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TI DP-Basic Research for Answering Florida's Residential Energy Conservation Questions

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TIDP - BASIC RESEARCH FOR ANSWERING FLORIDA'S RESIDENTIAL ENERGY CONSERVATION QUESTIONS

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ABSTRACT

The subject of energy conservation has not been a popular topic for scientific research and testing in the past as the cost of energy was so low that efficiency was generally not a consideration. However, following the Arab Oil Embargo of 1973, energy use did become important and homeowners began asking serious questions about energy conservation. As many of these questions reached state and federal agencies it became clear that existing research was totally inadequate and often conflicting. The situation was particularly bad in Florida where air conditioning, not heating is the primary environmental factor. This paper describes the State of Florida's efforts to provide a research facility to answer some of the fundamental questions of how energy is used and reduced in a warm, humid climate.

INTRODUCTION

The Technical Information Development Program (TIDP) is essentially a metering, instrumentation, and testing laboratory created for the purpose of providing data necessary to answer questions related to residential energy conservation in Florida. The TIDP is located at the University of Florida in Gainesville and currently part of the 23 acre research area known as the Energy Research and Education Park. The TIDP presently consists of 3 houses, 2 mobile homes, 1 instrument building, 6 test modules, miscellaneous sheds and covered storage areas, and a wide variety of instrumentation and data processing equipment. The project is primarily being funded by contracts with the Governor's Energy Office and the Department of Housing and Urban Development (HUD). Private industry has assisted the TIDP through contributions of products, equipment, and test structures.

BACKGROUND

The state of Florida funded its first energy organization in the spring of 1973. At the end of that year the Arab Oil Embargo occurred and shortly thereafter the price of energy rose dramatically. Beginning in 1974 homeowners began contacting the state to obtain information on steps they could take to reduce their home energy costs and by the middle of 1975 there were so many questions being asked that it appeared more cost effective to produce pamphlets and publications to address these questions. Once the decision was reached to prepare certain brochures and publications, background research on these questions was begun. Shortly thereafter it became obvious that most of these questions could not be answered properly because of lack of data substantiated through research, testing, and instrumentation. However answers were being given by others to most of the questions asked, but the answers represented "consensus opinions" of experts rather than answers based on solid research. As a result it was decided in late 1975 that some means should be found to get this research started. Throughout CY 1976 numerous state, federal, and private organizations were contacted for funds to begin this research. However it was not until 1977 that a program and source of funds was identified. A proposal was submitted in July 1977 to the Federal Energy Administration under the Energy Conservation and Production Act(ECPA). The proposal was approved in August 1977 and the program was designated to receive $851,400 over a period of 39 months. The first organizational meeting of the TIDP was held

in November 1977 and the first contract was signed with the University of Florida in January 1978.

OBJECTIVES

The original objective of the TIDP was to provide the test and metered data necessary to satisfactorily answer questions related to conserving energy in residential structures in Florida. The initial group of questions to be researched dealt with the following areas.

1. Attic ventilation problems and options
2. New, highly advertised devices
3. Heating and cooling equipment
4. The mass effect of concrete block
5. Roof insulation options
6. Duct losses and gains
7. Glass and glass treatments
8. Wall insulation
9. The value and location of vapor barriers
10. Calculation procedures to determine energy usage and savings.

The program was also established with the goal in mind of minimizing the total cost of residential energy conservation research for the state by performing all this research in one central location. The University of Florida was selected because of its central geographical location, its large inventory of existing needed equipment, the large number of necessary professional disclipines, and other resources such as student labor, computers, technical libraries, etc.

The TIDP concept was the result of lengthy discussions between the Florida State Energy Office and many segments of the private sector including the electric utilities, product and equipment manufactures, contractors, trade associations, numerous colleges and universities, planning and engineering organizations, etc. It was hoped that the State Energy Office and the Federal funds would serve as a catalyst for getting the lab started but that eventually the university and private sector would take over completely. It was felt this would occur because the research to be accomplished was needed badly by both the business sector and the public buying their products. Also by having the academic community perform the research and private industry reviewing the research methods, equipment and results, the much needed thorough research should be the end product.

In November 1979 the Governor's Energy Office renegotiated its contract with the University of Florida for the TIDP. The priorities for the new contract which extends through December 31, 1980 are shown below.

1. Produce energy audit workbooks for north, central and south Florida climatic zones.
2. Produce technical reports on 15 specified areas.
3. Produce 12 specific consumer pamphlets.
4. Provide 4 manhours of technical assistance to the Governor's Energy Office per week.
5. Continue the testing required to provide the needed data and information for the technical reports.

As a result of this renegotiated contract, the emphasis of the TIDP was shifted away from its original objective of obtaining answers to energy conservation questions through metering, testing, instrumentation and research. This shift in the TIDP's purpose has left incomplete much of the needed research and testing which should be resumed immediately in order for it to produce timely results.

STATUS OF ACTIVITIES

Work has been undertaken in a number of areas; some research has been completed

while other projects are still on going. The status of each project is presented in the list below. A detailed listing of lab facilities and equipment can be found in Appendix I.

DEVICES These are defined as hardware which can be added to an existing system with the intention of reducing energy use or cost.

1. Half Wave Rectifier: This device is inserted into an incandescent light bulb socket and reduces the energy consumed by the bulb. Testing is completed and the data is being analyzed. Report Due: May, 1980

2. Water Spray On Air Conditioning Condenser: This device increases the efficiency of an air cooled condenser by allowing a stream of water to be passed over the external cooling fins. A technical report has been completed and will be available shortly.

3. Light Dimmers: These devices are designed to replace a normal light switch and provide variable light levels. A technical report has been completed and will be available shortly.

STRUCTURES This area includes all of the components in the building envelope; testing covers both the entire structure and individual parts.

1. Concrete Block House: This structure was built as a test facility and well instrumented for temperature and humidity monitoring. Testing is on going. Report Due: December, 1980

2. Solar House: Attic ventilation tests were run in this 1950-1960 vintage house. A technical report is due by mid-May 1980 with additional testing to follow.

3. Mobile Homes: A complete analysis of energy usage was made for summer conditions and the report submitted to HUD but the report has not been released from HUD at this time. Additional testing is on going with subsequent reports due by mid 1980.

4. Wall Sections: Tests were conducted in a guarded hot box/cold box to compare different wall constructions with each other and to verify the calculated "R" values. Report Due: August, 1980.

EQUIPMENT AND APPLIANCES These are defined as electrically or fossil fueled apparatus designed to provide basic household functions.

1. Water Heater: Tests are on going. Sections of this work have been completed and the first report will cover resistance water heaters, dedicated heat pumps, solar water heaters and instantaneous or point of use heaters. Report Due: May, 1980

2. HVAC: Timers were placed on heating and air conditioning systems of selected residences in Miami, Orlando, Gainesville, Jacksonville and Tallahassee. These timers recorded operating hours for the equipment and form a base to verify average daily operating hours against. Report Due: July, 1980

3. Waste Heat Recovery: Devices which recover the heat that normally would be lost through an air conditioning condenser and use that heat for domestic hot water are becoming common. Testing of one of these devices under laboratory conditions has been completed. Report Due: September, 1980.

OTHER: These are test areas that overlap the previously described areas but do not fit neatly into any one of them.

1. Infiltration: Determination of the amount of air leakage experienced by different building types is important in the calculation of energy requirements. Tests are on going with wall sections having been completed. Report Due: December, 1980.

2. Infra-red Photography: Work is underway to see if this test can be used for Florida homes with summertime conditions. Report Due: November, 1980.

3. Mass Effects: A comparison of the structures under test will be performed to see if the mass effect can be extracted for each structure type. Report Due: January, 1981.

4. Vapor Barriers: Work is underway to determine the effects of vapor barriers (their use and placement) on condensation in the residential structure. Report Due: Late 1980.

FUTURE ACTIVITIES

The funding from the Governor's Energy Office is scheduled to end in December 1980, therefore efforts are now underway to obtain funding from additional sources. The funding sought will be utilized to do the remainder of its original objective of testing, metering, and instrumentation.

There are several ways of improving the accessibility and effectiveness of the lab to the average citizen as well as the business community. The funds being sought could be applied in the following areas.

1. Development of a clearinghouse for all energy related gadgets and devices used in Florida.

2. Design and build an energy-efficient "state of the art" house and a "house of the future".

3. Redesign, redevelop and improve the appearance of the lab area and equipment so that it would be more attractive and informative for tours. Addition of a visitor center and educational displays would help get the information to the public.

4. Design and construct a research laboratory for joint use by TIDP employees as well as private companies participating in joint research.

5. Design and construct a separate building to house and display "Appropriate Technology" products and equipment designed and built by Florida Citizens.

CONCLUSION

Much testing, metering and analysis has occurred over the last two years and answers to many basic questions are coming forth. However, this initial research has also uncovered many previously unknown problem areas; many problems are turning out to be far more complicated than was originally anticipated. As a result it is obvious that much more work needs to be done and done quickly. The word "quickly" is an understatement in light of the fact publications are still being written on energy conservation options based on energy savings calculations that have not yet been sufficiently substantiated by metering and testing.

The Residential Conservation Service (RCS) Program, which involves billions of dollars in retrofit funds is about to be implemented. Parts of this program will not produce the savings effectiveness desired. For example, certain combinations of retrofits such as radically improving the building envelope without downsizing the air conditioning system may result in an expensive investment with no correspondingly substantial savings in energy. Likewise, many potentially effective options may be omitted or discovered too late for most homeowners to use when making crucial decisions.

APPENDIX I

This appendix lists the physical structures and equipment which are a part of the Technical Information Development Program.

FACILITIES/STRUCTURES:

1. Instrument Building 400 sq. ft.
2. Mobile home 24'X 56'
3. Mobile home 14'X 56'
4. Mobile home modules (3) 12'X 28'
5. Mobile home modules (3) 24'X 28'
6. Concrete block house 1200 sq. ft.
7. Frame house 1200 sq. ft.
8. Solar house 1500 sq. ft.
9. Pump house (block) 150 sq. ft.
10. Chiller shed (metal) 100 sq. ft.
11. Storage shed (metal) 240 sq. ft.
12. Fenced security area 10,000 sq. ft.
13. Park is approximately 23 acres

FIELD EQUIPMENT:

1. Velometer
2. Light meter
3. Sound level meter
4. Thermometers
5. Hygrothermographs
6. Scales for weighing materials
7. Thermocon
8. Electrical Multimeter
9. Digital Voltmeter
10. Pyranometer
11. Constant Temperature baths
12. Oscilloscope
13. Potentiometer for calibration of DVMs
14. Voltage reference cells
15. NBS calibrated thermometers
16. Strip chart recorders (60)
17. Trailers (2)
18. Thermocouples - approximately 2000 installed

PERMANENT EQUIPMENT:

1. Computer PDP 11-34 10 MByte disk storage
2. Data acquisition system
   a) Processor
   b) 5 scanners
3. Weather station
   a) Pyranometer
   b) Pyrheliometer
   c) Wind speed 8ft. height and 30 ft. height
   d) Wind direction 8 ft. height and 30 ft. height
   e) Temperature (dry bulb)
   f) Relative humidity
   g) Barometric pressure
   h) Rain gauge
4. Solar calorimeter
5. Black box for glass tests
6. Solar collector test stands
7. Guarded hot box/cold box
8. 20 Ton water chiller

SYSTEMS AND EQUIPMENT FOR TEST AND DISPLAY:

1. Solar flat plate collectors
2. Domestic water heating system
3. Solar space heating system

4. Solar air conditioning system

5. Concentrating collectors

   a) Parabolic dish
   b) Parabolic trough

6. Hot air engines

7. Solar air heater

8. Solar ice machine

9. Solar water distillation units

10. Solar simulator

11. Heliostats