HabitEnergie. Success factors in the construction of very low-energy housing: the weight of stakeholder relationships and of household practices – a survey in three European countries

Véronique Beillan
EDF Recherche & Développement – ICAME Department
– *Trading Innovation, Analysis of Markets and of their Environment*
– *Research Group Energy, Technology, Society (GRETS), Knowledge of clients*
France
veronique.beillan@edf.fr

Emmanuelle Cayre
EDF Recherche & Développement – ENERBAT Department
– Energy in Buildings and Territories
France
emmanuelle.cayre@edf.fr

André Pouget
POUGET Consultants (France)

Daniela Sanna
Alphéeis – Energy & Environment Consulting
France
daniela.sanna@alpheeis.com

Dusan Novakov
Novasystem En+ (Switzerland)

Ulrich Rochard
Ebök (Germany)

Régine Trotignon
ADEME (France)

Keywords
energy efficient building, single-family house, decision-making process, behaviour, on-site survey, Passivhaus, Minergie

Abstract
In addition to technical factors, widespread development of energy efficient buildings depends on various factors including the strong willingness of the actors, favourable regulation and economic mechanisms, all of which influence the decision-making process.

In the design and construction stage, the most important factors are the relationship between different professional actors involved in the choice and implementation of energy efficient solutions for the envelope and the HVAC systems.

In the operation stage, the maintenance of the building, and the behaviour and practices of final users are the main factors for reaching energy efficiency objectives.

The HabitEnergie project aims to analyse, through a qualitative (on-site survey of several buildings and actors, among final users, decision makers and professionals) and geographical approach (France, Switzerland and Germany), the weight of these factors in determining the success of operations which aim to achieve very-low energy consumption.

The partnership brings together energy and services providers, and public and private energy and environment experts in the three EU countries involved in the survey.

For ensuring relevance of the survey results, the HabitEnergie project focuses on the single-family house sector where the final users are generally also the decision-makers.

This partnership will allow comparison of practices and analysis of results in order to:

- Weigh the differences between the 3 countries involved.
- Share knowledge about support and follow-up actions that enhance the influence of the different actors throughout all stages of the project process.

HabitEnergie will run from July 2006 for 18 months.

Introduction
This paper focuses on work carried out in the frame of the HabitEnergie project from the beginning until January 2007. The methodology of the project, the analytical approach, and main results from the first two phases are presented here:

- State of the art of the very low-energy consumption buildings in the three countries involved.
- Methodology developed to carry out this study.

The state of the art work integrates the study of the evolution of the very low-energy consumption building in the three countries involved. This work aims to present the analysis of main impacts of different key-points and the importance of the definition of a common frame for indicators and performance criteria in the different countries. It also includes the results of synthesis of the main socio-economic issues dealing with household behaviour and leading to the decision-making process for implementing these buildings.

The methodology for the on-site survey, the criteria of selection and the presentation of sites are also illustrated here via two examples.

What do we know about very low-energy buildings?

HISTORICAL EVOLUTION OF THE DEVELOPMENT OF ENERGY EFFICIENT BUILDINGS: SOME KEY FACTORS

To prepare the survey that will be carried out in the three countries (France, Germany and Switzerland), we have started by first making a comparison of the development of low energy buildings in the different countries. We have analysed the main facts occurring during the last 30 years and their effects on low energy buildings. We have split our analysis into five types of factors:

- Major societal events, such as the oil crisis, which has led to practically the same effects in each country. In Germany for example the oil crisis has also given birth to strong anti-nuclear groups.
- Evolution of legislation and the regulatory environment (mainly thermal regulation), which has evolved continuously in the 3 countries, moving at slightly different rates from limitation of consumption to the reduction of energy needs (low energy buildings).
- Government incentives, that have consisted of mainly three types of support: subsidies for demonstration projects, tax reductions for purchasing energy efficient appliances, and, more recently, preferential interest rates for the installation of efficient equipment.
- R&D progress: in each country the main effort has been put into the thermal isolation, the reduction of the air permeability, the limitation of the air flow rate, etc.
- Voluntary initiatives of market players: the private initiatives in Switzerland and Germany in favour of low energy standard (Minergy, PassivHaus) are older than in France where the Effinergy association has been recently created.

At the moment, this analysis is still on going, the final results will be available in spring 2007.

A SOCIO-ECONOMIC PERSPECTIVE OF DRIVERS, AND PRACTICES OF ACTORS, IN MOVING TOWARD ENERGY EFFICIENT BUILDINGS

An important part of the work has focused on key knowledge about socio-economic issues as they relate to very low-energy consumption buildings. Although the survey will be carried out only on new single-family houses, more general studies and work will also be used. Namely, data about social housing, and on attitudes towards renewable energy at the sites in question, have been collected and analysed.

Socio-economic issues of the project

A qualitative and geographical approach is used to analyse the weight of socio-economic factors in successful implementation of very low-consumption houses, where the final users have generally been at the origin of the project.

The factors related to the organisation of professional actors and the practices of users have been analysed. Namely, the work focuses on the socio-economic factors playing a role in the three following key-stages of the project:

1. Decision-making process (first reasons, decision, implementation)

A very-low energy consumption project starts mainly because of:

- The actors' willingness (private and public),
- Social demand (public opinion, household willingness to accept the "new" technical equipment that is on offer...)
- Support via regulations,
- Financial mechanisms / financial support.

2. Implementation

The technical and management choices toward energy efficiency are strictly related to:

- The existence of professional actors on the offer-side (architects, providers, enterprises…)
- Their coordination and relationship toward the implementation of optimised solutions

3. Operation

- Good maintenance of equipment (users and professional actors)
- Practice and behaviour of users in the operation stage.

The main resources available and used

There exist few studies related to very low-energy consumption in buildings and socio-economic issues. Furthermore, most of the studies deal with social housing and affordable housing aspects.

A first thing to underline is that only a small amount of this kind of building has been carried out in France today. In other countries, like Switzerland and Germany, the development of this kind of building is progressing. On the basis of surveys and studies realised, we are trying to understand the main reasons for this difference, focusing on practices and behaviour of users and their reasons given. At the moment, this analysis is still on going. Through analysis and extrapolation we aim to identify the main socio-economic issues and then orient the on-site survey around these.

Main orientations for the on-site survey

The synthesis of the studies and of surveys dealing with socio-economic issues does not give more detailed information about the relationships between the professional actors and the practices of the users. Meanwhile it is possible to orientate the survey toward some main specific factors.

Namely, the main points identified and to be treated are:

- **The start of the project.** How the family and professional networks play a role in the decision-making process?
- **The "ID" of the decision-maker/user of a very low-energy consumption building**. Does the decision-maker/user of a very low-energy consumption building have a specific "ID"? Does this "ID" correspond more or less to the "ID" of people having environmental-friendly practices?

- **Weight of "internal factors".** Cultural factors (like life-style in the three different countries) and lack of information on the energy and environmental impact of housing. Do these factors have a strong impact compared to the "external factors" in helping to support the decision-making process?
- **Weight of "external factors" (rules, labels, financial support and other financial mechanisms, information and dissemination, pilot sites…).** On the basis of the collected data and information, it is not possible to identify the relationship between these external factors and the final outcome of the decision-making process. Meanwhile, these factors may explain some differences between the three countries involved in the project (France, Switzerland, and Germany).
- **Use of renewable energy**. Which renewable energies are the most used? For which reasons? Does the "social image" have an impact in the choice of the equipment?
- **Weight of the advice and solutions provided by the professional actors.** Is the market-side ready to orientate and to drive owners and users toward this kind of building?
- **Degree of satisfaction of users**. Which are the main reasons for users' satisfaction or dissatisfaction? Does the daily reality correspond with, or is it above or below, the expectations?
- **Role of professional follow-up**. Is the professional follow-up sufficient? Is the information provided to users sufficient?

THE QUESTION OF THE "COMPARABILITY" OF LABELS

The inventory of low consumption construction requires an analysis of the different standards and labels applied in each of the 3 countries in order to place them in relationship to each other. However at the moment, the high energy efficiency of buildings is not subject to any definition recognised either at the international or even European level. As a result of the evolution of specific practices in each country, different labels have come into being. The scope of our study covers the German label "Passiv Haus", the Minergie programme in Switzerland and the new "HPE Basse Consommation" label in France[1].

Each national label focuses on a target energy performance expressed by the energy supplied to the building related to its surface area, i.e. a number of kWh divided by a surface area, a number of m². At first sight, with an essential climatic correction, the comparison seems simple. However on examining in more detail the 2 terms of this quotient, we see that a single reading of the target performances leads to a comparison of incomparable values. On the one hand the energy can cover different physical quantities, on the other hand the surfaces considered could be different.

The possible different expressions of energy: definitions

Several expressions of energy are possible; always expressed in kWh, they correspond however to different physical notions:

Figure 1.

Useful Energy expresses the energy needs of a building, i.e. the physical quantity of energy, which is necessary in this building to meet a well-defined need such as maintaining the volume of the building at a given temperature. In this case, this quantity of energy depends only on the characteristics of the building and the free gains. We will call this energy « **eu ».**

Final Energy expresses the energy supplied at the delivery point of a building by an energy supplier, i.e. the energy actually consumed by the appliances to meet the above noted energy need in the building. This quantity of energy depends on the useful energy and the characteristics of the appliances that are present in the building. We will call this energy « **ef** »

Primary Energy is an energy, which has not undergone any transformation. It means no longer assessing the energy consumed by a building at its own level but tracing the assessment back up through the network of transformation. Compared to final energy, primary energy takes into account the consumption of the production networks themselves, and of energy transport. The rate of transformation depends therefore on the nature of the energy vector. *In practice, the conversion factors are conventional coefficients fixed by each state.* We will call this energy « **ep** »

The expressions of the energy use in the 3 labels

Table 1 presents the expression retained for each label.[2]

The Passivhaus label introduces a supplementary demand relative to the energy needs of the building but the consumption demands of the 3 labels are expressed in primary energy. However, as we have seen before, the result depends on the conversion factors used, relative to each country.

Table 2 presents the conversion factors adopted for each of the labels.

Although expressed in Primary Energy, the use of different conversion factors makes any rough comparison impossible.

1. At present time in preparation. The definitive version could be slightly different from that described in this document.

2. Requirements in France: The coefficients a and b correct for climate and height.

Table 1.

	Germany	Switzerland	France
Label	Passivhaus PHPP	Minergie	HPE - BC
Requirement	Space heating Useful Energy max: 15 kWheu/m² Consumption max: 120 kWhep/m²	Consumption max for space and domestic hot water : 42 kWhep/m²	Consumption max for lighting, space and DSW heating (auxillaries included) : 50 (a+b) kWhep/m²

Table 2.

Label	Germany Passivhaus PHPP	Switzerland Minergie	France HPE - BC
Conversion factors Ef/Ep			
Elec	2,7	2	2,58
Wood	0,2	0,75	0,6
Fossil	1,1	1	1

Table 3.

	Germany	**Switzerland**	**France**
Label	Passivhaus PHPP	Minergie	HPE - BC
Uses taken into account for the calculation			
Heating	yes	yes	Yes
Domestic hot water	yes	yes	Yes
Air-conditioning	yes	yes	Yes
Auxiliaries: mechanical ventilation	yes	yes	Yes
Auxiliaries: Secondary heating	yes	yes	Yes
Auxiliaries: domestic hot water	yes	yes	Yes
Lighting	yes	no	Yes
Other domestic uses	yes	no	No

The energy consumption boundary of the labels

Energy consumption in buildings depends on the uses of energy that occur within them. In a residential building, we can define the following different types of use: space heating and cooling, domestic water heating, lighting, ventilation, cooking and all the specific uses of electricity. Each label covers an area of different uses. Table 3 synthesises the uses accounted for by each of the labels.

The reference surface area

Relating the energy consumption of a building to its surface area has the aim of allowing the comparison of buildings with each other by comparing their size. However the surface area of a building is a notion, which requires a more precise definition. Must one calculate it from exterior or interior dimensions? To express a quantity of energy, must one include the non-heated spaces, balconies and verandas? If yes, how? In answer to these questions, each country has adopted a different solution.

Table 4 presents an example of a calculation of the reference surface area according to the 3 methods for the same building.

Influence of the calculation method

We have just established that, although expressed by the quotient of energy consumed related to a surface area, the requirements of the 3 labels are not directly comparable.. As well as the three reasons presented above a fourth can be added: **the calculation method**. In fact, each label is based on the utilisation of a calculation method permitting the verification that the building design respects the requirement of the label. However, these calculation methods are different from one country to another. In the case of Switzerland and France, the calculation method for the label is the current thermal regulation (Norme SIA in Switzerland, and ThCE2005 in France). For Germany, the PHPP calculation method is unique to the Passivhaus label, different from the current regulation method (ENEV 2004). In

Table 4.

Label	Germany Passivhaus PHPP	Switzerland Minergie	France HPE – BC
Reference surface area	Energy reference Surface – definition PHPP	Energy reference surface – definition SIA	Thermal Regulation reference surface (SHON) – overall surface
Example for a 135 m² leaving space house	132 m²	189 m²	149 m²

Table 5.

	Germany	France
Calculation Method	Passivhaus PHPP	THCE 2005
Reference Surfaces	132 m²	149,1 m²
Final Energy kWhef/m²	24,14 *all uses*	24,41 ***(heating, domestic hot water, auxiliaries, ventilation, lighting)***

Table 6.

	Germany	France
Calculation Method	Passivhaus PHPP	THCE 2005
Reference Surface area	**149,1 m²**	**149,1 m²**
Final Energy kWhef/m² (heating, domestic hot water, auxiliaries, ventilation, lighting)	**9,6**	**24,41**

the framework of this project, we do not plan to analyse the different methods used, but we propose applying the 3 calculation methods to the same building in order to underline possible differences. At the current stage of advance of the project, we present a comparison between the calculation method PHPP (Germany) and THCE2005 (France), with equivalent base parameters of calculation. The comparison with the Swiss method (SIA) is still being carried out.

Table 5 below presents the results of each calculation for the consumption of the uses taken into account in the definition of Passivhaus and HPE – BC labels.

For this building, the 2 methods give a consumption of 24 kWh**ef**/m². This initial agreement hides important discrepancies. In fact, if one analyses the detailed results, one notices that the uses taken into account are different as well as the reference surface area considered. A correction, only taking into account the uses common to the 2 methods and related to the same surface area, gives the results presented in Table 6.

This second table shows a discrepancy of 150 % between the two calculation methods!

These partial results show the necessity of defining a method for comparing different requirements based on the analysis of the different expressions of the energy performance. This work is continuing with a complete comparison of the results of the different methods applied to types of buildings representative of the high efficiency construction in each country. This work will allow us to form a comprehensive picture of the results of applying each label, and how the labels differ. At the same time, an analysis of the current technical solutions for these buildings will complete the quantitative analysis.

Our approach, its original character

The main original character of our project is the European comparative approach on the part of the households, to trace back to the techniques and the network of implementation, in order to identify, in each of the three countries, the nature of the impediments or, on the contrary, the drivers for the implementation of low-energy consumption buildings.

THE METHODOLOGY USED FOR SELECTING THE SITES

First of all, for ensuring relevance of the survey results, the HabitEnergie project focuses on the new single-family house sector where the final users are generally also the decision-makers.

The criteria used for selecting the sites have been chosen in order to set up a panel of sites as diversified as possible. We have: general criteria, technical criteria, economic criteria, socio-economic criteria, and feedback experience criteria. See Table 7.

These same criteria are used to give a detailed presentation of sites.

Table 7.

Selection criteria table

General criteria	Label or certification that applies Location (rural zone, urban zone, city centre) Year of construction (construction code reference) Key-actors (owner, constructor) Other key-actors (architect, users, local authorities, energy providers…) Sources availability
Technical criteria	Housing type (« luxury/standard ») Building configuration (to detail according to calculation methodology) Heated surface, glazed surface (definition of a common surface to use) Construction system type Thermal characteristics of envelope (solar protection, glazing…) Energy equipment for heating and domestic hot water Ventilation type Other equipment (regulation, programme systems…) Availability of thermal studies Availability of energy bills Construction site management
Economic criteria	Investment costs, total costs without the land, maintenance costs Specific financial mechanisms (financial support (e.g. grants), bank products, tax benefits…)
Socio-economic criteria	Number of occupants Household type (with or without children; type of rent, professional skills…)
Feedback experience	Survey
Added value	*Specific interest for the project*

AN OVERVIEW OF SELECTED SITES

The on-site survey will be carried out on six sites per country (18 sites in total).

For each site, an identity sheet has been realised on the basis of the selection criteria.

We report here 2 examples of selected sites for Germany. See Tables 8 and 9.

THE METHODOLOGY FOR THE ON-SITE SURVEY AMONG FINAL USERS AND PROFESSIONAL ACTORS

The success of an innovation depends on multiple factors. Therefore, the spread of low energy consumption buildings on the territory depends on the available technology on offer (materials, construction procedures); on the demand of the population regarding this type of habitat (motivation, financial possibility, residential project), but also on the capacities of the actors to implement the technical and architectural solutions specific to the conception of a low energy consumption building: training and know-how of the network, interest of the network in promoting the innovation.

A regulatory and financial framework to encourage such developments is also involved in the spread of this type of building. The approach which we have adopted of comparing across three European countries, although posing methodological questions of comparability like the one invoked (cf. comparative table of labels), will help us to understand the role played by this regulatory and financial framework, given that the three countries considered are not at the same stage from the regulation viewpoint (cf. state of the art).

This study therefore proposes two main objectives:

- to understand the weight of these different factors: technical, organisational, sociological, in the success of real estate operations which aim to deliver very low energy consumption housing.
- to work on the link between demand and offer based, not on technical possibilities, but on the demand of the occupants, retracing the network of the offer and identifying the factors that might impede the link between offer and demand

To do this, we adopt a qualitative, geographical and compared approach. In fact, interviews with occupants and actors of the professional network will be conducted in the three countries considered. The very great diversity of situations and factors in the residential sector (individual and collective housing, private and social, new and old) leads us to target this study on new single-family houses and, in particular, those whose occupants have been decisive in the operation.

The occupants' survey

In-depth interviews, of about an hour and a half, in French or German, will be conducted in households occupying the selected houses. Therefore, 18 interviews with the occupants, six per country, will be conducted.

These interviews will be organised around four main themes:

- the motivation of the households to live in this type of dwelling;
- the decision process of the households and the implementation of the project;
- the domestic practices associated with life in this type of "eco" housing;
- more globally, the satisfaction regarding this type of building.

Table 8.

Passivhaus PH01 in Stuttgart

Key Actors		
Promoter:	BILFINGER+BERGER, Bauaktiengesellschaft	
	Ernsthaldenstraße 17	
	D-70565 Stuttgart	
Architect:	Rainfried and Hanna Rudolf	
	Hubertusplatz 1	
	D-70499 Stuttgart	
BET:	ebök	
	Johannes Werner	
	Schellingstraße 4/2	
	D-72072 Tübingen	
Photo		

Description		
General Information:	The house is situated in an estate with 52 semi-detached houses in Stuttgart-Feuerbach. Stuttgart has 590.000 inhabitants.	
Building:	Date of construction 1999	
	Semi-detached house at end of row. Construction in arénacé limestone and in concrete with exterior insulation.	
	3 habitable floors, no cellar. Orientation principal facade to the south.	
	Elements of construction:	
	Stone on floor in concrete with 27 cm of EPS 035 insulation, value-U: 0,126 W/(m²K)	
	Exterior walls: 17,5 cm arénacé limestone with 30 cm of PS 035 insulation, value-U: 0,112 W/(m²K)	
	Roof: 16 cm concrete, 40 cm of EPS 035 insulation, 1,5 cm wood covering, tiles in concrete, value-U: 0,084 W/(m²K)	
	Windows: Triple glazing, value-U: 0,815 W/(m²K)	
	System multi-integration (SMI) with mechanical ventilation double-flux, heat recuperation by thermal sharing, PAC with air extraction, electric space heating and domestic hot water and emergency electric cylinder heating integrated.	
	Hot-air heating. One infra-red spotlight in the bathroom.	
	For the mechanical ventilation, the external air passes in front of the SMI via a geothermic shaft of 30 m in length and a diameter of 175 mm to 2 m in depth.	
Technical Equipment:	Output of air of the VMC:	130 m³/h
	Level of heat recuperation:	80%
	Thermal power of the PAC:	1,1 kW
	Power of electric cylinder:	3,0 kW
	Volume of the boiler: 190 l	
Data		
Climate:	Stuttgart, South Germany, humid temperate with hot summer average temperature : 9,4°C, DJU 81,4 kKh/a	
	climatic region 11	
	latitude: 48° 46' 39'' north, longitude: 9° 10' 43'' east,	
	altitude 260 m	
Building:	habitable surface: 139,1 m²	
	surface SRE: 130,5 m²	
	ratio A/V: 0,6	
	pressure test result: 0,4 1/h	
Energetic values:	Useful heat annual heating:	16,3 kWh/(m²a)
Consumption:	primary energy: 114,8 kWh/(m²a)	
	Levels of consumption in 2000 and 2001	
	electricity total: 3.379 kWh/a	
	electricity for heating:	
	electricity for domestic hot water:	
	electricity for VMC:	
Investments:	Cost of construction:	
	construction building (KG 300):	997 EUR/m²
	technical installations (KG 300):	174 EUR/m²
	Sale price, without land:	164.000 EUR
	Financial support:	
Occupants	Family: 2 adults, 2 children	

Table 9.

Passivhaus PH03 in Kirchheim/Teck

Key Actors		
Architect:	oehler faigle archkom solar architecture	
	Stefan Oehler	
	Melanchthonstr. 10	
	D-75015 Bretten	
BET:	Söllner Ingenieurplanung	
	Bernd Söllner - Dipl.Ing. (FH)	
	Hermann-Löns-Str.	
	D-73240 Wendlingen	
Photo		
Description		
General Information:	Detached house in a mixed neighbourhood in Kirchheim/Teck (40 km to the south-east of Stuttgart). Kirchheim/Teck has 40.000 inhabitants.	
Building:	Date of construction 2005.	
	Mixed construction, part wooden framework, solid part in concrete with exterior insulation	
	3 habitable floors plus cellar (in the thermal casing). Orientation principal facade to the south-south-west.	
	2 apartments	
	Elements of construction:	
	Stone on floor in concrete with 28 cm of XPS 040 insulation under the stone, value-U: 0,114 W/(m^2K)	
	Exterior walls, wooden framework with 40 cm of insulation in mineral fibres, value-U: 0,086 W/(m^2K)	
	Exterior walls, concrete with 30 cm of EPS/XPS insulation, value-U: 0,112 W/(m^2K)	
	Roof: TJI girders with 40 cm of mineral fibres, value-U: 0,089 W/(m^2K)	
	Windows: Triple glazing, value-U: 0,724 W/(m^2K)	
	System multi-integration (SMI) with mechanical ventilation double-flux, heat recuperation by thermal sharing unity, PAC air extraction, electric space heating and domestic hot water and emergency electric cylinder heating integrated.	
	Hot-air heating.	
	For the VMC, the external air passes in front of the SMI via a geothermic shaft.	
	Recuperation of rainwater and utilisation for toilets and garden.	
	The house is equipped with a solar panel for domestic hot water and with photo-cell panels	
Technical Equipment:	Output of air of the VMC:	260 m^3/h
	Level of heat recuperation:	78%
	Thermal power of the PAC:	1,8 kW
	Electric power cartridge:	3,0 kW
	Surface solar cells:	8,4 m^2
Data		
Climate:	Kirchheim/Teck, South Germany, humid temperate with hot summer, climate as Stuttgart (climatic region 11, DJU 81,4 kKh/a)	
	latitude: 48°38'58" north, longitude: 9°27'09" east,	
	altitude 310 m	
	Habitable surface:	200 m^2
	surface SRE:	206 m^2
Building:	ratio A/V:	0,63
	pressure test:	0,31 1/h
	Useful heat annual heating:	14 kWh/(m^2a)
	primary energy (without PV):	74 kWh/(m^2a)
Energy Values:	Levels of consumption	
Consumption:	Electricity heating, domestic hot water, mechanical ventilation:	3122 kWh/a
	electricity household:	2.143 kWh/a
	electricity PV:	5.078 kWh/a
	Cost of construction:	
Investments:	construction building and technical installations KG 300 + 400):	
	400.000 EUR (2.000 EUR/m^2)	
	Credits with interest rates reduced by	
Financial support:	- BAFA: 1.000 EUR (subvention for solar cells)	
	- KfW: 50.000 EUR, 2,6%, 10 years (subvention passive houses)	
	- KfW: 40.000 EUR, 3,05%, 10 years (subvention photo-cells)	
Occupants	Family: 2 adults, 2 children	

Motivation of the occupants

To understand the motivation of the occupants we will concentrate on recording the representations and values, in particular in the domains of energy and environment, on which this motivation is based. We will also try to identify in their residential itinerary and their life's course, the events/experiences, which could have contributed to forging their "ecological" sensitivity in the matter of their home.

Process of decision and implementation of the project

We take the hypothesis that, depending on the countries, the maturity of the offers and their structure on the market are different and that this makes the implementation of a low energy consumption house more or less easy. We will concentrate therefore, in these interviews, on recording the different stages in the implementation of the households' projects, on identifying the network of actors on which they depended to elaborate and "give life" to their project as well as any difficulties which they could have encountered between the information phase and that of the start of construction.

Subsequently, interviews will be conducted with the key-actors who have influenced the decision process and/or developed the housing project.

Associated domestic habits

We will have to understand whether one can live in an "eco" house just like in a "traditional" house, or if this house concept implies adopting specific domestic habits in the domain of heating, lighting, use of domestic electrical appliances for example, to reach the energy efficiency "promised".

We will try otherwise to evaluate the impact that this possible change of habits and adoption of specific domestic behaviour makes on the lifestyles of the households.

Finally, we will pay attention to the "extent" of the deployment of these habits: is it limited to the area of the house or do these "acquired" habits infiltrate, more extensively, other fields of daily life such as consumption or mobility (e.g. "green" travel habits).

Satisfaction

To finish, we will try to measure the satisfaction of these households regarding technical and architectural solutions implemented in their housing, the possible constraints which they impose, in terms of thermal comfort and use for example, but also the benefits which they bring.

Finally, the opinions and habits declared by the households will be put in perspective with the uses prescribed and the recommendations formulated by the "prescription sphere" mainly constituted by the different professional actors playing a role in the operation. So, for example, we will analyse, when they exist, the contents of the user manuals supplied to the occupants. More generally, we will try to update the representations that the professional actors have of the "good use" of low energy consumption housing in order to measure, finally, the possible discrepancies between the prescribed practices and the current practices.

The survey with the actors implicated in the operations

The interviews with the inhabitants will also be the opportunity of identifying the network of actors on which each of these households depended for the conception and implementation of its housing project. The actors considered could be professionals: masters of works, companies, craftsmen or any other actor identified in the course of the study, such as people who give information and advice pertaining or not to the private sphere of the users.

These interviews with these actors could permit us:

- to determine the reasons for their implication in this type of project,
- to discover their opinions concerning the organisational, regulatory and financial factors, which encouraged or, on the contrary, impeded the projects,
- to identify the factors permitting, accordingly, the amelioration of the organisation of the network and the deployment of these operations,
- to record the prescriptions for use which they formulate for these buildings.

More generally, it will be a question of qualifying the action system of the professional network: which resources do the different actors have at their disposal and which constraints and factors influence them, notably with regard to national contingencies.

References

ARTEMIS/ANAH, Les Français sont-ils satisfaits de leur logement ? Septembre 2006

Beillan V., Testut N., "La rénovation dans l'habitat : état de la question". EDF R&D, Observatoire Sociétal, septembre 2005

Bertiaux F., Gram-Hansen K., "Socio-political factoirs influencing household électricity consumption : a comparaison between Denmark and belgium", ECEE Summer Study 2005.

Bilan de l'expérience acquise par les organismes HLM sur les installations thermodynamiques : informations recueillies, 1999, ADEME

B. Le Fur, Mesurer et comprendre les marchés d'amélioration de l'habitat », Club de l'Amélioration de l'Habitat, 2004

BVA, La perception de la consommation d'énergie par les Français », pour le collectif «Isolons la Terre contre le CO2, 2006

C. Derkenne, Comportements des consommateurs d'énergie, ADEME, Janvier 2006

Comparaison européenne sur les mesures destinées à l'amélioration énergétique des bâtiments. Constats en Allemagne,Suisse, France, Le moniteur n°5352, Juin 2006

CREDOC, Le baromètre d'opinion sur les Français et l'énergie, DGEMP-Observatoire de l'Énergie, Juin 2006

Deschamps A., Diaz-Pedregal V., Orhant I., Le solaire au quotidien. Usages et usagers de systèmes solaires photovoltaïques et thermiques en France, EDF, Septembre 2002 Beillan V., Testut N., La rénovation dans l'habitat : état de la question, EDF, Observatoire Sociétal, Septembre 2005.

De Boissieu, Maîtrise de l'énergie, Bilan 2005, Attitudes et comportements des particuliers, ADEME, SOFRES, 2005

Energy and environment in the European Union - Tracking progress towards integration, European Energy Agency, Juin 2006

Energy: Issues, Options & Technologies, Eurobaromètre, Commission Européenne, Décembre 2002

Eurobaromètre, Energy Technologies : knowledge, perception, measures, Commission Européenne, Janvier 2007

ICE/sowatt, DoMEnE, Diffusion du concept de maisons individuelles « très basse énergie » en France. Enquête réalisée dans le cadre du projet européen Passive-On, 2006

IFEN, L'environnement de plus en plus intégré dans les ménages français, Janvier-Février 2006

HLM, Bilan de l'expérience acquise par les organismes HLM sur les installations thermodynamique : informations recueillies, 1999, ADEME.

Hoffmann / Hastings / Voss, «Wohnbauten mit geringem Energieverbrauch», C.F. Müller Verlag, Heidelberg, 2005

I. Moussaoui, V. Beillan, P. Peretti-Watel, B. Hammer, Maîtriser ses consommations d'énergie : du concept de « MDE » aux réalités quotidiennes, EDF, Observatoire Sociétal, Décembre 2006

Institut Wohnen und Umwelt (IWU), «Wohnen in Passiv- und Niedrigenergie- häusern, eine vergleichende Analyse der Nutzerfaktoren am Beispiel der «Gartenhofsiedlung Lummerlund in Wiesbaden-Dotzheim», IWU, Darmstadt, 2003

Institut Wohnen und Umwelt (IWU), «Wohnen in Passiv- und Niedrigenergiehäusern aus sozialwissenschaftlicher Sicht», IWU, Darmstadt, 2003

Institut Wohnen und Umwelt (IWU), «Wissenschafliche Auswertung von Messungen in Passivhäusern/Niedrigenergiehäusern der Gartenhofsiedlung Lummerlund in Wiesbaden in der Messperiode 1997-1999» Kap. 3.3.1: Nutzereinfluss auf die Lüftung IWU, Darmstadt, 2001

Institut Wohnen und Umwelt (IWU), «Der Einfluss des Gebäudestandards und des Nutzerverhaltens auf die Heizkosten – Konsequenz für die verbrauchsabhängige Abrechnung», IWU, Darmstadt, 2003

Institut Wohnen und Umwelt (IWU), «Passivhaus-Bericht Nr. 11: Sozialwissenschafliche, IWU, Darmstadt, 1994

IPSOS/Caron Marketing, Sensibilité des ménages acquéreurs d'une maison individuelle aux thèmes de l'environnement et du développement durable, pour EDF, 2006

IPSOS-Le Moniteur, Logement : ce que veulent les Français, pour Le Moniteur, France info, Juin 2006

IPSOS-Le Moniteur, Les attentes des Français en matière d'innovation, Février 2005

Johann Reiß / Hans Erhorn, «Meßtechnische Validierung des Energiekonzeptes einer großtechnisch umgesetzten Passivhausentwicklung in Stuttgart-Feuerbach», Fraunhofer-Institut für Bauphysik, IBP-Bericht WB 117/2003, Stuttgart, 2003

La connaissance des marches locaux de l'habitat, ANAH, 2005

Le point sur le marché de l'amélioration de l'habitat, Club de l'Amélioration de l'Habitat », Octobre 2006

P. Lecuelle, La basse et très basse énergie dans l'habitat neuf et rénové. État des lieux et retours d'expériences de 4 pays européens, Energivie, Février 2005

Peretti-Watel P., Hammer B., L'énergie solaire. Analyse des réponses à l'enquête par sondage réalisée en fin 2004, EDF , Octobre 2005

Passivhaus Institut Dr. Wolfgang Feist, Protokollband Nr. 9: «Nutzerverhalten» Arbeitskreis kostengünstige Passivhäuser, PHI Dr. Wolfgang Feist, Darmstadt, 1997

Passivhaus Institut Dr. Wolfgang Feist Protokollband Nr. 21: «Architekturbeispiele: Wohngebäude» Arbeitskreis kostengünstige Passivhäuser Beitrag von Hartmut Hübner: «Nutzereinflüsse und Akzeptanz im sozialen Mietwohnungsbau», PHI Dr. Wolfgang Feist, Darmstadt, 2002

PROSES, Les parlementaires et l'environnement, ADEME, Septembre-Octobre 2003

Schnieders J., Hermelink A., "CEPHEUS results: measurements and occupants'satisfaction provide evidence for Passive Houses being an option for substainable building.", Energy Policy, n° 34, 2006.

TNS SOFRES/ADEME, Maîtrise de l'énergie - Bilan 2005, Attitudes et comportements des particuliers, ADEME, 2005

Traisnel J.P., Habitat et développement durable : bilan rétrospectif et prospectif. Les Cahiers du CLIP, n°13, avril 2001.

Wolfgang Feist, «Das Niedrigenergiehaus, neuer Standard für energiebewusstes Bauen», Kap. 12: Einfluss der Nutzer, C.F. Müller Verlag, Heidelberg, 1998

Wolfgang Feist, «Energieeffizientes Bauen in Europa; Erkenntnisse aus dem CEPHEUS-Projekt" «revue mensuelle: «»Bauphysik»» (No. 1/2002), Ernst&Sohn Verlag», Berlin, Feb. 2002

Wüstenhagen R., Wolsink M., Bürer M. J., „Social acceptance of renewable energy innovation : an introduction to the concept", Energy Policy, 2007.