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INTERNATIONAL ENERGY AGENCY
ENERGY RELATED ENVIRONMENTAL IMPACT OF BUILDINGS
ANNEX 31

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ABSTRACT

Annex 31 is a multinational project to support researchers engaged in determining how to measure the effects of buildings on their immediate, regional and global environments. Fourteen member countries of the International Energy Agency's (IEA) Implementing Agreement on Energy Conservation in Buildings and Community Systems are involved in the work, divided into 8 tasks. Tasks involve the development of ways to compare a diverse set of procedures, from those that merely score buildings according to a prescribed set of rules, to highly detailed methodologies that attempt to measure the environmental loadings of a building during its expected lifetime. Data on environmental loadings resulting from buildings will be surveyed and analysed. A report will eventually be produced on the work of the Annex as a whole with some intermediate supplimentary publications.

INTRODUCTION

If we could measure how buildings affect the environment then we would be a long way towards reducing the enormous detrimental effect that buildings have on our delicate environment. There are numerous groups around the globe endeavouring to find the most practical way of evaluating the links between buildings and the numerous direct, let alone indirect, impacts they have on their immediate, regional and global environments.

Considerable study has been made of the total life-cycle impact on the environment of many materials, especially packaging materials. To do this is no simple task, yet at least with such materials the end state of the material is definable: it is incinerated; converted to other materials or at worst buried. In the case of buildings however when investment decisions are made there is rarely any more than a guess as to its eventual disposition. We can expect that a large proportion of buildings already constructed will have life expectancies that stretch into a future when mankind realises that the environment is already enormously overtaxed as a result of energy intensive practices. It is important therefore to provide those who specify new and renovated buildings with means of estimating the life-cycle impact of their design decisions.

INTERNATIONAL ENERGY AGENCY

Annex 31 is a project operating under the direction of the IEA, Implementing Agreement on Energy Conservation in Buildings and Community Systems. IEA itself is operated by the Organisation for Economic Co-operation and Development (OECD), and whereas it has, until recently, almost exclusively focused on energy supply and efficiency issues, it now recognises that the capacity of our global environment to act as a sink for the by-products of energy use is at least as much a limiting factor to energy use than are the limits on energy supplies.

GOAL

The ultimate goal of the Annex is to have a marked influence on reducing the adverse affect of buildings on their local, regional and global environments.

To achieve this the Annex is co-ordinating the efforts of many research groups on four continents who are directly engaged in building, environmental and energy-related science and engineering. There are numerous professionals, industry and government representatives, property owners, lenders and others which differ from country to country, each influencing the definition of buildings and where they are constructed. This is far too diverse a group for one project to focus on. Instead, the practical goal of the annex is primarily to help researchers in each of the participating countries produce workable guidelines, demonstrations, policies, educational curricula or whatever else it takes to better understand the links between buildings and the detrimental effects they have on the environment.

SCOPE

Though life-cycle analysis (LCA) is not the only technique for relating the impact of material goods on their environment, it is probably the most readily understood. In the context of buildings however this begs an obvious question. If it is not possible to determine the life expectancy of a building, let alone the conditions in which it will have to survive, how can this life-cycle impact be defined? The answer is with difficulty and imprecisely. But the fact that it cannot be done accurately should in no way detract from the value of doing it as thoroughly as possible.

Before describing the most salient elements of building LCA it should be made clear that the Annex will not attempt to quantify the end-of-chain impacts on the environment, such as the declining biodiversity or ocean rise. Instead, the Annex will confine itself to the more straightforward task of defining first-level effects, such as atmospheric CO_2 concentration.

The following list should not be interpreted as being definitive or ranked in order of significance, but it serves to illustrate the scope of the Annex.

Operating energy. This is typically the largest category of energy use, namely the energy to maintain a comfortable interior environment. The primary influences on energy usage are climate, building envelope and the efficiency of the building's heating, cooling and ventilation equipment. An important factor in building design is therefore the built-in potential for improving a building's envelope and systems with minimal wastage ,as technology progresses over time.

Embodied energy. This is all of the energy required to put into place the total fabric of a building, both initially and during its life span. The longer the life of a building, the lower the level of embodied energy per annum.

Energy chains. Of every unit of energy used directly by a building a certain proportion will have been required to deliver it to the building. The primary elements of this externally used energy will usually be for processing and transportation. Though in the case of nuclear-generated electricity for example, a large proportion of the energy is the embodied energy required to build the generation plant. Including energy used in the energy chain may increase the directly measured energy in the order of 30%.

Externalities. These are difficult to account for. They are the factors that are not a direct part of the building but are definitely attributable to it. Certainly easiest to account for are the embodied and operating energies associated with the infrastructure that must be in place for a building to function, for example, the road, water and wastewater infrastructure. In a complete analysis one should be able to also ascribe to a building the environmental implications of such operations as central water treatment and pumping stations. If these are not included in the analysis, then the sometimes very significant implications of designing a building to have minimal dependence on the municipal infrastructure are not properly accounted for. One has to be particularly careful to ensure that infrastructure which may be included in *energy chains* is not doubly accounted for by inclusion in *externalities* also.

The future. Whilst this not in itself a categorisation of resource consumption, it is a vital consideration in any analytical approach. Its significance can perhaps be best illustrated by an example. Millions of dollars have been spent in recent year on upgrading and expanding hospitals in Ottawa, with of course the consumption of large quantities of building materials, and therefore energy. The provincial government has just announced that three of these hospitals will be closed. What underlies this step is the reality that medical practice has substantially reduced the typical length of patient stay and this trend was already clear when much of the upgrading of building fabric was taking place. Only time will tell whether the hospital structures will prove adaptable enough to be converted to other uses. This illustrates two points. The first is the importance of comprehensive scanning of trends that may have a large impact on even the near-term, let alone the long-term, viability of a building.
The second point is *adaptability.* Bearing in mind the ever-increasing rate of change of our societies, fed by an unprecedented introduction of new technologies, most elements of the future are impossible to predict with any degree of precision. A vital attribute of environmental benignity, "the greenness" of a building, should therefore include a measure of its adaptability to changing circumstances. The degree to which this aspect may be included within the scope of the Annex is not resolved. Demographic and climatic change, the future of work patterns, the prospect of being able to manufacture quite different materials and the changing balance between the economics of renewable and non-renewable energy technologies are amongst the factors that deserve consideration in building design.

STRUCTURE OF THE ANNEX

The product of the collaborative efforts of the annex will be a report, the planned structure of which reveals the way in which the annex is being managed. the work of the Annex has been divided into manageable tasks which are listed below. For each task a participating country is taking a lead role -- the country is identified after the title of each task. Other members participate in the tasks according to their ability to contribute. In many aspects of the work involved the achievements and results of many other organisations are brought to bear on the tasks to ensure that good wheels are not having to be reinvented.

1 *Methodological Framework- France* This vital task is to develop a means of comparing the primary features and scope of methods that link building energy use to environmental loadings.

2 *Survey of Existing Methods, Benchmarks and Tools- Germany* Using the aforementioned framework, this task is to document the many methods that have been or are being developed, in a consistent manner so that they become comparable. Types of methods, levels of detail and the scope of each method will be made evident.

3 *Recommendations for new Tools and Benchmarks- Australia* Resulting from task 2 the strengths and limitations of the documented methods will be made evident, and possible recommendations given on ways in which methods, tools and benchmarks might be made more relevant to the many potential audiences. Characteristics that will be taken into account by this task are: comprehensiveness, cost of application, degree of detail, specificity, currency, transparency and integratability with other design tools. This latter point may prove crucial to the affordability of applying LCA to buildings. A challenge with the evolution of appropriate methodology is to determine practical ways of combining readily measurable aspects, such as building operating energy, with the rather more nebulous, but still significant, aspects such as externalities and the implications of building location with respect to transportation energy requirements.

4 *Data Issues-Switzerland* All assessment methods are dependent on data. Much time has already been invested by researchers in developing data bases, for example on the embodied energy of building materials. By providing a framework for comparing data, the relative merits of the data, and more importantly, of the means by which they were generated, become evident.

5 *Sensitivity Analysis-Denmark* In terms of buildings in general and in terms of specific building design, what are the major building features that affect the environment? This is a crucial question. If commercially viable methodology to assess the environmental impact of buildings is to thrive then the cost of using a particular approach must be in keeping with the value that may be expected from its application. To achieve an efficiency in methodology it is important to ensure that due attention is paid to those factors that have substantial impacts and correspondingly less attention is paid to aspects that have little impact. Work undertaken in this task will therefore focus on how to rank or put into perspective the relative importance of building features with respect to environmental loadings.

6 *Stock Analysis- Canada* What is the net effect of the building stock on the environment? Methods have been developed to assess energy use at the community level and at the countywide level, based on national statistics. Being able to agglomerate the environmental effect of the building stock at both the regional and national level is imperative for regional and national planning for reduction of greenhouse gas emissions for example. A clear connection can

thus be made between the work undertaken by this task and national plans to meet greenhouse gas reduction targets. The inter-country comparisons will also be most valuable.

7 *Demonstration- the Netherlands* The essential task here is to convincingly illustrate the usefulness of the analysis the Annex will have undertaken, and more generally to show the importance and practicality of assessing how buildings affect their environment before design decisions are finalised. A most important aspect of this element of the Annex is its link to the Green Building Challenge '98 (GBC '98), an international performance assessment process of green buildings, culminating in a conference to take place in Vancouver in October 1998. The Annex and GBC '98 will operate synergistically to demonstrate as clearly as possible the big improvement that can be made towards benign buildings by applying appropriate analysis and subsequent green design practice.

8 *Information Dissemination- United Kingdom* Notwithstanding that the primary goal of the Annex is to support the work of researchers, the work of the Annex is too important to be limit just to them. To ensure the successful delivery of Annex results to the audiences to whom they will be of most valuable, it is necessary to determine how to package the results in a manner that will facilitate this. One product is to be a non-technical publication that intended to popularises the need to include environmental assessment in the design process.

ANNEX PARTICIPATION

Apart from the countries mentioned above that are undertaking specific responsibilities, Finland, Japan, New Zealand, Norway, Sweden and USA are also involved in the Annex. Canada is acting as the Operating Agent, namely the overall management of the project. The Annex is expected to take 3 to 4 years to complete.

ANY QUESTIONS?

As part of the information dissemination task, the Australian participants have set up a Web site, *http://annex 31.tce.rmit.edu.au iea home.htm*. From this site you can identify the participants from each of the 14 counties involved. If you wish for particular information or are engaged in a project that you believe is relevant but is probably as yet unknown to the Annex, you are encouraged to contact your national representative, identified from the Web site.