may have incomplete information about sizing requirements. **Florida consumers could benefit from an investigation of the magnitude of the sizing problem and improvement of sizing methods for AC systems in manufactured housing.**

This project has designed several programs which have the potential to increase the number of customers buying energy efficient, new manufactured homes. These programs are the Dealer's Handbook program, the *EnergyStar* program, the Duct Improvement program, the Energy Brochures program, and the Energy Label program.

The Dealer's Handbook Program: This program provides each manufactured housing dealer in the state with a Handbook which explains how to sell energy efficiency to a customer. The Handbook emphasizes selling additional insulation and shows how the savings on utility bills is greater than the additional mortgage cost of the insulation. It provides dealers with a method for comparing the cost-effectiveness of the insulation level the customer is currently considering with that of various insulation upgrades.

The *EnergyStar* Program: This program sets statewide standards for an energy efficient manufactured home. It allows dealers to promote *EnergyStar* homes with literature describing the cost-benefit analysis provided by the program sponsor. Although not as effective a program as one involving direct financial incentives to the customer, this program can supply the potential buyer with the cost comparison information necessary to make the most cost-effective decision on energy upgrades. The *EnergyStar* program includes a dealer's handbook, a set of standards, publicity suggestions and informational brochures.

The Duct Improvement Program: Improving the integrity of the duct system is another cost-effective measure for promoting energy conservation. Energy losses through leaky ducts pose significant problems for both new and existing manufactured home owners. However, designing a program to promote the purchase of homes with good duct systems is a difficult project. One would think that consumers should not have to pay more to get duct systems that do not leak. However, present institutional arrangements and technical features of duct

systems are clearly inadequate from the standpoint of consumer interests. **The Florida State Energy Office should set up a series of meetings with the duct experts from the Florida Solar Energy Center, the manufactured housing producers, and other interested participants to discuss and solve the problems with leaks in the air handling system.**

The Energy Brochure Program: This program provides dealers with a variety of brochures describing the benefits of energy efficiency measures, particularly insulation upgrades. When consumers have information about the full costs of alternative energy conservation packages, they are in a position to make rational choices. Information brochures represent one vehicle for educating consumers and inducing greater emphasis on conservation by housing manufacturers and dealers.

The Energy Label Program: This program is modeled after the federal appliance energy labels. The labels cannot be as specific as those labels because manufactured housing customers special-order homes more often than appliance buyers special-order appliances. Nevertheless, this program gives customers something familiar to look for when they are looking at model homes, and making comparisons of life cycle costs. Again, the key goal is to give greater weight to energy conservation during the consumer search process. Then energy efficiency becomes a salient feature of manufactured housing--not just an afterthought.

Note that we are not singling out manufactured housing as particularly problematic in terms of energy efficiency. Many manufacturers and dealers make a genuine effort to produce and sell homes promoting energy conservation. However, the industry as a whole could do better. The programs recommended here represent first steps towards improved energy efficiency in manufactured housing. Although such homes represent only a fraction of Florida's housing stock, the recommended programs can be refined and extended to other sectors.

TABLE OF CONTENTS

Executive Summary	i
TABLE OF CONTENTS	iv
Section 1: Introduction	1
1.1 Background	1
1.2 Project Goal	2
1.3 The Need for Higher Insulation Levels	2
1.4 The Need for Improved Duct Systems	2
1.5 The Need for Improved AC Sizing Procedures	3
1.6 Potential Programs	3
Section 2: Analysis of the Problem	4
2.1 What Impedes Energy Efficiency in Manufactured Housing?	4
2.1.1 Manufacturing	4
2.1.2 Dealers	5
2.1.3 Installation	6
2.1.4 Regulation	6
2.1.5 Customers	7
2.1.6 Trade Organizations	7
2.2 Analysis of Energy Efficiency Measures	7
2.2.1 Insulation	8
2.2.2 Improvements in Duct Systems	9
2.2.3 Gas Heat	9
2.2.4 Electric Heat Pumps	10
2.2.5 Energy Efficient Appliances	10
2.2.6 Double-pane Windows	10
Section 3: Methodologies Used	10
3.1 Simulations of Thermal Performance	10
3.2 Cost-Benefit Analysis	11
3.3 Assumptions Used in Calculations	12
Section 4: Project Description	13
Section 5: Project Advisory Committee	15
5.1 Committee Input	16
5.1.1 Initial Input	16
5.1.2 Dealers' Handbook	17
5.1.3 Energy Brochures	17
5.1.4 *EnergyStar* Program	17

5.1.5 Energy Label	17
5.2 Review of the Final Draft	17
5.2.1 Duct Improvement Program	18
5.2.2 Utility Rates	18
5.2.3 Methodology, Data and Assumptions	18
Section 6: Focus Groups	21
6.1 Manufactured Housing Dealers/Salespeople Focus Group	21
6.2 Manufacturers Focus Group	22
6.3 Utility Focus Group	22
6.4 Customer Focus Group	23
Section 7: Florida Solar Energy Center Study on Duct Leaks	23
7.1 Supply Leaks	24
7.2 Return Leaks	25
7.3 Project Recommendation	26
7.4 JEA/GRU Letter to DCA	27
Section 8: Project Deliverables Required by Contract	27
8.1 Twelve Potential Programs	27
8.2 Final Programs	27
8.2.1 THE DEALER'S HANDBOOK PROGRAM	28
8.2.1.1 Program Design	28
8.2.1.2 Benefits of Program	28
8.2.1.3 Likelihood of Success	29
8.2.2 THE *ENERGYSTAR* PROGRAM	29
8.2.2.1 Program Design	29
8.2.2.2 Benefits of the Program	31
8.2.2.3 Likelihood of Success	31
8.2.3 THE BROCHURE PROGRAM	32
8.2.3.1 Program Design	32
8.2.3.2 Benefits of Program	33
8.2.3.3 Likelihood of Success	33
8.2.4 THE DUCT IMPROVEMENT PROGRAM	33
8.2.4.1 Program Design	34
8.2.1.2 Benefits of Program	35
8.2.1.3 Likelihood of Success	35
8.2.5 THE ENERGY LABEL PROGRAM	35
8.2.5.1 Program Design	36
8.2.5.2 Benefits of Program	36
8.2.5.3 Likelihood of Success	36
Section 9: Programs Beyond the Required Deliverables	37
9.1 Utility Participation	37

9.1.1	Utility Enhancements to the *EnergyStar* Program	37
9.1.1.1	Customer Incentives	37
9.1.1.2	Dealer Incentives	38
9.1.2	Utility Inspection of New Homes	38
9.1.3	Utility Retrofit Programs	39
9.2	Legislation/Regulation	39
9.2.1	Revised HUD Standards	39
9.2.1.1	Duct Systems	39
9.2.1.2	Insulation	39
9.2.2	Inspection Programs	40
9.2.3	Contractor Licensing for Setup Crew	40
9.3	Retrofit Programs	40
9.3.1	Specific Retrofit Recommendations	41
9.3.1.1	Research Program	41
9.3.1.2	Utility Retrofit Program	41
9.4	Other Potential Programs	42
9.4.1	Radio Public Service Announcements	42
9.4.2	High School Curriculum Suggestions	43
9.4.3	Study of Air Conditioner Sizing Rules for Manufactured Housing	43
Section 10: Concluding Remarks		43

APPENDICES

- A. *EnergyStar* Program
- B. Energy Brochure Program
- C. Energy Label Program
- D. Dealers' Handbook Program
- E. Statement in Support of Revisions to HUD Standards
 Letter in Support of JEA rEquest for Declaratory Statement
- F. Duct Improvement Program
- G. Other Potential Program Suggestions/Recommendations
- H. List of Proposed Programs--January 1991
- I. Evaluation Matrix for Suggested Programs--January 1991
- J. Cost-Benefit Analyses--Tables for North Florida
- K. Cost-Benefit Analyses--Tables for Central Florida
- L. Cost Benefit Analyses--Tables for South Florida
- M. Miscellaneous Tables
 Manufactured Housing Sales by Region

Energy Efficiency in Manufactured Housing

Section 1: Introduction

1.1 Background

Manufactured homes account for almost 20% of the new homes sold in Florida each year. In 1989, nearly 22,000 manufactured homes were sold in Florida.¹ In some areas of the state, manufactured homes represent a majority of new homes purchased. For example, Clay Electric Cooperative finds that almost sixty percent of its new hookups are manufactured homes.

Manufactured homes are exempt from state residential construction standards because their construction is regulated by the federal Department of Housing and Urban Development. HUD set energy-related standards in 1976; these standards provided a major improvement in manufactured housing. Before that time, many homes were built with no insulation at all, and occupants had excessive utility bills. The HUD standards have not been changed significantly since 1976, while state building codes have dramatically improved the energy efficiency of site-built homes.

In Florida, the current HUD insulation standards mean that as many as half of Florida's new manufactured homes may not contain a cost-effective level of insulation. Homes sold in North Florida are much more likely to be sold with minimum insulation than homes in Central or South Florida. Adding insulation after the manufactured home has left the factory is usually very difficult and very costly, so the decision to add extra insulation must be made when the home is purchased.

In Florida, according to the Florida Solar Energy Center (FSEC), the current HUD construction standards have not prevented manufactured homes from developing costly leaks of conditioned air in the air handling and duct systems. (This problem apparently occurs in other states as well.) These leaks may be the result of poor construction procedures. They may result when the home is moved from the factory to the homesite. They may be exacerbated if the home is moved first to the dealer's lot and then to a homesite. The leaks may also be introduced by the set-up crew which installs the home at the customer's site. These leaks can often be easily and cost-effectively repaired if they are located, but the customer is likely to assume that his home was constructed and installed properly and not check for such leaks. In addition, some manufactured home are designed so that checking for and repairing the leaks is almost impossible. Leaks in the duct and air handling systems reduce the energy efficiency of any level of insulation so that the many manufactured housing customers pay unnecessarily high energy bills.

¹ See Appendix M for tables showing the sales of manufactured homes by county in the North, Central and South regions of Florida.

1.2 Project Goal

The goal of this project is to improve the energy efficiency of new manufactured housing purchased in Florida. The project team has identified three significant ways in which energy efficiency could be increased. The first involves increasing the insulation levels in new manufactured homes. The second involves improving the integrity of the duct systems in these homes. The third involves improved sizing procedures for air conditioning units. These areas currently require the development of voluntary programs and cooperative efforts because manufactured homes, unlike site-built homes, are not required to meet the energy efficiency standards of the state building code.

1.3 The Need for Higher Insulation Levels

The HUD insulation standards are basically intended to insulate homes from winter cold. Thus, manufactured homes constructed for northern states must contain significantly higher insulation levels than those constructed for southern states. However, Florida's hot, humid climate makes the state's air conditioning load comparable to the heating load in many northern states. Thus, Florida manufactured home owners who purchase a home with minimum HUD insulation pay higher electricity bills than if they had invested in the cost-effective insulation level.

Computer simulations of the thermal performance of three sizes of manufacture homes indicates that higher levels of insulation than are currently found in most of Florida's new manufactured homes can be cost-effective. By adding insulation at the time a manufactured home is purchased, homeowners can generally downsize their air conditioning units and save energy and dollars. Unfortunately, the manufactured housing industry does not provide much energy efficiency information to customers at present.

Conclusion: *The energy efficiency of new manufactured housing can be improved by promoting purchase of the most cost-effective amount of insulation that can be added to the home.*

1.4 The Need for Improved Duct Systems

Throughout this project, a recurrent theme of energy loss from leaking ducts has been heard. The Florida Solar Energy Center completed a study of duct leakage in late January and identified manufactured housing as having significant leak problems with the ducts and air handling system. Our discussions with a member of a manufactured home installation crew also indicated that this was a severe problem. In the interview, he commented that the installers did not worry about lining up the ducts properly when they "married" the two sections of a double wide. Their responsibility was solely to get the ends of the sections to match up; if the manufacturer had not built the two sections so that the ducts joined together, the home was installed without correcting the problem. This and other problems with ducts were confirmed upon subsequent conversations with utility energy auditors,

manufactured housing inspectors from the Department of Motor Vehicles, and even manufactured housing dealers.

This problem is another one that is apparently regulated by HUD and the state is preempted from protecting Florida residents beyond the level of federal protection. The Jacksonville Electric Authority has asked the Department of Community Affairs to determine whether the state has authority to regulate those parts of the duct system which are connected after the plant leaves the manufacturer. (See Section 7.3) If the state can regulate this area, customers will receive some protection, but this solution does not address the interior duct system.

Conclusion: *The energy efficiency of many new manufactured homes can be increased by improving the integrity of the duct and air handling systems in both the manufacturing process and the installation process.*

1.5 The Need for Improved AC Sizing Procedures

Given the diversity of manufactured houses, including ultimate site orientation, the use of rough rules of thumb is understandable. However, the cost-effectiveness of conservation investments (including insulation) partly depends on the home-buyers' ability to downsize air conditioning units. Thus, we recommend a comprehensive examination of current and best practice. Our work indicates that standards used by dealers would allow significant savings from downsizing. Manufacturer's recommendations might be more conservative, since they cannot afford to have dissatisfied customers. Homeowners expect to be able to achieve desired levels of comfort with these systems. Unless savings associated with downsizing are emphasized, the one unhappy customer will outweigh the increased satisfaction of the ten who are aware that their decision to purchase energy efficiency leads to real savings.

Conclusion: *Since the cost-effectiveness of added insulation is sensitive to air conditioning sizing procedures, the industry and utilities should address this issue in conjunction with evaluations of duct material and installation procedures.*

1.6 Potential Programs

The project team initially identified thirty potential programs that might contribute toward achieving project goals. After consultation with various groups and the project advisory committee, the team narrowed the field to three top programs: 1) brochures which promote the purchase of additional insulation at the time a new home is purchased; 2) an *EnergyStar* program in which the program sponsor sets and publicizes statewide energy efficiency standards for new manufactured homes; and 3) an energy label program similar to the federal Energy Guide labels for appliances. After further input from advisory committee members, two additional programs--an Energy Efficiency Handbook for

Manufactured Housing Dealers and a Duct Improvement Program--were included in our top recommendations. These programs are explained in detail in this report.

The team has added four additional recommendations and provided some supporting documentation for the Energy Office. These include: state testimony in support of changes to the HUD standards; research into a cost-effective energy-efficiency retrofit program for existing manufactured homes; a state investigation into air conditioner sizing methods for manufactured housing; and development of a program to help the Department of Education to educate high school students about the benefits of energy efficiency measures in manufactured housing.

Section 2: Analysis of the Problem

Determining the best programs to increase the number of energy-efficient manufactured homes sold in Florida required analyzing two aspects of the problem. First, we had to understand the barriers to achieving energy efficiency in the manufactured housing industry. Second, we had to determine the most cost-effective energy efficiency measures to promote.

2.1 What Impedes Energy Efficiency in Manufactured Housing?

The project team approached the study of barriers to energy efficiency through interviews, surveys and focus groups conducted with the various segments of the manufactured housing industry. (For details of this approach, see Section 6 of this report.) As a result of this analysis, the project team concluded that energy efficiency could be improved at six levels in the manufactured housing industry: manufacture, sales, installation, regulation², consumer education, and the trade organization. The following discussion outlines impediments to energy efficiency that arise in each level.

2.1.1 Manufacturing

Manufacturers Sometimes Build Minimal Efficiency HUD-Standard Homes. Unless a customer special-orders a home with insulation upgrades, many manufacturers keep their costs low by constructing their homes with the minimum HUD insulation rating. HUD insulation standards make new manufactured homes much improved from the manufactured housing of twenty years ago, but the standards are not sufficient to achieve cost-effective energy efficiency today. Although these standards mean that a manufacturer cannot build

² The project was initially intended to address only voluntary programs because state regulatory authority over manufactured housing construction is preempted by federal rules implemented through the Department of Housing and Urban Development (HUD). However, HUD is currently reviewing its standards; a change in the federal HUD standards could significantly impact the energy consumption of manufactured homes. Therefore, the project has included a recommendation that the state aggressively request HUD to enact Florida-specific standards that address the problem through regulation. (See Appendix E.)

a home with less insulation than HUD allows, the standards also mean that manufacturers can call a home built with the minimum insulation energy-efficient because the "government" has said that level of insulation is all right.

Much of the literature from the industry lauds HUD-standard manufactured homes as being very energy efficient when they are simply more efficient than they used to be. The HUD-standard homes³ are not as energy-efficient as new site-built homes in Florida. Manufactured homes can achieve much higher levels of cost-effective energy efficiency than the HUD standard home. (See Appendices J, K and L for a comparison of cost-effectiveness of insulation levels.)

Manufacturing Processes Sometimes Result in Unintended Energy Losses. Many existing manufactured homes lose energy through the duct system. This problem has been documented by the Florida Solar Energy Center. (See Section 6 below for a more extensive summary of the FSEC duct study.) Most of these problems are a result of the manufacturing processes, although some are a combination of manufacturing design and the transportation and installation procedures. Improvements in this area are needed, but regulation and inspection is the best approach here. A voluntary program by manufacturers to develop improved techniques will result in some manufacturers making the improvements and others opting for cheaper production methods. Since duct leaks are not readily apparent, many customers may never realize they have a problem.

2.1.2 Dealers

Dealers Often Promote HUD Standard Homes. At the dealer's level, energy efficiency suffers for several reasons. First, many dealers who buy model homes for their lots buy the HUD standard home. This way the least possible amount is invested in the home. But the dealer may also have more incentive to sell his display model. If he wants to replace his current model with a new version, he is likely to promote the HUD home with its minimum insulation level so that he can get it moved off of his lot and out of his pocket instead of recommending that the customer special-order one with more insulation from the manufacturer.

Dealers Seldom Promote Insulation Upgrades to Lower Income Customers or Short-term Owners. Many dealers believe that lower income customers cannot afford to purchase additional insulation for their homes. These dealers are not sufficiently convinced that the extra cost will be returned to the customer. Even those who do believe this are not willing to push extra insulation on those customers who are just buying a manufactured home on a short-term basis. They seldom tell these customers that they will save enough in utility payments to pay for the monthly mortgage increase. Instead they look at the two-and-a-half

³ In this report, when we refer to a "HUD standard home", we mean a home that has insulation of R11--ceiling, R7--walls, and R7--floor. In most cases, this insulation level satisfies HUD's minimum insulation requirements.

to three year average payback period for the additional insulation. This is a valid consideration only if the customer is paying cash for the home, will live in it less than the payback period, and cannot resell it at a premium (due to its reduced energy costs).

Lower income customers would seldom have enough cash for outright purchase of a home, so they would benefit so long as they used air-conditioning. Even if they do not air-condition their homes, they may break even on insulation with heating savings. However, this depends on several factors such as region of the state, type of heating system, and size of the home. (See Appendices J, K and L for tables showing this data.)

2.1.3 Installation

Installers Sometimes Reduce the Energy Efficiency of a Home Through Faulty Installations. Energy efficiency may also suffer at the hands of the manufactured housing installer. Even an energy efficient manufactured home can be rendered less efficient than expected when the installation is faulty. Installers sometimes leave gaps in the floor, the ceiling and/or the ends of the home when they are putting the two sections of a double-wide home together. These gaps may be the result of poor lay of the land or faulty construction of the home. If the two sections do not fit together properly, the installer should fill in the gaps with additional insulation, but this takes the installer more time and may not be done. Installation problems are generally the responsibility of the dealer, but can sometimes be laid at the feet of the manufacturer. However, buyers are often unaware of the potential inefficiencies that can arise at this stage. Information and education programs can induce greater customer involvement in ensuring that appropriate procedures are followed.

2.1.4 Regulation

Federal Regulations Often Fail to Recognize State-Specific Concerns. Florida has adopted stringent energy-efficiency building codes for site-built homes. These codes take into account the special climate problems faced in Florida. The state's high humidity and high temperatures require different solutions than states with lower humidity, lower temperatures or both. Florida is presently in a region for HUD insulation standards that also includes much of the rest of the country. The standards are oriented less toward heavy air-conditioning loads than mild heating loads. Thus, Florida manufactured home owners who purchase HUD-standard homes do not have a cost-effective level of insulation for cooling.

A Regulatory Gap May Arise Between Federal Regulation and State Regulation. Some areas of manufactured housing construction may go essentially unregulated because neither jurisdiction is exercising regulatory authority or one is exercising it in an overbroad manner. One example of this shows up in the area of manufactured housing installation. HUD inspectors do not inspect the installation of a manufactured home, yet some parts of the air-handling system that are connected during the installation process are supposedly regulated by HUD, and state inspectors generally do not check them. Thus, the customer has no

regulatory protection in this area where improper connection procedures can result in energy losses.

2.1.5 Customers

Customers Do Not Have Adequate Information on Which to Base Their Purchasing Decisions. Literature from the manufactured housing industry implies that manufactured housing is highly energy efficient. While many homes are--if they are special-ordered that way, or if the manufacturer builds homes above HUD specifications--many are built to minimum HUD specifications. HUD-standard homes are not energy efficient from a cost-effectiveness standpoint. They are only energy-efficient compared to homes with very little insulation. Thus, customers do not get the best bargain for their money when they purchase a HUD-standard home. No other literature is widely-available to manufactured housing customers, although there are some publications such as the manufactured housing brochure published by the Energy Extension Service of the Institute of Food and Agricultural Science at the University of Florida, or a brochure distributed by Clay Electric Cooperative to some of the manufactured housing dealers in its service area.

2.1.6 Trade Organizations

Manufactured Housing Lobbyists Work to Maintain a Positive Image for the Industry. The Florida Manufactured Housing Association tries to promote the image of manufactured homes as energy-efficient, safe, affordable housing. They perceive efforts to promote energy efficiency as having a potentially negative effect on their industry, since it seems to draw attention to a potential liability of this housing type. For example, they believe that customers who see information explaining the benefits of added insulation will respond not by buying a manufactured home with additional insulation, but by not buying a manufactured home at all. The industry has not emphasized programs to educate customers about their energy options.

Manufactured Housing Lobbyists Seek to Protect Their Industry from Programs that Might Treat Manufactured Housing Differently from Site-built Housing. Representatives of the manufactured housing industry are concerned about their industry being treated any differently from the builders of site-built homes. They feel that their competitive position is reduced with regulations and they insist that any new programs--whether voluntary or mandatory--apply equally to both types of home builders. This concern, which is valid when the problems are identical, is sometimes carried over into areas where the problems are different and the solutions must also be different.

2.2 Analysis of Energy Efficiency Measures

A variety of energy efficiency measures were considered by this project, but in general only those that were extremely cost-effective have actually been recommended. This is because the project was asked to recommend programs that were *voluntary* and *low-cost*. Voluntary

programs must be ones that will have a high degree of acceptance by the participants. Extremely cost-effective measures are most likely to be attractive to all groups whose participation is desired: manufacturers, dealers and customers. Customers who do not currently consider energy efficiency in their manufactured housing purchases are unlikely to be sold on measures that show little return on investment or just break even. Dealers are not going to promote measures for which customers express no interest.

2.2.1 Insulation

The project team has concluded that insulation is a cost-effective purchase that a manufactured home-buyer could make to improve the energy-efficiency of a manufactured home that only satisfies minimum HUD insulation standards. According to a survey of manufacturers and manufactured housing dealers, many manufactured homes sold in Florida have an insulation rating of R11 in the ceiling, R7 in the walls and R7 in the floor. This minimum level of insulation satisfies current HUD standards.

Using a computer simulation (described in further detail in Section 3), heating and air conditioning costs were computed for three different sizes of manufactured homes: a single-wide home 14 feet by 74 feet; a double-wide home, 24 feet by 48 feet; and a double-wide home, 28 feet by 56 feet. These homes were simulated for four different insulation levels: R11-7-7; R19-11-11; R21-11-14; and R28-11-19. The R11-7-7 home was considered the baseline home and the costs for all other homes were compared to the costs for the baseline home. Comparisons were also made for upgrading from one insulation level to the next. (These comparisons are found in tables in Appendices J, K, and L.) Costs were computed for three climate zones of the state--North, Central and South--and for three types of heating--LP gas, electric strip heat, and electric heat pumps.⁴

The simulations show that an insulation level of R28-11-19 can be cost-effective in all regions of the state. Not only do customers save money on their heating and cooling bills with this level of insulation, many customers can also downsize their air conditioning units by from one-half to one ton and save money on the initial purchase of the air conditioner. Calculations of net cost-effectiveness (decrease in monthly utility payments offset by increase in monthly mortgage payment to cover the cost of the insulation) include the assumption that the air conditioner will be down-sized; the cost of the insulation is therefore reduced by the savings on the air conditioner. Calculations of cost-effectiveness assuming no downsizing were also performed, although this assumption is somewhat unrealistic; the difference in thermal envelopes of the R11-7-7 home and the R28-11-19 home is so great that if the air conditioner is not downsized it will be larger than required, cost more than it should, and place an unnecessary burden on the utility. Because calculations without

⁴ The counties in each of these climate zones are listed in Appendix M. Tables showing the results of the simulations are included in three appendices to this report. Appendix J contains the tables for the North Florida region; Appendix K for Central Florida; and Appendix L for South Florida.

downsizing are much more conservative, the savings are substantially reduced, but many customers still benefit.

As a result of the simulations, the project team has concluded that new manufactured home buyers are better off buying extra insulation in almost all cases. One type of buyer who might not benefit is the buyer who pays cash for the home and lives in it for less than two years; these buyers will not recover the extra cost of the insulation during the time they live in the house. However, they should be able to recapture some of the cost when they sell the house because it should have a better market value than one with less insulation.

The other buyer is the one who does not use air conditioning a substantial portion of the year. This buyer may or may not be better off with insulation depending on the type of heating used (see tables in Appendices J, K and L). However, if this buyer even installs a window unit (a likely event in Florida), he would be better off with extra insulation. Therefore, since the additional cost of insulation is so small, even the poorest buyer should be encouraged to buy a minimum of R19-11-11 insulation in North Florida.

2.2.2 Improvements in Duct Systems

The project team reviewed the duct study performed by the Florida Solar Energy Center (see Section 6 below) to determine whether improvements in the duct system should be a part of any recommended program. The difficulty in recommending duct improvements as part of a consumer education program is that the ducts are an essential part of the home and most customers are likely to assume that they should be constructed properly. Unlike the purchase of extra insulation, customers may believe they should not have to pay extra for properly constructed and installed duct systems since that is what they were supposed to be paying for to start with. A program emphasizing the inadequacy of current installation arrangements could cause a loss of consumer confidence in the manufactured housing industry. Furthermore, the FSEC study was technical in nature, avoiding specific recommendations for duct improvements. Thus, the project team was unable to tell customers what to ask for. Our recommendation is that the Energy Office develop a series of workshops with the FSEC staff and representatives of the manufactured housing industry to determine the most cost-effective ways to improve the duct systems. Electric utility representatives also ought to be involved since they might identify programs qualifying for Florida Public Service Commission conservation cost recovery. The involvement of utility inspection or certification would give impetus to improved installation procedures.

2.2.3 Gas Heat

Heating systems using either natural gas or LP gas are cheaper for the customer to operate than electric strip heating. (See tables in Appendices J, K and L) Dealers should be made aware of that fact and should encourage their customers not to purchase electric strip heating if at all possible. Literature for customers should also point out the high cost of electric strip heating.

2.2.4 Electric Heat Pumps

Many manufactured homes, particularly in South Florida, are heated with electric strip heating. This is an extremely energy-wasteful method of heating and contributes to large peak demands. However, an analysis of replacing electric strip heating with electric heat pumps shows that this is not cost-effective for most customers. (See tables in Appendices J, K, and L.) Heat pumps may be extremely cost effective for utilities, however. Thus, we recommend that any effort to convince customers to buy heat pumps must include some incentive from the affected utility. Otherwise, dealers who generally broker the HVAC system purchase will have minimal customer-oriented basis for promoting heat pumps.

2.2.5 Energy Efficient Appliances

Energy-efficient appliances are one way to save energy in manufactured homes. However, the new federal appliance efficiency standards mean that efforts to convince customers to purchase high-efficiency appliances are not as important as in the past. Although purchase of appliances that exceed the federal standards will still result in energy savings, many appliance dealers do not yet carry appliances that exceed the standards. Therefore, the project team has not included specific appliance recommendations in any manufactured housing program.

A specific example of this point arises in the air conditioning area. The federal standard for air conditioners will require purchase of an air conditioner with an SEER of 9.5 or 10 by January 1992. Current air conditioners average SEER 8. The more efficient air conditioners are highly cost-effective, but the federal standards are likely to be in effect before any program recommended by this project could be fully implemented.

2.2.6 Double-pane Windows

Double-pane windows for manufactured homes were not found to be attractive investments for manufactured housing customers, and therefore, have not been recommended for inclusion in any of these programs. Although double-pane windows are cost-effective, the return on investment is very small and the payback period far larger than most customers are willing to accept.

Section 3: Methodologies Used

3.1 Simulations of Thermal Performance

In order to determine the savings that might be realized for each insulation upgrade option, computer simulations of thermal performance were run on three manufactured homes of sizes representing the most common models sold. The simulation was performed using a computer program called A Simplified Energy Analysis Method (ASEAM) produced by the

American Consulting Engineering Council. ASEAM uses the ASHRAE modified-bin method to make heat loss or heat gain calculations.

The simulation relies heavily on temperature data and solar data collected from several weather stations around the state of Florida. Tallahassee weather data was used to represent the North Region. Tampa weather was used to represent the Central Region. An average of Tampa weather data and the Miami weather data was used to represent the South Region. The program assumed that customers would cool their homes to 75° and heat them to 68°. The program also assumed that customers would not air condition their homes if the temperature was below 78° or heat them if the temperature was above 65°.

In each region, three sizes of homes were simulated. The home sizes, representing homes commonly sold, were as follows:

Large single-wide	14x74
Average double-wide	24x48
Large double-wide	28x56

Each size home was simulated at four insulation levels. These levels (ceiling-wall-floor) were:

R-11-7-7	(minimum HUD standard)
R-19-11-11	(commonly sold level)
R-21-11-14	
R-28-11-19	(practical maximum for the average design home presently being manufactured)

Homes were simulated with an air conditioning system with SEER 10 because the National Appliance Efficiency Standards that go into effect on 1 January 1992 require that degree of efficiency for split systems. Three heating systems were simulated: a Propane (LP) heater (AFUE 0.78), an electric resistance heater, and an electric heat pump.

The differences in energy consumption for heating and cooling that result from the simulation of homes with different insulation levels should be used for comparison purposes rather than as exact answers. Actual consumption will vary for specific individual homes, but the savings ratio from one insulation level to the next should be comparable.

3.2 Cost-Benefit Analysis

A computer spreadsheet was used to perform the cost-benefit analysis. The spreadsheet used inputs from a dealer and manufacturer survey about prices for various options and from the cooling and heating loads developed by the ASEAM simulation. From these inputs we determined the energy (Kwh) and demand (Kw) savings for each insulation option was determined.

The spreadsheet then compared the energy use of homes with varying levels of insulation and calculated the yearly savings on a customer's utility bills as a result of increasing the insulation levels. The spreadsheet can perform calculations for the following options: home sizes of 14x74, 24x48, 28x56; insulation levels of R11-7-7, R-19-11-11, R-21-11-14, R28-11-19; heating with LP gas, an electric furnace (electric strip heat), or an electric heat pump.

The ASEAM computer simulations and the spreadsheet program were developed initially in projects conducted for Clay Electric Cooperative and Seminole Electric Cooperative. The spreadsheet program was revised and refined for the analyses needed by this project.

3.3 Assumptions Used in Calculations

Customer Behavior: The simulation assumed that customers would cool their homes to 75° and heat them to 68°. The simulation also assumed that customers would not air condition their homes if the temperature was below 78° or heat them if the temperature was above 65°.

Energy Costs: The cost of electric energy was assumed to be \$0.08 per Kwh, which is approximately the statewide average price for residential electricity for 1000 kwh. LP gas was assumed to sell for \$1.10 per gallon, a number verified by an informal survey of local distributors of LP gas. The installation costs of similar options were considered to be the same.

Sizing the Air Conditioner: A survey of manufactured housing dealers and their air conditioning installers showed that most of them use the following rules for sizing the cooling equipment.

Insulation Level	Sizing Rule
R-11-7-7	1 ton per 400 square feet
R-21-11-14	1 ton per 500 square feet
> R-21-11-14	1 ton per 600 square feet

No independent calculations of HVAC sizing were performed in this project. Installer's sizing rules were consistent among the different contractors that were surveyed, and the decision was made to accept those rules in order to avoid the possibility of conflicting with the size recommendations the dealer gives the customer.

Commenting on an earlier draft of this report, representatives of the Florida Manufactured Housing Association (FMHA) questioned this use of dealer's sizing rules. They said that these rules seriously undersize the air conditioning units. This may indicate an internal problem in the industry if the customer bases his purchase decision on the salesperson's statement that a smaller (and cheaper) unit is acceptable and then the manufacturer says that a larger and more expensive unit is necessary. This discrepancy between the dealer's rules of thumb and the FMHA standards needs to be resolved within the industry so that

the customer obtains appropriate information. Undersizing can be a problem for the customer while oversizing not only increases customer costs, but can affect the utility industry adversely.

Costs of Insulation Upgrades: These costs were representative of what the majority of dealers said they would charge a customer for an insulation upgrade package.

(ceiling-wall-floor)	Single Wide	Double Wide
R-19-11-11	\$300	\$400
R-21-11-14	\$450	\$550
R-28-11-19	\$600	\$700

Cost of Split-System Air Conditioner: These numbers are the result of a survey of air conditioning dealers. They should only be used for comparison purposes and not as exact prices.

Size-ton	SEER 10
2.0	\$1183
2.5	1346
3.0	1541
3.5	1657
4.0	1732

Section 4: Project Description

The directive for this project was to find ways to increase the purchase of energy-efficient manufactured homes through low-cost, voluntary programs. After studying the various segments of the market, the project team concluded that successful programs must target one or more of the following groups:

- Manufacturers must be stimulated to build more energy-efficient homes.
- Dealers must be stimulated to sell more energy-efficient homes.
- Customers must be stimulated to request energy-efficiency in manufactured homes.

The project has examined several ways to achieve this stimulus: direct financial incentives, indirect financial incentives, and regulatory requirements. Financial incentive programs require a sponsor who receives some direct financial gain from increased energy-efficiency. Indirect incentives include such programs as marketing programs and customer education on the economic benefits. Regulatory requirements do not fit the description of voluntary programs, but if the goal is highly desirable and has strong public benefits, regulation can be the least-cost way to obtain the results.

Direct financial incentives could be provided by the utilities. If utilities perceived a benefit to them from improved energy efficiency in manufactured housing, they could sponsor one or more of the following programs:

- Reward dealers for selling energy-efficient homes.
- Reward manufacturers for building energy-efficient homes.
- Reward customers for buying energy-efficient homes.

These incentives could take the form of cash payments to dealers or manufacturers, cash rebates to customers, or a lower electric hookup charge for customers buying an energy-efficient home.

Indirect financial incentives can arise through the marketplace. If customers understand the savings involved with energy efficient home purchases, they should have a financial incentive to purchase such a home without any additional direct cash inducements from utilities. The following programs can help increase the demand for energy-efficient manufactured homes by providing customers with the information they need to understand the savings.

- Set energy-efficient homes apart with a seal of energy quality.
- Set energy-efficient homes apart with an energy consumption label.
- Provide customers with information on cost-effectiveness of energy-efficiency
 - (a.) at the dealer
 - (b.) before they go to the dealer

Regulatory programs can also provide the desired stimulation. The following programs could help decrease the supply of less energy-efficient homes.

- Increase HUD standards.
- Set Florida standards for any energy efficiency measures not precluded by HUD standards.
- Require dealers to carry a stock of energy efficient homes.

The manufactured housing industry, however, views increased regulations as a detriment to the survival of the industry. Citing a heavy existing regulatory burden, the industry representatives have expressed a fear that any additional regulations would reduce their industry's competitive edge and drive more dealers and manufacturers out of business.

The challenge for the project team was to take the viewpoints of all the participants into account and then develop a series of programs with the following objectives:

1. To increase the purchase of energy-efficient manufactured homes.
2. To educate the public about the benefits of purchasing more insulation than HUD standards require.

3. To involve supplier groups (utilities, manufactured housing dealers/producers) in helping increase energy efficiency.

Section 5: Project Advisory Committee

The project advisory committee was designed to include members from each of the groups potentially interested in programs to improve the energy efficiency of manufactured housing. These groups included: manufacturers/dealers, homeowners, utilities, and regulators.

The following individuals comprised our advisory committee:

Manufacturers/dealers: Beth Loftus, Florida Manufactured Housing Association

Homeowners: Elsie McGregor, homeowner and representative of the Florida Federation of Mobile Home Owners
Fred Yonteck, former director of the Florida Mobile Home Owners Association; director of the Florida Institute of Resident-Owned Communities
Thelma Moore, representing the American Association of Retired People

Utilities: Jack Davis, Florida Power Corp.
J.D. Steedly, Clay Electric Cooperative (through April)
Ed Bennet, Clay Electric Cooperative (since May)

Regulators: Jim Dean, Florida Public Service Commission (through April)
Roland Floyd, Florida Public Service Commission (since May)

Energy Research: Dr. Subrato Chandra, Florida Solar Energy Center

Ex-officio: Daryl O'Connor, Florida State Energy Office

The advisory committee was formed to help evaluate the potential programs identified by the project team and to suggest additional approaches.

In February, we provided the project advisory committee with a list of thirty possible program options with a brief description of how each could work. The project team had spent the first six months of their effort in identifying these thirty candidate programs and had tentatively identified four of these programs as having the most merit. Project advisory committee members were asked to assist in narrowing the list of thirty programs to three

model programs by identifying the programs they felt should be ranked first, second, and third and to comment on the descriptions of the proposed programs.

The project team then revised the ranking of the top three programs in response to the input received from the committee members and the Energy Office. A few committee members did not submit any evaluation, although all members who had not commented were contacted several additional times and asked for their feedback.

5.1 Committee Input

The project team kept the project advisory committee apprised of all stages of the project and solicited comments on the proposed programs at all stages of their development. Some of the input is summarized below.

5.1.1 Initial Input

Several committee members urged us to include a retrofit program as one of the three model programs. However, the Florida State Energy Office project monitor emphasized the goal of achieving energy efficiency in new manufactured housing, so we dropped retrofit programs from the top three. Nevertheless, we have included a recommendation on retrofit programs as a part of this report.

Comments from the utility representatives on the project advisory committee changed the focus of the programs slightly. There appeared to be little interest in the utilities becoming significantly involved in programs for new manufactured homes. Several factors were involved here: few utilities believe new manufactured homes to be a significant part of their new home market; and the downturn in the economy this year made the utilities reluctant to consider investing in new conservation programs. Finally, many of these programs should be sponsored on a statewide basis; a program by a single utility will not have the same impact as a program with a statewide sponsor.

As a result of the initial committee input, the project team concentrated primarily on developing programs that would (a) have a statewide impact; (b) affect only new manufactured homes; (c) be relatively inexpensive to implement; and (d) be voluntary. The list was narrowed to the following programs: the *EnergyStar* program; the energy labelling program; and the information brochures program. The *EnergyStar* program includes the potential for enhancement by the utility industry and that possibility should be presented to the Florida Public Service Commission for their consideration.

After further discussions with advisory committee members in June and July, the team concluded that one additional program should be added to the final set. That was a handbook program directed at the manufactured home dealers and salespeople. Some committee members were skeptical that consumers would voluntarily purchase additional insulation even with more information. The handbook program will provide

dealers/salespeople with background information and may give them some financial incentive to promote sales of additional insulation if they can convince their customers to spend the potential savings on additional features.

5.1.2 Dealers' Handbook

The advisory committee has reviewed the draft handbook. No comments or suggestions were made about the handbook concept, but the FMHA raised a number of questions about the methodology of the study and the final results on which part of the handbook was based. These comments are discussed more fully in Section 5.2.

5.1.3 Energy Brochures

The advisory committee reviewed copies of the proposed brochures. Members' comments were incorporated, and revised brochures were developed. The Brochure Program is described in detail in Appendix B.

5.1.4 *EnergyStar* Program

The committee was given an extensive follow-up description of the *EnergyStar* program and how it is designed to work. Committee members were asked to provide any additional guidance or suggestions. Most committee members liked the *EnergyStar* program concept, although a few expressed reservations about the emphasis on insulation upgrades. Comments received from the FMHA in early August indicate a marked lack of enthusiasm in the industry for the program. The FMHA suggests that using a quality seal program like the *EnergyStar* program will lead customers who feel they cannot afford an *EnergyStar* home to decide not to buy a manufactured home at all. The *EnergyStar* Program is described in detail in Appendix A.

5.1.5 Energy Label

The advisory committee reviewed copies of the proposed design for the Energy Label. The only adverse comments were from the FMHA which considers the energy use labels to have the same negative connotation as the *EnergyStar* program. The Label Program is described in detail in Appendix C.

5.2 Review of the Final Draft

The advisory committee reviewed the first draft of the final report and individual members made a variety of comments. The FMHA, which had not identified any problems with our proposals until early August, requested a meeting to discuss the technical analysis which forms the basis of some of the project conclusions. This meeting was held on September 10, 1991. All members of the advisory committee were invited to the meeting as an opportunity to provide any final feedback on the project. The format for the meeting

included an initial presentation about the project background and recommendations. Then the FMHA representatives raised questions about the methodologies, data, and assumptions used in the study. (See Section 5.2.3 below for a more detailed discussion of these issues.) After a lengthy discussion, the meeting broke for lunch, and committee members divided into small discussion groups. This part of the meeting allowed committee members representing different interests to discuss issues with one another.

5.2.1 Duct Improvement Program

The FSEC representative reiterated his feeling that improving the duct systems was important to achieving energy efficiency in manufactured housing. Although duct improvement is not especially conducive to the type of programs recommended in this report, the project team agreed that improving ducts should be a major thrust of a manufactured housing program. Therefore, the project team has added a recommendation on a Duct Improvement Program to its final set of programs.

5.2.2 Utility Rates

One of the utility representatives said the cost effectiveness calculations were questionable because the average price of electricity was actually 7¢/kwh and LP gas was actually \$2.00/gallon. Our research was unable to verify this. We located only one utility whose current residential electric price was as low as 7¢/kwh. Florida Power & Light's rate is almost 7.9¢/kwh--more likely to represent the state average. A survey of LP gas dealers indicated that bulk residential LP gas sells for 90¢ to \$1.10 per gallon.

5.2.3 Methodology, Data and Assumptions

The FMHA representatives expressed their concerns with the methodology, data, assumptions, and conclusions of the report, especially with regard to the cost-effectiveness of the insulation levels. They asked the following questions or made the following statements about the study:

1. Why did the project use ASEAM instead of ASHRAE Manual J to perform the cost effectiveness analysis?

The project team used ASEAM which uses the ASHRAE modified bin method to determine the annual heating and cooling energy required for buildings. ASHRAE Manual J calculations give only the sizing information; the ASEAM calculations provide the total energy needed to heat or cool a structure. We did not use the ASHRAE Manual J procedure to size the air conditioner needed. As stated above, we used the sizing rules that the dealers reported that they used.

2. Present homes cannot be built with R28 insulation in the ceiling and would have to be completely redesigned. In some cases that redesign would have the effect of making the home so tall that it could not pass under bridges.

In the survey of dealers and manufacturers conducted in 1989 and verified by some additional interviews in 1990-1991, all of the dealers said the R28 ceiling insulation was a level that they sold and none mentioned redesign being necessary. If R28 is not technically feasible, the manufacturers have not communicated this to their dealers. The dealers are apparently taking orders and the manufacturers filling orders for such homes saying they have been constructed with this insulation level.

3. If Florida homes were required to meet the U values for states which have cold winters, the end result would be that the air conditioners would be grossly oversized.

The project team has recommended that Florida be considered for high insulation levels based on the heavy air-conditioning load for the state. This AC load is comparable to the heavy heating load for northern states. Oversizing the air conditioner in Florida based on the size heating system needed in northern states does not seem rational. If HUD is developing new standards, they should be able to address the air conditioning situation in Florida and set specific AC requirements separate from the heating requirements in the colder states.

3. The sizing rules we recommended in our report were not realistic. No air conditioner could cool 600 square feet per ton even with R28-11-19 insulation. Why didn't the project use ASHRAE Manual J to size the AC units?

The project did not develop sizing rules; we merely reported on the sizing rules the dealers and AC installers said they used when selling manufactured housing customers an air conditioning system. If the dealers are recommending undersized air conditioners, they need to have better communications with the manufacturers.

In the discussion of AC sizing, the FMHA representatives said that although manufacturers are required to size the air conditioner for each home they build, they do not size the air conditioner based on the exact orientation of the home. Since they do not know the orientation, they size it based on the worst case orientation (East-West exposure). This results in oversizing of a half-ton for homes that have a North-South orientation. The oversizing means that some customers pay more for their AC units than necessary and that the demand on the utility is larger than it should be. With 22,000 homes sold each year, if half of them have air conditioners that are oversized by a half ton, the state has 5,500 unnecessary tons per year of air conditioning added to the utility system if all homes are air conditioned. At a demand rate of 1.5 Kw per ton of air conditioning and assuming a diversity factor of 50%, this amounts to 4125 kW or 4.13 megawatts of unnecessary capacity the utilities must supply each year.

The utility representatives at the meeting said that they frequently found oversized air conditioners on manufactured homes when they did energy audits. Sometimes the AC's were oversized by as much as two tons. Thus, it appears that oversizing of air conditioning units is a potential energy problem with manufactured housing.

The sizing issue is also an example of the disparity in energy efficiency between manufactured homes and site-built homes. Under the insulation levels required by the Florida Energy Code, many site-built homes can be cooled with 1 ton per 1000 square feet. Thus, manufactured homes with lower insulation levels place a much greater burden on the utility system of the state.

Conclusion: *The state should develop a program to deal with potential oversizing of air conditioners in manufactured housing.*

4. The manufactured housing market in North Florida is different from South Florida. Higher insulation levels are sold in South Florida.

This statement is correct and any program to increase the energy efficiency of manufactured housing must take these regional differences into account. The data tables developed by the project are divided by region of the state, and cost-benefit calculations were performed for each region. A Dealer's Handbook must similarly be tailored to the specific region where the homes are sold. When the dealer uses the handbook to determine the benefits of additional insulation, he must start with the level of insulation his customer plans to buy and then determine if a higher level is also cost effective.

5. Your draft report says that the average manufactured home sold in Florida has an insulation level of R11-7-7. Homes with R11-7-7 are not widely sold in Florida.

The draft report should have said that many homes in Florida are sold with minimum HUD insulation levels, not that the average home had that insulation level. The University of Florida surveyed dealers for Seminole Electric Cooperative in 1989 with the following results:

Cooperative	Percent of homes sold with insulation greater than minimum
Central Florida	35%
Clay	33%
Glades	15%
Lee County	52%
Okefenokee	29%
Peace River	97%
Sumter	30%
Suwannee	29%
Talquin	50%
Tri County	18%
Withlacoochee	79%

Section 6: Focus Groups

Initially, the project planned to use focus groups to determine the best procedures to follow in implementing the program. As the project team began to identify the relevant interest groups, it became clear that it would be more productive to work with individual members from some of the groups rather than try to set up a true focus group meeting for each category originally envisioned for the project. Nevertheless, representatives of utilities and manufacturers participated in focus group discussions. Chris Janiszewski, Assistant Professor (Marketing) provided guidance on the structure of these gatherings.

6.1 Manufactured Housing Dealers/Salespeople Focus Group

The initial survey of manufactured housing dealers/salespeople indicated that they were not willing to take time from their businesses to go to a meeting and discuss marketing techniques in front of competitors. They were very happy to meet with us at their place of business and to spend up to an hour discussing the manufactured housing business. They gave us a good insight into their customers and the impediments to selling customers more insulation. Thus, our plan for a focus group of manufactured housing dealers/salespeople was dropped in favor of individual interviews with area dealers/salespeople and a mail

survey of dealers and salespeople around the state. The mail survey participants were drawn from the participants in a previous survey of manufactured housing done by the Industrial & Systems Engineering Department for Seminole Electric Cooperative.

The information gathered from the interviews and surveys showed that most of the dealers knew that insulation above the minimum required by HUD standards is a good buy for their customers. However, most dealers do not want to guarantee their customers a specific savings. Furthermore, customers tend to suspect that the salesperson's real motive is to increase profits. Therefore, the dealers want backup documentation from a reliable, objective source that they can show their customers in order to convince the customers that spending more on a new home will actually save the customer money. They were extremely interested in having someone like the University of Florida provide this information.

Conclusion: *The customer needs to have information on energy efficiency purchases from a neutral, objective source.*

6.2 Manufacturers Focus Group

The impediments to a manufacturers focus group were similar to the dealer focus group. The project team discussed with the advisory committee representative of the Florida Manufactured Housing Association the possibility of running a focus group session at the FMHA annual meeting. This was not possible to arrange because the annual meeting was scheduled to occur within two months of the start of our project and the agenda for the annual meeting had already been firmly established with no time available for additional presentations. Therefore, the project team used the same interview technique as with the dealers to gather the necessary information. The final project meeting included four representatives from the FMHA and provided that group with an opportunity to critique the draft report, resulting in a de facto focus session.

At the interviews which were conducted during site visits to manufacturing plants, the manufacturers stated that they knew that HUD insulation standards were very low. Some manufacturers already build all their models with higher insulation levels than required under HUD standards. They all expressed their interest in seeing the HUD standards increased. Without a mandatory requirement for a high insulation level, some manufacturers will build homes at the present HUD minimum because some customers are more concerned with the initial cost rather than the operating cost of the home.

Conclusion: *Manufacturers need a strong incentive to increase the insulation levels voluntarily. A state seal of energy efficiency approval could serve as a marketing incentive.*

6.3 Utility Focus Group

In October 1990, the project team met with the energy conservation committee of the Florida Electric Power Coordinating Group. This committee is composed of representatives

from each utility who are responsible for their utility's energy conservation programs. A comprehensive focus group approach was used with the committee members. These were the people who would have to sell manufactured housing conservation incentive programs to the company. They would also be the ones who would design and implement any energy conservation program directly targeting manufactured housing.

The utility representatives were divided into two small groups of approximately equal size. At each group, the issue of the utility incentives for energy conservation was discussed. The question of adding manufactured housing to utility conservation programs was also covered.

Utility staff generally stated that the utility's interest in conservation revolved around issues of customer service. When customers complain about high bills, utilities try to satisfy those customers through conservation programs. Defaults on bills (often because of an inability to pay high bills) is another area of utility concern. To the extent that conservation helps reduce the default rate, utilities have an additional incentive to promote their programs.

With respect to manufactured housing, many of the utilities did not consider new manufactured homes to present a significant conservation opportunity in their territory. The percent of new manufactured home hookups was small compared to new site-built homes. According to the utility representatives on the advisory committee, however, manufactured home owners do have frequent high bill complaints.

Conclusion: *Utilities will only develop significant manufactured housing efforts if:*

- 1) they perceive manufactured housing to be a large (and negative) part of their market; or,*
- 2) they receive a directive from the Florida Public Service Commission to include energy efficiency improvement of manufactured housing in their conservation programs.*

6.4 Customer Focus Group

The plan for setting up a customer focus group was dropped. Identifying potential manufactured home buyers was difficult. The team considered interviewing people who had just purchased a home, but were unable to get that information from the dealers. Although the county tag agent seemed a likely alternative source of this information, this turned out not to be feasible because the tag agent did not keep records of which tags were manufactured home tags. The only information they had was how many tags were manufactured home tags, not who the purchasers were.

Because the project team had developed insight into the reasons for customer resistance to energy efficiency measures through its interviews of the manufacturers and dealers, the customer focus group was dropped. With the high proportion of advisory committee members representing this segment, the project team believed that this perspective would be retained through the extensive review of all project materials and the comment process as a result of the reviews.

Conclusion: *Customers do not receive the information they need to evaluate the benefits of energy efficiency measures. In part, this is because the salespeople do not have the information. Therefore, a successful program must convince the salespeople as well as the customer that energy efficiency is a cost-effective purchase.*

Section 7: Florida Solar Energy Center Study on Duct Leaks

About six months into our study, we received preliminary results from the Florida Solar Energy Center (FSEC) study on energy losses through duct leaks. This study covered all types of residential housing including manufactured homes. It became apparent that solving problems in the construction and installation process was necessary to insure the integrity of ducts in manufactured housing. The FSEC final report verified these problems, but did not make specific recommendations for solving the problems with respect to manufactured housing. A summary of the report follows:

According to the FSEC study⁵, leaks in the duct system of manufactured homes are a significant cause of energy losses. Thus, a program which emphasizes improved duct systems would contribute to energy savings in this housing sector by preventing energy losses.

The FSEC study found the major problems with duct leaks in manufactured housing occurred in the air supply system. In order of magnitude, the problems occurred in the following areas: supply arm seals; supply duct to floor connections; the end of supply trunk lines; misaligned supply registers; and flex duct connections.⁶

Additional leaks were found in the return duct systems. The largest leaks, in order of magnitude, developed in the package unit cabinet; the central return box; the flex duct connections; and when the subfloor space is used as a return plenum.⁷

Many of these leaks could be prevented or at least mitigated with better manufacturing practices. Our suggestions for changes follow each identified problem.

7.1 Supply Leaks

1. The leakage at the supply arm seals occurs because the joint between the main supply trunk and the metal shafts to the floor are not usually sealed.

⁵ Investigation of Air Distribution System Leakage and Its Impact in Central Florida Homes (Final Report to the Governor's Energy Office); James B. Cummings, John J. Tooley, Jr., Neil Moyer; Florida Solar Energy Center; January 31, 1991 (hereinafter referred to as FSEC Duct Study)

⁶ FSEC Duct Study, p. 25.

⁷ FSEC Duct Study, p. 24

This results in moderate to large leaks into the subfloor area.⁸ If the subfloor area is not well-insulated, the energy loss is further increased.

Manufacturers should seal the joint between the main supply trunk and the metal shafts to the floor.

2. The supply arm is seldom sealed to the floor; instead, the metal duct is simply stapled to the subfloor material. Large leaks often result at these junctions.⁹

Manufacturers should apply a sealant to the metal duct and then staple it as well. Caulking around the duct after it is stapled would also help mitigate the leakage.

3. Sometimes, the ends of the supply trunk lines are not sealed. When this occurs, large supply air leaks occur.¹⁰

Manufacturers should insure that the ends of the supply ducts are closed off. This could be part of a check list for installing the duct system.

4. Occasionally the supply duct hoses are not lined up with the floor register. This causes large leaks because the connections are not air tight.¹¹

Manufacturers should insure that the ducts are correctly aligned with the registers.

5. Leaks often occur whenever a duct is joined to another piece of the air conditioning system (the air handler, the trunk line) or when two ducts are joined together. Sometimes, these joins are completely unconnected. These joins may also separate during the process of transporting the home from the factory to the new owner's property.

Manufacturers should develop procedures to ensure that the connections do not separate. This may include using an adhesive connection rather than staples or using a stronger adhesive. Areas likely to come loose should be

⁸ FSEC Duct Study, p. 25

⁹ FSEC Duct Study, p. 25

¹⁰ FSEC Duct Study, p. 25

¹¹ FSEC Duct Study, p. 26

placed on the installer's checklist so that resealing can be performed as part of the installation.

6. Many new manufactured homes are constructed with the supply ducts in the ceiling and there is no access to the ducts in this ceiling cavity unless the ceiling is removed. Thus, any leaks in these ducts are essentially permanent.¹²

Manufacturers should carefully weigh the advantages of this construction method over the disadvantages to the customer of the potential for high energy losses.

7.2 Return Leaks

1. Often the bottom of the package unit cabinet rusts out. This can cause large air flow leaks.¹³

This does not seem to involve the manufactured housing manufacturing process. However, either the manufacturer or dealer could provide the customer with some notice of this problem and advise them to keep an eye on the package unit. If it is the AC manufacturer's responsibility to develop better drainage, the state should look into air conditioning unit construction standards.

2. At the point where the return duct meets the house floor, there is a return plenum box which is a central return. This commonly leaks to adjacent walls or at the floor connection.¹⁴

The return duct should be carefully sealed to the return plenum box. The manufacturer should include this on the installer's checklist.

3. Some homes are manufactured using the space between the floor and the pan as a return plenum. When this happens, large leaks occur because this area is not airtight.¹⁵

¹² FSEC Duct Study, p. 32

¹³ FSEC Duct Study, p. 24

¹⁴ FSEC Duct Study, p. 25

¹⁵ FSEC Duct Study, p. 25

Manufacturers should not use this space as a return plenum. New models should be designed with airtight return plenums. New HUD standards should outlaw this type of design.

Duct leaks have a significant impact on peak electric demand. This is because the air conditioner must work longer and harder during the hotter parts of the day to provide the desired cooling.¹⁶ Preventing leaks in the first place through better manufacturing procedures would alleviate the need for corrective action later. In addition, utility audit programs should target duct leaks in manufactured housing. The potential for such leaks may be greater than with site-built homes because the manufactured homes are generally moved after much of the duct system is installed.

7.3 Project Recommendation

The Florida Solar Energy Center has offered no specific recommendations for duct improvement for manufactured housing and has no plans at present for achieving such duct system improvement. However, FSEC is currently setting up duct workshops for site-built homes so that the problems may be solved for that segment of the residential housing population. This project recommends that a series of workshops be conducted for manufactured housing to provide that industry with similar assistance. An outline for such a program is included as Appendix E.

7.4 JEA/GRU Letter to DCA

The Jacksonville Electric Authority has requested the Florida Department of Community Affairs to decide whether some or all parts of the duct system of manufactured homes are exempt from HUD standards. JEA would like the state to consider adopting energy standards to tighten up the energy losses from duct leakage. This project has sent a supporting letter to DCA as a result of our studies. (See Appendix F.)

Section 8: Project Deliverables Required by Contract

8.1 Twelve Potential Programs

Although the contract called for the project to identify and briefly describe twelve programs from which to select a set of three that could be implemented, the project monitor for the State Energy Office requested that the list not be limited to twelve. Instead, the team was requested to supply as many programs as possible even if some of the programs might not initially seem feasible. As a result, the team developed a set of thirty potential programs. These programs were briefly described in an attachment to the January 1991 quarterly

¹⁶ FSEC Duct Study, p. 39

report (see Appendix H). Copies of the descriptions were sent to the advisory committee for their comments.

8.2 Final Programs

Under the contract, the project was to develop three programs for the Energy Office which, if implemented, should meet the goal of improving the energy efficiency of new manufactured homes. Although the team in conjunction with the advisory committee had begun to develop three programs, as additional input was received, the project team decided to include five top programs. These programs (described below and in the Appendices) are the Dealer's Handbook program, the *EnergyStar* program, the Brochure program, the Duct Improvement program, and the Energy Label program. All of the programs are voluntary. Most help provide the customer with a step-wise comparison of the cost difference between energy-efficient homes and HUD standard homes. They are relatively low-cost programs and have few implementation problems. The program to distribute Energy Efficiency in Manufactured Housing Handbooks to dealers targets the dealers and salespeople with the goal of persuading them to convince their customers to buy additional insulation. A Dealer's Handbook should be included with the *EnergyStar* program and the Brochures program, but if neither of those programs is implemented, a separate Dealer's Handbook would be very useful in educating the salespeople.

8.2.1 THE DEALER'S HANDBOOK PROGRAM

Enlisting the dealers and salespeople in the effort to promote the sales of more energy efficient homes is an important step. Unless these people are convinced that they can increase their sales, and perhaps also increase their commissions, they are unlikely to push additional insulation and other energy-saving features.

8.2.1.1 Program Design

Program Sponsor: This program should be sponsored by the Florida State Energy Office. Providing handbooks to the dealers should be done on a consistent basis. An alternate way to sponsor dealer handbooks would be through the state's utilities, but some confusion may arise as to which utility should provide the handbooks when more than one utility serves the area in which a dealer has his market. Furthermore, dealers may be confused as to whether the handbook applied equally to all utilities in their market area or only to the sponsoring utility.

Dealer's Handbook: The Dealer's Handbook will provide dealers and salespeople with basic information they need to understand the benefits of additional insulation. It will also show them how they can profit from that information. The handbook will include a worksheet to show salespeople how to explain the benefits to their customers. A copy of the Dealer's Handbook is found in Appendix D.)

Distribution of Handbook: The handbook could be mailed to dealers through the Florida Manufactured Housing Association.

Publicity: The program sponsor should ask the FMHA to include information about the handbook in the FMHA newsletter. The handbook could also be a topic of discussion at the annual meeting of the FMHA.

8.2.1.2 Benefits of Program

Industry Benefits: The manufactured housing industry would benefit from the availability of a dealer's energy efficiency handbook because many dealers do not have access to what can be termed "objective" information about energy efficiency. The handbook would give the dealers the ability to show their customers information generated from outside the industry. It would also help better educate some of the dealers and salespeople about the merits of energy efficiency.

Customer Benefits: If salespeople are better informed about the benefits of energy efficiency, they will help the customers make better informed decisions. Customers who purchase energy-efficient homes will save money.

8.2.1.3 Likelihood of Success

This program will only be successful if the salespeople read and understand the handbook and then pass the information on to their customers. This makes the contents of the handbook and any publicity effort within the industry crucial to the success of the program.

8.2.2 THE *ENERGYSTAR* PROGRAM

The *EnergyStar* program is a voluntary, reasonably low-cost, continuing energy efficiency program with the potential to significantly increase the sales of energy efficient manufactured housing. It is a marketing program that is designed especially to inform the low-to-moderate income purchaser of manufactured housing of the benefit to them from purchasing a new manufactured home with maximum insulation levels. Targeted at those buyers with high-school educations or less, the program provides a recognition signal so that customers can easily identify their Best Energy Buy manufactured home.

The *EnergyStar* program is similar in concept to programs in other states such as the Bonneville Power Super Good Cents program for manufactured homes, the South Carolina Governor's Energy Efficiency Standards for Manufactured Homes, and the Santee-Cooper (SC) Cooperative Good Cents Program for Manufactured Homes.

8.2.2.1 Program Design

Program Sponsor: For state-wide exposure, the program requires a sponsoring organization with statewide visibility and credibility. State governmental entities, such as the Governor's Office, the Department of Community Affairs or the Public Service Commission (PSC), would be excellent sponsors. State-wide utility organizations, such as the Florida Electric Utility Coordinating Group or Seminole Electric Cooperative, are other program sponsor possibilities. The Florida State Energy Office is currently considering program sponsorship.

Standards: The program sponsor will set voluntary minimum standards for energy-efficient manufactured housing. Manufactured homes that meet or exceed these standards will qualify as *EnergyStar* homes. The recommended standards include:

- an insulation package of R28 (ceiling), R11 (walls), and R19 (floors);
- energy-efficient fluorescent lighting fixtures in kitchens and bathrooms;
- energy-efficient fluorescent outdoor porchlights;
- insulation of all hot water pipes exposed to outside air; and,
- water conserving plumbing fixtures.

Although installation of an AC system with an SEER greater than 10 is highly desirable, most manufacturers do not install the air conditioning system. Therefore, this option is not one of the recommended standards. It could, however, be part of an enhanced program in cooperation with the state's electric utilities. Note that the extent of downsizing is a key determinant of the cost effectiveness of additional insulation. See Tables 1-3 in Appendices J, K, and L for the savings per dollar investment--under different sizing assumptions.

If duct standards can be developed, these should be part of the *EnergyStar* program. As an alternative, a blower door test could be part of the installation process for an *EnergyStar* home, but this will add to the installation cost and the customer should not have to bear this burden of checking the home to insure that the manufacturer built it properly.

Certification/Logo: The program sponsor will provide a standard logo/seal that manufacturers can place on any home meeting the *EnergyStar* criteria. However, the program sponsor is not responsible for certification, and literature describing the program should make that clear. The manufacturer must certify that a home meets the *EnergyStar* standards; this certification occurs when the manufacturer places the *EnergyStar* logo on a home.

Purchasers of an *EnergyStar* home will receive a certificate from the manufacturer stating that they have purchased an *EnergyStar* home. They can use this certificate if they resell their home. They will also receive a booklet describing other energy efficiency measures they can take to site, setup, and operate their manufactured home.

Inspection Program: The program sponsor could initiate some type of minimal inspection program to insure that manufacturers are actually building the *EnergyStar* home when they certify it. However, this inspection program may create potential liability for the state that would not exist in the absence of inspections. Rather than develop an inspection program for the actual homes, the project team recommends that the program sponsor tour the manufacturing facilities and watch the process. If a manufacturer failed to construct a home to standards, the sponsor could revoke that manufacturer's right to use the *EnergyStar* logo. Even this program comes close to creating liability.

Publicity: Advertising is an important component of the program. The program sponsor should provide Public Service Announcements (PSA's) to radio and TV stations. Dealers should be encouraged to include their sales of *EnergyStar* models as part of their own advertising. These advertising costs would be incorporated into the dealer's own advertising campaign. (Sample PSA's are included in Appendix A.)

Documentation for Dealers: The program sponsor will provide dealers with written information describing the benefits of the program for use in promoting the *EnergyStar* homes. (Sample informational brochures and flyers are included in Appendix A.)

8.2.2.2 Benefits of the Program

Almost 20% of the new homes in Florida each year are manufactured homes. The total number of manufactured homes sold in Florida in 1989 was 22,000. According to our survey results, at least half of these are constructed with only the minimum level of insulation. Of the others, very few contain the level of insulation recommended by this report. If this program results in a significant increase in the insulation of the homes sold, the state will realize energy benefits in both number of kilowatt hours consumed and in kilowatts of demand required.

Utility Benefits: A home that is insulated at the *EnergyStar* standard will generally result in a demand reduction of 1.5 kilowatts because the air conditioning system can be downsized by 1 ton. This will help utilities with peak load control. If half of the homes currently sold with only the minimum level of insulation (approximately 5,500 homes) were upgraded to the recommended insulation level, the state would realize a demand reduction of 8.25 megawatts. Even with a diversified demand of 50%, the demand reduction would be approximately 4 megawatts per year.

Customer Benefits: Customers can significantly reduce their energy use for heating and air conditioning with increased insulation. They will save more on their monthly utility bill than the monthly mortgage cost of the additional insulation, resulting in a net benefit to the individual customer.

Manufactured Housing Industry Benefits: If the *EnergyStar* program allows manufacturers to standardize their production line, they will realize some dollar savings.

Furthermore, as people learn that cost-effective energy-efficient insulation reduces the real cost of owning manufactured housing, the program could increase the sales of manufactured homes by making them even more competitive with site-built housing. Dealers who use the *EnergyStar* program as a marketing tool may also realize a greater market share than their non-participating competitors and may realize greater profits from the higher initial cost of the home.

8.2.2.3 Likelihood of Success

Customers should respond positively. They will have independent information about the cost-benefit of spending a little more money on insulation in order to save money on electric and gas bills. They are more likely to believe information from an unbiased source than they are to trust a salesman with a profit motive.

Dealers should also support this program. They have asked for written documentation to support the claim that additional insulation saves the customer more money than it costs. The credibility of such documentation would be high with government sponsorship. This program provides such documentation through the dealer's handbook.

Manufacturers should be pleased because this program involves voluntary standards. It does not require changes in the manufacturing process. The manufacturer's only new obligation is to certify that the home meets the *EnergyStar* standard; this is the equivalent of the manufacturer's current duty to certify the homes are built to HUD standards. If the *EnergyStar* program standardizes requests for additional insulation, the manufacturing process should be simplified.

Utilities should support this program because it can help reduce peak demand for electricity.

8.2.3 THE BROCHURE PROGRAM

Brochures which provide customers information on energy savings measures they can take are an essential part of an effort to educate customers about the benefits of energy efficiency in manufactured housing. Consumers cannot make informed decisions without information, and that information is not currently available to the majority of potential customers visiting manufactured housing dealers. Manufacturers and dealers have been understandably reluctant to print such brochures, fearing that they might constitute a guarantee of performance. However, a state agency or a utility could provide such brochures to dealers for distribution to customers. Both entities would command customer respect. Neither entity would have to supply a brochure that seemed to guarantee a specific dollar savings.

The brochure program could also complement the *EnergyStar* program. Brochures which encouraged the purchase of additional insulation as well as other energy saving measures could point out the *EnergyStar* program as one option for energy efficiency.

8.2.3.1 Program Design

Program Sponsor: The Florida Public Service Commission or the Florida State Energy Office could sponsor the brochure program. Brochures such as this are a typical responsibility of state government.

Utilities or utility organizations such as Seminole Electric or the Florida Electric Power Coordinating Group (FCG) would be good brochure sponsors. This program is a better candidate for a more generic brochure by Seminole or FCG simply because dealerships may sell to customers in more than one utility's service area. However, neither organization has the same consumer-assistance orientation that the individual utilities do. Clay Electric Cooperative is already supplying an energy-efficiency brochure to dealers in its service area. Both Clay and Seminole have expressed interest in the brochures developed by the project.

Brochure Design: The brochures should be brief, eye-catching, easy to read, and easy to understand. They should explain the value of insulation upgrades in terms of net dollars saved per month or per year. The brochures should be written so that the examples are clearly just examples and the customer's own energy savings will depend on the customer's lifestyle.

The brochures should be targeted toward a lower-income, high school educated population. This group is least likely to understand the value of additional insulation. Furthermore, salesmen seldom try to sell insulation upgrades to this group.

Sample brochures designed by the project team are included in Appendix B.

Distribution: The biggest problem with the brochure program is in distribution of the brochures. Sending brochures to all the manufactured housing dealerships may be unwieldy for a state-wide sponsor. However, the FMHA may be willing to help mail brochures to their member dealers or to make them available upon request.

If individual utilities sponsor brochures for their service area, the distribution problem will be lessened.

Documentation for Dealers: Dealers are the key to making the brochure program successful. Dealers must promote the brochures to their customers in order to increase the number of customers who read and understand the information. Dealers must also provide room for the brochures in their sales office and must display them fairly prominently. Dealers should also make sure their salesmen understand the brochures.

As with the *EnergyStar* program, documentation for dealers is an important component of the brochure program. Dealers must have some additional backup information to answer questions that the brochures may generate.

8.2.3.2 Benefits of Program

The benefits of the brochure program are similar to the benefits of the *EnergyStar* program. Each manufactured home sold with added insulation and other energy efficiency features as a direct result of the brochures saves the owner money and the state energy.

8.2.3.3 Likelihood of Success

Manufactured housing dealers do not currently have energy-efficiency brochures available for their customers. Thus, each customer who is handed one of the program brochures, or who picks it up at the dealer, is likely to learn more about energy-efficiency than he knew before he read the brochure. Educating customers is critical to getting them to purchase energy efficiency measures.

8.2.4 THE DUCT IMPROVEMENT PROGRAM

According to the Florida Solar Energy Center study, duct leaks are a significant source of energy loss in many Florida homes. The leaks have a number of causes such as poor workmanship, failure to use proper sealing materials, or even failure to seal the ducts at all. These leaks are prevalent in site-built homes and the state is undertaking an effort to remediate the situation.

One might expect that duct leaks would be less likely to occur in manufactured homes because they are mass-produced in controlled factory situations with supervisors around at all times. However, the rate of duct leaks is apparently at least as high in manufactured homes. The problem may be exacerbated in manufactured housing because the homes are moved after they are constructed and the duct connections are subjected both to the stress of moving at high speeds along the highways and to the stress of bouncing up and down on bumpy roads and streets. A further complication is that the set-up crews for manufactured homes are not required to be licensed and sometimes these set-up crews have little or no experience in the correct installation procedures.

A program to improve the integrity of the duct systems in new manufactured homes is clearly needed in Florida. Such improvements could more easily be implemented than with site-built homes because there are fewer manufactured home producers than site-built home producers, and changes to the duct sealing system can be incorporated into new home construction on the production line more easily than with the myriad of home builders around the state. A program like this could allow the manufactured housing industry to improve its image by publicizing its efforts to improve the ducts. However, with HUD standards precluding state regulation, this program can only be voluntary and without the cooperation of the entire manufactured housing industry, many Florida manufactured home owners will continue to suffer unnecessary energy losses. Therefore, in addition to any voluntary program, the state should ask HUD to review the FSEC duct study and develop more stringent standards for the duct systems.

8.2.4.1 Program Design

Program Sponsor: A duct improvement program for manufactured homes should be sponsored by the Florida State Energy Office. The Energy Office was the sponsor for the FSEC contract and should take the results of that contract and use them to improve the state's energy situation. No other agency has the same goal.

Workshops: The Energy Office should set up one or more workshops to bring together the parties interested in the duct leak problem with manufactured housing. Suggested participants are: the FSEC researchers on the duct study; members of the manufactured housing industry; utility conservation department staff members who do energy audits on manufactured housing; air conditioning supply and installation specialists; a representative of the Florida Bureau of Mobile Homes; energy staff members from the Florida Senate and House; a representative of the Florida Public Service Commission; and possibly a representative of HUD's manufactured housing office.

Workshop sessions should address: duct leak problems that have been identified; the extent of the energy loss that results; causes of these leaks; manufacturing methods for preventing the leaks; voluntary and regulatory options for implementing any desired changes.

Following up on the Workshops: The manufactured housing industry may be willing to implement a voluntary program for duct improvement. If so, FMHA should be encouraged to develop some uniform guidelines for all of its manufacturers and some means to encourage voluntary compliance. The industry could police itself by providing random blower door tests on newly-installed homes to insure that their improvements were working. Some manufacturers told the project team that they corrected problems in the design and on their assembly line when they found recurring problems in their product.

The utility industry could also assist with duct improvement by offering new manufactured home purchasers with a blower door evaluation of their home shortly after the home is installed. While this would not prevent the leaks from occurring, it would help the customer identify whether the installer or the manufacturer was responsible for the leaks.

The Energy Office could develop a consumer information program that identified duct leaks as a potential problem with manufactured homes and alerted customers to check their ducts for such leaks. This type of program should not be adopted unless the industry fails to deal with the problem. The Energy Office could also ask HUD to review the duct problems and put more stringent duct standards into their anticipated revisions.

The legislature could require satisfactory results from a blower door test before any new home, manufactured or site-built, received a certificate of occupancy.

8.2.1.2 Benefits of Program

The FSEC study showed duct leaks to be a problem in 21 of 29 manufactured homes, or 72%. If these numbers carry over to the general population of manufactured homes, a significant proportion of the state's manufactured home owners are paying too much to heat and cool their homes.

8.2.1.3 Likelihood of Success

Duct improvement will only occur on a voluntary basis if the manufacturers are willing to implement changes to achieve such improvement. However, the manufacturers interviewed for the project expressed their willingness to correct problems with their homes if they can be identified. Therefore, any meeting to discuss the problems should probably have a representative of each manufacturer in the state in attendance. The manufacturers want to make sure their products are performing adequately.

8.2.5 THE ENERGY LABEL PROGRAM

This program involves the development of energy use labels for manufactured homes similar to the federal labels for appliances. The labelling program should be directed only at display model manufactured homes and not at all homes that leave the factory. Instead of giving the energy use for the exact home on the lot, the label should provide information about the approximate cost of heating/AC for a range of insulation levels.

This program does not break new ground. The federal government already has an appliance labelling program that is not perceived as a guarantee program, but rather an information program.

8.2.5.1 Program Design

Program Sponsor: This program also requires a statewide sponsor such as the Florida State Energy Office, the Florida Public Service Commission, the Florida Manufactured Housing Association, or the Florida Electric Power Coordinating Group. To implement the program, the label sponsor would provide labels either to manufacturers to be placed on the display homes as they left the factory or to dealers to place on their display models when they arrive on the lot.

Label Design: The label design should mimic the federal appliance energy labels, but should be specifically designed to point up heating/AC savings for manufactured housing. It should be easy for customers to understand, and should not be misleading. The sample label included in Appendix C is a general label that includes relevant information on savings due to insulation upgrades.

Publicity: The sponsor should have a publicity program to educate potential customers about the labels. Although brochures explaining the labels may be helpful in answering some questions, the labels themselves must be essentially self-explanatory.

Dealer's Handbook: Dealers will also have to understand the information presented by the label so they could explain it to their customers. The program sponsor will provide a dealer information sheet to give the dealer answers to customer questions. (A copy of the dealer information sheet is found in Appendix C.)

8.2.5.2 Benefits of Program

Labels will draw energy use to customers' attention. Many customers may not have realized that they could spend less on utility bills if they increased the insulation in their home. The comparison tables on a label will help customers understand this better. If the labels are well-designed, customers should respond by buying more efficient homes. This will result in substantial energy savings for the state.

8.2.5.3 Likelihood of Success

If well-implemented, this program will probably be more successful than the brochure program simply because more customers would be likely to see a label prominently displayed in a model home than they would be to pick up a brochure. However, the success depends on whether dealers choose to put labels on the display models. The voluntary nature of the program leaves the degree of success somewhat up to the industry itself.

Section 9: Programs Beyond the Required Deliverables

In addition to the four final programs described in Section 8, the project team has performed additional work on several other programs. The project team has included brief descriptions of these additional programs, has provided greater detail in the appendices for some of the programs, and has listed recommendations for further action by the Florida State Energy Office where appropriate. The programs are not ranked by desirability, but are categorized as programs that involve utility participation; programs that involve legislation or regulation; retrofit programs; and miscellaneous other programs.

9.1 Utility Participation

9.1.1 Utility Enhancements to the *EnergyStar* Program

Utilities will realize a reduction in peak demand for each *EnergyStar* manufactured home. An FP&L study shows a significant contribution to peak by a typical manufactured home. A 1989 study by the University of Florida determined that a demand reduction from .75 to

1.5 kilowatts is the likely result from each new manufactured home upgraded from the HUD standard insulation of R11-7-7 to the *EnergyStar* standard of R28-11-19.

9.1.1.1 Customer Incentives

Utilities could give customers incentives to increase the efficiency of their *EnergyStar* home. For example, the customer could qualify for a rebate if the *EnergyStar* home were installed by a certified/licensed setup crew. This would insure that the installation was energy-efficient. A similar incentive for an *EnergyStar* customer who purchased an AC system with an SEER greater than 10 would result in additional kilowatt and kilowatt-hour savings.

Since each kW of demand costs the utility at least \$1000 to supply with base load capacity, the utilities could offer to share the savings with customers who insulated their home to a level that reduced the tonnage of the air conditioner. A one-ton reduction in size is equivalent to a 1.5 kW reduction in demand. Assuming a diversified demand of 50%, a customer who reduces the size of his air conditioner by one ton will save the utility approximately \$750. If the utility shared half this savings with the customer, the customer would have \$375 to help pay for the insulation upgrade. If the air conditioner was downsized by one-half ton, the share the utility could offer the customer would be about \$180 to help pay for the insulation.

This size incentive should be more than enough to persuade a customer to upgrade the insulation. For example, assume \$700 is the maximum needed for an insulation upgrade (as most of the dealers said). If the customer could downsize a ton, he could pay for half of the extra insulation with a \$375 utility incentive. He would also save an additional \$200-300 on the downsized air conditioner. Thus, instead of costing him \$700, the extra insulation would only cost between \$75 and \$175. He will save this amount on his utility bills *in less than a year*. If this same customer were looking at a home with R19-11-11 insulation to begin with, his incremental cost of insulation would be less, but his demand reduction would be the same because the dealers say there is no downsizing of the air conditioner expected when increasing the insulation from R11-7-7 to R19-11-11. In this case, even a half-ton reduction in size would be paid for in most cases by a utility incentive of \$180 plus between \$70 to \$200 savings on the smaller air conditioner.

9.1.1.2 Dealer Incentives

Utilities could give dealers an incentive to display *EnergyStar* model homes by giving the dealer a one-time payment for each different *EnergyStar* model displayed on the lot. The rebate could be equal to the cost of the extra insulation. Some provision must be made to ensure that the dealer replaces an *EnergyStar* model with another *EnergyStar* model when he sells a display model. This could be part of the utility's contract with the dealer. In essence, the utility would purchase the right to have an *EnergyStar* model displayed.

The cost of providing a financial incentive to the dealer is far less than the cost of providing a financial incentive to every *EnergyStar* home purchaser. Utility costs to provide a dealer incentive for the display program depend on the number of manufactured housing dealers in the service area and the number of *EnergyStar* models the utility wants displayed. The utility should not have many additional costs after the one-time investment in a dealer's display models. However, the relatively high turnover among dealerships could increase the administrative and incentive costs associated with this program variation.

Customer participation should be greater with these additional program options. The State Energy Office should ask the Florida Public Service Commission (FPSC) to consider directing utilities to develop a manufactured housing component of their energy conservation programs.

9.1.2 Utility Inspection of New Homes

Utilities would inspect manufactured homes as part of the hookup to electricity procedure. This inspection would only be required following the set-up of a manufactured home and not when the hookup was due to a change of occupancy status.

The inspection would look at the joins of a double-wide manufactured home to make sure they were well-insulated. It would also look at the crossover vents to insure proper connections. The inspection could also include an energy audit to ensure that the occupants knew how to achieve the most efficient use of energy. Using a blower door to inspect could provide a check against duct leaks.

The FPSC could allow utilities to refuse service to a manufactured home that did not meet some minimum level until the problem was fixed.

9.1.3 Utility Retrofit Programs

See Section 9.3.1.2 below.

9.2 Legislation/Regulation

9.2.1 Revised HUD Standards

One of the most efficient ways to upgrade the energy efficiency of new manufactured homes is to revise the HUD standards. The State of Florida should put together a coalition of affected interests (consumers, regulators, utilities, dealers) and seek Florida-specific HUD standards for insulation and improved standards for duct systems. (See Appendix E for a sample program.)

9.2.1.1 Duct Systems

Many of the duct leakage problems could be solved by new manufacturing standards which require both better sealants and construction processes that minimize any duct separation in transit. If the ducts are in the ceiling and are relatively inaccessible, checking for leaks is difficult and repairing them is almost impossible. Thus, HUD should prohibit designs which make ducts inaccessible. HUD should also prohibit designs which involve joining duct systems in the installation process. If necessary, both halves of a double wide should have independent duct systems which could only join at a point where the join was accessible and serviceable.

9.2.1.2 Insulation

Increased insulation standards should be set for Florida. The air conditioning load due to the state's heat and high humidity is comparable to the heating load in much colder climates. Thus, insulation levels should be comparable also. With Florida commanding a large share of the nation's manufactured housing market, a Florida-specific standard (which could include other Gulf Coast states) should not be onerous for manufacturers. Florida manufacturers say they would welcome such a standard. Furthermore, insulation is commonly special-ordered, so no major assembly line changes would be needed, even for out-of-state manufacturers who did not need to meet the same insulation criteria in their own state.

The insulation standards we recommend are based on the maximum insulation levels reasonably achievable in today's manufactured homes. The space between the ceiling and the roof cannot accommodate a level higher than R28, and the walls cannot accommodate higher than R11. Higher insulation levels could go under the floor, but R19 is a cost-effective level. Since air-conditioning is a large component of Florida's heating/cooling load, insulating the floor to retain cool air longer is important.

9.2.2 Inspection Programs

Even the most energy-efficient manufactured home models may be installed poorly. This does not negate the value of increased insulation, however; it simply means that customer does not get the full benefit of it. Legislation requiring a comprehensive inspection program or some type of licensing requirement for the installation crews could help solve this problem. The PSC could also encourage utilities to include either full inspections or spot checks as part of a conservation program. Most utilities do not otherwise want to be involved in inspection programs.

9.2.3 Contractor Licensing for Setup Crew

Some duct leaks result from the manufactured housing setup process. For example, the join of duct systems for a double-wide home can be a significant source of air leak. If the

manufacturer misaligns the ducts, the setup crew is the only point at which the misalignment can be corrected. Often, however, the setup crew has no training or no materials with which to realign the ducts, and the home will likely be installed so that the ducts leak from the outset.

Other energy leaks result from misfits between the two sections due to the misalignment of other parts of the manufactured home or to the lay of the land.

9.3 Retrofit Programs

Retrofit programs for manufactured homes are a necessary component of the state's effort to decrease energy consumption. New manufactured homes account for approximately 20 percent of the new homes purchased each year in Florida. Thus, manufactured homes comprise a significant part of the housing stock in some Florida counties.

The Florida Solar Energy Center identified major energy losses in the duct systems of manufactured homes. Duct repairs for existing manufactured homes were estimated to cost approximately \$120.¹⁷ A typical \$200 duct repair should reduce the winter peak by about 1.6 kW, which has an avoided capacity construction cost of about \$1100. Winter peak demand impacts from duct leaks are greater than summer peak demand impacts. Most of the added heating load created by duct leaks is met by electric resistance heating which has a COP of 1.0 compared to the air conditioner COP of greater than 2.0. Thus, each increment of heating load adds at least twice as much to the utility's demand as does the cooling load.¹⁸

Repair of duct leaks statewide could yield 5000 MW of freed-up generation capacity at approximately one-sixth the cost of building new power plants.¹⁹ Manufactured homes account for approximately 1/4 of the existing housing stock. Thus, repair of manufactured housing duct leaks would account for approximately 1250 MW, or the equivalent output of two large coal-fired power plants. Since repair of manufactured housing is less expensive, this 1250 MW would be freed up at about one-tenth the cost of the new capacity.

¹⁷ FSEC Report, p. 51

¹⁸ FSEC Report, pp. 51-52

¹⁹ FSEC Report, p. 47

9.3.1 Specific Retrofit Recommendations

9.3.1.1 Research Program

The Energy Office should fund a research effort that specifically targets the development of innovative retrofit programs as its goal. The Florida Solar Energy Center would be an obvious group to perform the work for that effort.

9.3.1.2 Utility Retrofit Program

The Florida Public Service Commission should consider directing the state's utilities to develop retrofit programs oriented toward manufactured housing.

Manufactured Housing Park Retrofit Program: Because many manufactured homes are located together in manufactured home parks, utilities could maximize their retrofit effort. Older manufactured home parks are good candidates for energy retrofits since those homes may have lost their original air-tightness over time; they may also have been purchased at a time when customers were not energy-conscious. Utilities could develop a program for mass inspection of manufactured housing. Using techniques such as infra-red thermography from airplanes to locate energy losses, the utility could inspect homes on a park-by-park basis. For homes with substantial energy losses, the utility should then conduct an energy audit to determine the exact problems.

Having pictures of a home's actual heat loss may make customers more likely to respond favorably to retrofit suggestions. This is especially true if comparable homes in the same park show smaller energy losses and reflect that in their utility bills.

This program requires equipment for performing the infra-red thermography analysis. Although the equipment may be expensive, there are several ways to mitigate this expense. For example, Seminole Electric could purchase the equipment for use by its member cooperatives. Utilities with adjacent service territories, such as TECO and FPC, could share the cost of the equipment. FCG could purchase the equipment for use (or lease) by all the utilities.

Review of Utility Bills of Manufactured Homes: Utilities could search their records for manufactured homes with high bills and then arrange energy audits with those customers. This may provide a set of homes that need energy retrofits at less cost than the thermography program.

Once the homes with major energy losses are identified, the utility could then work with individual homeowners to retrofit the homes for higher energy efficiency. Because the utility would know exactly which homes needed work, it could schedule a retrofit team to work on all homes in the park during the same time period.

Heat Pump Retrofit Program: Heat pumps are not a cost-effective purchase for many manufactured home owners, particularly in the South Florida area. (See tables in Appendices J, K and L.) Even though the heat pumps save energy and place less of a demand on the utility, this savings is less than the cost of the heat pump. Thus, customers are not likely to pay for heat pumps themselves. However, because of the extensive use of electric strip heating in South Florida, the savings the utility realizes in decreased demand may be sufficient to warrant a rebate program that compensates for the additional cost of the heat pump.

9.4 Other Potential Programs

9.4.1 Radio Public Service Announcements

Whether any other programs are adopted and implemented or not, the State Energy Office should consider sending public service announcements (PSA's) to radio stations around the state. These PSA's should extol the virtues of increased insulation. If other programs, such as the Dealer's Handbook program or the Energy Efficiency Brochure program are implemented, the PSA's could reflect this by recommending that potential buyers pick up a brochure or ask their dealer for additional information. (See Appendix G for sample PSA's.)

9.4.2 High School Curriculum Suggestions

Educating potential buyers in an objective forum can help promote the goal of energy efficiency in manufactured homes. High school teachers could include simple exercises related to cost-benefit analysis in their math classes. Some of the classes which are taken by students unlikely to go to college may provide a potential target audience. Remedial math, home economics, survival skills (home economics for boys), and basic science classes are possibilities. (See Appendix G for some sample problems.)

9.4.3 Study of Air Conditioner Sizing Rules for Manufactured Housing

This project has noted a discrepancy between the air conditioner sizes recommended by the manufactured housing dealers for specific insulation levels and the statements by other industry representatives. In addition, the utility representatives on the project advisory committee as well as other utility staff members verified that oversized air conditioners units are a problem with manufactured homes. Although the customers do not see larger utility bills if their AC is oversized, they pay more for the unit than they need to and the utility must provide more capacity to serve that customer.

Finally, although the manufacturers say they size the air conditioner to each individual home produced, they do not size the air conditioner with respect to the individual orientation. Instead, they assume the worst case (an East-West orientation) and size the air conditioner

for that. This can oversize the unit by a half-ton. Again, this places an unnecessary burden on the utility to provide capacity for that unit.

With 22,000 manufactured homes sold each year, if half of them have air conditioners that are oversized by a half ton, the state has 5,500 unnecessary tons per year of air conditioning added to the utility system if all homes are air conditioned. At a demand rate of 1.5 kW per ton of air conditioning assuming a diversity factor of 50%, this amounts to 4125 kW or 4.125 megawatts of unnecessary capacity the utilities must supply each year. At a cost of \$1000 per kW for new base load capacity, this oversizing problem costs the utility industry \$4,125,000 per year.

Section 10: Concluding Remarks

Manufactured housing in Florida has a mixed record when it comes to energy efficiency. The existing housing stock reflects underinvestment in energy conservation, given current and projected energy prices. We did not address retrofit programs, but were asked by the State Energy Office to develop initiatives for new manufactured homes. We found that the industry is quite diverse. Many purchasers of manufactured homes have chosen those homes because they are affordable. By taking a life cycle approach to purchases, buyers could achieve much more affordable housing. At the high end of the market, new buyers could also benefit from improved information and programs that draw attention to energy conservation opportunities.

We conclude that energy efficiency of manufactured housing could be significantly improved in three areas: the level of insulation in the home, the integrity of the duct system, and the energy efficiency of the major appliances--particularly the HVAC system. Project guidelines constrained the strategies which we could propose for making progress in these areas to be *voluntary* and *inexpensive*. So we tried to identify points of leverage in the decision-process.

This project has designed several programs which have the potential to increase the number of customers buying energy efficient, new manufactured homes. These programs are the Dealer's Handbook program, the *EnergyStar* program, the Duct Improvement program, the Energy Brochures program, and the Energy Label program.

The Dealer's Handbook Program: This program provides each manufactured housing dealer in the state with a Handbook which explains how to sell energy efficiency to a customer. The Handbook emphasizes selling additional insulation and shows how the savings on utility bills is greater than the additional mortgage cost of the insulation. It provides dealers with a method for comparing the cost-effectiveness of the insulation level the customer is currently considering with that of various insulation upgrades.

The *EnergyStar* Program: This program sets statewide standards for an energy efficient manufactured home. It allows dealers to promote *EnergyStar* homes with literature

describing the cost-benefit analysis provided by the program sponsor. Although not as effective a program as one involving direct financial incentives to the customer, this program can supply the potential buyer with the cost comparison information necessary to make the most cost-effective decision on energy upgrades. The *EnergyStar* program includes a dealer's handbook, a set of standards, publicity suggestions and informational brochures.

The Duct Improvement Program: Improving the integrity of the duct system is another cost-effective measure for promoting energy conservation. Energy losses through leaky ducts pose significant problems for both new and existing manufactured home owners. However, designing a program to promote the purchase of homes with good duct systems is a difficult project. One would think that consumers should not have to pay more to get duct systems that do not leak. However, present institutional arrangements and technical features of duct systems are clearly inadequate from the standpoint of consumer interests. **The Florida State Energy Office should set up a series of meetings with the duct experts from the Florida Solar Energy Center, the manufactured housing producers, and other interested participants to discuss and solve the problems with leaks in the air handling system.**

The Energy Brochure Program: This program provides dealers with a variety of brochures describing the benefits of energy efficiency measures, particularly insulation upgrades. When consumers have information about the full costs of alternative energy conservation packages, they are in a position to make rational choices. Information brochures represent one vehicle for educating consumers and inducing greater emphasis on conservation by housing manufacturers and dealers.

The Energy Label Program: This program is modeled after the federal appliance energy labels. The labels cannot be as specific as those labels because manufactured housing customers special-order homes more often than appliance buyers special-order appliances. Nevertheless, this program gives customers something familiar to look for when they are looking at model homes, and making comparisons of life cycle costs. Again, the key goal is to give greater weight to energy conservation during the consumer search process. Then energy efficiency becomes a salient feature of manufactured housing--not just an afterthought.

Note that we are not singling out manufactured housing as particularly problematic in terms of energy efficiency. Many manufacturers and dealers make a genuine effort to produce and sell homes promoting energy conservation. However, the industry as a whole could do better. The programs recommended here represent first steps towards improved energy efficiency in manufactured housing. Although such homes represent only a fraction of Florida's housing stock, the recommended programs can be refined and extended to other sectors.

The four programs outlined here are intended as prototypes. Many features are relevant for site-built homes as well. However, we were asked to identify cost-effective conservation opportunities in the manufactured housing market, so this is the focus of the study. We

have tried to provide supporting documentation and illustrative material which could be used in new initiatives. Further refinements may well be called for, but the proposed programs at least provide a comprehensive framework for improving energy efficiency in this important part of the Florida housing sector.