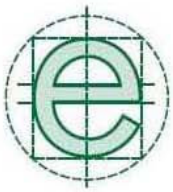

ENVIROSPEC
THE ENVIRONMENTAL DIVISION OF ELECTRONIC BLUEPRINT

ENVIROSPEC is committed to sustainable building construction and operation.
We provide assessments and specifications for sustainable building products.

Benchmarking and Specification of Sustainable Building Products [1]

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Abstract:
This paper discusses the ecolabelling of building products, relevant to applications in the United Arab Emirates, and similar environments. It considers life-cycle based ecolabelling schemes, third-party certification and electronic specifications, used to define and promote sustainable products. As an example, the paper details procedures for determining energy efficiency. It describes the principle of "sustainability benchmarking", to gauge the effect of various options in the context of common construction. The paper concludes with a case study, the energy analysis of accommodation units at Saadiyat Island, Abu Dhabi.

Introduction

The provision of environmentally sustainable solutions, which are credible and designer-friendly, represents one of the most significant challenges facing building product-suppliers. There are the three major developments that affect the selection of appropriate building products:

- Life-cycle based Ecolabelling schemes;
- Third-Party Certification of Alternative Solutions under performance based regulations;
- Electronic Specifications and Details.

Sustainability issues are taking on a major focus in building design and certification. To date, the approach in most building regulations has been to concentrate on the in-service performance of buildings, making provision for both Deemed-to-Satisfy Solutions and Alternative Solutions (based on computer simulation and the published verification methods). This is a soundly–based decision, given that, in many cases, in-service energy performance far outweighs the other energy expenditure associated with building products. However, there is now a strong push to consider the energy involved in winning the raw materials, manufacture, transport, construction and demolition of building products.

Use of Life Cycle Inventory Data

There have been various initiatives to collect comprehensive data on the sustainability aspects of building products.[2] This data will be used to populate design software, enabling designers to minimize environmental impacts. It will also be used to provide ecolabels for building products.

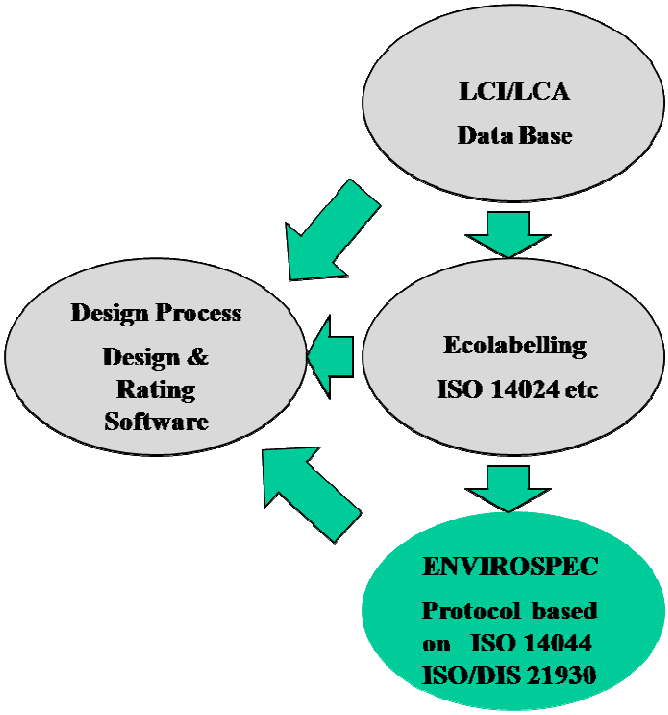
However, there is a real danger that the ecolabels may fail to provide enough precise data on the in-service performance for each product, under a range of applications and climates. If unchecked, this could lead to poor decision-making and the selection of products, which appear to be environmentally friendly, but are, in fact, inappropriate for the actual application.

The ENVIROSPEC Protocol[3] has been formulated to provide for the orderly collation of data for ecolabels, in a technically credible format, geared specifically for use by designers, and tailored for marketing innovative building products in particular applications.

This Protocol deals with the effects of a building product on the sustainable operation of the building into which it is built, in the context of what is both common practice and what is permissible under the building regulations. It provides for the collection of data for subsequent publication in:

- Environmental Declarations (life-cycle analysis and other environmental data)
- Environmental Benchmarking (the comparison of a product's life-cycle analysis and other environmental data to those of the most common acceptable alternative, "benchmark construction").

Environmental Declarations and Environmental Benchmarking should account for the sustainability impacts of the manufacture, transport, construction, demolition and re-use of building products, together with their in-service performance. They should comply with ISO 14044 and ISO/DIS 21930



[2] The author, Rod Johnston, is currently participating in the comprehensive Australian Building Products Innovation Council (BPIC) initiative for the creation of a Life Cycle Inventory (LCI) for building products.

[3] For further details of the ENVIROSPEC Protocol, refer to www.electronicblueprint.com

There is clearly a need for product specifications to:

- Honestly identify products that contribute to sustainability, considering both embodied effects and in-service performance in the intended application and climate

- Clearly quantify the contribution to sustainability

- Create awareness and distribute reliable technical data to Architects, Engineers and Builders.

Third-Party Product Certification and ISO 9001 Compliance
Various complex changes to regulations, have led to a situation where Building Surveyors, Architects, Engineers and Inspectors can no longer be confident that particular building products are capable of achieving the required general and sustainability performance.

Third Party Certification may be used to demonstrate conformity with regulations relevant to building products in specified applications and climates. Assessment may be against specific clauses of product standards and/or the building regulations, either by Deemed-to-Satisfy Provisions or by demonstrating compliance with relevant Performance Requirements. It is important to understand that such third-party certification schemes can only deal with compliance with particular nominated clauses of the regulations or standards. They cannot deal with issues that are outside the scope of such regulations or standards.

Third-party product certification requires the manufacturer and/or supplier to have "effective control" over the manufacture, testing, packaging, branding, delivery, installation and commissioning of the particular products. Whilst most of these may be achieved by well managed companies, operating with effective quality assurance systems, the installation and commissioning aspects offer a particular challenge to manufacturers and suppliers. The most effective method of demonstrating such control is the comprehensive training and the diligent operation of a quality management system complying with ISO 9001. This requires, among many other matters, the preparation of a Quality Manual and Standard Operating Procedures; and provision of an effective record-keeping system. It involves regular Internal Management Audits, Management Reviews, Training, Nonconformance Reporting, Corrective Action and Preventive Action.

There are considerable risks associated with approving faulty construction and inappropriate product selection. On one hand, design for sustainability will increase the likelihood of spurious or inappropriate claims of greenness – "green-wash". On the other hand, the orderly presentation of ecolabelling data reduces this risk..

ENVIROSPEC Service
The ENVIROSPEC ecolabel is based on clearly defining and marketing the sustainability features of particular building products, both qualitatively and quantitatively. It requires the identification of relevant local and international regulations and standards, governing the sustainability of building products.

The ENVIROSPEC ecolabelling service includes the following levels of environmental declaration.

1. Assessment of "first party" declarations (i.e. those made by the supplier).
2. Assessment of declarations made by other LEED accredited organisations.
3. Assessment and declarations made by the Electronic Blueprint Group, based on data presented by the supplier.

The ENVIROSPEC ecolabel may comply with the following

- LEED
- LEED + Life Cycle Analysis (based on ISO 14044 and ISO/DIS 21930 + Benchmarking

Format of Environmental Declaration

The assessment, report and environmental declaration shall comply with ISO 14044 and Draft ISO 21930. The properties that should be investigated and reported, and units, are:

- Use of non-renewable material resource kg
- Use of renewable material resources kg
- Use of non-renewable energy resources MJ
- Use of renewable energy resources MJ
- Climate change kg of CO_2
- Destruction of the ozone layer kg of CFK-11
- Formation of photochemical oxidants kg of ethene
- Acidification kg of SO_2
- Eutrophication kg of PO_4
- Waste to recycling/reuse or energy recovered kg
- Non-hazardous waste to disposal kg
- Hazardous waste to disposal kg
- Energy content of the product MJ.kg
- Water use m^3
- VOC emissions to indoor air $mg/m^3.h$
- HCOH emissions to indoor air $mg/m^3.h$
- Ammonia emissions to indoor air $mg/m^3.h$
- Carcinogenic compounds to indoor $mg/m^3.h$

The report must also identify the following, which enable the properties to be placed in context.

- Reference service life.
- Details of the representative manufacturers, geographical covering, time covering, and special conditions.
- The life cycle stages that are included in the environmental profile.
- The life cycle stages not included in the environmental profile. This is most important, since it is often convenient to omit in-service considerations from broad-based sustainability claims and ecolabelling. However, since in-service performance of products associated the building envelope often affects heat flow, such omissions are often erroneous and misleading.
- Reference conditions and maintenance specified for the reference service life.
- Scenarios for transportation, construction, maintenance, replacements and demolition based on the reference service life.
- Scenarios for relevant recycling, energy recovery and waste treatment processes.
- Qualitative information related to environmental effect.
- References, standards and relevant reports.

In order to properly understand the relative significance of the “embodied” effects and the “in-service” effects, each of the impacts should be reported in the following stages. The difficulties of reporting the “in-service” effects for a range of climates and application are discussed in detail in the ENVIROSPEC Protocol.

- Product stage
- Building stage
- End of life stage
- Sub-total
- In-service stage
- Total

Finally, the report should state, for each of the properties in each of the stages, the following:

- Performance (in the units stated above)
- Benchmark (in the same unis as for performance)
- Comparison (Performance/Benchmark x 100) %
- Sustainability Statement

Example - Benchmarking Non-renewable Energy Use

The principal goals of ecolabelling and life-cycle analysis are to minimize the use of energy and generation of greenhouse gas. The following procedure outlines the principal steps.

Criterion Definition

The use of the product shall lead to a reduction in the non-renewable energy use (in MJ), when compared to "Benchmark Construction". It shall be assumed that non-renewable energy is used throughout the product life, unless there is evidence to the contrary.

Benchmark Construction Definition

The relevant benchmark construction is defined as "the proposed building, but designed to incorporate the minimum form of construction that is permissible under the relevant building regulations".

Compliance Demonstrated by Life Cycle Analysis

Calculation of embodied energy shall take account of the energy used throughout the life-cycle to carry out the following processes.

- Procure and transport the raw materials to the manufacturing facility,
- Establish the manufacturing facility,
- Operate the manufacturing process,
- Transport the materials to a typical building site,
- Build the materials into a typical building,
- Demolish and dispose of the materials at the end of the building life, and
- Provide a credit for the proportion of the materials that may be recycled.

Calculation of operational energy shall take account of the climate characteristics of the intended location, acceptable comfort levels, use or otherwise of artificial heating and cooling and the characteristics of both the Product and Benchmark Construction.

Performance may be demonstrated by the following process:

1. Calculate the embodied energy of the Product throughout its life-cycle, E_{pe}.

2. Calculate the operational energy consumption of the building, incorporating the Product, throughout its life-cycle, E_{po}.

3. Calculate the embodied energy of the Benchmark Construction (that the Product is intended to replace) throughout its life-cycle, E_{be}.

4. Calculate the operational energy consumption of the building, incorporating Benchmark Construction, throughout its life-cycle, E_{bo}.

5. Determine the net increase or decrease in total energy use if the Product is used in lieu of Benchmark Construction, from the following.

   Net Energy = Total energy for Product – Total energy for Benchmark Construction
   $= (E_{peN} + E_{poN}) – (E_{beN} + E_{boN})$

6. Report the Net Energy (increase or decrease), together with full calculations.

Case Study - United Arab Emirates, Abu Dhabi, Saadiyat Island - Accommodation

Project

In 2008, House Energy Rating[4] was commissioned to assess the energy efficiency and thermal comfort of a 20,000 person camp at Saadiyat Island, consisting of stackable modular accommodation units.

Procedure

The consultant was supplied with architectural drawings incorporating all proposed building materials and building services. The goal was to understand and predict the buildings' performance before construction was undertaken. Design elements identified for consideration included:

- Building form – ratio of wall to floor area
- Glazing location, thermal performance, shading and ratio of glass to floor area
- Materials making up the building envelope including insulation.
- Colour (absorptance and emittance) of external surfaces with any solar exposure
- Occupancy, the hours that the building is used and the comfort conductions expected by the occupants.

Modeling

The building was thermally modeled using the EnergyPlus simulation software package, developed by the United States Department of Energy. This simulation package accepts inputs for a building including

- Form and materials
- Occupancy
- Comfortable temperatures
- Appliances
- Heating and cooling,
- Many other factors which influence energy use in buildings.

Shading was also modeled, using an external program.

The building parameters were entered into the software, together with a weather file containing temperatures, wind speeds and directions. The software calculates the amount of energy used to keep the building within designated comfortable temperature ranges. The software is very flexible, and can predict:

- Hourly internal temperatures in non-air-conditioned or free-running buildings; and
- Running costs for entire buildings by fuel type, etc

Modeling of Various Design Options

Changes were made to the building in the model, and the building simulation was re-run. The energy load for a set of options for the building fabric and envelope were calculated and recorded. By making changes to the design elements listed above, the proposed building was tested with a number of different materials, glazing and orientation.

Conclusions

- The energy use in the buildings is dictated principally by the number of occupants,
- It is quite possible to have a potentially very energy efficient building with little net energy use.
- Performance for this particular development is driven by the hot local climate.
- Protecting the sub-floor spaces from external conditions resulted in the most significant reduction in overall energy use, up to 50% reduction in overall cooling load.
- Reductions to the external surface absorptance of the building, and incorporation of roof design features also had a beneficial effect on thermal performance.

[4] House Energy Rating is an Australian based sustainability consultant, and a partner of Building Product Certification Pty Ltd (part of the Electronic Blueprint Group).

Conclusions

1. Green-wash !!! - Credibility is Paramount
   We are all aware of "green-wash" - the making of environmental claims based on hearsay, subjective opinion or incomplete assessment of partial data. Suppliers must understand that "quick cheap" ecolabels may provide a short-term marketing advantage, but eventually expose them longer term credibility loss and litigation.

2. What are the appropriate standards?
   The comparison of comprehensive life cycle analyses of competing products is the most equitable basis of selecting sustainable products. Environmental Declarations should be determined in accordance with ISO 14044 and comply with ISO/DIS 21930.

3. Consideration of In-Service Performance in Ecolabels
   Environmental Declarations should account for the sustainability impacts of the manufacture, transport, construction, demolition and re-use of building products, together with their in-service performance.

4. The importance of Environmental Benchmarking
   It is necessary to consider the effects of various building products on the sustainable operation of the building into which they are built, in the context of common practice and what is permissible under the Building Regulations. This is achieved through Environmental Benchmarking, the comparison of a product's life-cycle analyses or other environmental data to those of the most common acceptable alternative, "benchmark construction".

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