Design of Energy Efficient Air-Conditioned Buildings: A Challenging Era

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1. Introduction

The Egyptian community in its path for rapid development is endeavoring to make all necessary and appropriate measures to enhance the efficiency of energy utilization and increase the beneficiation of the energy resources. The energy production, transmission, distribution and utilization efficiency becomes a vital factor and measure of national development. The different governmental organization was established earlier to be responsible for energy planning and efficient utilization, information dissemination and capacity building. Throughout the Nation Energy resources are widely used and consumption rates are in general exceeding the International accepted values. The use and application of new and renewable energy sources can be harnessed to design, construct and operate a solar building of moderate size for desert applications. Endeavor to prepare models for expressing requirements on indoor air quality, thermal comfort in winter and when appropriate in summer, visual comfort, etc is targeted with a common procedure for an "energy performance certificate". Ultimately it is needed to design, construct and operate a solar Building that can meet the rural and desert requirements and save the diminishing fossil fuel sources.

2. Key Features

The paper demonstrates the importance of incorporating an energy performance directive as a Standard in our region. Such a goal will aid energy savings in large buildings and set regulations to energy efficient designs that are based on Standard calculation methods. The proposed Standard would be largely based on International Standards and appropriately modified to suit local practices. The target is to develop standardized tools for the calculation of the energy performance of buildings, with defined system boundaries for the different building categories and different cooling/heating systems.

Table 1. List of energy related standards and aspects in buildings.

Aspect	Sub-aspect	ISO Standards
Thermal characteristics	building components	ISO 6946, 10292,13370, 10077, 13789
Method for calculation of the design heat load.		ISO 13790, 13786
Air-conditioning installation	cooling load, efficiency	DIS18618 Under preparation
Orientation of buildings, outdoor climate		ISO 13790, 15927
Climatic data		ISO 9050

A comprehensive calculation method should clearly include:

- Method to build up internal gains by adding individual components from the bottom and up
- Built-in lighting could be included, with the possibility to give credit for natural lighting in this approach
- Calculation of energy supply from solar water heating and solar heating systems including active seasonal storage or the use of other renewable energy sources such as wind and geothermal
- Indication of the bases for specific real energy use compared to design energy use
- Energy use normalization criteria, such as kWh/m^2, for benchmarking purposes; a clear definition of which m^2 to be used is necessary

The present work opens the field for further investigation to focus on some issues that have to be developed before the preparation and implementation of an energy directive for Egypt:

i. Cooling load and energy use for cooling

ii. When lighting has high priority, a method to calculate all internal gains should be developed

iii. A method for establishing the air change rate based on air leakage (air infiltration), airing and natural / hybrid / mechanical ventilation should also be developed

iv. Verification and normalization methods for credibility and to compare between countries

v. Calculation schemes for the use of renewable energy sources in different applications in buildings and particularly in desert areas

It is probable, that one calculation method will not cover all aspects and building categories of the Directive. For some applications, more advanced simulation models will have to be used to provide satisfying accuracy. The ongoing and future work on methods for validation and documentation of simulation tools at HBRC and Cairo University [1,2], could be valuable in a process of approving models.

3. Conclusions

From the above analyses, one may conclude the importance of incorporating an energy performance directive as a Standard in our region such a goal will aid energy savings in large buildings and set regulations to energy efficient designs that are based on Standard calculation methods. The proposed Standard would be largely based on International Standards and appropriately modified to suit local practices. The proposal is basically to:

1. Develop standardized tools for the calculation of the energy performance of buildings
2. Define system boundaries for the different building categories and different heating systems
3. Prepare models for expressing requirements on indoor air quality, thermal comfort in winter and when appropriate in summer, visual comfort, etc.
4. Develop transparent systems to determine necessary input data for the calculations, incl. default values on internal gains
5. Provide transparent information regarding output data (reference values, benchmarks, etc.)
6. Define comparable energy related key values (kWh/m2, kWh per person, kWh per apartment, kWh per produced unit etc.). The areas/volumes need to be defined.
7. Develop a method to translate net energy, used in the building, to primary energy and CO2 emissions
8. Develop a common procedure for an "energy performance certificate"
9. Develop and compile relevant standards applicable for each individual building category.

4. References and Bibliography

1. Khalil, E.E., 2005, "Energy Performance of Buildings Directive in Egypt: A New Direction," HBRC Journal, vol. 1.
2. Medhat, A.A., and Khalil, E.E., 2006, "Thermal Comfort Meets Human Acclimatization in Egypt," Proceeding of Healthy Building, June 2006, Lisbon, Portugal.

Author's Biography

Prof. Dr. Essam Eldin Khalil is Professor of Mechanical Engineering in the Department of Mechanical Power Engineering at Giza, Cairo University, Egypt. He received the Ph.D. degree from London University, England, and the DIC degree from Imperial College, London, in 1977. His international Activities include:

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- Chair, Arab World HVAC Committee, 2005 - present
- Chair, National Ventilation Code Committee, Egypt, 2005 - present
- Member National Energy Code Committee, Egypt 2000-Convenor ISO, TC205 WG2, on Design of Energy Efficient Buildings, 2003 - present
- Member European/African Wind Energy Committee, 1998 - present
- Distinguished Lecturer ASHRAE, 2004 - present
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