

TREES

Training for Renovated Energy Efficient Social housing

Intelligent Energy -Europe programme, contract n° EIE/05/110/SI2.420021

Intelligent Energy  Europe

Section 2 Tools 2.3 Life cycle assessment

Bruno PEUPORTIER
ARMINES – CEP



TREES



Main issues and definitions

- ▶ **Eco-design : Integrating environmental aspects during the design, e.g. of a new construction or a renovation project**
- ▶ **Environmental aspects :**
 - **Preservation of resources (energy, water, materials, land),**
 - **Protection of ecosystems at different scales : planetary (climate, ozone layer), regional (forests, rivers...), local (waste, air quality...)**
 - **Links between environment and health**
- ▶ **LCA (life cycle assessment) : accounting substances taken from and emitted to the environment, deriving environmental indicators, e.g. global warming potential, interpreting the results**

Possible applications of life cycle assessment

- ▶ manufacturers can study the eco-design of building materials and equipment,
- ▶ Architects and building consultants can compare various alternatives during the design phase in order to reduce the environmental impacts of a renovation project,
- ▶ facility managers can study the influence of the users behaviour and advise appropriate measures during the operation phase of a building,
- ▶ building owners and local communities can require and check the environmental performance level of projects.

Example LCA application : renovation of a social housing block near Paris

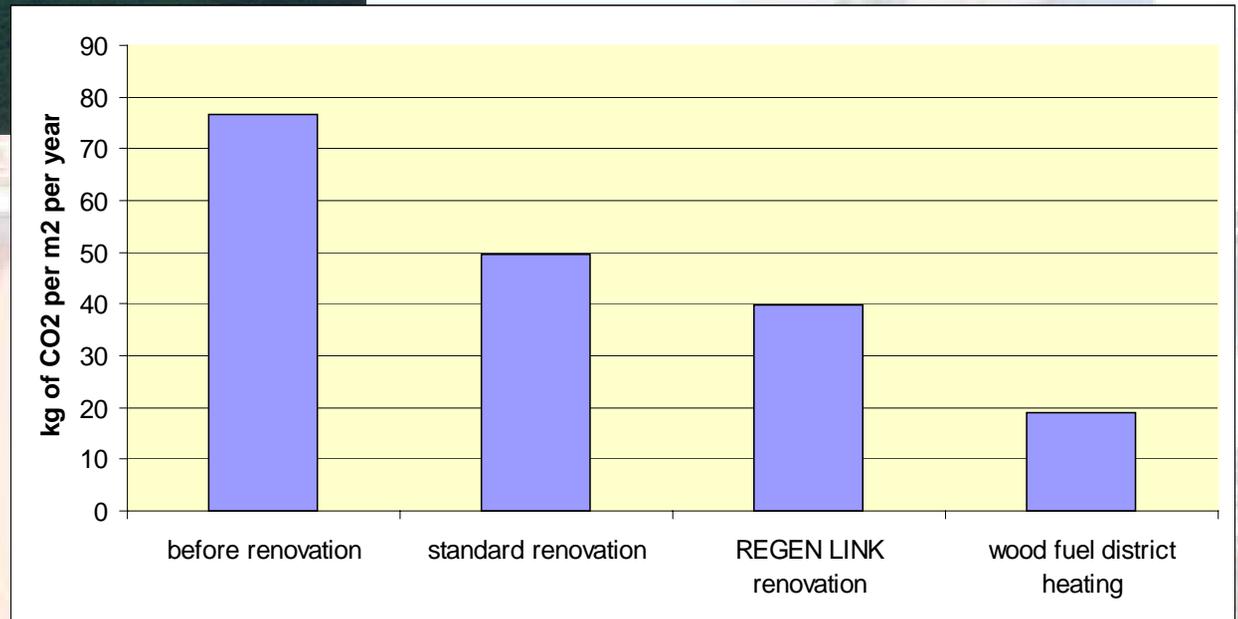


Construction : 1969

not insulated, single glazing

heating load : 150 kWh/m²/an

**Comparison of
renovation
alternatives
using EQUER
(www.izuba.fr)**



CO₂ emissions per m² and per year

Contents

- ▶ **Introduction**
- ▶ **Presentation of the method, assumptions,**
- ▶ **list of tools and web sites, tool validation and inter-comparison,**
- ▶ **example application in the retrofit of social housing : reduction of the environmental impacts obtained with various technical measures,**
- ▶ **sensitivity studies**
- ▶ **Conclusions**

Introduction

- ▶ **Important environmental problems : climate change, toxic emissions, resource depletion, waste...**
- ▶ **High contribution of the building sector, e.g. 40% of the energy consumption, 30% of raw material consumption, 30% of solid waste generation**
- ▶ **Need of integrating environmental issues in design, largely influencing the performance of buildings**
- ▶ **Life cycle assessment constitutes a relevant tool, in new constructions but also in renovation**



Contribution of the building sector to environmental burden

- ▶ **40% of the total energy consumption (United Nations Environment Programme), 45% in Europe**
- ▶ **30% of raw materials use (UNEP data)**
- ▶ **20% of the total water consumption and effluents (UNEP)**
- ▶ **40% of CO₂ emissions (UNEP)**
- ▶ **30% of solid waste generation (UNEP)**
- ▶ **Essential effects on human health (we spend 90% of our time in buildings) : air quality, noise...**



Eco-design of buildings

- ▶ Integrating environmental aspects during the design of a new construction or a renovation project
- ▶ Preservation of resources (energy, water, materials, land),
- ▶ Protection of ecosystems at different scales : planetary (climate, ozone layer), regional (forests, rivers...), local (waste, air quality...)
- ▶ Links between environment and health
- ▶ LCA (life cycle assessment) is a method to assess these issues



Possible applications of life cycle assessment

- ▶ manufacturers can study the eco-design of building materials and equipment,
- ▶ Architects and building consultants can compare various alternatives during the design phase in order to reduce the environmental impacts of a project,
- ▶ facility managers can study the influence of the users behaviour and advise appropriate measures during the operation phase of a building,
- ▶ building owners and local communities can require and check the environmental performance level of projects.



ISO 14 000 standards

- ▶ **14001 : management system**
- ▶ **14010 : audit**
- ▶ **14020 : labels**
- ▶ **14030 : environmental performance assessment**
- ▶ **14040 : life cycle assessment**
- ▶ **14050 : glossary**

14040 standards (LCA)

- ▶ **14040 : general principles (1997, updated 2006)**
- ▶ **14041 : goal and scope definition and inventory analysis (1998)**
- ▶ **14042 : life cycle impact assessment (2000)**
- ▶ **14043 : interpretation (2000)**
- ▶ **14044 : requirements and guidelines (2006)**
- ▶ **14047 : examples of application of ISO 14042 (2003)**
- ▶ **14048 : data documentation format (2002)**
- ▶ **14049 : examples of application of ISO 14041 (2000)**



ISO/TC 207's ninth plenary will be held in Kuala Lumpur, Malaysia from July 1-8, 2001. Further details to follow...

-  About ISO/TC 207
-  ISO/TC 207 Committee Structure
-  ISO/TC 207 Work Program
-  Document Development
-  Members Only
-  Frequently Asked Questions
-  Net Survey
-  Articles & News
-  CSA International
-  Standards Council of Canada

Welcome to the official ISO/TC 207 website! This website is the home of the [International Organization for Standardization's \(ISO\) Technical Committee 207 on Environmental Management](#)--the committee responsible for developing the [ISO 14000 series](#) of standards and guidance documents. The secretariat of ISO/TC 207 is held by the [Standards Council of Canada \(SCC\)](#) and administered by [CSA International \(CSA\)](#).

Late breaking news from Stockholm...



[Resolutions from ISO/TC 207's 8th plenary \(in PDF format- click here\)](#)

[Version française \(format PDF - cliquez ici\)](#)

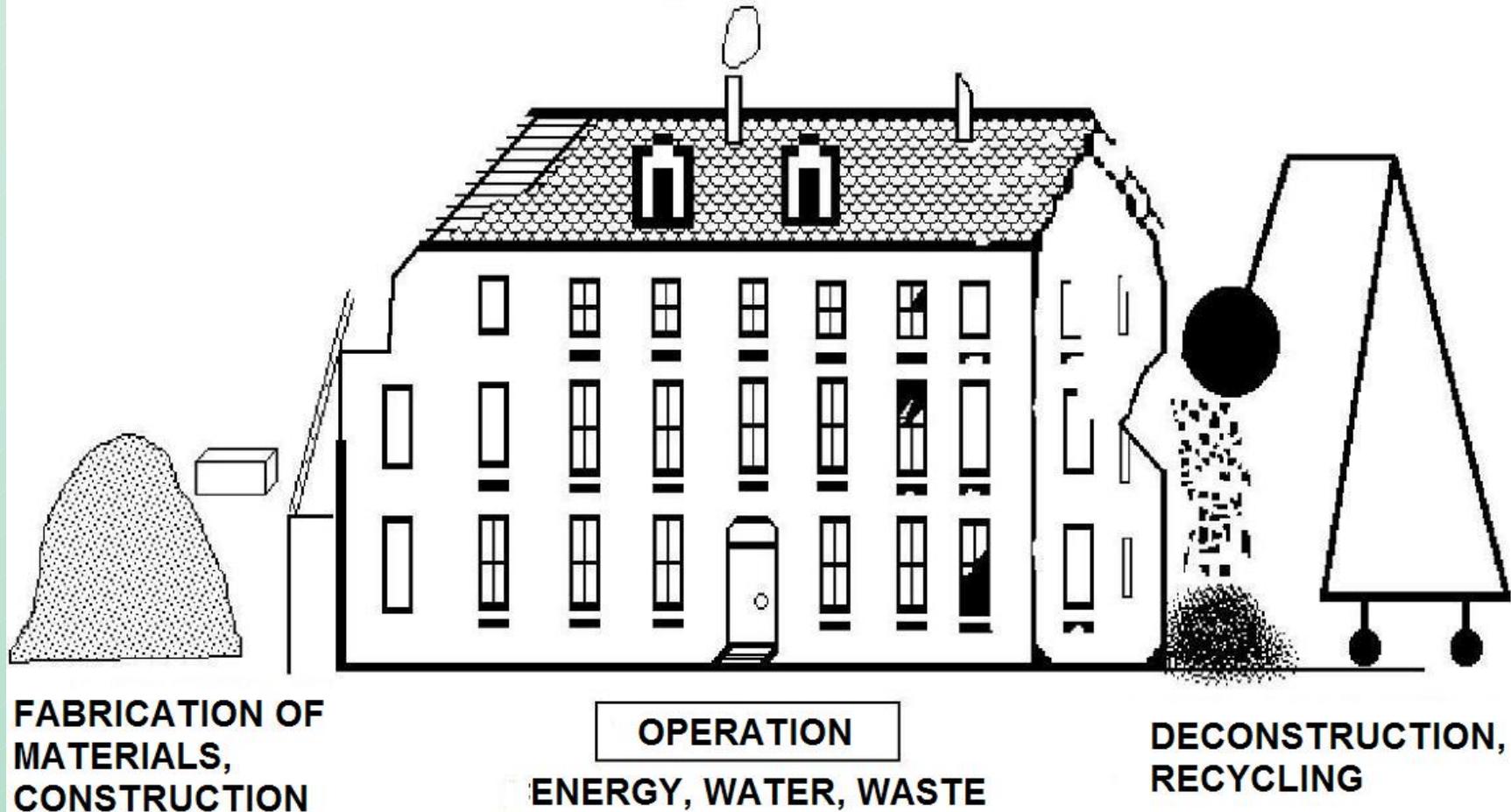
[Resoluciones en Español \(tecleo aquí\)](#)

French standards regarding buildings (AFNOR)

- ▶ **P 01-010 : information about environmental characteristics of construction products**
- ▶ **P 01-020 : environmental and sanitary characteristics of buildings**
- ▶ **P 01-030 : environmental management of building projects**

Life cycle of a building

LIFE CYCLE OF A BUILDING



TREES

Phases of an LCA (ISO 14040)

▶ **Goal and scope definition**

- Functional unit
- Systems boundaries

▶ **Inventory analysis**

- Hypotheses regarding energy, transport, recycling etc.

▶ **Impact assessment, eco-profile**

▶ **Interpretation**

▶ **+ applications, e.g. product development and improvement**

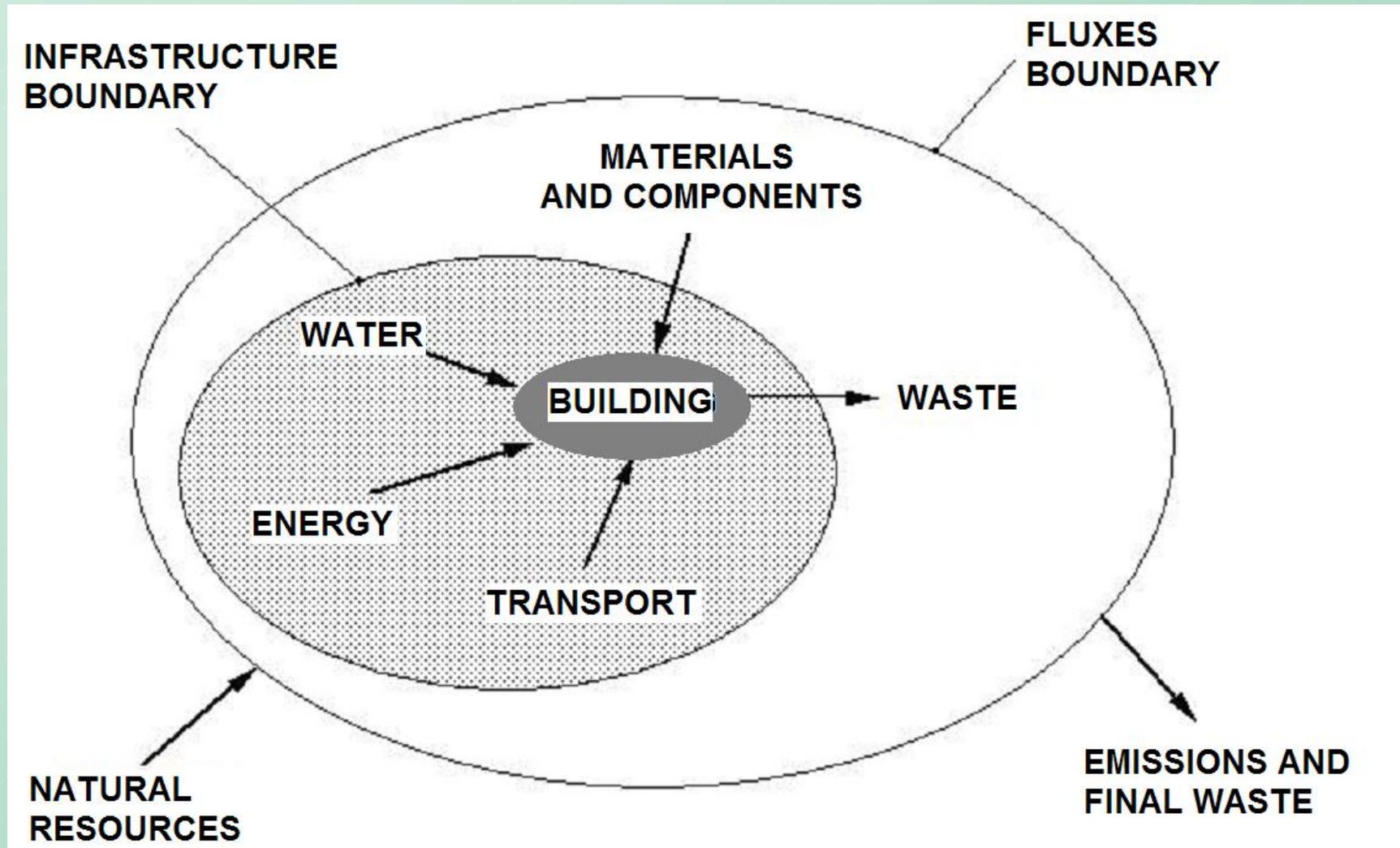


Goal and scope definition

- ▶ **Design a building with lower impacts**
- ▶ **Functional unit :**
 - Quantity, e.g. 4,820 m² or 1 m² dwelling area,
 - Function : apartment building,
 - Quality of the function : comfort (clear, 20°C in winter and under 30°C during a typical summer, quiet...), health (air and water quality...)
 - Duration : e.g. 30 years, or 1 year
- ▶ **System and boundaries (see next slide),**
- ▶ **Method and hypotheses (see next slides)**



System boundaries corresponding to a building



TREES

Hypotheses regarding energy, transport, recycling...

- ▶ **How is energy consumption calculated (correlation, simulation) ?**
- ▶ **Is renewable energy included ?**
- ▶ **How is the transport of materials modelled (load calculated according to the quantity and density of the material, assuming empty return of vehicles ?)**
- ▶ **How is recycling accounted for, e.g. bonus at both the fabrication and end of life phases, « value corrected substitution method », International iron and steel Institute method**

Inventory phase

- ▶ **Substances taken from and emitted to the environment (input and output fluxes) :**
- ▶ **Raw materials, primary energy...**
- ▶ **Emissions into air**
- ▶ **Emissions into water**
- ▶ **Emissions into the ground, waste**
- ▶ **Including upstream processes (e.g. extraction and transport of energy, raw materials...)**
- ▶ **Including downstream processes (waste)**



Exemple inventories : several hundreds of data

Oekoinventare, ETH Zürich

		Laine minérale	Manganèse	Minerai de Fer	Mousse dure PUR	NaCl	NaOH
Cd Cadmium m	kg	1.26E-10	5.65E-11	1.98E-11	4.14E-10	1.11E-10	8.94E-11
Cd Cadmium p	kg	1.96E-08	1.53E-08	1.15E-09	1.21E-08	3.61E-10	2.50E-09
Cd Cadmium s	kg	2.08E-08	1.05E-07	3.40E-09	8.81E-07	1.03E-08	2.32E-08
CF4 p	kg	1.70E-08	2.58E-07	1.21E-08	1.72E-07	5.31E-09	4.25E-08
CH3Br p	kg	0	0	0	0	0	0
CH4 Methan m	kg	9.74E-07	2.94E-06	6.66E-06	7.12E-06	3.51E-07	6.72E-07
CH4 Methan p	kg	0.00379	0.00929	0.000246	0.00871	0.000196	0.00153
CH4 Methan s	kg	1.41E-05	0.000116	3.25E-06	0.000176	4.88E-06	2.03E-05
CN Cyanide p	kg	3.60E-16	1.73E-15	1.41E-16	2.80E-08	2.88E-15	2.39E-15
CN Cyanide s	kg	1.56E-08	1.09E-08	9.56E-10	8.79E-09	2.24E-10	1.74E-09
Co Cobalt m	kg	6.74E-10	4.63E-09	7.27E-09	4.89E-09	1.01E-10	7.58E-10
Co Cobalt p	kg	1.56E-09	1.83E-09	3.06E-10	1.60E-09	6.12E-11	2.73E-10
Co Cobalt s	kg	4.03E-08	6.38E-07	6.63E-09	1.17E-06	1.24E-08	1.05E-07
CO Kohlenmonoxid m	kg	3.03E-05	7.73E-05	0.000139	0.000146	1.86E-05	2.50E-05
CO Kohlenmonoxid p	kg	0.0747	0.000314	7.71E-05	0.00774	7.58E-06	3.54E-05
CO Kohlenmonoxid s	kg	0.000453	0.00141	0.000126	0.00142	5.30E-05	0.000193
CO2 Kohlendioxid m	kg	0.0135	0.0412	0.0647	0.0699	0.0073	0.0114
CO2 Kohlendioxid p	kg	0.975	0.0342	0.00517	0.174	0.00161	0.00518
CO2 Kohlendioxid s	kg	0.39	5.03	0.0591	4.91	0.0854	0.809
Cr Chrom m	kg	5.32E-10	3.65E-09	5.74E-09	3.86E-09	7.99E-11	5.98E-10
Cr Chrom p	kg	3.88E-08	1.77E-08	3.18E-09	1.77E-08	7.04E-10	2.98E-09
Cr Chrom s	kg	2.76E-08	4.82E-07	4.51E-09	6.65E-07	1.14E-08	8.09E-08
Cu Kupfer m	kg	1.15E-07	3.44E-07	5.10E-07	8.11E-07	6.36E-09	5.56E-08
Cu Kupfer p	kg	1.11E-08	3.50E-08	1.64E-09	2.55E-08	8.37E-10	5.81E-09
Cu Kupfer s	kg	1.02E-07	1.03E-06	2.88E-08	1.82E-06	2.28E-08	1.71E-07
Cycloalkane p	kg	0	0	0	0	0	0
Dichlormethan p	kg	1.27E-09	4.11E-09	5.54E-11	1.16E-07	2.68E-11	3.80E-06
Dichlormonofluormethan p	kg	4.44E-08	3.17E-08	6.46E-09	3.07E-07	3.65E-08	5.43E-06



Other data bases

- ▶ www.ecoinvent.ch (Switzerland, hundreds of materials and processes)
- ▶ www.ivam.uva.nl/uk/ (The Netherlands, data base compatible with the SIMA PRO LCA tool)
- ▶ www.inies.fr (France, no process and fewer materials : concrete blocks, timber, gypsum, PVC tiles, aluminium, polystyrene, reflecting insulation...)

Aggregation in environmental indicators, examples

environmental theme	unit
energy consumption	MJ
water consumption	m ³
depletion of abiotic resources	10 ⁻⁹ (1/1 billion), dimensionless, calculated by dividing used resources by known resources
waste creation	tons
radioactive waste creation	dm ³
global warming	ton CO ₂ equivalent
depletion of the ozone layer	kg CFC11 equivalent
acidification	kg SO ₂ equivalent
eutrophication	kg PO ₄ ³⁻ equivalent
aquatic ecotoxicity	m ³ of polluted water
human toxicity	kg, human weight
photochemical oxidant formation	kg C ₂ H ₄ equivalent
malodorous air	m ³ of contaminated air (ammonia is used as a reference)



Indicators, example : contribution to climate change

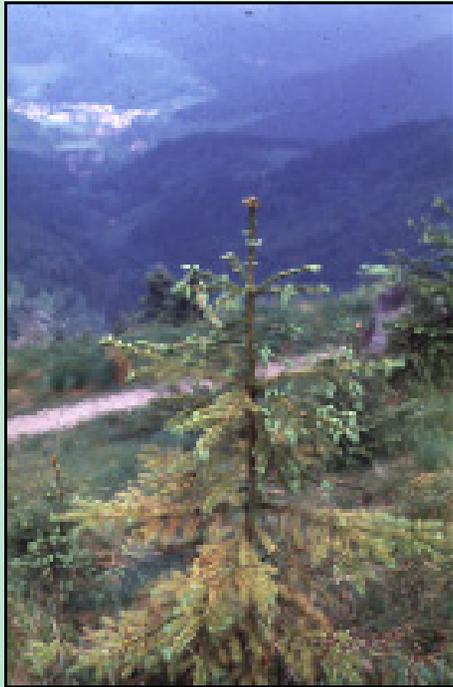


Source : school in Les Houches

- ▶ *Global Warming Potential*
- ▶ *depends on optical properties of gases*
- ▶ *equivalent CO₂, over a 100 years duration*
- ▶ $GWP_{100} = kg\ CO_2 + 25 \times kg\ CH_4 + 320 \times kg\ N_2O + \sum GWP_i \times kg\ CFC\ ou\ HCFC_i$
- ▶ *effect (potential) and no impact (real)*



Contribution to acidification



- ▶ **Acidification Potential (eq. SO_2 or H^+)**
- ▶ **Potential effect (real impact depends on background concentration)**

Contribution to eutrophication



Photo : Halte aux marées vertes

- ▶ Eutrophication Potential (eq. PO_4^{3-})
- ▶ Increase of a natural phenomenon
- ▶ Potential impact (real impact depends on dilution, e.g. greater in a small lake than in a large river)

Air quality and ozone



Source : Frederic Cherqui, Doctorate thesis

- ▶ ozone and altitude, 2 different problems :
- ▶ Stratospheric level (30 km), Ozone depletion potential (eq. CFC-11)
- ▶ Tropospheric level (ground level), Summer smog (photochemical ozone formation), eq. C_2H_4

TREES

Critical volumes method

- ▶ maximum tolerable concentration C_m at which 95% of individuals are preserved in water (kg/m^3)
- ▶ critical volume (m^3) = Emissions / C_m
- ▶ aquatic ecotoxicity indicator :
 Σ critical volumes (m^3 of polluted water)
- ▶ same method for terrestrial ecotoxicity
- ▶ Human toxicity : dose instead of concentration, e.g. threshold = dose at which the risk of cancer is 1/10, 000 , average human weight, planetary average and not local indicator



Other critical volume indicator : odours

- ▶ **Odours, detection threshold = concentration C_s at which 50% of a representative sample detects the product**
- ▶ **critical volume = Emission / C_s**
- ▶ **Odours indicator (m^3 of polluted air) = Σ critical volumes**

Primary energy

- ▶ 1 kWh electricity needs more energy to be produced than 1 kWh heat (related to the efficiency of electricity plants and grid)
- ▶ The primary energy indicator allows different types of energy to be integrated on a homogeneous basis
- ▶ Upstream processes should be included (e.g. extraction and transportation of gas) otherwise displacement of pollution would not be accounted (e.g. replacing a boiler by electric heating reduces emissions inside a building but increases them upstream in electricity plants)
- ▶ Higher heating value is preferable
- ▶ Renewable energies are preferably included



Other indicators

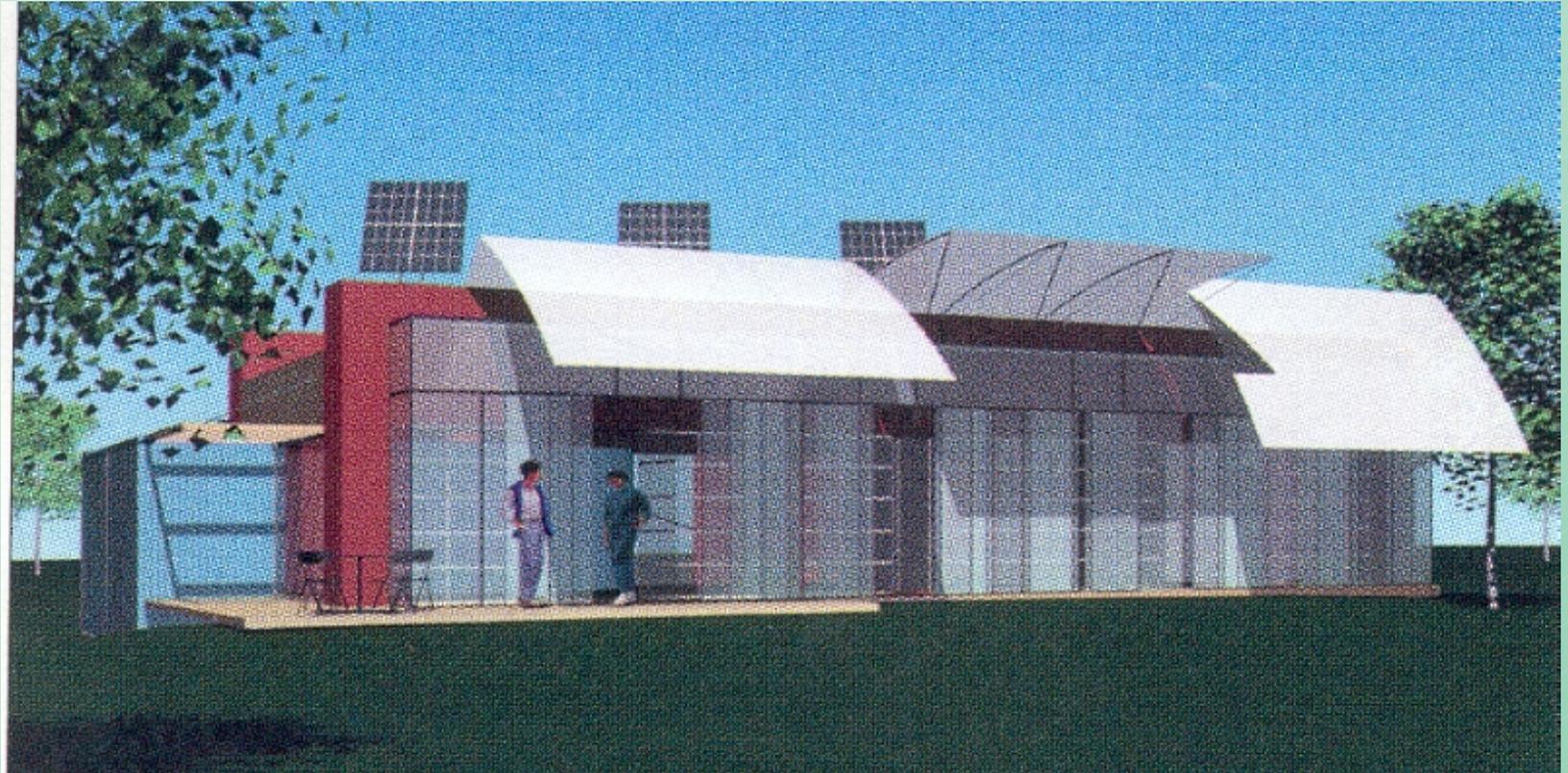
- ▶ Exhaust of resources, for instance :
 $\Sigma M_i / \text{available reserves } i$
- ▶ Water consumption, e.g. expressed in m^3
- ▶ Produced waste, e.g; expressed in tonnes
- ▶ Radioactive waste, dm^3



Photo : PNUÉ



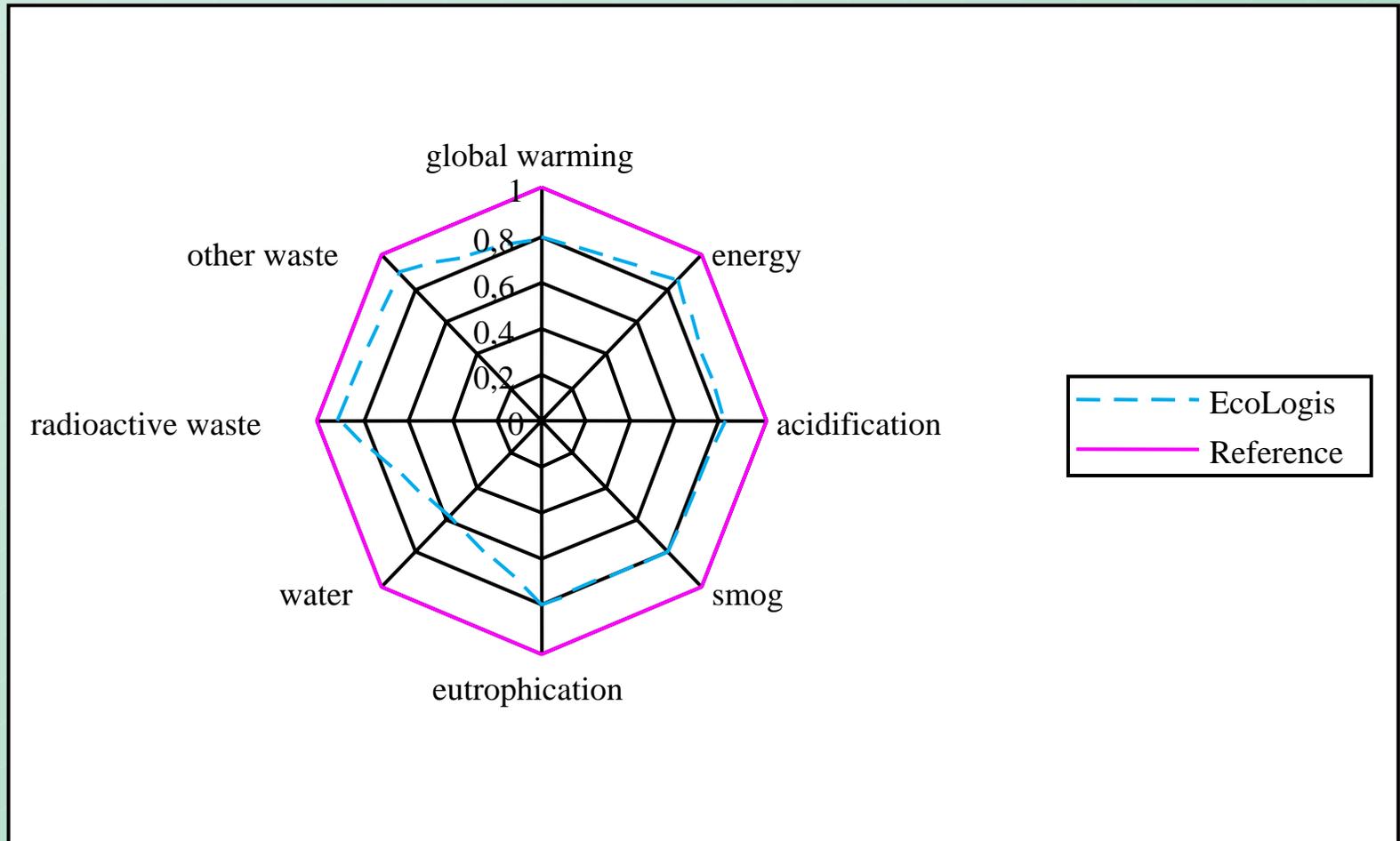
Example result, EcoLogis exhibition in Paris



**Impacts of this innovative project have been compared
To a standard house in the same site**



EcoLogis exhibition, comparison with a reference



Each axis corresponds to an indicator. The reference value is 1 and relative values are given for the project, e.g. the contribution to global warming is reduced by 20%



Normalisation

- ▶ **Collect average impact per person and year, e.g. 13 tons CO₂ per person and per year in Europe**
- ▶ **Divide the indicator value by this average in order to derive normalised values in equivalent persons**
- ▶ **Example : if the CO₂ emissions are 1,300 tons for a building, the normalised value is 100 eq. Persons**
- ▶ **Normalising all indicators for which average data is available helps to define priorities (in general, higher priorities for higher normalised values)**

Limits of the approach

- ▶ uncertainties concerning data (inventories) and indicators : for instance, the global warming potential (GWP) of other gases than CO₂ is known with 35% uncertainty
- ▶ processes like electricity production may vary -> one year functional unit corresponding to near future
- ▶ processes occurring at the end of the building life cycle difficult to foresee -> scenarios and possibly probabilities
- ▶ **multi-criteria decision making -> define priorities in agreement with concerned actors (owner...)**

Presentation and comparison of various building LCA tools

Work performed in the frame of the PRESCO
European thematic network

Objectives of this work :

- ▶ **Assist a more environmentally friendly approach in building design**
- ▶ **Exchange between tool developers**
- ▶ **Benchmarking and intercomparison**
- ▶ **Definition of a common baseline for assessment methodologies**

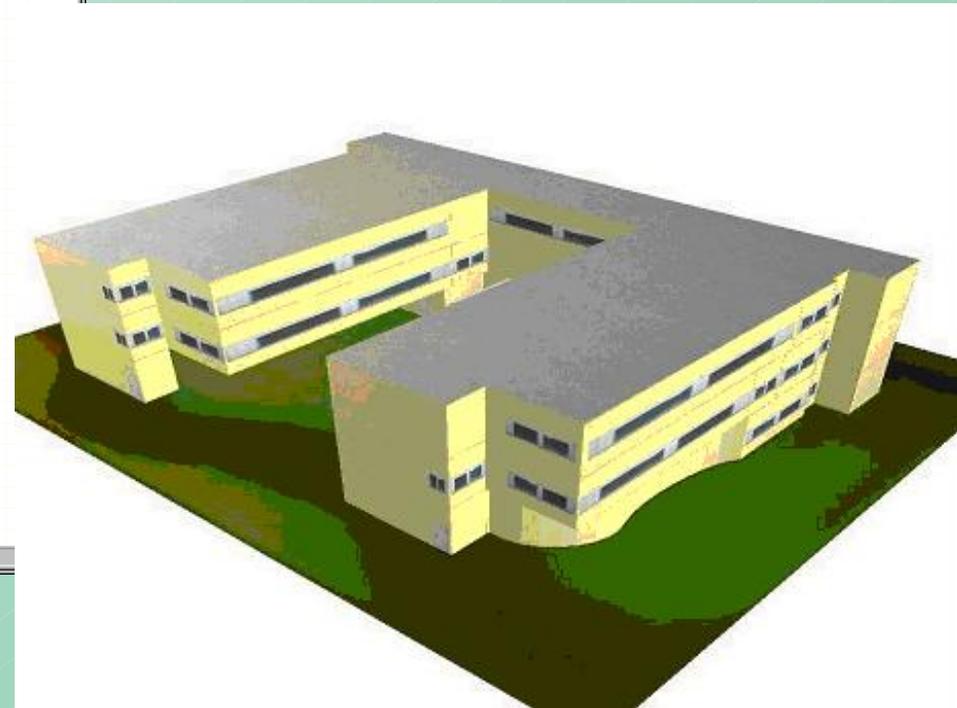
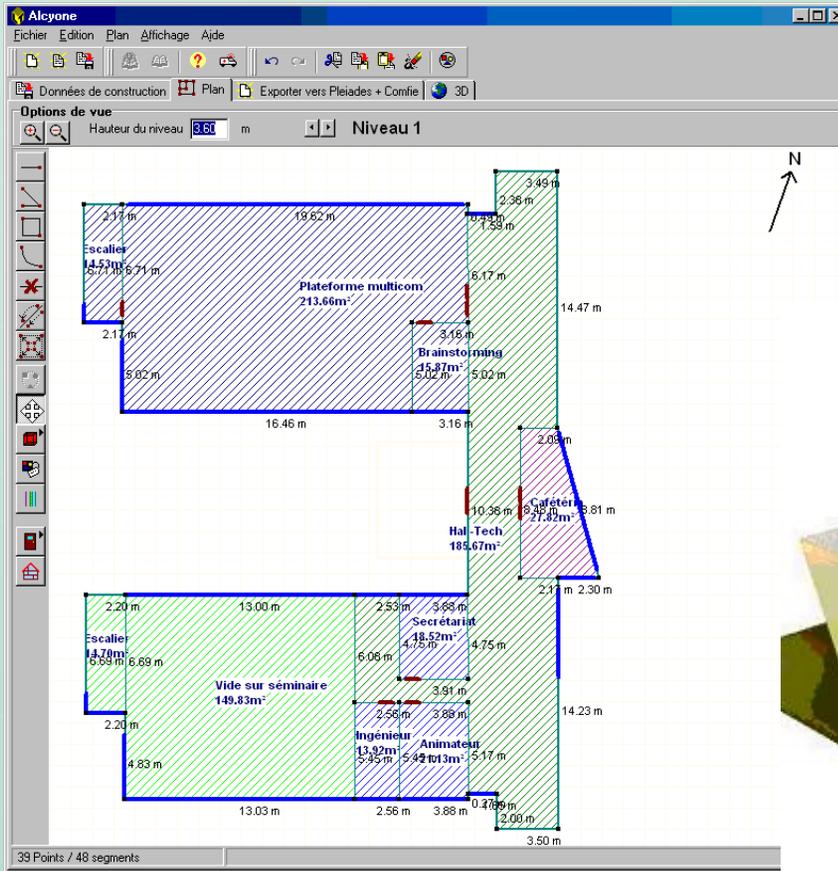


Participants and tools

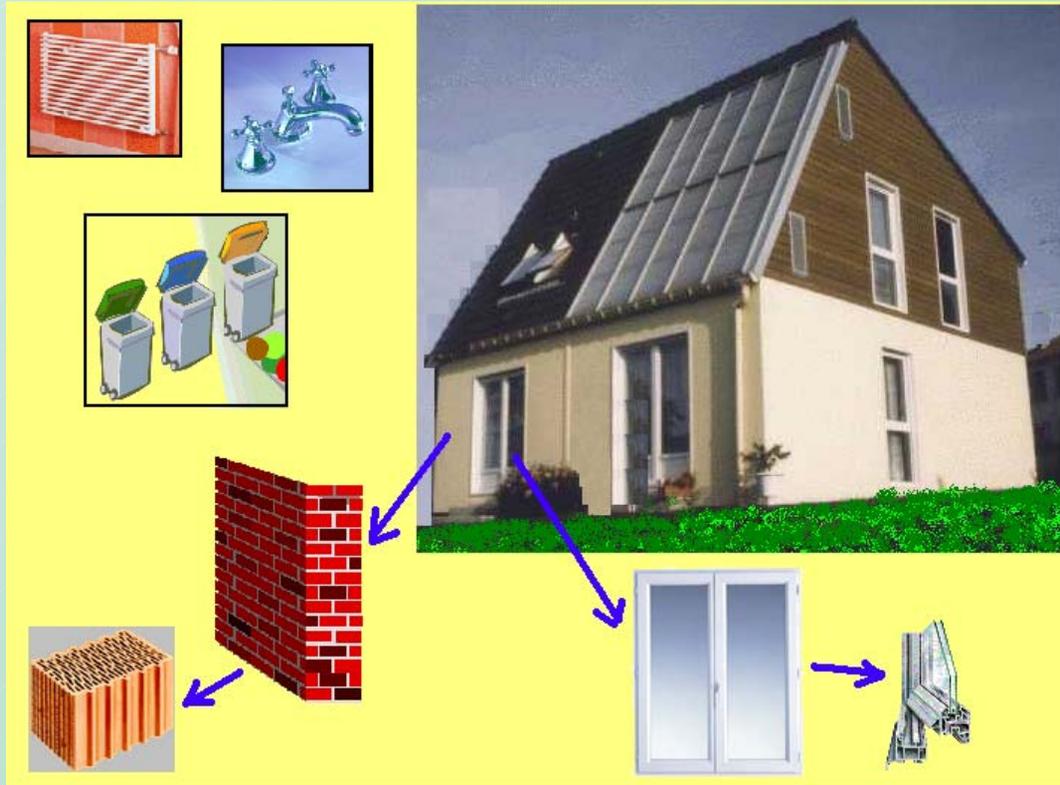
- ▶ **W/E, NL, ECO-QUANTUM**
- ▶ **EMPA, CH, LTE OGIP**
- ▶ **ARMINES, F, EQUER**
- ▶ **BRE, UK, ENVEST 2**
- ▶ **VTT, Fi, BECOST**
- ▶ **CSTB, F, ESCALE**
- ▶ **IBO, A, ECOSoft**
- ▶ **ASCONA and IFIB, D, LEGEP**

PRESENTATION OF EQUER, www.izuba.fr

First step : 2D – 3D Description using ALCYONE

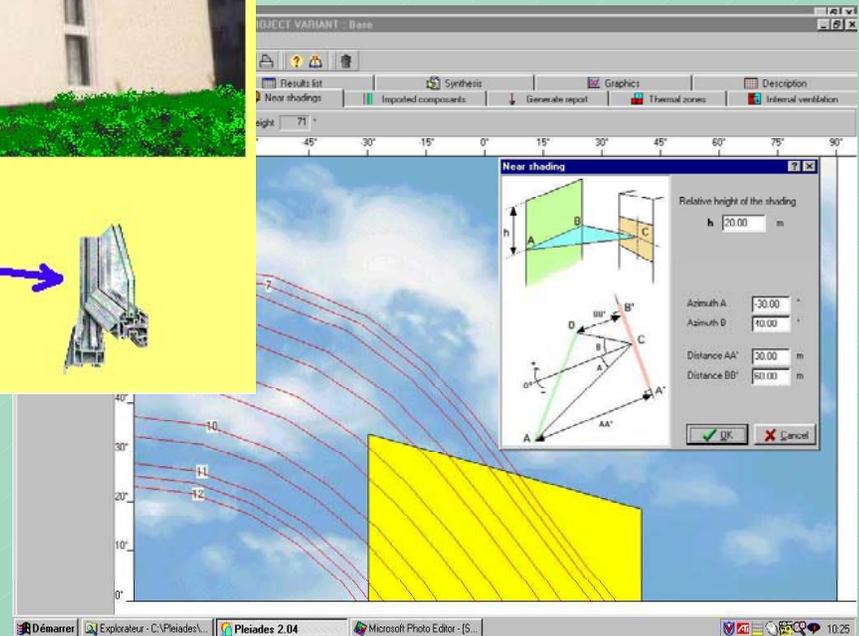


Building model



Choice of materials and components

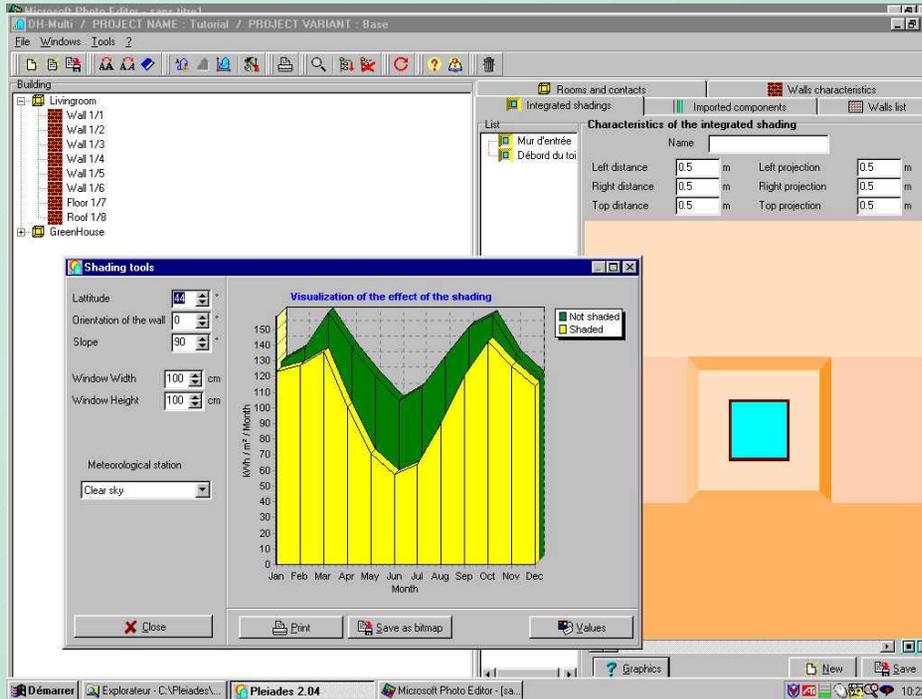
Description of the site and climate



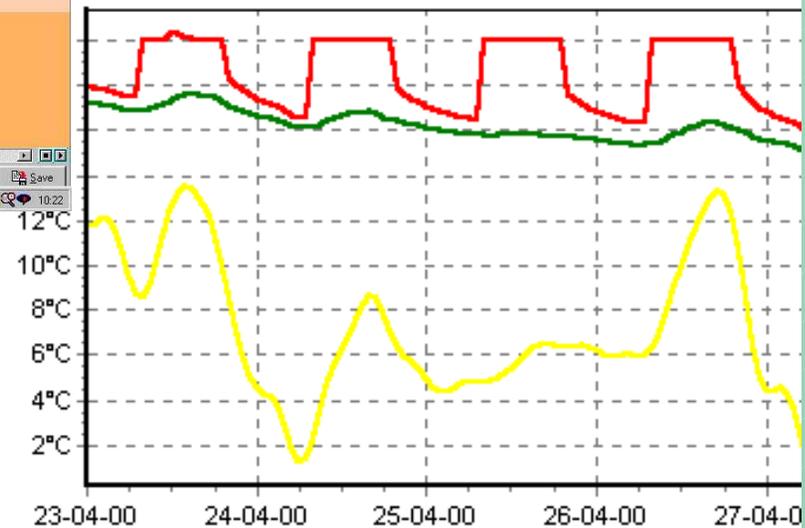
TREES

Link with thermal simulation, COMFIE

Heating and Cooling loads



ole Vabre / réhabilitation + / Classes
ole Vabre / réhabilitation + / Couloir
ole Vabre / réhabilitation + / Extérieur



Temperature profiles



Equer, example input window

Equer [Fichier ?]

Transport | Eau | Energie | Déchets | Matériaux | Calcul | Graphiques | Comparatif

Prendre en compte le transport quotidien des occupants

Distances

	Distance domicile-commerce	<input type="text" value="10000"/> m	<input type="button" value="Défaut : Urbain"/>	<input type="button" value="Défaut : Banlieu"/>
	Distance au réseau de transport en commun	<input type="text" value="5000"/> m	<input type="button" value="Défaut : Rural"/>	<input type="button" value="Défaut : Isolé"/>
	Distance domicile-travail	<input type="text" value="10000"/> m		

Usagers

 % des occupants effectuant le trajet journalier

Mode de transport

 Présence de pistes cyclables

Mode de transport journalier

Type de site

 Urbain Banlieu Rural Site isolé

Equer, example data window

The screenshot shows the Equer software interface. A dialog box titled 'Saisie caractéristiques' is open, displaying the following data for 'Béton B25':

Caractéristiques	
Nom	Béton B25
Catégorie	Mat
Etape	FAB
Procédé	N
Unité	kg

Below the dialog box, a table lists various materials and their categories:

Nom	Catégorie
Béton B25	Mat
PVC double vitrage	Com
Isolant transparent 10 cm	Com
Isolant transparent 5 cm	Com
Acier de construction	Mat
Polystyrène	Mat
Bois - planche	Mat
Polyéthylène faible densité	Mat
transport M 28t	Trs
transport M train	Trs
Polystyrène	Mat
PVC dur	Mat
Poluréthane	Mat

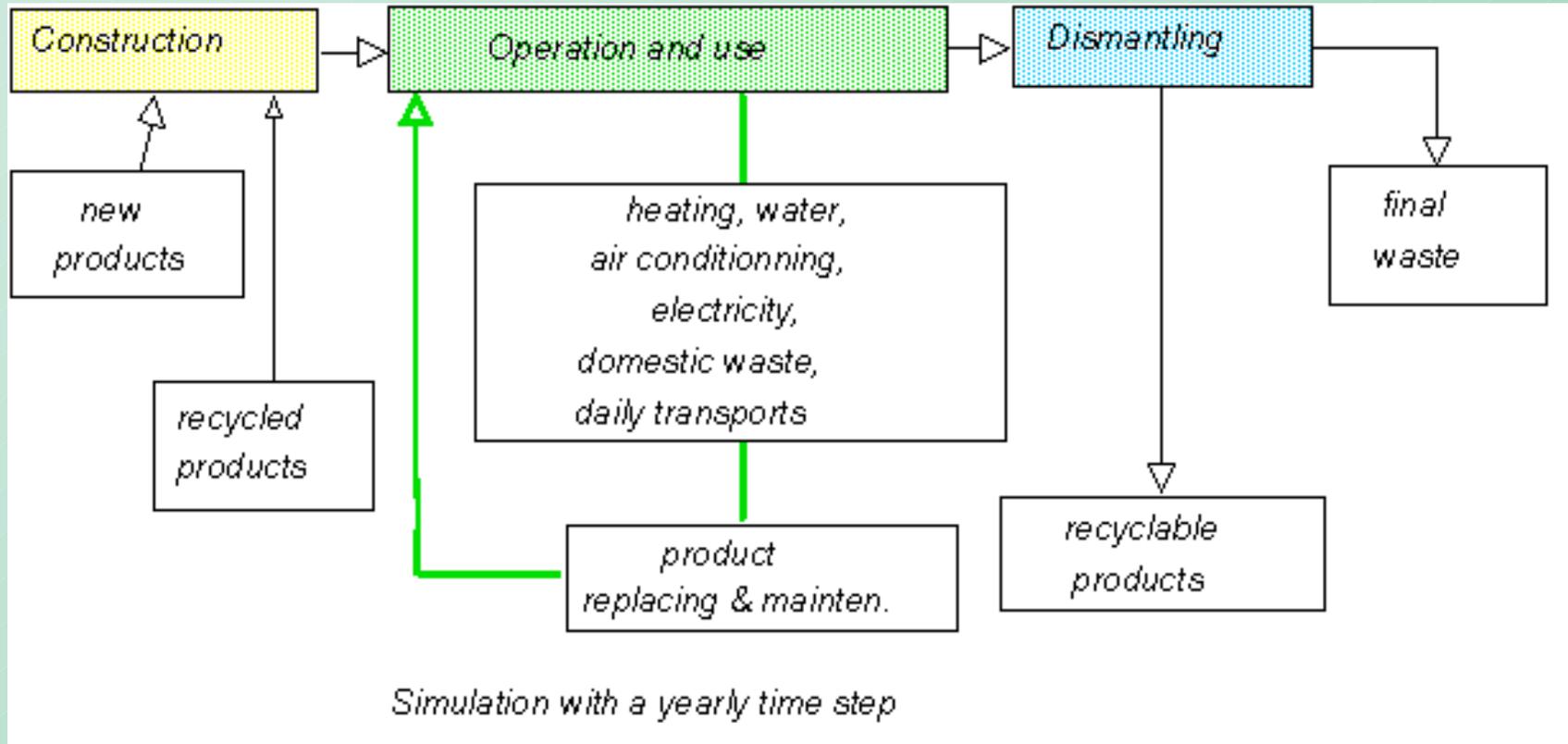
The dialog box also includes a 'Pollution' section with the following data:

Caractéristique	Valeur	Unité
Effet de serre (kg CO2)	0.133000	kg
Acidification (kg SO2)	0.000364	kg
Energie consommée (MJ)	1.000000	m2
Eau utilisée (litres)	0.688000	m2
Dechets inertes produits (kg eq)	0.007630	m2
Epuisement des ressources abiotiques (E-15)	0.240600	kg
Eutrophisation (kg PO4)	0.000046	kg
Production d'ozone photochimique (kg C2H4)	0.000034	kg
Ecotoxicité aquatique (m3)	0.000003	kg
Dechets radioactifs (dm3)	0.000008	tkm
Toxicité humaine (kg)	0.000964	tkm
Odeur (m3)	0.000000	kg

TREES

Oekoinventare 1996 data base (ETHZ)
New version using www.ecoinvent.ch

Life cycle assessment tool, EQUER



Simulation of the life cycle, accounting impacts year by year

EQUER, example quantitative results

Equer [Fichier ?] [Transport] [Eau] [Energie] [Déchets] [Matériaux] [Calcul] [Comparatif]

Durée de l'analyse: 80 ans

Lancer le calcul

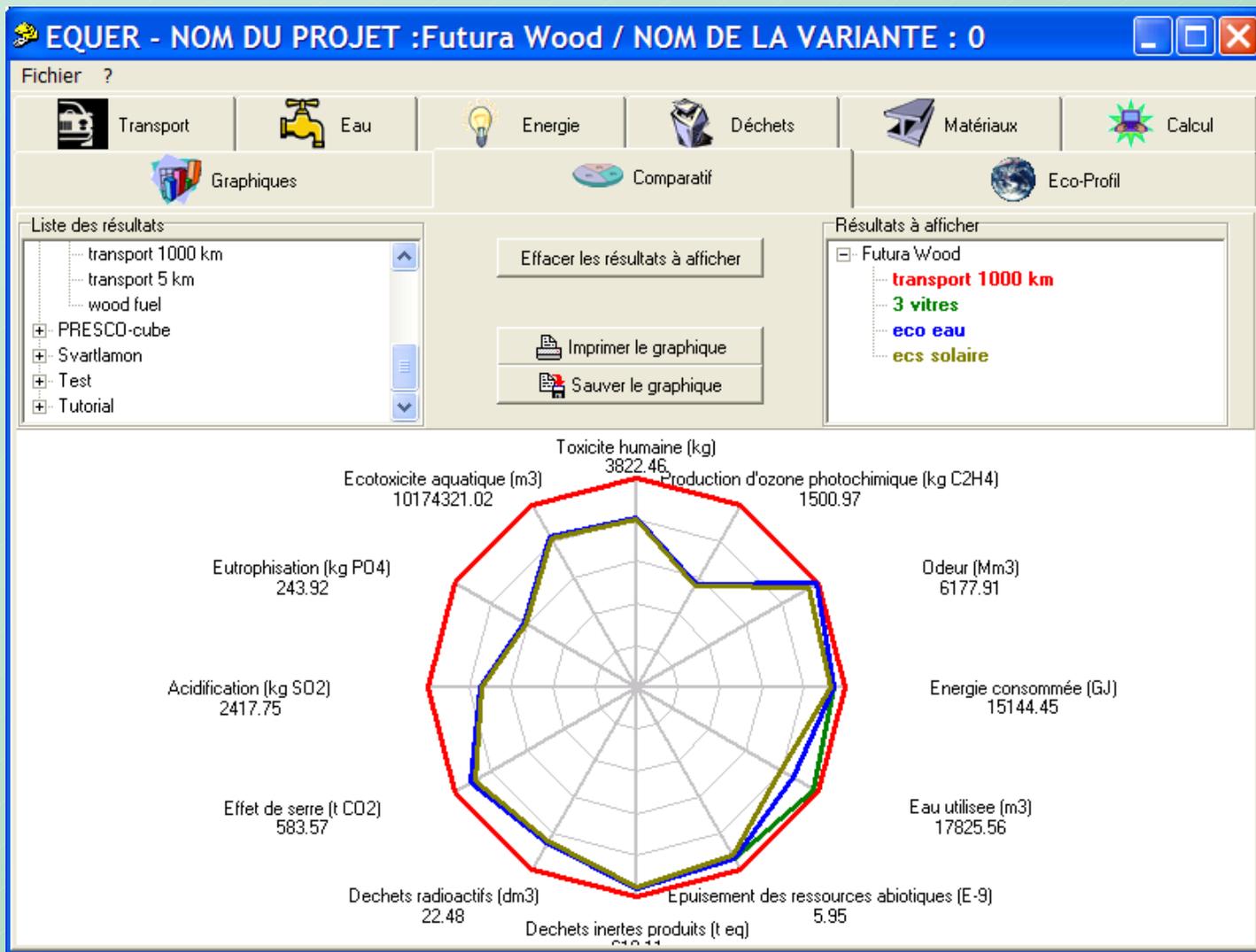
Equality console

Equer console

Résultat à afficher: []

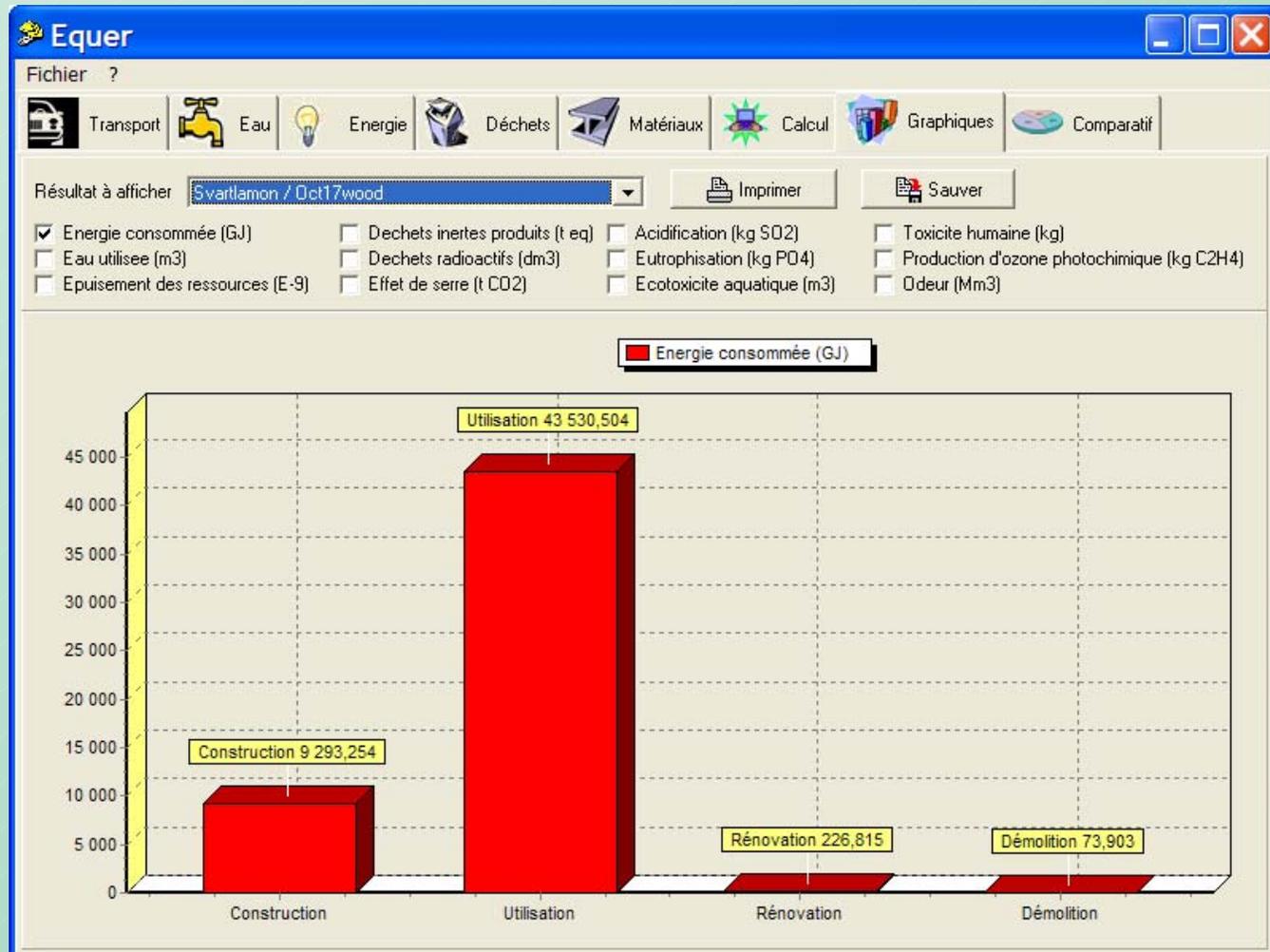
Impact	Construction	Utilisation	Rénovation	Démolition	Total
Energie consommee (MJ)	1010491.46549	36280678.88702	319335.12472	111654.34319	37722159.82042
Eau utilisee (m3)	940.97307	55194.76972	3511.86744	2159.00561	61806.61584
Utilisation des ressources abiotiques	0.0000000000	0.0000000000	0.0000000000	0.0000000000	0.00000
Dechets sterils produits (t eq)	60858.24260	42.73526	16601.10105	591113.34123	668615.42014
Dechets radioactifs (dm3)	0.21719	0.08402	0.00086	0.00042	0.30249
Effet de serre (kg CO2)	113903.78428	279082.45213	14912.05492	11638.59898	419536.89031
Acidification (kg SO2)	528.28276	753.09125	48.73926	45.75189	1375.86516
Eutrophisation (kg PO4)	70.65370	64.86307	6.34764	8.34285	150.20726
Ecotoxicite aquatique (m3)	1836042.29954	5428963.49935	521158.06157	359811.60214	8145975.46260
Toxicite humaine (kg)	205773184.20386	963.61531	411545124.88232	64.00529	617319336.70678
Production d'ozone photochimique (kg C2H4)	457.92271	392.19398	27.92867	48.25344	926.29880
Odeur (m3)	418249687.33301	3924453154.07812	12723086.42888	4484683.18819	4359910611.02820

EQUER, example comparison of alternatives

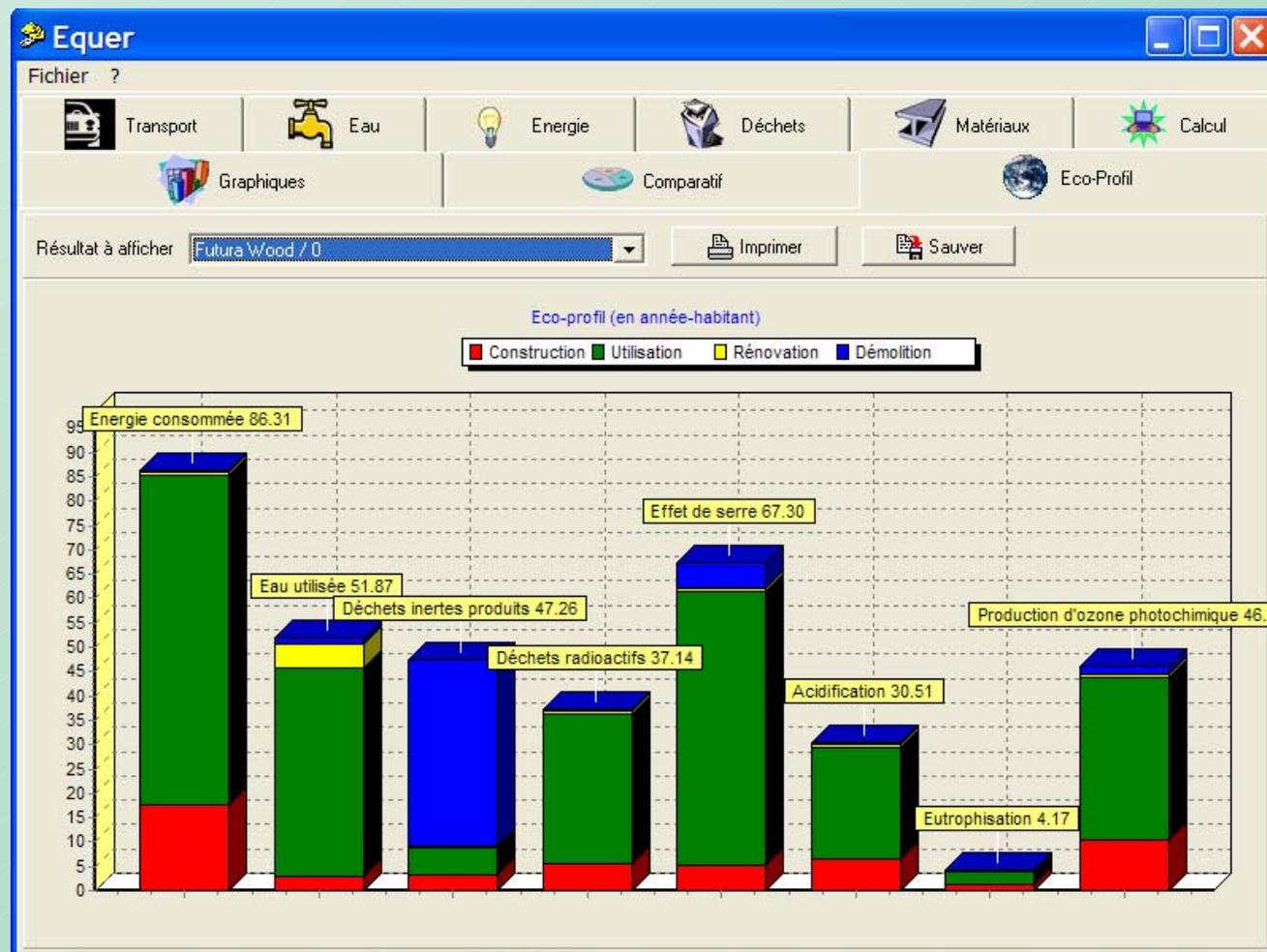


Contribution of life cycle phases

Construction, operation, renovation and demolition



EQUER, example eco-profile



Normalisation -> same unit for all indicators : equivalent-person-year

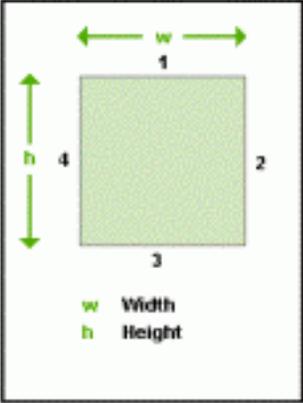


ENVEST, United Kingdom

www.bre.co.uk/services/ENVEST.html

ENVEST II Environmental Impact Assessment & Whole Life Cost

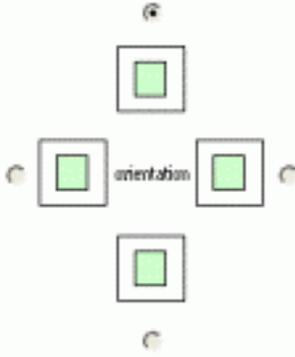
About Envest | Login | Your account | Contact us | Help



w Width
h Height

Plan depth	<input type="text" value="50.0"/>	Building width	<input type="text" value="50.0"/>
Number of storeys	<input type="text" value="3"/>	Building height	<input type="text" value="10.0"/>
Storey height	<input type="text" value="3.5"/>	Perimeter	<input type="text" value="240.0"/>
Elevation 1	<input type="text" value="50.0"/>	Ground floor area	<input type="text" value="3600.0"/>
Elevation 2	<input type="text" value="50.0"/>	Upper floor area	<input type="text" value="7200.0"/>
Elevation 3	<input type="text" value="50.0"/>	Total floor area	<input type="text" value="10800.0"/>
Elevation 4	<input type="text" value="50.0"/>	Total wall area	<input type="text" value="2520.0"/>
		Roof area	<input type="text" value="3600.0"/>
		Eco-points	<input type="text" value="0.0"/>
		Whole life cost	<input type="text" value="0.0"/>

orientation





Envest, normalized profile

Issues	One UK Citizen	Normalised Data
Climate Change	12270 kgCO ₂ eq (100yr)	0.022
Acid Deposition	58.88 kgSO ₂ eq	0.037
Ozone Depletion	0.28595 kgCFC11 eq	0
Pollution to Air: Human Toxicity	90.7 kg.tox	0.036
Pollution to Air: Low Level Ozone Creation	32.23 kg ethene eq (POCP)	0.0024
Fossil Fuel Depletion and Extraction	4.085 toe	0.012
Pollution to Water: Human Toxicity	0.02746 kg.tox	0.000021
Pollution to Water: Ecotoxicity	837600 m ³ tox	0.0000013
Pollution to Water: Eutrophication	8.006 kg.PO ₄ eq.	0.022
Minerals Extraction	5.04 tonnes	0.2
Water Extraction	417600 litres	0.0036
Waste Disposal	7.194 tonnes	0.015
Transport Pollution & Congestion: Freight	4140.84 tonne.km	0.062



LTE OGIP, <http://www.ogip.ch/>

Bauwerkteil definieren

Datei Hilfe

Bauwerkteil - Bezeichnung

Bauteilart: E4 Wand

Anwendererweiterung: DZ-01

Identifikator: E4 - DZ-01 - 2

Bauwerkteil - Eigenschaften

Referenzmenge: 1.00 Referenzeinheit: m2

k-Wert: 0.000

g-Wert: 0.000

Glasanteil: 0.000 Vorwerte

Kataloge

Norm-BEK Freie-BEK Alle-BEK Projekt-BEK Sonderelemente

Filter

###.###:

T - Umgebung

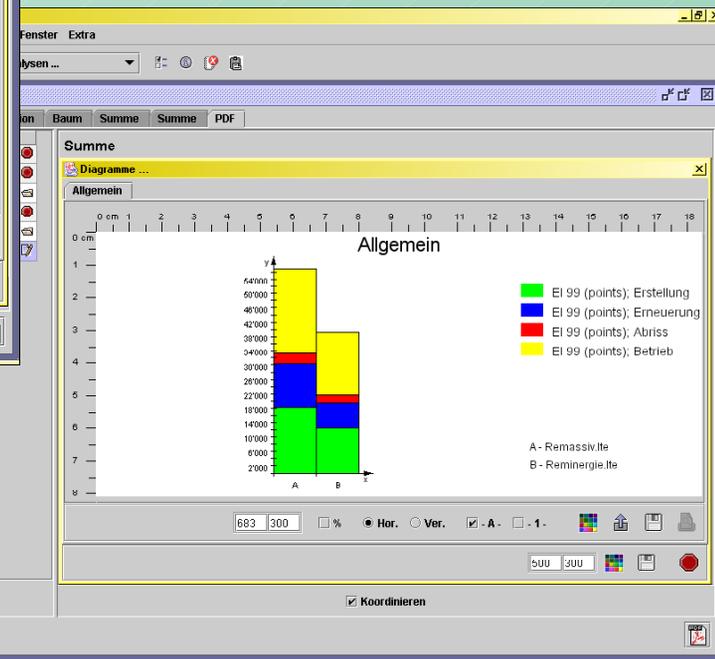
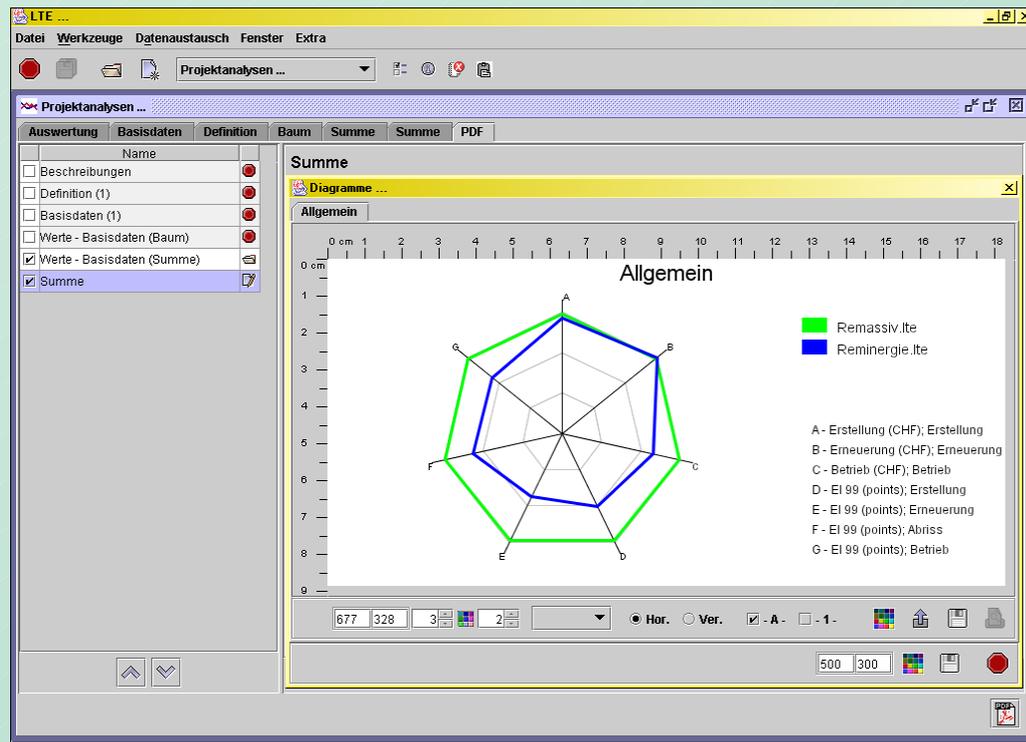
Volltext

Schichtung des Bauwerksteils

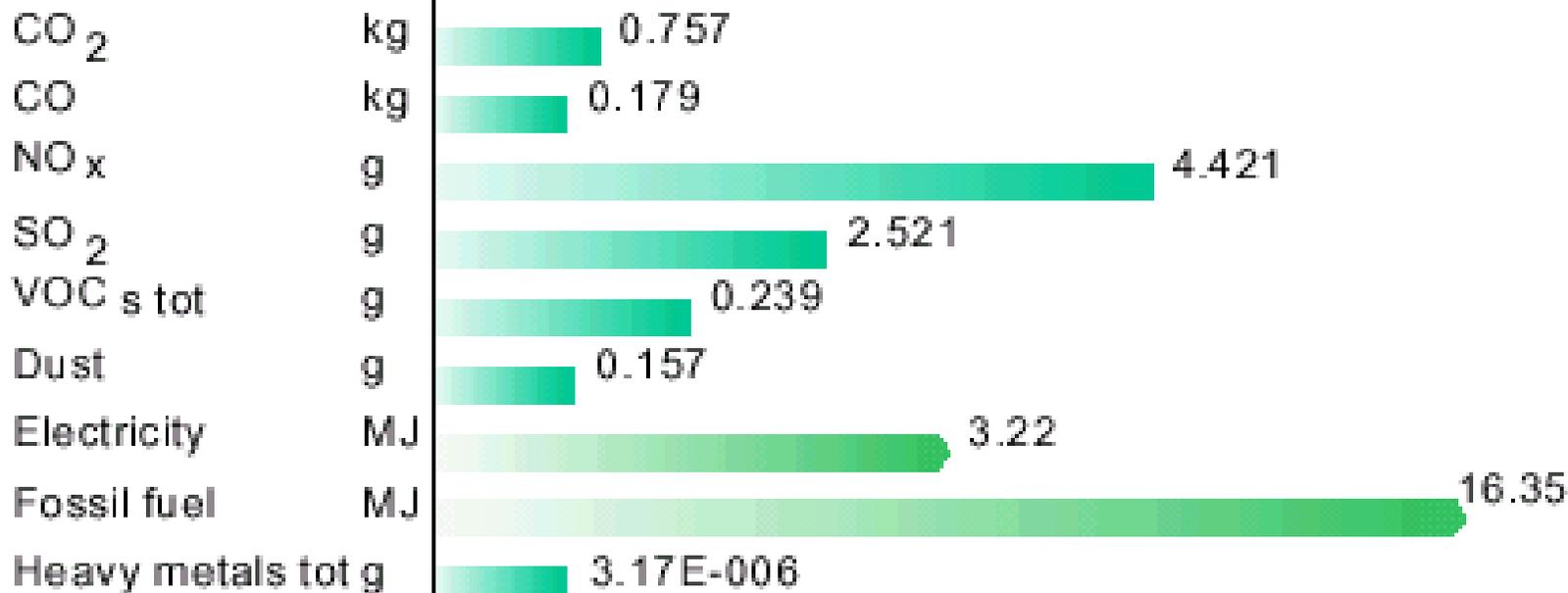
	ID-Nr.	Suchtitel	Menge	m2KW	
1	M4 111.111	1x Tiefgru...	1.000		
2	E4 141.123	Mauerdicke	1.000		
3	E4 247.214	Plattendicke	1.000		
4	E4 141.122	Mauerdicke	1.000		
5	E4 311.112	1x Organosi	1.000		

Grundputz, mineralischer Deckputz und Anstrich.
 Untergrund künstliche Steine sowie Dämm- oder Putzträgerplatten, Wände eben.
 Gips- oder Gipskalkgrundputz, Putzdicke mm 10. Deckputz auf Weisskalkmittel mit Zementzusatz, Korngröße mm 1,6 bis 2,0, abgerieben.
 1 Anstrich Tiefgrund, 1 Anstrich Dispersionsfarbe, matt.

LTE OGIP, OUTPUT



BECOST, Finland : <http://www.vtt.fi/environ>



Elinkaarialyysi voidaan esittää ympäristöprofiilina - toiminnallisen yksikön vaikutuksena ympäristöön.

ECO-QUANTUM, The Netherlands, www.ecoquantum.nl

The screenshot shows the Eco-Quantum software interface. The left pane displays a tree view of material usage under 'Materiaalverbruik', with 'Buitenblad' selected. The right pane shows a table of alternatives for 'Buitenblad'.

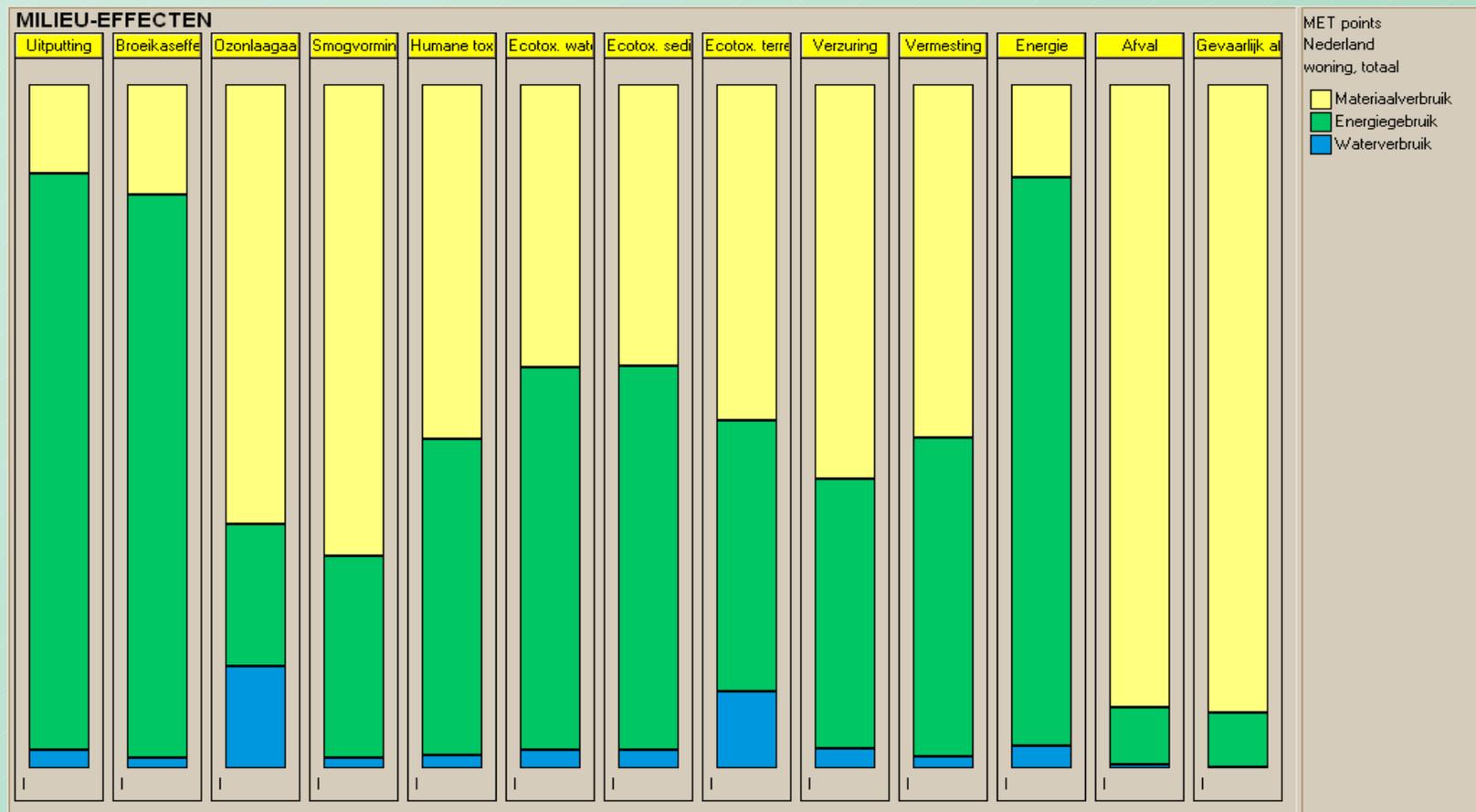
alternatieven	hoevee	eenheid	levensc
<input checked="" type="checkbox"/> volkern; bekleding,platen	0	m2	[25] [A
<input checked="" type="checkbox"/> baksteen; metselwerk	0	m2	[75] [A
<input checked="" type="checkbox"/> kalkzandsteen; metselwerk	0	m2	[75] [A
<input checked="" type="checkbox"/> betonsteen; metselwerk	0	m2	[75] [A
<input checked="" type="checkbox"/> multiplex; bekleding,platen; +schilderwerk@	0	m2	[20] [A
<input checked="" type="checkbox"/> beton; element,prefab@{0%puin}	0	m2	[75] [A
<input checked="" type="checkbox"/> hout,duurzaam; bekleding; +schilderwerk@{	0	m2	[40] [A
<input checked="" type="checkbox"/> hout,niet duurzaam; bekleding; +schilderwerl	0	m2	[30] [A
<input checked="" type="checkbox"/> cement,gemodificeerd; pleisterwerk@{gesch	0	m2	[40] [A



INPUT



Eco-Quantum, output



Contribution of different elements (floors, walls...)

12 environmental effects, 4 scores, 1 indicator



ECOSoft, Austria

AW_brick_ExternalWall.xls

Baustofftabelle Baustoffe.xls Eintrag löschen
 Kategorie Wählen Sie aus Update
 Baustoff Wählen Sie aus Speichern

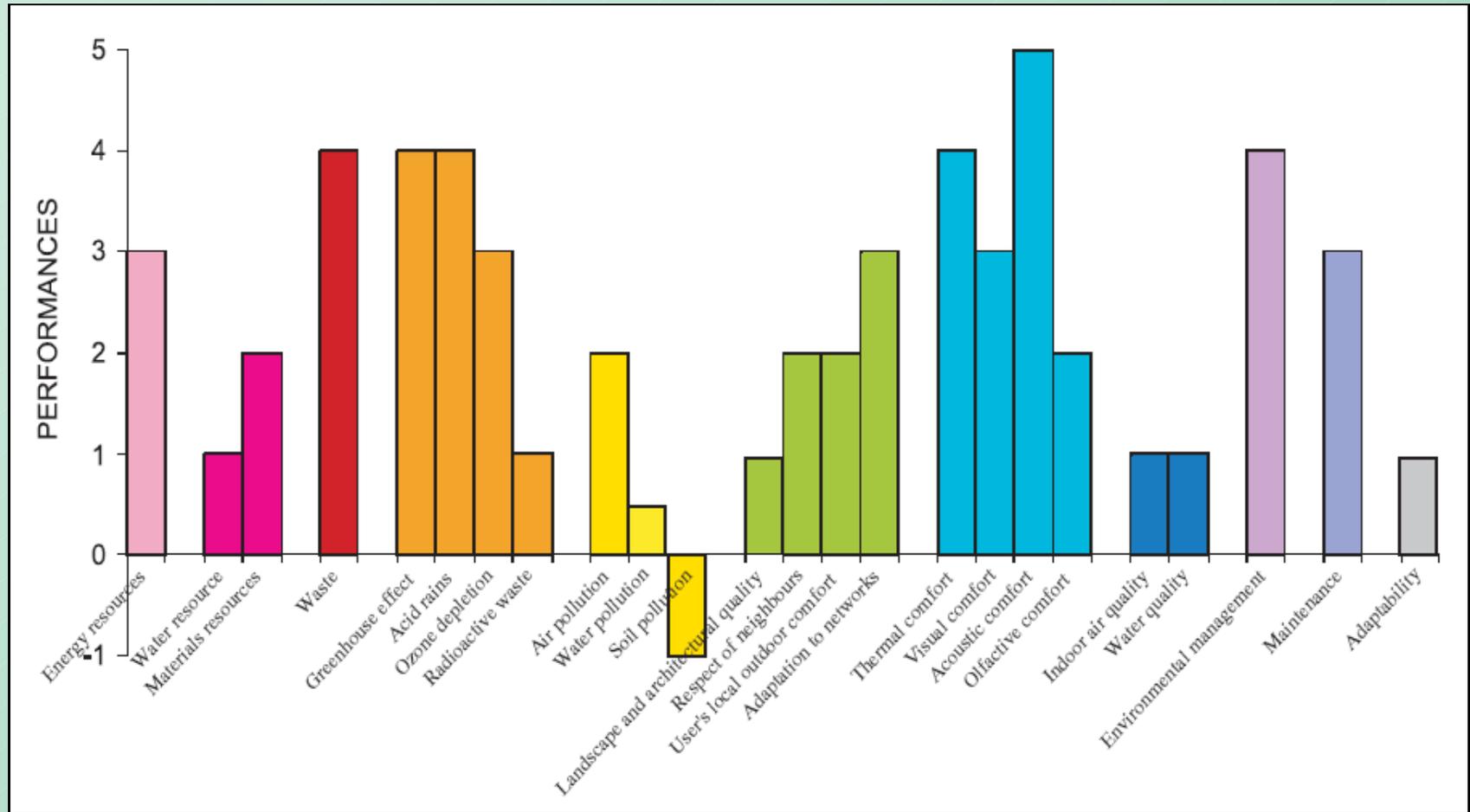
Schicht Nr.	Benennung der Schicht	Katalog	Dicke Anteil		Dichte	Masse	Nutzungs-dauer	global warming (GWP100)	ozone layer depletion (ODP)	photo-chemical oxidation	acidifi-cation	eutrophi-cation	PEI nicht erneu erbar	PEI erneu erbar	
			m	%											kg/m ³
1	Gipsputz	Baustoffe.xls	0,005	100%	1100	5,5	80	0,583	1,3915E-07	0,00005104	0,00159	0,000173	11,02	0,15	
2	Hochlochziegel hochporosi	Baustoffe.xls	0,25	100%	750	135	80	33,750	0,000010449	0,0016065	0,1404	0,010679	370,74	6,52	
3	Mörtel	Baustoffe.xls		100%		10	80	2,080	0,000000753	0,000159	0,00676	0,000673	15,78	0,72	
4	Mineralischer Kleber	Baustoffe.xls		100%		5	80	1,040	3,765E-07	0,0000795	0,00338	0,000337	7,89	0,36	
5	Holzweichfaserplatte	Baustoffe.xls	0,17	100%	210	35,7	80	-34,568	1,81237E-05	0,0088298	0,243593	0,011127	682,55	731,05	
6	Glasfaserarmierung	Baustoffe.xls		100%		0,2	80	0,312	0,000000117	0,0000228	0,001904	0,000149	6,50	0,26	
7	Silikatputz	Baustoffe.xls	0,01	100%	1800	18	80	3,744	1,3554E-06	0,0002862	0,012168	0,001211	28,41	1,30	
Betrachtungszeit								80	6,941	3,13138E-05	0,01103484	0,409795	0,024348	1122,89	740,37
Materialkosten															
Arbeitskosten															
Gesamtkosten								0							

AW_brick_ExternalWall Statistik



ESCALE, France

combined with INIES and SIMA-PRO



Notes between 0 and 5 for 12 criteria



LEGEP, Germany, www.legep.de

LEGOE PRESCO

- ✓ Gesamtgebäude
- ✓ Folgekosten
- ✓ Laufende Kosten
 - ✓ Jährliche Kosten
 - ✓ Monatliche Belastung
- ! Kostengruppen
 - ✓ Kostengruppen ge...
 - ✓ Absolute Werte
 - ✓ Kostengruppen ge...
 - ! Absolute Werte
 - ! Kostenstellen
 - ! Absolute Werte
- ! Positionen
- ! **Wärme / Energie**
 - ✓ Hüllflächen
 - ! **Übersicht**
 - ✓ Monatsbilanz
 - ! Projektspezifische Dicken
 - ! Details
 - ✓ Wärmeflussdiagramm (E...
 - ✓ Wärmeflussdiagramm (P...
 - ! Heizwärmebedarf
 - ! Transmissionsverluste
 - ! Prozentualer Anteil
 - ! Gesamter Verlust
 - ! Wasserfluss
 - ! Bedarf
 - ! Strom
 - ! Wasser
 - ! Warmwasser
 - ! Heizung
 - ! Prozentualer Anteil
 - ! Gesamter Bedarf
 - ! Endenergie / Primär...
 - ! Energiekosten
 - ! Amortisation
 - ! Kosten
 - ! **Ökologie**
 - ! Stoffmasse
 - ! Übersicht
 - ! Übersicht grafisch
 - ! Entwicklung

Berechnungsgrundlage
 Lüftung **natürlich**

Luftdichtheitsprüfung **Nein**

Photovoltaik **Nein** Solarkollektoren **Nein**

Regenwasser **Nein**

Wärmeerzeugung **Strom**

Rechenverfahren **Energieeinsparverordnung 2002 (Vereinfacht)**

Ergebnis

Jahresheizwärmebedarf kWh/Jahr

Anlagenaufwandszahl (primärenergiebez.) nach DIN V 4701-10

spezif. Transmissionswärmeverlust Maximal zulässig W/(m²K)

Primärenergiebedarf QP* Maximal zulässig kWh/m²Jahr

Alle Angaben in kWh/m²Jahr

Lüftung 3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0

Solarrer Gewinn
Innerer Gewinn

Anlagenverluste und Primärenergiebereitstellung

Transmission Verluste

Grenzwert
151 Primärenergiebedarf
Gewinne

Die Energieeinsparverordnung wird nicht erfüllt

First study : « cube »

Steel reinforced concrete, 20 cm thick

Electric heating

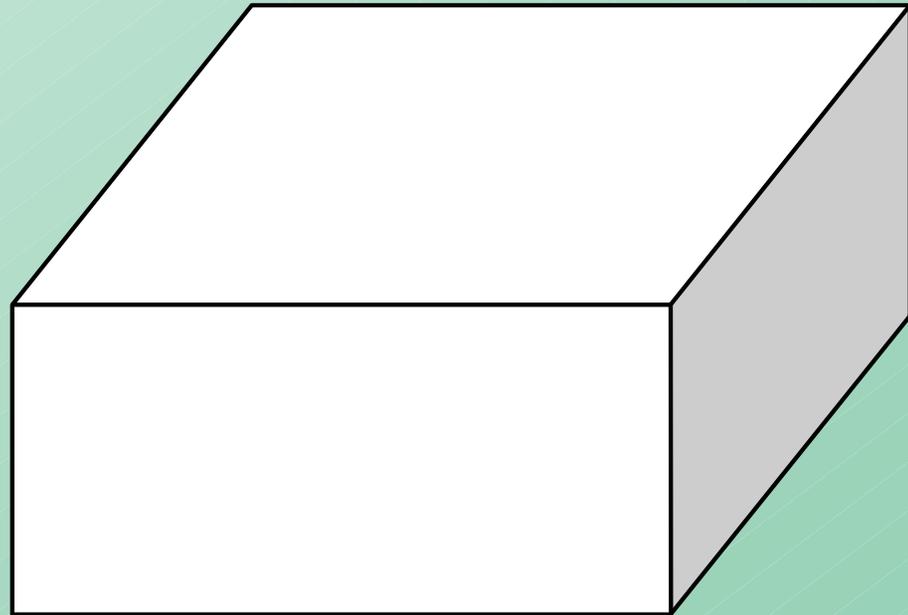
(E.U. electricity mix)

50 years

Transport

Construction

End of life



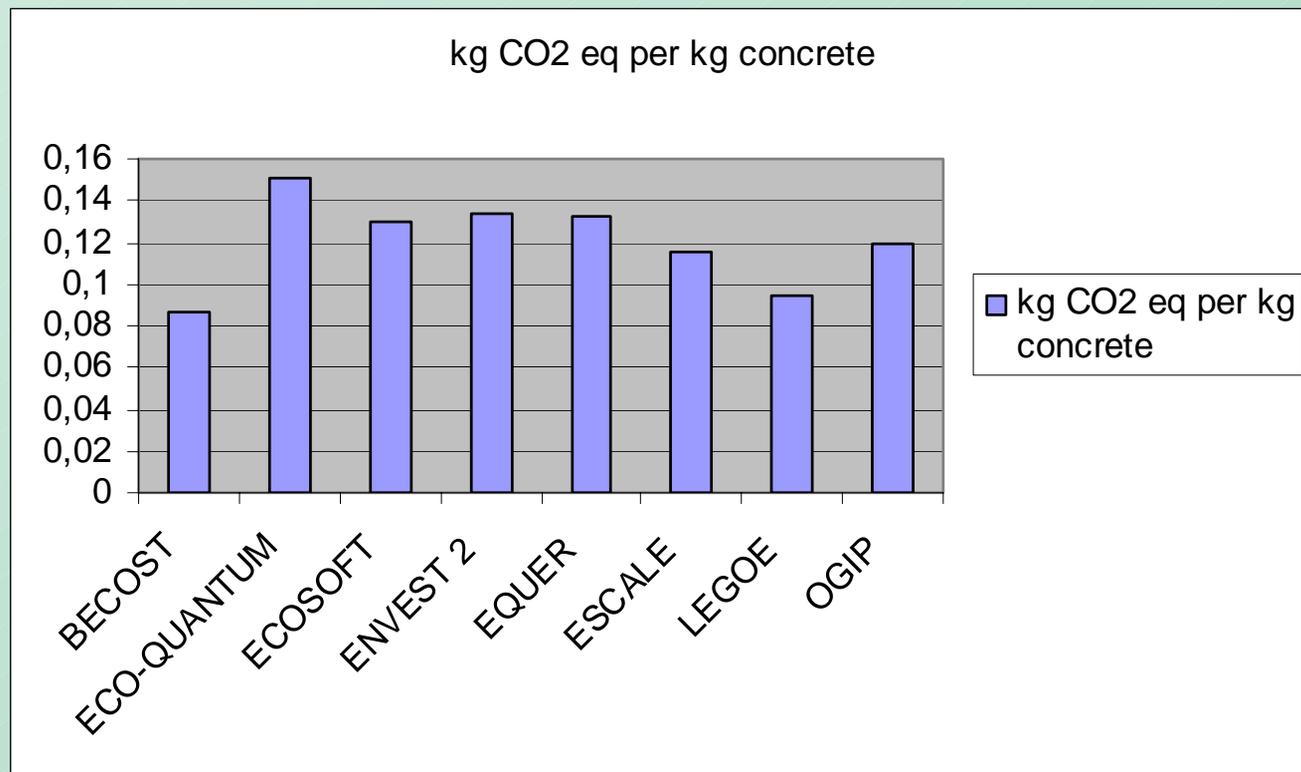
Main assumptions (1)

- ▶ **Transport of materials**
- ▶ **Quantity and management of construction waste**
- ▶ **Electricity production and transport**
- ▶ **Occupants related impacts (e.g. water consumption, domestic appliances, home-work transport, domestic waste)**

Main assumptions (2)

- ▶ **Energy calculations (EN 832, simulation)**
- ▶ **Refurbishment processes**
- ▶ **Demolition processes**
- ▶ **Transport of waste**
- ▶ **End of life processes**

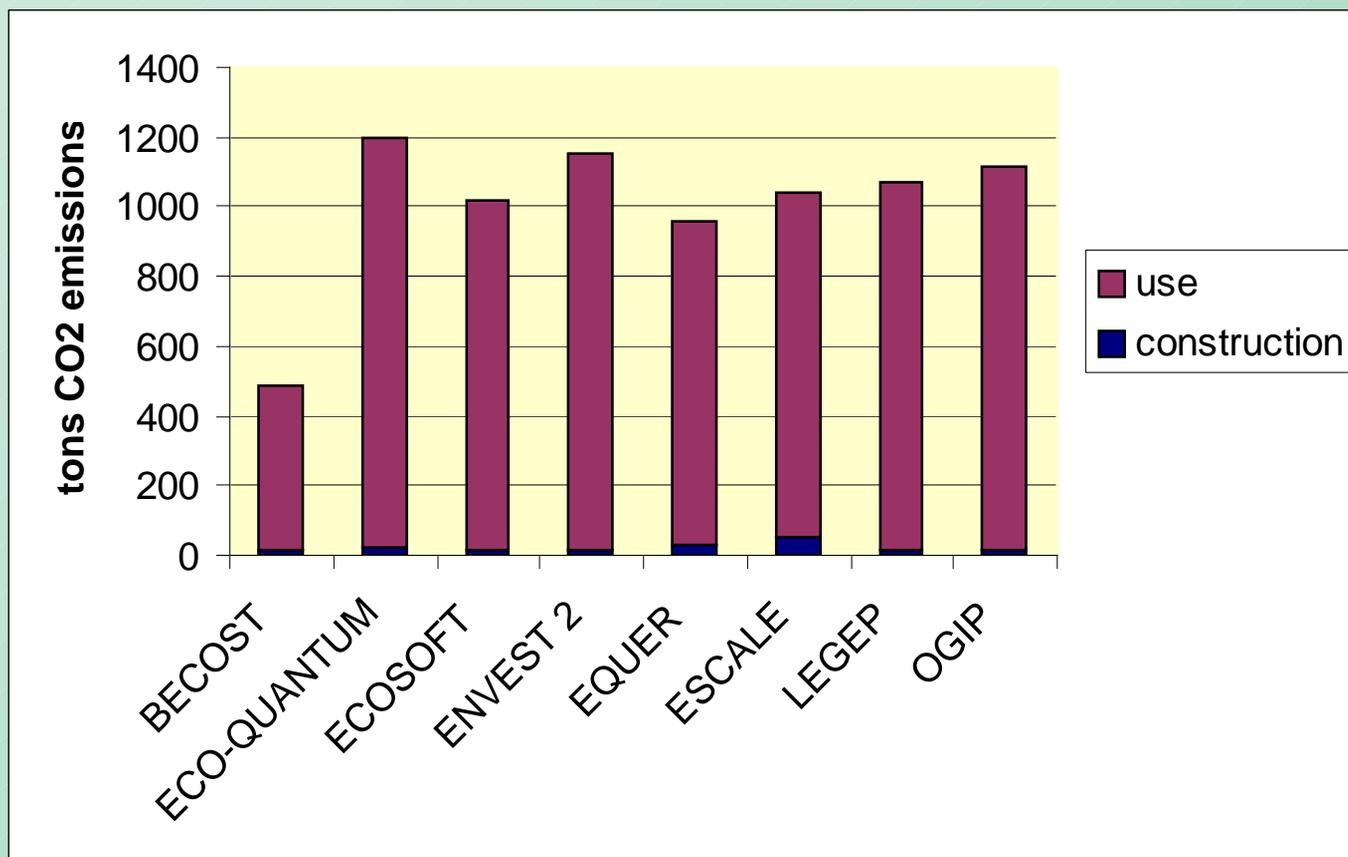
Example, LCI of concrete



Different qualities, cement content 120-300 kg/m³
Different processes (prefabricated) and energies
Different indicators : IPCC, CML... + alloc. (ash)



Results for climate change



*+ / - 10% discrepancy except Becost
(use of Finnish electricity mix)*

Uncertainties, discrepancies

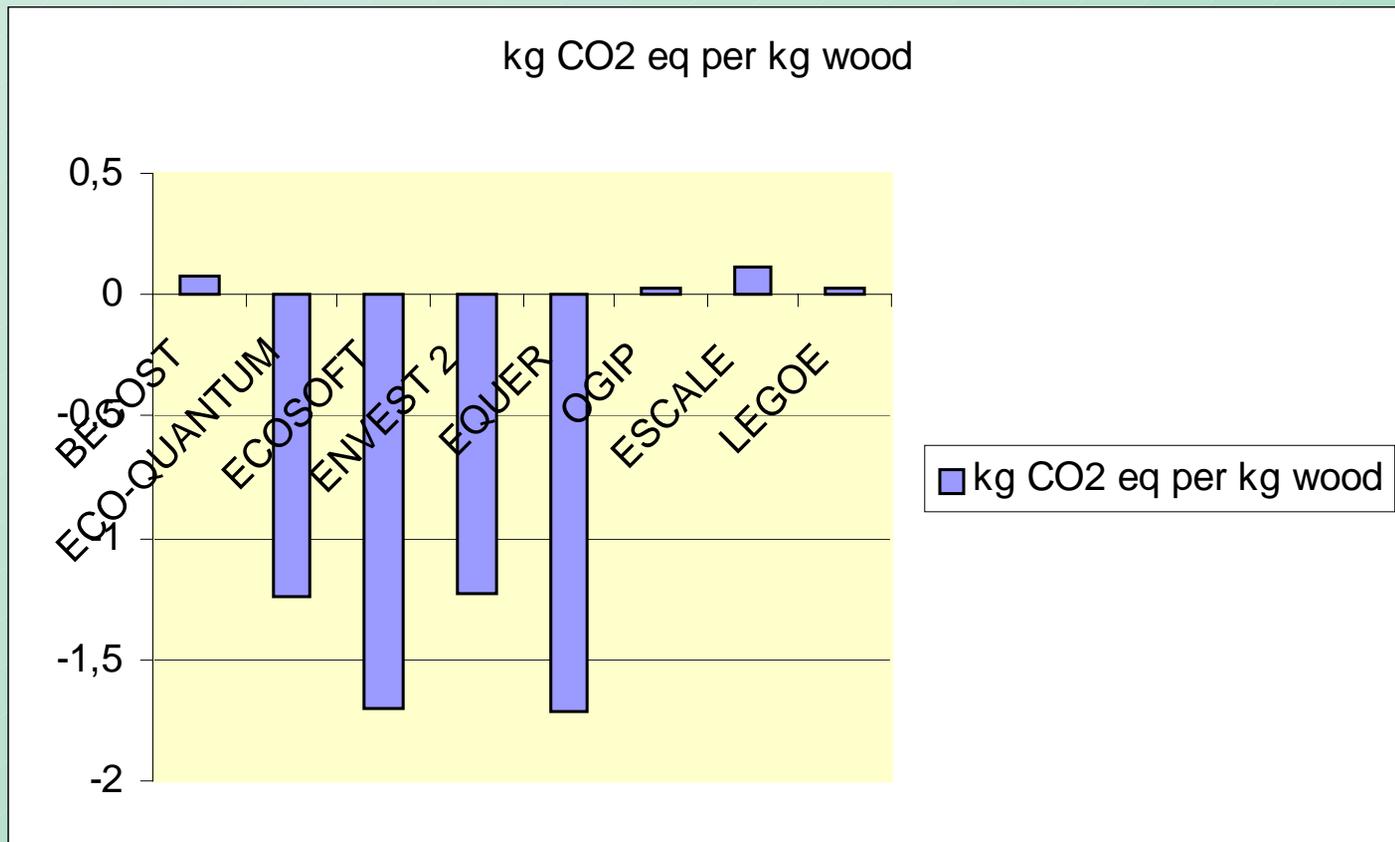
- ▶ **Quantities (internal / ext. Dimensions)**
- ▶ **Steel % in reinforced concrete 0.83 to 3%**
- ▶ **% surplus during construction (0 to 10%)**
- ▶ **Transport of materials : 0 to 50 km**
- ▶ **Life span of materials and components**
- ▶ **Transport of waste : 0 to 20 km**
- ▶ **End of life : landfill**

Second study : FUTURA House



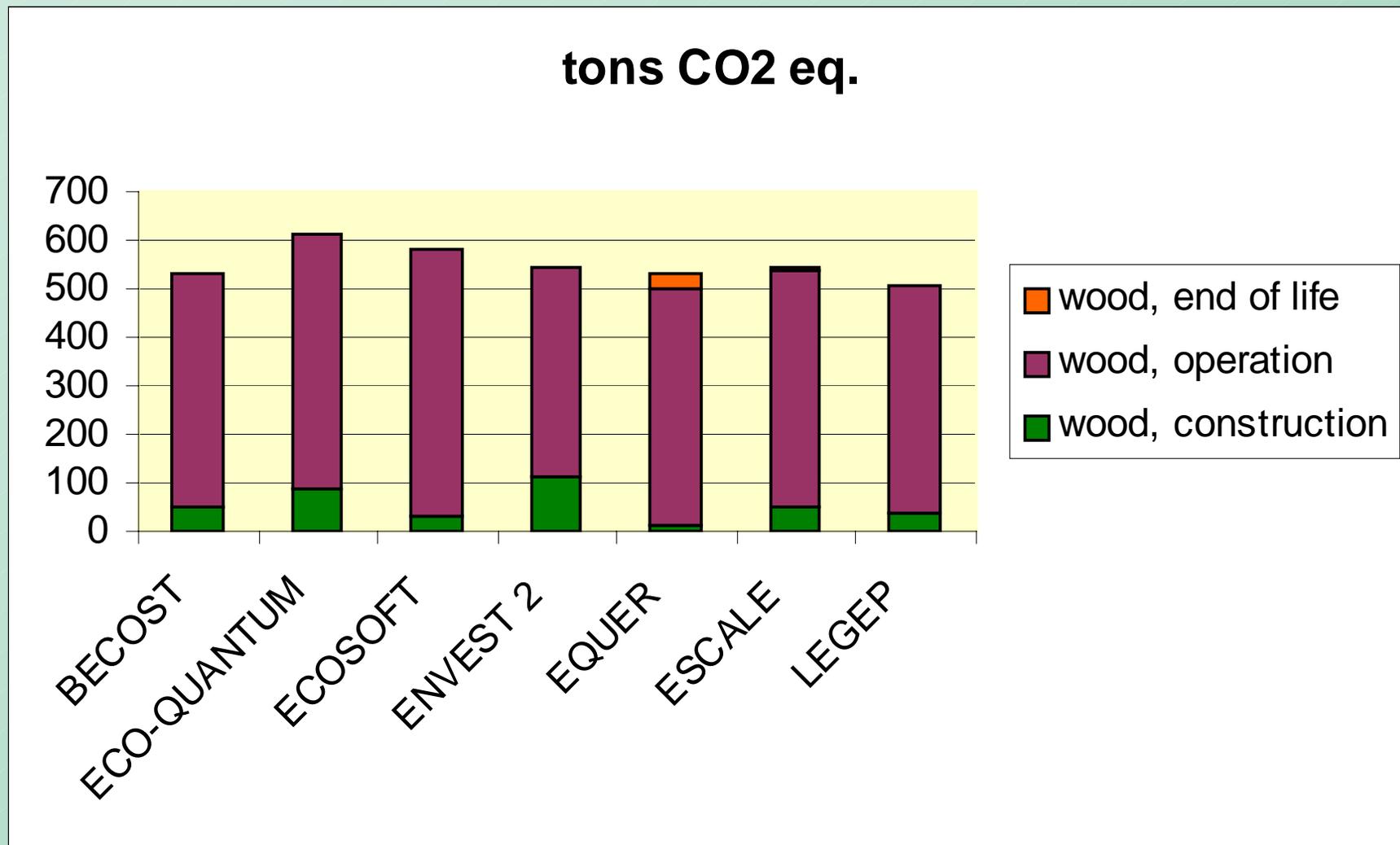
Single family house, 210 m², gas heating, 80 years

LCI of wood production



2 groups of tools : 0 CO₂ balance versus storage

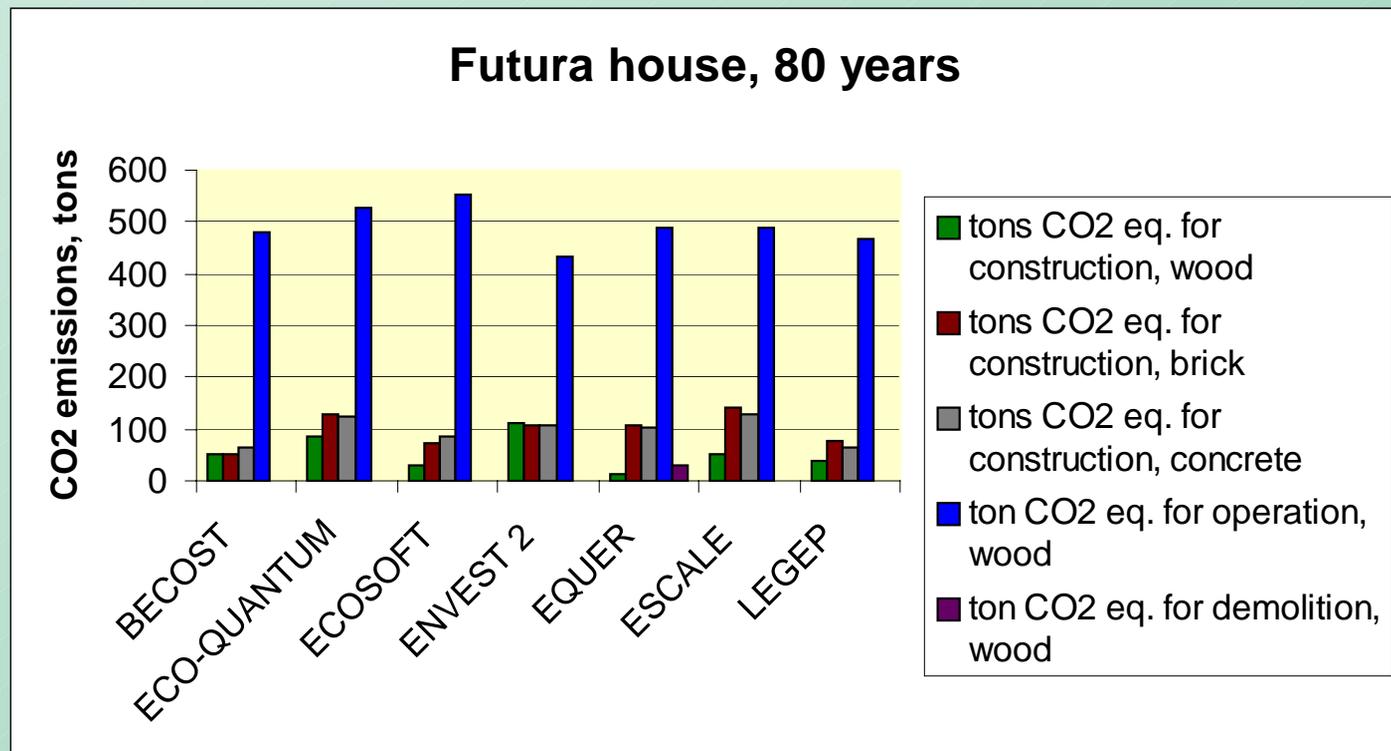
Comparison of LCA tools



+ - 10% discrepancy over the life cycle

Comparison of wood, brick and concrete constructions, CO₂

+/- 10%



CO₂ emissions with wood <= other materials
CO₂ with brick > CO₂ with concrete ?
yes for 4 tools, no for 3 tools



Examples of good practice

- ▶ **scope, assumptions and methodology should be transparent**
- ▶ **recent and specific data with consistent methods**
- ▶ **promote the use of recycled materials + recycling at the end of the life cycle**
- ▶ **default value for transport to site and for each type of waste treatment process (incineration, landfill, recycling, ...), product specific values if available data**
- ▶ **water : should be included in the results --> can promote water saving measures**
- ▶ **Aggregated weighting factors (e.g. ecopoints) not recommended**



Example LCA application, renovation of a social housing block near Paris



Construction : 1969, not insulated, single glazing

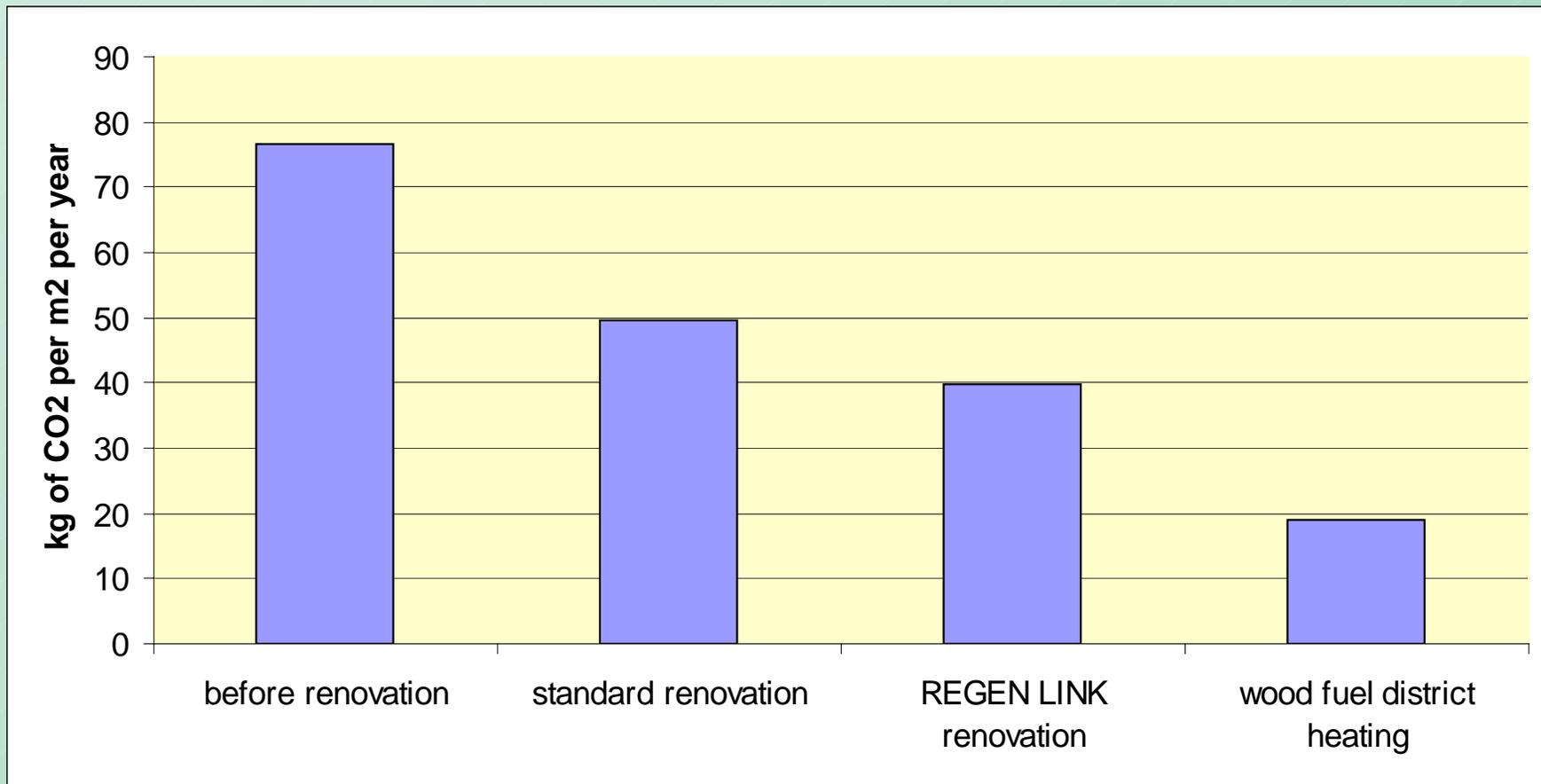
Heating load : 150 kWh/m²/an

TREES

Comparison of alternatives

- ▶ **Before renovation**
- ▶ **Standard renovation : 6 cm external insulation, standard double glazing**
- ▶ **European project REGEN LINK : 10 cm insulation, low emissivity glazing, moisture-controlled ventilation, air preheating in glazed balconies, low flow rate sanitary equipment**
- ▶ **Use of biomass in district heating**

Results of life cycle assessment, EQUER

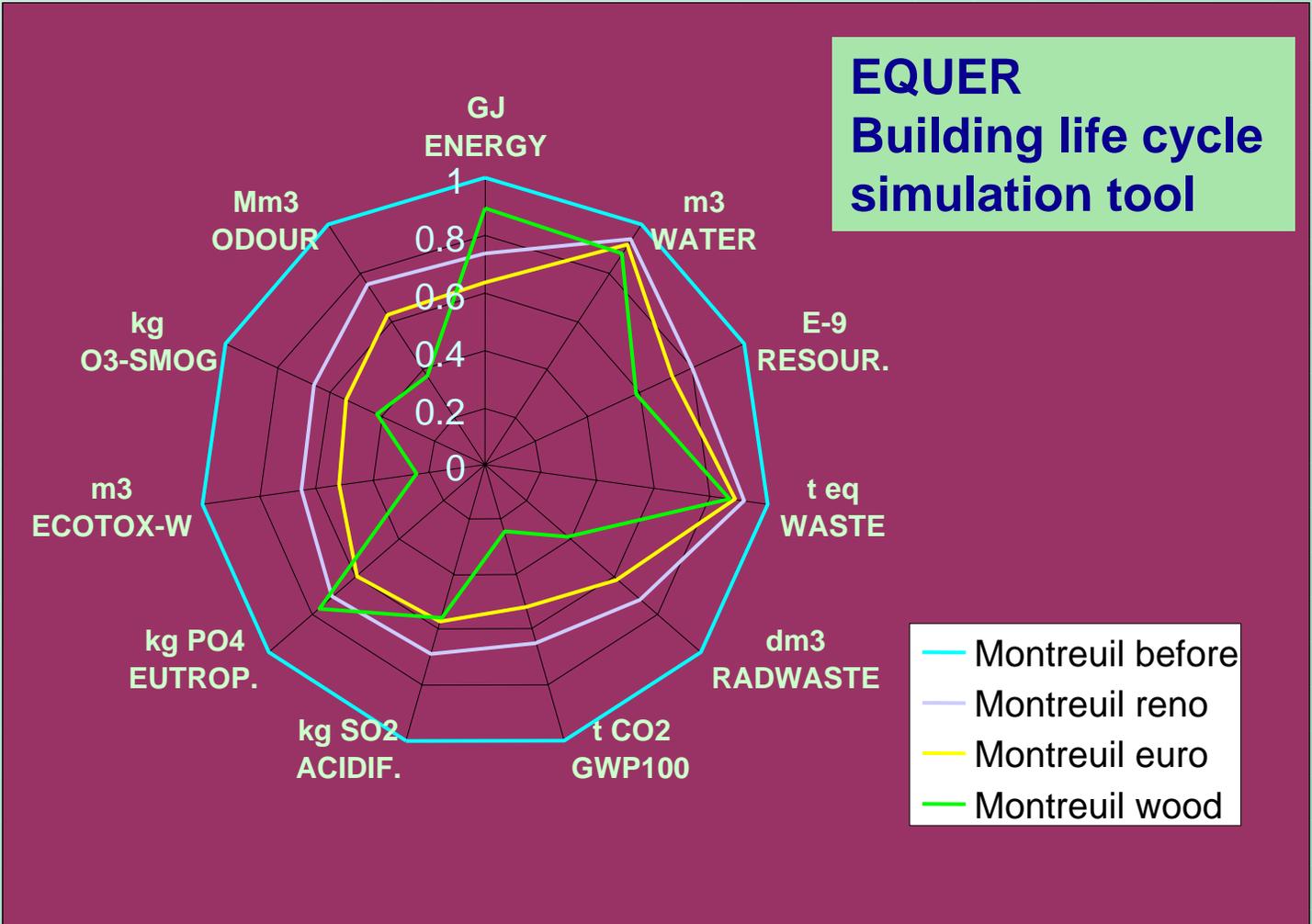


CO₂ emissions per m² and per year

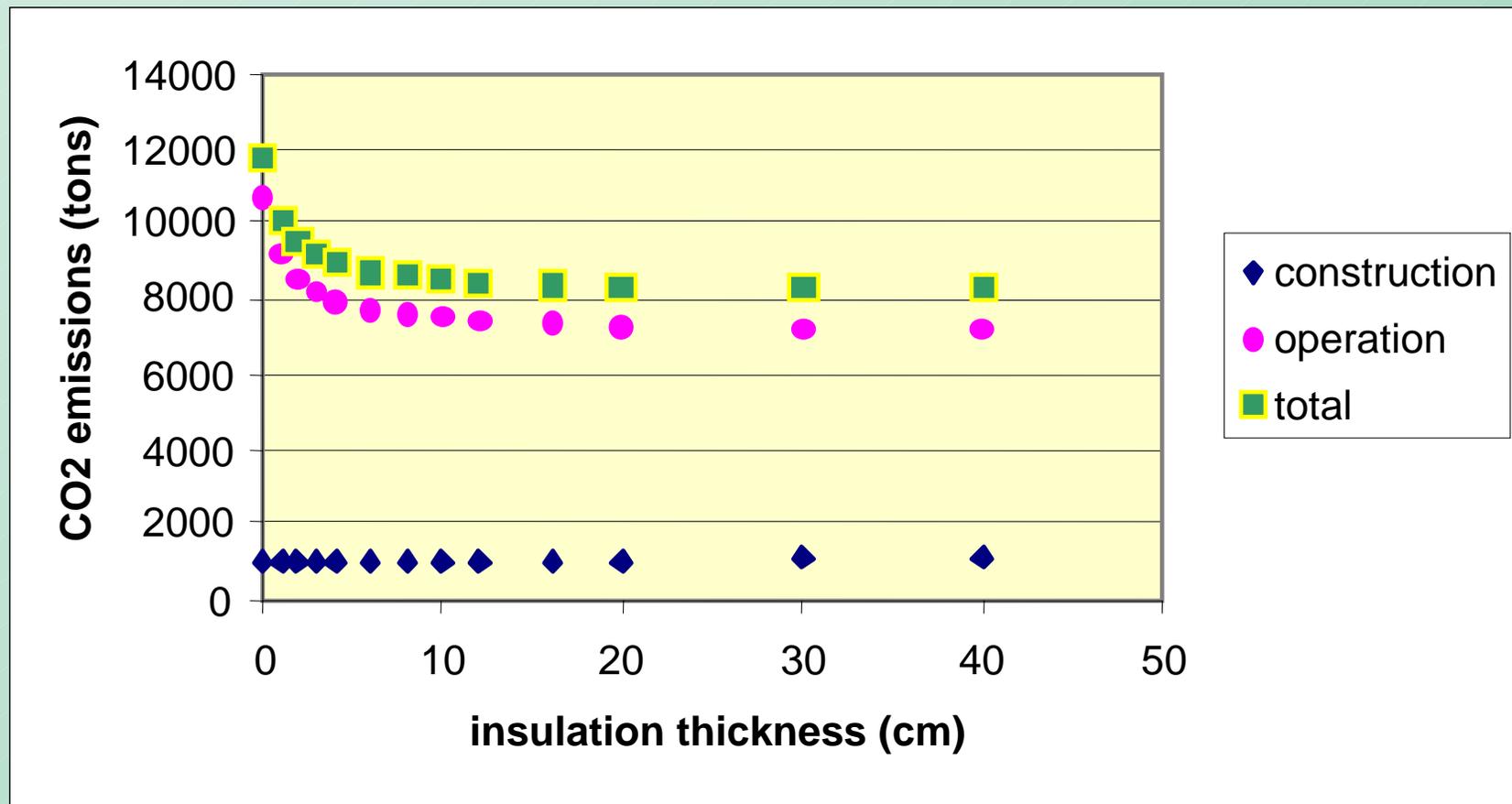


Results of life cycle assessment, EQUER

EQUER
Building life cycle simulation tool



Facade insulation



Life cycle assessment, example : CO₂ emissions
Optimum 20-40 cm (CO₂), 10 cm (cost)



Influence of building design and occupants behaviour on environmental performance

- ▶ **2 building designs**

Standard house in France

Higher environmental quality house

- ▶ **2 types of occupants' behaviour**

« **Economical** »

« **Spendthrift** »

2 building designs

Component	Reference (REF.)	"Higher environmental quality" (HEQ)
insulation	8 cm internal	12 cm external
glazing area	10 m ² , north oriented	25 m ² , south oriented
controlled ventilation	without exchanger	heat recovery, efficiency 0.5
sanitary installations	standard	reduced water flow rate (of 50%)
waste sorting equipment	only for glass	for paper and glass

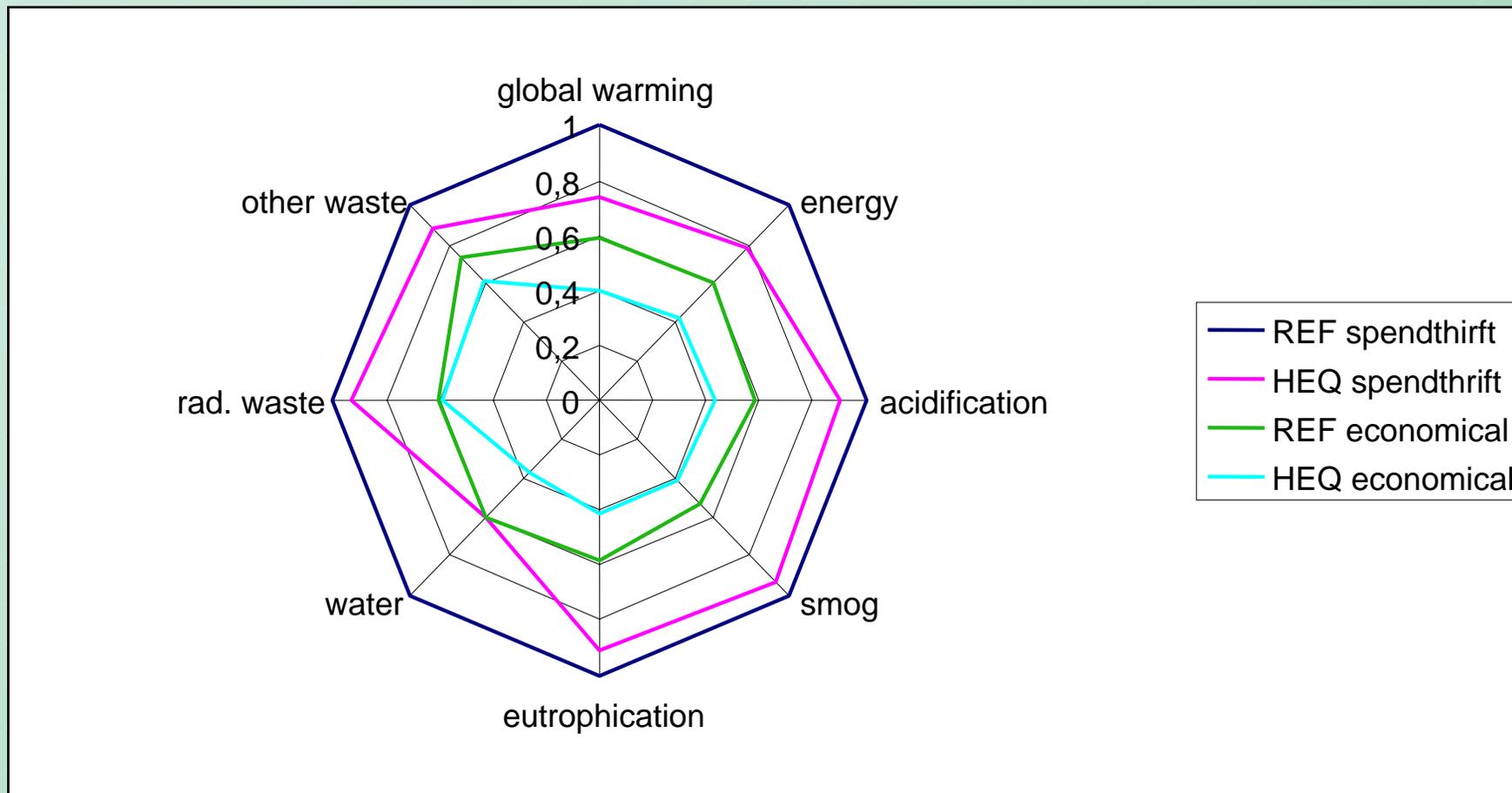
2 types of occupants' behaviour

Parameters	"Economical"	"Spendthrift"
Set point temperature	varying between 14°C and 19°C	21°C constant
Ventilation	0.5 ACH	1 ACH
Electricity consumption	150 W	300 W
Domestic hot water	40 l/person/day ^A	60 l/person/day ^A
cold water	80 l/person/day ^A	150 l/person/day ^A
urban waste	0.8 kg/person/day	1.5 kg/person/day
paper sorting	60% ^B	0%
glass sorting	80%	0%

^A *divided by two for the "Higher environmental quality" case, due to the reduced flow rate.*

^B 0% for the reference case as there is no paper sorting possibility.

LCA results



Design is not sufficient, information of residents about proper management is essential



Conclusions

- ▶ **Life cycle simulation is operational, though only emerging and used by specialised architects and consultants**
- ▶ **LCA could be used to determine appropriate environmental targets according to a context, and to check the compliance of projects**
- ▶ **Environmental benefit from RE in buildings, materials become important with lower energy use**
- ▶ **Retrofit can be compared to rebuilding**

