Conditions for the Diffusion of High Performance Windows—an Organisational Perspective

Pirkko Kasanen, Work Efficiency Institute
Agneta Persson, EMC AB

1. Synopsis

Conditions for the diffusion of high performance windows, an example of energy efficient technologies, are studied. Key actors and stages in decision processes are identified.

2. Abstract

The paper presents a study of conditions for the diffusion of high performance windows, as an example of an energy efficient technology. High performance windows are loosely defined as windows promising significant energy efficiency improvements over conventional windows. Exact definitions vary from country to country, according to local conditions. Our study is based on Finnish and Swedish conditions.

We first build a framework drawing on theoretical and conceptual insights from literature on innovation diffusion and the dissemination of technologies. The empirical data comes from interviews with actors relevant in the context of window choice, both in renovation and new construction. We organise the empirical analysis in terms of stages of decisions and adoption, considering the actors involved in supply, demand and intermediate functions, and examining their interaction. We have also interviewed actors involved in cases where high performance windows were chosen.

The conclusions suggest ways in which to put the particular problems that could be solved by high performance windows on the agenda. Ways to improve the planning sequence of new construction and renovation are suggested, as are ways of giving high performance windows a fair chance in comparisons with conventional alternatives.

3. Introduction

The rehabilitation of old buildings represents a very substantial potential for energy efficiency improvements especially in the countries of Northern Europe. In Finland, the rehabilitation of existing dwellings and blocks of flats would reduce their energy consumption by 30-50%, using available energy saving measures (ETRR 1993). The heating of buildings corresponds to about 37% of the total carbondioxide emissions. These are typical figures in the Nordic countries.

Installing energy efficient windows is an important part of such rehabilitation. Energy efficient windows are available on the market. Besides improvements in the energy performance of a building and indoor climate, a well insulated building envelope allows savings in rehabilitation and building (for new buildings) costs by making it possible to simplify the heating system of the house. Better insulation also gives better possibilities for flexible use of space, giving more value for the investment.

However, the question is how to make full use of this potential for energy conservation. Rather than look for specific barriers, such as lack of information or inappropriate attitude on the part of expected adopters of the new technology, we assume that the actors within the system are functioning in a reasonable way, given the existing set of social and economic circumstances (Guy & Shove 1993). Our task is then to study these circumstances, as

regards high performance windows, and assess the representation of the technology in the circumstances.

In this study we focus on the stages in making decisions concerning windows in construction or renovation projects. We identify the actors making decisions or otherwise relevant in the context of the decision, and examine their concerns in context. We suggest changes concerning the process and the roles of actors, as well as specific measures that could be taken to improve the dissemination of high performance windows.

4. Theoretical and conceptual background

4.1. Innovation diffusion

As background, we will use certain ideas developed in research on innovation diffusion. The traditional approach to innovation studies emphasises the adoption perspective. Innovation diffuses through space and time much like a contagious disease. The flow of information and the characteristics of individuals (innovativeness) are important factors in this approach (Hägerstrand 1967; original in the 50s in Swedish).

Brown (1975, 1981) switched attention to the supply side. He takes the view that the opportunity to adopt an innovation is often and in many cases purposefully unequal. It is also important to notice that innovation is a continuous process of change. Specific technologies may be improved gradually, while the development of complementary technology may make them advance more rapidly. Institutions may also have to change for a technical innovation to be beneficial or to take root at all. All these considerations may lead an individual or a firm to delay adoption because further improvement is expected, rather than because they are inherently resistant or less innovative than the 'early adopters'.

Also a critic of a simplistic view of innovation diffusion, Linstone (1991) points out crucial differences between the perspectives of science and technology, and those of the people and organisations involved in adopting and using innovations. In this context two differences are worth noting. While the technological perspective seeks the best or optimal solution, cost-benefit analysis and linear programming being examples of tools developed within this perspective, organisations and individuals often strive to maximise their options, rather than confine them by selecting 'the best' solution. In this way it is the cost, rather than the likelihood of failure which is minimized. The other crucial point is the consideration of time horizons. Human beings apply a psychological discount rate to their own past and future.

Linstone goes on to suggest a multiple perspective concept for the study of innovation diffusion—besides the technical-economic perspective, organisational (or societal) and personal (or individual) perspectives should be used. None of the perspectives can be proved 'right', no 'proper' weighing of them is possible; and two perspectives may reinforce each other or cancel each other out. In the following, we present a set of important points according to Linstone. In using these perspectives to organise the material of our study, we do not suggest that these perspectives could be totally disconnected. It is human beings in organisations who apply all three perspectives in various situations— no perspecive has a life of its own.

4.2. Technical, organisational and personal perspectives: hypotheses for the window choice

In this section we introduce the different perspectives in the context of various aspects of decisions concerning technology. These aspects are among those suggested by Linstone (1991). We also briefly discuss ways in which these points could be relevant for the decisions concerning windows.

Goal: The technical (T) perspective has produced a superior window and can prove it. Some problems can be solved with the aid of this product. Organisations (O) faced with a window choice will try to use conventional decision making process, striving for stability. Persons (P) faced with a choice or a problem prefer to use and demonstrate their own power and influence. While people also like to gain prestige and power, new alternatives may be avoided due to the perceived risk.

Mode of inquiry: The T perspective provides us with data on the superiority of the high performance window. In organisations, the opinions of other people involved, and the views of other relevant departments are important. On the personal level, people learn from their own experience, or from that of close associates. Intuitive risk aversion is hard to break.

Issue selection: Cause and effect studies of investment cost and energy saving, framed only in terms of the T perspective, are not enough. In the O perspective, an improvement, such as high performance windows, needs to be put on the agenda, to be a part of the problem of the moment. Such agendas could be concerned with productivity, health problems, sustainable development or image questions. Persons tend to respond to problems as they are challenged by them, as well as carrying on with routine, taken for granted practice.

Evaluation -delegation: While the T perspective tries to simplify the problem into e.g. clear-cut comparisons of costs and savings, in the O perspective the problem is delegated to the appropriate level and sector, thereby also determining which factors come into consideration. A technically relevant factor may be excluded if it does not relate to the responsibility of the part of the organisation dealing with the issue. In the P perspective, personal needs are attended to. Even great potential savings or other improvements may go unnoticed if there are more pressing issues.

Evaluation - operating procedures: The T perspective can identify trade-offs between benefits and costs associated with alternatives. For the O perspective, it is important to stay within standard operating procedures, and to follow existing script and roles for actors. Procedures could be changed, but only with the aid of some incentive. It may be difficult to suggest that exceptions be made to the standard procedures, in order that high performance windows become accepted.

Evaluation - bargaining: The T perspective will show average figures and probabilities. For the O perspective, it is more relevant to find compromises between different interests, and to bargain for one's own interests.

Justification: While the results of window experiments within the T perspective may be valid and replicable, in the O perspective choices are also affected by context specific loyalties among members and political sensitivities, perhaps totally unrelated to the high performance window question. Personally, people want a certainty that their chosen solutions will work as expected. Old may therefore win in comparison with new.

Change: The T approach can quantify certain costs and benefits, suggesting the optimal window solution. In the O perspective it seems more secure to make incremental changes (where some things stay constant). Therefore, it may be a problem if high performance concepts are presented as total changes. Individuals (P) are sometimes afraid of any change.

Uncertainty: Technically it is correct to note uncertainties in a solution. Organisations tend to avoid uncertainties, biasing solutions toward the conventional. For any uncertainty, the organisations should be presented with a certainty of a satisfactory solution, in case the issue associated with the uncertainty should materialise. Besides technical uncertainties, social or organisational uncertainties can be important: For example, uncertainty about who else in the actor network can be persuaded to support the new solution. Personally, people keep sane by filtering out inconsistencies - once a belief is chosen, it is adhered to.

5. Methodology

Linstone recommends the use of unstructured interviews for collecting data on the organisational and personal perspectives of innovation diffusion. 'What is *not* said may be as important as what is said. Volunteered asides may be as significant as answers to questions' (Linstone 1991, 69).

The study if based on two sets of interviews. First, in order to identify the stages, actors and relationships involved in construction and renovation projects, 19 interviews were carried out with relevant professionals in Finland during Spring 1996. These interviews were unstructured and their contents varied widely. After reporting

these findings, results were compared with the Swedish conditions (as known by an expert).

Later, Autumn 1996, another set of 11 interviews, also in Finland, were carried out. The interviewees were professionals who had a key position in projects in which high performance windows were actually chosen. These interviews were structured and a questionnaire was used. The findings reported here are qualitative.

6. Stages and actors involved in the diffusion of new windows

The choice and installation of a window is a result of various preparatory stages. For the purposes of this analysis, it is useful to distinguish between (a) stages resulting in the demand for windows, (b) stages resulting in the supply of windows, and (c) intermediate stages that bring the two together.

6.1. Demand stages

A decision to build is taken by a land owner/developer, planning to sell a building once ready, by the future owner, or by a real estate company planning to rent the finished building. *A need for a renovation in an existing building* is perceived by the owner could be a real estate company or department, resident or user; the need is sometimes suggested by the superintendent or tenants. To assess the need, owners sometimes ask for help and support from real estate services or an association of housing companies.

Decisions about the overall concept and architecture of a new building are made by those who decide to build/have built, with input from an architect. Contractors also have a lot of influence. Cutting investment rather than life cycle cost is a major criterion. *Decisions about the scope and concept of renovation* are made by the owner or by a meeting of owners in housing companies, sometimes with support from real estate services or association of housing companies; sometimes after a survey of tenants in rental housing.

The real estate company or developer engages an architect, structural and HVAC designers, sometimes through a call for tenders, to make *plans for new construction*. Windows are included in these plans. Unless new concepts are introduced at earlier stages, standard (less than high performance) windows are expected at this point. Plans are then approved by the real estate company (or other decisionmaker). Housing companies sometimes engage structural designers to make (window renovation) *plans for renovation*. Sometimes plans made by the superintendent are used as a basis for a call for tenders. In other buildings consultants are engaged to organise planning and renovation. Plans are again approved by the owner.

The housing company or developer submits plans to *local authorities for approval* in terms of compliance with the building code (national) and local city planning. Aesthetic aspects of windows, as a part of the total appearance of a building, are very important in some cities, e.g. Helsinki and Stockholm.

In the case of new construction, often the contractor, though sometimes the real estate company, organises the *call for tenders for windows* based on plans and window specifications. In renovation in housing companies, tendering is sometimes organised by a consultant, sometimes by superintendent. For other owners, consultants take care of organising the renovation process, based on plans (including window type).

Comparison of tenders is done by the actor sending the calls; it may be approved also by those above in the hierarchy, if any. Evaluation criteria are often influenced by the need to follow the initial plan, look for low cost, and assess the reliability of quality and schedules. Tenders sometimes suggest better solutions than those specified in the plans. Such alternatives sometimes influence outcomes in renovation cases. *Decision* is based on the comparison and is sometimes formally made higher in the hierarchy than the level on which the call for tenders was organised.

Installing is a task which involves co-ordination and scheduling with other phases in construction and/or with residents or other users.

Inspection, feedback and reclamation follow installing. Contractors, real estate companies, and architect bureaus employ specific personnel for this stage. Residents are asked to list problems. Experiences at this stage affect the future choices of windows (etc.) by contractors.

6.2. Supply stages, production

Product design and development is done by manufacturing companies. They receive input and constraints from R&D, marketing feedback and also from building codes set by the government.

Components are produced by the window manufacturer, subcontractors and other suppliers, and out of the components, *windows are manufactured*.

In renovation, *installation* is done by the manufacture's own or subcontracted team, or by others (depending on the window manufacturer). In new construction, this work is done by the contractor's team. Afterwards, the questions raised by *inspection* are dealt with.

6.3. Supply stages, marketing

Information about products and concepts is supplied by manufacturers' marketing personnel who send brochures to and visit potential clients and designers, to demonstrate their products and services. Manufacturers also develop catalogues of design details for architects to offer *design support*.

Marketing personnel make unsolicited *offers* to housing companies by contacting superintendents, and by calling, door to door, on the owners of detached houses.

Marketing personnel sometimes influence the planning stage and the specification of the *call for tenders* in order to include a high performance window in the specifications.
The call for tenders is answered either to the letter, or with suggested improvements such as high performance windows.

6.4. Intermediate functions

Follow-up of (energy and other) costs or energy audits by real-estate service companies, can be the activity that initiates the renovation planning process on the owner's side. *Advice* is provided to housing companies regarding the need for and scope of renovation.

Detailed window designs are made by architects, often using catalogues of details provided by window manufacturers. The *structural design aspects* are taken care of by engineers. Interaction between the two designer groups is needed because structural concerns can make it necessary to change the architectural design of the window. Interaction between architects and *HVAC designers* is crucial. A building with high performance windows and one with conventional windows need very different HVAC systems.

The design stage is *constrained by* the building code (energy, safety, noise etc.), local building authorities with respect to aesthetics and local noise levels, cost constraints and responsibilities. Engineers are responsible for the cost and performance of their designs. Architects do not have that kind of responsibility but have their name connected with a building. The real estate company and other designers are unwilling to adopt designs that differ too much from the conventional ones.

Criteria for the choice of windows (by architects) typically relate to issues of aesthetics, functionality of the design process, functionality of the result, other technical aspects, demanded performance and design of the building (e.g. no radiators, making the use of the building more flexible).

6.5. Indirect involvement in all stages

The building code set by *the government* constrains the decision to build, the overall concept and the detailed plans. The structure of the code (component specific or other requirements) may also have an impact on how the design process is structured into stages. *The research community* develops new concepts and does research on their impacts. *Public opinion* affects for example the criteria used by State Real Property Authority, and municipal decision making.

7. Factors and conditions influencing choice

7.1. Organisational perspectives

In this section we summarise the contents of the 19 interviews that were carried out in Finland in terms of the hypotheses presented in the theoretical and conceptual background.

Goal
In an organisational context where stability and conventional procedures are important, architectural competitions are a conventional procedure for promoting non-conventional solutions. For example, competitions with ecological themes can be a good way to give a new set of rules for designers to follow. From the designers' perspective, successful participation in a competition enhances prestige.

The process of planning a residential building has a very established sequence in terms of which decisions are made at which stage (some implicitly). At the moment, the window question comes up at a point when the choice of high performance windows would imply redesigning many other components of the building. In practice, it is often too late to make such changes. The real estate company is in a key position here for if this player accepts a new concept everything else will follow.

Architects are careful in what they want to try, because the buildings and their problems will be connected with their names. Problems will hurt their personal prestige.

Mode of inquiry
In a housing company, renovations are typically discussed informally, after a formal meeting, so that the views and opinions of apartment owners and the superintendent can be established. Often the association of housing companies is asked to give advice as to the scope of the renovation. This is a way of learning from the experience of others in similar contexts.

According to our architectural respondents, familiar products are chosen because they are easy to use, due to previous experience, and because their functions are known. A new product implies learning new design systems, all of which takes time and trouble.

If a product or a concept is also familiar to the real estate company, it is easier for the architect to make a case about the merits of the product or concept.

Individuals are often convinced of the merits of high performance windows by means of demonstrations, on the basis of references or neighbour's experiences. These are concrete enough and count as learning by experience.

Issue selection
Even technically superior improvements need to get on the agenda. The State Real Property Authority is developing a policy of sustainable development in its activities. This agenda is somewhat influenced by public concern about certain issues. Aspects of sustainability include the use of aluminum, the useful life of components, the replacability of components, the eco-friendliness of structures, including the energy consumption in the production of components, and what is to be done to discarded components. Energy consumption of the building, when in use, is not conspicuously on this agenda according to the interview in the Authority. However, the prob-

lem of mould and related health issues are presently on the agenda of many people.

Ecological alternatives are becoming a marketing issue, even if more expensive than the conventional options. In the context of municipal buildings, citizens may demand energy conservation. A national initiative (by organisations, government) supporting high performance windows, such as information on sustainability or energy conservation, would help the work of people who sell the windows.

Energy conservation issues are increasingly connected with cooling rather than heating requirements in e.g. offices. Cooling is a relatively new perceived need in the Northern countries. Taking energy efficiency into account, possibly with the aid of high performance windows, seem easier in the context of a new procedure than in an established context such as heating.

High performance windows were offered directly in cases where the benefits are obvious due to concerns already on the agenda or specific challenges met in the case in hand, for example, relating to health (UV radiation) or excessive heat radiation. In general, the window salesperson should figure out the real needs of the customer and act accordingly.

High performance windows will be on the agenda more often if the price of energy goes up. Energy efficiency is not yet a common issue in the window context, but is probably coming. In individual homes energy issues are important even now.

Evaluation - delegation
An earlier improvement in the window technology, wood-aluminum frames, was also difficult to get accepted, regardless of calculations comparing costs and savings over the life of the window. The first to accept it were social real estate companies who also had responsibility for maintaining the building and were therefore in the position to enjoy the benefits to be expected, when maintenance costs went down.

In the municipal sector responsibility for construction and maintenance on the one hand, and heating (or cooling) the buildings on the other hand is often divided between separate departments. Therefore, an optimal window decision from the point of view of the building department may be an expensive one from the point of view of the department paying the energy costs. Even a social real estate company representative mentioned that it is not possible to consider the running costs (energy costs) of a building when making construction decisions.

In public or office buildings (e.g. State Real Property Authority), a real estate service company is charged with maintaining the value of the building and reducing the running costs.

In housing companies renovations are not always technically or economically optimal. Individual owners consider the maintenance of the common property (the cost of which must be shared among owners) from the point of view of their individual benefits and costs. The condition of the property as a whole does not tend to count as much as comparisons of which individual gets what individual improvements in the process. Example: rather than changing the windows that need it (e.g. on the south wall or in apartments where care is neglected), all windows are changed. In order to cut costs somewhere, inferior windows may then be chosen.

Evaluation - Operating procedures
Above it was mentioned that the various costs associated with the building over its life, often accrue to different municipal departments (or in general, different actors). If a standard operating procedure does not force each actor to take into account the point of view of the others, e.g. energy costs when making renovation decisions, optimal decisions are not made. In individual cases, a strong leader could change the procedure and convince the other departments. However, it would be crucial to make standard procedures such that the costs and benefits of different windows stand a chance of being evaluated.

A real estate services company suggests a procedure, which is in use at least in the buildings owned by the State Real Property Authority: The customer (owner of a building) gets feedback on energy and other costs. If energy costs are alarming, an energy follow-up study is commissioned. The results are interpreted. If necessary, an energy

audit is carried out. Improvements are suggested. Renovation is carried out. This procedure ensures that energy considerations feature in the renovation (possibly window) decisions.

The association of housing companies promotes a decision making process in which renovation and maintenance is planned for a long time ahead, and in which funds are collected gradually to finance renovations. In this context there is a real chance that costly but beneficial improvements will be adopted.

In experimental building, a group of designers gets together early in the process, agreeing on the process and the schedule. The suggestions of other members of the group are taken into account, and necessary adjustments made. This is an improvement over the conventional procedure in the regular residential building sector.

In conventional construction, social real estate companies give designers some rules about acceptable designs and components. E.g. wood-aluminium windows, 3-pane (2 as a sealed unit) are common specifications for apartment buildings.

The building code is strictly followed, according to a social real estate company representative, but extra improvements are not made, due to the costs.

It is normal procedure in Finland to ask for three tenders. However, Superglass, by Fenestra has until recently been by far the prominent high performance window alternative. The problem of not getting more than one high performance tender is considered severe by some Finnish architects and real estate owners. This could have two consequences: On one hand, it seems problematic to deviate from the normal procedure used in planning and decisionmaking. On the other hand, this situation suggests that the price of high performance windows is not competitive.

Evaluation - bargaining
In renovation of apartment buildings, windows are sometimes changed earlier than necessary, according to an architect who suggests that people want visible results given the high cost of the total project.

In some housing companies residents may end up with different, individually chosen windows (to a high cost) because a common renovation plan cannot be agreed on.

A promising technical solution may never be seriously marketed if it seems that nobody can make a profit of it; especially if it seems that some of the established actors lose ground. Energy conservation should be encouraged through company- and resident specific incentives.

Justification
According to a window salesperson, it is often difficult to find the real decision maker (in a window context) in an organisation. Decision makers and influencers lie behind each other. These power relations could influence window decisions while having nothing to do with their substance.

The salesperson often offers better and more expensive windows than those specified in the call for tenders. In selling windows, certain sensibilities have to be observed: The decisionmaker should not be given the impression that the person making the call for tenders is not competent enough. Therefore, Fenestra's Superglass is still marketed as a novelty.

A caretaker in a housing company (if any) is a key person in the window decision, as he can convince both residents and board members. He is also crucial for the practical management of window renovation.

Change
Rather than looking for optimal solutions, organisations tend to favour incremental changes, keeping many things constant. Individual persons may be afraid of change altogether. Thus a three-pane window may seem like a good incremental improvement which is not too big a change.

When other renovation is done at the same time, windows should not be too expensive.
When answering a call for tenders concerning the facade, a contractor cannot offer e.g. changes in the heating system that might become possible if the windows are improved. On the contrary, reductions must be made to the original, tightly defined offer. When looking for the cheapest possible incremental improvement, housing companies sometimes commission disadvantageous 'renovations' (a contractor's view).
Institutional owners such as insurance companies go for proper renovations.

It might be credible to compare conventional against high performance window alternatives, taking into account the smaller dimensions of the conventional heating system (circulating water) alongside the use of high performance windows. However, it would be less credible if the comparison required including a totally different heating system (e.g. air), according to a social real estate company representative.

According to window salespeople, customers do not always know enough about developments in glass technology to 'need' or demand characteristics that are in fact available.

Uncertainty
New products present a potential problem of liability should something go wrong. Uncertainty about the performance of a new procuct can be reduced by means of experiment (own or neighbour's). In the bulk of residential construction, technical risks are avoided. Even in more unique construction projects, special designs can lead to awkward responsibility problems. Ten year warranties rule out experimentation.

In an interview it was mentioned that engineers used to doubt the durability of the special properties of glass. The long term performance of the gases used in some high performance windows is often doubted. One way of convincing people of the reliability of Superglass is by referring to the 15-20 year experience in American space technology ('while new in Finland, this is not untried').

Apart from the window itself, there may be uncertainty concerning the performance of the building as a whole. If the windows are better, there is still a need for ventilation. If this is arranged by means of an opening near the window, will there still be draught?

In the window sale situation, the salesperson sometimes filters out uncertainties by promising to take care of the whole project, including taking measurements, arranging installation etc. Individual homeowners feel insecure when faced with a window choice. A feeling of trust towards the salesperson is decisive, as long as the price is roughly acceptable.

A contractor will pay a slightly higher price to avoid uncertainty as regards schedules etc. A social real estate company has annual contracts with window manufacturers. The benefits of such contracts are lower costs and greater certainty. Only the most reliable manufacturers are asked to compete for the contracts.

Economic uncertainties are reflected in window choices. In housing companies, people whose income is not stable, are unwilling to pay too much for window renovations.

7.2. Crucial actors in realized high performance projects

Apart from the interviews made to clarify the stages, actors and their roles in window decisions in general, a number of interviews were made (11 in Finland) concerning projects where high performance windows were actually chosen. We now report examples of results concerning the crucial actors for high performance window choice in these projects.

A large renovation project of a fair centre (a new entrance and a winter garden): The HVAC consultant got very strict design instructions as regards thermal conditions in the building. Faced by the constraints the designer, using a simulation programme to study various alternatives, suggested high performance glazing (Superglass) as a way to reach the intended conditions with lowest overall costs (including cooling as necessary). The decision about the glazing was made by the owner of the building before the main contractor for the project was chosen.

A new hotel building: When subsequently starting a new hotel building, the same owner found it natural to consider - and choose - high performance windows on the sunny side of the building. This project was organised as a 'project direction contract' rather than a more common total contract. Decisions can and must be made during the process, rather than being tied to one main contract.

A new school building: When planning a school building in the North of Finland, the representative of the municipality suggested high performance windows before the planning process started. The designers did not, however, manage to make full use of the possibilities to design a smaller heating system, which suggests that there would be use for a simple tool for the comparison of the different aspects of the design.

In a new residential apartment building as well as a school renovation project, the architects suggested high performance windows in the staircases and corridors.

An office renovation project: A representative of the owner, faced with demands by tenants to renovate the windows, found out about high performance windows and made the decision, supported by Fenestra's marketing efforts.

Summary:
Somebody who is involved early enough (developer, contractor, architect) must know of and be convinced of the benefits of high performance windows. Setting ambitious demands concerning thermal conditions, and having a designer who knows about high performance windows as a possibility is crucial. It is helpful if the designers have tools to balance windows, heating and cooling. In many of the cases cited above, people have been typical early adopters in the innovation diffusion.

8. Conclusions

This section identifies changes in the social and organisational conditions needed to accelerate the diffusion of high performance windows. In addition, some practical actions are suggested that would help bring about some of the necessary changes.

High performance windows serve as solutions to certain problems providing energy conservation in heating, reduction of cooling needs, improved use of space and improved comfort. *These issues need to be put more clearly on the agenda* when planning and designing new buildings and renovations.

The common sequence of design and decision stages is not conducive to the inclusion of building concepts including high performance windows. The sequence and procedure need to be changed. To make full use of the benefits associated with high performance windows, all members of the design team need to be co-operating. To achieve this, a high performance concept for a new building or a renovation project should be chosen at an early stage of the design project. The developer or real estate company should make a decision, and let a project manager take care of coordinating the design process. Succesful examples are to be found in experimental construction. In the longer term, education of building designers should emphasize these integrative aspects.

In renovation projects it might be helpful to ask for renovation ideas before the more specified call for tenders, in order not to exclude important alternatives.

High performance windows need a fair chance in the comparison of alternatives. If the favourable design implications, life cycle energy costs or the increased productivity of office workers are not taken into account in comparisons, cheaper but inferior windows are likely to be chosen on grounds of cost. Poor financing arrangements are also detrimental to well considered window choices.

If the costs and benefits associated with window choice do not accrue to the same people or departments, ways should be devised to involve all relevant actors in the decision. For example in municipal buildings, the depart-

ment responsible for energy costs should be making window decisions along with the department responsible for producing or renovating the buildings.

Even at the stage of a call for tenders it is useful to suggest a high performance alternative, especially when the particular needs of the project suggest it.

The following practical suggestions are made to enhance the three points made above.

To put relevant issues on the agenda, ambitious standards for eg. thermal conditions should be set by the real estate company, developer or public authorities. Even non-binding standards might help if suggested by relevant public or cooperative bodies (association of housing companies, public health authorities, proponents of energy efficiency, cooperative bodies for municipalities etc.).

The building codes set by governments are of course very influential concerning new construction. Apart from the values specified, the composition of the building code may affect the way the components of a building are considered, and the way design integration is attempted. Tightening the code will of course imply greater use of higher performance windows. Many actors comply with the code, but do no more.

To improve the planning sequence and process in favour of high performance windows, general or real estate company specific manuals should be developed. Such manuals exist and are appreciated. They usually specify the materials and dimensions etc. to be used in the projects of a certain developer. These manuals should be developed to include the high performance window and the associated HVAC design aspects. Apart from these, the correct planning sequence, making the integration of these aspects feasible, should be specified.

The State Real Estate Authority in Finland is in fact preparing a checklist for more sustainable building programmes, for its own use. Such checklists and programmes should refer to the energy consumed during the use of a building, not just to the environmental aspects of material choices.

In renovation, routines of energy follow up, audit and renovation planning, and systematic renovation plans combined with long-term financing plans (such as suggested by the association of housing companies) would help to highlight high performance alternatives before such options have been inadvertently excluded.

To give the high performance alternative a fair chance, a tool for presenting convincing comparisons is needed. The various trade-offs between investment costs in windows and other parts of the building, energy costs, and quality issues should be easily computed, taking into account the conditions of the project in question.

Positive feedback, both in terms of design quality and in terms of experiences in energy costs and comfort, should be provided in attractive form for decision makers and those who influence window choice.

Loans or subsidies should be available for the cases where the investment cost in the high performance alternative remains significantly higher than that for other alternatives. Subsidies creating a bias for high perfromance alternatives would also serve as a powerful signal of public preference, and as a moral support, even if the incremental costs are not fully covered.

Some window manufacturers prepare product catalogues that include design support for the most common details. This support is appreciated by architects. These catalogues should include high performance windows and the specific design details that might be relevant. For purposes of the design process, it would be helpful to include references to other design issues and possibilities in terms of space use, HVAC etc. Design support should also be available in the form of computer software.

References

Brown, Lawrence A.1975. “The market and infrastructure context of adoption: a spatial perspective on the diffusion of innovation.” *Economic geography*, 51: 185-216.

Brown, Lawrence A.1981. *Innovation diffusion: a new perspective*. London: Methuen.

ETRR 1993. Energy Efficient Buildings and Building Components. Final report on the energy research programme 1988-1992. Ministry of trade and industry, energy department, reviews B:162.

Guy, Simon and Elizabeth Shove.1993. “Leaping the barriers: Sociology, offices and the environment.” Manuscript (Part of research funded by ESRC “Putting Science into Practice: Saving Energy in Buildings”)

Hägerstrand, Torsten.1967. *Innovation diffusion as a spatial process*. Chicago: The University of Chicago Press.

Linstone, Harold A. 1991.”Multiple perspectives on technological diffusion: Insights and lessons.” In Naki´cenovi´c, Nebojπa & Grübler, Arnulf (eds.): *Diffusion of technologies and social behavior*. Berlin et al.: Springer-Verlag. Pp 53-92.

Shove, Elizabeth.1992. Environmental Cowboys? Commercial interests in energy efficiency. Manuscript (Part of research funded by ESRC “Putting Science into Practice: Saving Energy in Buildings”)