

Application of the AHP Method to the Planning of a Solar House in China

Y. Run-Ming

L. An-Tian

L. Bai-Zhan

ABSTRACT

In this paper, the authors carry out a system analysis in accordance with present building heating energy types and factors, such as environment, economics, transport condition, climate, use, and building type, by an analytic hierarchy process (AHP) with a self-adjusting function. The planning of a solar house in China can be done by this method. This study aims to provide the building's investor a choice of the best place to build a solar house.

INTRODUCTION

Solar heating is one of the most successful ways to make use of solar energy. It can not only decrease the greenhouse gases that result from burning fossil fuel, thus slowing down the globe's warming trend, but can also save conventional resources. Especially in remote areas and in the countryside, where there is a shortage of conventional energy sources and distribution facilities are not available, it is extremely important to apply solar heating systems to improve living conditions. By extensive cooperation with developed countries, China has made great achievements in solar heating theory and design. However, because of the low flow density of solar energy and its high collecting cost, the initial investment for a solar house is higher than that of ordinary buildings. Moreover, the efficiency of the solar heating system is significantly affected by the local climate, which makes it difficult for solar housing to be widely used. The research into site selection and planning of a solar house is insufficient; as a result, the energy savings and economic benefits have not reached the desired level.

In order to make good use of solar heating systems, it is necessary to analyze various factors—such as the environment, economics, resources, transport conditions, climate, use, and building type—and specific circumstances. In this study, the analytic hierarchy process (AHP) is applied in planning a passive solar house in China. With experts' estimation, an AHP model of solar house planning and its computer program were set up. This model also may be beneficial for some developing countries that are short of energy resources and funds.

AHP MODEL FOR SOLAR HOUSE PLANNING

AHP, which was put forward by American operational expert T.L. Saaty in the 1970s, is an effective process to quantitatively describe unquantitative incidents and factors.

The system should first be divided into various factors according to its properties and main goal. Then these factors are classified in successively subordinate grades or levels through which the analytic hierarchic model can be set up. Thus the importance of the factors in the lowest hierarchy can be related to the factors in the highest hierarchy on the basis of expert estimation. In this way, the order of the process from the best to the worst can be determined.

Planning a solar house is a complicated subject. First of all, we consider the best building heating energy type as the main goal of the system. Then the influential factors and the type of energy resources available for heating limit the hierarchy and program hierarchy, respectively.

Determination of Hierarchy Restraints

There are many factors that can affect the best selection of energy source for heating. Eight of them have been listed in the program as main factors after investigation and repeated comparison.

F1—Environment This includes atmospheric and indoor environments. It is principally concerned with the effect of the energy consumed by heating on the environment, as well as with limits on the energy resources adopted.

F2—Economic This is an evaluation of the economic benefits of solar houses, including environmental costs.

F3—Initial Cost Building a solar house will increase the primary investment. Because of the undeveloped economy and the imbalance of economic development in various areas of China, solar house planning will be limited by availability of funds.

F4—Resources This includes solar energy and conventional energy resources. Since the distribution of both over every part of China is out of balance, it is essential to take the resource factor into consideration in order to make a comprehensive study of solar house planning.

F5—Distribution This is chiefly about distribution of energy resources from the energy-producing base to the building.

F6—Climate Since China is a country with a vast territory, great differences of climate exist. Solar heating is strongly influenced by the local climate; therefore, the climatic factors must be considered when making solar house plans.

Yao Run-Ming is an M.S. and Liu An-Tian is a professor at Logistic Engineering Institute, Chongqing, China; Li Bai-Zhan is an associate professor at Chongqing Institute of Architecture and Engineering.