ABSTRACT

This paper on prototype passive solar buildings in Louisiana presents state of the art passive solar design. According to U.S. Department of Energy report, the annual energy consumption for a single family detached dwelling in Louisiana is from 31,000 to 51,000 Btu/sq.ft./yr, with a mean at 38,000 Btu/sq.ft./yr. and for an office building is from 39,000 to 58,000 Btu/sq.ft./yr. Incorporation of passive solar design may provide a major percentage of the energy consumption with only 2 to 8 percent of additional construction cost. The projected savings as presented in this report are an approximate estimation. However, the actual savings will vary depending upon the occupancy, operation, and maintenance of the building.

At the same time, such design represents an increased involvement for the architect. The full potential of this passive solar design depends on a sensitive awareness of the relationship between climate, comfort and the thermal characteristics of buildings and building materials.

The primary purpose of this work is to offer a working definition and fundamental understanding of a number of practical applications of passive solar designs in Louisiana. Four new buildings and six existing retrofitted buildings are presented.

NEW RESIDENTIAL BUILDING
Type I

- Building Description:
This one-story, three bedroom house has approximately 2,000 sq. ft. of living space. The exterior walls are wood frame with a 4 inch brick veneer.

- General Objectives:
The house is designed to have a minimum heat gain in the summer, solar assisted heating in the winter and to require a minimum amount of energy to operate on a year-round basis. A close relationship between interior and exterior spaces, ceiling fans, and the possibility of natural ventilation make this house comfortable as well as practical. The estimated energy savings of 50 percent over a conventional house of this style is achieved through the design features listed in the following summary. The additional construction cost of this type design is approximately 2-4%.

NEW RESIDENTIAL BUILDING
Type II

- Building Description:
This two-story wood frame house with wood exterior siding has three bedrooms and two baths. The living space is approximately 1,600 sq. ft.
-General Objectives:
This house is designed to achieve a balance between the benefits of a compact two story home and the openness of a single level plan. It is also designed for a small site and is carefully oriented to receive maximum heat gain in winter with maximum shading in summer. Earth berms and a sloped roof provide an aerodynamic form to face the winter north winds. A thermally isolated open kitchen prevents internal loads from building up during the summer. The estimated average energy savings is approximately 45 percent. The extra cost for construction is between 2 and 4 percent.

PASSIVE SOLAR DESIGN FEATURES

- Site orientation for correct solar exposure
- Shaded and ventilated west wall
- Roof overhang shades south windows and walls in summer
- Compact plan
- East windows shaded in summer by vertical shading fins
- Windows and doors, located for natural ventilation
- Shaded windows on east & west
- Thermally isolated kitchen and laundry room
- Zoning to locate heat-producing spaces on northern side
- Earth berms on north side
- Ventilated northern and southern sloped roof
- Ecotour living spaces
- Tight shell construction, high insulation standards and double glazing
- Air lock door system on north side
- Ceiling fans
- Exposed brick pavers for thermal mass
- South facing clerestory for winter heat gain and natural lighting with overhang to prevent summer heat gain
- *Not a truly passive feature
- **With foil radiant barrier

See Figure 3, 4 and 5 for design description.

RESIDENTIAL RETROFIT Type I-
- Building Description:
A simple one-story, slab-on grade structure of approximately 1,000 to 1,400 sq. ft. in floor area is typical of houses built throughout the state area in the 1950's. These houses have low levels of insulation, high levels of infiltration, and inadequate attic ventilation.
- General Objectives:
The goal is to ease the cooling load as listed in the following summary form. An estimated savings of approximately 25 percent when the suggested modifications are used. The payback period of the cost is less than 2 or 3 years.

ADDED PASSIVE SOLAR DESIGN FEATURES

- New trellis with deciduous vines on south wall
- New ventilated double wall on west wall
- Improved attic insulation
- Air lock door system
- Additional ventilation in kitchen and bathroom
- New ceiling fans
- Additional control of infiltration levels
- Ceiling insulation with foil radiant barrier facing up
- Not a truly passive feature

See Figure 6 and 7 for design description.

RESIDENTIAL RETROFIT Type II-
- Building Description:
This example is an older, "large" two-story wood frame house common to this region. It has high ceilings, low levels of insulation, a front porch and an attic which are features that may respond to passive retrofit improvements.
- General Objectives:
The goals of this retrofit recommendation are to provide:
- An increase in natural ventilation
- Additional protection from summer heat gain and winter heat loss.
- Additional heat gain in winter
- Additional outdoor living spaces
The results of these modifications should amount to an approximate 35 percent savings in energy consumption.

ADDED PASSIVE SOLAR DESIGN FEATURES

- Controlled infiltration levels
- New floor and ceiling insulation
- New operable windows on front porch to provide sun spaces
- Additional roof ventilation
- New north side screen patio
- New floor grills for added ventilation
- New ventilated double wall on west and east
- New overhangs on south side to protect from summer sun
- New ceiling fans
- Shading devices for east and west windows
- It is assumed that the east and west walls are fully exposed to the summer sun (i.e., no shade from trees, etc.)
- **With foil radiant barrier

See Figure 8, 9 and 10 for design description.

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Type III-

Building Description:
This example is a 2,000 sq. ft. brick veneer house which contains a living room, dining room and kitchen. It is a one-story structure. General Objectives:
This structure has a high level of insulation and a tight shell. The goal, to reduce energy consumption, is achieved by controlling heat gain in the summer and in the winter. A 25 percent savings in energy cost is expected with the modifications indicated.

Increased insulation in attic
New air lock door system
New greenhouse for heat gain in winter
New landscaping and earth berming
Additional exterior living spaces
New ventilated double wall on west and east sides
Extension of roof overhangs
Improvement of ventilation in kitchen, bathrooms and laundry
New ceiling fans*
Shading on east and west windows
Add foil radiant barrier in attic

*Not a truly passive feature

See Figure 11, 12, 13 and 14 for design description

NEW COMMERCIAL

Type I-
Building Description:
This small, three-story office building has under 50,000 square feet of floor area. This building type covers a wide variety of construction types. Typically built on speculative basis, low initial and operating costs are essential. Low energy consumption is a significant factor in maintaining low operating costs.

General Objectives:
This primary objective is to achieve low overall annual energy consumption while providing a building which satisfactorily meets the needs of the owners and building users. Since lighting and space conditioning account for over 90 percent of the total energy usage, conservation strategies should concentrate on temperature and insulation control, and the use of daylight.

A carefully designed office building may result in an approximate 50 percent energy savings as compared to similar buildings in which energy use has not been a consideration. This improvement can be achieved with only an approximate 3 to 5 percent increase in the construction cost.

Orientation for solar control
Buffering heat gain with uninhabited spaces
Use of unconditioned, naturally ventilated spaces
Zoning office space for use of natural light
Venting heat producing spaces
Efficient HVAC strategies (i.e., fresh air cooling, variable air volume systems, planned shut down for air systems, localized illumination controls)
Reduced illumination levels*
Form to minimize heat gain
Building operation management training

*Also reduces electrical energy consumption

See Figure 18, 19 and 20 for design description

NEW COMMERCIAL CONSTRUCTION

Type II-
Building Description:
This typical office tower is a multi-story, single use with only daytime occupancy and has minimum skin surface to volume ratio. The primary energy consumption factors are lighting and space conditioning. An important design consideration is the need for flexibility in office layouts.

General Objectives:
The main goal of this design is to reduce the cooling loads which dominate buildings of this type. These heat gains are generated by both internal and external forces and are affected by the nature and characteristics of the occupancy. The heating load in tall office buildings in this climate can be dealt with by envelope design. The annual energy savings can reach 60 percent through the appropriate design considerations. The additional construction cost is about 2 to 4 percent more than conventional design.

Orientation for solar control
Buffering heat gain with uninhabited spaces
Use of unconditioned, naturally ventilated spaces
Zoning office space for use of natural light
Venting heat producing spaces
Efficient HVAC strategies (i.e., fresh air cooling, variable air volume systems, planned shut down for air systems, localized illumination controls)
Reduced illumination levels*
Form to minimize heat gain
Building operation management training

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See Figure 18, 19 and 20 for design description

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COMMERCIAL RETROFIT
Types I and II-
- Building Description:
Existing low rise and tower office buildings are often large consumers of energy when compared with their new or future counterparts. The problems with existing buildings are a result of lack of concern about energy conservation design. This is evident by buildings with improper site orientation, inefficient HVAC systems, limited use of natural light, and other factors. However, since these buildings may still be used over a long period of time and represent a large economic investment, energy conserving retrofit modifications are practical.
- General Objectives:
The goal of these retrofit designs is to reduce the cooling load and overall energy consumption by introducing sound economic modifications. The building form, orientation and internal organization can not be reasonably modified in existing structures; however, the incorporation of other passive features could result in an approximate 50 percent savings.

ADDED PASSIVE SOLAR DESIGN FEATURES
- New shading devices on east, west and south walls
- Rewiring of existing lighting fixtures to allow local switching and the use of daylight
- The clustering and venting of internal heat sources
- The reorganizing of office space to buffer heat gain with unoccupied or service spaces
- The use of economizer cycle in HVAC equipment
- Additional use of unconditioned spaces (hallways, lobbies, etc.)
- Building operation and management training
- Planned shut down for air systems

See Figure 21, 22 and 23 for design description.

COMMERCIAL RETROFIT
Type III-
- Building Description:
This building is a pre-fabricated metal building. These structures are typically constructed with a lack of natural ventilation, daylighting, and adequate insulation.
- General Objectives:
The goal of this energy remodel is to improve occupant comfort conditions in the structure. The existing conditions, resulting from the design and construction of the building, limit the ability to make large improvements. It should be noted, however, that any existing structure that was designed with little concern for energy conservation may be more energy efficient by certain types of modifications, as listed in the following summary form. The energy conservation is projected about 35 percent.

ADDED PASSIVE SOLAR DESIGN FEATURES
- New doors placed for cross ventilation
- New continuous ridge vent
- New roof spray system
- Installation of new shading devices on existing improperly placed skylights
- New north facing roof monitors
- New solar domestic hot water system if needed
- New ceiling tiles

*Not a truly passive design feature
See Figure 24, 25 and 26 for design description.

REFERENCES
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Figure 1
SOLAR COLLECTOR FOR DOMESTIC HOT WATER
NORTH SIDE FASCIA TRIMS FOR SHADIER AND PROTECTION FROM WIND/PV

Figure 2

Figure 3

Figure 4

Figure 5
continuous ridge vent for improved ventilation
ADDED with full radiant barrier

Figure 6
MEMS VINES ON SOUTH SIDE
WALL

Figure 7

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Figure 8

Figure 9

Figure 10

Figure 11

Figure 12

Figure 13

Figure 14

PROTECTION FROM WINTER WINDS
NEW PROTECTED, PRIVATE LIVING AREA

NEW EARTH BERM ON NORTH

SUMMER SHAD

INCREASED OVERHANG WITH TRELLIS
Figure 23

Figure 24

Figure 25

Figure 26