Smart technology for homes - An integrated approach to sustainable development

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1. SYNOPSIS

This paper presents a new approach to energy savings in houses enabled by the use of smart technology, also referred to as *domotics*.

Domotics is not commonly used in English, but is a translation of Domotica (a combination of Domus (= home) and Electronica (Electronics) or Informatica (Informatics). It is used in various ways to describe developments and technology that are related to home automation and the use of information and communication technology to provide services for consumers.

2. ABSTRACT

In this paper a package of interventions is formulated based on a new market approach to stimulate energy savings in homes. New information and communication technology is used as a driving market force, which stimulates the integration of energy systems and other functions. This development is used to stimulate parties from various market sectors and different government departments to co-operate and realise a synergy to meet both the goals of the energy policy and important social and economic targets.
The interventions are initiated to give energy savings indirectly a more important – and largely more positive – role for both the consumer and various players who are currently almost entirely unfamiliar with the concept of energy saving. In combination with behaviour interventions, these developments will in all probability lead in time to an increase in public support for energy saving measures.

The approach is considered necessary, because economic prosperity and technological developments lead both directly and indirectly to an increase in energy consumption. In order to attain the targets for energy use, new ways of combining prosperity with the saving of energy are required. ‘Smart technology for homes’ is such a new approach. Based on discussions with parties in the market and consumer research the interventions will in 2001 focus on a market approach to 1) integrate security, care and energy saving measures and investigate other product-market combinations and 2) make information and knowledge available to relevant parties and 3) stimulate co-operation between currently divided market sectors.

3. INTRODUCTION

Economic prosperity and technological developments enable us to live ever more luxuriously and to increase our demands for comfort and safety. These social trends lead both directly and indirectly to an increase in energy consumption that is completely at odds with government policy to limit energy consumption and CO_2 emissions. The government has no desire to restrict the consumer’s freedom to purchase and consume: on the contrary, the government stimulates new developments and aims to ensure the Netherlands occupies a prominent position in the small group of countries who are prepared for the coming information society. In order, meanwhile, to attain the targets for energy use, it thus becomes necessary to find new ways of combining prosperity with the saving of energy.

In some respects, prosperity and technological developments with regard to the consumer pose a **threat** to energy policy because:

- Increasing luxury and technical possibilities/functions lead to an increase in the number of appliances.
- Higher demands for comfort generally lead to increased energy consumption.
- Energy saving has a lower priority than comfort, health or the need to spend time efficiently. In addition, rising incomes mean, too, that energy costs take up a relatively smaller proportion of the household budget.

However, the developments can also offer **opportunities**:

- Developments in the information and communication technology offer options to optimise the efficiency of energy systems by making the technology more 'smart' and improve interaction with the user.
- A higher average disposable income creates opportunities for the marketing of high quality, energy-efficient products.
- New information and communication technologies make the division between energy functions in both technology and marketing disappear. This offers chances to combine 'high-interest' products such as security, with a 'low-interest' product such as energy. This can accelerate the introduction of sustainable energy systems and concepts.

The underlying strategy of the integrated approach is that:

1. the goals of the government on CO_2 and energy savings can be related to social-economic issues and existing market forces and
2. the government formulates generic incentives to stimulate demand, rather than technology push incentives to stimulate the reaching of these goals. It is left to parties in the market to determine how these goals will be attained and to indicate how the government should further facilitate this.

The necessity for such an integrated approach exists because – as long as the energy prices do not increase rapidly – there is not enough incentive in energy conservation in itself to realise a market transformation. In the long run energy saving goals may only be obtained if the energy savings are related to essential necessities, such as safety, health, comfort, convenience and communication. With smart technology options exist to achieve this synergy.

The integrated approach is divided into three main areas: Smart homes, Energy Functions and activities to stimulate energy efficiency behaviour. Making houses smart focuses on adapting existing technology to the house and on behaviour of the users. Energy savings are to be achieved by 1) automatically optimising the energy performance of the house and 2) by improving the user friendliness and informing the user, thus avoiding unnecessary energy consumption.
Activities that primarily deal with energy functions focus on the supply side of appliances. Smart technology can be integrated on appliance level (e.g. using sensors) to improve energy efficiency or by feedback to stimulate energy saving behaviour. In the market other options may occur by combining energy efficiency with other functions, such as security or care. This development is already set in motion through the liberalisation of the energy market. Energy companies are investigating possibilities to expand their services to customers in which energy efficiency may be combined with services such as security. The other field of interest lies in the government policy to stimulate the elderly to continue living on their own. Smart technology makes it easier to stay on their own without daily care. This technology may easily be combined with the energy systems to improve indoor climate conditions and save energy at the same time.

In the course of 2001 smart technology plans to experimentally test and make available at least five smart energy-saving concepts for the consumer and the new product-market combinations arising from them. During the concept development stage, national and international knowledge is applied and a network is set up of experts and parties in the market. The new product-market combinations have been chosen with a view to upscaling and widely marketing them after 2001.

The effect of the intervention should, however, be seen in a wider context than direct energy savings. The interventions will cause energy to assume a more important – and largely more positive – role for both the consumer and various players who are currently almost entirely unfamiliar with the concept of energy saving. In combination with behaviour interventions achieved via various means including the dissemination of information, these developments will in all probability lead in time to an increase in public support for energy saving measures.

4. SMART TECHNOLOGY FOR HOMES

Actual situation

Information and communication technology operates in a rapidly developing field in which energy saving plays little or no role. The trend is for luxury, comfort and ease, all of which will increase the demand on energy in the coming years. This increase is clearly apparent in the increasing number of appliances, a rise in the demand for comfort (the call for higher temperatures in winter and cooled air in summer) and, presumably the increased durability (and stand-by mode) of such appliances as PCs.
The current improvements in energy efficiency and the move towards sustainable energy are insufficient to maintain the current level of fossil energy use, or to reduce it.

Smart technology for homes includes a wide range of applications within the house to improve energy efficiency automatically or by improving the interaction with the user, thus stimulating energy saving behaviour. For example sensors that detect the presence of people can be used to automatically control the heating and ventilation system. The sensors may also be used for a bugler alarm, the ventilation system can be connected with the heating system and controls can be managed separately for each room. An interface can inform the user of the consequences of the current settings and provide direct options to improve the settings without decreasing the comfort.

Overall strategy

The use of smart technology makes the bounderies between energy functions disappear. Logical combinations can create new options to stimulate energy savings. These opportunities exist in integrating energy functions, such as security, health care and energy control. The synergy is enabled by developments in the information and communication technology, but in order to succeed will also need to take form in the government policy and market. The strategy concentrates on the use of focused interventions to stimulate parties in the market to make use of these ‘opportunities’. This will be stimulated by bringing parties together, by making knowledge learned in other sectors transparent and accessible, and by means of field projects challenging parties in the market to follow through on their promises.
The starting point of the interventions is not a blueprint of a house or co-operation between market parties, but the demands and needs of the people that live in the houses and market parties involved in services and building practices.
Made-to-measure solutions are then sought. The parties in the market are free to decide how energy is to be saved as long as they reach a certain level. In this way, new concepts and product-market combinations are sought which:

1. Lead directly to collaboration, to larger scale provision of services and products, and
2. As an indirect spin-off cause all parties, including the consumer, to pay more attention to the question of energy. In particular, a positive view of energy saving in the context of comfort, luxury and ease could accelerate its acceptance.

For this reason, the attention surrounding new product-market combinations is directed at the top, luxury market segment and the better-off middle classes with the aim of finding out how they can be motivated to combine new luxuries and functions with energy saving. The key is most likely status, the knowledge exhibited by the person installing the new appliance, and so forth.
The gulf between various market sectors prevents these developments from automatically disseminating through the market. In addition, they do not appear to offer short-term profit and are associated with new insights in the areas of social and behavioural science of which no one is yet sure.

A related problem is that products still do not sufficiently match up to consumer requirements and behaviour. The interaction between the smart technology, appliances and behaviour is most apparent in this issue. What is offered should meet the needs of the user and offer still more – added value – for a reasonable price. Added value consists of increased ease, comfort, beautiful design and the fast and accessible provision of information. What information is of interest to the user and how this is provided and displayed is a major subject of study. Only useful and well displayed information will in the long run be accepted and used by the consumer. Therefore the projects included research on consumer friendly designs, consumer testings and monitoring of acceptance and behaviour.

Energy saving

On the basis of the problems and the possible areas in which the solutions lie, a coherent package of interventions is formulated. The successful implementation of this package can lead to a reduction in the growth of energy use of 15 PJ (Petajoules) [4,2 TWh] in the Netherlands by 2010. New functions, luxury and comfort relative to the autonomous growth in the number of households and the increase cause the impact this may have. The overall change in energy use is not calculated, because the increase is highly dependent on economic growth and is not directly related to the interventions.

The opportunities for energy saving offered by smart technology in houses lie primarily within the functions heating and ventilation and to a far lesser degree within lighting, recreation and communication.
An indication of the split of the actual saving through smart homes per function is: heating and ventilation 80% (roughly half of which is from demand-driven ventilation) and 20% for the other functions.

Suppliers, however, will primarily be on the look-out for ways to forge a logical link with the energy-saving options offered by the above-mentioned functions in the field of security. It appears from discussions with parties in the market that the application of security, in particular, shall sharply increase in the coming years and this provides an opportunity to accelerate the introduction of advanced energy control systems and feedback. The combination of security and energy-efficient functions may possibly even create a 'killer-application' that will speed up energy efficient sales- and user behaviour.
The estimated energy outcomes will be realised by:

1. Optimising existing energy concepts: aided by improved organisation and consumer-focused design, enabling systems to meet the perceptions and behaviour of users: *from energy efficient building to energy efficient living, working and recreation.* The estimated effect is strongly dependent on the spin-off from the players' transfer of knowledge and the support of a set of generic instruments**.** With a saving of around 10 GJ/residence (circa 10%) and an upscaling to around 500,000 residences, the saving in 2010 would be about 10 PJ (5-15 PJ) [2,8 TWh (1,4 - 4,2 TWh)].

2. The accelerated introduction of energy-efficient concepts by coupling the marketing of a 'low-interest' product such as energy to 'high-interest' products such as security and communication. The effect is estimated as being an average saving of around 10 GJ/residence. The number of residences that would be reached is difficult to estimate and is roughly estimated at around 50,000 with a saving of 5 PJ (3-7 PJ) [1,4 TWh (0,9 –1,9 TWh)]

The effect of the intervention should, however, be seen in a wider context than just the calculated energy savings. The interventions will cause energy to assume a more important – and largely more positive – role for both the consumer and various players who are currently almost entirely unfamiliar with the concept of energy saving. In combination with behaviour interventions achieved via various means including the dissemination of information, these developments will in all probability lead in time to an increase in public support for energy saving measures.

5. PROBLEMS AND ROUTES TO SOLUTIONS

As noted in the course of projects and during workshops with parties in the market, various problems have been identified and routes to solutions for these have been formulated. The problems and directions in which solutions might lie are summarised below for individual interventions and groups of interventions.

Table 1. Problems, routes to solutions, and interventions

Interventions	Problems	Routes to solutions
1. Facilitate exchange of knowledge Energy-effect: see int. 2 and 5 Support & basis for spin-off of knowledge arising from int.	• Industry and installation sectors are not inclined towards productive collaboration • Suppliers have no insight into consumer behaviour	• To somehow facilitate the exchange of knowledge between behavioural science, technology suppliers and clients • The creation of a virtual knowledge centre
2. Functional integration technology and marketing	• Domotic's market development has primarily been in the area of products for care, safety and 'gadgets' that will ensure a rise in energy consumption	• The generation of attention for energy by autonomous domotics developments, including energy consumption within parts of domotics itself
3. International aspects • Standardisation • European efficiency requirements • Make inventory and keep abreast of developments, policy instruments and techniques Energy-effect: Supported by interventions 1, 4, 5 and 6; efficiency requirements are generally generic instruments and similarly important for 2	• There is no open communication system ('plug and play' principle) used by all suppliers. This leads to the creation of monopolies, which may in turn lead to there being one supplier, and there being no guarantee of flexibility or adaptability for the consumer. There won't be a *level playing field* for new or small-scale players. • Many technical developments happen abroad – no point reinventing the wheel • Domotics will be promoted in other European countries	• The investigation and support of possible efficiency requirements at European level • The investigation and support of possible standardisations, at national (Dutch) and European level • Make inventory and keep abreast of developments in areas of technological development and (government) instrumentation that may be advantageous to domotics
4. Consumer-oriented concept development Energy-effect: Necessary preparation for int. 5. Partly a consequence of intervention 2.	• Insufficient attention is paid to how the consumer will use an appliance, so it is used incorrectly and energy consumption rises as a result. • Ideas are not solution- but product-driven. The integration of functioning systems often involves the choice of ad hoc solutions. This causes extra energy consumption.	• The stimulation of consumer-oriented thinking and action by suppliers of products and systems • The stimulation and support of concept development by market players
5. Practical projects Preconditions are 4 and spin-off via 1 and 2. Translation to generic instruments at 6	• Clients are unaware of the possibilities, new concepts must first be demonstrated before they are applied on a large scale and the government is expected to set an example.	• The stimulating and support of demonstration projects which are specifically accessible to the general public, undertaken in close collaboration with the Ministry of Economic Affairs e.g, through the application of energy from the Ministry of Housing's ID-Neighbourhood (ID-Wijk) and the Ministry of Transport's Knowledge Neighbourhood (Kenniswijk)
6. Translation of domotics intervention into a set of generic instruments Energy-effect: Precondition for the realisation of the energy effects by 2010 by int. 2 and 5.	• Current generic instrumentation such as legislation, standardisation and subsidies take little or not account of domotics. This is primarily because domotics derives its value from integrated systems and not from isolated products or components, which makes it difficult to add it to the current body of instruments.	• The investigation of possibilities to stimulate domotics by means of generic instruments such as EPN, EPA and EPR

The formulation and elaboration of the specific interventions and routes to solution are still broadly defined because they are at their early stages of the process. The ideas for new intervention arose by analysing various energy saving projects, consumer research and discussions with parties in the market.

Interventions

Knowledge exchange between behavioural scientists, technology suppliers and clients

The speed with which information and communication technology develops makes it difficult for parties in the market to keep abreast of developments. Developments are supply driven, underpinned by the belief that supply itself creates a demand. The consequences of this are twofold: i) a poor overview of products and lessons learned from field projects elsewhere, so that the wheel is repeatedly invented – often by means of expensive research, and ii) that products and systems available on the market do not correlate closely enough with local demand or consumer behaviour.

a) Objective

An increase in the *collaboration* and *exchange of knowledge* between owners, technology suppliers, consumers and behavioural scientists.

b) Results to be achieved

- More accessible information about international developments, products, systems and demonstration projects.
- Increase in knowledge of relevant consumer behaviour on the part technology suppliers and clients.
- Increase in collaboration between clients, technology suppliers and behavioural scientists.
- Improvements in the user-friendliness of appliances, systems and concepts.

c) Approach

The application of behavioural science knowledge to a very technical and strongly supply driven market demands, for many parties, a considerable shift in their ways of thinking and working and it will take some time before the benefits of this shift are apparent. The proposed activities in 2001 are primarily 'low-threshold' and focus on: i) parties who wish to work in accordance with policy, but who lack the knowledge to do so (e.g. charitable corporations and progressive project developers) and ii) 'innovators and early adaptors', who will quickly appreciate the advantages of the new approach (e.g. innovative suppliers).
These experiences will enable investigation into whether the early and late majority can be reached in this way – although possibly somewhat more slowly - or whether this will require extra measures after 2001.

Functional integration in marketing and technology

The market development of domotics has primarily been in the area of products for care, safety and 'gadgets' that will only ensure a rise in energy consumption. It is technically possible for various systems to be used for several functions, such as security sensors and chip card keys for indoor climate regulation. The linking and integration of functions seems, moreover, not only interesting in the technical sense, but also offers marketing opportunities for combinations. There are numerous advantages that can be made attractive to technology suppliers:

- The environmentally friendly image.
- The ability to supply a broader and more interesting range of products and services.
- Economies of scale and the streamlining of the organisation in marketing, customer networks, service and maintenance (the one-stop shop notion).

a) Objective

To stimulate attention for energy through autonomous domotics developments, including energy consumption within parts of domotics itself.

b) Results to be achieved

- Insight into new product-market combinations.
- Insight into possibilities for European efficiency requirements.
- Realised collaboration between technology suppliers in different market sectors.

c) Approach

The liberalisation of the energy market and the increase in the size of businesses have already led to combined services being offered to some degree. This process is not automatic and/or does not lead to the *saving* of energy. Through the stimulation and facilitation of collaboration between umbrella organisations, potential

suppliers and the institutions concerned, parties in the market come into contact with potentially interesting partners and possible commercial advantages become apparent. The collaboration and integration of technology and marketing can be further elaborated during concept development and in field projects.

International aspects

Domotics' technological supply has a strong international component. European and world-wide agreements and developments in this area are relevant because:

- Many foreign products, systems and projects can be made available, with some adaptation, for use in the Netherlands.
- Policy on labelling, standards and efficiency requirements *(including the use of stand-by)* takes place at European level; interventions at European level are required if domotics is to retain control of the autonomous growth of its own consumption of its machinery.
- International agreements on standards for domestic networks. The possibility of influencing these via Dutch policy appears severely limited because these agreements primarily take place between multinationals and are barely influenced by European policy. It is, however, important to keep track of developments in order to keep Dutch activities in step with them and to be able to anticipate intervention opportunities.

a) Standardisation of domestic networks in detail

For domotics' concepts to function well, appliances must communicate with each other and thus speak the same language. The ultimate aim is for a domestic network to which each appliance can be 'plug & play' connected. Examples of such networks are the PC, printer, scanner and digital camera, or central heating boiler, solar boiler, thermostat and, for example, the possible connection with the TV for feedback**.** This system can be physically created with cables, but the possibility of 'wire less' networks is also being looked at.

There is as yet no standard for the domestic networks (the 'plug and play' principle) used by all suppliers. This means that the flexibility offered by domotics solutions are not guaranteed over time, and the risk exists that:

- Systems cannot continue to expand after a couple of years (as happened to the Philips' V2000 video system).
- Networks can only communicate poorly with each other, or not at all, which causes disruptions and errors by the operating system (comparable to the collaboration between Word Perfect and Word in Windows; it works, but with a lot of problems).
- Monopolies may develop, which destroys the *level playing field* necessary for new or small-scale players *and* new systems are sold for unnecessarily high prices (e.g. Intel processors and Windows).

b) Objective

To obtain an overview of current international developments in the field of domestic networks, standardisation and policy developments relevant to domotics, *and* to gain insight into the possibilities of policy instruments that can be translated into the Dutch situation and stimulate standardisation appropriate to the Netherlands.

c) Results to be achieved

- Insight into international developments and standardisation in the field of domestic networks and possibilities to promote standardisation.
- An overview of internationally developed policy instruments which can foster domotics and energy saving.
- Acceleration of the spread of knowledge and development.

d) Approach

Alongside research for the creation of an inventory of policy developments, model projects and technological developments, considerable time will be spent on the expansion of the existing network of international clients and on seeking possibilities for collaboration.

Consumer-focused concept development

Technological development in domotics is strongly supply led: technological renovation puts new products on the market, and many products are marketed without a preceding demand analysis. Contrast this with the IKEA concept, in which the supply is tailored to sales. This is often the case for new domotics applications. They are thrust onto the market with the help of extensive advertising campaigns. The problem is, namely, that it is not

easy and takes a great deal of time to assess the need for a new product with a previously unknown function. A quick adjustment to the product, and sometimes to the marketing technique, given reactions to the first-generation product is an indirect way of reacting to demand. The danger exists that the product is indeed eventually sold because it is trendy or because it delivers just enough added value, but that the product is far from user friendly or fails to meet user needs. And what's more: its defects keep the market in flux and demand is created for an improved product, which once again is not optimal - as is the case with Microsoft Windows.

Consumer-oriented design is not concerned with sales figures. It is concerned with long-term quality and maximising the user friendliness of a product or concept while gaining a broad insight into consumer needs. Better-designed products lead to better use and thereby to energy-efficient use.

a) Objective

To better meet consumer requirements and to increase the user friendliness of domotics concepts and products, thereby (1) preventing a rise in energy consumption caused by incorrect use and (2) increasing the acceptance of energy-efficient domotics systems by consumers.

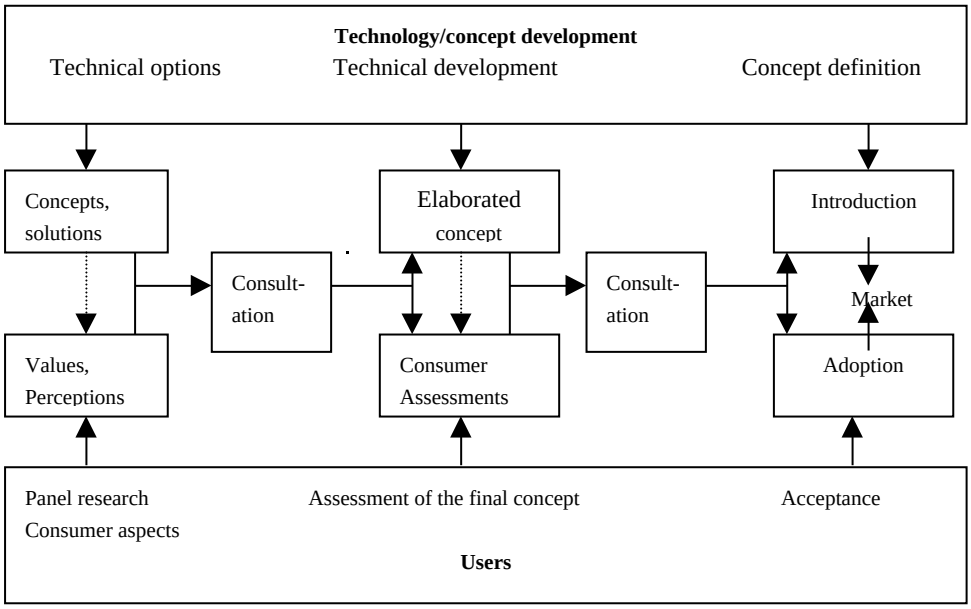
b) Results to be achieved

- Consumer-focused methods of developments appropriate for target groups.
- An overview of about 10 interesting product-market combinations.
- Insight into the possibilities and effects of the use of sensors for climatisation, power management and demand side management (in preparation for differentiated tariff structures, green energy supply and the local regulation of the supply and use of sustainable energy (e.g. the fridge or heat pump temporarily moved from peak demand to low demand).
- At least one consumer-oriented global concept for about 10 product-market combinations. The development is to take place via the method outlined, which is currently being tested in an experiment project with NUON and Honeywell.
- At least six energy-efficient and user-friendly domotics concepts worked out in all in practical details.

c) Approach

By bringing consumer issues to the attention of the market parties involved early on in the development process of the concept, account can be taken of the requirements of the eventual user. Where interaction takes place between technology developers and end users, concepts can be developed in a consumer-oriented manner (interactive planning). The interaction between the consumer (authority) and the developer is especially important, given that a developer cannot learn about consumer reasoning by reading reports. For this reason, the development process should involve meetings between consumers and developers. Fonk has elaborated this method in the Vision of the Future for Consumers (TvC) methodology. The method is presented schematically in the following figure.

This method is presented in the following schematic:



The method was originally created for product development but can, of course, be adapted for new designs in parts of a home. The method has two important features: (1) all parties involved in the development process are brought together and (2) at various points in the development process, consumer discussion panels are held.

These and other methods can be used to make domotics concepts user friendly. There remain, indeed, great differences in behaviour between consumers, and for the making of product-market combinations, it is useful to divide households into *rough* categories, on the basis of, for example, their time and financial budget (see table).

	Little money	**A lot of money**
Little time	Among others, single earners with children, the self-employed and young families. Profits from extra (low threshold) functionality added to existing appliances	Growing category of households. Open to the purchase of domotics and high-tech domestic appliances, and options to enable limited time to be better spent, such as various tele-activities
A lot of time	Primarily immigrant households and minimum wage earners, usually reliant on the subsidised rents of housing associations. Has the time to learn how to use domotics, but lacks the necessary facilities.	Increasing number of 'empty nest' households. One- or two-earners older than about 55. Includes the need for (private) care services and the strengthening of social networks, in which domotics can serve as a resource. Places high demands on comfort and service.

Field Projects

On paper and in the suppliers' shop windows the possibilities for domotics appear endless. Whether or not the possibilities work in practice and live up to the requirements of residents and how residents actually handle them can only become clear when they are applied in real life. Before new concepts can be adapted for use on a larger scale, it must be shown that they function correctly. It is preferable for a concept to be tested in a large number of buildings, which at the same time limits the risks of experimental applications to projects of a restricted size. This dilemma can be overcome by incorporating as guidelines several levels of aims:

1. Smart homes – energy efficient: minimum level; works with systems that are ready for the market and is more energy efficient without many risks (an energy saving of 10-20%), indication: in 70%-90% of all buildings/households involved in the project global monitoring of energy effect, behaviour and perception. Goal: to increase the general public's familiarity and to make large-scale effects apparent.
2. Smart homes – energy ambitious; an energy saving of 20-40%; manageable risks, extensive monitoring within behavioural and technical parameters; indication of project size 10-20%. The aim is to test an improved concept in practice for its technical function and user acceptance. The size is too small to enable the measuring of any representative effects on behaviour.
3. Smart homes – energy neutral living; this level is not always worthwhile: the detailed measurement of the technical functioning of components and behavioural parameters (e.g. internal environmental parameters over time, the functioning of a mix-gas sensor, power management or a fingerprint technology).

N.B. the concepts under 2 and 3 should take the energy-efficient concept under 1 as their starting points.

In addition, there are ever more initiatives in the field of domotics in which energy conservation is of no interest at all. Clients are often not aware of the possibilities, while some often do exist in technical and marketing areas. With focused interventions in the process, energy can be put on the agenda.

The government itself has started a number of projects, partly with the aim of setting a good example, such as the Ministry of Transport's Knowledge Neighbourhood (Kenniswijk) in Eindhoven and the initiatives currently running via the Ministry of Housing's ID-Neighbourhood (ID-wijk). These projects should certainly draw attention to an integral approach.

a) Objective

To stimulate and support demonstration projects that are specifically accessible to the general public, undertaken in close collaboration with Ministry of Economic Affairs, e.g through the application of energy from Ministry of Housing's ID-Neighbourhood and the Ministry of Transport's Knowledge Neighbourhood. The purpose of the projects is to increase familiarity with the new possibilities on the part of the parties involved and the general public (both directly and indirectly through subsequent spin-off through the parties involved).

During the upscaling of the applications, the projects should furnish insight into the perception and behaviour of users, the functioning of organisation and technology, and the actual energy consumption of the concepts in real life.

b) Results to be achieved

- Overview of current domotics energy projects in the Netherlands and interesting international projects.
- Incorporate energy conservation into the development process at the 'Knowledge Neighbourhood' in Eindhoven.
- Start 5 energy-saving domotics projects in 2001.
- Plans for behaviour research in the coming years to be realised in field projects.

c) Approach

The consumer-oriented concept and product development could lead to the desired 'killer application'. As every designer will agree, real life is, however, unpredictable and, in consumer-oriented design too, daily reality cannot be imitated. The testing and good analysis of concepts in practice furnish valuable information about:

- The perception of various users
- The technical functioning of the system/concept
- The relationship between behaviour, technology and service, and actual energy use
- The organisation of process around the application, possible energy services as well as service and maintenance
- The attitude and approach of the parties involved, which can be used to formulate follow-up activities (such as focused process support, agreements and the facilitation of partnership) in order to accelerate the application's introduction on a larger scale.

Translating domotics into a set of generic instruments

Current generic instrumentation such as legislation, standardisation and subsidies take little or no account of domotics. This is principally because domotics derives its value from integrated systems and not from isolated products or components, making it difficult to add to current instruments.

a) Objective

To obtain insight into the possibilities of energy efficient smart homes being stimulated by existing or new generic policy instruments.

b) Results to be achieved

- Insight into technologies that can be converted into generic instruments.
- Advice and support in converting technologies into generic instruments.
- The energy-efficient domotics concepts and technologies are incorporated into and spread throughout Novem programs from 2002 onwards.
- Advice about possible use in the Netherlands of instruments developed abroad.

c) Approach

Through consumer-oriented concept development, field projects, contacts with technology suppliers and inventories in the Netherlands and abroad, insight is gained into smart technologies that in time may pay off by being accepted as generic instruments. Suppliers can be guided through the processes they must follow to get their product accepted, which might, for example, include an equivalency certificate or input via relevant commissions. Where necessary, support can be given to help the supplier to adapt the technology to meet acceptance requirements.