COST C25

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Building Sustainability Assessment and Certification Method

Methodology MARS-H

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OBJECTIVES

- To approach the sustainability assessment in the building sector.
- To present and discuss a sustainability assessment method for Portuguese residential buildings (Methodology MARS-H).

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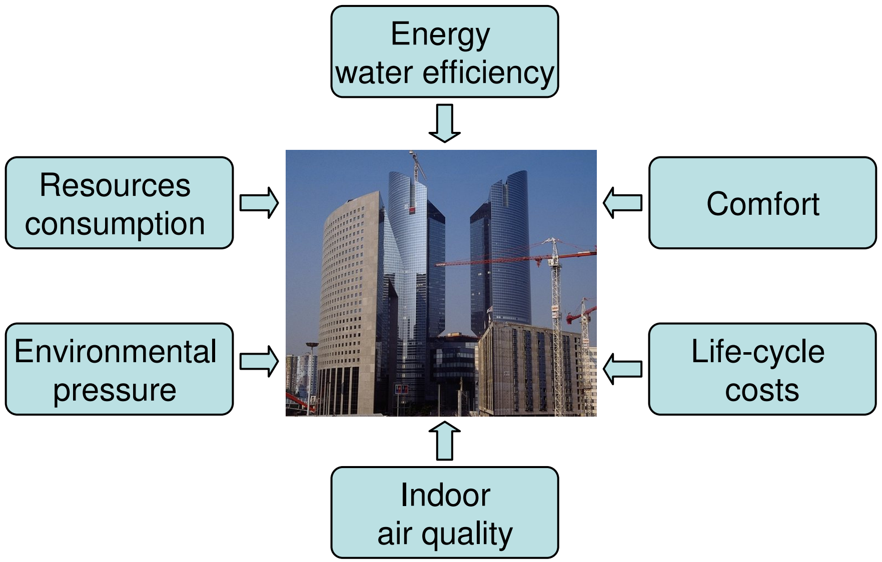
INTRODUCTION

- A building project can be regarded as sustainable only when all the various dimensions of sustainability are balanced: environmental, economic, social and cultural.



- The purpose of sustainability assessments is to gather and report information for decision-making during different phases of construction, design and use of a building.

- Several approaches base the sustainability assessment in a list of indicators.

- Different indicators have been developed by administrations, organizations and industries at local, national and global levels.

Major reasons…

- The **political**, **technological** and **cultural differences** between countries.
- The dependence of a **subjective valuation** involved in each general methods developed so far.

Different indicators (methods) = Different results

DEVELOPMENT OF BUILDING SUSTAINABILITY ASSESSMENT

- In order to standardize, facilitate the interpretation of results and comparison between different building assessment methods developed within the European Countries, CEN (European Centre of Normalization) launched the Technical Committee 350 (CEN/TC 350).

- Based in the CEN/TC 350, a residential building sustainability rating tool, especially to be suitable in Portuguese traditions, climate, society and national standards is being developed.

↓

Methodology for the Relative Sustainability Assessment of Residential Buildings (MARS-H)

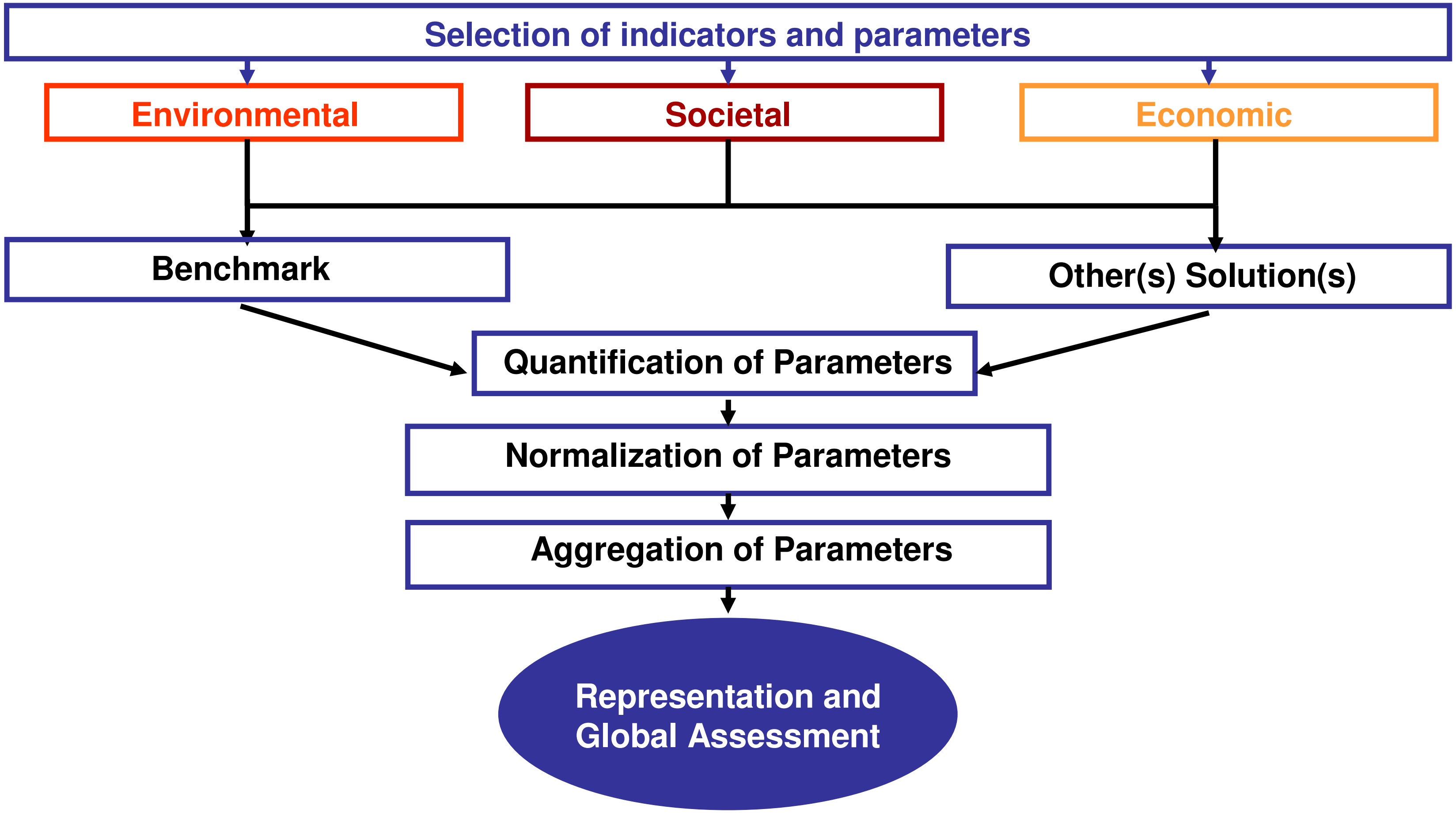
Goals of the methodology

- To develop a regional method based in the SBTool approach suitable to assess buildings in the Portuguese context;
- To harmonize it with the CEN/TC350 draft standards “Sustainability of Construction Works – Assessment of Environmental Performance of Buildings”;
- To include all different sustainable dimensions in the assessment;
- To have a list of parameters wide enough to compromise the most relevant building impacts and at the same time limited enough to be practical (maximum of 50 parameters);

Goals of the methodology

- To limit the use of subjective and/or qualitative criteria that is hard to validate (e.g. aesthetics and technical innovation) ;
- To increase the reliability, through the use of LCA methods to assess the environmental performance;
- To define a list of mandatory parameters;
- To develop an assessment output and certification label easily understandable by all intervenients.

Structure of the methodology MARS-H



Selection of indicators and parameters

Assessment of 9 categories and 44 parameters

Environmental

1) Climate change and outdoor air quality;

2) Biodiversity;

3) Energy;

4) Materials use and solid Waste;

5) Water use and effluents;

Societal

6) Occupants health and comfort;

7) Accessibility;

Economic

8) Life-cycle costs;

9) Building adaptability and flexibility.

Quantification of Parameters

▪ Environmental

1) Using the materials EPD (MARS-H uses a list of 5 *Mid Point* impact categories. Those impacts together with the non-renewable embodied primary energy are the same that are referenced in the material's EPDs.)

Emissions and environmental impacts

Environmental impacts

All figures refer to functional unit (FU)

	Unit	Raw materials	Manufacturing	Building site	Use	Demolition/ Disposal	Transport/ packaging	Total
Climate change	kg CO2 - equiv.	7,1E-01	6,8E-02	2,9E-02		2,9E-02	5,6E-02	8,9E-01
Ozone depletion	kg ODP - equiv.	1,2E-12	6,5E-12	4,0E-12		4,0E-12		1,6E-11
Acidification	kg SO2 - equiv.	1,5E-03	1,9E-04	9,9E-05		9,9E-05	4,2E-04	2,3E-03
Formation of photochemical oxidai	kg POCP-equiv.	4,1E-04	9,8E-04	2,3E-06		2,3E-06	2,7E-05	1,4E-03
Eutrophication	kg PO4 - equiv.	1,6E-04	1,3E-05	5,8E-06		5,8E-06	7,4E-05	2,6E-04

Figure 1: Example of an EPD for cold finished structural hollow sections (Source: Contiga, Norway)

Problem: since they are not mandatory, it is very hard to find EPD for all construction materials.

Quantification of Parameters (cont.)

2) Using external LCA software tools and methods (e.g. SimaPro software and CML 2 baseline 2000 for the environmental impacts assessment and Cumulative Energy Demand method for embodied primary energy).

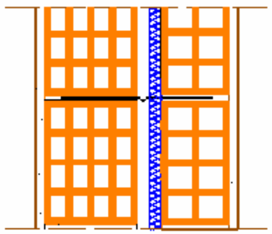
Problem: LCA procedures are very time consuming and usually limited to experts and academics.

3) To develop and use databases with the environmental impacts and embodied primary energy for each construction solution (walls, floors, windows, doors, finishings, etc.).

Best Solution!

Quantification of Parameters (cont.)

Database (example)

Building Solution:	Hollow brick cavity wall (15cm+11cm) with thermal insulation (extruded polystyrene) in the air gap									Ref.: Wall1
Scheme	Life-cycle Stage	Embodied environmental impacts						Embodied energy	
		Abiotic depletion (Kg Sb)	GWP (Kg CO_2)	Ozone depeltion (kg CFC-11 eq)	Acidification Potential (kg SO_2 eq)	Photochemical Oxidation (Kg C_2H_4 eq)	Eutrophication (kg PO_4 eq)	Non-renewable (MJ eq)	Renewable (MJ eq)
	Cradle to gate	3,4E-03	4,9E-01	5,7E-08	1,6E-01	1,0E-02	2,0E-02	9,6E+00	8,8E-01
	Demolition/ disposal	1,1E-04	1,5E-01	1,9E-09	5,0E-03	3,3E-04	6,5E-04	1,6E-01	-
	Total	**3,5E-03**	**6,4E-01**	**5,9E-08**	**1,7E-01**	**1,0E-02**	**2,0E-02**	**9,8E+00**	**8,8E-01**
Comments:	Considered materials: Used LCA method(s): Used LCI libraries(s): Others:								

Quantification of Parameters (cont.)

- **Societal**

  Using one of the different analytical methods or through experimental monitoring.

- **Economic**

  Using costs databases or through the use of external Life-cycle costing (LCC) tools.

Normalization of Parameters

- The objective is to avoid the scale effects in the aggregation of parameters inside each indicator and to solve the problem that some parameters are of the type "higher is better" and others "lower is better".
- It is a way to compare the performance of the solution with the best and conventional/reference practices (Benchmarks):
- MARS-H uses the Diaz-Balteiro equation:

$$\overline{P_i} = \frac{P_i - P_{*i}}{P_i^* - P_{*i}} \forall_i$$

with,
P_i – Value of *i*th parameter;
P_{*i} – Reference practice value of *i*th parameter;
P^*_i – Best practice value for the *i*th parameter;

Normalization of Parameters (cont.)

- Besides of turning dimensionless the value of the parameters, it converts values between best and reference practices into a scale bounded between 0 (reference/conventional value) and 1 (best value).

- Excellent practices will have a score above 1 and performances bellow the reference will have a negative normalized value.

Aggregation of Parameters

- The objective is to synthesize in one value the average performance of a solution inside each category, dimension and also the overall performance.

- The methodology uses a complete aggregation method:

$$I_j = \sum_{i=1}^{n} w_i \cdot \overline{P_i}$$

with,
I_j – Weighted average of all normalize parameters;
w_i – Weight of the *i*th parameter;
$\overline{P_i}$ - Normalised value of the *i*th parameter.

- Difficulties in this method lie in setting the weight of each parameter and in the possible compensation between parameters.

Graded scale for performance assessment

- The normalized values of the parameters and aggregated parameters are converted in a graded scale using the following conversion:

Grade	Values
A+ (Above best practice)	$\overline{P_i} > 1{,}00$
A	$0{,}90 \le \overline{P_i} \le 1{,}00$
B	$0{,}70 < \overline{P_i} \le 0{,}90$
C	$0{,}50 < \overline{P_i} \le 0{,}70$
D	$0{,}30 < \overline{P_i} \le 0{,}50$
E	$0{,}10 < \overline{P_i} \le 0{,}30$
F (Reference practice)	$0{,}00 < \overline{P_i} \le 0{,}10$
G (Bellow reference)	$\overline{P_i} < 0{,}00$

Calculation Method (example)

Weights

▪ Environmental (US EPA's TRACI method)

Table 1: Relative Importance Weights based on Science Advisory Board Study

	Relative Importance Weight (%)	
Impact Category	*8 Impacts*[a]	*12 Impacts*
Global Warming	24	16
Acidification	8	5
Eutrophication	8	5
Fossil Fuel Depletion	8	5
Indoor Air Quality	16	11
Habitat Alteration	24	16
Water Intake	4	3
Criteria Air Pollutants	8	6
Smog		6
Ecological Toxicity		11
Ozone Depletion		5
Human Health		11

▪ MARS-H allocates the considered environmental parameters in the impact categories of the TRACI method

Weights (cont.)

Societal

A scientific based methodology was developed in order to assess the weight of each health and comfort stressor in the perceived global comfort

Perceived global comfort (C_G) results from the combination of all different comfort stressors (P_i):

$$C_G = P_1 \times W_1 + P_2 \times W_2 + P_3 \times W_3 + P_4 \times W_4$$

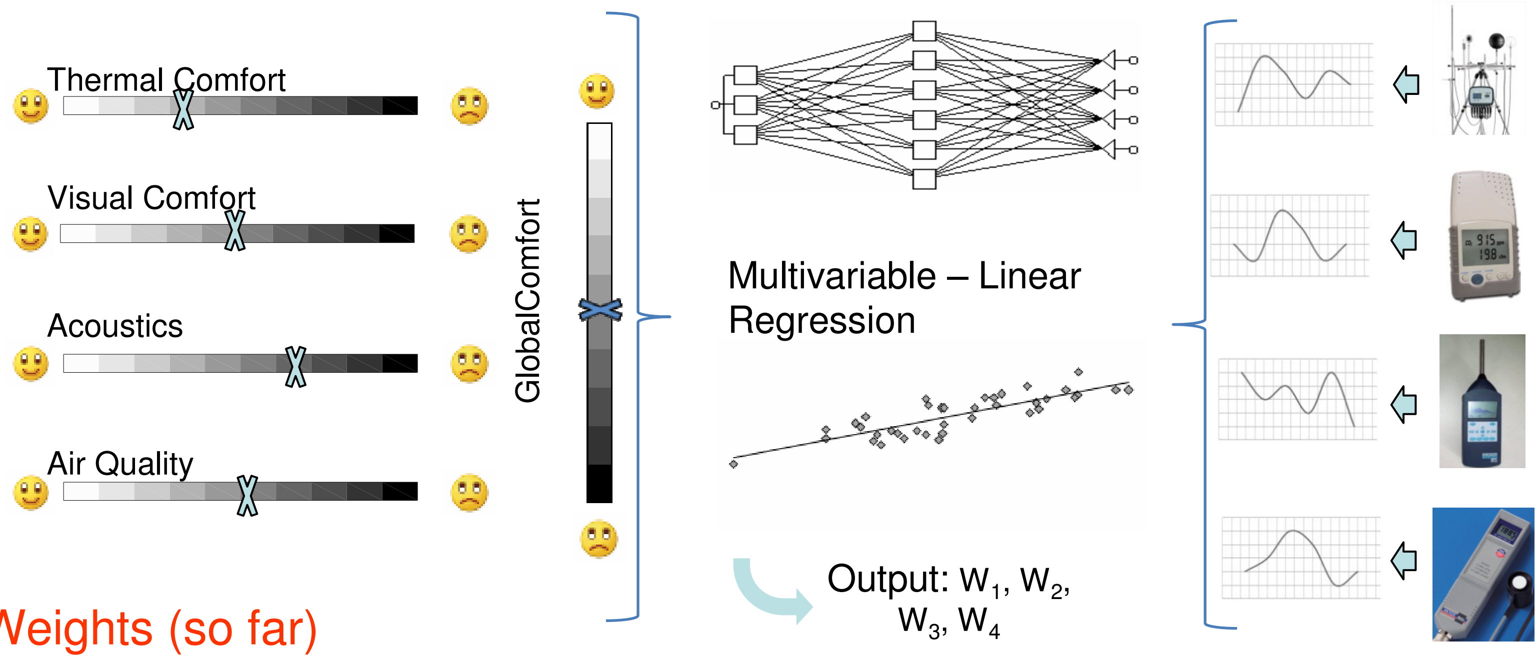
Each parameter distinctly affects the global comfort and therefore it has a different subjective weight (Wi).

Weights (cont.)

Methodology

Subjective evaluation

Objective evaluation



Weights (so far)

Thermal comfort: 38%

Lightning: 27%

Acoustic: 13%

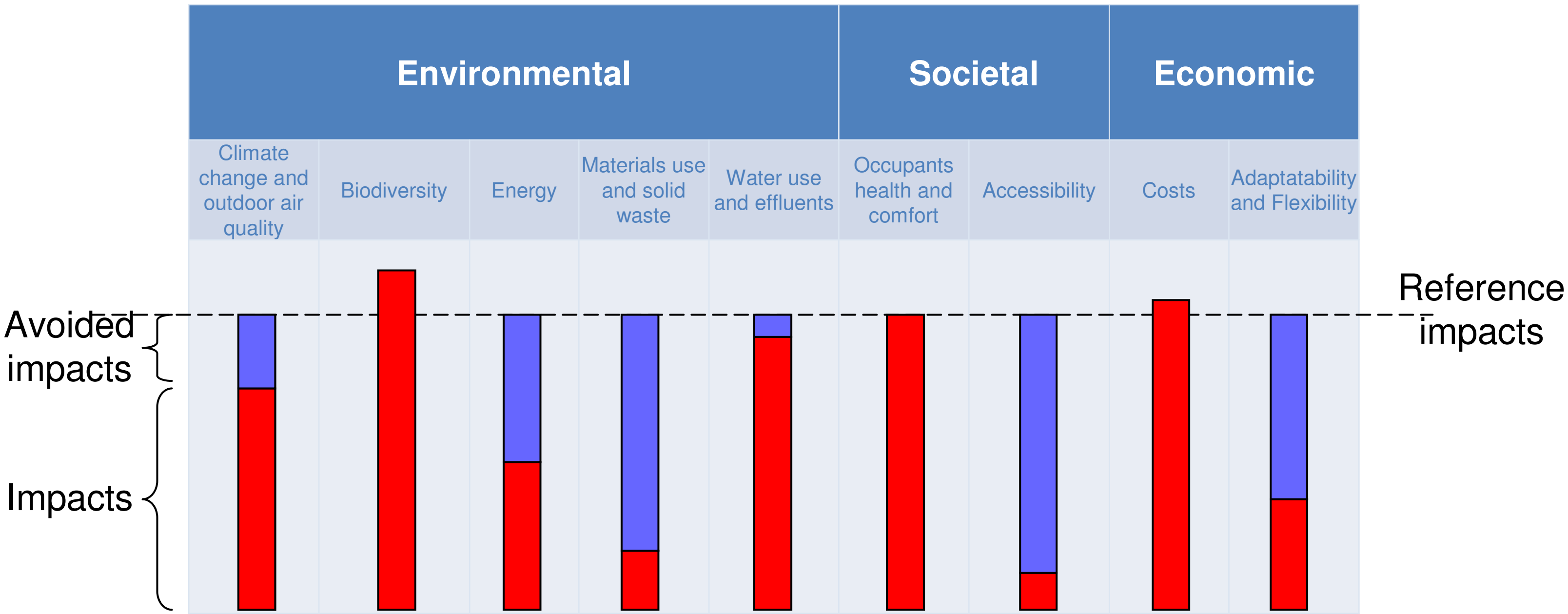
Indoor Air quality: 22%

Representation and global assessment of a project

- The assessment output are presented at two levels:

Level 1: Categories

Figure 2: Performance of the solution at the level of each category



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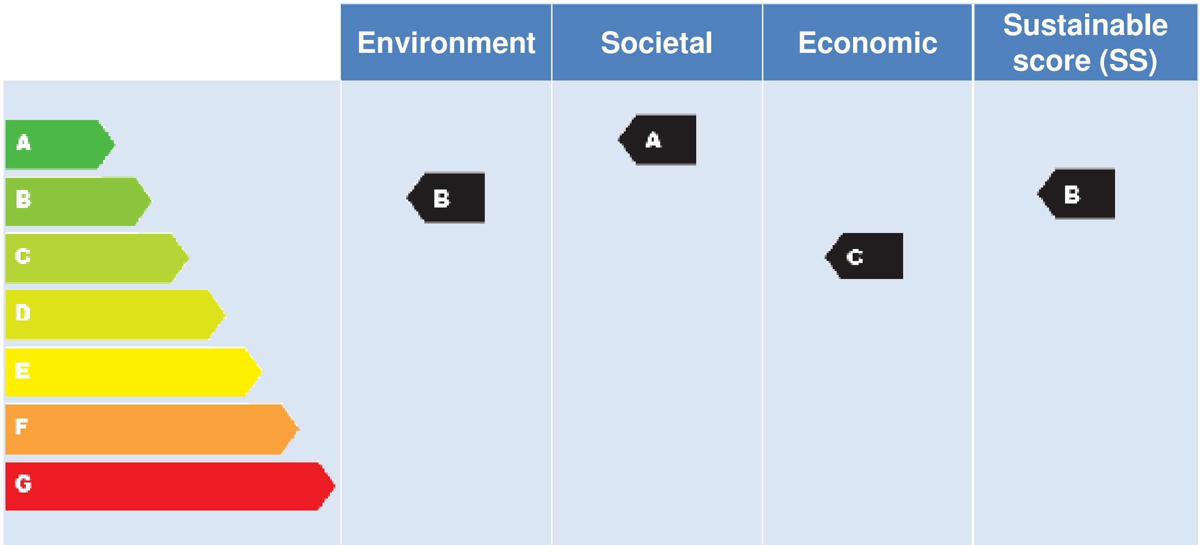
Representation and global assessment of a project (cont.)

Level 2: Sustainable dimensions and sustainable score

- The assessment output is similar to the approach adopted by existing schemes such as EU Energy labelling scheme for white goods and European DisplayTM Campaign posters.

Figure 3: Performance of the solution at the level of each dimension and overall score



Building Sustainability Certification Poster

CONCLUSIONS

- **Sustainable design, construction and use of buildings are based on the evaluation of the environmental pressure, functional, societal and economic aspects.**

- The sustainable evaluation involves **subjective rating** and depends above all on the **type of solution**, as well as on **socio-economic and cultural heritage of the subject**.

This way…

- **Despite of numerous studies about it there is a lack of a worldwide accepted methodology to assist the architects and engineers in the design, production and refurbishing phases of a building.**

- The work of the framework for assessment of integrated building performance (CEN/TC 350) is very important to **harmonize the different building sustainability assessment approaches at European level.**

Based in that outputs…

- MARS-H intends to foster the sustainable construction in Portuguese residential buildings through the definition of a list of goals and aims, easily understandable by all intervenient in construction market, compatible with the Portuguese construction technology background.

The End !

THANK YOU…