IEA-SHC Task 27: Environmental Performance Assessment of glazing and windows: context, overview, main concerns

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INTRODUCTION

While all industrial sectors are integrating the environment concern into their culture and strategy, actors of the construction field seem to be torn between motivation and suspicion in front of this new topic. In most countries, the economic situation of the passed years for building was not suitable for investing in new long-term approaches, and the strong particularities of the building world appear as many complicating elements for introducing new concepts easily.

But now the awareness for a sustainable development of all human activities is also growing in our sector, and it is time to take benefit of some favourable habits like the use of multi-criteria analysis: beyond performances, suitability for use, and durability, environmental quality criteria will just widen the actual scope of the technical assessment of building products.

The first question is a double one : Who will use environmental criteria related to the building products, and for which purpose ? Because actors in the field are many, we will have several distinct answers, which may call for different tools.

In other industrial sectors, two approaches have been experimented: the Life Cycle Analysis (LCA) and the environmental labelling. Between LCA and green labels, several relevant tools are in development for the building products, each of them adapted to specific users and objectives, and most often of limited use in other contexts.

A short review of the studies already performed on the environmental quality of glazing and windows revealed quite a small amount of available matter, and justifies the work undertaken within the programme of IEA/SHCP/Task 27, which will be presented in the third part of this paper.

THE BUILDING PRODUCTS IN THE SUSTAINABLE DEVELOPMENT CONTEXT

The Building Sector and the Sustainable Development

The very broad concept for the "sustainable development" has been defined for the first time in 1987 in the Bruntland Commission report as *"developments that meets the needs of the present without compromising the ability of future generations to meet their own needs"*

Such a large concept has been then analysed in details in order to translate it into practical actions, and for that it has to be considered along several axis:

1. The human life sectors (agriculture, transport, industry, health...)
2. The issues (environmental, economic, social)
3. The technical scale (material, single product, complex work, large scale system or infrastructure)
4. The observation scale (local, regional, national, global)
5. The time scale (year, decade, lifetime of the object, generation...)

The Earth Summit held in Rio de Janeiro in 992 constituted a turning point in man's attitude with respect to his environment, and from there were initiated more concrete action illustrated by the so called "Agenda 21"

Construction is one of the industry related human life sector (position on axis 1) to be considered and Luc Bourdeau [1], gives some guidelines for establishing the Agenda 21 for Sustainable Construction, and in a further step a system of relevant indicators.

The building sector has a significant part in the environmental impact of the human activity (use of natural resources, CO2 emissions through heating and cooling, construction and demolition waste). It is one of the main economic component as an industrial sector but also as major pole of the family budget, and it plays a key role in the social field, for quality of life, health, cultural and relational aspects, employment.[1]

In the present document, our purpose is restricted to the environmental field (position on axis 2), which burdens are mainly raw materials and energy consumption, emissions to air, soil and water, and solid waste production. The aim is then to identify, and measure these environmental impacts, and provide tools for assessing, and guidelines for reducing them.

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[1] *It is a well known fact that the construction industry is Europe's largest industrial employer. Less well known, are the "cradle to grave" aspects linked to the creation, use and disposal of built facilities. Construction activities consume more raw materials than any other industrial sector. The built environment moreover, accounts for the largest share of greenhouse gas emissions in terms of energy end usage. Measured by weight, these activities also produce Europe's largest waste stream. Consequently, the extraction of these raw materials, the consumption of energy in the built environment and the disposal of waste from construction activities and demolition, constitute significant environmental impacts. It is common knowledge that the industrialized nations are consuming the world's natural resources at an unsustainable rate. Nowhere is this more pronounced than in the consumption of fossil fuels. These simple facts imply that in absolute volume terms, the construction industry – and the sustainability of its products; principally buildings – in order to become sustainable in the long term, faces an environmental challenge that, in absolute volume terms, is greater than that of any other industrial sector. For too many years, nation states have been remarkably slow in recognising the scale of the difficulties involved in achieving sustainability in the built environment. Moreover, these are no longer simply national issues or even European ones; there are global in their extent.[1].*

The Place of the Building Products in the Environmental Quality of Construction.

Here comes now the selection of a position on axis 3: the technical scale. For the Construction sector, it is easy to consider three levels: the *product scale*, from material (wood) to component (window), the *building scale* (the work: a house, a school, an office building), and the *urban scale* (a group of houses, the neighbourhood, the city).

The purpose of that report is addressing windows and glazing, which are building products, from the simplest window to the complex façade component. We are thus dealing with the product level on axis 3, but some comments have to be brought for a better understanding of the approach.

The building sector in a complex one, for several reasons.

First of all the building (the house, the "work") is of course the sum of products assembled together, but not only. The destiny for a building product is to disappear when installed in the work, so that during all its life, the building as a whole could fulfil its function. From the environmental point of view, it is thus clear that beside the environmental impacts of the products, those from the work (energy consumption, water cycle, domestic waste) are the major ones, and cannot be imputed to any specific product.

A good example of that particularity is the so called European "new approach", applied for the assessment of building products in the framework of the open market (free circulation of goods). The construction product directive (CPD) [2] stipulates that building products performances must be so that the work in which they will be incorporated fulfil six essential requirements, which are n°1 "safety", n°2 "structural stability", n°3 "hygiene, health and environment", n°4 "fire resistance", n°5 "noise attenuation" and n°6 "energy economy and heat retention". The environmental issues are partly dealt with by requirement 3 and 6.

Another approach is to consider the actor's view.

The designer has to produce a building, and that scale is the relevant one for assessing the (expected or actual) environmental performance. So the tools developed for that purpose (GBC, LEAD, ENVEST, ECO-QUANTUM, ESCALE, ATHENA....) address the whole construction work, requiring data from the products only for some of the targets or criteria.

The inhabitant, or final user, is also using a house, not a building product: as he seldom acts as a product specifyier, he should be more interested by the environmental quality of the house than of the products. But his interest for products is enhanced when health issues are concerned, and also because it is easier to highlight product performance than building performance.

Finally the owners are carrying also the same ambiguity, when calling for tenders for new projects: they want construction works with environmental performances at that scale, but the temptation is high to specify products or choice criteria at the product scale.

For all that reasons, manufacturers have to be ready for making available environmental data related to their products

THE ENVIRONMENTAL ASSESSMENT OF BUILDING PRODUCTS

Life Cycle Analysis (LCA) as a basis

What is LCA

Life Cycle Analysis (LCA) is based on an inventory of material and energy flows of every step in the product's life (manufacturing, transport, use phase, end of life). These consumed and emitted flows (raw material and energy consumption, emissions to air, water and soil) are then aggregated (balanced to a given functional unit), and interpreted in terms of impact categories on natural ecosystems. Until now several environmental impact categories reached a consensus at the international level.[2]

The product is identified by its functional unit, that describes how much of it is required to fulfil a given function, thus allowing some sort of comparison between different alternatives and possibly products. The basic scientific framework has been established in 1992 by the University of Leiden (NL) [3] and SETAC, a working group of chemical industry representatives, who developed the methodology at an international level [4]. LCA is now progressively being standardised by ISO/TC 207 [3].

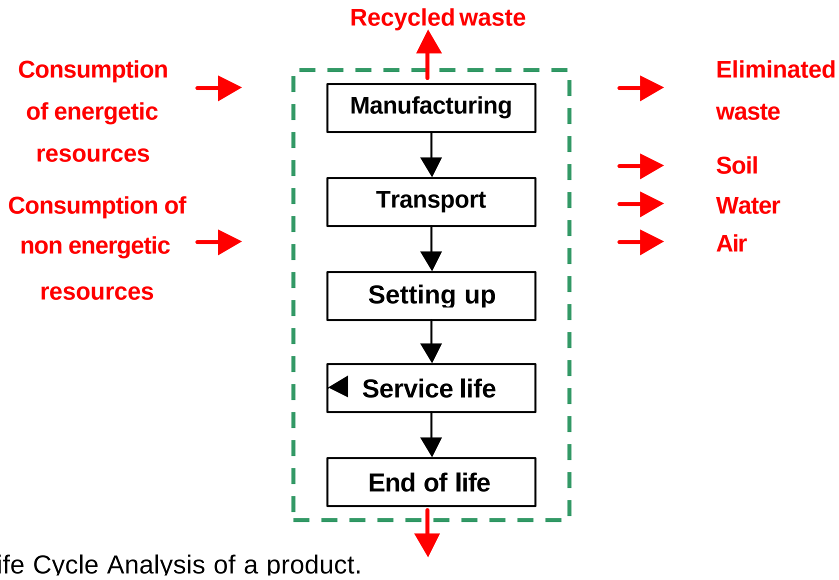

Fig. 1 Life Cycle Analysis of a product.

The methodology is now recognized as the best approach for assessing the environmental performance of a product, and the only method guarantying transparency, objectivity and exhaustivity. But on the other hand some comments on LCA address its complexity, the difficulty to get usable results, and the risk of biased use of parts of it. One also stresses

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[2] *Global Warming Potential (GWP) in kg of CO² equivalent*
Ozone Depletion Potential (ODP) in kg of CFC 11 equivalent
Acidification Potential (AD) in kg of SO² equivalent
Nutrification Potential (NP) in kg of PO^4 equivalent
Photochemical Ozone Creation Potential (POCP) in kg of C^{2}H^4 equivalent

[3] *ISO 14040 Life Cycle Analysis - Principles and frameworks (1997)*
ISO 14041 Life Cycle Analysis - Scope, system boundaries and inventory analysis (1998)
ISO 14042 Life Cycle Analysis – Life cycle impact assessment (2000)
ISO 14040 Life Cycle Analysis – Life cycle interpretation (2000)

some weaknesses: LCA hardly covers local impacts, like those on human health; the amount of required data to reach the final level of assessment is really huge; for complex products including various materials, respecting the rules for environmental flow may lead to undertake the LCA of a significant part of the planet!

Building product particularities

The product complexity. In the construction field, the object of an environmental assessment must be a product operating a function in the building. It is generally made out of several materials, and enters in a larger work. It must include the complementary materials such as mortar for bricks to become a wall. In some cases it may be difficult to identify it out of the whole building itself.

Specific phases. Three phases of the life cycle of a building product are quite specific : the installation phase (the construction site), the service life, and the end of life (the demolition site). On the construction site, it is obvious that some processes required to install the product are strongly dependent of the type and location of the building, and on the skill of the workers. Many construction products still undergo some sort of a manufacturing process on the site. At the end of the life of a building, a relevant modelling of a demolition site is a challenge because products are often not separable one from the others. In addition, they may enter in other product cycles which strongly depend upon local situations. Finally the service life is the longest one: much longer than for any other product. At the end of the life of a construction product, regulations or policies will be different than today, the use of the building will possible have changed, and the Construction Company may not exist anymore. The product will have been submitted to various maintenance operations to compensate for its degradation - during such a long period, we cannot neglect the (reverse) effect of the environment on the product, which is measured by the durability.

The indoor environment concept. During service life phase, a product somehow disappears, as the building itself exists, and creates around the inhabitants an intermediate environment (the « indoor environment »), which adds another complexity to the problem. Most flows playing on this indoor environment cannot be allocated to single products (concentration of Nox emissions from open gas burners will depend on the room's architecture, use and ventilation, for instance). Health of the inhabitants is now becoming a strong concern (whereas it is sometimes considered to be out of the scope of the environmental quality)[2].

The construction actors. Another important feature is the number and diversity of the actors during the life cycle of a building product (typically 10+ in France, for instance). This has several consequences: the first one being that nobody keeps track of a product all along its life, as several professionals (or users) are successively concerned by it: manufacturer, designer, builder, successive occupants, maintainer, demolition contractor. The second one is the importance of the actor's aims or preferences for decision making, which may differ strongly at the various levels.

The data quality. Finally, and as a consequence of all the previous statements, the data required for any inventory are quite difficult to gather. Most of the time, they are dispersed because the process is not an industrial one, they differ from one site to another (differences of procedures, climate, lifetime, transport need,...), they may also be unavailable or don't even exist. In front of that situation, extra caution is highly necessary when using any available database, and their is a risk to minimise or forget flows or phases, or even effects only because we have no data.

It can be seen from the particularities presented here that applying LCA methodology to the construction product may be a difficult task. I addition to national research programs [5], a first EU Brite-Euram project was performed by the main ENBRI research centres to develop a frame work [6]. Later, and while the first environmental declaration format were experimented in several countries, international initiatives took place to provide harmonised guidance for the purpose of assessing the environmental performance of building products; the NIMBUS project for Nordic Countries [7], and a specific SETAC expert group at the European level [8].

Environmental labelling of building products

Environmental labelling according to ISO

When considering the user's need, one has to think about the communication means of environmental information and data. The consumer expects simple and understandable pieces of information, while the topic is complex and multi-criteria. While the user wants to know if the product is good or bad for the environment, the experts wants to explain that the impacts categories are various, and as different as raw material consumption and biodiversity. Some attempts were developed for reaching a single value through aggregation, ranking and weighting, but of course there is no international consensus on that process, and such an approach let think that environmental impact is an absolute assessment, which is wrong.

A set of standards developed within ISO TC207 is now available[4], and defines three types of labelling and declarations.

Type I environmental labelling addresses programmes developed by public or private bodies (usually independent from manufacturers) for communicating on the environmental quality of a family of products, according to a pre-determined set of criteria, and on a voluntary mode. The European Eco-label is a good example of Type I.

Type II environmental labelling includes the self declarations provided by manufacturers, claiming for their products for instance "recyclability", or "bio-degradability", or "design for disassembly".

Type III environmental declaration is the more sophisticated approach, and the only one based on the LCA. It is also the more transparent one, as it requires a well define methodology with several options, and including

[4] *ISO 14020 Environmental labels and declarations – General principles (1998)*
ISO 14021 Environmental labels and declarations – Self declared environmental claims (type II environmental labelling) (1999)
ISO 14024 Environmental labels and declarations – Type I environmental labelling – Principles and procedures (1999)
ISO/TR 14025 Environmental labels and declarations – Type III environmental declarations (2000)

elements of data quality. But the ISO document couldn't reach until now the standard status (it is only a technical report) because of divergences between manufacturers and other members of the committee about third party certification principle. Until now it seems that this type of communication has been experimented essentially in the construction sector.

Environmental Labelling and Declarations of building products

The building products manufacturers introduced already many years ago in their communication procedures some environmental claims corresponding to type II labelling: "my product is recyclable", "my product has a low embodied energy", "my product is environmentally friendly". The most frequently used is probably "my product is natural".

Only a few building products appear among the different national and international programmes for Type I labelling over the world. Blue Angel in Germany covers components usually associated with energy saving, Green Seal in the US addresses also several building products, and until now the European Eco-label applies to paints and varnishes for building applications.

Even if such labelling aspects are easy to use for prescribers, they suffer from two main weaknesses: the lack of transparency, and the mono-criteria approach.

First of all the "black box" type claim is not relevant for building products. A building product has intrinsic environmental burdens, mainly related to the production phase. But he has also extrinsic ones, when the product is incorporated in a construction work. It is obvious that according to:

- the distance and transportation mode from factory to site
- the technical options of construction
- the use changes of the work
- the maintenance and replacement protocols
- the end of life scenario

the related environmental loads may vary in significant proportions for the down stream phases of the life cycle.

The second aspect is the mono-criteria approach, at to levels: the environmental quality addresses several independent criteria and a product may good for one and bad for another. But more important is that the performances of a product to be incorporated in a construction work must fulfil the functional requirements: environmental quality must not be consider apart of technical performance and service life duration, and of course cost and architectural considerations are also important decision criteria.

For these reasons, there is an international consensus for considering that the type III declaration is the relevant approach for communicating the environmental performance of building products.

Environmental Product Declaration (EPD) development

During the last 5 years, many initiatives were undertaken at national and international level, mainly in the European landscape. They came from scientists, building research centres, public bodies or from the manufacturers themselves, but with the same goals: provide the specifiers with relevant environmental characteristics on building products, for helping their choice process, so that their construction work may better respect the environmental concern: EPD is the source for data to be introduced in the environment assessment tools at the building level. But in the same time the EPD can be a good tool for improvement of products, and a good reference document for multi-criteria product assessment.

At the moment several schemes (methodologies and communication format) are used all over Europe for EPD, and the modes of production and communication are different: it is still mainly a voluntary approach, but the procedure is a public requirement in some countries (for instance in The Netherlands), a standard and a future data-base in France [9], a data base in Finland.

Two years ago, a workshop organised by SETAC, ENBRI (network of building research centres) and CEPMC (European association of manufacturers) was the European starting point of a general harmonisation work, now in progress under the Directorate “Enterprise” of the EU, and fig2 is extracted from the interim report of that action [10].

Country	**Programme organiser**	**LCA Schemes for materials and buildings**	**Year**
CH	SIA, Swiss Society of Engineers and Architects.	SIA declaration matrix	1994
D	Stuttgart University	Ganzheitliche Bilanzierung von Baustoffe und Gebäude (LCA of building materials and buildings)	2000
D	AUB	Umweltdeklarationen (environmental declarations) (in development)	2002/ 2003?
DK	Danish Building and Urban Research – SBI	MVDB (Environmental Product Declaration f or Building Products) (in development)	2002 (?)
F	AFNOR (French standardisation organisation)	Experimental standards - Information concerning the environmental characteristics of construction products: - XP P 01-010-1: Methodology and model of data declaration - XP P 01-010-2: Guidelines for the application of environmental characteristics to given construction work.	2001
FIN	Building Information Foundation RTS	Environmental Product Declaration for building products	2001
N	Norwegian Building Research Institute NBI	Environmental Declaration of building products	1999
NL	NVTB – Dutch construction Products Association	MRPI (Environmental Relevant Product Information)	2000
NL	NEN – Dutch standardisation organisation	MEPB (Material Based Environmental Profile for Building) (in development)	2002/ 2003?
S	Ecocycle Council for the Building Sector.	Building Product Declarations (BVD)	1997
S	Swedish Environmental Management Council (Svenska Miljöstyrningsrådet)	Environmental Product Declaration	1997
UK	Building Research Establishment (BRE)	Environmental Profiles of Construction Materials, Components and Buildings	1999

Fig. 2 EPD programmes established in different European countries for building products [10].

In the same time, the same goal drove experts of the ISO TC59 “building and constructed assets” Committee, when they create in 2000 the Working Group “sustainability in building construction”. Now close to become a Sub-Committee, this group is ready to submit as Committee Draft a document called “environmental declaration of building products”.

One example: The French Standard for EPD

The French Standard XP-P 01-010 [11] provides the methodology for communicating environmental characteristics of building products. It is published in two parts. Giving some details on it is a good illustration of the typical content of an EPD.

Part I, “*Information concerning the environmental characteristics of construction products – Methodology and model of data declaration”* relates to the data declared on the basis of the LCI (Life Cycle Inventory).
Part 2, “*Information concerning the environmental characteristics of construction products – Framework for exploitation of environmental characteristics for application to a given construction work”* aims to characterise the contribution of products to the environmental impacts of a given construction work. It indicates what information must be retrieved from part 1 and how to exploit it.

This standard results from a work performed in collaboration with all the building stakeholders. The two part structure creates a mandatory step at the inventory level. The data have to be provided with mentioning elements related to data quality (origin, accuracy and representativity). Data must be issued from a LCA. They are provided by the manufacturer, from measurement or declaration for the manufacturing phase, and through explicit scenarios for the downstream phase. Al data must be communicated under pre-drawn tables for 8 categories of flows, in which the life cycle phases are separated. In addition, a description of the product, as well as the functional unit, the technical performances and the typical service life are requested.

In part 2 the inventory data are translated in terms of environmental impacts, and fig 3 gives the list. Documenting them is for some of them mandatory for all products, for some others mandatory for specific product families, and for the last ones optional.

N°	Environmental impact	Unit
1	Consumption of energy resources	MJ/FU
2	Consumption of non-energy resources	kg/FU
3	Water consumption	litre/FU
4	Solid waste	kg/FU
5	Climate change	kg equivalent CO2 /FU
6	Atmospheric acidification	kg equivalent SO2 /FU
7	Air pollution	m3 / FU
8	Water pollution	m3 / FU
9	Soil pollution	Qualitative
10	Destruction of the stratospheric ozone layer	kg equivalent CFC R11 /FU
11	Formation of photochemical ozone	kg equivalent ethylene /FU
12	Affecting of biodiversity	qualitative
13	Contribution to indoor air quality	Semi-qualitative
14	Contribution to water quality	Semi-qualitative
15	Contribution to hydrothermal comfort	Qualitative
16	Contribution to acoustic comfort	Qualitative
17	Contribution to visual comfort	Qualitative
18	Contribution to olfactory comfort	Qualitative

Fig. 3 List of environmental Impacts from the French Standard XP-P 01-010 [11]

GLAZING AND WINDOWS: A SPECIFIC CASE

Particularities

All that has been written in the previous paragraphs is applicable to glazing and window, as both are building products. But when looking more in details, the situation may appear more complicated. Which combination is the product? glazing is a product, the frame is another one, but the function is fulfilled by the window, which includes also the handling system, and the sealants (both for the double glazing and for the glazing and frame assembly). So are we going to consider each component separately or in combination?

The key for defining the functional unit is of course the function. And the function is performed by the window as a whole. So the unit must be the window. But which function? In fact a window has many functions. One first mention energy saving and light entrance (which may be contradictory), but envelope continuity for tightness, privacity and intrusion prevention are also important, and confirm that the window as a whole is the relevant unit.

So the window is a actually a building product, but maybe the most complicated one, particularly as far as environmental assessment and LCA are concerned. It involves many different material families: glass, metals and oxides for the coating, rubber for the sealant, wood or Aluminium or steel or PVC for the frame, etc...It is the result of several successive elements assembling phases, some of them strongly industrialised and some not.

Finally the most questioning problem is because a window is considered as contributing to the thermal insulation of the house, and for that bearing a role of energy saving during the life-time. Within the LCA theory, only input or output environmental flows must be considered, not the “crossing” ones. But of course the energy flow through the window during its life time, and more precisely the avoided energy losses are generally recognized as much higher than the embodied energy (energy consumption during the production phase), which may result in a negative overall effect on the environment for those impacts issued from energy consumption.

Fig 4 is an adaptation of the generic scheme for LCA to the window. First of all the window is drawn attached to the wall in order to show that it has to be analysed when incorporated into the construction work.

The small panes symbolize the life cycle stages, and one can see that the use phase is the longer one. But that duration is an open question, with answers only in Switzerland [12], assuming 30 years as a minimum.

Then the flows appear in blue for consumption, in red for rejections. Emissions are attached to the use phase, towards indoor space for air emissions and towards outdoor for those to water and soil. All emissions are mainly attributed to complementary products (for instance preservatives and paint for wood)

Finally the crossing flow of (avoided) energy losses is drawn through the window, without stating if it has or not to be considered within LCA...

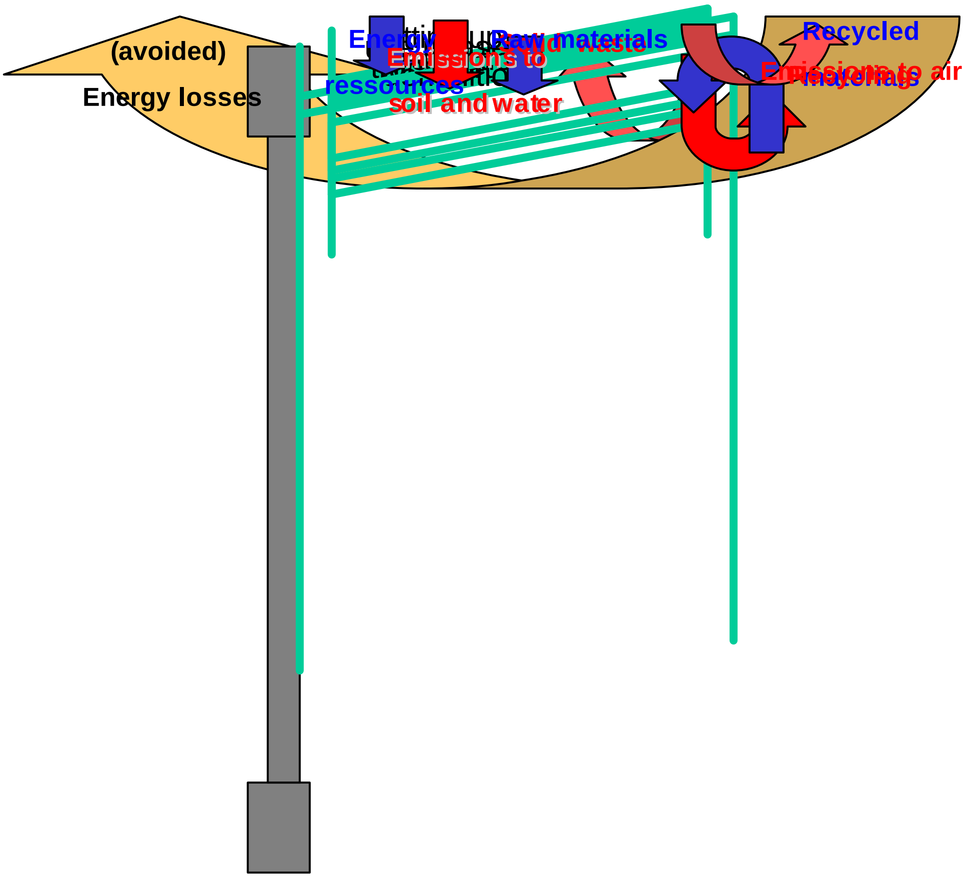

Fig. 4: Life cycle Analysis of a window

State of the art

The previous considerations may explain why the studies on the Environmental performance assessment of the windows are quite few, and why the approaches differ so much.

Some studies have been performed quite early in Germany Switzerland and Austria, dealing with LCA of the different window families. The German one (in German) [13] was ordered in 1992 by the Ministry of housing (in the same time as floor renderings and paints). It is a very detailed and extensive study, treating separately the frame materials, glass, coating materials and plastic glazing candidate materials. The authors try to respect the LCA rules, but in some tables we can find qualitative or ranking statements instead of numerical values. In the Brite-Euram project [6], wooden window frame was one of the four examples treated by sending questionnaires to several building actors in various countries: from the small number of responses, we essentially noticed the strong national particularities.

More detailed was a Norwegian work [14] trying a LCA comparison between several scenarii for retrofitting old windows, on the energy balance point of view, but also considering other impact stressors. The result is in favour of an inner frame attached to the old window, and it is a good example of LCA producing a precise answer to a precise question.

An Austrian report [15] comparing the three main materials for the frame, and ordered by the plastic frames producers, brings quite different results compared to a report from Switzerland, and ordered by the wooden frame producers. Different? not so different: the PVC producers say that PVC may be better and better when recycling rate is growing, and the wood people say that wood is better, but PVC could become a competitor by developing recycling!

More recent studies, from USA [16] and Switzerland [12], are dedicated to document the balance between the environmental impacts from pure LCA studies and the environmental benefit on energy saving (and energy related environmental impacts avoided) when improving the thermal and optical performances of the windows. Improved modelling tools are developed to calculate that balance, the most sophisticated trying to take also in account the increasing electrical lighting and its impacts due to solar controlling glazing.

From the communication point of view, the mostly spread environmental message from the window and glazing manufacturers addresses the avoided energy losses, and the avoided related environmental impacts.

At least three national eco-labelling procedures (type I) have already considered glazing and window. The US Green Seal published a special report on windows [17], in which the selected criteria are a good illustration of the priority given to the technical quality (thermal and visual performances, durability), before considering two environmental criteria: dangerous substances content of frame and sash materials, and recyclability of the packaging. The German “blauer engel” (blue angel) considered the high insulation glazing units, with a mono-criteria approach on the heat loss coefficient, as the only selected environmental aspect. Thus, products from almost all the high insulation glazing manufacturers in Germany got the label.

Finally the Nordic countries have established a list of requirements and criteria for a future labelling of windows: they are related to materials, wood preservatives, waste during manufacturing, thermal performances, installation, packaging.

It is to mentioned that in some programmes or in some countries, PVC is banished “a priori” from the labelling procedures, probably because of the risk of emissions in case of fire. This question induced documents from the EU (the green book on PVC) and another from the manufacturers.

As far as environmental declarations are concerned, and when reviewing the table of national procedures in fig 2, it is quite difficult to find any declaration addressing a window, except in the Finish system, where two windows are registered. Some declarations are available for window frames only (in Germany, The Netherlands and UK), as well as declaration for flat glass according to the French standard.

Finally references for different glazing and/or frames are available in the Athena system [18] in Canada and in the BEES [19] data-base in the US.

IEA/SHCP Inputs

Within the Task 18 programme (“Advanced glazing materials”) developed between 1992 and 1997, a project was already dealing with environmental performance. Then at the definition workshop held in Washington in 1998, where T 27 was firstly outlined, the sustainability concern was addressed trough a specific paper [20].
Finally, sustainability is the title of one of the 3 subtasks within T 27 ‘”Performance of solar façade components”, and project C1 deals with “Environmental performance assessment”

Task 18

In the final report of the project called “environmental and energy impacts” within the former Task 18 of IEA [21], energy was the main concern, and the first conclusion was that advanced windows will certainly bring benefits on CO_2 emissions, as a significant amount of energy will be saved during the life-time of the window. In comparison, the impacts of procurement and manufacturing of the materials for glass, frame and coating were rather small, because of the small weight relatively to the building's weight. It is important to mention that different tools were necessary to comply with different demands, like inhabitant or government. Some fear was also expressed about the use of average data and generalised assumptions.

Task 27 Project C1

The expert group actually working for the project C1 is rather open in terms of activity and countries, and it includes several industries. The aims of the project are the following:

- reach a common level of knowledge in terms of terminology and categories of tools.
- perform a survey of national approaches (needs and priorities, tools used, work already done or in progress on glazing, windows and solar devices)
- agree on appropriate methodologies to assess the environmental performance of our products, and also on target and communication formats
- perform application exercises on a glazing, a window, and a solar collector through four steps: agree on priorities, system limits and criteria, collect data, conduct the procedure and communicate results

After more than two years, and thanks to previous work from some participants from Italy [22] and Denmark [23] on related topics, the work plan was rather well followed, but the major difficulties lies in the fluctuations of the funding situation according to the national political situations, and the contrasted position of our industry partners for providing data.

The following inputs and progress can be registered yet:

Common understanding and international connexions. The group reached a good level of common understanding related to environmental assessment principles and building product particularities. The group is also a key forum for disseminating information about the environmental topics, especially the environmental declaration approach, making a bridge between Europe and America, as well as for the confrontation of the wishes and concern from different stakeholders. Especially the statements made by the manufacturers were very useful for understanding some difficulties when collecting LCA data.

Methodology: data collection A questionnaire has been agreed for data collrction, to be filled by the manufacturer provided that the aim of the data collection is clear, as defined during a scope meeting.

Methodology: data processing. An agreement was reached on the following methodological principles: The main methodological points are discussed and the following decision are adopted:

- input data: 98% cut-off rule, except for dangerous substances including heavy metals.
- transportation data and service life duration from assumption made by the manufacturers.
- treatment of data (allocation, data on electricity, aggregation) to be decided among experts.
- life cycle phases: extraction always included: if no data available: use the data-bases, but in transparency.
- use phase: will be separated into two: 1) energy consumption during the service life, 2) use phase for maintenance, cleaning, etc...
- end of life: from scenarios given by manufacturers, but expressed in terms of recommendations.
- presentations: 4 calculated impacts (GWP, Eutrophisation, Acidification, Ozone depletion), and remaining Input / Output (I/O) flows.
- sources: product specific or generic as available

Two reports have been produced in relation with data collection. One illustrates the assessment procedure to be performed for documenting impact categories from a set of data produced by one industrial participant on two types of coated glass panes. The second one points out the problems we may face when using data bases of different LCA tools as data sources, showing that the results in terms of impacts may differ strongly, due to differences in assumptions, some of them even not explicit.

Now the group must concentrate his efforts for performing two case studies in details, using data provided by the industry partners through the questionnaire, processing them following the agreed methodological options , and then calculating impacts of the products, for the essential purpose of assessing the environmental impact changes of innovative improvements of the products.

Case study one is a wooden frame window with a double glazing sealed unit, and case study two is a solar collector. As a product, the solar collector, not addressed in the present paper, is another rather complicated example. When the window is avoiding energy losses, the solar collector is producing energy, and as for windows, whilst this flow is of course of great importance for the environmental assessment, it is not formally addressed by LCA...

The successful completion of these case studies is strongly dependant of the willingness of our industry partners, and on the funding condition of the experts in charge of the work for 2003.

CONCLUSION

In the context of the sustainable construction, environmental declarations of products is a key issue for product improvements, decision making help, and product documentation in the environmental assessment tools of building.

Glazing and windows (as well as solar collectors) have a special position in the landscape as they play a role in the energy balance of the work, which may be counted for compensating their proper environmental impacts.

An international agreement on the methodological approach for documenting these aspects is needed, but before that the situation has to be clarified for the environmental assessment of building products in general, through harmonisation efforts and international standardisation. Then the data quality availability is a key issue, mainly in the hands of the manufacturers.

The work undertaken in IEA T 27, because of the quality and diversity of expertise, and as a crossroads for open discussions and for information dissemination, can be a major contribution in that huge task, provided that the conditions for a good work will continue in the next future.

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