The Factor 4 project

and its life cycle costing models for optimising retrofitting programmes for social housing towards a factor 4

www.suden.org/english/actions_projects/factor4.html

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The models' objective: to reach the factor 4 by:

- optimising retrofitting programmes for one building or a building stock

- working out territorial or building stock strategies

ASCOT for Denmark

SEC for France

BREA for Italy

Existing energy calculation software have been tested if any of these could be used as a common tool for the Factor 4 project. The selected tool must include features for calculation of the following aspects **towards an optimum (as regarding together energy, CO_2 emissions and costs + charges**):

•Estimate of the yearly energy need for space heating and domestic hot water but also lighting and electrical appliances.
•Estimate of the heat losses in the heat production and distribution.
•Estimate of the energy saved by selected energy savings technologies according to the technology list.
•Estimate of investment cost and the economic reliability of the selected energy savings technologies (pay back return).
•Estimate of the impacts upon tenants charges
•Estimate of the environmental impact of the energy needs and savings.

Most of the existing tools are not tools to be used by social owners themselves but tools for consultants or specialists. The social owners involved in Factor 4 wanted a simple tool with quick results for making decisions on implementing sustainable solutions **for optimising the retrofitting programmes and working out strategies**.

The conclusions of this state of the art are that among all these existing models, the ASCOT is the most appropriate one but it needs some modifications in order to fit as well as possible with the Factor 4 objectives and a specific model is necessary for each country according to the technologies used (and costs).

In France, social owners don't know the data needed for using the model, such as the U-Value or electricity consumption data in the dwellings for example.
Then the French SEC model has been modified and improved in order to estimate these missing data.

These models have been tested by the researchers and by social owners on many representative cases studies in the various countries.
The following Factor 4 models have been worked out:

Denmark	ASCOT(Assessment of Sustainable Construction and Technology cost model)
France	SEC (Sustainable Energy Cost)
Italy	BREA (Building Retrofitting Energy efficiency Assessment model)

In Germany
and in Romania, they will use a version of the SEC model adapted to the Romanian context.

Factor 4 partners

The project is coordinated by SUDEN and gathers the following partners : L'Union Sociale pour l'Habitat (France), Habitat & Territoires Conseil (France), Crdd La Calade (France), Cenergia (Denmark), Ricerca e Progetto (Italy), Volkswohnung (Germany), Moulins Habitat (France), Association of Local Development Promotors (Romania), Soc Coop ABITA ARL (Italy) and KAB (Denmark)

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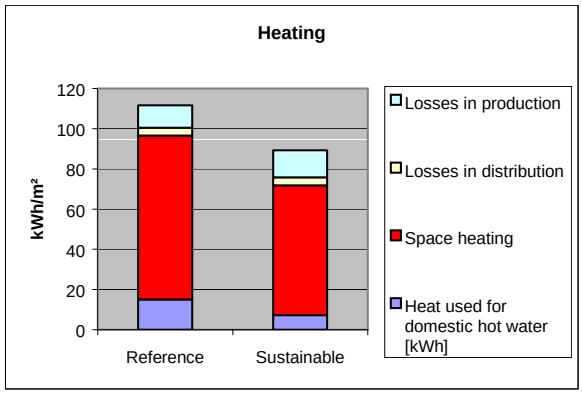
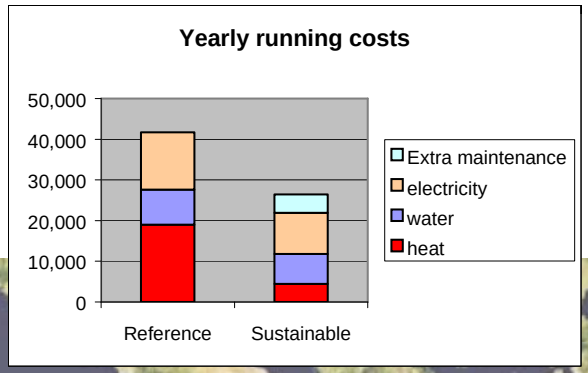
The ASCOT (**A**ssessment of **S**ustainable **CO**nstruction and **T**echnologies cost) tool is developed to assist the user in evaluating and thereby optimise the economical costs of a building project in relation to sustainable development issues.
The tool is designed to take into consideration:
•all investment and operation costs over the total lifetime of the building;
•the savings from the investments with respect to sustainable issues (energy, water, waste) over the total lifespan of the building
•the reduced environmental impact from the energy savings
•the social or environmental and other external costs incurred by the project (included in the first prototype in a simple way but can be elaborated at a later stage)
The ASCOT model allows a comparison between a traditional (reference) building renovation and different sustainable concepts for the improvement of the building. The tool is primarily intended for use in the early stage of the design process. It can be used for both new constructions and renovation projects.
The ASCOT tool has been completed in a first version and made available as a downloadable file from the website of CENERGIA: www.cenergia.dk. The tool has been downloaded by companies and institutions from all over Europe.
It is the intention of CENERGIA to keep contact with the ASCOT user group and to try to implement wishes for improvements of the tool from this group.
The second generation of the ASCOT tool is in the process of development. A new model will be based on the ISO standard and it will be launched on a conference in September 2007. The new model is still a software tool for pre-calculation of an energy design but with more accurate estimate of the energy demand. The target user is architects, housing associations, and energy auditors in the housing sector.

Typical indata to ASCOT

Project ID	**DK1 - Kildevænget**	
Year of construction	1958	
Size of the buiding project (treated floor area)	42205	m²
Number of dwellings	450	
Number of floor levels	3	
Building category	Building block with flats	
Central- or individual heating	Central heating system	
Internal distribution	Insufficient insulation	
Energy resource (Fuel type)	District heating	
Efficiency of the heat production	88%	
Reference, electricity	31	kWh/m²
Reference, water inclusive hot water	0.70	m³/m²
Reference consumption hot water	30%	
Weather data		
Station	DK, Copenhagen	
Building characteristics		
Wall, U-Value	0.52	W/m²K
Roof, U-Value	0.42	W/m²K
Floor, U-Value	0.42	W/m²K
Window, U-Value [W/m2K]	3.10	W/m²K
Data for new heating system		
Central- or individual heating	Central heating system	
Heating supply system	District heating	
Efficiency of the heat production	95%	
Economic data		
Investment of reference project	0.00	euro/m2
Set aside (maintenance)	2.5%	%
Expected economic lifetime	30.00	years
Discount rate	5.0%	
Tax of interest	0.0%	
Inflation of energy	2.5%	
Inflation of maintenance	2.0%	

Results from ASCOT





SEC model for France

The SEC model objectives

The SEC (Sustainable Energy Cost) model is an operational tool for:

•getting an overall analysis of a building stock in a territorial (for a local authority) or in a patrimonial (for a social owner) approach in order to build up a retrofitting strategy towards the factor 4,

•optimising a retrofitting programme for one or a group of buildings towards the factor 4 (including socio economic and ecological optimisation).

The SEC model has been developed and improved through an iterative process with several social owners associated to the project: 32 case studies representing more than 150 buildings and 15000 dwellings.

The SEC model steps

1. Analysis of a social owners' building stock typology (of the overall building stock or on a territorial area)
2. Choice of representative buildings in the stock
3. Analysis of the energy consumption of these buildings (energy audit)
4. Elaboration of scenarii for the building's retrofitting (along realistic hypothesis or along technical consultancy companies' projects)
5. Assessment of the impacts from the scenario on the three dimensions: energy, CO_2 or GEG emissions and socio-economy
6. Choice of the best scenario for each category of buildings according to the social owner's priorities
7. Elaboration of an iterative process defining an optimised strategy (multi-criteria analysis)
8. Elaboration of a retrofitting project or programme

The main characteristics of the SEC model

• Easy to use and complex in its elaboration

•The model works at the scale of representative building that is to say at the scale of real buildings

•The model suggests default values to enable the estimation of the building's thermal losses and its heating system yield

•Possibility of ranging the building or the building's homogeneous group along various criteria and indicators : energy labelling, CO_2 factor or CO_2 labelling, life cycle energy costing, return time

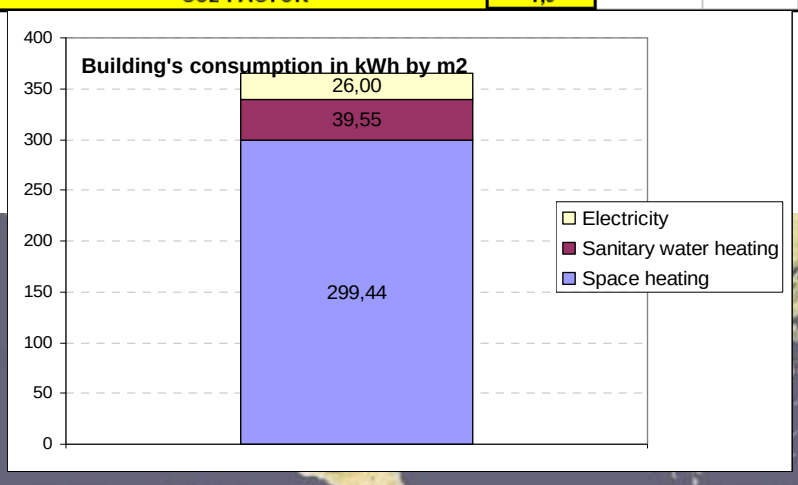
•Possibility of allocating the costs of retrofitting work and the financial needs to each building or each building's group

Extract of the input data sheet

If available, existing data on:
Space Heating
Sanitary hot water
Common space's electricity
Dwellings' electricity
Compulsory part on the building characteristics
Building type
Year of the construction
Location (local authority)
Location (county number)
Number of buildings
Size (living area in square meters)
Number of dwellings
Average height under ceiling (in meters)
Number of floors (minimum : 1)
Heating system
Sanitary hot water system
Roof
Ventilation
Windows type
Technical data - Envelope
Has a thermal retrofitting of walls been realised?
Has a thermal retrofitting of floors been realised?
Has a thermal retrofitting of the roof been realised?
Installation year of the heating system
Replacement year of the boiler
Replacement year of the hot water tank in case of separate hot water system
Climatic data
Degree days related to the input data
Average degree days (on 30 days) - base 18 ° C
Sunshine in J/cm² /day
Average annual temperature

Results for a scenario with the initial energy audit (below)

Economic assessment	BENEFITS		
	€ / m² - year	€ / dwelling - year	€ / project - year
Investment in actualised € by year	6,40	218	11 325
Other essential investments with an energy impact	1,57	53	2 777
Annual maintenance		0	0
Economy saving at constant price (inflation not included)	-9,38	-319	-16 605
Hypothesis of energy price increase	-5,89	-201	-10 430
Net result in net actualised € by m²	**-7,30**	**-249**	**-12 933**
CO2 FACTOR	**1,9**		



BREA model for Italy

BREA (**B**uilding **R**etrofitting **E**fficiency **A**ssessment) is a tool thought to help designers and decision makers in appraising the potential benefits of retrofitting actions.
The Model is developed by RicercaeProgetto starting from the ASCOT tool adapted to Italian reality.
The BREA spreadsheet has been not conceived to precisely calculate the energy needs for heating buildings even if a rough calculation is performed.
Users are suggested to input this data which can be easily calculated with one of the main tools existing in Italy following the EU EPB Directive.
BREA should be used to evaluate the efficacy of some typical retrofitting actions, in terms of investment returns and of ecological benefits. In fact the attention is paid not only to economical convenience (that is how many years it will take to a specific technology to repay itself when implemented in building retrofitting), but also to the energy source savings, emissions reductions and other externalities.
Although the spreadsheet is able to roughly estimate energy needs, given the building type, the transmittances of main envelope parts, the general location climatic features, its main function is the comparison before and after the retrofitting of a given building: users can choose among many technologies to apply, such solar panels, floor insulation, etc. which are extensively described in individual sheets, and the spreadsheet calculate their effects with regard to the specific situation.

MODEL STEPS

"Basic data" - The first sheet requires the user to specify general features of the building: some data are essential, some others are optional, since when such information lacks the spreadsheet can provide a general estimate, usually based on predictable national data; at the bottom of this page economic data are provided, and user is able to modify them, in order to carry on subsequent cost-benefits analysis. A graph presents the actual heat consumptions, split in: losses in production, losses in distribution/emission/regulation, space heating, domestic hot water; these are the particular issues which retrofitting technologies are going to influence.

"Select technologies" - The second sheet is a list of technologies to choose among, divided into three categories (heating, sanitary hot water and electricity): each one is here accompanied by an estimation of yearly savings, in energy and in money, and other cost parameters. User is allowed to change the starting parameters for technologies in order to select most appropriated ones and input real costs according to the local market.

"Results" - The last main sheet reports results: parallel histograms produce a visual comparison of the situation, before and after retrofitting, and numerical figures are expressed for each separate theme, such as electricity, water, losses in production, etc. Then the reduction of pollutants emissions is reported.
Eventually, running costs are compared and benefits put in evidence. User can specify here the expenses already planned for ordinary maintenance, so that the actual cost of retrofitting, the net cost, can be estimated. Simple payback time and net present value of the investment are also calculated.

List of Retrofitting Technologies

COD.		Heading / Technology
		Heating
H9		Additional thermal insulation of walls
H10		Additional thermal insulation of roof
H11		Additional thermal insulation of floor
H6		Windows
		Sum of transmission diminishment through building shell
H1	☐	Passive solar heat design
H2	☐	Controlled mechanical ventilation (with heat recovery, too)
H3	☐	Airtightness
H4	☐	Energy savings through water saving
H5	☐	Energy savings / tenants behaviour
H7	☐	Individual meters
H8	☐	Cold bridges reduction
H12	☐	Pipes insulation (only for central heating)
H13	☐	Balance between distribution
H14	☐	Building energy management systems (BEMS)
H15	☐	Heat pumps (only for central heating)
H16	☐	Thermostatic valves
H17		New heating system
		Sum of chosen initiatives
		Sanitary hot water
W1	☐	Individual meters
W2	☐	Active solar heat, DHW
W3	☐	Hot water distribution lagging
W4	☐	New hot water tank with semi-istantaneous system
		Sum of chosen initiatives
		Electricity (lightning)
E1	☐	Energy efficient lighting
E2	☐	Electricity savings through ventilation
E3	☐	Electricity savings / tenant behaviour
E4	☐	Hard white goods - Grade A or better
E5	☐	Roofed clothes drying yards
E6	☐	Daylight optimisation
E7	☐	PV panels
E8	☐	Regulation of circulation pumps of individual boilers
E9	☐	Closing audiovisual and electric equipment
E10	☐	Collective laundry
		Sum of chosen initiatives
		Total