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The Energy Concept Adviser—A tool to improve energy efficiency in educational buildings

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Abstract

Educational buildings such as kindergartens, schools and universities display many similar design, operation and maintenance features in most countries. The two most noteworthy similarities amongst these building types are the high energy consumption and the necessity for retrofitting many buildings within this sector. However, studies have shown that during retrofit, energy saving measures are only rarely applied, because the decision-makers lack knowledge of investments and the efficiency of potential energy saving measures. The main goal of the International Energy Agency ECBCS Annex 36 is to provide the educational building decision-makers with sufficient data, information and tools to improve their learning and teaching environments by improving the energy efficiency of their buildings.

This is the background for the development of an Energy Concept Adviser (ECA) for energy and financial retrofit measures that is useful during the planning and concept development phases for educational buildings. On the one hand to help the owner to find the most efficient energy saving measures and on the other hand to prevent that exaggerated expectations are raised. The ECA should be applicable during the entire retrofitting phase to ensure that both the calculated energy savings and financial success will be achieved after retrofitting.

This paper describes a tool that assists educational building decision-makers while the construction project is still in the design phase. This tool will improve new or existing buildings through the identification and calculation of potential energy savings. The ECA includes suggestions of energy systems to use and potential design concepts to be considered during the design phase.

During the past 6 years, data have been gathered from all the 10 participating countries of the Annex 36. This electronic Internet-based tool incorporates an interactive source book of information, which includes design concepts, design advise, design and decision programs, and case studies. The tool has been translated into several languages.

Keywords: IEA Annex 36; Energy consumption; Energy Concept Adviser; Energy savings

1. Introduction

Analysis of the building structures of commercial buildings performed during International Energy Agency (IEA) Future Buildings Forum (FBF) workshop in Stuttgart, Germany in 1997 has demonstrated that public-owned buildings are constructed similarly in many countries and experience gained with retrofits of these types of buildings can easily be transferred from other countries. An especially large group among these buildings is the group of educational buildings [1]. The kindergartens, schools and universities have high energy consumptions and very often need to be refurbished [2].

Nevertheless, energy saving measures are applied only rarely when these buildings are retrofitted. One important reason for this is often the decision-makers' lack of knowledge of potential energy saving measures [3]. Due to this lack of knowledge, in many cases systems and equipment were selected without regard to their energy use or impact on the operational costs.

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Table 1
The list of Annex 36 participating countries

Denmark	Italy
Finland	Norway
France	Poland
Germany	United Kingdom
Greece	United States of America

The conclusion of the FBF workshop was that a new annex on retrofitting of educational buildings should be established within the IEA Energy Conservation in Buildings and Community Systems Project.

IEA Annex 36 ''Retrofitting of Educational Buildings—REDUCE, Energy Concept Adviser for Technical Retrofit Measures'' was initiated in 1999 and was completed in 2004. Work however continues on a national basis with several initiatives to adapt the Energy Concept Adviser to national requirements. Countries, which officially participated in Annex 36, are listed in Table 1.

The defined objectives of the Annex were: (i) to provide tools and guidelines for decision-makers and designers to improve the learning and teaching environment of educational facilities through energy-efficient retrofitting, (ii) to give recommendations on how to operate the retrofitted buildings, (iii) to promote energy- and cost-efficient retrofit measures and (iv) to support decision-makers in evaluating the efficiency and acceptance of available concepts.

2. The structure of Annex 36

In order to accomplish the defined objectives, the participants undertook work in four subtask areas and a joint working group. The elaborated structure of Annex 36 is shown in Fig. 1.

2.1. Subtask A: selection and analysis of existing information

In this Subtask A, existing information and knowledge in IEA Member countries were collected and analyzed. The state-of-the-art knowledge was documented and differences between the countries were identified to make evident existing gaps of knowledge and to point out appropriate solutions to be elaborated within the other subtasks. The work mainly focused on requirements, guidelines, building types, technologies, benchmarks, decision criteria and case studies. The work of Subtask A was structured into eight project areas in which the participants:

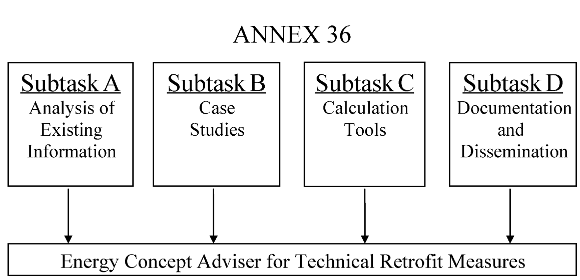

Fig. 1. Organisational structure of Annex 36.

- collected existing case studies and gave an overview on the conditions of existing buildings,
- identified functional requirements,
- defined building types,
- investigated existing solutions (systems, costs, etc.), including analysis of case studies,
- reviewed existing guidelines,
- defined energy benchmarks (national/local building type),
- defined parameters for decision criteria,
- identified functional gaps in knowledge and appropriate solutions.

2.2. Subtask B: new case studies

The Annex case studies included 25 ''newly'' retrofitted buildings (from the late 1990s), a few of which were under construction and were finished in 2000–2001. The case studies included schools, a nursery school, institutional and laboratory university buildings, with innovative energy saving measures, day- and artificial lighting systems with advanced control systems. Measured performance data included temperatures, illumination and other comfort criteria for interior spaces, heating, cooling and electric lighting consumption, the power consumption of the installations and control systems, the total building energy consumption. User acceptance of environmental conditions was assessed through questionnaires. The work of Subtask B was structured into eight project areas in which the participants:

- selected case studies and assessed their status,
- established a design forum and design studies for conceptional buildings, based on design guidelines (using draft guidelines of Subtask A) and parameter analysis,
- observed the case study construction management and commissioning,
- monitored the case studies (short-term/long-term monitoring), evaluated the monitoring data and set up monitoring guidelines,
- established final design guidelines,
- made recommendations for the operation of retrofitted buildings,
- produced documentation of the case studies.

2.3. Subtask C: software development and analysis methods

The design tools used included selected tools, ranging from simple spreadsheets to advanced computer programs that take into account the impact of light and heat in buildings. Work on simple and integrated design tools included model development and validation as well as improvement of user interface and optimisation of calculation procedures. Work on analysis methods focused on comparison of audit procedures and evaluation measures. The work of Subtask C was structured into five project areas in which the participants: