# A flexible methodology to integrate energy issue in strategic asset management in social housing: the ECOSIM French experience

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## Keywords

social housing; energy strategic asset management (ESAM); energy efficiency; EPBD

## Abstract

In order to improve the efforts to reduce energy use in the Social Housing sector, the IEE-ESAM project (completed in December 2008) aimed to develop adequate tools to integrate the issue of energy in strategic asset management (SAM) processes. The present work details a methodology built with the aim of a sufficient flexibility to be adaptable of the different Social Housing Operators (SHO) situations. The paper illustrates this methodology by a successful experience of development.

The objective was to develop a tool satisfying the practical expectations of the Social Housing Operators. Examples of the difficulties that had to be overcome include difficulties in knowing in detail some technical properties of the housing stock (thermal properties, glazing properties, history of refurbishment) and lack of internal skills in thermal modelling to evaluate the different possible actions.

The final tool developed can be used for one particular building, a set of buildings or at the whole stock scale. The tool does not use an integrated thermal calculation core but external databases and/or feedback based on experience. It offers a description of the energy performance level of the stock, points out the worst-performing elements, evaluates solutions to improve the energy performance (for building envelopes and equipments) and quantifies the gains (energy and carbon saved, financial) and the costs (investment) of these solutions. The tool assists the SHO in taking decisions (regarding priorities for investment) which include energy efficiency parameters in addition to classical SAM parameters.

The success of the approach has been demonstrated by the SHO that manages the stock used as a field test for this project. They are currently using the tool developed from the methodology to plan stock investment actions.

## Introduction

In France, the social housing stock is clearly identified as a priority target in the residential sector for energy savings policies [1]. Using the energy performances certificates, the dwellings classified G to E-label represent 27% of the stock. By increasing the performance of these dwellings up to "C-label", 8 TWh/year and more than 1.5 $10^6$ $tCO_2$/year could be saved [1]. The potential of energy savings in social housing sector is also true at the European scale. The stock of buildings concerned is heterogeneous and relatively old (number of new constructions is small compared to the existing ones). To decide which buildings must be refurbished, social housing operators (SHO) use strategic asset management (SAM) tools. Based on a multi criteria analysis (economical, attractiveness, financial possibilities…), these tools enable a SHO to identify the most promising strategies. But not all the operators, mainly due to their size, have this type of tool (60% for the French SHOs in 2007 [2]) and for the ones who have a SAM tool, the energy dimension is generally not integrated. As will be detailed later, one reason for this is that for the question of energy to be a strategic criterion for decisions, information is needed which is not often available in the databases of a SHO.

The present energy saving policies make the interest in this question more important than in the past e.g. financial incentives like white certificates [3], can be considered by the SHO as a financing resource. This argument, coupled with a real wish for exemplarity of some SHOs, explains the interest in a potential integration of energy issues in SAM. In some situations, this opportunity was the occasion for some SHO to implement a real SAM tool for the first time. The implementation of the EPBD [4], particularly the energy certificates, is also an opportunity which facilitates the treatment of energy in decision making. They enable SHOs to know (even with a questionable precision) the energy status of a building or a dwelling.

All these reasons make sense for the Intelligent Energy Europe project ESAM [5] (Energy Strategic Asset Management) which studied, through the example of six different SHOs in six countries, a better way to integrate energy in a strategic tool. Due to the heterogeneity of the consortium, it was decided to leave the partners free to implement their own tool, on the basis of recommendations established during the project, instead of one tool which would have been difficult to adapt. The present work corresponds to the French methodology developed and its implementation in the tool named ECOSIM. The country was represented by two SHOs: *Le Toit Angevin* (7000 dwellings) and *Le Val de Loire* (9500 dwellings). In France, 75% to 80% of the social organisms manage less than 9000 dwellings [6]. Due to their small size and the internal skills available (the inner technical knowledge is often too much expensive for them), it has been decided that the tool would not integrate a core calculation of energy performance of the considered buildings. The number of SHO concerned justifies the necessity to propose them some solutions.

Energy Performance Certificates (EPCs) have been compulsory in France since November 1st 2006 for sales of dwellings [7] and since July 1st 2007 for rented dwellings [8]. So the period of implementation of EPCs was included in the duration of the project, which was turned to profit of the methodology proposed (EPC have been identified as a complementary resource in the methodology). This was not the case for all the countries of the consortium and explains the different strategies adopted in the project [5]. The interest for an energy strategy to gather the certificates for the SHO is well underlined in the EEI project EPI-SOHO [9] (and in the previous project DATAMINE [10]) and the information given by them was used in the present work (technical data of the buildings for example).

Energy certificates are not enough to be used alone in a strategic tool as considered here. The first reason is the calculation method of energy certificates can be improved in the future. For example, stronger regulations or financial incentives conditional for an improvement in the energy rating of a building, could imply a more precise calculation method. The results thus gathered can become obsolete. Another reason is the possibility to implement the certificates based on energy consumption mentioned in heating bills, in the case of centralized heating systems. So in this situation (not rare in social housing), technical data (used in "classical" energy certificates implementation) are not available. One of the difficulties met in the two SHOs studied was the lack of technical energy characteristics of the stock in their databases. For example, it was difficult (often impossible) to know properties of the building envelope, except when a refurbishment had been made recently. So the methodology and the tool developed must take into account this situation and must not only be based on energy certificates. To be really usable, the methodology must be flexible and not too complicated. The aim is not to have a precise thermal diagnosis of each element of the stock, but sufficient information on energy and costs to help SHOs to take strategic decisions in accordance with their SAM goals.

## Objectives

The methodology, developed in an operational research logical, must take into account the possible various situations, depending on the SHO energy knowledge of the stock, technical availability and/or knowledge to perform calculation…The necessary flexibility for an adaptability to the different possible SHOs situations, can be ensured by the combination of several data sources and by the possibility to use a future data resource without having to update the results previously established. Furthermore the tools built from the methodology must be capable of facing situations of buildings with heterogeneous knowledge of their characteristics. They must be easy to implement and to use. Finally, the tools should be built in order to "learn from its past". This means that the more information is collected (in particular for the scenarios of refurbishment, their energy and cost gains) the more efficient and relevant the tools will be. These guidelines were followed to propose the methodology described in this work.

The methodology proposed has three objectives: to enable a *strategic diagnosis*, to give *technical recommendations and their impacts*, and to help with *strategic decisions*. The *strategic diagnosis* must provide a synthesised vision of energy performance of the stock through an evaluation of the performance of the buildings. It couples this information with other relevant parameters for strategic analysis e.g. financial resources, general policies of the SHO. The *technical recommendation*s must be performed at the building scale and must give the potential for energy savings as well as cost and financial efficiency of the recommendations. The help with *strategic decisions*, based on the two previous objectives, should enable SHOs to identify the elements of the stock that should be refurbished (through a grading selection), to compare several strategies and to evaluate their global impacts.

In a first part, the structuring of methodology is described with the details of the different parts needed. The second part details how to implement the tool. The third part is about the tool actually developed by the two French SHOs.

## Methodology structuring

The methodology is structured in modules and basic elements (databases, external resources…) which can be adapted every one, depending of the SHOs situations and objectives when they will develop the tool. The methodology thus proposed ensures the flexibility desired.

As is shown in figure 1, the tool can be divided into three different types of resources: 6 modules (white boxes), 3 databases (internal-SHO databases (grey boxes) and databases built in the tool (hatched boxes)) and the calculation and intermediate resources (dotted box).

The table 1 details the content and the function of each module. The table 2 specifies the resources needed. Definitions or examples (table 3) are given when it is necessary. In the table 5, the contents of the databases are detailed.

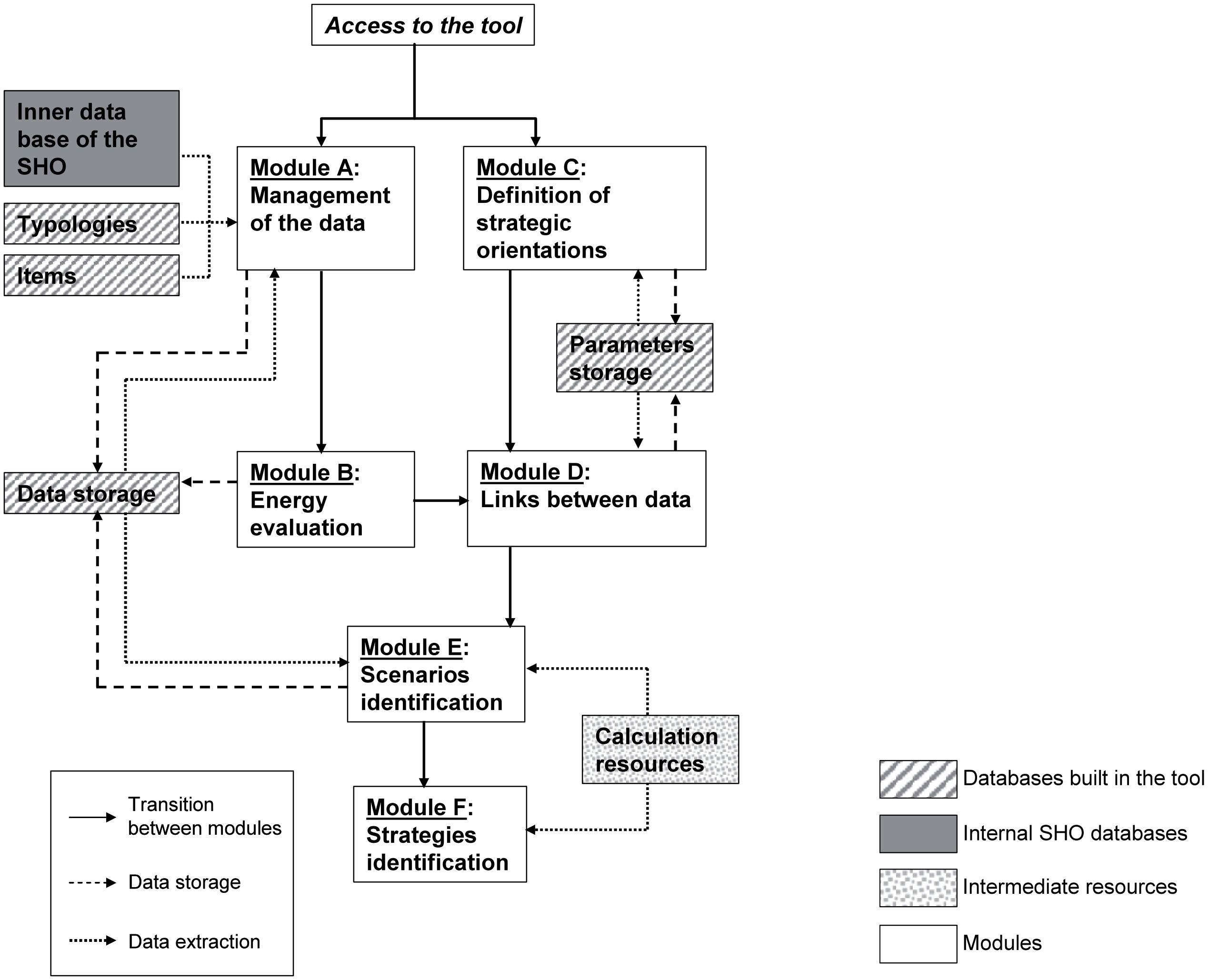


*Figure 1. Architecture of the methodology.*

**Table 1. Content of the modules.**

| | |
|---|---|
| Module A:<br>Management of the data | This module aims to gather information on patrimony elements (a patrimony element can be a building, a set of buildings or a dwelling). Depending on their availability, the information can be general (address, number of dwellings technical (type of heating systems, date of last refurbishment linked to energy (consumption, energy certificate ratings if they exist) |
| Module B:<br>Energy evaluation | The scale considered here is again the patrimony element. Point essential of the flexibility desired, the energy information can come from external sources (energy audits), energy certificates, consumption data (bills), computation… depending on the SHOs skills and knowledge. |
| Module C:<br>Definition of strategic orientations | Definition of the objectives, priorities, constraints (in term of energy saved or in term of investment) on a strategic scale that can influence the choice of final energy refurbishment scenario. |
| Module D:<br>Links between data | The patrimony element information (cf. modules A and B) must be linked to the strategic orientations (cf. module C) |
| Module E:<br>Scenarios identification | A table must be available in the tool, with the main elementary options for thermal refurbishment and their unit costs. Scenarios are built in this module for each patrimony element, by combinations of elementary actions. Here again, the building of the databases can come from external resources (e.g. energy audits), gathering of experience feedback of the SHOs, inner assessments through computational tools… |
| Module F:<br>Strategies identification | This module makes the synthesis of the analysis performed in the other modules. A scenario is assigned for each patrimony element (according to its strategic objectives) and the analysis, at the strategic scale, is carried out to measure their global impact. |

**Table 2. Calculation and intermediate resources.**

| | |
|---|---|
| Typology | Based on the definition of typology given below, this database contains all the information on the different typologies possible to meet in the stock. Typologies are used to extend solutions of refurbishment to all the elements of a similar category (in the technical and thermal points of view). |
| Items | They are complementary to the typology information. These parameters compose the list of the main components of a patrimony element that influence its energy performance. It is possible, via the items, to refine the typology concept (see example below) |
| Calculation resources | This is the part which evaluates the energy performance of an elementary action of refurbishment (and its unit cost). This resource can be a core calculation or (like in the present situation) tables built externally for each typology. |

**Table 3. Example of items.**

| Item | Component | Potential for improvement and reference value associated | | | |
|---|---|---|---|---|---|
| Vertical walls of envelope | walls | Present situation (equivalent U-value1) | 1st level of improvement (equivalent U-value2) | 2d level of improvement (equivalent U-value3) | 3rd level of improvement (equivalent U-value4) |
| Vertical walls of envelope | windows | Present situation (e.g. single glazing) | 1st level of improvement (e.g. double glazing) | 2d level of improvement Double glazing (argon) | 3rd level of improvement Double glazing (argon + low emissivity) |
| … | … | … | … | … | … |
| Heating system | Heat production efficiency | Present situation (e.g. boiler type 1) | 1st level of improvement (e.g. boiler type 2) | 2nd level of improvement (e.g. boiler type 3) | 3rd level of improvement (e.g. boiler type 4) |
| Heating system | Heat distribution efficiency | Present Situation $\eta_0$ | Insulation level $\eta_1$ | Insulation level $\eta_2$ | Insulation level $\eta_3$ |
| … | … | … | … | … | … |
| Item i | … | … | … | … | … |
| … | … | … | … | … | … |
| Item n | … | … | … | … | … |

### DEFINITION OF TYPOLOGIES

The definition of the typologies can be made with different levels. Thus, one of the main typologies is often based on the type of construction (and indirectly the period of construction). The relevant data to define this typology are: form of the building, type of masonry, structure of walls and roof. The stock of the SHO *Le Toit Angevin* and Le *Val de Loire* can be divided in 12 typologies [5], but other sub-typologies can be relevant from an energy point of view. For example, typologies classes can be built from heating systems (defined by energy and technologies used), from hot water production systems, from ventilation systems…

### DEFINITION OF ITEMS

The table 3 is an example that illustrates the item notion. If the patrimony element (e.g. a building) studied in this example is an element of the typology: "*1960s building, flat roof, walls made with concrete, central heat plant, no ventilation system*", some possible items for this building can be equivalent U-value of walls (note that definition allows successive improvement of the wall to be taken into account), equivalent U-value of windows or heat production system efficiency. The items are associated to discrete values that allow the potential for improvement to be calculated.

Through the interaction between typologies and items, the items of a new patrimony element without any details about its characteristics are similar to those of the typology of this element. It is then possible to keep these default values or to update the data.

### CALCULATION RESOURCES

Key element of the methodology, this part also contributes to the flexibility of the tool. From the knowledge of energy performance of a patrimony element, it allows to quantify the energy efficiency of an elementary action of refurbishment. This efficiency can be determined from various resources. If the technical skills are available in the SHO services, a numerical tool can be used to evaluate the efficiency and the cost of an action or a composite action (through a sensitivity analysis for example). But some alternative solutions are possible. In this works, an exhaustive list of elementary actions of refurbishment have been established from the experience of the technical services of the SHO. Then, tables have been built with the cost information and the elementary energy gain (based on a reference case for each typology) for each actions. A basic algorithm has been developed to quantify the energy savings and costs of all possible composite actions imagined by the SHO, for the patrimony element considered.

**Table 4. Definition of databases.**

| | |
|---|---|
| Patrimony element database<br>*(an element of the "Data Storage" database, in figure 1)* | It contains all the data for the patrimony element (general information, typology and items of the element, scenarios of refurbishment for the element, etc). This database is updated each time a new element or new data is added and each time a new scenario is proposed. This makes it possible to propose for another element (of the same typology) scenarios recorded in this database. |
| Parameters database<br>*(an element of the "Data Storage" database, in figure 1)* | Starting from a strategic configuration of the objectives (recorded here), this database will stock several possibilities of combinations of elementary refurbishment actions. |

**Table 5. Summarize of input data.**

| | | |
|---|---|---|
| General data | Basic data | Reference of the building, number of dwellings, net floor surface area, address, age of the building, etc |
| | Financial data | Rent, maximal rent, financial possibilities, etc. |
| | Data coming from the SAM | Attractiveness, urban context, management, etc. |
| Energy data | Energy consumptions, energy certificates, energy audits, etc. | |
| Typology data | *See details in the previous section* | |
| Items data | *See details in the previous section* | |

## Implementation of the information system (IS)

The implementation of the methodology is only an example linked to the French SHOs situations of the project. But the methodology has been built in order to be adaptable for different situations, depending on the national context (availability of EPCs, knowledge and internal skills of the SHOs, availability of a SAM tool…). Details of all the calculation methods are not described but they can be found in the different documents available on the project's web site [5]).

### INPUT DATA

A number of data items are necessary to implement the IS tool for each patrimony element. Module A divides this data (sometimes partly available) into four groups which are detailed in the table 5. These data come either from the database of the SHO or from external resources.

### ENERGY EVALUATION

This function corresponds to module B. The final result is expressed as annual consumption in kWh/m². However to make possible the identification of scenarios and strategies, it is necessary to extract from this value the value of energy needs for heating (coming from the estimated and/or measured consumption by separating heat losses via systems efficiencies), and the value for hot water consumption. The former is obtained from the consumption data by the use of tabulated values for heating systems efficiencies [5]. It should be noted that a new scale must be defined to class the different patrimony elements because all of them are included in only one or two classical classes met in the EPCs (C or D). Hot water demand is obtained from statistical studies which link the hot water consumption to net floor area. In some countries, hot water consumption is linked to the number of residents but in the French context, all technical documents and tools available (e.g. [11]) and potentially used in the methodology, calculate the consumption from the net floor area. The information of energy cost supplements the previous values. Figure 2 summarizes the treatment of input energy data (the sole energy for heating is considered in this figure, but not in the final tool).

Once the treatment achieved, a rating is given to the patrimony element, which will guides the scenario conception (module D). This rating results from the assessment of potential of improvement from the state of the patrimony element. The rating can come from an adaptation (refine scale) of the EPC classical classes, depending of the statistical distribution of the stock. This is the choice made in this work. The knowledge of the state allows to priority to be identified between an objective of energy saving or an investment amount available for the patrimony element. This choice is possible in the module C (figure 3).

### ITEMS AND TYPOLOGIES

The information available in these categories is the core of the scenario attribution process. To set up for the first time, the user, due to his knowledge of the stock and technical skills, limits the list of components concerned by the scenarios attribution mechanism. The objective is not to build a totally automatic tool which gives the "best" solution. The tool must leave the operator free to impose conditions coming from example from a global strategic orientation. This is one of the powers of the methodology since it allows the question of energy to be handled even if a SAM tool is not available. This corresponds to the strategic orientations filter in the figure 3.

In a second time, the components are classified. The criterion is the potential energy-cost of the actions of refurbishment. This classification is made in two times again: a classification of the components where the criterion is the strategic priority level and then the analysis of the ROI (return on investment). This classification is finally used to identify a combination of elementary actions to build a scenario (figure 4)

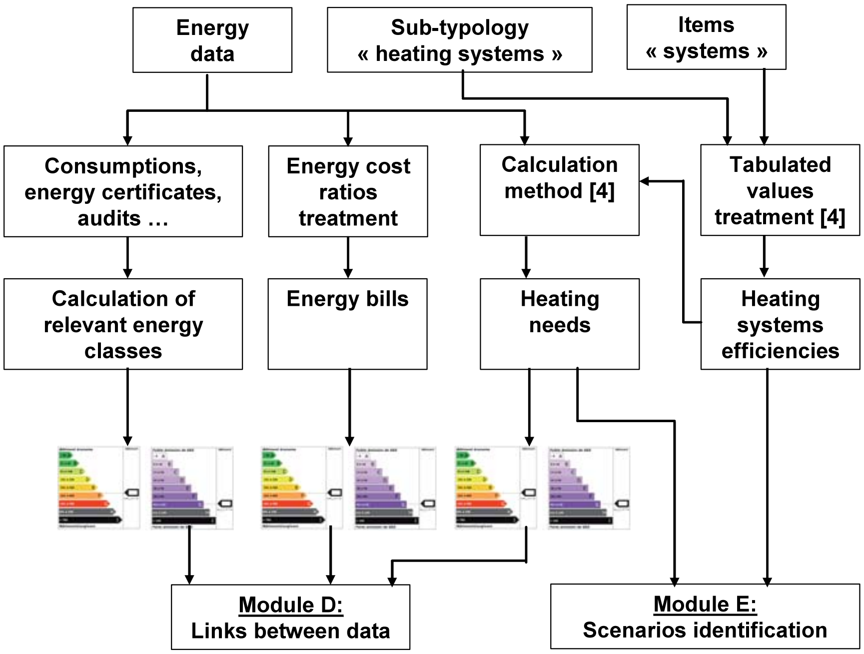


*Figure 2. Energy input data treatment*

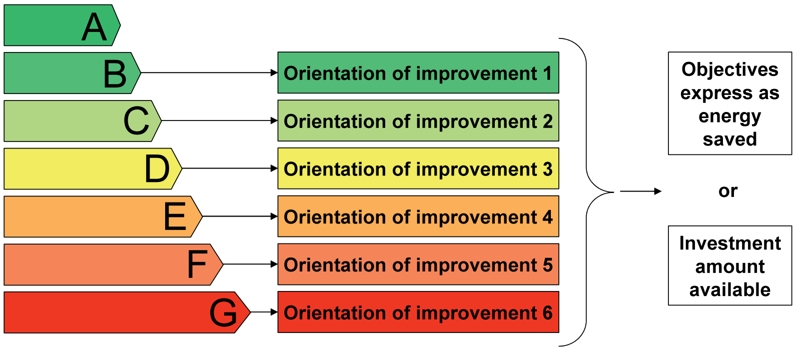


*Figure 3. Schema of guide to the scenario conception (module C)*

### SCENARIOS IDENTIFICATION

The scenarios are combinations of elementary actions (e.g. insulation of the external walls with a given thermal resistance + changing of the windows with double glazing unit + insulation of the roof with a given thermal resistance value). So, defining a scenario is defining which component must be treated and which objective is fixed for this component. The necessary information to do that comes from module D. The following data must be crossed together: orientation based on the rating obtained by the patrimony element and classification of the components.

The identification process is iterative: elementary actions are added until the final objective or until the strategic orientation constraints are reached. The number of components increases progressively (using the classification made previously), then for a finite number of components the level of improvement increases too (always with the respect of the classification) and a test is made to verify if the objectives (energy or cost) are reached or not. The iterative procedure continues until the final objectives are met.

Finally, the user must be capable of adjusting the scenario. Therefore it is necessary that the tool displays the result (or not, if does not exist) of the user action in "real time" (energy, cost and ROI results). The different scenarios can be saved, under the same strategy orientation category, to be compared.

### GLOBAL STRATEGY IDENTIFICATION

The objective for the user is to compose a global strategy from the set of scenarios allocated to the patrimony elements. To obtain this result, module F proposes the relevant data, coming from the previous steps, to allow the user to build his strategy. This information for each patrimony element is: general and energy information, typologies, values of the items for the different components, energy evaluation and results of the different scenarios. The module F proposes several possibilities and level of sorting. It is then possible, for example, to consider only patrimony elements with a limited ROI value, to add scenarios (using different arrangements) until an investment amount is reached, to consider only some categories of buildings or to favour energy saved or ROI by the scenarios (figure 5).

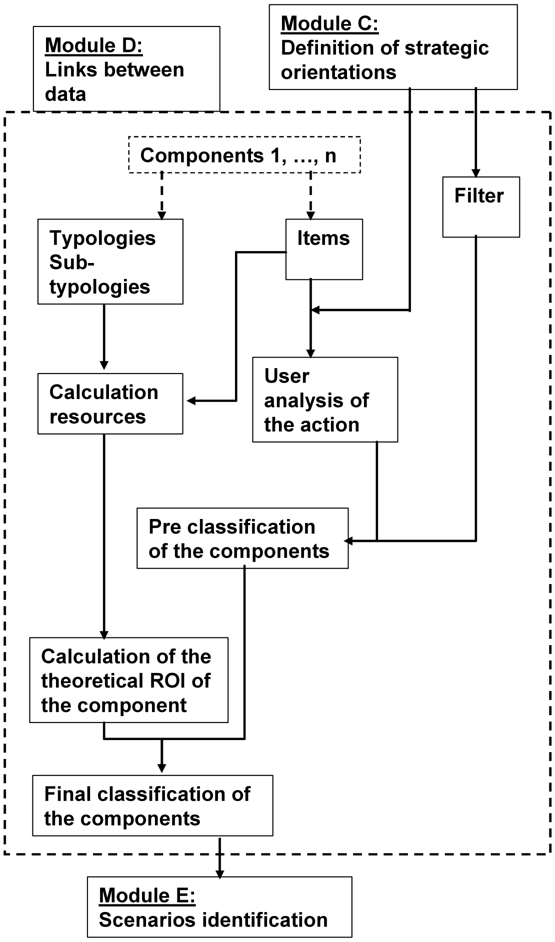


*Figure 4. Typologies and items interaction in the scenario attribution process*

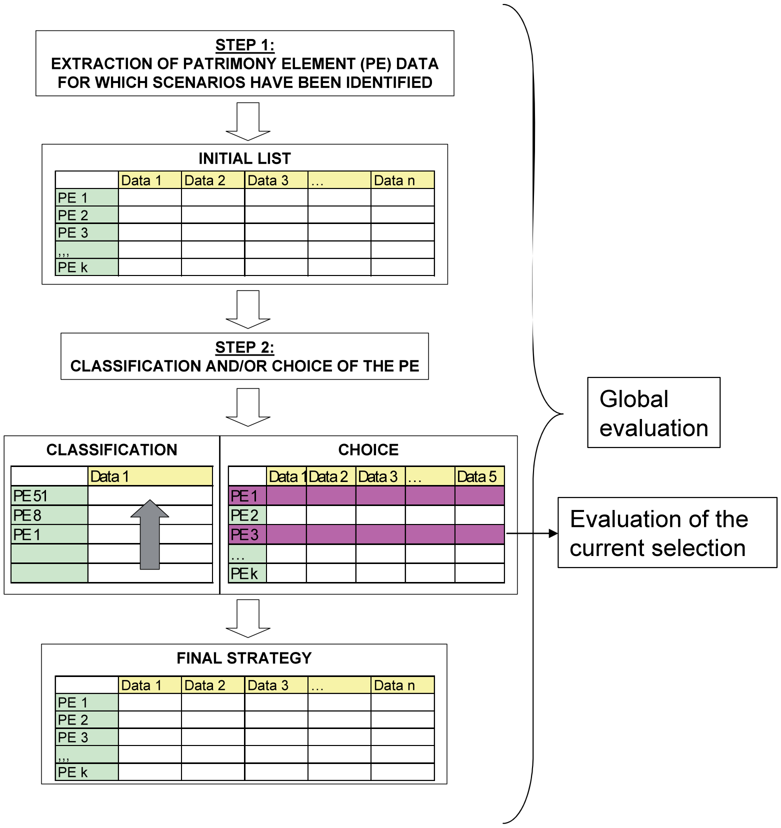


*Figure 5. Global strategy identification*

The final result can contain, for example, the following information: average values on energy consumption before and after the strategy is applied, average values for other energy information (bills, heating needs, hot water needs…), energy performance before and after (figure 6), costs of investments for each scenario average value of the ROI for all the scenarios…

## Implementation in the French situation: Presentation of the tool

The methodology described above was implemented by the French SHOs *Le Toit Angevin* and *Le Val de Loire,* in a tool called ECOSIM. The methodology was adapted to their particular situation but is very close to the one detailed here.

The module A is operational and enabled (with a relevant interaction with the existing data bases of the SHOs) to access the patrimony elements of the entire stock. As is shown in figure 7, general information is available as well as characteristics like the typology and the envelope properties (cf. tabs).

The figure 8 shows the details of the tab "typology". In the first frame, energy consumption and greenhouse gas (GHG) emissions are displayed. In the second tab, the user chooses the different levels of typologies and the technical characteristics associated ("Bâti" = type of construction, "chauffage" = heating systems, "Eau chaude sanitaire" = Hot water systems, "Ventilation" = ventilation). The tab of the envelope is shown in figure 9.

The last screen shots (figures 10 and 11) correspond to the implementation of the modules C, D, and E. In figure 10, the user can change or let the tool to choose the characteristic values of the items to build a scenario for the patrimony element considered. As it can be observed in this figure details of the impact of each actions on the envelope in term of energy saved and in term of investment necessary, can be followed. A similar screen is available for the systems. The figure 11 shows an example of the results obtained with the scenario built in figure 10. Starting from the initial values of these characteristics, ECOSIM calculates the impact of the choice on the energy consumption of the patrimony element (87 kWh/m$^2$y after refurbishment against 150 kWh/m$^2$y before, figure 11), the GHG emissions corresponding to the improvement choices (41 $Kg_{eq}CO_2/m^2.y$ before 23 $Kg_{eq}CO_2/m^2.y$ after, figure 11), just as the costs and the ROI associated (278,481 Euro in five years, figure 11).

These results are possible because the relevant modules (A, B, C, D, E) have been implemented, the calculation and the intermediate resources are operational, as well as the databases and the connection between al these elements of the methodology.

At the moment, the module F has to be developed to enable the strategic functionalities of the tool and its interaction with the SAM. It is under development at the present time.

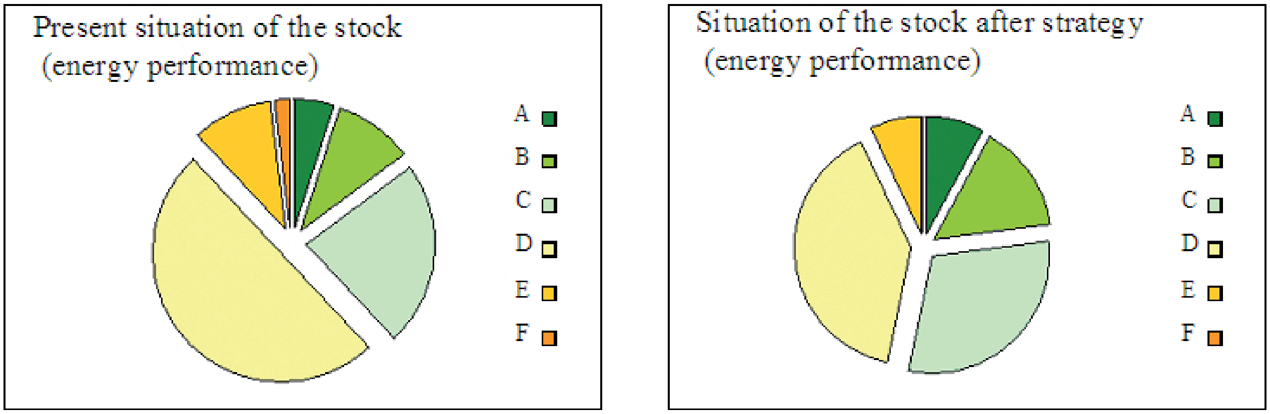


Figure 6. Impact of the global strategy (example of presentation).

Groupe : 0001-ANGERS CHEF DE VILLE I

**Groupe**

49100 ANGERS

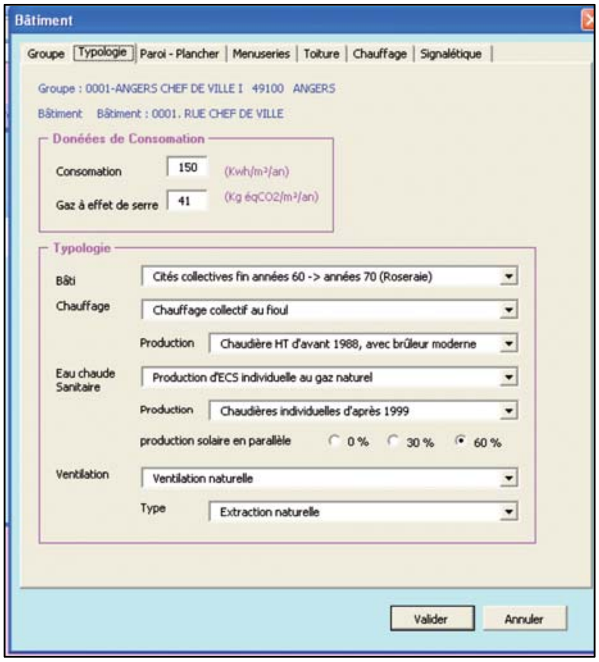
| | |
|---|---|
| Année de construction | 1954 |
| Nombre de logements | 18 |
| Surface Habitable | 972 |
| Surface Corrigée / Utile | 1710 |

**Bâtiment : 0001.**

RUE CHEF DE VILLE

| | |
|---|---|
| Nombre de logements | 12 |
| Surface Habitable | 618 |
| Surface Corrigée / Utile | 1098 |

Figure 7. ECOSIM screen shot: patrimony element integration.



Groupe : 0001-ANGERS CHEF DE VILLE I 49100 ANGERS

Bâtiment Bâtiment : 0001. RUE CHEF DE VILLE

**Données de Consomation**

Consomation 150 (Kwh/m²/an)

Gaz à effet de serre 41 (Kg éqCO2/m²/an)

**Typologie**

Bâti: Cités collectives fin années 60 -> années 70 (Roseraie)

Chauffage: Chauffage collectif au fioul

Production: Chaudière HT d'avant 1988, avec brûleur moderne

Eau chaude Sanitaire: Production d'ECS individuelle au gaz naturel

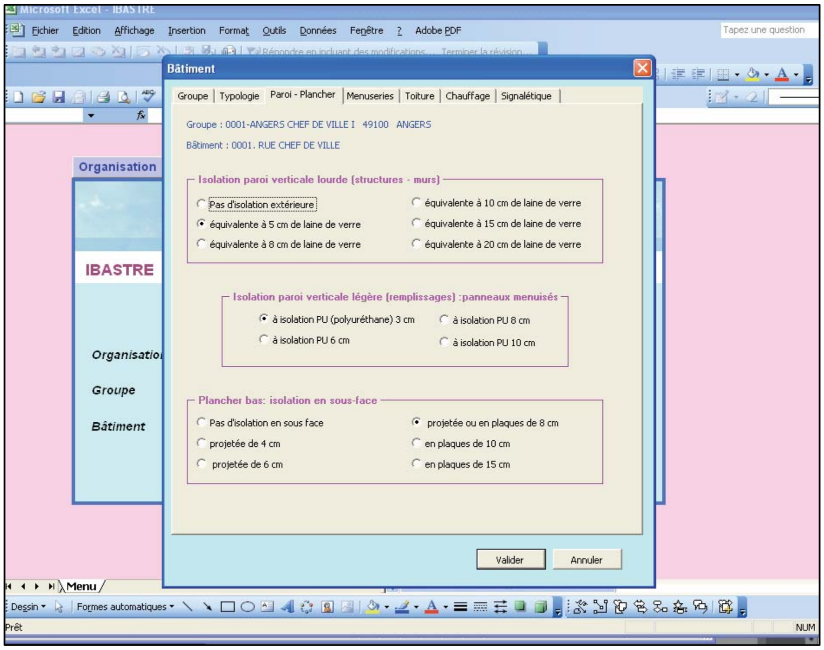
Production: Chaudières individuelles d'après 1999

production solaire en parallèle ○ 0 % ○ 30 % ● 60 %

Ventilation: Ventilation naturelle

Type: Extraction naturelle

Figure 8. ECOSIM screen shot: definition of typologies.



Groupe : 0001-ANGERS CHEF DE VILLE I 49100 ANGERS

Bâtiment : 0001. RUE CHEF DE VILLE

**Isolation paroi verticale lourde (structures - murs)**

○ Pas d'isolation extérieure
● équivalente à 5 cm de laine de verre
○ équivalente à 8 cm de laine de verre
○ équivalente à 10 cm de laine de verre
○ équivalente à 15 cm de laine de verre
○ équivalente à 20 cm de laine de verre

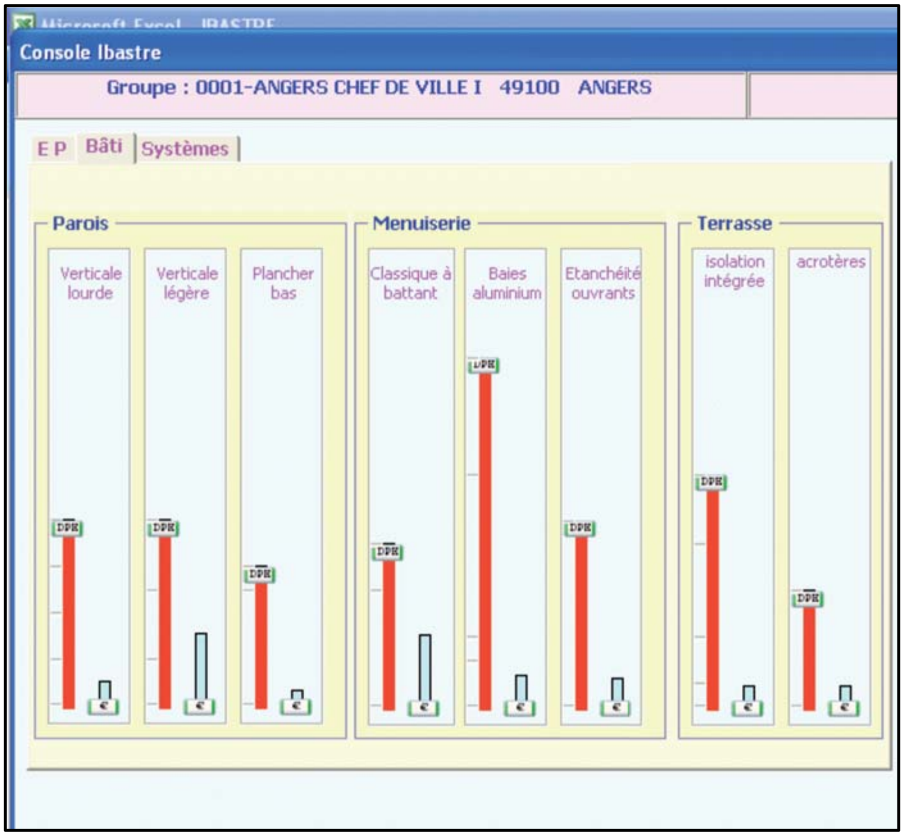
**Isolation paroi verticale légère (remplissages) :panneaux menuisés**

● à isolation PU (polyuréthane) 3 cm
○ à isolation PU 6 cm
○ à isolation PU 8 cm
○ à isolation PU 10 cm

**Plancher bas: isolation en sous-face**

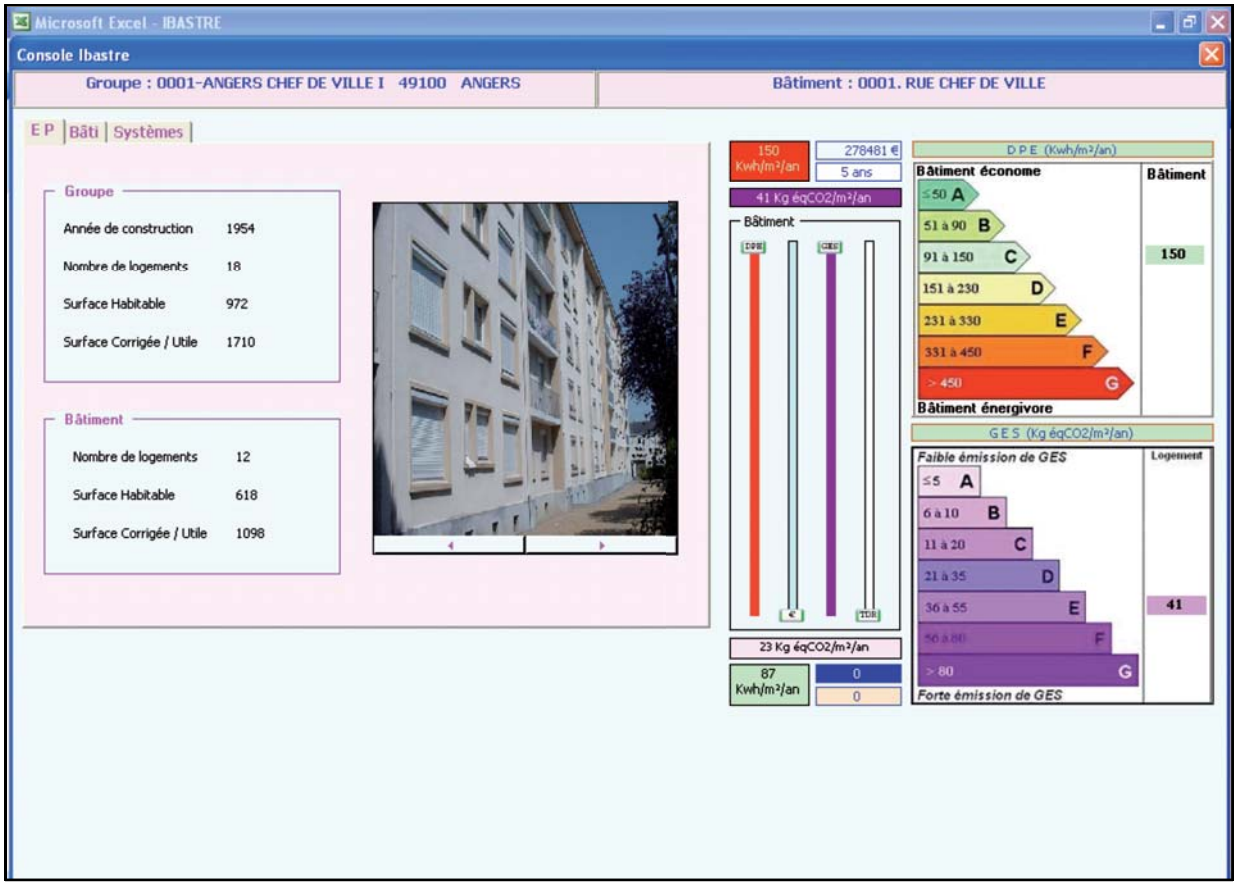
○ Pas d'isolation en sous face
○ projetée de 4 cm
○ projetée de 6 cm
● projetée ou en plaques de 8 cm
○ en plaques de 10 cm
○ en plaques de 15 cm

Figure 9. ECOSIM screen shot: technical properties.



Groupe : 0001-ANGERS CHEF DE VILLE I 49100 ANGERS

Figure 10. ECOSIM screen shot: scenario construction.



Groupe : 0001-ANGERS CHEF DE VILLE I 49100 ANGERS

Bâtiment : 0001. RUE CHEF DE VILLE

**Groupe**

| | |
|---|---|
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**Bâtiment**

| | |
|---|---|
| Nombre de logements | 12 |
| Surface Habitable | 618 |
| Surface Corrigée / Utile | 1098 |

150 Kwh/m²/an

278481 €

5 ans

41 Kg éqCO2/m²/an

Bâtiment

23 Kg éqCO2/m²/an

87 Kwh/m²/an

0

0

Bâtiment: 150

Logement: 41

Figure 11. ECOSIM screen shot: evaluation of the scenario impact .

## Discussion

The end of the project (December 2008) corresponds to the beginning of the operational use of the tool by *Le Toit Angevin*. This use in real life will allow the tools to be improved. *Le Toit Angevin* ,which has a SAM tool, was motivated to developed from the methodology proposed a tool capable to give energy solutions at different scales of its stock, in line with the classical strategic management. ECOSIM helps the SHO in this way since before that energy actions were considered only at the building scale. The tool is too young to present results of its use but this use is real. For *Le Toit Angevin*, the energy information and the possible quantified actions given by ECOSIM aim to become effective decision parameters in the SAM tool.

A national dissemination, carried out by the SHO association DELPHIS, has been performed through a meeting where several SHOs were present. *Le Toit Angevin* and *Le Val de Loire* came to testify of the interest of the approach. Since the dissemination, the interest for the approach by other SHOs starts to be expressed. This is an additional reason for DELPHIS and Le Toit Angevin to continue to improve and to promote the approach and the tool.

One of the interests of the methodology (and the tool) is the definition of the relevant typologies, in particular in the energy point of view. It allows the lack of precise information for each building to be overcome and the global decisions to be analysed without external expensive studies necessary otherwise. These studies can thus come later, more specify (and so less expensive) in the process.

Another power of the approach is the adaptability of the resources available, skills and knowledge of the SHO. In the present case the choice of a tool without a core calculation was made mainly because of the size of the SHO (no specialist in the organization to use this kind of tool). This situation corresponds to an intermediate case in the consortium of the project.

The decision of combination of energy information came partly from the analysis of the poor potential of the EPCs in answering the question. Several reasons can explain this report, at least in France. First of them, the EPCs do not allow a sufficient sensitivity analysis to identify precisely actions that can be proposed, mainly because of the uncertainties of the calculation methods. These methods have not been design with this objective. Furthermore the cost information and ROI given by EPCs are not sufficient to help with strategic decisions. Another reason is the possibility to perform an EPC only from heating bills in the case of heating district systems (not rare in the social housing sector). This possibility doesn't give sufficient information to help with strategic decisions. Furthermore the tool must not be dependant of the possible modifications of EPCs in the future, as it has been mentioned in the introduction.

## Conclusion

The objective of this work was to develop a methodology to address the issue of energy in the strategic asset management of SHOs. The solution proposed is adapted to the SHO since it has been developed in collaboration with them and aims to be appropriated by any organisations that could be interested. The example of implementation (ECOSIM) is only the result of the French partners' appropriation of the methodology. An implementation by other SHOs would certainly give a different result.

The power of this approach is its flexibility. Adaptations are possible depending on information resources, inner skills of the SHO and degree of knowledge of the stock. Another interest of the methodology proposed is its self auto improvement, by the gathering feedback from refurbishment experiences, coupled to the typology approach, in composing scenarios.

## Abbreviations list

| | |
|---|---|
| ESAM | Energy Strategic Asset Management |
| SHO | Social Housing Operator |
| SAM | Strategic Asset Management |
| EPC | Energy Performance Certificate |

## References

[1] http://www.legrenelle-environnement.gouv.fr

[2] Mission interministérielle d'inspection du logement social (Miilos), report 2007, http://www.logement.gouv.fr/IMG/pdf/miilos-rapport_2007_cle0d718a.pdf

[3] Vine, E. and Hamrin, J., 2008. Energy savings certificates: A market-based tool for reducing greenhouse gas emissions. Energy Policy, 36(1), 467-476.

[4] European Union, Directive 2002/91/EC of the European Parliament and of the council of 16 December 2002 on the energy performance of buildings, Official Journal of the European Communities, January 4th 2003.

[5] www.esamproject.org

[6] Les organismes de logement social, http://www.logement.gouv.fr/IMG/pdf/Organismes2006_080307.pdf

[7] Arrêté du 15 septembre 2006 relatif au diagnostic de performance énergétique pour les bâtiments existants proposés à la vente en France métropolitaine. NOR : SOCU0611881A. Publication au JO du 28 septembre 2006 – Texte 10 sur 138. http://www.logement.gouv.fr/IMG/pdf/arrete150906_dpe-3.pdf

[8] Arrêté du 3 mai 2007 relatif au diagnostic de performance énergétique pour les bâtiments existants à usage principal d'habitation proposés à la location en France métropolitaine. NOR : SOCU0751057A. Publication au JO du 17 mai 2007 – Texte 30 sur 309. http://www.logement.gouv.fr/IMG/pdf/arrete_3mai2007.pdf

[9] www.epi-soho.eu

[10] http://env.meteo.noa.gr/datamine

[11] http://www.logement.gouv.fr/IMG/pdf/Justificatifs-3CL.pdf

## Acknowledgements

This work has been carried out through the Intelligent Energy Europe ESAM project, coordinated by DELPHIS (33 rue Saint Augustin, F-75002 PARIS) with the French SHO partners: Le Toit Angevin and Le Val de Loire. Contact details for all the partners are available on the project website.