ENHANCE SOLAR ENERGY UTILIZATION
THROUGH INCORPORATION OF PHASE CHANGE MATERIALS (PCMs)
WITHIN BUILDING ENVELOPES

By

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An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

Major Subject: BUILT ECOLOGIES

The original of the complete thesis is on file
In the Rensselaer Polytechnic Institute Library

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April 2008
(For Graduation May 2008)

ABSTRACT

Beginning in the early 1970s, the research level on solar energy for building use has paralleled popular attention to the problem of an unsustainable level of global fossil energy consumption, in which a significant amount is related to building mechanical operations for heating and cooling. Coupling the emerging energy crisis and relatively low efficiency of state-of-art solar energy harvesting techniques for buildings presents architects with the question of how to better harness this vast renewable energy resource through architectural design. The intrinsic problems of integrated passive solar use include the inability of most systems to effectively control the harvesting, storage and distribution of quality heat on demand at needed comfort temperatures, and their propensity to overheat occupied spaces under certain conditions. Phase Change Materials (PCMs) undergo large amount of latent heat exchange at their phase change temperature. For use in buildings, materials can be selected on the basis of their melting temperatures and in some Phase Change Materials, these temperatures are adjustable. This research concentrates on the strategy of integrating a Combined Active and Passive Phase Change Material (PCM) System that utilizes a hydronic building heating sub-system linked to building thermal envelope matrix to augment and control the capture, transfer, storage and distribution of solar heat through thermal envelopes and habited space surfaces on demand, at desired temperatures. In addition to utilizing available solar energy, this strategy also has the potential to reduce the sizing and use of conventional fuel based primary and backup HVAC mechanical systems. The proposed solar integrated PCM system uses a highly renewable paraffin wax PCM material system to better control, store and distribute interior solar heat gain for long-term and short-term use on demand, thus increase the contribution of solar energy as a percentage of the total building energy consumption. Interior thermal comfort is enhanced both

physically and psychologically at a controllable constant level, while taking advantage of the available resource, minimizing dependency on fossil fuels and infrastructure to distribute energy. The test case used for the design research is a multifamily housing application in San Francisco, where heating load dominates most of the year. Conclusions speculate on the appropriateness of similar systems for alternative climate types.