ORIGINAL
1976

UNIVERSITY OF MASSACHUSETTS/AMHERST
ENERGY ALTERNATIVES PROGRAM

DOC ENT SH-1-GEN'L-1.
REV. 6/76

SOLAR HABITAT-ONE and THE WIND FURNACE

ORCHARD HILL, UNIVERSITY OF MASSACHUSETTS, AMHERST

A Research and Demonstration Project at the Amherst Campus of the University of Massachusetts. Sponsored by the U. S. Energy Research and Development Administration, The U. S. National Science Foundation, The U. S. Department of Agriculture, Private contributors to The Mark Swann Account, and the University of Massachusetts.

This is a Project in the Energy Alternatives Program of the University of Massachusetts (Amherst) under the direction of William E. Heronemus, Professor of Civil Engineering. The Project Manager is Dr. Duane E. Cromack, Associate Professor of Mechanical and Aerospace Engineering. Ten other faculty in four departments of the School of Engineering and in the Department of Agricultural Engineering, fifteen graduate research assistants, and eight technicians in the School of Engineering have made significant contributions to the project. The Physical Plant Department of the University, Amherst Campus, under the leadership of Mr. George A. Norton, has provided invaluable assistance in the construction of the Habitat.

PURPOSE: Over twenty-eight percent of all the energy consumed in the United States is used for heating and cooling buildings and heating domestic hot water. The Wind Furnace is a Solar Energy Space and Water Heating system which combines some specified area of flat plate solar collector with some size of wind generator for space and water heating. It has been estimated that there are at least three million farm homes so located that some combination of collector and wind generator could, economically, save about thirty barrels of petroleum per year per home, when substituted for combustion of heating oil. It has also been estimated that other suitable applications of single or multiple wind wheel Wind Furnaces could create an annual saving within the United States of nearly 300 million barrels of petroleum per year.

Here at Solar Habitat One in Amherst you can see the Wind Furnace concept undergoing test and evaluation. You are WARNED, however, not to be dismayed at the apparent complexity of the system. There is a great multiplicity of hardware being used in this laboratory setting compared against the relatively simple set that would be installed at one residence. This comes about because many different versions of the Wind Furnace are to be tested, and various key parameters must be varied so that the optimum set can be found.

THE HOUSE: The House is very unusual in many respects. It was originally designed and constructed by Professor Curtis Johnson of the Department of Food and Agricultural Engineering, funded via a Hatch Act Grant from the Massachusetts Agricultural Experiment Station. It was conceived as an energy conservant building that could be fabricated in a factory, then transported over the highway system to an erection site. It was conceived as a competitor to the so-called mobile home, so very popular today, and so very wasteful of heating energy. One of the hopes of this project is that some one or more companies interested in factory production of homes will decide that this design should be replicated.

The house is constructed around seven frames. Each frame consists of a laminated floor beam, two vertical box columns and a large laminated roof beam. Frames are assembled on the ground, then erected as units. Floor, roof and wall panels, pre-assembled with insulation and window openings are then placed in position between the supporting frames. Six inches of fiberglass insulation is used in all wall and floor panels: eight inches is used in the roof panels. The roof was sprayed with several thin layers of a PVC filming material. One inch of polystyrene insulation sheet was put on the outside of the wood walls, then a fiberglass mesh and a coat of Drivit^R, a mix of cement sand and plastic compound, were applied.

The building is designed to have one volume change of air per hour. Exhaust air is pumped out through a simple heat exchanger which reduces the heat loss during the air exchange process. Fresh air is brought in through triple glazed windows, each fitted with a filter, so routed that the incoming air is warmed by the heat normally lost through the window. High-density plywood doors containing three inches of insulation are used to further reduce the heat loss.

The house is intended in most instances to sit on a treated wood foundation with a crawl space only beneath the floor. Such a crawl space could contain the necessary Wind Furnace components. On Orchard Hill, however, the house has been placed on top of an oversized poured concrete basement which will serve as a research and teaching laboratory and demonstration site of considerable size.

A Clivus Multrum Aerobic toilet, donated by Ms. Abby Rockefeller, has been installed for demonstration purposes.

At this time the auxiliary heating system (which we think will be required to provide no more than 20 percent of the home's heating) is a conventional hot-air system fired with bottled gas. In time a wood-burning auxiliary system will be fitted.

THE WIND FURNACE: The Wind Furnace concept in one of its models is shown on the attached Figure (1). The major components are: (1) a wind generator, (2) an expanse of flat plate solar collector and (3) a thermal storage, in this instance a tank of water. The appropriate size of each of those three major components will be matched to a given heating load at a given location. For this particular house plus basement laboratory at Amherst, the set of components which design calculations said would work the best are:

(1) Solar Collectors: 200 square feet of copper tube collectors mounted vertically on the south facing wall. Vertical mounting gives us almost uniform productivity, all twelve months of the year. A Propylene-glycol and water mixture are circulated through the five collectors. A propylene mixture-to-water heat exchanger is located in the thermal storage tank.

(2) A 2000 Gallon Water Thermal Storage Tank: This tank was cast integrally with the poured concrete foundation, then lined with thermal insulation and waterproofed. It will be some time before the ideal thermal storage tank details have been identified.

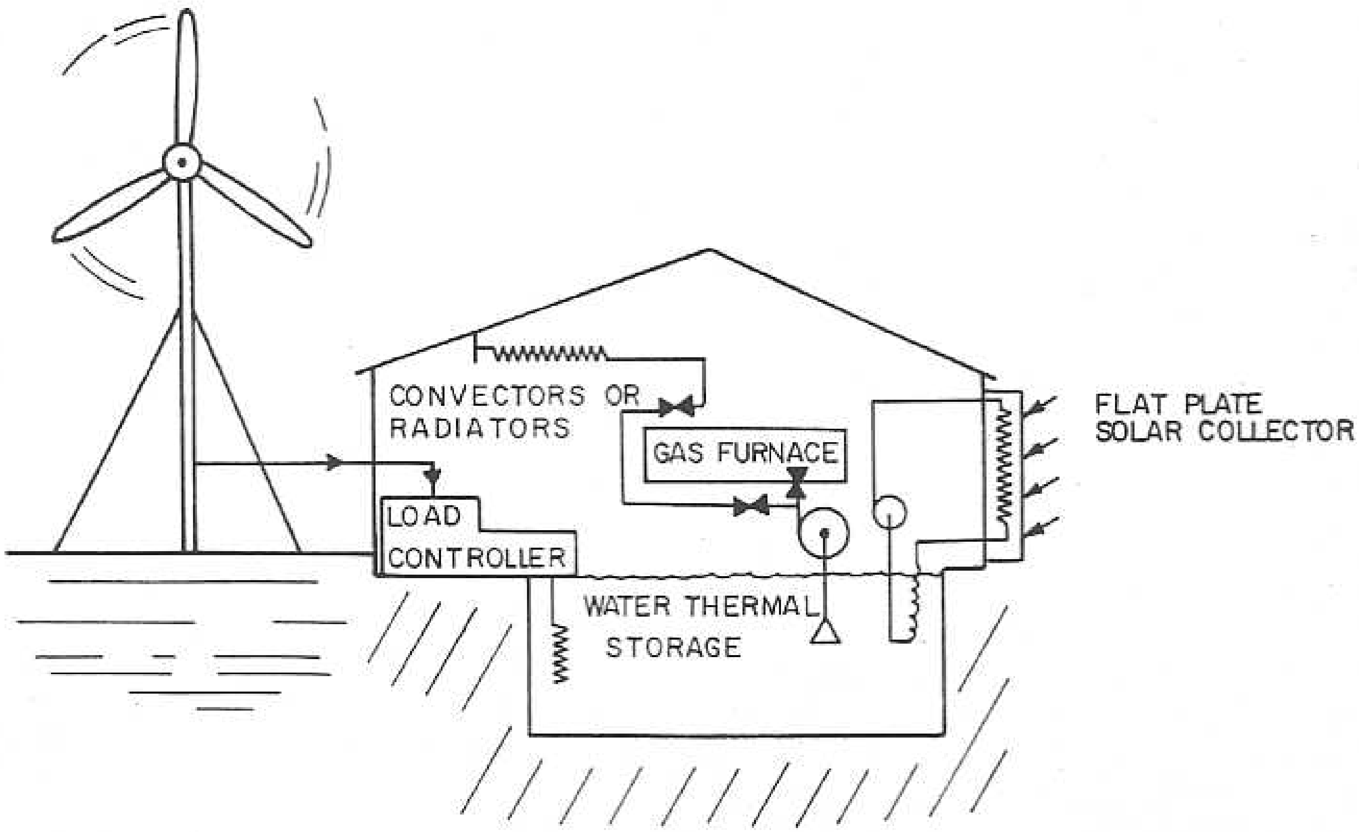
(3) A Windmill: This particular windmill drives an electric generator for Model One, Two and Three of the Wind Furnace concept. In Model Four it drives a mechanical churn (mechanical energy to heat energy dissipater) via a mechanical shaft. This windwheel is 32.5 feet in diameter, three-bladed, horizontal axis propeller type, whose rated speed of turning is 167 rpm.

The blades of this windmill are continually controlled in pitch so that it will (a) start up in the least possible wind speed, (b) maximize its productivity at whatever wind speed it is turning, and (c) protect itself against excessive speed of turning in very strong winds. In very strong winds, or upon signal from the Central Logic, the blades can be driven to such an angle of pitch (called "feather angle") that they will hardly rotate at all.

(4) Auxiliaries and Controls: There are many other pieces, parts, subsystems required to connect together those three major components. A more detailed description of all hardware is available in Document SH-1-GEN'L-2, for those who ask for it at SH-1.

When this project has reached that point where concept credibility has been established and a preferred set of parts has been identified, a complete set of working drawings, a Bill of Material, and all pertinent Technical Reports will be available to all via the National Technical Information Service.

COMMERCIALIZATION: The UMass Energy Alternatives Team has already started a small effort to interest existing or prospective industrial groups in the manufacture, sale or leasing, installation and maintenance of Wind Furnace Systems. As time permits, commercialization briefings or seminars will be held in Amherst.



THE WIND FURNACE