# Towards energy-efficient housing: prospects for UNECE member States

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Photograph on the cover: a power station overlooking housing estates in Moscow (taken by Oleg Golubchikov, February 2009).


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For more information on the First UNECE Workshop on Energy Efficiency in Housing (Sofia, 21-22 April 2009) see: www.ee-housing.com.

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## EXECUTIVE SUMMARY

In the UNECE region, buildings are responsible for over a third of total final energy consumption; by and large, this energy goes to the residential sector (20-30% of total final energy consumption on average). Demographic, economic and cultural changes will only increase the pressure of housing on energy consumption and will be accompanied by even higher levels of greenhouse gas emissions. On the other hand, evidence suggests that it is the buildings sector and, particularly, the residential sector that could generate some of the greatest energy savings. Exploring this opportunity, the present paper delineates key benefits, challenges and prospects for the UNECE member States in the field of energy efficiency in housing.

Energy efficiency should be regarded as an alternative source of energy, investing into which has the same result as investing in increased capacities of energy supply, but much cheaper, quicker, and with further environmental, social, economic, and political benefits. In addition to contributing to carbon reduction and energy security, interventions in this sector improve the conditions of living, decrease fuel poverty, mitigate social inequality, stimulate innovations, and regenerate the built environment. Thus, benefits from energy efficiency in housing are not limited to any particular spatial scale, but involve local, regional, national, and global impacts. However, these impacts are particularly visible at the national or international levels, at which energy balances are seen in their totality and at which differentiated and often contradictory microeconomic interests comes aggregated. This highlights the importance of government policies in driving the complex technological and institutional change towards improved energy efficiency.

It is important to stress that the most serious challenges for energy efficient housing are not simply technological. Technology is certainly central, but for the most part the technology of energy efficiency is well understood, fast developing and, if embraced under the economy of scale, becomes increasingly cost-effective. It is estimated that at present 25-40% of direct energy savings, depending on the UNECE member State, may be reached in the housing sector by applying existing cost-effective technology. However, investment in energy efficiency is undertaken only on a limited scale, far below of what may be considered as rational. This paradox is known as the energy efficiency gap. It appears that most vigorous challenges lie with establishing a proper institutional structure that would set large-scale efficiency measures in motion.

The paper proposes an analytical approach to understanding the institutional structure of energy efficiency in housing. Better energy efficiency is considered to be a result of the application of technology and/or knowledge, which, in turn, is driven by conditions that are conceptualised by five "in"-keywords, including **investment, information, innovations, incentives** and **initiative**. Government, landlords and building industries represent the triangle of the major stakeholders, whose mutual interrelations determine the status of the five "in"s in terms of delivering energy efficiency.

Using this approach, a number of barriers to better energy efficiency in housing are visible. The most common barrier for investing in energy efficiency in housing is a lack of incentive and low priority of energy issues versus alternative opportunities surrounding households and economic agents. Energy prices are unstable or incomplete; energy efficient products are more expensive than less efficient alternatives. If there are low priorities for efficiency and no mechanisms that allow the energy performance of buildings to influence their value, the whole technological chain involved in the design, production, and management of houses is malfunctioning. There is also the problem of high "transaction costs" in investing in energy efficiency; households are sensitive to the effort and time spent improving energy efficiency. Other barriers include a lack of information and awareness, lack of initiative and organisational barriers, lack of innovation and technological backwardness, and lack of investment and finance (including limited affordability, limited access to capital, uncertainties and risks associated with energy efficiency projects).

Although much progress has been made recently, the existing situation in all UNECE countries leaves much room for improvement. Even those members that are considered to be advanced for building standards are far from fully realising the potential of the sector. Transition countries in particular lag behind and their housing is characterised by low efficiency standards (especially panel-built houses of the 1960s-1980s). A specific challenge for these countries relates to overcoming what can be called the “energy inefficiency trap”, or a situation in which countries having lower energy efficiency are unable to change their respective status due to the lack of funds, experience, technology, motivation and initiative. That said, it is also found that that the legacy of central planning features a number of positive factors, such as the large number of standard multi-apartment residential blocks to which similar solutions may be used, a strong tradition of district heating, and a high use of combined heat and power.

Having analysed these experiences, the paper discusses policy implications and provides a set of recommendations for governments and international organisations.

<u>The prerequisites for successful policies</u>

*Contextual underpinning*. There are large differences across the UNECE region with respect to the levels of economic development, legislative and organisational structures, the history of the residential sector, and climate conditions. Policies should be sensitive to this diversity and be sufficiently embedded into local socio-economic, institutional and geographical context.

*Multidimensional character*. It has been suggested that there is no ‘silver bullet’ able to resolve energy efficiency in housing quickly and hassle-free. Policies should be comprehensive, thoroughly developed and integrative of a number of instruments, including regulatory and non-regulatory ones.

*Social responsibility*. It is vital to interlink energy efficiency policies in housing and social policies. Policies should ensure affordable access to energy, mitigation of social inequality and improved social wellbeing. To consider energy efficient housing in simply narrow technocratic terms is wrong from both social and political points of view.

*Political and organisational leadership*. The nature of the problem requires a devoted process of policy-making, of implementation and control rather than a one-off endeavour or declarative programmes. Energy efficiency policies are rarely successful unless they are underpinned by strategic thinking and strong leadership. It is advisable that a special organisational structure is charged with the responsibility to coordinate government efforts in the field.

*Statistical backing*. Policy-making and management activities need to rely on data that allow assessing both the current situation and policy impacts. It is important that statistical capacities are raised. In addition, information systems need to be set up at the regional and local levels.

<u>Accommodating energy efficiency: policy priorities</u>

*Raising awareness and public dialogue.* Legally-binding informational instruments such as mandatory energy performance labelling of household appliances, energy performance certification of buildings or other declarations of energy consumption are already widely in use, and should be promoted to make energy efficiency be highly visible in the residential market. Other, “soft” instruments to be encouraged include capacity-building, educatory and training measures; good practice and informational exchanges; voluntary energy labelling; demonstration projects; promotion of energy-efficiency technologies; and promotion of sustainable lifestyles. Polices should not only encourage informational instruments, but also themselves be broadcasted widely and transparently. It is particularly those societies that have raised energy efficiency and environmental concerns to the levels of everyday discourse where policies receive public support and loyalty.

*Energy pricing in the housing sector.* One of the essential elements in the energy efficiency incentive system is energy pricing. It is important to establish an adequate pricing system and to get rid of fixed-cost payment systems for energy. A number of measures should, however, parallel or precede energy price reform. Criteria may be developed as for what percentage of the household income may be spent on energy; for those in energy poverty, targeted subsidies should be provided (which would ideally help to improve the energy performance of homes). Other measures may include differentiated tariff systems, such as block tariffs, which make utilities affordable for lower income families and yet encourage conservation. Utility companies should also be strongly encouraged to improve their energy services.

*Energy performance standards for buildings.* Updated and mandatory energy efficiency performance standards in buildings belong to the most effective instruments to increase energy efficiency and should be therefore used actively. Appropriate national targets and measures should ensure the increasing penetration of passive, zero-energy, and zero-carbon innovative building solutions, with preparations to eventually require all new homes to be based on this technology. However, buildings codes should also be balanced against the level of prosperity of a particular country or region and may include differentiated requirements depending on the size of the affected project or status of the developer. A crucial factor is also to enforce the implementation of mandatory building codes. The codes should also be supported by other instruments, including subsidies to lower-income groups to acquire efficiency technologies. On the other hand, energy efficiency must be a condition for subsidy in construction or capital renovation. Furthermore, it is not only the technological attributes of buildings that contribute to the reduction of energy use, but also appropriate planning attributes, residential density, mixed-used developments, public transit and integrated district heat-electricity systems, so that energy efficiency policy should be sufficiently accommodated in spatial and land use planning.

*Housing management and maintenance.* The system of housing management should operate within a strong framework of capacities and incentives to deliver better energy efficiency. Improving and professionalizing housing management is a key institutional requirement. This field represents a particular challenge for the transition countries. There must be legal provision for establishing collective coordinating bodies, such as residents' associations, on which obligations for maintenance and economic incentives can be imposed. Energy efficiency improvements in condominiums can be mainstreamed through financial instruments, such as renovation loans. Again, special forms of support are needed for low-income households. The social housing sector should be prioritised in government energy efficiency programmes.

*International cooperation.* Policy making will greatly benefit from being informed by international experiences. Furthermore, capacities should be established to assist less developed countries of the UNECE with technological and institutional know-how transfer. International organisations should accumulate and exchange knowledge and experiences on good practices and bad failures in the housing field. One recommendation for international organisation, such as the Committee on Housing and Land Management of the UNECE, can be to include specific recommendations in Country Profiles on energy efficiency in housing for those countries that lag behind in order to estimate their contextual requirements and to offer targeted policy advice.

# 1. INTRODUCTION

Initiatives to address the problems of energy efficiency are not new. They have been developed for decades, if not centuries, especially intensifying as the oil crisis of the 1970s hit the capitalist economies hard. What has yet changed more recently is the growing sense of emergency and the 'globalisation' of the scale at which the problem is now perceived. Issues such as climate change, energy security, economic uncertainty, and poverty have all come to their summits and all achieved 'global' status, demanding immediate, adequate and comprehensive responses. Because of the scope of energy consumption in the housing sector and since dwellings belong to the longest lived parts of the human technological infrastructure, housing provides a major avenue for action here. There have, indeed, been considerable improvements in the field over the past few decades, but as most houses today still fail to be as energy efficient as they practically could, much of the potential of the residential sector remains untapped, while contemporary challenges require even faster rates of change and improvements.

The principal aims of the report are therefore to provide an overview of the economic, social and environmental impacts of the problem, to consider current policies, solutions and barriers to effective policies, and to discuss priorities that need to be addressed by international and national governments. These considerations will also inform UNECE's initiatives in policy advice, policy formulation and assistance to national governments with regard to improving energy efficiency in the housing sector.

*Improved energy efficiency in housing is defined as successful efforts to reduce the present energy requirements of the residential sector without compromising the levels of wellbeing of the residents or environmental conditions.* Alternatively, the housing sector with relatively excessive energy consumption, environmental pollution and/or problems with energy affordability cannot be considered as energy efficient. We believe that this is a responsible definition that recognises the importance of energy efficient housing for all the three pillars of sustainable development - environmental, social and economic.

While informed by the developments in the ECE region as a whole and considering cases from Western Europe and North America, this report focuses in particular on countries that lag behind and where the greatest untapped potential for energy efficient housing exist – particularly transition countries, including Eastern Europe, Caucasus and Central Asia (EECCA) and South-Eastern Europe (SEE). The specific challenge for the policy-makers of these countries relates to overcoming what can be called *energy inefficiency trap*, or a situation in which countries having lower energy efficiency are unable to change their respective status due to lack of funds, experience, technology, motivation and initiative.

Although a number of studies exist to date and discuss various aspects of the complex problematic raised here, the specific contributions of this report are as follows:

- A sectoral focus: this study focuses on the housing sector and offers deliberations on energy efficiency in housing;

- A holistic approach: the study solicits a multidimensional set of measures which is not restricted to any single sector of activity, but encompasses many of them in their complexity;

- A socially-responsible perspective: the report maintains that maximising energy efficiency is a great opportunity to promote environmental stewardship, human rights, quality of life and social equality. Energy efficiency should improve all the three pillars of sustainable development and contribute to the Millennium Development Goals. On the contrary, socially-detrimental energy saving measures cannot be considered "energy efficient";

- A geographical scope: although the study keeps its focus on the post-socialist countries of the UNECE region, it explores the developments in the UNECE region as a whole, thus providing a unique pan-European perspective with further insights from North America. By oscillating a focus between the UNECE region as a whole and its parts, it is possible to better understand the advances and challenges across the region;

- An applied utility and policy focus: the report examines some experiences from the UNECE countries and provides policy implications and recommendations to be considered by international organisation and national governments.

The paper consists of this Introduction and three consequent chapters. Chapter 2 discusses the multiple benefits and opportunities that improved energy efficiency in housing brings for all the three pillars of sustainable development. Environmental, macroeconomic, microeconomic benefits, social implications and energy security issues are discussed, along with a specific case of the transition country. Chapter 3 reviews the current state of development of energy efficient technology and international regulatory institutions and considers a number of barriers that hamper energy efficiency measures. These issues are discussed in light of our five-IN approach (investment, information, innovations, incentives, initiative) presented in the Chapter. Based on this analysis, Chapter 4 finally considers policy implications and delivers policy recommendations.

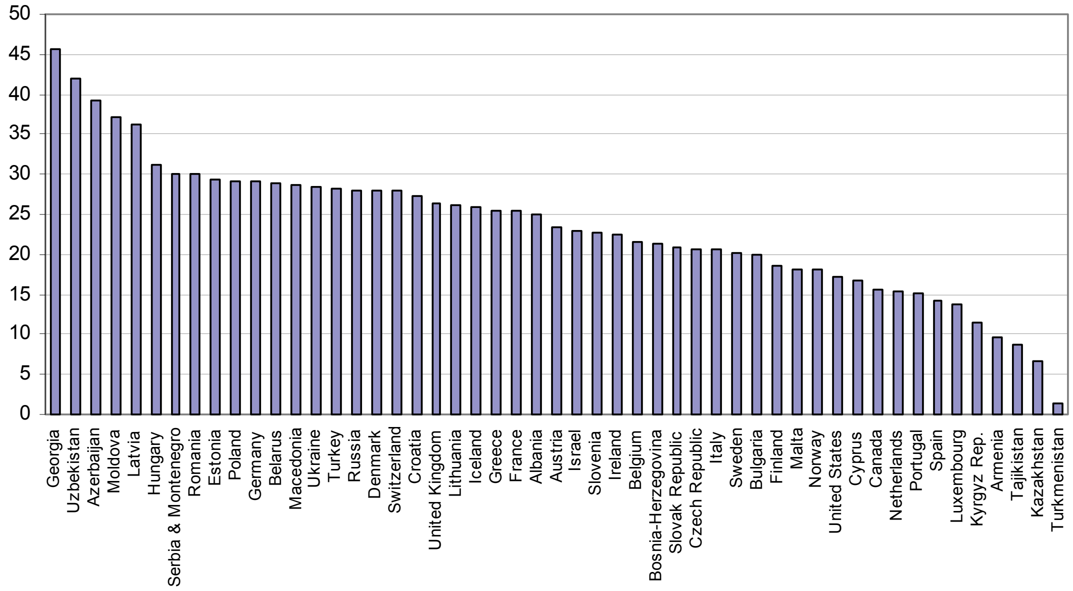
## 2. THE MULTIPLE BENEFITS OF ENERGY EFFICIENT HOMES

### 2.1. The importance of housing for energy use and energy efficiency

Approximately one third of total energy consumption in the UNECE region is consumed in buildings – by and large in the residential sector, which is responsible for 15-40% of total energy use depending on a country, or for about 20-30% on average across the region (Figure 1). As a rule, poorer countries consume less energy in housing per capita – with the exception of some energy-exporting countries (Figure 2).

For many countries, however, the statistical data are not particularly reliable and this may explain significant differences between individual countries, as well as fluctuations from year to year. Even beyond Central Asian members, for which only limited data exist, the share of residential buildings in total energy consumption across the UNECE region ranges from 10% in Armenia to 46% in neighbouring Georgia. Since most official energy data are derived from institutionalised sources, they may be distorted. Lower figures as for per capita consumption may mean that most energy is produced autonomously by combustion of dirtier carbon fuels (e.g. coal, kerosene or wood); such small-scale energy-producing/energy-consuming activities is not counted statistically unless adequate methodology is exercised by statistical bodies. Even in the "old" EU members, energy statistics is widely distorted (Werner, 2006)

**Figure 1 Residential energy consumption as % of total final energy consumption in UNECE-51 (2005)**



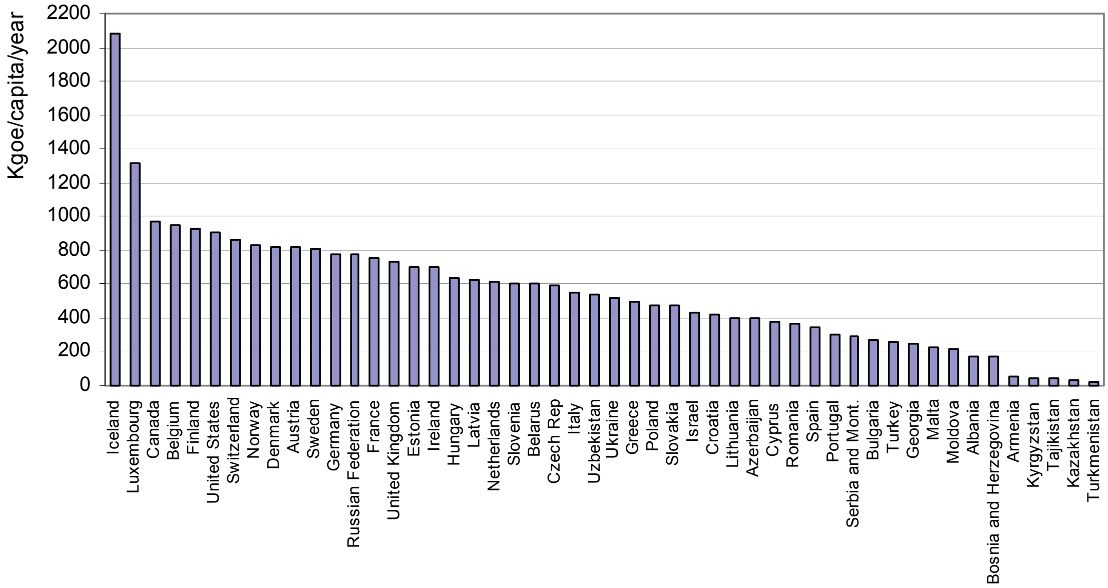

**Note**: For Central Asian countries other than Uzbekistan, residential data only include electricity consumption.
**Source**: Data as reported by Enerdata (www.enerdata.fr)

From 80% to 90% of total energy used during the life of a building is consumed during its operation, while the rest in the construction and demolishing phase (EEA, 2007). Most energy in the residential sector is used for space and water heating. As the UNECE region stretches geographically from the subtropics to the arctic, there is also a climatic variation in the structure of energy consumption and, as a consequence, different requirements, opportunities and mechanisms for improved energy efficiency. Southern territories have a smaller share of space heating and a larger share of cooling in their energy balances than their northern counterparts.

Numerous social, economic and cultural changes increase pressure of the residential sector on energy consumption. Importantly, demographic changes in many UNECE countries mean that households become smaller, live longer and require larger floor space per household. The increased levels of consumerism and technological change stimulate the use of energy-hungry electrical appliances. In case of poorer countries, as incomes rise, energy consumption also increases.

Given the importance of the residential sector for energy consumption, this Chapter follows with considerations of some of the benefits that energy efficiency in housing may bring and *is* bringing, as well as some pitfalls of inadequate practices. It will be shown that many benefits from energy efficiency arise from the quantitative saving of energy; but benefits are not restricted to this. Qualitative and quantitative impacts stretch beyond direct energy conservation.

**Figure 2 Residential final energy consumption per capita in UNECE-50 (2005)**




**Note**: For Central Asian countries other than Uzbekistan, residential data only include electricity consumption.
**Source**: Data as reported by the World Resources Institute (www.wri.org) based on IEA (2007; 2008) and ESA (2007).

## 2.2. Environmental impacts and opportunities

At the global scale, environmental impacts of energy efficiency in housing stem from the essence of energy as the major contributor to climate change. As most of energy produced for the moment comes from fossil-fuelled power plants, it is energy production that is responsible for most of carbon dioxide ($CO_2$) emission into the atmosphere. The increasing $CO_2$ emissions are believed to result in irreversible changes in the global climate and the global environment, the consequences of which are little predictable, but which are believed to impose tremendous economic cost of mitigation and adaptation, if not catastrophic effects on the human future (e.g. Stern, 2007). Due to its energy consumption, buildings are accountable for about 40% of global $CO_2$ emission. Furthermore, land use changes account for a high proportion of global carbon emissions, mostly due to deforestation linked to urban expansion - this should also be accounted when the impact and contribution of buildings to climate change are considered.

In UNECE countries, the main sources of energy in the buildings sector are electricity, district heat (especially in EECCA) and natural gas. This means both direct $CO_2$ emissions from the buildings sector via 'on site' combustion of fossil fuel and indirect (upstream) emissions via demand for electricity and district heat; upstream emissions are dominant in the UNECE countries. The degree of electrification in a country and the type of energy source used to generate heat and electricity influence the volumes of emissions from the buildings sector. For example, the upstream $CO_2$ emissions from buildings in France are very low, since nuclear power is the main source of electricity in the country and a high degree of electrification.[1] This also applies to the countries relying on hydropower as main sources of energy for houses, and to Iceland, which relies on geothermal energy for heating its housing stock.

On "business as usual" trends, direct and upstream $CO_2$ emissions from buildings are expected to rise 70% and 140% to 2030 and 2050 respectively (Stern, 2007). However, the International Panel on Climate Change estimates that there is a potential to reduce 29% of the projected baseline emissions by 2020 in the residential and commercial sectors by better energy efficiency (Levine et al., 2007). This is a greater potential gain in comparison to other sectors.

Related to decreased $CO_2$ emissions are opportunities to sell carbon credits, especially for those countries that due to their industrial decline in the 1990s and improved environmental standards have seen a certain gap between allowed $CO_2$ emission and the actual emissions. Increased energy effectiveness may widen this positive gap. For example, it is argued that by ignoring the consequences of its $CO_2$ emissions, Russia misses out about $10 billion a year in carbon credits, and risks compromising its international standing on a commitment to fighting climate change (World Bank Group, 2008). On the other hand, countries that are required to buy carbon credit due to exceeding their quotas will be able to economize by increasing their energy efficiency.

In addition to contributing to climate mitigation, better energy efficiency for homes in the UNECE region also makes the sector more resistant to extreme weather events which are predicted to increase in frequency with climate change. Energy efficiency in homes in the UNECE countries may therefore also be considered as contribution to adaptation measures to climate change (Deda and Georgiadis, 2009).

## 2.3. Improved energy security and political stability

It is important to be reminded that energy saving is equivalent to buying energy or, alternatively, producing energy. Indeed, less energy spent means more energy available for alternative uses or to be converted into capital – either directly through sale or indirectly through avoided cost. Investing in energy efficiency therefore should be regarded as an alternative source of energy, which is yet much cheaper and giving quicker results than traditional sources of supply.

For energy-importing countries, the dependence of national economies on energy import is considered to be one of their major political challenges. More energy efficient homes not only allow an improved availability of energy nationally, but also means that housing itself is more protected against possible energy disorders. The collapse of energy and heating systems of several Central, Eastern and South-Eastern European countries due to the disruption of gas delivery from Russia through Ukraine in January 2009 left several million people without adequate heating at homes – even if energy for house-heating was diverted from manufacturing

[1] The nature of the nuclear fuel cycle inevitably involves the debate of health and safety associated with the risk of release of radioactive materials (as most tragically demonstrated by Chernobyl), as well as with the risk of proliferation, and remains a sensitive issue; in the United States, for instance, no single nuclear power plant has been ordered over three decades (UNDP, 2007, p.134).

and other consumers. The magnitude of the collapse would have been smaller if the housing sector were more efficient.

On the other hand, investing in energy efficiency for the countries that are exporters of energy can achieve the same results as investing in increased capacities of energy supply, but at the portion of the cost of the latter and much quicker. It is estimated, for instance, that through increasing the energy efficiency of its economy Russia can address rising internal and external demands for its oil, gas and electricity at one-third or less of the cost of investing in new deposits. The residential sector offers even a greater saving ratio in this respect than all the other sectors (World Bank Group, 2008).

In both exporting and importing countries, inefficient energy performance in housing means increased chances of resorting to electrical heating during the fall in winter temperatures. Such loads may trigger breakdowns in major electricity networks.

As a further benefit of improved energy efficiency in housing, the risk of internal political instability is mitigated. Since housing affects virtually everyone, citizens are very sensitive to the circumstances in this sector. As the same example of disruption of gas supply in January 2009 demonstrated, missing heat at their homes in the cold winter, residents in Ukraine, Bulgaria and other affected counties were quite willing to organise street protests. Rising energy bills for residents – not least in those countries where energy prices are still substantially subsidised and which drive towards energy liberalization – may also provoke social protest, unrest and political turmoil. In less affluent countries and regions, which have considerable strata of the population living below poverty line and where anti-government militants are not uncommon, such destabilising situations may only boost extremist impulses, thus threatening national and international security. As also discussed below, energy efficiency decreases the risk of energy poverty for the population and thus mitigates such political risks.

### 2.4. Macroeconomic and microeconomic impacts

In addition to energy security and carbon trading opportunities, other macroeconomic benefits from improved energy efficiency in housing may be identified. These include positive impacts on research and innovation, on business development and employment, as well as strengthened national competitiveness.

Investing in retrofitting can have a strong positive impact on the job market. It is estimated, for instance, that in France the work required to implement criteria set by the national Grenelle de l'Environment could create 220,000 jobs just in one year (CECODHAS, 2009). Retrofitting and construction projects often rely on labour intensive, locally implemented projects and then can improve unemployment rates. On the other hand, new technologies require a high level of expertise for their development, implementation, and user training, while achieving a necessary level of the market capacity for the energy efficiency can also boost the associated retail and consulting industries. This implies that direct and indirect impacts may stretch far beyond the construction industry and have a genuine multiplication effect. This effect is little investigated, however, so that it remains a matter of judgment and interpretations.

The benefits highlighted so far are particularly visible at the aggregated macro scales; what is important for the commercialisation and expanding of energy efficiency in housing is, however, the creation of bottom-up demand from the multitude of individual firms and households – effectively, a microeconomic level.

The basis for the calculations of the cost effectiveness of the energy efficiency projects is usually savings on capital from energy conservation; these are therefore the key to any extensive deployment of such projects. Indeed, energy savings in the housing sector may range from 25% to 40% across the UNECE region. The crucial variable for cost effectiveness assessments is energy prices. Subsidised energy prices may imply very long payback periods, so that such projects are often considered unprofitable, especially in transition countries, given the higher expected rates of return. However, when reduced costs for municipalities are included, such projects have much shorter payback periods (EEA, 2007). Unfortunately, there always remains asymmetry between different levels of economic consideration in this respect, as well as split incentives between different stakeholders and market uncertainties (as further discussed in Chapter 3) so that even if prices correspond to the market ones, they alone do not necessary present a strong case for individual economic actors to invest into energy efficiency.

Nevertheless, a number of further benefits from improved energy efficiency in housing are available at the microeconomic level and these under the condition of sufficient awareness may be included in investors' cost-benefit analyses. Better indoor thermal and moisture conditions imply higher levels of comfort of living, as well as lower rates of wear and longer cycles of refurbishment and repair. Reduced exposure to the fluctuation of outdoor conditions due to thermal insulation prevent dampness, rusting and mould formation. In winter internal walls remain warm and cold-radiation effect is eliminated; in summer thermal insulation prevents walls being heated and can have a cooling effect (Boermans and Petersdorff, 2007). Distributive electricity networks also experience less load intensity due to improved energy efficiency in housing and their life is extended. Positive side-effects from energy retrofitting projects may also include an improved aesthetic of the buildings (e.g. of high-rise buildings of the 1960s-1970s), better noise isolation and, if combined with more comprehensive measures, other technical improvements of the buildings.

Such factors taken together also have beneficial impacts on property values. Leading real estate associations, such as the Appraisal Institute or the Royal Institute of Chartered Surveyors, started considering energy efficiency standards in their methodologies at least since the early 1980s (Levy, 1987). With the introduction of mandatory energy certifications of buildings and raised awareness, the influence of energy efficiency and green standards on the appraisal process increases, even if though it is still far from being strong vis-à-vis other factors (e.g. Guidry, 2004).

## 2.5. Energy poverty, health, and further societal effects

It is well known that low thermal efficiency in housing, especially if combined with deficient social welfare, has detrimental health and living effects. Such negative social effects are becoming more significant for lower-income groups of the EECCA and SEE countries, but are by no means limited to them. The increased cost of fuel, the liberalisation of energy markets and decreased levels of welfare provision in capitalist countries in Europe since the 1970s and in the transition countries since the 1990s mean that an increasing number of low-income households cannot afford the costs of heating. In the UK, this problem becomes known as the "choice between heating and eating". Alternatively, it is known as "fuel poverty" or "energy poverty".

Those who cannot afford the adequate levels of energy consumption (usually for heating and hot water) either go into energy indebtedness and face the threat of disconnections from the utility provision or need to reduce their consumption. Either choice means hardship, exposure to health risks and the feelings of being alienated by society – which only deepens the vicious circles of social exclusion.

More energy poverty thus leads to more energy conservation, but energy conservation of this kind should be considered disgraceful. It is important to draw a clear line in this respect between energy efficiency and energy conservation. If residents are forced to sacrifice their energy consumption to the level that threatens their health and welfare, this situation is unsustainable. Unless behavioural patterns are voluntary, improved incomes will always lead to the recovery of the higher energy consumption level. Energy efficiency, on the contrary, improves structural energy requirements and thus decreases energy consumption needed for the same useful amount of energy services and thus has a positive impact on the household's wealth and welfare.[2]

Unfortunately, energy conservation via energy poverty has been a common trend for many post-socialist countries experiencing since the start of transition a sharp decline in real incomes and, at the same time, a considerable energy price inflation. And yet some of these countries are among the coldest in the UNECE region, with the heating season lasting up to seven months. The scale of the problem is further aggravated as in many EECCA and SEE countries residents unable to afford or connect to other means of energy have increased the levels of use of "dirty" fuels and retreated to cheap stoves, which have high levels of CO2 emission, pollution and attendant detrimental effects on indoor air quality and health.

Since it is most vulnerable, poorer strata of the population who experience the dilemma of "heating or eating", it is they who face the associated health risks first. Cold and damp houses expose the occupants' health to the risk of respiratory, cardiovascular, allergy and infectious diseases, psychological stress, and cold-related death. However, detrimental effects due to low energy efficiency and insulation also affect all the other social groups; such effects include worsened comfort of living, mould and faster deterioration of housing with the necessity of repair and refurbishment measures more frequently than in efficient homes. Dump conditions provide fertile ground for the growth of bacteria, fungi and dust mites.

So, even without all the other benefits of energy efficiency in housing, the social and health problems associated with poor and inefficient housing would provide a strong case for energy efficiency policy in housing (Bell et al., 1996). More developed countries have funds for welfare support to the vulnerable groups, including for energy. The problem of "energy poverty" however has both the income and expenditure side, so that a policy to improve energy efficiency may bridge them two and represent better value for money in the longer term than energy support (Boardman, 1991). Of course, this is only true if energy efficiency measures achieve at least the same targets as energy welfare supports (i.e. "affordable warmth" in Boardman's words) and if social inequality, poverty and social exclusion are still promptly addressed by wider social welfare and redistribution policies.

The issue of affordability of energy efficiency measures themselves also need to be addressed. Social housing may provide one of the most fruitful avenues here, since social housing is able to integrate both social welfare policies and energy efficiency measures.

## 2.6. The case of the former socialist countries

Although many problems, as well as potential benefits, are common for the UNECE countries, there remains a lot of regional specificity. The countries of EECCA and SEE sub-regions themselves are much different between each other. As for the topic of the present discussion important differences include, for example, their geopolitical affiliation, energy production status, climate, and levels of economic development. However, there are many features which are common for these sub-regions and which relate to their history as socialist countries and their experience of transition to the market economy.

As a rule, these countries are characterised by lowest standards of energy efficiency in housing in the UNECE region, especially for panel-built housing of the period between the 1960s and 1980s. Although during the socialist era heating and hot water in larger cities was administrated centrally via district heating system, distribution systems were typically characterised by large amounts of losses, while residents had little control over space temperature other than by inefficient means such as opening windows (EEA, 2007). Furthermore, socio-economic

[2] See also the section concerning "the rebound effect" in Chapter 3. In the residential sector, the effect particularly concerns poorer households and therefore implies positive social effects.

problems linked to post-socialist transition have further brought many novel and specific challenges for these countries, such as the downgrading of infrastructural quality, increased energy prices and "primitivisation" of the standards of living, leading to deprivational energy conservation (Buzar, 2007). Many of the post-socialist countries have seen a growing "slumification" of their housing stock, as well as alarming trends towards informal settlements with self-made low-quality low-energy-efficient shelters (Tsenkova et al., 2009). High prices for centrally-distributed energy made many residents switch into alternative (less efficient) heating means, such as kerosene, electricity, coal or wood, increasing deprivation. If the problem takes a massive scale in any location, the operation of infrastructure and energy supply to that location becomes unfeasible, so that even those residents who are able and ready to pay are penalised (the situation is familiar to the Balkan region, Caucasus and Central Asia). This has certainly worsened the energy efficiency status of these countries.

At the same time, the legacy of central planning in many post-socialist countries features a number of opportunities that compare favourably with other UNECE countries. The large number of standard multi-apartment residential building blocks means that similar solutions for improved energy efficiency may be used, thus ensuring the economy of scale. The strong tradition of centralised district heating in larger cities, while bringing a number of problems at present, represents an excellent institutional and technical foundation for efficient heating and cooling in the future; particularly the high use of combined heat and power (CHP) stations in Kazakhstan and Russia is a positive factor. Furthermore, despite extensive privatisation of the housing stock, there remains a tradition of strong municipal and state involvement in the issues of housing management, which may simplify the task of large-scale publicly-funded retrofit programmes (EEA, 2007).

After more than a decade of stagnant housing production in the EECCA and SEE counties, recent years have seen a certain recovery in new housing programmes, with some larger cities, at least in the years preceding the most recent economic crisis, experiencing a construction boom. The increased levels of housing production represent further opportunities to improve the energy efficiency of the overall housing stock. This can only be achieved, however, if necessary measures are implemented by policy-makers. Many government representatives from EECCA and SEE acknowledge that they become aware of energy efficiency problems through the discourse on global climate change, but that they have little direct incentives to improve the state of affair in the area of their direct responsibilities. It is therefore important to raise awareness about the whole bundle of benefits.

Furthermore, given the status of Russia as a chief energy provider to many UNECE countries, the international community, in order to ensure the security of future energy supply, should assist Russia in improving its energy efficiency. The Russian northern and continental location cannot justify numerous losses due to the use of inefficient technology and poor communal infrastructure. The Russian federal minister for regional development maintains that local losses in the housing economy can be up to 20% for water, up to 15% for electricity and up to 40% for heating energy (Basargin, 2009). While the per-capita energy consumption in the Russian housing economy may rise as standards of living are improved, energy efficiency measures in this sector may achieve substantial progress (also see Box 1).

**Box 1 Cost-effective energy efficiency potential in the residential sector in Russia**

A study presented by the World Bank Group (2008) is illustrative of the degree of direct economic potential in the residential sector in a single country. The amount of potential energy savings was considered in the study at three levels of investment:

- Technically viable: energy savings are determined by the best technologies available;
- Economically viable: energy savings are greater than the cost of alternative increase of production, i.e. investment can save energy and money for Russia, but the savings cannot necessarily be captured by any single energy consumer; the method assumed a 6% opportunity cost of capital;
- Financially viable: energy savings are greater than buying energy, i.e. investment can save energy and money for individual consumers; the method assumed internal tariffs as in 2007, a 12% opportunity cost of capital for private firms, and a 50% opportunity cost of capital for household.

It is found that the residential sector offers the greatest potential for improving energy efficiency. Energy use in buildings (144.5 mtoe) was responsible for more than one-third of energy end-use in Russia, mostly consumed in the residential sector (108.3 mtoe). The technical potential to reduce energy consumption in the residential sector is estimated as 53.4 mtoe (or -49%), of which 84% is achievable through investments that are economically viable and 46% that are financially viable.

Most of the potential energy savings comes from improvements in space heating and water heating. Space heating is estimated to be responsible for 58% of overall energy consumption in residential buildings in Russia (with district heating systems serving three-quarters of dwellings), while water heating for 25%. Only a small percentage of the buildings erected after 2000 in compliance with new thermal insulation standards meet modern thermal performance requirements. The Russian average annual heating energy intensity for multi-family high-rise buildings is reported as 229 kWh/m2 versus 77 kWh/m2 for new multi-family high-rise buildings built in Moscow. The technical potential to reduce energy consumption in residential space heating ranges from 17 to 42 mtoe, equivalent to 35% to 49% of total 2005 final heat consumption. The technical potential for improving the efficiency of water heating is 13.4 mtoe, equivalent to 35% of 2005 use. Installation of hot water meters alone can save 30-40% energy on hot water by encouraging changes in consumer behaviour. Most of the investments required to improve space and water heating efficiency are viable economically (78%) and financially (38%) with 2007 heat prices.

The study argues that the most significant barriers to energy efficiency in residential housing relate to building standards, public behaviour, and difficulties in organizing and financing energy efficiency improvements in common areas. Mandating energy standards in new and renovated buildings is the most cost-effective way to ensure energy savings in the residential sector.

**Source:** World Bank Group (2008)

# 3. CURRENT EXPERIENCES AND BARRIERS TO EFFECTIVE PRACTICES

## 3.1. The 5-IN approach: innovations, information, incentives, initiative, and investment

The previous chapter discussed the multiple benefits of enhanced energy efficiency in housing. The other side of the equation is the availability of technology and the costs of providing energy-efficiency (material resources and labour). As one study after another demonstrates, a wide range of effective and affordable technological solutions does already exist and may easily unlock those benefits that energy savings bring. It is estimated that from 25% to 40% of only direct energy savings may be reached in the housing sector depending on the country. If also wider benefits are taken into account, it may be supposed that all rational actors must be hurrying up for such actions. In reality, however, the investment in energy efficiency is done on a very limited scale, far below what may be considered as rational by neoclassical economic models. This paradox is known in the literature as the "*energy efficiency gap*". Thus, it appears that most vigorous challenges are associated not with technology, which is well understood, readily available, fast developing and, if embraced under the economy of scale becomes increasingly cost-effective, but rather with establishing a proper institutional structure that would set large-scale energy efficiency measures in motion.

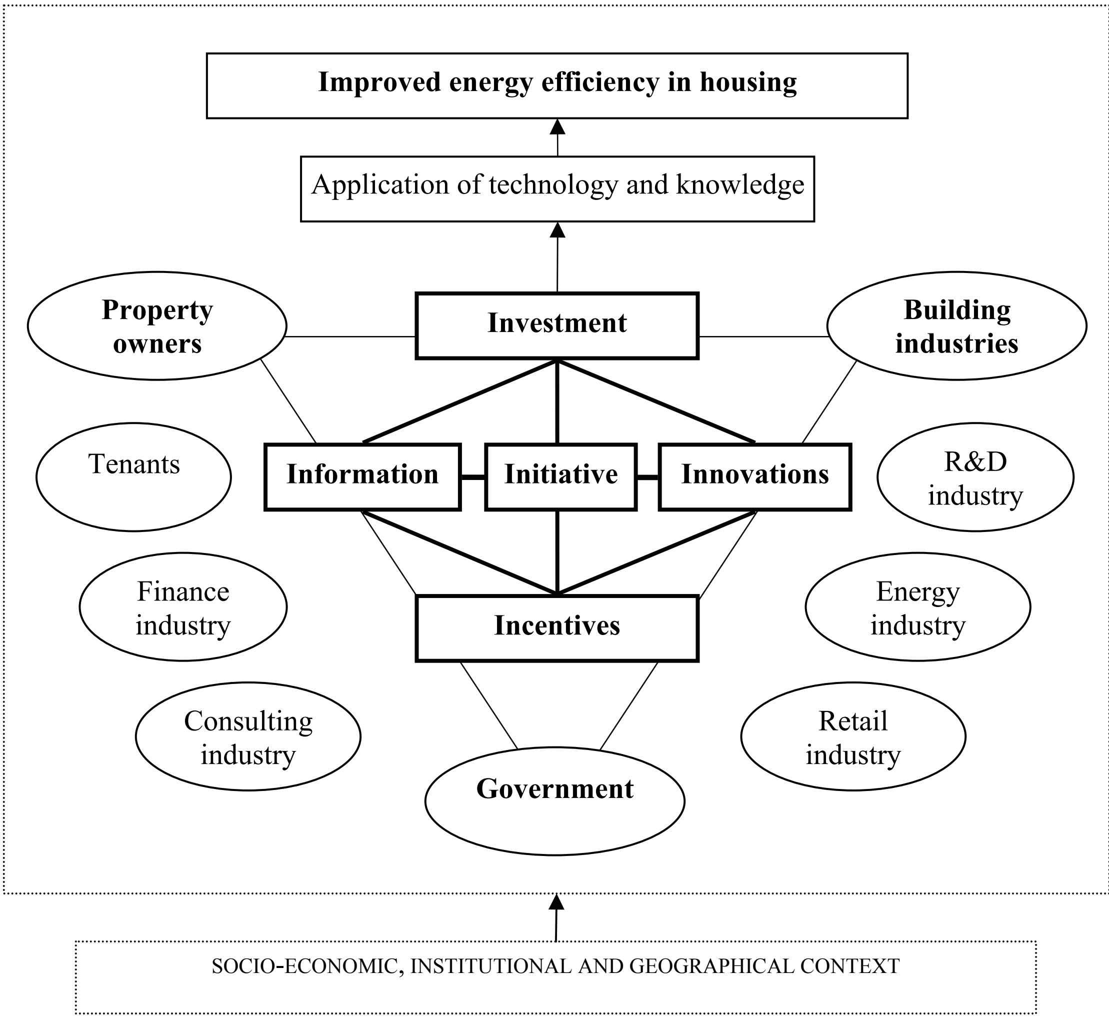
This chapter provides an overview of the current state of technological development, policies and other experiences in the UNECE countries and discusses barriers leading to the energy efficiency gap in the residential sector.

These issues are considered from the perspective of our 5-IN analytical approach (Figure 1). The approach recognises several key concepts and stakeholders important for more energy efficient housing. As shown in Figure 3, improved energy efficiency in housing is a result of the application of technology and/or knowledge (including that of knowledgeable behaviour). The application of technology and knowledge is driven by a number of conditions, which may be conceptualised by five "in"-keywords, including "investment", "information", "innovations", "incentives" and also, importantly, "initiative".

"Investment" (usually of capital and time, but also effort) is a necessary precondition for improved energy efficiency; particularly, financial resources represent an important limitation. Technology and techniques, as well as ideas and priorities, change over time and are associated with "innovations". Another important element is "initiative" or purposeful enterprise that initiates and steers investment into energy efficiency. Such initiative is based on "information" available (including awareness and know-how) and "incentives" (financial, legal and other stimulus and institutions). There are a number of stakeholders behind these concepts, with three groups notably representing "a triangle" of the major groups of agencies, including government, property owners and building industries. It is the interactions between the stakeholders that determine the status of the five "in"s; if these interactions make any of the five "in"s a weak link, the results are deficient.

As also reflected in Figure 3, the interactions between stakeholders are also bounded by a more general socio-economic and institutional context, which includes existing policies and strategies, but also social and economic realities and inherited preconditions. It is important to take into account the different levels of economic development and budget constraints of countries/groups of countries belonging to the UNECE community.

**Figure 3 Key concepts and stakeholders in energy efficiency in housing**




3.2. The development of energy-saving technology

Most of the housing stock for many years to come will represent the same housing stock as exists today and it will take long time until buildings built after 1980 will constitute the majority of homes.[3] Given these conditions, it is important to invest money and efforts into energy efficient refurbishment and retrofitting of existing buildings. Such measures typically address the structural parts of buildings, including the thermal integrity of the building envelope, air conditioning system efficiency, mechanical ventilation, lighting systems, water heating, and elevators. In addition, the conditions of electrical appliances and electricity and heat losses during distribution are addressed. Speaking about retrofitting techniques more specifically, they usually concern roof, wall and floor insulation, multiple window glazing, draught sealing, central heating, lagging jackets, ventilation improvement. A great variety of insulation and glazing materials and other energy efficient technologies and techniques are available. Applying them more comprehensively to, for example, the housing stock dating from the 1960s to the 1980s, demonstrates that an average reduction of energy consumption by 50% to 60% is possible (UNECE, 2008).

[3] The new building stock, on the other hand, amounts to only 1-3% of the existing building stock in any given year, while representing about half of the value of the construction industry, including construction and renovation.

It is also still important to develop and introduce energy efficient technologies for the new housing construction, as eventually it is new housing that will determine the status of energy efficient housing in the future. In many countries, “low-energy” buildings become increasingly widespread, with heating energy consumption per $m^2$/year of less than 50 kWh, as compared with 150 to 200 kWh in “normal” housing (UNECE, 2008). Many countries have officially designated “low-energy buildings” as a class below certain energy performance.

Some of the latest developments include “passive housing”. The passive house standard was defined in 1988 and the first passive house was built in Darmstadt in Germany in 1990 (Laustsen, 2008). Comfortable room temperature is achieved by means of passive components, such as high levels of insulation of walls, roofs and windows, heat recovery from recycled air and use of internal sources of heat (including existing household appliances and “human heat”), design of the building to fit a specific location, use of passive lighting and active shading and energy efficient appliances and lighting. The additional energy for electricity, the cooling system or hot water can come from conventional sources or from autonomous renewable energy such as solar energy. Passive housing is still mostly defined for the colder European climatic conditions. It reduces heating energy consumption to at least 15 kWh, or by up to 90% compared to “normal housing” and by 60% compared to innovative low-energy buildings. Experiences of Austria, Germany, Switzerland and Scandinavia show that such buildings are popular with the residents, as they may be even entirely independent of off-site energy supplies and have lower operative costs than in more conventional buildings.

Related types of buildings include “zero-energy” buildings that do not use fossil fuels but get their required energy from renewable energy sources. There are no established definitions for zero-energy buildings or homes. Laustsen (2008) distinguishes a few subtypes of such buildings:

- Zero Net Energy Buildings deliver as much energy to the supply grids over a year as they use from the grids.

- Zero Carbon Buildings do not use energy that entails carbon dioxide emission or balance over a year off-site fossil fuel use by producing enough CO2-free energy on-site.

- Zero Stand Alone Buildings do not require connection to the grid other than as a backup. Stand alone buildings have the capacity to store energy for night-time or wintertime use.

- Plus Energy Buildings deliver more energy to the supply systems than they use. Over a year, these buildings produce more energy than they consume.

There are higher cost of the production and, consequently, prices for innovative buildings. This, coupled with the lack of established mechanisms to promote sustainable buildings (lack of information), inertia of the construction industry (lack of initiative), market barriers (lack of incentives) and only limited financial resources available (lack of investment) represents serious challenges for their widespread use (for more details see Section 3.4).

However, it is not only the technological attributes of buildings and their interior that contribute to the reduction of energy use, but also the very spatial and density attributes of communities and cities at large. Town planning and land use zoning can therefore make a large difference, particularly as far as new building sites are concerned. Higher residential density, mixed-used developments, good public transit provision and integrated district heat-electricity systems are all important considerations for energy efficiency and reduced GHG emissions, since such measures typically reduce vehicle use, bring more efficiency to energy consumption, and reduce municipal infrastructure requirements (e.g. Droege, 2008; Brown and Southworth, 2008; Ewing et al., 2007).

## 3.3. Regulatory frameworks and strategies

Reduction of energy consumption in the buildings sector constitutes important part of measures needed to reduce greenhouse gas emissions and comply with the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) and legally binding international commitments to reduce greenhouse gases emissions (Annex A of the Protocol addresses energy efficiency). As the "commitment period" of the Kyoto protocol expires in 2012, a treaty succeeding the Kyoto protocol is expected to be adopted at the United Nations Climate Change Conference in Copenhagen, Denmark in December 2009.

Important regulatory developments can be seen at the EU level. The EU Directive (2002/91/EC) on Energy Performance of Buildings (EPBD) is the main tool that provides for a holistic approach towards efficient energy use in the buildings sector, including regulatory and information-based instruments (see Box 2). Apart from the EPBD, there are a number of other EU Directives dealing with energy aspects in buildings, such as Eco-Design of Energy-Using Products Directive (2005/32/EC), Directive on the Promotion of Cogeneration (2004/8/EC), Energy End-Use Efficiency and Energy Services Directive (2006/32/EC), and the new Directive on the Promotion of the Use of Energy from Renewable Sources.

**Box 2 The EU Energy Performance of Buildings Directive (EPBD)**

The Directive came into force in January 2003. It is indented to lead to substantial increases in investments in energy efficiency measures within residential and non-residential buildings. The EPBD requires Member States to set up:

- A methodology to calculate integrated energy performance of buildings, based on a general framework established by the EPBD, to be set up either at the national or regional levels.
- Minimum energy performance requirements for new buildings (and mandatory consideration of alternative heating systems for planned buildings over 1,000 m2).
- Minimum energy performance requirements for building with a total useful floor area over 1,000 m2 undergoing major renovation.
- Energy performance certificates (EPC) of buildings required when a building is constructed, sold, or put up for rent. The certificates are for information only and may include recommendations for the cost-effective measures to improve the building's energy performance.
- Either a regular inspection of boilers of certain specification or adequate provision of advice to users on the heating system, as well ass a regular inspection of air-conditioning systems.

The certification of buildings, the drafting of the recommendations and the inspection of boilers and air conditioning systems should be carried out by independent, qualified and/or accredited experts, private or public. Member States can go beyond the minimum requirements set in the Directive and be more ambitious. The EPBD had to be eventually transformed into national law by all EU Member States by January 2009.

In November 2008 the European Commission proposed a new version of the EPBD that seeks to strengthen the main "pillars" of the Directive (including deleting the 1000 m2 threshold). Member States will also be required to actively promote the higher market uptake of buildings of which both CO2 emissions and primary energy consumption are low or equal to zero by producing national plans with clear targets. Some of the expected benefits of the (upgraded) EPBD include:

- 60 to 80 Mtoe/year energy savings by 2020, i.e. a reduction of 5-6% of the EU final energy in 2020;
- 160 to 210 Mt/year CO2 savings by 2020, i.e. 4-5% of EU total CO2 emissions in 2020;
- 280,000 to 450,000 potential new jobs by 2020, mainly in the construction sector, energy certifiers and auditors and inspectors of heating and air-conditioning systems. New jobs would also be stimulated by the need for products, components and material used or installed in better performing buildings.

In December 2008, the European Parliament endorsed an integrated package of energy and climate policy proposed by European Commission in 2009, including the following legally-binding targets to be reached by 2020 (known as "20-20-20"):

- To cut greenhouse gas emissions by at least 20% in 2020 compared to the 1990 levels (30% if other developed countries commit to comparable cuts).

- To raise the share of renewable energy to 20% of total energy consumption by 2020.

- To reduce energy consumption by 20% of projected 2020 levels by improving energy efficiency.

The 20% energy efficiency target was also incorporated in the Commission Communication of 19 October 2006 entitled "Action Plan for Energy Efficiency: Realising the Potential" (COM(2006)545) which was endorsed by the European Parliament in its non-legislative resolution of 31 January 2008 and which also identified the significant potential for cost-effective energy savings in the buildings sector. The Action Plan is set to run for the period of January 2007-December 2012. In its resolution, the European Parliament proposed to consider measures such as for example: to require all new buildings needing to be heated or cooled to be constructed to passive house standards from 2011; to gradually introduce district heating and cooling grids for all buildings; to create a transparent database of national, regional and local measures promoting energy efficiency in buildings in the interests of the exchange of best practices and of public awareness; to ensure that the tax systems reflect the aim of improving energy efficiency in buildings; and to increase research into human behaviour regarding use of energy.

The EU Structural Funds can be used to realise energy-saving measures. Housing expenses of the European Regional Development Fund are eligible only in new members, but the funds are to be opened in 2009 to all EU members and regions for the purpose of energy efficiency refurbishment in existing housing. This, as believed, will contribute to the implementation of the 2008 European Economic Recovery Plan.

Relevant EU funding programmes also include Intelligent Energy Europe Programme, established by the Decision of the European Parliament and of the Council of 24 October 2006 as part of the EU Competitiveness and Innovation Framework Programme (2007 to 2013). It distributes funds in energy efficiency areas such as capacity building, exchanges of experience, development of efficiency market, awareness raising and information provision.

In March 2009, the European Commission has approved a plan to phase out sales of the conventional light bulb between 2009 and 2012, beginning in September 2009 with the 100-watt bulb. The plan is to replace them with energy-efficient bulbs that use up to 75 percent less electricity.

Most other national governments in the UNECE countries also have their own strategies and law oriented to improve energy efficiency on their economies. These documents are translated into regional and local policies and legislation. The workability of the national and regional documents, however, varies. In many countries, especially in EECCA, energy efficiency legislation and strategies often remain declarative and include only limited mechanisms of implementation (EEA, 2007).

Further development of the national regulatory regime with respect of energy efficiency in housing needs to be comprehensive and address those barriers that lead to energy efficiency gap (see next section). One specific dimension of this is also advancing the rent and home ownership legislation. For example, while in countries such as Germany maintenance measures have been imposed as obligation on every owner (or housing manager for condominiums communities), in most transition countries implementation of major maintenance measures depends on good will and financial possibilities (Boermans and Petersdorff, 2007). There must be clear regulatory mechanisms established in this respect and to the inclusion of energy efficiency measures.

Apart from regulatory instruments, a number of financial, educatory, and voluntary instruments can be found across the UNECE countries (see Table 1 for a few examples).

### 3.4. <u>Factors leading to energy efficiency gap in housing</u>

It is apparent that energy reduction in housing has been a major field of policy, research and development. Despite such important efforts, however, trends in many UNECE countries are not optimistic. Some of these trends are connected to the 'contextual' problems, such as economic downturns in former Soviet and in Balkan countries; but even in those UNECE countries that have had more stable economies and that are traditionally considered to be advanced for building energy standards, signs of sluggishness or even regress are not unusual. For example, Ryghaug and Sorensen (2009) note that office buildings built in Norway after 1997 are less energy efficient than those built before the 1930s. As another example, the housing stock in the UK – the country which has pioneers many energy efficiency initiatives – is still among least energy efficient in the EU and technical capacities remain limited. As discussed above, although energy efficient technology is available and regulatory frameworks increasingly support energy efficiency, there remains energy efficiency gap. It is therefore important to identify barriers that explain the gap and to address these barriers in policy making. Some major barriers are considered below in light of our 5-IN approach.

#### *3.4.1. Lack of incentives*

The most common barrier for investing in energy efficiency in housing is little incentive to do so – that is, low priority of energy issues versus many other problems and alternative opportunities surrounding those individuals, households, firms, developers and other economic agents who are supposed to invest their capital and effort in energy efficiency. Even if individual actors share concerns about energy, they may be incapable to respond appropriately. Energy efficient products are usually more expensive or require additional efforts or additional knowledge at the same time as the provision of such products is not necessarily rewarding in terms of property value.

Lack of incentives can be seen at different levels – at the level of households, landlords, and the construction industry.

Households see high 'transaction costs' for investing in energy efficiency. Households are sensitive to the effort and time spent improving the energy efficiency of their home. They generally face a broad range of "things to do", where energy efficiency is low priority.

The position of landlords is most important, but not uncontroversial, As Bell et al (1996: 5) noted: "Unless we understand the motivation of owners (owner-occupiers and landlords) to invest in energy efficiency and are able to devise the means by which they can be encouraged to do so, it is unlikely that the problems which give rise to energy concerns (the environment, fuel poverty, health) will be solved". However, landlords will have little incentive to invest in energy efficiency, if the operating costs are born by tenants, while the tenants may not see the return of their capital investment into energy efficiency during the life of their tenure (this is also known as "split incentives" or "principal-agent problem"). Subsidised energy prices may imply very long payback periods, so that energy efficiency projects are often considered unprofitable with current assessment techniques (particularly so in transition countries, given the higher expected rates of return). When reduced costs for municipalities and other benefits are included, such projects have a much shorter payback period. Even so, there always remains asymmetry between different levels of economic consideration.

If there are low priorities for energy efficiency and no mechanisms that allow energy efficiency quality to be internalised in the market properties, the technological chain involved in the design, production, management and operation of homes is malfunctioning. Engineers and architects are discouraged from increasing the cost of the project by improving energy efficiency. If developers are building housing for sale or speculation and not for future operation by themselves, they will not consider it profitable to increase energy efficiency beyond minimally required standards.

Incentive asymmetries also exist between the producers of energy and utility companies and the demand side. Energy producers are naturally interested to increase their production and to grow; this task is usually quite the opposite to that of energy conservation. There must therefore be incentives to align utilities' and consumers' interests.

### *3.4.2. Information asymmetries and lack of awareness*

Energy efficiency in housing is surrounded by informational barriers, failures and asymmetries. Actors on the demand side in the building chain have little knowledge, skills and training in energy efficiency, while the supply side has limited understanding of how to promote energy efficient technologies. Even if customers are interested to buy or to invest in energy efficiency, information about energy technologies is often incomplete, hard to obtain or hard to understand. There are obstacles to find competent and affordable advice locally, especially from the financial institutions, were energy expertise is almost nonexistent (IEA and AFD, 2008). As a result, the rate of market penetration of energy efficiency technology, technique and other know-how, even when they exist in practice, may remain low.

Besides these direct informational problems, there is also a great fluctuation in energy markets leading to uncertainties and, consequently, higher risk premium for energy efficiency investment analysis. Under the condition of relatively low or distorted energy prices, high transaction costs for obtaining sufficient information and the greater costs of technological solutions due to their limited market penetration, energy efficiency projects may turn to have negative profits in traditional investment analysis and, as such, of low appeal to self-interested rational actors. There is a strong argument in favour of changing traditional financial approaches and evaluation techniques for energy efficiency – including increasing time horizons to fully accommodate the lifecycle of buildings (T'Serclaes, 2007).

Public awareness is another important issue, as psychological aspects and perception affect human behaviour and lifestyles and these are difficult to change. In particular, household lifestyles influence energy use via choice of indoor temperature, airing habits, consumption of hot water and electricity. As just one example, a survey of almost identical homes in one village in Southern Sweden showed hat energy consumption varied with a factor of 2.5. Such a large variation could not be explained by factors other than lifestyle (Nylander et al., 2006). Although there may be inflexible conditions behind lifestyles (such as health or age of inhabitants), the potential for reduction in energy demand in housing due to change lifestyle is generally very high.

### *3.4.3. Lack of initiative, innovations, and investment capacities*

Provision of technology and services for improved energy efficiency in housing depends on industry champions. However, construction industry is traditionally one of most conservative. The voluntary intake of even simple cost-effective solutions is low in this sector in many countries. As the market for energy efficient technology is not developed, the technological solutions and innovations remain relatively expensive, thus further raising the issues of affordability and cost-effectiveness. Limited access to capital for low-income borrowers or small businesses further aggravates these vicious cycles.

As was noted in the UNECE Concept Note, which forewent the present report (UNECE, 2008), in the EECCA and SEE countries, such barriers are even more pronounced and include a weak public sector with insufficient budgets for housing, outdated building codes, low innovative capacities of the local construction industry, weak public and private research and development activities, and immature demand-driven housing markets, which weaken the role of consumers seeking for more efficient homes. Besides, there is the lack of proper organizational structures and decision-making structures within municipalities and in multi-family buildings. In the latter case, responsibilities for management and operation (M&O) are often unclear, with a result that no organised initiatives are promoted to renovate common spaces. Improvements have often been technically incorrect, bringing worse performance instead of better efficiency. In other cases, subsidies and grants have led to the construction of random pilot projects, which are not replicable or contributing to the overall solution of energy efficiency.

A specific challenge for these countries relates to overcoming what we call the *energy inefficiency trap*, or a situation in which countries having lower energy efficiency are unable to change their respective status due to lack of funds, experience, technology, motivation and initiative. Low-income UNECE countries would therefore benefit from know-how transfer from other parts of the UNECE region in all relevant fields, including technical knowledge, capacity building and institutional development. Where the high initial cost of energy efficient technologies delay their application in lower income countries, especially when the technologies need to be imported, domestic capacities should also be enhanced.

### *3.4.4. The rebound effect: a barrier or a benefit?*

It is important to be reminded while assessing the impacts of energy efficiency on energy savings and emission reductions that there may also be a certain "rebound effect" (or take-back effect) of energy efficiency (see Sorrell, 2007; Greening et al., 2000). The effect means that economic agency or households, who have gained an efficient technology for a given energy service, may actually offset some of its conservation effect by a greater use of that service, because it becomes more affordable and more productive. More insulation, for example, has historically followed by higher indoor temperatures – hence, some of the energy conservation is "lost back".

In the residential sector, this effect may offset 10-40% of energy saving gains depending on energy service. The economy-wide implication of the rebound effects is that energy efficiency may improve productivity and accelerate economic growth rather than decrease energy consumption and carbon emission to the extent as envisaged by engineers and policy-makers. The concept of rebound effects is not without controversies, but it is still sensible to discount technological energy/emission savings in estimating future gains. As it is energy conservation and emission reduction that are usually the primary target of national energy efficiency policies (rather than corresponding benefits), even greater use of efficiency is required for achieving the desired levels of energy/carbon saving. Certain policies may discourage the rebound effect, such as, for example, differentiated progressive energy tariffs that offer certain minimum amount of energy at a very affordable price but are increased for higher levels of energy consumption.

**Table 1 Some examples of measures to stimulate energy efficiency (EE) in housing from the UNECE countries**

| Policies and practices | Examples | Challenges and constraints |
|---|---|---|
| **Regulatory measures** | | |
| Mandatory building energy codes/energy performance standards | - Most countries have building codes, including requirements for energy performance, however these vary considerably. Laustsen (2008) calculated "total U-value" for the building envelopes from the national prescriptions of some OECD members. The strictest code in terms of overall u-value was found in Sweden with an overall value close to 0.7, followed by Denmark (0.77) for renovation or extensions (while u-values are not set for totally new constructions) and Norway (0.84) and then followed by Finland (0.94) and Ontario, Canada, for its coldest parts (0.93). | Opposition from the building industries for tightening the codes; problems with enforcement, especially at the scale of smaller projects. Limited means by poorer self-builders to meet the requirements of demanding buildings standards. |
| **Financial incentives** | | |
| Grants and subsidies for energy efficient equipment for homeowners | - In Austria, there are subsidies which are combined with EE requirements that are stricter than the building codes and which can include additional insulation, improved windows or installation of renewable energy sources or efficient appliances. In some Austrian provinces this has lead to nearly all buildings being constructed with EE which is better than the requirements in the codes (Laustsen, 2008). | The amount of grants may be insufficient to meet demand. |
| Grants to low-income households and affordable housing providers | - The US Department of Energy provides grants through the Weatherization Assistance Programme (since 1976). It helped lowering space heating energy consumption in participating low-income households by 30% between 1993 and 2002 (Geller et al., 2006).<br>- The Canada-Ontario Affordable Housing Energy Efficient Program launched in 2007 is funded by both the provincial and national government and offer affordable housing providers provides up to $850 per unit to help offset the incremental cost of purchasing ENERGY STAR qualified products to encourage the use of energy efficient products and practices. | Increased burden on the public budget, sometimes lack of information and complicated procedures for vulnerable groups. |
| Tax credit or deductions on energy-efficient investment | - In the UK, all new zero-carbon homes up to £500,000 in value are exempted from stamp duty land tax (until 2012); the Landlord's Energy Saving Allowance (LESA) provides tax deductions to owners who make investments in certain energy saving measures; VAT deductions are also available.<br>- In France, tax credits for EE installations apply to all responsible for paying energy bills (different rates, up to 50% since 2006); the tax credits are coordinated with other measures, such as direct subsidies; the limit is €16,000 from 2005 per dwelling per couple. (IEA and AFD, 2008).<br>- In Sweden, households can benefit from a 30 % tax credit when converting from direct electric heating and oil-based heating to systems based on bio mass or heat pumps (since 2006).<br>- Bulgaria offers property tax exemption for the purchase of efficient to very energy efficient housing. This tax exemption lasts for ten years if the housing is of class A and five years in it is of class B (ADEME, 2008). | A risk of costly efforts with little impact - unless financial incentives are coordinated with other instruments. It is advisable to provide incentives for newly commercialized technology with high initial cost but good prospects, rather than for mature products in the market. |

| | | |
|---|---|---|
| **Voluntary measures, partnerships** | | |
| Voluntary and semi-voluntary energy performance standards in housing | - Switzerland's voluntary Swiss Minergie standards requires that total energy consumption of the building must not exceed 75% of that of average buildings and less than 50% of the energy can be from fossil fuels. The Minergie-P standard requires virtually zero energy consumption.<br>- England's Code for Sustainable Homes (2007) assess new home against nine sustainability categories, rating the 'whole home' as a complete package from 1 to 6 stars (6 stars for highly sustainable and zero net carbon homes). From 2008, all new social housing must be built to a minimum of 3 stars. The Code is voluntary for privately-built housing; however, all new homes are required to have a Code rating in the mandatory Home Information Pack (HIP); if they are not assessed against the Code, HIP must include a nil-rated certificate. This is done in anticipation for gradual tightening of the building regulations towards a zero carbon home target from 2016. | Effective only if firms see more benefits of participating over costs of doing so. The goals may be not stringent enough and some firms may fail to comply. To be effective, voluntary agreements need to be complemented with financial incentives, technical assistance, and the threat of taxes or regulation if companies fail to meet their commitments (Geller et al., 2006) |
| Voluntary green building partnerships | - Europe's Smart Energy Home (SEH) consortium consists of five multinational companies, supporting a new generation of buildings which would provide sustainable living experience without any radical increase in costs. In order to show the technical, social and financial feasibility of the SEH concept, the SEH initiative sets up a network of DEMObuildings: attractive, multi-dwelling buildings, adapted to local conditions, with energy performance ranking among the top of the national building stock. | Such initiatives may have limited impact as stand-alone, but great impact en masse. |
| **Educational measures and capacity-building** | | |
| Energy labelling and certifications | - EU Energy Performance Certificates (mandatory) – see Box 2.<br>- The US Environmental Protection Agency's Energy Star Programme (voluntary): a home may earn the Energy Star label if it is verified to be 30% more efficient it its heating, cooling, and water heating than the requirements of the 1993 Model Energy Code, and it is 15% more efficient than the state energy code. Energy Star homes are eligible for financial incentives.<br>- Leadership in Energy and Environmental Design (LEED) standard developed by the U.S. Green Building Council for commercial, institutional and high-rise residential buildings. | Voluntary certifications have only limited impacts; mandatory certifications are likely to meet industry opposition. |
| Research and development programmes | - The development and commercialization of new energy technologies. | Usually a long pay-back period. Needs to be complemented by regulations and financial incentives, otherwise market barriers present serious constraints. |
| Comprehensive programmes | - European Commission's Intelligent Energy for Europe (since 2002). One of the goals is to increase EE by 1% a year across the EU. It supports strategy development, financial and marketing structure, promotion schemes, R&D and demonstration activities, monitoring and evaluation, energy targeted initiatives. | Sufficient information and high skills are required to obtain funding. |

# 4. POLICY IMPLICATIONS AND RECOMMENDATIONS

Based on the outlook in the previous chapters, this chapter considers policy implications and provides some recommendations in the field of energy efficient housing to be considered by the national governments and international organisations. Thus, the next section highlights a number of principles that can form a solid foundation for an effective policy in the sector, followed by a section that considers further pillars for energy efficiency policies in housing.

## 4.1. Basic principles for successful policies

### 4.1.1. *Contextual underpinning*

Exchange of experiences and knowledge and continuous learning from mutual experiences are the key to policy advancement. That said, there are substantial differences as for how far individual countries or groups of countries of the UNECE region have advanced for energy efficient housing. There are also large differences across the region with respect to the levels of economic development, legislative and organisational structures, history of the housing sector, as well as to the outdoor climate conditions. Organisational, legislative, financial or technical approaches, which are effective in one context, will not necessary be same in another. Policies and practices should be sensitive to this diversity and, if necessary, sufficiently embedded into local socio-economic, institutional and geographical contexts.

### *4.1.2. Multidimensional character*

Many studies and assessments suggest that there is no 'silver bullet' able to resolve the problem of energy efficiency in housing quickly and hassle-free (e.g. IEA and AFD, 2008). It would be improper for policy makers to concentrate on one specific challenge or obstacle or to rely on a limited number of instruments. The problem is multidimensional, so that policies should also be comprehensive, thoroughly developed and integrative of a number of measures and instruments, both regulatory and non-regulatory (technological, informational, educatory, organisational, fiscal and financial). Despite the seeming difficulty of operating comprehensive solutions versus simple one-dimensional ones, the former have a "snowball" character and will much sooner lead to self-sustaining energy efficiency results than a series of disintegrated policy actions.

### *4.1.3. Social responsibilities and safety net*

Energy efficiency in housing is integral part of the housing experience and, as such, is part of the wider social experience. It is therefore vital to interlink policies seeking to improve energy efficiency in housing and social policies. To consider energy efficient housing in narrow technocratic terms (e.g. merely through a lens of energy conservation or extra incomes generated to utility services due to higher energy prices) is wrong from both social and political point of view. Technocratic targets are still important but they are only appropriate if part of a larger socially-responsible policy package. Sufficient measures should be sought to ensure affordable access to energy, to decrease fuel poverty, to mitigate social inequality and social exclusion and to improve social wellbeing in general; social safety net for low-income citizens and other vulnerable groups must include energy considerations.

#### *4.1.4. Political and organisational leadership*

The nature of the problem of energy efficiency/energy inefficiency requires a continuous and devoted process of decision-making, implementation and control rather than a one-off endeavour or declarative programmes. Energy efficiency policies are rarely successful unless they are underpinned by strategic thinking and strong leadership – especially so when critical changes are to be set in motion. It is advisable that a special organisational unit is charged with the responsibility to coordinate energy efficiency policies, with powers over other departments and local governments as far as these policies are concerned.

#### *4.1.5. Statistical data and informational backing*

Policy-making and management activities directed toward improved energy efficiency needs to rely on data that allow assessing the current situation and controlling the results. In many countries, however, the relevant statistical data are limited or divided between sectoral agencies, while central statistical bodies do not have methodology and authority to process the data. It is important that statistical capacities and universal standards are raised in all UNECE countries. In addition, energy information systems need to be set up at the regional and local levels.

### 4.2. Priority areas for energy efficiency policies in housing

#### *4.2.1. Raising awareness and public dialogue*

Very much can be achieved for energy efficiency through increased public awareness. Informational instruments positively affect energy efficiency by promoting informed choices and possibly contributing to behavioural change and should be prioritised.

There are two groups of information instruments that should be used – "hard" and "soft".

The former group represents legally-binding informational instruments such as mandatory energy performance labelling of household appliances, energy performance certification of buildings or other declarations of energy consumption (e.g. indication by stars). These instruments, which are already widely in use in the EU and some other countries, are low-cost and should be promoted by national regulatory regimes in all UNECE countries in order to make energy efficiency be highly visible in the residential market. If potential buyers or residents receive reliable, verifiable and controllable information about their future operation cost, they will make more informed choices and the market will adjust.

The "soft" instruments of raising energy efficiency awareness include, for example, informational campaigns; capacity-building, educational and training measures; good practice and information handbooks; voluntary energy labelling of products; demonstration projects; advertising and promotion of energy-efficiency buildings and technologies; and promotion of sustainable lifestyles. Accordingly, policy measures should be undertaken for the relevant sectors – including programmes for primary, secondary and tertiary education, for continuing education and advanced training, support to environmental NGOs, assistance to research, development and demonstration (RD&D), tax incentives and financial opportunities to businesses which provide energy efficiency solutions.

Polices should not only encourage informational instruments as much as possible, but should broadcast themselves widely and transparently, with much use of the national and local mass media. Experiences suggest that it is particularly in those societies that have raised energy efficiency and environmental concerns to the levels of everyday public discourse that relevant policies receive public support and loyalty.

### *4.2.2. Energy tariffs in the housing sector*

One of the essential elements in the energy efficiency incentive system is the organisation of energy pricing and billing. If residents associate their use of energy with a burden to their budget, they attach a greater value to energy efficient housing and are more willing to reduce energy consumption. The threshold of cost-effective energy efficiency investment also rises as energy prices rise. It is therefore important to establish an adequate pricing system and, furthermore, to get rid of fixed-cost payment systems for energy (electricity, heat, gas, and hot water). However, there must be at least two conditions satisfied. Firstly, it is important to explicitly link energy payments with the actual energy use by the households, by informing them through energy bills and energy metering. The metering system installation should therefore precede energy price reform. Secondly, the pricing according to use is only sensible if users are able to fully control their use of energy or otherwise they will not be able to respond to price stimulation (e.g. heat will be taken as supplied by district heating provides) and there will be a zero energy efficiency effect (Boermans and Petersdorff, 2007).

It is often incorrectly assumed, however, that the deregulated energy prices are sufficient to stimulate energy-efficiency investments and that therefore particularly those countries that remove energy subsidies will have better prospects. Firstly, such measures are not sufficient and need to be understood as only one element of the integrated package of energy efficiency policy, while, secondly, energy pricing needs to take into account the socio-economic context of a particular country. Even in the most affluent countries there is no smooth energy efficiency response to the price stimuli due to the failure of energy prices to fully incorporate externalities, uncertainty in future price dynamic and other market asymmetries discussed above. Moreover, privatised utility companies or energy producers are interested in sell more energy at market price and not in improved energy efficiency with reduced consumption. There should therefore be many supplementary policy solutions. Furthermore, there is a real danger particularly for less affluent countries that, given their poorer population, limited investment capabilities and inefficient housing stock, increased energy prices will only aggravate social problems, the cumulative cost of which will overweigh energy efficiency gains. In many transition countries, monetary “incentives” alone have proven to lead to non-payment and disconnection crisis, pubic infrastructural demolition, increased levels of dirty energy and, while possibly lessening loads on electricity or gas distribution grids, have worsened both the conditions of living and the environment.

A number of measures should be done alongside energy price reform (or in order to correct the energy market mechanism where market prices are already in force). Criteria may be developed as for what percentage of the household income may be spent on energy before it is considered to be in fuel/energy poverty. For those in energy poverty, targeted subsidies or assistance should be provided, which would ideally help improve the energy status of housing, so that less energy is consumed for same levels of comfort. More universal (non-targeted) measures may include differentiated tariff systems, such as block tariffs, which make utilities affordable for lower income families and yet encourage conservation (EEA, 2007). Under such systems, households are charged progressively for the unit of energy used depending on energy use bands or thresholds. To be effective, the tariff difference for a next energy use band should be large enough.

Sufficient measures should be done to encourage utility companies to improve their services. An example is White Certificates increasingly used in the EU; other measures may include, for example, obliging energy providers to spend the extra income received from the higher energy use bands exclusively for energy efficiency.

### 4.2.3. *Building codes and technology development*

Evidence internationally shows that updated and *mandatory* energy efficiency standards in buildings (being independent or part of building codes) belong to the most effective instruments to increase energy efficiency. While the experience of those countries that have voluntary building codes (e.g. Japan) suggests that such codes do not pay significant roles in improved energy efficiency, the countries that have institutionalised mandatory buildings codes have been able to achieve much progress via this mechanism (Geller et al., 2006). In the countries where sub-national states are responsible for building codes, there should still be strong national policy in this respect grounded in model national building codes.

Mandatory building codes must be regularly reviewed so that minimal requirements are raised to the new levels of cost-effective and feasible energy-saving technology. Many countries choose to set future energy demands years ahead the change in order to give the industry time to adjust and prepare for the new regulation. This mechanism of "dynamic building codes" reduces the costs by the change and reduces the opposition from the building industry or manufacturing (Laustsen, 2008).

However, buildings codes should also be sufficiently balanced against the general levels of economic prosperity of a particular country. Stringent and universal buildings codes may be unfeasible for smaller developers and individual self-builders in less prosperous countries, thus pushing them into informality and illegal practices. It may be advisable to have differentiated requirements depending on the size of the affected project and status of the developer. Larger developments and the public sector may be required to meet higher and more challenging standards than private individuals who build for their own habitation. There must also be a degree of flexibility for local municipalities to set their own standards (e.g. more stringent regulations than minimal national requirements).

Developed mechanisms to enforce and control the implementations of the mandatory codes are a crucial element of the system; there is no point to have advance building codes which are not followed.

Building codes should also be supported by other instruments, including subsidies to lower-income groups to acquire energy efficiency technologies. On the other hand, energy efficiency must be a condition for subsidy in construction or capital renovation.

Furthermore, the development of affordable technology for low-energy and passive buildings should be prioritised in national energy efficiency strategies. National activities in research, development and demonstration (RD&D) should stimulate technological advances in this respect. Appropriate national targets and measures should ensure the increasing penetration of passive, zero-energy, and zero-carbon buildings and other innovative solutions, with preparations to eventually require all new homes to be based on this advanced technology by a certain year.[4]

### 4.2.4. *Housing management and maintenance*

Investment in better housing energy efficiency depends to a large extent on the organisation of the system of housing management and maintenance. Therefore, an institutional environment should be in place and that would enable and enforce the system of housing management to operate within a strong framework of capacities and incentives. There are several interrelated fields within this priority area, as follows.

[4] In the UK, for example, a complete transition to zero-carbon homes is currently envisaged to be by either 2016 or 2019.

Firstly, improving and professionalizing housing management is a necessary institutional prerequisite for better energy efficiency in housing. This field is important in all UNECE member States, but represents a particular challenge for the former socialist countries, which are characterised by a conflict between, on the one hand, a large proportion of multi-apartment buildings with now a complex ownership form and, on the other, limited self-management skills and capacities of the residents. There must be mandatory provisions for setting up collective coordinating bodies, such as owners' associations, on which legal obligations for maintenance should be established (see *Guidelines:* UNECE, 2003). These collective bodies should also be required to keep their maintenance funds, which can finance energy efficiency projects as part of maintenance activities and serve as collateral for loans.

Secondly, it is necessary to set up a system of economic and legal incentives that would stimulate homeowners to deliver better energy efficiency. Various fiscal incentives and subsidies are already in use to this end in many countries. However, innovative institutional forms should also be designed for the problem of split incentives between owners and occupiers. One suggestion may be to change the conventional "giving" direction of fiscal incentives for landlords and rather to impose a "taking" energy inefficiency tax on them - see Box 3. That tax might still be supported by "giving" incentives, but would increase the value of energy efficient hosing as "hassle-free".

Thirdly, financial relationships should be developed to enable owners and other stakeholders to raise capital for energy efficiency (e.g. renovation loans and public subsidies). It is important in this respect to improve cooperation between homeowners and financial institutions. While financial institutions should learn how to incorporate energy efficiency projects in their practices and raise technical expertise for appraisal and risk assessment, provisions should be made as for collaterals, guarantees and insurances that the banks can use for financing such projects. In this respect, owners associations should also have certain enforcement possibilities against owners who are not willing to take part in maintenance schemes or unable to fulfil their obligations.

Fourthly, support schemes should be provided for low-income households (such as income-related subsidies for refurbishments) to improve energy efficiency, including for residents in condominiums that are undergoing refurbishments according to the owners association's decision.

Fifthly, separate efficiency polices should target the public/social housing sector, which represents particular opportunities from the institutional point of view. Public housing in some countries such as the UK already delivers better standards of energy efficiency than average private homes; among other advantages this helps tackle fuel poverty. There should be special programmes of investing in retrofitting of the existing public stock and stricter requirements for better energy efficiency performance for new homes. As the organisation of the institution of public housing varies considerably across the UNECE region, different combinations of financial and legal measures should be provided depending on the context. In some transition countries, private housing can now reach as much as 80-90% of the total housing stock, while remaining public/non-privatised homes may be scattered among privatized flats in multifamily building. Whilst such a structure promotes socio-spatial mix, it also requires the governments to find proper organisational solutions.

### *4.2.5. International cooperation*

Policy making benefits greatly if firmly informed by wider international developments and experiences and if it continuously seeks for best practices internationally and considers their transferability or adaptability to the local context in a sustainable manner. Furthermore, capacities should be established to assist less developed countries of the UNECE with technological and institutional know-how transfer.

International organisations should accumulate and exchange knowledge and experiences on best practices or policy failures in the housing field. One suggestion for the Committee on Housing and Land Management of the UNECE can be to include specific analysis and recommendations on energy efficiency in housing in the Country Profiles for those countries that lag behind in order to estimate their contextual requirements and to offer targeted policy advice.

The UNECE is particularly well placed to provide such assistance, as its is a unique pan-European and trans-continental regional forum that brings together insights, establishes a multilateral dialogue, and delivers policy advice to the countries with a diversity of social, cultural, economic and political backgrounds. Sharing experiences, cross-national learning and international efforts are especially important for the energy efficiency agenda, as it delivers common benefits from reducing climate change risks.

**Box 3 Raising incentives and awareness through an energy inefficiency tax scheme**

One suggestion how to stimulate property owners to invest in energy efficiency in residential buildings is to introduce a scheme under which property owners are charged an energy *inefficiency* tax on their property unless they are able to document that the property complies with certain minimal energy requirements (in which case the tax is not levied).

If they want to avoid paying the tax, this scheme would encourage landlords to improve energy efficiency and/or to acquire necessary energy documentation for their property (e.g. energy performance certificates). In any case, the tax scheme would raise their awareness. In parallel, public subsidies and grants should be made available for improving energy efficiency in housing. The energy inefficiency tax may partly or completely offset the expenditures from such funds.

There are a number of benefits from such a scheme. It will further boost the submarket for energy audit and advisory, provide extra incentives both for property owners to prioritise energy efficiency and for the real estate market to include energy efficiency in property valuation, will bring statistical data on energy efficiency in buildings at little cost to the public budget, and bring more tax revenues to use for targeted public assistance in the field of energy efficiency.

The energy inefficiency tax may be small in the beginning, but increase as capacities and awareness grow. The tax may be levied based on the value of real estate or be proportionate to the size of property. Sufficient actions should be taken to explain the purpose of the tax and what measures can be taken to be exempt from paying it.

A limitation of this scheme shares much common with other regulatory and fiscal regimes: it requires a formal housing economy, while much of energy inefficiency in the UNECE region is concentrated in unregistered and non-taxable informal houses of the poorer countries, which are built domestically without consideration of the official building standards.

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