A Common Evaluation Protocol

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A large variety of technical innovations regarding the energy design and the control systems are to be implemented in the retrofitting, conversion or new erection of the buildings involved in the Eco-Building Projects.

Especially innovative is the integrated approach and combination of energy efficient technologies with comprehensive interventions on the building itself on the basis of scientific research and simulations.

The performance of Innovative technologies has to be assessed in a comprehensive and organised way, thus a common evaluation protocol has to be used.

Such an Evaluation Protocol has been prepared by the DEMOHOUSE Project and is used by the partners in the program.

The Protocol involves three main subtasks :

-The Energy Evaluation Part

-The Environmental Evaluation Part

-The Socio – Economic Part

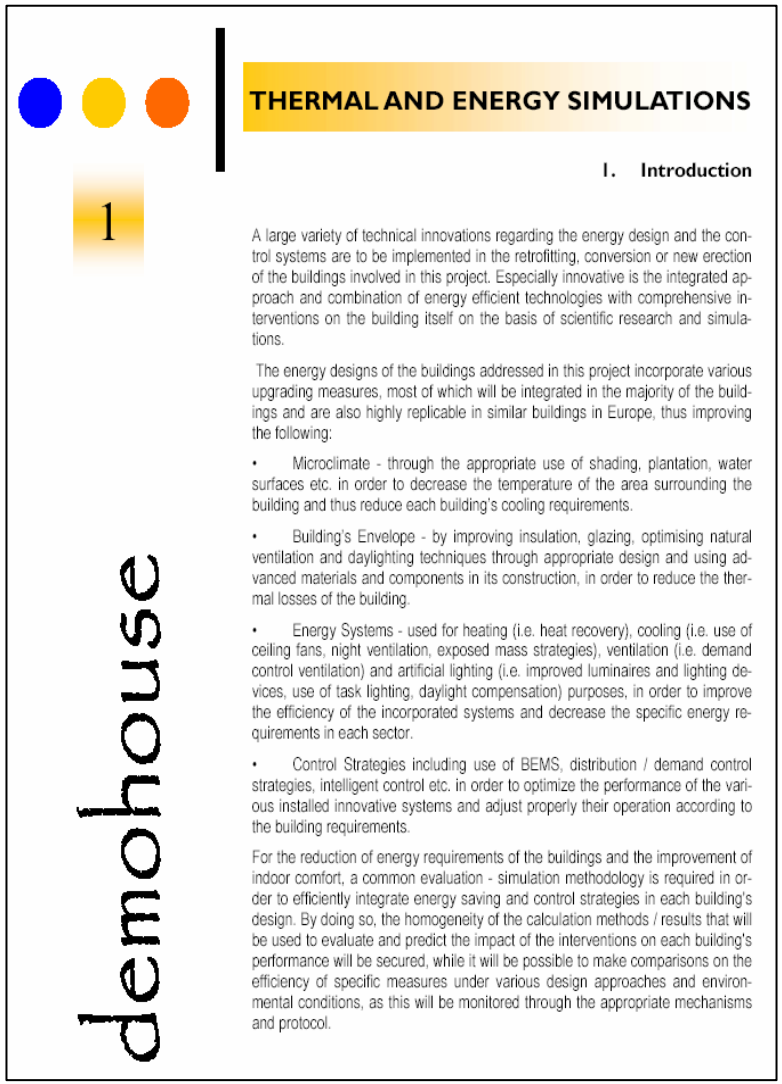
The energy designs of the buildings addressed in these projects incorporate various upgrading measures, most of which will be integrated in the majority of the buildings and are also highly replicable in similar buildings in Europe, thus improving the following:

- **Microclimate -** through the appropriate use of shading, plantation, water surfaces etc. in order to decrease the temperature of the area surrounding the building and thus reduce each building's cooling requirements.

- **Building's Envelope -** by improving insulation, glazing, optimising natural ventilation and daylighting techniques through appropriate design and using advanced materials and components in its construction, in order to reduce the thermal losses of the building.

- Energy Systems - used for heating (i.e. heat recovery), cooling (i.e. use of ceiling fans, night ventilation, exposed mass strategies), ventilation (i.e. demand control ventilation) and artificial lighting (i.e. improved luminaires and lighting devices, use of task lighting, daylight compensation) purposes, in order to improve the efficiency of the incorporated systems and decrease the specific energy requirements in each sector.

- Control Strategies including use of BEMS, distribution / demand control strategies, intelligent control etc. in order to optimize the performance of the various installed innovative systems and adjust properly their operation according to the building requirements.



THERMAL AND ENERGY SIMULATIONS

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I. Introduction

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A large variety of technical innovations regarding the energy design and the control systems are to be implemented in the retrofitting, conversion or new erection of the buildings involved in this project. Especially innovative is the integrated approach and combination of energy efficient technologies with comprehensive interventions on the building itself on the basis of scientific research and simulations.

The energy designs of the buildings addressed in this project incorporate various upgrading measures, most of which will be integrated in the majority of the buildings and are also highly replicable in similar buildings in Europe, thus improving the following:

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- Control Strategies including use of BEMS, distribution / demand control strategies, intelligent control etc. in order to optimize the performance of the various installed innovative systems and adjust properly their operation according to the building requirements.

For the reduction of energy requirements of the buildings and the improvement of indoor comfort, a common evaluation - simulation methodology is required in order to efficiently integrate energy saving and control strategies in each building's design. By doing so, the homogeneity of the calculation methods / results that will be used to evaluate and predict the impact of the interventions on each building's performance will be secured, while it will be possible to make comparisons on the efficiency of specific measures under various design approaches and environmental conditions, as this will be monitored through the appropriate mechanisms and protocol.

The evaluation of the scenarios for each building, is done by using exact simulation techniques. Energy calculations - simulations have two main objectives:

- To carry out sensitivity studies to assist designers to investigate the impact and performance of a parameter, component, system or a combination of them, in a building and adapt its/their design accordingly
- To calculate the specific and global energy and environmental efficiency and performance of the final design of a building, in order to compare with initial targets, existing consumption data and classify it according to a rating scheme.

The simulation / evaluation tasks aims to optimize the design by calculating the specific and overall performance of a building considering all the major subsystems and in particular:

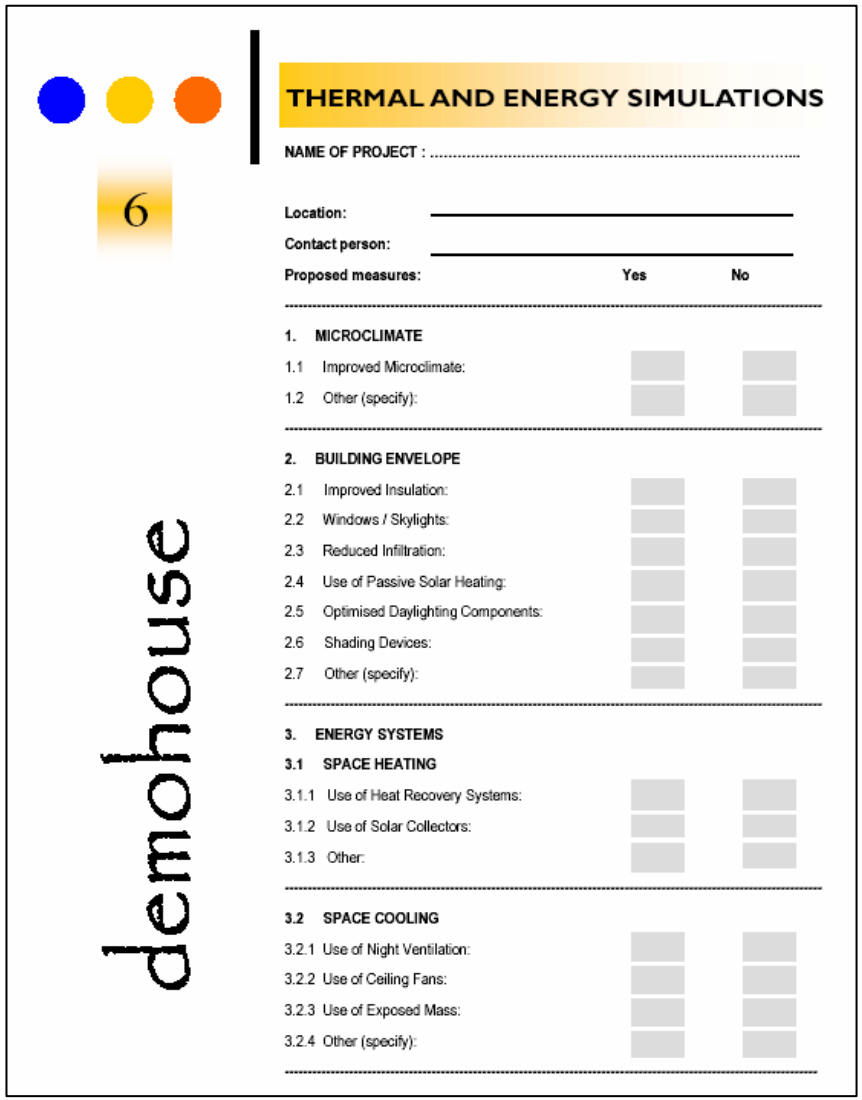
1. The outdoor environment defining the microclimate
2. The building envelope
3. The indoor environment
4. The active systems and mainly the HVAC system as well as the lighting and
5. The control - management system.

The evaluation methodology permits to homogenize the specific as well as the global energy consumption of buildings, and then compare them with a common reference traditional building.

The reporting format of the evaluation protocol for each building contains two sections. In the first section, all the technical details concerning the measures package / scenario improvements are presented in accordance with the matrix of incorporated features and aspects. In particular :

Microclimate, Building Envelope, Energy Systems, Space Heating, Space Cooling, Ventilation, Artificial Lighting, Control Systems, and other Measures.

In the second section scenarios and packages are reported in a more comprehensive level with for example energy results on monthly basis, accumulated frequency curves for indoor temperatures and economic figures to assess the viability of the investment.



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NAME OF PROJECT : .....

Location: _____

Contact person: _____

Proposed measures:	Yes	No
1. MICROCLIMATE		
1.1 Improved Microclimate:		
1.2 Other (specify):		
2. BUILDING ENVELOPE		
2.1 Improved Insulation:		
2.2 Windows / Skylights:		
2.3 Reduced Infiltration:		
2.4 Use of Passive Solar Heating:		
2.5 Optimised Daylighting Components:		
2.6 Shading Devices:		
2.7 Other (specify):		
3. ENERGY SYSTEMS		
3.1 SPACE HEATING		
3.1.1 Use of Heat Recovery Systems:		
3.1.2 Use of Solar Collectors:		
3.1.3 Other:		
3.2 SPACE COOLING		
3.2.1 Use of Night Ventilation:		
3.2.2 Use of Ceiling Fans:		
3.2.3 Use of Exposed Mass:		
3.2.4 Other (specify):		

In particular:

- Part A, is concerned with basic data valid for the examined measures package / scenario for each building. For example data on the existing / new building, on simulation tools and models, data on the requirements influencing the energy consumption and the indoor comfort levels, etc. These data have to be reported once per building study.

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Proposed measures:	Yes	No
3.4 ARTIFICIAL LIGHTING		
3.4.1 Improved Efficiency Luminaires:		
3.4.2 Use of Task Lighting:		
3.4.3 Reduced Installed Power:		
3.4.4 Use of Efficient HF Ballasts & Lamps:		
3.4.5 Other (specify):		
4. CONTROL SYSTEMS		
4.1 Use of Improved Controls / BEMS:		
4.2 Distribution /Demand Control:		
4.3 Intelligent Lighting Control:		
4.4 Other (specify):		
5. OTHER MEASURES		
5.1 Use of PV Cells:		
5.2 Use of other Energy Sources:		
5.3 Other (specify):		

Part A, includes information on :

-.Microclimate
- Building Envelope
- Energy Systems
- Space Cooling
- Artificial Lighting
- Control Systems
- Other

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BUILDING ENVELOPE

Shading Devices:

Type	Units	Orientation	Dimensions	Shading factor	% of window area shaded	Materials used
Fixed:						
Overhangs						
Side fins						
Baffles						
Louvers						
Brise-soleil						
Other						
Movable:						
Awnings						
Jalousies						
Venetian						
Curtains						
Other						

Drawings/details:

Other (specify):

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BUILDING VENTILATION

Demand Controlled Ventilation:

	Present ACH	Proposed ACH	Volume m^3	% of total build. volume	Present cfm/person	Proposed cfm/person
Zone 1						
Zone 2						
Zone 3						

Other Devices:

	Units	Operating schedule	Air changes ACH	Fan power kW	Purpose
Extract fans					
Internal vents					
Ducts					
Others (specify)					

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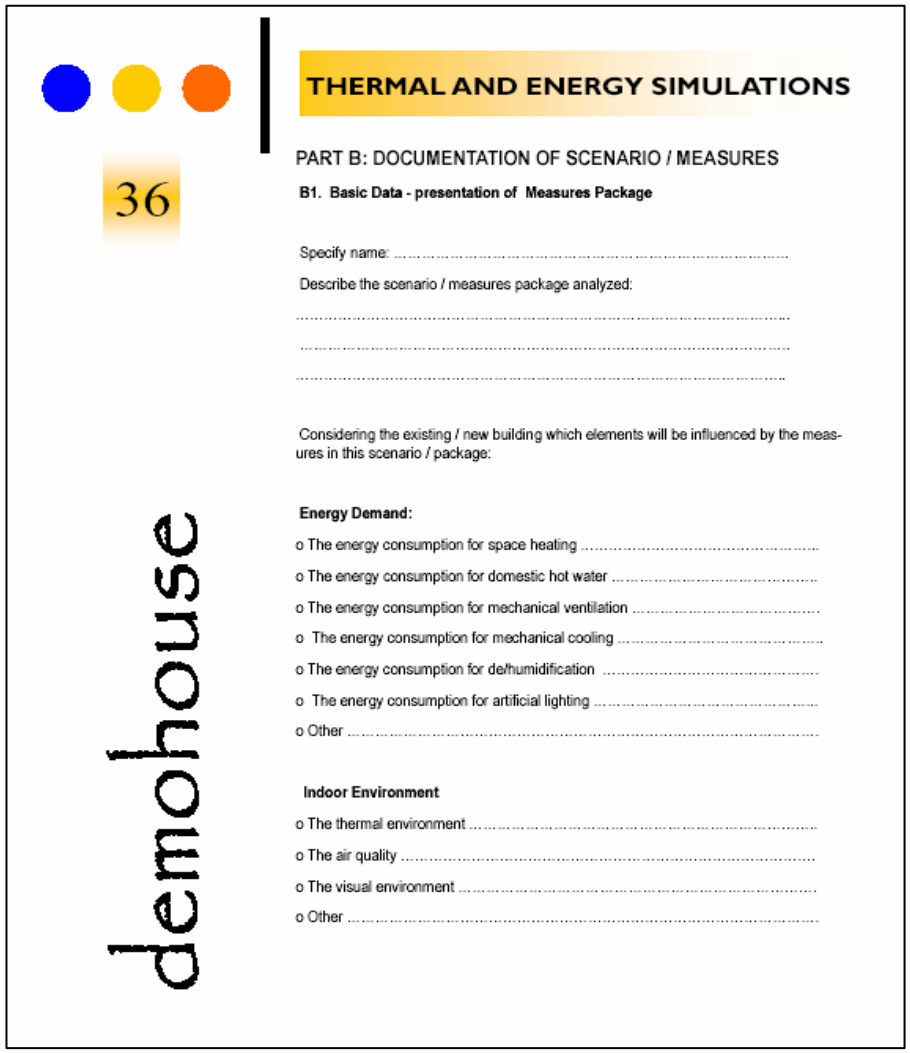
Scenario Evaluation Results:	Percentage contribution to energy savings % (thermal & electrical)	Capital cost (eiros)
1. MICROCLIMATE		
1.1 Improved Microclimate:		
1.2 Other (specify):		
2. BUILDING ENVELOPE		
2.1 Improved Insulation:		
2.2 Windows / Skylights:		
2.3 Reduced Infiltration:		
2.4 Use of Passive Solar Heating:		
2.5 Optimised Daylighting Components:		
2.6 Shading Devices:		
2.7 Other (specify):		
3. ENERGY SYSTEMS		
3.1 SPACE HEATING		
3.1.1 Use of Heat Recovery Systems:		
3.1.2 Use of Solar Collectors:		
3.1.3 Other:		
3.2 SPACE COOLING		
3.2.1 Use of Night Ventilation:		
3.2.2 Use of Ceiling Fans:		
3.2.3 Use of Exposed Mass:		
3.2.4 Other (specify):		
3.3 VENTILATION		
3.3.1 Natural Ventilation:		
3.3.2 Demand Control Ventilation:		
3.3.3 Other Devices:		

Part B, is a summary of the calculated energy results (kWh/ m^2) - key figures concerning the whole building. In particular the specific energy needs for heating, cooling, lighting, ventilation, humidification and dehumidification, have to reported on a monthly basis for all the zones of the building.



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PART B: DOCUMENTATION OF SCENARIO / MEASURES

B1. Basic Data - presentation of Measures Package

Specify name: .....

Describe the scenario / measures package analyzed:

.....

.....

.....

Considering the existing / new building which elements will be influenced by the measures in this scenario / package:

Energy Demand:

o The energy consumption for space heating .....

o The energy consumption for domestic hot water .....

o The energy consumption for mechanical ventilation .....

o The energy consumption for mechanical cooling .....

o The energy consumption for de/humidification .....

o The energy consumption for artificial lighting .....

o Other .....

Indoor Environment

o The thermal environment .....

o The air quality .....

o The visual environment .....

o Other .....

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Thermal comfort results like maximum and minimum temperatures are reported. Each study building is evaluated under operational control conditions.

Visual comfort and indoor quality simulation results are also reported.

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Mandatory Energy results and analysis during intended operation.

Energy results and analysis:

	Dwelling 1 Zone I	Dwelling 2 Zone 2	Dwelling 3 Zone 3	Whole building
Q (heating)	28.6	24	26.7	26.47
Q (hot water)				
Q (cooling)	10.4	3.4	16.2	10.14
Q (de/ humidification)	N/A	N/A	N/A	N/A
Q (ventilation)	N/A-natural	N/A-natural	N/A-natural	N/A-natural
Q (lighting)	31.025	31.025	31.025	31.025
Q (equipment)	6.2	6.2	6.2	6.2
Q (thermal total) (heating)	28.6	24	26.7	26.47
Q (electric total) (cooling+lighting+equipment)	45.2	40.6	53.43	47.36

Table 2. Simulated annual gross energy demand divided in zones [kWh/m²/year] (if more than three zones please extend the table).

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Results concerning Indoor Comfort.

Thermal comfort:

Comfort results during intended operation:

	Zone 1	Zone 2	Zone 3
Average Maximum temperature during summer period [°C]	26	26	26
Average Minimum temperature during winter period [°C]	20	20	20
Mean temperature [°C] during cooling period	26	26	26
Mean temperature [°C] during heating period	20	20	20
Are requirements to thermal comfort fulfilled during intended operation ?	YES	YES	YES

Table 6. Temperature pattern in the different building zones during intended operation. (if more than three zones are simulated please extend the table).

Visual comfort:

Analysis of results if such exist. ... EXCELLENT .....

Air quality:

Analysis of results if such exist. ..... EXCELLENT .....

Analysis of additional results (if any) .....

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ECONOMIC ANALYSIS OF THE MEASURES
Economic results for scenario or package:

Capital costs of measures in present value : .....
(Euros/m²) excluding those which are not directly related to improvements of energy performance or indoor climate: .....

Energy prices:

Thermal energy [Euros/kWh] .....

Electrical energy [Euros/kWh] .....

Table 7. Annual energy costs and their increase (+) or decrease (-) in present

	Annual energy costs (including	Increase (+) or decrease (-) in energy costs	Energy Cost Savings [%]
Space heating			
Hot water services			
Mechanical cooling			
Air de/ humidification			
Mechanical ventila-tion			
Artificial lighting			
Equipment			
Other (specify)			
All building ser-vices			

value for different auxiliary energy services [Euros/m²/year].

C2. Simple Pay-Back Period. (see appendix A), [year]: .....

D3. Analysis of additional results: Describe (if any): .....

.....

.....

Part C, includes the results of simple financial analysis. Economic values for each specific energy cost are given, as well as saved energy costs, saved running costs, capital costs and subsequently simple pay back period estimations.

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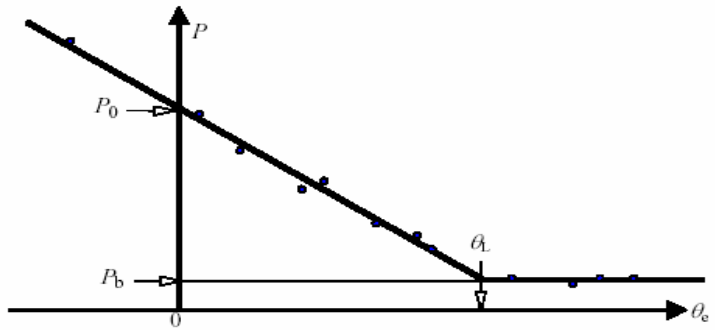
Energy signature

Heating or Cooling energy use is correlated to climatic data over a suitable period. Plotting for several time periods the average heating or cooling power versus average external temperature allows a fast detection of malfunctions and provides useful information on the building energy performance. This monitoring method assumes constant internal temperature, and that external temperature is the most influential parameter. It is useful in buildings with stable internal gains and relatively low passive solar gains.

Energy use for heating and cooling, as well as average external temperature or accumulated temperature difference is recorded at regular intervals. These intervals can be as small as one hour , but for manual monitoring, a week is often used. The average external temperature can also be obtained from a neighbouring meteorological station. Average power is obtained by dividing the energy use by the duration of the time interval between successive records.



The average power is plotted versus the average external temperature or degree-days. For the heating season, a diagram as shown in the above figure — is obtained. Lines are drawn through the dots measured during the heating season (heating on, cooling off), the cooling season (cooling on, heating off) and intermediate season (both off) using a linear regression (see Figure)

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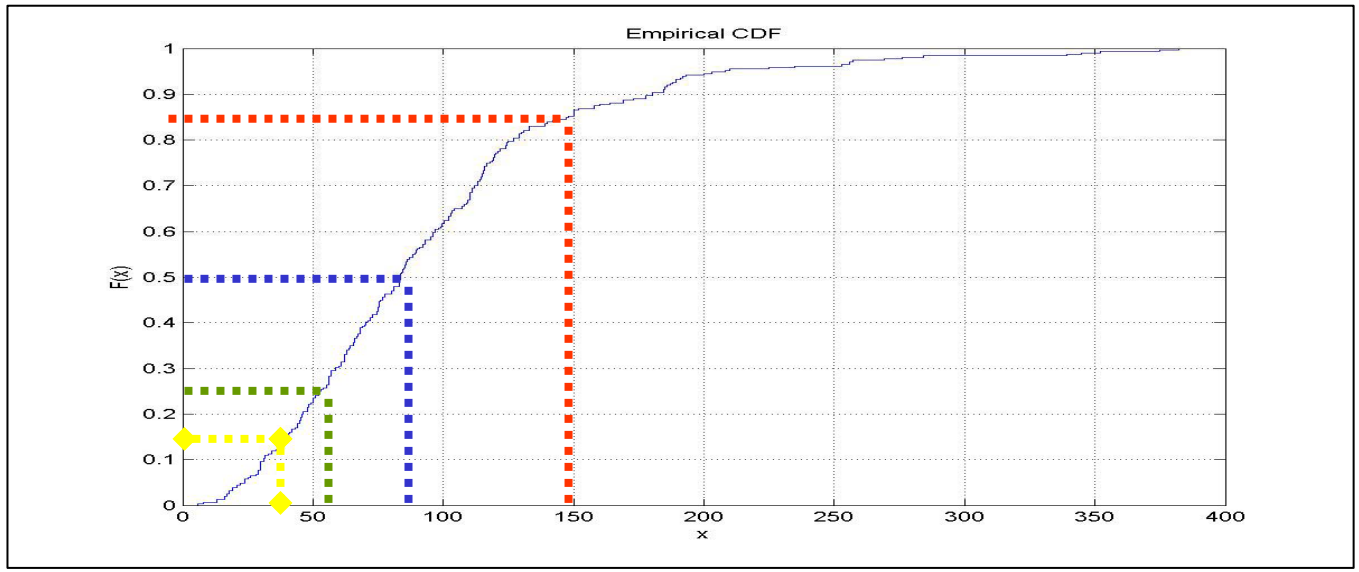
Energy Signature techniques are used to calculate the dynamics of each building and its relative performance against the local climate.
Both energy signatures for summer and winter are calculated.

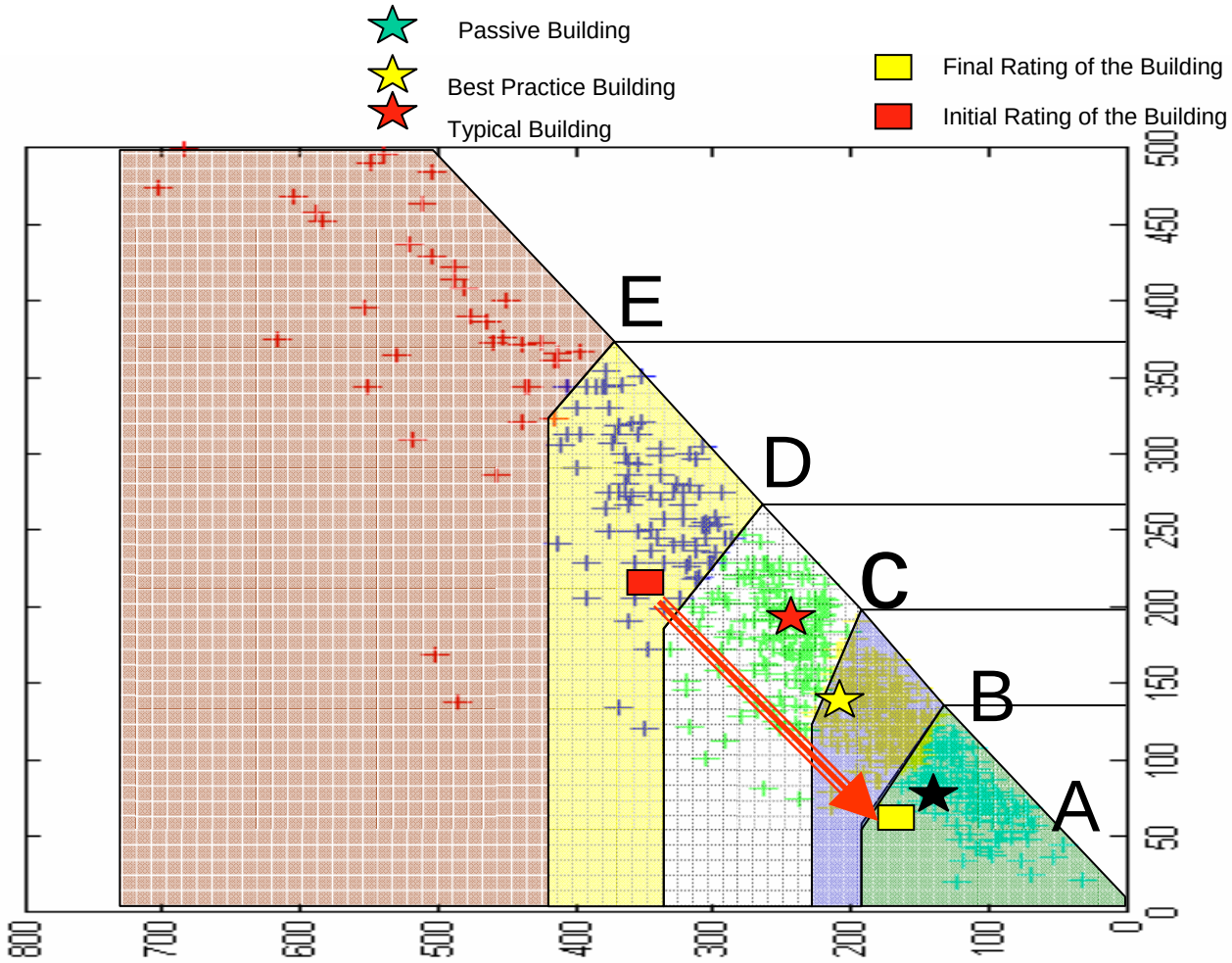


FINAL CONSUMPTION

BEST PRACTICE BUILD

TYPICAL BUILDING

INITIAL CONSUMPTION


Passive Building
Best Practice Building
Typical Building
Final Rating of the Building
Initial Rating of the Building
E
D
C
B
A
800
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
350
400
450
500

The common evaluation protocol includes aspects related to the sustainability of buildings. The specific aspects considered by the method includes :

- Water, seawater and rainwater
- Materials and constructions
- Waste
- Energy, and
- Building and urban development area. Methods for sustainable development and sustainable urban management.

Green Build questionnaire, including suggestion for "energy and environmental points" [ ]

A) Water, rainwater and sewage

	PHASE 1	PHASE 2
1. Water saving toilets with differentiated flush is installed (3/6 litre) [1]	☒	☐
2. Rain water collection for garden irrigation is installed [1]	☐	☐
3. Water saving taps are installed: Toilet-sink max. 6 l/min., kitchen-sink max. 12 l/min. and shower max. 12 l/min [1]	☐	☐
4. A main water metering device is installed at each main plot of land (for use in main green accounting) [1]	☐	☐
5. Measures that minimise amount of rain water collected by the sewage system are carried out (permeable pavements, rain water ponds etc.) [1]	☐	☐
6. Rain water collection for use in washing machines is installed [2]	☐	☐
7. Rain water collection for use in toilet flushing is installed [3]	☐	☐
8. Washing- and dishwashing machines with minimised water consumption are installed [1]	☐	☐
9. Thermostat-mixing tabs of a type which can be serviced without the installation is opened is installed [1]	☐	☐
10. "Grey" wastewater is utilised [1)] [4]	☐	☐
11. Individual water meters installed [1]	☒	☐

Building owner's suggestions for other measures within " Water, rainwater and sewage":

A full questionnaire has been prepared for all the participants. The „Green Build" questionnaire is based on the Danish developed Green Build Tool, which works as an „energy and environmental point system". It has for example been used in the EU „Energie" supported project, „Green Solar Regions".

B) Indoor air climate

	PHASE 1	PHASE 2
1. Air tightness of the building is measured to be less than 0.1 per hour [2]	☐	☐
2. Noise from installations is kept below 25 dB. [3]	☒	☐
3. Daylight optimisation [3)] is performed and documented [2]	☒	☐
4. Passive solar energy design is applied. How the problems with overheating are coped with so the indoor temperature is not exceeding 26°C. Is documented [2]	☒	☐
5. In-door materials with in-door climate certification is applied, if such is available for the material type in question [1]	☒	☐
6. There is a minimum air exchange rate of 30 m³/h per person. The mechanical air exchange rate is at least 0.4/h and it is possible to have 0.6/h extra air exchange rate by manual opening of windows [2]	☒	☐
7. Balanced ventilation, exhaust and inlet air [2]	☒	☐
8. Moisture controlled ventilation [1]	☐	☐
9. Individually controlled ventilation [1]	☒	☐

Building owner's suggestions for other measures within " Indoor air climate":

The answering of the questionnaire is divided into two phases. One phase for what is the intention to do and another phase is telling what is the aim to do just before the building project starts when the final economy is known.

Phase 1 is thus what the building owner intends to do with his building from the beginning.

D) Waste

	PHASE 1	PHASE 2
1. Space for composting container is included in the garden plot [1]	☐	☐
2. Appropriate containers for fractionated waste disposal is built in both in kitchen and in the out door disposal place [1]	☐	☐
3. Green accounting is applied on the household waste [1]	☐	☐
4. The waste from the construction phase is sorted in as many fractions as the municipality can find an outlet for [1]	☐	☐
5. At each main plot of land space is reserved for "waste-islands" where the waste can be disposed off in fractions as paper, cardboard, metal, electronic waste etc [1]	☐	☐
6. Life cycle assessment of materials [1]	☐	☐
7. Documentation and maintenance guide concerning materials [2]	☐	☐

Phase 2 is about what the builder intents to do just before the building project starts, when the economy is known.

Can e.g. be delivered to the municipality in connection to the application for a building permit.

Socio economic aspects play an important role in the overall feasibility of large residential renovation projects. Especially in renovation projects that aim at a sustainable renovation, it is even more important to address socio economic factors from an early stage in the project. If these factors would be ignored, it is very likely that during several phases of the project problems related to inhabitants and finances will be encountered that could threaten the continuation of the whole project.

Two important factors determine the socio economical feasibility of the project: the possibility to cover the ‘extra’ investments necessary for the sustainable measures and the cooperation of the inhabitants. In (social) rental housing, these extra investments are usually covered through a rent increase. Nevertheless, in most cases the tenants have to agree on this additional rent increase. If the tenants do not agree, the landlord is not able to cover investments through the rent and consequently the sustainable dimension of the project is likely to be abolished.

A set of indicators has been developed to evaluate the socio-economic aspects. With these indicators, the changes in the pilot projects resulting from implementation of the solutions will be measured.
The indicators are addressed to the tenants of the pilot projects, the pilot projects and to the participating landlords.
Based on these socio-economic indicators, a set of questionnaires is developed to assess the necessary data **before** the demonstration in the pilots:

1.A) Tenant questionnaire preceding demonstration
2.B) Landlord questionnaire preceding demonstration

Landlord-1 questionnaire - the DEMOHOUSE pilot project

0) General questions

Name of the landlord:

Country:

Your name:

Description of your job within the organisation:

Your telephone nr.:

Your email adres:

1) Proportion of tenures. The number of dwellings for each of the following tenure-categories, before and after renovation:

	before:	*after:*
a) private rental		
b) social rental (local authorities)		
c) social rental (housing associations)		
d) owner occupied		
e) owner occupied with buy-back guarantee		
f) other forms of tenure, e.g. shared ownership		

2) Accessibility of the dwellings. The number of dwellings that are accessible through:

a) ground floor level		dwellings
b) stairs (only those dwellings that are not accessible by elevator)		dwellings
c) elevator		dwellings

3) Renovation costs in Euro/m2 — Euro/m^2

4) Cost of renovation of the project in relation to cost of new construction (supposedly on the same site). — %

5) Total investment cost of the project — Euro/m^2

6) Marketing of the project costs per investment costs — %

7) (Project-)subsidies as percentage of investment costs in the project — %

8) Market value of the dwellings before and after renovation, Euro/m2.

a) market value BEFORE renovation		Euro/m^2
b) market value AFTER renovation		Euro/m^2

9) Maintenance costs before renovation, in Euro/year/building and in Euro/year/dwelling.

a) maintenance costs in Euro/year/building		Euro/year/building
b) maintenance costs in Euro/year/dwelling		Euro/year/dwelling

10) Legally necessary level of agreement in decision-making as % of the tenants/inhabitants. — %

11) The total number of housing units before and after renovation.

a) before renovation		dwellings
b) after renovation		dwellings

12) Per dwelling type: number of housing units and corresponding size, before and after renovation. Dwelling types:

	Number:	*Size (m2):*
a) Detached		
before renovation:		
after renovation:		
b) Semi-Detached	*Number:*	*Size (m2):*
before renovation:		
after renovation:		
c) Row-rise multi-dwelling houses	*Number:*	
before renovation:		
after renovation:		
d) High-rise multi-dwelling houses	*Number:*	*Size (m2):*
before renovation:		
after renovation:		

13) Number of rooms before and after renovation, per dwelling type.

a) Detached		
before renovation:		rooms
after renovation:		rooms
b) Semi-Detached		
before renovation:		rooms
after renovation:		rooms
c) Row-rise multi-dwelling houses		
before renovation:		rooms
after renovation:		rooms
d) High-rise multi-dwelling houses		

before renovation:		rooms
after renovation:		rooms

14) Year of construction of the dwellings / estate — Yr.

15) Rent levels before and after the renovation, per type. Dwelling types:

a) Detached		
net rent before renovation:		Euro
net rent after renovation:		Euro
b) Semi-Detached		
net rent before renovation:		Euro
net rent after renovation:		Euro
c) Row-rise multi-dwelling houses		
net rent before renovation:		Euro
net rent after renovation:		Euro
d) High-rise multi-dwelling houses		
net rent before renovation:		Euro
net rent after renovation:		Euro

16) Average number of inhabitants per dwelling type, before and after renovation. Dwelling types:

a) Detached		
before renovation:		inhabitants
after renovation:		inhabitants
b) Semi-Detached		
before renovation:		inhabitants
after renovation:		inhabitants
c) Row-rise multi-dwelling houses		
before renovation:		inhabitants
after renovation:		inhabitants
d) High-rise multi-dwelling houses		
before renovation:		inhabitants
after renovation:		inhabitants

17) Areas for communal activities, as % of total building floor area; and in m2/100 m2

areas for communal activities, as % of total building floor area:		%
areas for communal activities, in m2/100 m2:		m2 / 100 m2

18) Housing affordability per dwelling type, before and after renovation. Rent in % of average national household income related to dwelling types. Dwelling types:

a) Detached		
before renovation:		inhabitants
after renovation:		inhabitants
b) Semi-Detached		
before renovation:		inhabitants
after renovation:		inhabitants
c) Row-rise multi-dwelling houses		
before renovation:		inhabitants
after renovation:		inhabitants
d) High-rise multi-dwelling houses		

before renovation:		inhabitants
after renovation:		inhabitants

19) Level of tenant participation in the DEMOHOUSE pilot project. Please check the box reflecting best the level of tenant participation in your perception.

	very high
	fairly high
	not high / not low
	fairly low
	very low

A common monitoring protocol has been prepared and is under discussion inside the group. The objective of the monitoring protocol are :

- To investigate and assess real performance of implemented strategies and features
- To evaluate the specific performance of the five subsystems, (microclimate, building cell, indoor, systems and control).
- To assess the global environmental and energy performance including energy conservation, thermal and visual comfort and indoor air quality.

A common evaluation protocol for the demonstration buildings has been prepared by DEMOHOUSE. The protocol involves :

-An energy performance evaluation part
- A sustainability evaluation part, and
- A socioeconomic evaluation part

A common monitoring is also prepared and is under evaluation.

The common evaluation protocol is available to any wishing to use it.