6 Buildings

Location of city studies covered in this chapter

Facts and figures

- Residential, public and commercial buildings use around one-third of total energy consumption in SEE and EECCA. Energy use is dominated by heating and cooling, followed by hot water, appliances and lighting.
- Typically, 80–90 % of total energy used during the whole life of a building is consumed during the use phase. Investment aimed at improving energy efficiency and heat loss during occupancy will give strong environmental and economic benefits over a building's lifetime.
- Residential energy consumption per capita in EECCA is slightly higher than the EU average, and twice as high as the SEE average. It ranges from about 11 000 kWh in Russia to less than 600 kWh in Armenia. Household water consumption is generally significantly higher than EU averages.
- Distribution losses are high in the heating and water supply networks. In Russia, for example, heat loss during distribution is estimated to be 20 % in some regions. For water distribution, losses of 30–50 % are typical in the SEE and EECCA regions, and in some countries many water distribution systems are close to collapsing.
- SEE and EECCA countries could dramatically reduce energy and water consumption through introduction and enforcement of stricter codes for new buildings; retrofit of the huge stock of inefficient multi-apartment blocks; modernisation of energy and water distribution networks; installation of metering and controls in apartments; and reform of tariffs to create economic incentives for saving.
- In SEE, there is widespread use of electricity for heating and hot water in households. Significant environmental gains could be achieved by switching to gas or renewable energy sources for heating and hot water, and freeing up electricity for use in the growing number of appliances.
- Reuse and recycling of demolition waste can be an effective measure for reducing the use of virgin construction materials in buildings. This does not currently occur on any significant scale.

6.1 Introduction, approach and SCP perspective

6.1.1 Introduction

Buildings are known to be responsible for a significant share of the resource use and the negative impacts on the environment in most developed societies. This chapter considers trends and the overall importance of residential, public and commercial buildings with respect to environmental pressures. It identifies potential opportunities for reducing environmental and social impacts within this sector and outlines progress in making policy. Finally, examples of individual initiatives and good practices are presented.

Focus is placed on urban areas, especially large cities for the following reasons:

i) Urban expansion between the 1960s–1980s involved the construction of a vast number of similar multi-apartment buildings, which consequently share many problems to which similar solutions can be applied.

ii) In spite of growing privatisation, many multi-apartment blocks in cities in EECCA and SEE are still owned by local or national governments. This makes publicly funded retrofit programs possible.

iii) District heating systems are common in larger cities of the regions. Antiquated systems are the cause of high energy consumption but at the same time present opportunities for efficient heating and cooling in the future.

To illustrate the analysis in this chapter, local studies on buildings were conducted in the following cities: Ashgabat, Turkmenistan; Dnipropetrovsk, Ukraine; Dushanbe, Tajikistan; Minsk, Belarus; and Tbilisi, Georgia.

6.1.2 General SCP aspects of buildings

Buildings provide for many basic needs, such as a comfortable inner environment, space and facilities for washing, cooking, eating and sleeping, or alternatively for carrying out business, administration, education, healthcare or leisure. Ideally, sustainable buildings should provide for these needs for all social groups as efficiently as possible with the least environmental impact.

Infrastructure

Typically, 80–90 % of total energy used during the lifespan of a building is consumed during the use phase (Ala-Juusela *et al.*, 2006). Therefore, increased investment in the design and construction phase, aimed at reducing energy consumed in the use phase, can give strong environmental and economic benefits over a building's lifetime. For example, it is estimated that the European Union's 2003 Energy Performance of Buildings Directive (EC, 2002) will lead to an annual increase in infrastructure investment of EUR 3.9 billion by 2010, but the resulting annual energy cost savings will be nearly double this at EUR 7.7 billion per year (Ala-Juusela *et al.*, 2006).

Conversely, a lack of consideration and awareness at the design and construction stage can lead to a building which is predisposed to high energy consumption, regardless of the behaviour of its occupants.

Energy use in buildings during occupancy is typically dominated by control of the inner environment (heating and cooling), followed by use of hot water, appliances and lighting. Sustainable building design includes high levels of thermal insulation of walls, roofs and windows, efficient heating and cooling systems (i.e. using waste heat from industry, heat pumps/cooling pumps, efficient boilers etc.), design of the building to fit a specific location, use of passive lighting and active shading, solar water heating, and energy efficient appliances and lighting.

Box 6. 1 Buildings on the international policy agenda

Buildings are not specifically mentioned in the Sustainable Consumption and Production Section of the 2002 Johannesburg Implementation Plan. The following action, however, can be taken to relate directly to buildings as key long-life energy-consuming infrastructures:

'States have common but differentiated responsibilities. This would include actions at all levels to…integrate energy considerations, including energy efficiency, affordability and accessibility, into socio -economic programmes, especially into policies of major energy -consuming sectors, and into the planning, operation and maintenance of long-lived energy-consuming infrastructures.'

One of the Working Groups established as part of the Marrakech Process concerns Sustainable Building and Construction. The group's first report focuses on energy use in buildings. In addition, UNEP launched the Sustainable Buildings and Construction Initiative in early 2006, aimed at developing a broad global partnership to promote progress in sustainability in this sector with a focus on reducing climate change impacts.

The technology exists today to create sustainable buildings entirely independent of external energy supplies and with lower lifetime costs than conventional buildings. Typical barriers to the widespread implementation of these technologies include:

- real estate markets which place emphasis on cutting costs of construction;
- lack of building codes for architects and contractors which would promote construction of sustainable buildings;
- lack of energy information for potential buyers and lack of consumer interest when energy prices continue to be heavily subsidised;
- a widespread lack of knowledge and resistance to change within the construction industry.

A sustainable buildings policy needs to tackle all of these barriers. Moreover, it must optimise interactions with heating, electricity and water distribution systems in order to increase efficiencies. A sustainable building policy should also focus on improvements in efficiencies of the existing building stock, making the best use of potential positive characteristics, i.e. existing district heating and multi-apartment housing. More efficient building infrastructure will also yield social benefits by increasing access to and affordability of comfortable inner environments, considerable economic gains, and an increase in the security of the energy supply.

Finally, the construction industry is one of the sectors that consumes the greatest amount of material resources. Virgin material consumption can be reduced by extending the useful life of buildings, improving material efficiency, greater use of renewable materials (i.e. wood), integrating reusability into building design, and mobilising recycling and reuse of demolition waste.

Household behaviour

In terms of energy consumption, household behaviour can be pre-determined by existing building infrastructure. For example, if the level of heating cannot be controlled, householders will make use of wasteful practices such as opening windows to reduce temperatures on milder winter days.

Other wasteful behaviour patterns in water and energy consumption can result from:

- a false perception dating back to centrally planned economies that water and energy are free resources;
- a lack of awareness of environmental, social and economic impacts of water and energy use;
- a lack of economic incentives to reduce consumption.

Economic instruments can only be brought to bear if actual energy and water use is measured and householders and building operators have control over their costs. Again, there is an intimate relationship between the building infrastructure and household behaviour.

6.2 Trends, driving forces and impacts

6.2.1 Historical background

The forced transfer of populations from rural to urban areas in the 1930s, the destruction of urban infrastructure during the Second World War, and chronic under-investment in housing during the post-war years left the Soviet Union with just 4 m² of usable housing space per capita by the end of the 1950s. From the 1960s onwards, new construction principally in urban areas was designed to fill this gap as rapidly as possible. The effort was so enormous that by 1989, housing space had risen to 15.8 m² per capita (Renaud, 1992). Urban construction from 1960 onwards largely consisted of low- to medium-rise multi-apartment houses using a technique known as large-panel construction. Across the Soviet Union, 75 % of all urban housing was built with these construction techniques (Molnar, 2003) (Klyachko *et al.*, 2003).

Housing built during this period had characteristically low levels of thermal efficiency. Panel-built housing began to be phased out in the rest of Europe during the oil crises of the 1970s (Molnar, 2003). In the Soviet Union construction of such housing continued with only minor improvements. This was due to the continuation of three factors: low energy prices in the closed energy markets; a lack of cross-cutting energy policy; and monopolistic, non-innovative construction companies (Renaud, 1992).

A positive element of central planning was that heating and hot water were centrally administered with 50–70 % of urban households typically connected to district heating. However, heating, along with water and electricity prices for the residential sector were largely subsidised by the State with payment unrelated to use. This gave no economic incentive to an occupant to save energy. In any event, the typical apartment-tenant had little or no way of controlling heating and temperatures other than by opening windows (Shapiro, 2006).

The results were low thermal efficiencies in housing and public buildings; little control over use; no incentive to reduce consumption where it was controllable; and inefficient distribution systems which led to high levels of primary energy use and water consumption in a number of countries.

The decade following the break-up of the Soviet Union saw the gradual collapse of the energy and water supply as well as the distribution systems. Wars and turmoil in the former Yugoslavia had a similar effect on energy and water networks in SEE.

The costs for municipalities of supplying energy and water services increased with rising primary energy costs. At the same time the economic recession hit municipal budgets and the widespread practice of cross-subsidising residential energy consumption by industry became less feasible as industry faltered. Meanwhile, the possibility of transferring the real costs of energy and water supply to residential consumers was still unrealistic. During the 1990s average incomes in the countries of the former Soviet Union dropped by 50 % while energy prices increased by 177 % (Lampietti and Meyer, 2002). The result was a long period of under-investment during which supply and distribution systems deteriorated badly. This was characterised by continual breakdowns or the complete collapse of supplies.

During the mid-1990s many governments in the EECCA and SEE regions began a policy of intensive privatisation of state housing funds as well as the gradual privatisation of energy and water utilities. This was encouraged by the international community ([1]) and accompanied in some cases by tariff increases. Privatisation and tariff increases were largely confined to electrical power, and were most progressive in SEE countries. However, energy prices also escalated in other places, such as Georgia, as did heating tariffs in Serbia. Where tariff increases were not accompanied by improved service, non-payment became widespread, damaging the economic situation of energy and water supply enterprises. Disconnection from the district heating system and a switch to cheaper but dirtier forms of heating (i.e. wood and oil-fired stoves) occurred in a number of countries ([2]).

The economic upturn in the regions during the late 1990s improved the financial situation of energy enterprises and increased the potential for full cost recovery. Nevertheless, ten years of zero investments have taken their toll on supply systems, and resources still remain limited for making the necessary improvements to reduce inefficiencies. Furthermore, in many cases the ownership of utilities is still unclear, undermining incentives to invest in infrastructure.

Construction of new buildings has increased dramatically over the past five years, providing an opportunity for significantly improving the thermal efficiency of the building stock. However, this can only be achieved if carefully selected and enforced building codes are in place.

6.2.2 Trends and outlooks

Building stock and construction trends

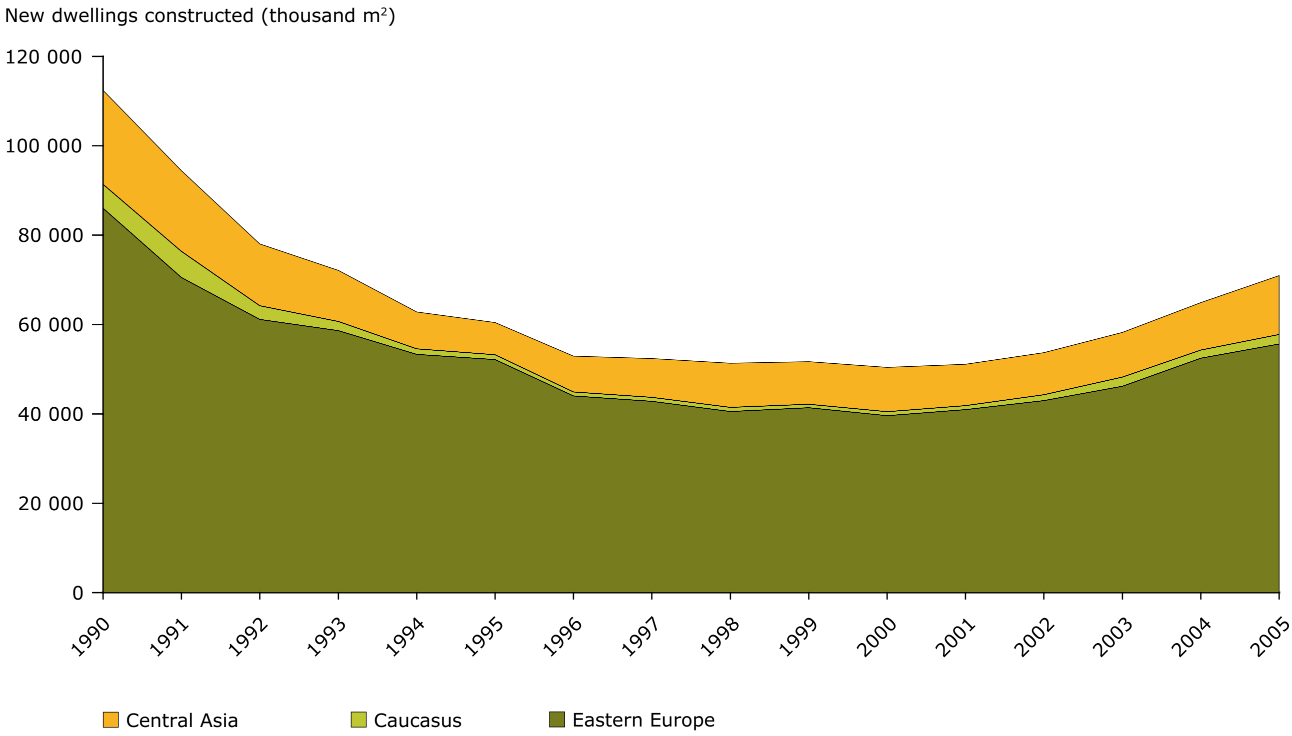
The building of new dwellings has generally corresponded with the developments in GDP since 1990 (Figure 6.1). Much of the EECCA region saw a construction boom after 2000, mostly centred in the larger cities. For example, in Moscow 15 % of current dwellings were built after 1998 compared to 7 % in the rest of the country (Matrosov, 2005).

Construction of new living space has outpaced demolition rates in all EECCA countries (even in countries with stable or falling population levels), and total living space has increased by between 4 % (Moldova) and 23 % (Azerbaijan) since 1990 (CISSTAT, 2006). These increases have been encouraged by policies that raise sanitary norms for living spaces. Moreover, they have had positive social effects, although energy demand for space heating has consequently increased. Nevertheless, housing space remains low in the less affluent countries of Central Asia (see Table 2.2 in Chapter 2).

Much of the construction is aimed at the new wealthier classes; a development which has been accompanied by a significant reduction in municipal housing. A new phenomenon appearing in a number of cities is the suburban district containing low density detached housing or luxury residential blocks. This style of urban living is particularly popular on the outskirts of Moscow (Boret *et al.*,

([1]) Via, for example, the World Bank's 1998 Europe and Central Asia Energy Sector Strategy (World Bank, 2003).
([2]) E.g. Armenia, Bulgaria, Moldova and Georgia.

Figure 6.1 Construction of new living space after 1990



Source: CISSTAT, 2006.

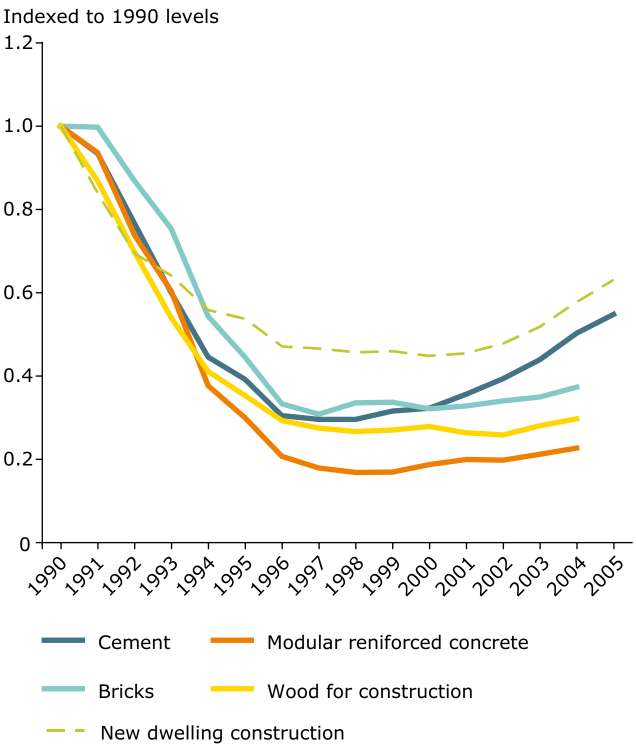
2004) and other large cities, and is generally causing urban sprawl, increasing the demand for transport and reducing opportunities for district heating.

Despite recent strong growth, the construction of new dwellings remains significantly below the high levels seen during the 1960 and 1980s. It is approximately 60 % of 1990 construction levels in EE and CA, and 40 % in the Caucasus. The housing stock of most cities remains dominated by dense developments of multi-apartment buildings constructed during the 1960s and 1980s. Box 6.2 describes the stock of buildings in the five cities.

Production of construction materials by weight across the EECCA region between 1990 and 2005 has closely followed developments in housing construction. Only cement production has enjoyed a higher growth than housing construction. The relatively slower growth in the use of bricks, lumber and prefabricated concrete modules may demonstrate changes in construction methods (i.e. greater use of concrete), or an increase in the import of these construction materials.

Reuse and recycling of construction and demolition waste can be an effective measure for reducing the use of virgin construction materials. However, city

Figure 6.2 Production of key construction materials in EECCA countries



Source: CISSTAT, 2006.

Box 6.2 Housing stock and new development in the five cities

Ashgabat

Like Dushanbe and Tbilisi, Ashgabat lies in an earthquake zone. The city began to expand in earnest during the 1960s with the establishment of large panel multi-storey designs able to withstand earthquakes. The most intensive period of construction was between 1966 and the end of the 1980s. Some 70 % of the current housing stock consists of buildings 5 storeys or higher. Current living space per person is approximately 12 m^2. Following a decision by the President in 1999, emphasis has been placed on the construction of buildings of 7–25 storeys with large comfortable apartments, and/or offices and shopping space, etc. In addition to high rise development, a very large new area of suburban detached housing has been planned to the north of the city, covering 1 million m^2 of living space.

Dnipropetrovsk

There are no official statistics for the age of housing stock for the city. Of new dwelling construction, 64 % consist of multi-storey apartment blocks, while 36 % are detached individual houses. One-third (33 %) of apartment blocks are aimed at the luxury end of the market. Almost all new developments are privately constructed and owned. Municipal housing construction for disadvantaged groups has almost disappeared.

Dushanbe

The entire city was not built until after 1922 and most of this since the development of an urban construction plan in 1956. By area, 98 % of the current stock are multi-apartment buildings of 4 storeys or more and 92 % are privately owned. The General Urban Plan aims to increase living space per person from the current 7 m^2 to 16 m^2 by 2030. This will require more than a doubling of the housing area. Most of the planned new development will be 4–5 storey housing (4.5 million m^2), with some 6–9 storeys in the central area (0.8 million m^2) and a small number of 2–3 storey apartments (0.4 million m^2) in the suburbs. So far, new construction has not met the rigorous ambitions of the plan due to unattractive loan conditions. The involvement of international contractors may change this.

Minsk

Most of the housing stock has been built after World War II, with at least 80 % after 1960. Housing is dominated by medium-rise multi-apartment blocks (87 % > 5 storey). New development is continuing to focus on multi-apartment blocks. There is a strong political drive to increase the living space per person in apartments. In 2003 the sanitary norm was raised from 15 m^2 to 20 m^2 per person. By area, 20 % of all building space represents office space.

Tbilisi

Although the central area of the city is old, approximately 70 % of the building stock in the city was constructed between 1960 and 1990. It consists of multi-apartment blocks. Around 18 % of current dwellings are detached houses. Nearly two-thirds of all buildings built in Georgia since 2000 are in Tbilisi. Construction rates were highest between 2000 and 2003, but have now slowed. The area of the average new apartment has been increasing and approximately 91 % are privately owned. In 2002, a major earthquake damaged more than 10 000 of the city's buildings.

studies demonstrate that the reuse of demolition waste is unlikely to occur on a significant scale (see Box 6.3).

Finally, the use of hazardous substances in construction has been common in some parts of EECCA. Phenol formaldehyde was added to concrete in medium-rise buildings in Russia during the 1970s and 1980s to add strength and to prevent fire and noise. Subsequently, during the 1990s apartments in such buildings were found to have high air concentrations of formaldehyde and phenol. Asbestos was also widely used in ventilation systems, partition walls and insulation. Its use remains widespread in new construction (Gormsen, 2006).

Box 6.3 Construction and demolition waste handling in the five cities

Ashgabat

In 1999, the government recognised the opportunity to reduce the need for new construction materials by 40 % through recycling building waste. However, it is not known to what degree this potential has been utilised.

Dnipropetrovsk

Construction companies are responsible for the disposal of demolition waste. None of the 15 companies interviewed engages in recycling or reuse. This is not economically viable due to ready availability of cheap materials. Some ad hoc reuse is carried out by the public. The most pressing issue is ensuring that building waste is deposited according to law. Of a total estimated at 250 000 m^3 annually, only 63 000 is landfilled. The remainder is illegally dumped.

Dushanbe

By law, all residual building waste must be transported to a dedicated building waste disposal site. Deposited waste increased from 683 to 866 thousand m^3 between 2002 and 2005. The recycling of building waste is carried out ad hoc at the demolition site. Construction companies may reuse some elements while the public also scavenges.

Minsk

No statistics are available on building wastes. However, there is some reuse of reinforced concrete waste from multi-storey housing. The iron content is reused for scrap and a part of the rubble used for road surfaces. Some wood wastes are taken away by local residents for heating.

Tbilisi

There is only one building waste disposal site in the city that collects 120–150 thousand m^3 per year. As with the other cities, no reuse of building waste takes place at the official disposal site. An attempt was made in 2002 by a foreign firm to set up a recycling plant. However, it was abandoned shortly afterwards. As in the other cities, ad hoc recycling of windows, floorboards, tiles, etc. is happening at demolition sites by city dwellers for use in their homes.

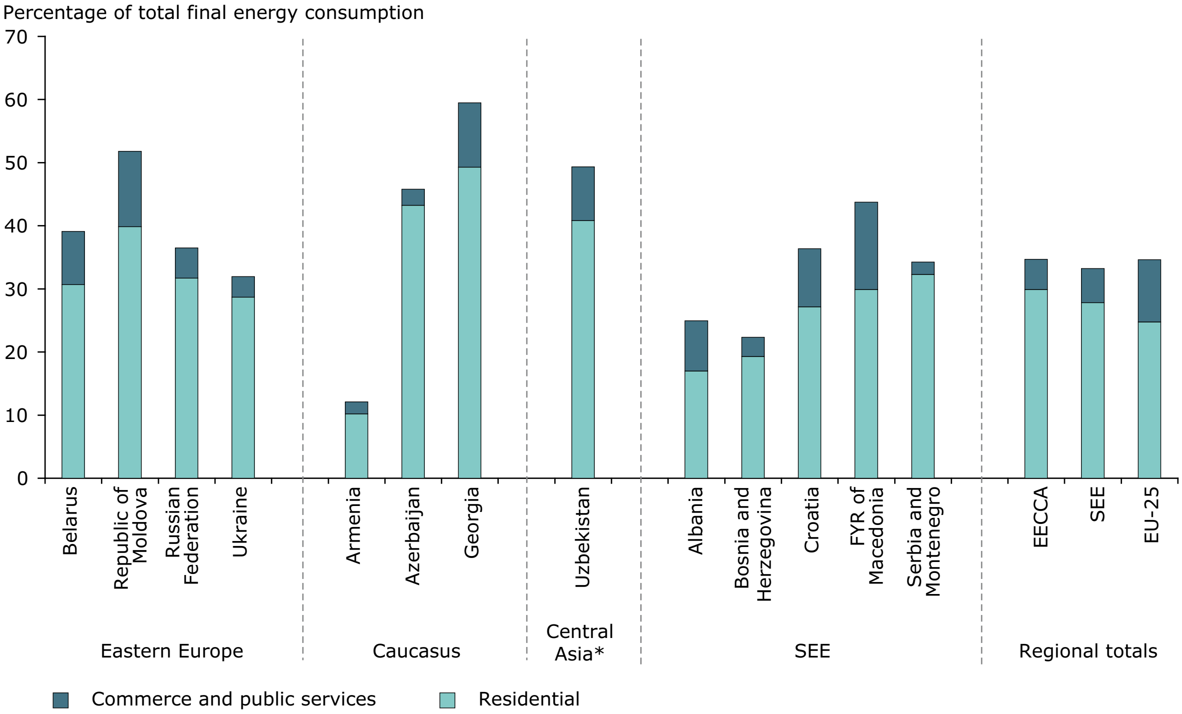
Current trends in energy and water consumption

Across EECCA and SEE residential, public and commercial buildings consume around one-third of total final energy consumption (Figure 6.3). This compares very closely to the EU-25. However, there are significant differences across individual countries, with the share of buildings in total energy consumption ranging from approximately 12 % of the total in Armenia to 50 % or more in Georgia, Moldova and Uzbekistan.

Average residential energy consumption per capita across EECCA (Figure 6.4) has declined since 1994 despite economic growth due mostly to drops in Russia and Ukraine. Nonetheless, it, remains higher than the average residential energy consumption in the EU-25. In SEE countries, residential energy consumption per capita has grown by 40 %. However, it remains less than half the level of EECCA and EU-25 averages. This is partially the result of climatic differences.

Consumption per capita is lowest in the less affluent countries of Armenia, Georgia, Moldova and Albania, whereas in Russia residential energy consumption is 25 % and 40 % higher than the EECCA and EU-25 averages, respectively (Figure 6.4). While data are only available for electricity consumption for most Central Asian countries, the carbon dioxide output per capita presented in Figure 2.8 in Chapter 2 suggests that residential energy consumption in Kazakhstan and Turkmenistan could be of a similar order of magnitude to Russia's.

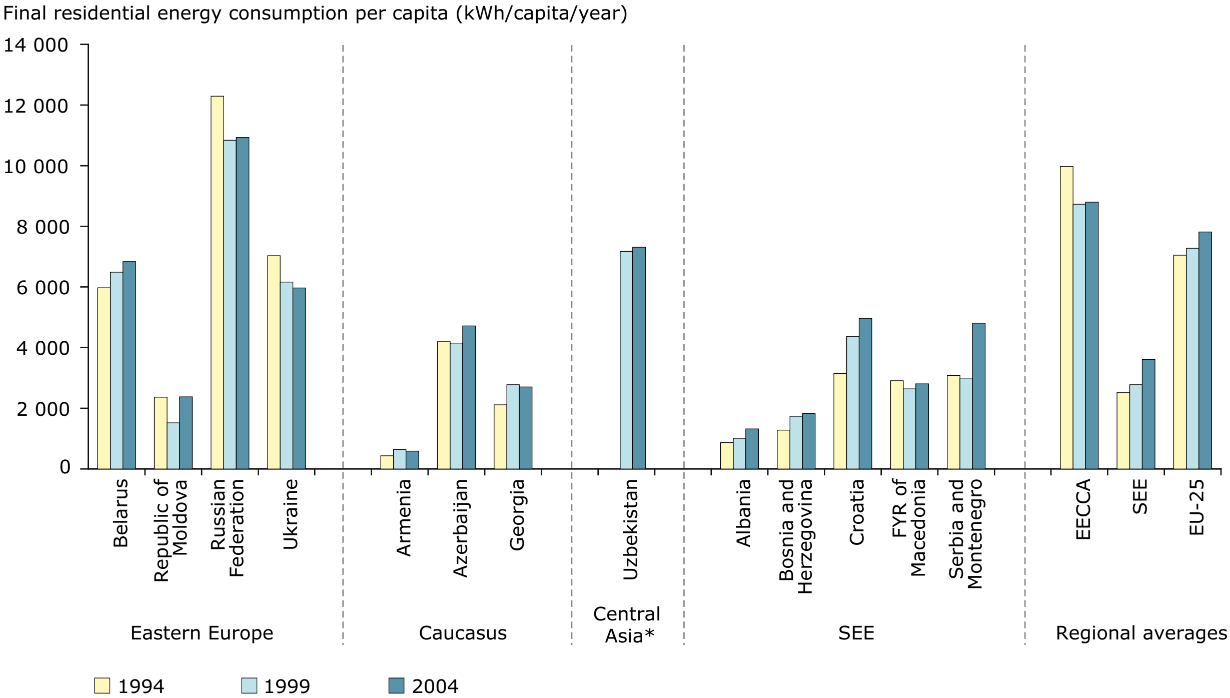
Figure 6.3 Residential and services final energy consumption as a proportion of total final consumption (2004)



Note: * For Central Asian countries other than Uzbekistan, residential data exist only for electricity consumption. EECCA average does not include Central Asia other than Uzbekistan.

Source: IEA, 2006.

Figure 6.4 Residential final energy consumption per capita (1994–2004)



Note: * For Central Asian countries other than Uzbekistan, residential data exist only for electricity consumption EECCA average does not include Central Asia other than Uzbekistan.

Source: IEA, 2006.

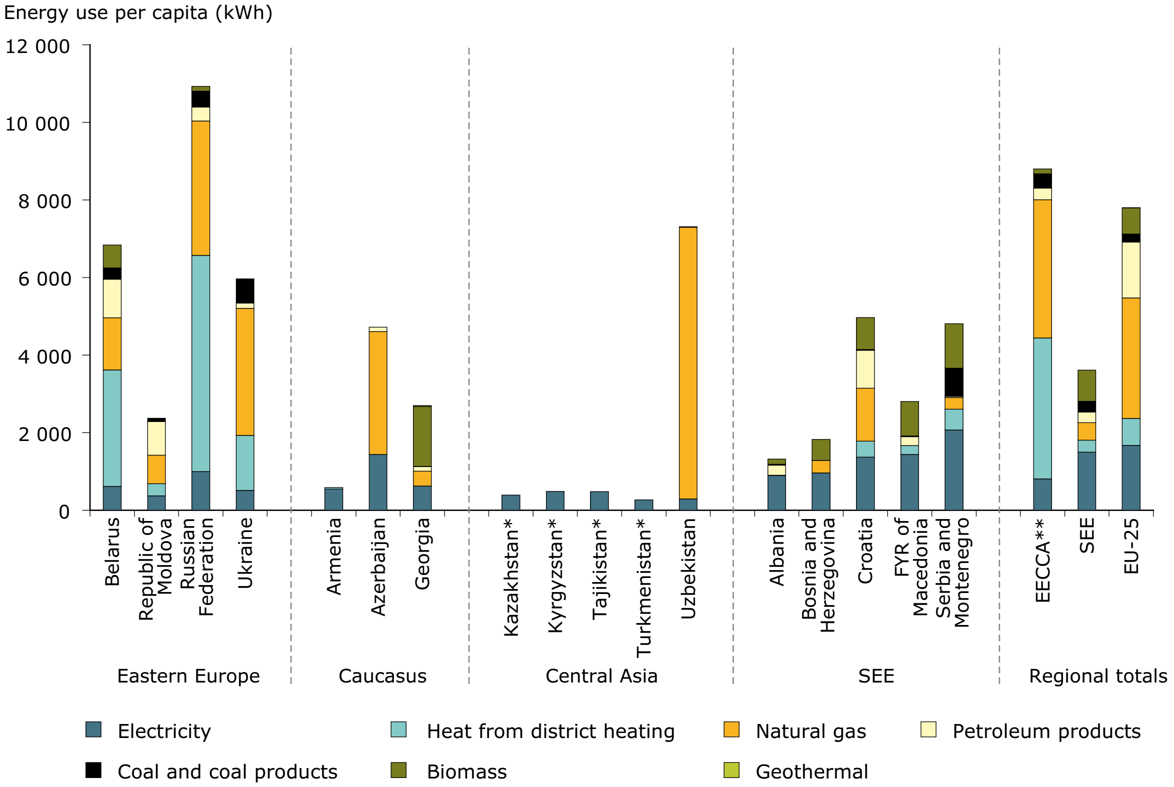
Figure 6.5 divides final residential energy consumption into the various energy carriers directly used in residencies, i.e. gas where gas is burnt directly in the building for heating and cooking, or hot water where hot water is provided by district heating companies for direct use in buildings for heating or bathing ([3]). Across EECCA as a whole, heat from district heating systems represents 45 % of total final energy consumption in households. This is significantly higher than in SEE or the EU and is largely due to Eastern Europe. Natural gas is the other main energy carrier consumed directly in households across EECCA.

In SEE, nearly half of the energy consumed in households comes in the form of electricity, and electricity consumption per capita is three times higher on average than in EECCA countries. However, the reason for high residential electricity consumption in SEE countries is not a result of high appliance use, as in the EU, but rather the widespread use of electricity for space heating and hot water. Ownership of electrical appliances is generally significantly lower in SEE and EECCA countries than in the rest of Europe.

Typical proportions of functional energy used in residential buildings in EECCA countries in colder climates are 65–75 % for heating, 10–20 % for hot water, 10–15 % for cooking, appliances and lighting. These proportions may also be typical for SEE ([4]).

Compared with energy consumption, the share of water consumption in buildings in EECCA and SEE is less significant than the share of other sectors. In EECCA countries, the agricultural sector accounts for 44 % of water consumption, industry/energy sector for 41 %, and residential and services for only 15 % (EEA, 2007).

Figure 6.5 Residential energy consumption per capita by final use energy carrier (2004)



Note: * For Central Asian countries other than Uzbekistan, residential data only exist for electricity consumption.
** EECCA average does not include Central Asia other than Uzbekistan.

Source: IEA, 2006.

([3]) Only the energy carried by the energy carrier is included. No account is taken of the primary energy consumed to produce hot water at the district heating plant or for producing electricity in the power plant.

([4]) For the former Yugoslav Republic of Macedonia, for example, the figures are 71 % (heating and cooling), 17 % (hot water) and 12 % (appliances) (Energy Charter Secretariat, 2006a).

Water consumption for the residential and services sector in EECCA fell by 20 % between 1990 and 2000 and has remained stable since then (EEA, 2007). In Russia, residential water consumption per capita dropped from 304 litres/day in 1995 to 247 litres/day in 2005 (UNEP, 2006). These figures are comparable to the upper end levels of consumption in the EU ([5]). However, water consumption in the larger Russian cities is nearly double this average (OECD, 2003). In Tbilisi and Ashgabat water consumption per capita is 800 and 700 litres/day respectively. Due to high losses and lack of available water, water services in many cities are rationed ([6]).

In conclusion, energy consumption per capita in buildings is high in Eastern Europe (excluding Moldova), Uzbekistan, Kazakhstan and Turkmenistan, and to a lesser extent Azerbaijan, Croatia and Serbia. Some countries in the regions still have very low residential energy use per capita. Water consumption, meanwhile, appears to be higher than EU averages in most of SEE and EECCA.

Expected trends in future consumption of energy and water

Heating and hot water: Russian forecasts show a reduction in residential district heat consumption of around 0.6 % per year until 2020 (APEC, 2006) as a result of the improvements in energy efficiency standards of new buildings (see Section 6.3) and rehabilitation programmes for district heating.

For apartment tenants not connected to district heating, energy consumption for heating is limited by income. Where average incomes rise, consumption increases. Increasing incomes may also encourage a switch in fuel types from kerosene or wood to electricity or gas for heating and hot water ([7]).

An additional factor influencing heating demand is the general increase in total living space in all EECCA countries. In Eastern Europe living space is increasing by approximately 1 % per year (CISSTAT, 2006).

Appliances: Appliance ownership stagnated or even declined in most EECCA countries during the 1990s and early 2000s, as appliances bought during the 1980s fell into disrepair. In SEE, growth of appliances was slow in some countries but rapid in others ([8])([9]). However, average incomes across Eastern Europe and SEE overtook pre-1990 levels in 2002 and are now growing rapidly at 5–10 % per year. It is expected that growth in appliance ownership will follow. Ownership of high-end appliances is highest in cities ([10]).

Greater ownership will be accompanied by increasing electricity consumption unless the efficiency of appliances improves at similar rates. Residential electricity demand is expected to double in Kazakhstan by 2030 (Energy Charter Secretariat, 2006b) and increase in Russia by 1 % per year up to 2020 (APEC, 2006).

6.2.3 Current systems for the provision of heat

There are three kinds of heating for urban households, commercial and public buildings across the regions.

1. District heating (DH) — supplying hundreds or thousands of homes and public buildings. Heat is generated at one or two central boiler stations and supplemented by many small boilers. The large boilers burn fossil fuels or occasionally waste or biomass.

2. Autonomous building-level heating — central boilers in multi-apartment or commercial/public buildings which provide heat to all apartments. These boilers tend to burn gas or oil.

3. Individual heating — apartment-level heating using gas heaters, wood stoves or electric heaters.

Connection to DH is highest in Eastern Europe and in Kazakhstan. Connection rates were even higher at the beginning of the 1990s, but lack of maintenance rendered many systems unusable ([11]) in EECCA while conflict in the Balkans damaged DH systems

([5]) EU per capita consumption varies by country from 120 to 280 litres/day (Eurostat).
([6]) For example, in Ukraine — 9 hours a day in Lviv, 9 to 10 hours a day in Mykolayiv http://www.globalwaterintel.com/index.php?page=articleView&articleId=820.
([7]) In Montenegro, which has no district heating, 48 % of households use electricity for heating and 42 % use wood. However, only 36 % of households with incomes of less than EUR 125/month use electricity, while of households with over EUR 275/month, 77 % use electricity for heating (Austrian Energy Agency, 2006).
([8]) Ownership of dishwashers doubled in Croatia and the former Yugoslav Republic of Macedonia, 1995–2005.
([9]) Data collected from national statistics offices.
([10]) In Belgrade, 20 % of households had air conditioning units in 2005 up from 14 % in 2003 (Statistical Office of Serbia, 2004 and 2006). Ownership is only 4 % in the rest of Serbia where incomes are lower. Similarly in Tirana, Albania, 4.1 % own air conditioners compared to 1.3 % in the rest of the country in 2001 (Albania Institute of Statistics, 2005).
([11]) The DH network in Tbilisi, Georgia was abandoned at the end of the 1990s. In Baku City, Azerbaijan, 80 % of those houses connected to the DH network cannot receive heat (Kulichenko, 2005).

there ([12]). The system in Sarajevo was repaired as part of a World Bank-funded project during the late 1990s but similar work is yet to be carried out elsewhere (Austrian Energy Agency, 2006).

Autonomous heating is widespread in other parts of the region, for example, Turkmenistan (see Box 6.4). In Kazakhstan most new multi-apartment buildings also have autonomous heating systems.

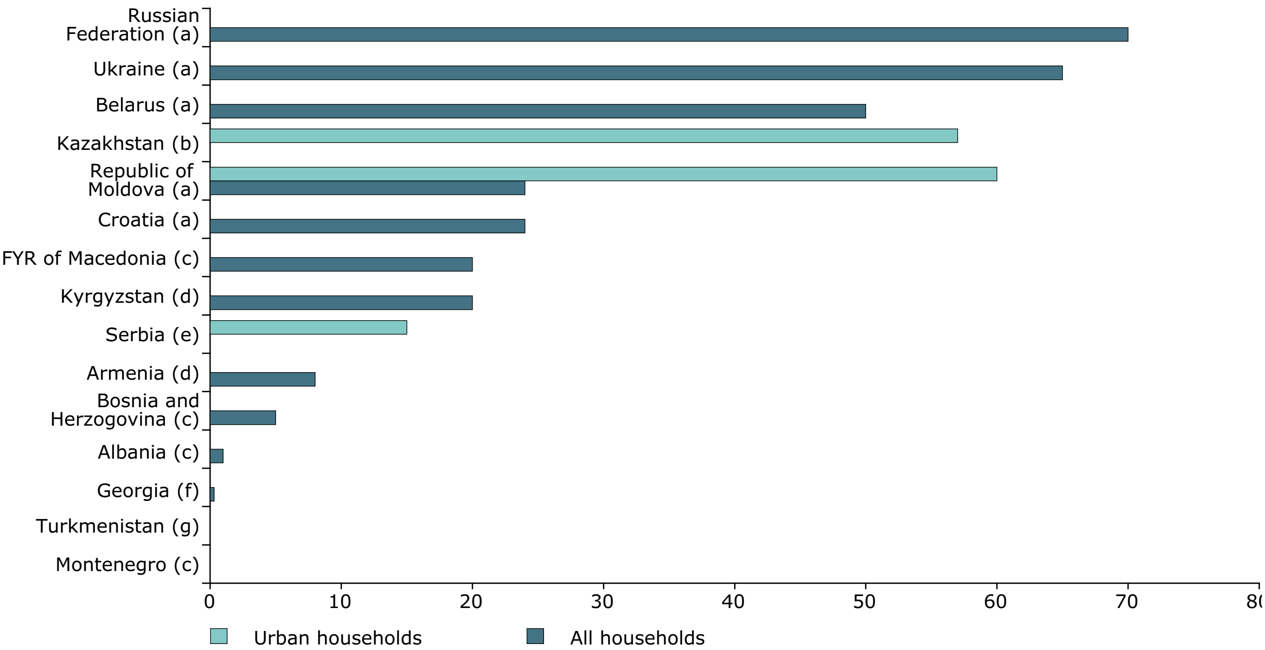
Other countries are less well supplied with either DH or autonomous heating. The situation is deteriorating due to the absence of legal requirements for establishing autonomous systems

Box 6.4 Heating systems in the five cities

The heating systems in the five cities vary widely. In Minsk 99.6 % of all multi-storey residential buildings are connected to district heating. The figure is 75 % in Dnipropetrovsk, with 15–20 % of households having autonomous heating and the remaining 5–10 % using apartment level boilers. Approximately 30 % of the buildings in Dushanbe are connected to the DH system with other buildings using autonomous systems powered by diesel. Around 60 % of the DH heat supply in Minsk, and 95 % in Dushanbe come from combined heat and power (CHP) plants. About 20 % of heat in Dnipropetrovsk is from CHP or industrial waste heat, with the remainder from heat-only boilers. The fuel used for CHP and heat-only boilers in Dnipropetrovsk is around 80 % gas and 20 % coal.

At the beginning of the 1990s, Tbilisi had a large DH network with 85 % of buildings connected to it. This network closed down when the gas supply to the city was discontinued. The population turned to kerosene or electricity for heating. By the time the gas supply returned in 1996, the DH system was in total disrepair. Residents turned to apartment-level gas connections for heating and cooking. In Ashgabat there is no large DH or CHP. However, approximately 95 % of buildings have autonomous heating either for a single building or for small groups of buildings, while new buildings are regularly fitted with autonomous heating.

Figure 6.6 Percentage of households connected to district heating



Sources: a) Lampietti and Meyer, 2002 taken from www.districtheat.org; b) Energy Charter Secretariat, 2006b; c) Austrian Energy Agency, 2006; d) Lampietti and Meyer, 2002 authors' own estimates; e) Beogradske elektrane, 2005; f) Georgian State Department of Statistics, 2005; g) City study.

([12]) In Bosnia and Herzegovina, DH was available in most cities with a population of over 25 000 before the war, and served 120 000 households (Austrian Energy Agency, 2006). Damage during the war reduced this figure by two-thirds (Ciagne *et al.*, 1999).

or links to DH. Electric heaters in apartments are common in Georgia, along with gas heaters, in Armenia, the former Yugoslav Republic of Macedonia, Montenegro and Albania. 58 % of Albanian households use electricity for heating (Austrian Energy Agency, 2006).

6.2.4 *Key driving forces in energy and water consumption*

Residential energy consumption per capita (Figures 6.4 and 6.5) varies by a factor of nearly 20 across the region, ranging from ~ 11,000 kWh in Russian households to less than 600 kWh in Armenia. Part of the reason for this is the large climatic differences across the region. While this may explain differences in residential energy consumption in Russia, Ukraine and Belarus, it does not explain the much greater disparities between these countries and Armenia or Georgia.

These differences may be due to a combination of lower fuel prices, higher incomes and better connections to district heating systems (see Figure 6.6). The district heating systems inherited from the Soviet Union are largely inefficient due to poor design, lack of maintenance and losses in distribution. Nevertheless, those households connected to the systems have continually enjoyed subsidised heat, even during the economic crises of the mid- to late- 1990s. This has led to continually high levels of energy use. In contrast, countries with no DH, where householders purchase fuel for heating by the unit, and fuel prices are high (e.g. Georgia and Armenia), economic hardship has had a direct effect on consumption. Householders have cut costs by heating only those rooms in use and maintaining them at low temperatures during the winter.

Most countries within the regions share at least some of the following specific driving factors:

Low thermal efficiencies of buildings

Existing medium and high-rise buildings constructed between the 1960s and 1980s are characterised by low thermal efficiencies, low efficiency boilers (in those buildings with autonomous systems) and wasteful heat distribution systems which lack heat exchangers between the buildings and the DH system.

Even new buildings are being built with low thermal efficiency. While a number of countries have updated building codes for new buildings (see Section 6.3.2), several still use construction norms and regulations (SNiP) dating back to the Soviet period. Energy efficiency in Ukraine's housing stock is 3–5 times lower than that of western countries (Kopets, 2006). Heat loss in buildings in Kazakhstan is 50–60 % higher than in developed countries under comparable conditions (Energy Charter Secretariat, 2006b).

There is also evidence that even these building codes are not being complied with by contractors ([13]).

Losses in distribution systems

There are some 180,000 km of district heating pipes in Russia alone, many of which are not insulated, leak or are broken. Currently only 250–300 km, i.e. ~ 0.15 % is being replaced annually, compared to the minimum requirement of 4 % which is needed to keep the networks running. Rosstat estimates heat loss is close to 20 % in some regions (Milov, 2006).

For water distribution, losses of 30-50 % are typical in the regions. Losses in Croatia are estimated at 50 % (EBRD, 2001), while Russia's Federal Agency for Water Resources reports losses of 30–40 % for its tap water during distribution ([14]). Many water distribution systems are close to collapse. Approximately 60 % of the network is worn out in Moldova (Austrian Energy Agency, 2006) and in Russia 40 to 70 % of the systems are in need of replacement.

Lack of finances for energy and water supply enterprises

Losses and inefficiencies in supply and distribution systems can only be remedied through significant investment either from the private sector, the public sector or a combination of the two in joint ventures.

Most countries are in the process of raising tariffs. Currently, tariffs are closest to recovering the full cost for electric power, and farthest for water (Fankhauser and Tepic, 2005). Moreover, non-payment rates are high which can lead to financial crises for energy enterprises and limit their ability to fund improvements. Curiously this

([13]) Some buildings constructed during the 1990s in Tbilisi have been found to have heating requirements 30 % greater than that required by the SNiP.
([14]) www.mosnews.com/news/2005/03/22/waterlost.shtml.

problem is less critical for electric power despite higher tariffs.

Non-payment can have a number of causes:

Non-affordability — costs for electricity services are above affordability thresholds ([15]) for the 10 % of the population with the lowest incomes in both the former Yugoslav Republic of Macedonia and Croatia. Heating service costs are close to affordability thresholds in Serbia and Montenegro and Kyrgyzstan, and likewise for water in Russia and Tajikistan (Fankhauser and Tepic, 2005). Elsewhere, affordability is not an issue due to subsidised tariffs.

Inability to control consumption and costs — there is not a lot of willingness to pay higher costs when one has no control over them. This may explain why non-payment is lowest for electricity for which payment according to use is widespread (see below).

Dissatisfaction — willingness to pay is critically affected by the quality of the service.

Cultural attitudes and lack of economic incentives to reduce consumption

Wasteful practices in the home are a contributory factor to excessive energy and water consumption. A lack of metering and payment by use, and a lack of awareness are to blame.

A common perception inherited from the Soviet era is that access to energy and, especially, water should be free and unlimited. The earlier high levels of subsidies have created the impression that the water supply, in particular, comes without any economic and environmental costs. This has led to wasteful practices which have been documented for example in Georgia (Shubitidze, 2006). Many people find it difficult to come to terms with the transition to a market economy and a future with higher tariffs for the use of water.

Metering and payment according to use at the apartment level are most common for electricity and gas (see Box 6.5). Metering of heating as well as hot and cold water is reasonably common for large businesses, but much less so for households and public buildings; although this varies from country to country. Heat consumption meters are scarce in Kazakhstan, but hot and cold water meters are proving popular whereas the former Yugoslav Republic of Macedonia has 100 % apartment level metering for heat ([16]). Water metering is increasing in Eastern Europe but the majority of apartments are still without it ([17]). In general, heat and water metering is more common at the building level than at individual apartment level. Consequently,

Box 6.5 Status of metering in the five cities

Electricity meters are provided at apartment level in all five cities. In Minsk, Dushanbe and Dnipropetrovsk, 100 % of apartments are equipped with individual electricity meters, whereas the figures are 93 % and 90 % in Tbilisi and Ashgabat, respectively.

Metering for heat and water in Minsk and Dnipropetrovsk depends on the age of the building. Water and heat are provided only at building level for older buildings in Minsk, with all buildings constructed since 2002 having apartment-level metering. This is similar to the situation in Dnipropetrovsk, although older buildings are also gradually being equipped with apartment level meters under the 'Programme on Restructuring and Development of Households'.

There is no metering of heating in Dushanbe even in newly constructed buildings. In Tbilisi and Dushanbe there is no residential water metering even at the building level, although most commercial buildings are metered. The same is true in Ashgabat, since water is provided free and in unlimited quantity. While gas in Ashgabat is unmetered in older buildings, meters are commonly installed in new buildings at apartment level. In Tbilisi gas is 100 % metered.

([15]) Fankhauser and Tepic (2005), based on a review of studies, suggest affordability thresholds of 10 % for electricity, 10 % for heat and 5 % for water. In Russia Bashmakov (2006) has identified two sets of thresholds. The first, when exceeded, will lead to a declining payment discipline which he sets at 7 % for combined services. There is a second threshold over which further increase will raise no additional revenue at 15 % for combined services.

([16]) Skopje's DH company is privatised and the management had an incentive to meter and bill based on consumption because the demand exceeded capacity (Austrian Energy Agency, 2006).

([17]) 9 % of multi-apartment buildings and 17.5 % of public buildings in Ukraine have water meters.

this does not create an incentive for individual consumers to control their consumption unless they know their neighbours will do the same.

Limited ability by householders to reduce consumption

In many older multi-apartment buildings supplied with autonomous or district heating, individual apartment owners can do little to adjust the supply of heating to their apartments. Cold and hot water and electricity can be controlled directly by turning off taps or light switches. In most countries of the region, however, residents and businesses have little means for controlling how much electricity and water is consumed by appliances, due to the still limited use of appliance labelling (see Section 6.3.2).

6.2.5 Environmental and social impacts

The construction sector is one of the biggest consumers of raw materials, other than fossil fuels, in most countries. The impacts of extraction and fabrication of construction materials in EECCA and SEE countries are not documented, but it can be assumed to have impacts on land use, impacts related to energy and water consumption and to generation of quarrying waste. The environmental impact of the use phase of buildings mainly relate to pressures arising from primary fossil fuel use either directly in buildings or at power stations and district heat plants. These pressures include the emission of gases which contribute to climate change, acidification and tropospheric ozone production.

While data are available on direct carbon dioxide (CO_2) emissions from households (World Resources Institute, 2006), they do not provide any insight into the total indirect carbon dioxide emissions from primary fossil fuel use related to residential energy consumption. In other words, they do not include emissions from primary fossil fuel consumption ([18]) in district heating plants, electricity plants, etc. It is likely, however, that the differences between countries are at least as large as for total CO_2 emissions per capita given in Figure 2.8 in Chapter 2. Energy consumption in buildings contributes a significant proportion of these emissions, consuming on average about one-third of total final energy demand. The proportion of primary energy consumption attributed to buildings is typically even higher ([19]).

Countries with probable low CO_2 emissions related to residential energy use include Armenia, Georgia, Kyrgyzstan, Tajikistan and Albania. All of these countries have low residential energy consumption per capita (see Figure 6.4) and their use of non-fossil fuels is high either directly in households (i.e. biomass and geothermal in Georgia) or for production of electricity (see Figure 2.7 in Chapter 2). Renewable electricity production (mostly hydro) is high in: Albania (98 %), Tajikistan (98 %), Kyrgyzstan (93 %), Georgia (87 %) and Armenia (70 %).

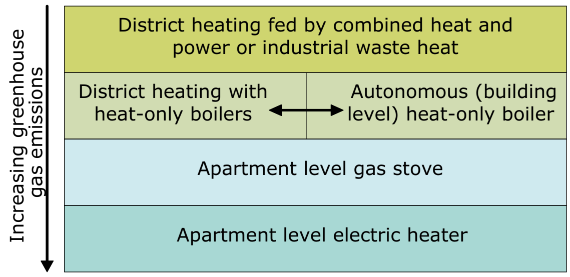
In countries with high levels of final residential energy consumption and with high dependency on fossil fuels, direct and indirect carbon dioxide and other emissions per capita related to residential energy consumption are considerably higher. Examples include Russia, Ukraine, Belarus, Kazakhstan, Turkmenistan and Uzbekistan where direct and indirect residential CO_2 emissions per capita are likely to be similar to or higher than those in the EU (see Figure 2.8 in Chapter 2).

In countries that rely mostly on fossil fuel sources for heat and power, the greatest efficiencies (and therefore lowest impacts) can be achieved in dense urban areas through the use of combined heat and power stations (CHP), provided that the accompanying DH distribution systems are modernised. Use of CHP is highest in Kazakhstan ([20]) and Russia ([21]) and lowest in the SEE countries (Energy Charter Secretariat, 2006a). The type of fossil fuel used for heat and power is also critical. Electricity can be produced from gas with 25 % lower CO_2 emissions than oil and 40 % less than coal (Ecofys, 2006) with even greater improvements for sulphur dioxide and nitrogen oxides.

A heating hierarchy with respect to the impacts of air emissions can be drawn up for countries with low or moderate levels of renewable electricity (Figure 6.7).

([18]) Final energy use is the energy used directly by the final energy consumer. Primary energy use includes the total direct and indirect uses of energy to supply that consumer including intermediate uses of energy, energy in transforming one energy form to another (eg, coal to electricity), and energy used by suppliers in providing energy to the market.
([19]) The Russian district heating sector accounts for about 45 % of all domestic energy consumption and for about 50 % of fossil fuel use (Alliance to Save Energy, in press).
([20]) 40 % of heat to DH systems in Kazakhstan is produced by CHP (Energy Charter Secretariat, 2006b).
([21]) ~ 30 % of heat to DH systems in Russia is produced by CHP (Pierce, 2004).

Figure 6.7 Heating hierarchy for fossil fuel economies



Meanwhile, high water consumption has the most serious environmental effects in countries with high levels of water stress (the ratio of water abstraction to fresh water supplies). Three EECCA countries, Uzbekistan, Turkmenistan and Azerbaijan, have the highest levels of water stress across pan-Europe (EEA, 2007).

The social impacts of low thermal efficiency in housing have been significant for lower income groups in those countries with little or no district heating. This was particularly in evidence in Moldova, Armenia and Azerbaijan during the late 1990s where many tenants heated their houses to survival levels only. These groups have also been using 'dirty' fuels, such as kerosene, in cheap stoves which have had detrimental effects on indoor air quality and health. Regular stoppages in energy and water services have also been widespread as a result of inefficiencies in households and distribution systems.

The lack of maintenance of water distribution systems is a growing cause of health and social problems. In Central Asia, one-third of the population drink water that does not meet WHO hygiene standards (OECD, 2003).

The use of toxic materials in construction has had adverse health effects for example in the so-called phenol buildings in Moscow. The use of asbestos in buildings can have adverse health effects on demolition workers if proper precautions are not taken. There is also a health risk for building tenants.

6.3 Opportunities and policy initiatives

6.3.1 Opportunities

There is a huge potential for a reduction in energy and water consumption in SEE and EECCA countries. Such efficiency improvements could also lead to considerable social benefits, as people heat their houses at comfortable temperatures without increasing energy consumption. The potential for environmental benefits is particularly high for those countries which currently use very high levels of fossil fuel energy: Belarus, Kazakhstan, Russian Federation, Turkmenistan, Ukraine and Uzbekistan.

The following opportunities exist to reduce final energy and water consumption:

- taking advantage of the current construction boom throughout the region by ensuring that new buildings are built to stricter thermal standards than previously, and with efficient heat distribution systems;
- thermal efficiency rehabilitation and heating system modernisation of the existing building stock, possibly to be financed by mobilising future cost savings;
- provision of technical expertise and funding for modernisation of energy and water distribution networks;
- furnishing householders with information on how to reduce wasteful practices and providing economic incentives to encourage this, i.e. by extending metering and payment by use at the household level;
- introducing energy labelling in electrical appliances to promote greater efficiency and/or introducing minimum energy efficiency standards for appliances.

Considerable savings in primary energy use and environmental pressures can be achieved through efforts to move up the energy hierarchy (see Figure 6.7) including:

- preserving and taking advantage of the widespread existence of district heating in urban areas to facilitate greater use of co-generation (i.e. CHP). CHP presents an opportunity for improvements in efficiency and cost-effectiveness of electricity and heat provision, provided that distribution systems are modernised;
- promoting autonomous heating systems or connections to DH (where it exists) for new multi-apartment buildings through building regulations or town planning mechanisms;

- discouraging the use of electricity for heating and hot water;

- encouraging a switch to fuels with higher calorific values, or to biomass or waste, in large heating boilers/co-generation plants.

There are also considerable opportunities for the construction industry to reduce raw material extraction by encouraging the greater recycling of building and demolition waste. In some countries of the EU the vast majority of demolition waste is recycled within the construction industry. For example, Denmark and the Netherlands recycle or reuse 90 % of building and demolition waste, while Germany recycles or reuses around 70 %.

6.3.2 National policies and legislation

Energy efficiency strategies

Policies for the efficient use of energy in buildings are usually included in more general energy efficiency programmes under national energy strategies. Improving energy efficiency is a key element of energy strategies in those countries which are party to the Kyoto Protocol (Croatia, Russia and Ukraine), or have limited domestic energy sources (e.g. Albania, Georgia, Belarus, Moldova, Ukraine) or wish to limit their energy dependence on neighbouring states.

Moldova's energy strategy includes a goal of reducing energy intensity by 2–3 % annually between 2003 and 2010 (Austrian Energy Agency, 2006). The National Program of Energy Savings 2006–2010 of Belarus aims to reduce energy intensity by 25–30 % over 5 years, following on from the success of the first five-year programme which resulted in an 18.7 % reduction. Energy efficiency strategies and legislation (often combined with renewable energy strategies) have been recently adopted or are under consideration in Albania, Armenia (MUNEE, 2007), Moldova and the former Yugoslav Republic of Macedonia.

A few countries have policies or programmes aimed at the residential/buildings sector and/or district heating. For example, Serbia developed two Strategic Programs called 'Energy Efficiency in the Municipal Sector' and 'Energy Efficiency in the Building Stock'. The former Yugoslav Republic of Macedonia's draft Energy Efficiency and Renewable Energy Strategy requires the implementation of Residential and Commercial Buildings Programmes. Armenia has also adopted a programme, 'Improving Energy Efficiencies of City Heating and Hot Water Systems'.

In Ukraine, the Law on Energy Conservation provides a comprehensive set of actions. Key elements with relevance to the buildings are: 1) creation of favourable economic conditions for energy conservation 2) educating the population in economic, social and environmental advantages 3) gradual transition towards usage of meters and charging by use 4) identification of financial support for energy conservation projects, and 5) the setting up of a fund on energy conservation.

Croatia is the only country in the two regions known to have adopted policies encompassing energy use during the full life cycle of buildings. Its Energy Efficiency in Building Construction Program is aimed at reducing energy needs during the design, construction and use of buildings.

It is not clear, however, to what extent energy efficiency policies are implemented in practice. A number of elements of Russia's 1996 Energy Efficiency Act proved too controversial (i.e. privileges to consumers utilising efficiency technologies) or were ignored (e.g. mandatory requirement for metering of all energy connections by 2000) (Milov, 2006). In Ukraine, the Fund for Energy Conservation has yet to be established. There are several such examples of implementation failures due to a lack of institutional capacity, a shortage of fiscal/budgetary resources or inadequate political will ([22]).

Policies and strategies on more sustainable sources of heat and power

A few countries have adopted policies whose aim is to shift towards a lower greenhouse gas emission heating and power supply (i.e. moving up the heating hierarchy in Figure 6.7).

Croatia's Centralised Thermal Systems Energy Efficiency Program encourages the development and enhancement of district heating in areas with a high density of heat or heat and electricity consumers (Austrian Energy Agency, 2006).

The 2005 Ukrainian Law on Combined Generation of Thermal and Electrical Energy (Co-generation) establishes a framework that favours combined heat and power (CHP) generators. This includes tax reductions for new CHP, and first rights of CHP

([22]) Personal communication: Angela Morin, Alliance to Save Energy.

plants to sell their electricity production through shared distribution networks.

One objective of the former Yugoslav Republic of Macedonia's National Development Strategy is to shift residential heating from electricity to gas in order to reduce primary energy consumption. Just such a shift was achieved in the principal cities of Georgia by tripling national tariffs on electricity and kerosene, but not on gas (World Bank, 2003). In the early 2000s in Serbia electricity rate increases and joint government/international donor projects encouraged 10 % of households to switch from electricity to other energy sources for heating ([23]).

One current gap in the promotion of the heating hierarchy is a lack of building or planning regulations. This would either require new buildings to be connected to existing DH networks or require the supply of autonomous rather than individual apartment-based heating systems.

Thermal standards and energy labelling for new buildings

New building energy codes (e.g. those introduced since 2000) have been developed in Albania, Armenia, Croatia, Kazakhstan, Russian Federation, Tajikistan, and Ukraine. New codes are being considered in Georgia and Moldova.

The Russian package of codes and standards is particularly comprehensive. It provides thermal efficiency standards for new and renovated buildings, so that the energy consumption is at least 35 % lower than in older buildings. It also provides technical assistance to architects and contractors on how to construct high-efficiency buildings. It seeks to ensure compliance with codes by requiring energy audits and gives guidance on carrying out energy audits as well as identifying retrofit measures for old buildings. Finally, it provides labelling schemes and energy passports to promote energy efficient buildings (Matrosov, 2005).

Energy labelling for appliances

There is little use or knowledge of energy performance labelling of appliances for buyers in EECCA countries. While Russia, for example, has minimum but very low performance standards for a number of appliances, there is currently no active energy labelling programme. However, the government has considered adoption of the European label (Harrington and Damnics, 2001). Recent Armenian legislation on the Renewable Energy and Energy Efficiency Programme requires energy labelling for appliances (MUNEE, 2007).

Energy labelling is more widespread in SEE. Croatia transposed the EU Directive on Energy Labelling into national law in 2006, and most large retail stores included energy labels prior to this on a voluntary basis (Kolega, 2006). The Albanian Energy Efficiency Law also makes energy labelling of appliances mandatory (Hido, 2005).

Tariff reforms

Tariff reforms have three functions in improving energy efficiency and conservation: 1) improving finances for energy and water enterprises; 2) encouraging energy efficiency investments by building/apartment owners, and; 3) reducing wasteful practices by residents. The latter two functions require metering and payment by use.

Tariff reforms have progressed much further for electricity and gas than for other energy and water services, partially due to widespread metering and payment by use as well as higher levels of privatisation. Tariff increases for electricity have progressed most rapidly in SEE countries but also in Georgia, Armenia and Moldova. A number of countries still have laws that do not allow municipalities or privatised enterprises to raise tariffs unilaterally ([24]).

Tariff reform can also include provisions which make utilities affordable for lower income families yet still encourage conservation. Block or lifeline tariff systems provide essential levels of energy and water at low cost, with tariffs increasing for higher levels of consumption (Box 6.6). Block or lifeline tariffs require apartment level metering.

Material efficiency in construction

Only two countries among those that replied to the UNEP policy questionnaire have policies aimed at encouraging the reuse of demolition waste in new construction. The Waste Management Strategy of Croatia has the long-term aim of 80 % demolition waste recovery, and includes measures

([23]) USAID and Alliance to Save Energy jointly funded and coordinated projects with the Serbian government. Electricity consumption for heating decreased by 1 700 GWh or 22 % from the previous winter (using weather-adjusted data). Total winter electricity consumption (for all uses, not just heat) declined by 5.5 percent and peak demand by 7 percent (500 MW).

([24]) For example, in the Russian Federation tariff changes need to be approved by the Federal Energy Commission.

Box 6.6 Examples of block tariffs in EECCA and SEE

In Turkmenistan, electricity and gas are provided free to households up to limits of 530 kWh and 600 m^3 per year per family member. Households have to pay a fee per unit used over these limits (city study).

In 2001, Serbia became the first country in SEE to introduce block tariffs for electricity consumption. The block tariffs aim at allowing affordability and discouraging high consumption and use of electricity for heating. The three bands originally introduced were as follows: 0–7 200 kWh; 7 200–19 200 kWh; and over 19 200 kWh per household (Austrian Energy Agency, 2006). The lower tariff band was very broad and covered consumption of 70 % of households. It did not provide much incentive for reducing consumption and was subsequently revised to 0–4 200 kWh per household (SIEPA, 2005).

There is also a block tariff system in place in Georgia with the following three bands: 0–1 200 kWh; 1 200–3 600 kWh; and over 3 600 kWh per household per year (city study). Tariffs in the highest band are only 25 % higher than in the lowest. Either the lowest band rates are not affordable for low income families or conversely, the higher tariffs are unlikely to encourage conservation in affluent households.

for stimulating the use of 'environmentally friendly construction materials'. Moldova adopted a programme for the use of construction wastes in 2000. It is not known though whether either of these policies or programmes has been implemented.

Control of toxic materials in construction

Control of toxic materials in construction exists within the sanitary norms of a number of countries. This includes the control of toxic substances in cement (Armenia), control of radioactive substances (Tajikistan, Uzbekistan) and the control of a number of toxic substances in general construction materials (Moldova, Russia, Kazakhstan). Lists of controlled substances are significantly shorter than in the EU. In particular, asbestos is still widely used within many EECCA countries. Within the region as a whole only Croatia, Serbia and Montenegro have limitations on the import and use of asbestos in construction (Global Unions, 2005).

Moscow municipality set the goal to pull down all apartment blocks where phenol formaldehyde was added to concrete. The first such buildings were pulled down in late 2006 (Gormsen, 2007).

6.3.3 Local initiatives and innovative approaches

Decreasing raw material use in construction

Box 6.7 gives two examples of initiatives to reduce the use of raw materials either through the reuse of building waste or more efficient material consumption.

Box 6.7 Reducing raw material use in buildings

Recycling of pre-fabricated building components, Germany. Beginning in 2001 the Institute for Rehabilitation and Modernisation of Buildings (IEMB) investigated the feasibility of re-using pre-fabricated components from Soviet-era multi-apartment buildings in former East Germany. Large prefabricated concrete panels were removed from buildings which were consigned for demolition and used to construct new detached houses. Houses required only 2 % of the energy input during construction, need fewer raw materials, and cost 75 % less in construction (IEMB, 2006).

Low material use buildings, Chisinau, Moldova. The 'Arhiconi-Group' has plans to construct small groups of 'Canadian-style houses' in Chisinau ([25]). These houses are made out of wood and lightweight materials, and only require 30 % of the material use of conventional buildings of the same size. They also have superior thermal efficiency. Such pre-fabricated buildings can be adapted, disassembled and re-used much more effectively than conventional buildings ([26]).

([25]) http://www.botschaft-moldau.de/eng/construction.html.
([26]) http://www.artiindex.com/en/houses.html.

Box 6.8 System level cost-effectiveness studies

Heating strategy for urban multi-apartment buildings, Moldova

A USAID/Alliance to Save Energy-financed project was begun in 2001 to identify measures to improve the financial status of district heating enterprises. Phase I of the project included the development of a heating strategy for urban areas. The cost-effectiveness of district heating supplied by CHP versus autonomous (building-based) heating was assessed for a number of cities (Kalkum, 2002).

CHP schemes for public buildings, Albania

In 2003, the Albanian National Agency for Energy (NAE) funded feasibility studies for two new CHP schemes — one for the largest hospital in Albania (Mother Teresa Hospital) and one for the campus of Tirana University. The schemes proved feasible and cost-effective, and the NAE and the Ministry of Industry and Energy are now seeking funds for implementation of a CHP system for the hospital (Recover, 2005).

Combined heat and power, and district heating feasibility projects

If sustainability is to be integrated into municipal energy planning, detailed economic and environmental assessments need to be conducted prior to making decisions over the future of heating networks (Box 6.8).

In densely-populated cities with colder climates, DH can be more cost-effective and environmentally advantageous than autonomous building level systems, provided the systems have been modernised and distribution losses reduced. Use of CHP or waste heat from industry in the DH system should dramatically improve cost effectiveness. Where DH networks powered by CHP would not be cost-effective, individual boilers in the building (but not in apartments) may be the most sustainable solution. These options could be incorporated in planning and building regulations.

System refurbishment projects

A significant number of DH and water systems have undergone recent refurbishment or are about to be modernised to improve efficiencies and cost-effectiveness. A few of these are listed in Box 6.9.

Box 6.9 District heating modernisation projects

Belgrade DH Refurbishment

The Municipality of Belgrade, with co-funding from the EBRD, is about to launch a EUR 36 million refurbishment project for their district heating system, including installation of new substations and heat exchangers, burner management systems in boilers and new well insulated piping.

Lviv, Ukraine DH Energy Efficiency Project

Between 1997–1999 Lviv Teplokomunenergo, a state-owned heating enterprise, undertook a major refurbishment of distribution piping in the city network and the piping systems within buildings to reduce heat losses and water leaks. Heat meters were installed in buildings at the same time. The aim was to improve the financial situation of the enterprise and to reduce environmental pressures (EBRD, 1997).

Irkutsk, Russia Heat Supply Renovation Project

Between 1997–1999 the Irkutsk Municipal Enterprise, in association with the Irkutsk Energy Centre, and with a USD 3.2 million loan from Sberbank, carried out a DH renovation project. Inefficient boiler houses were closed down, three separate DH systems connected, and heat hydraulics in 33 residential and public buildings modernised to improve heat transfer.

Innovative technologies for new buildings

The new Russian building codes mentioned earlier include mandatory energy labelling for new and renovated buildings. The two upper bands (A and B) in the five band labelling system are for low and very low energy buildings, which go beyond mandatory efficiency requirements for a new building. This has the potential to provide incentives for innovative high efficiency technologies. However, to encourage the full spectrum of innovative technologies the Russian codes need to be extended to cover hot water systems and lighting.

A number of initiatives have been completed or are under way in SEE and EECCA countries using innovative technology for buildings (see Box 6.10). Use of geothermal energy is being investigated especially in the SEE region. There is also an opportunity for innovative efficient cooling for buildings in Central Asia and SEE.

Retrofitting of existing buildings

There is a huge potential for energy saving through the retrofitting of existing buildings in EECCA countries (CENEf, 2001). Retrofitting at building level can include:

- improved insulation of walls and roofs;
- refurbishment of heating boilers (where the building is not connected to DH);
- introduction of a heat exchanger between the DH and building circulation.

Retrofitting at the apartment level can include:

- improved sealing of windows and doors (weatherisation);
- installation of low energy appliances and lighting;
- installation of control valves and meters.

A World Bank project in Cherepovets, Russia, retrofitted 663 buildings to improve thermal efficiency during the late 1990s. Monitored buildings showed a 45 % average reduction in heat demand following retrofitting of which 27 % was gained from the retrofitting of the shared facilities, i.e. the building and its heating system, and 18 % gained from apartment-level improvements (Bashmakov, 2006). A feasibility project in Uzhgorod in Ukraine found similar overall savings available from retrofitting (Diefenbach and Luksha, 2006). Measures were identified which would yield savings of between 36 % and 64 %, depending on the housing type. Again, the majority of savings would

Box 6.10 Innovative technology initiatives

Geothermal heating for housing projects, Bosnia and Herzegovina

A project led by a German-Bosnian company with the participation of EAN-Nord GmbH has set the goal of establishing a geothermal heating plant for a group of buildings in Lidza, a suburb of Sarajevo. If high geothermal temperatures are encountered there are plans for partial conversion to electrical energy. There are similar projects in progress at Bosanski Samac and Kakanj (Recover, 2005).

Solar water heating capacity building and grants, Albania

Demand for hot water in residential sectors of Albania is projected to grow from 600 GWh in 2000 to 875 GWh, by 2015. Meanwhile, 82 % of households in Albania use electricity to heat their water. The Albanian government has secured Global Environment Facility/UNDP funding to create policy and economic frameworks to help solar water heating. The target is 20 % growth per year to reach 540 000 m^2 of installed capacity by the end of 2020. More recently, the Government's Renewable Sources Fund supplied partial grants for solar panels in 2 650 private households in 2005 (Leskoviku, 2006).

Water heating solar plant project, Kazakhstan

Kazakhstan has a considerable solar energy potential which remains under-utilised. The UNDP/GEF financed a pilot and capacity-building project, with participation from the local DH Company (ATKE) to install a solar pre-heating plant at a district heating boiler house. Annual output of the solar plant is 193 000 kWh which would lead to savings of 24 000 m^3 of gas. The expected payback time is 10 years (UNDP, 2005).

be achieved through increased insulation of walls and roofs (Kopets, 2006).

Retrofitting projects must be implemented in a way that does not reduce ventilation to the detriment of inner air quality. This is especially important in housing blocks which contain phenol and formaldehyde in construction materials and which are released into the indoor air. The municipality of Moscow has a demolition policy for all such buildings in the near future, but other countries have not yet followed suit (Gormsen, 2006).

Where buildings are owned by municipalities or where municipalities subsidise a large part of energy and water costs, there is a clear economic incentive to initiate retrofitting of the least energy efficient buildings (Note: this will only be acted upon where budgetary policy cuts across municipal departments). The effectiveness of economic incentives for retrofitting is much less clear for the increasingly high proportion of multi-apartment buildings which consist of privately owned apartments. In these buildings the collective body on which economic incentives can act is weak or non-existent. An example is Ukraine where privatisation contracts contain no obligation to establish bodies representing residents' interests (Kopets, 2006). There have been a number of initiatives to establish voluntary residents'

Box 6.11 Building retrofit projects in EECCA and SEE

The Intelligent House, Moscow

A pilot project is being funded by Danish Danfoss to retrofit a multi-apartment building with 83 apartments served by a city DH system. The project is called the Intelligent House. Improvements have included placing a heat exchanger and building heat control system between the DH and the building's hot water circulation (Shapiro, 2006).

Improved energy efficiency of public buildings, Korca, Albania

An initiative was carried out in Korca, Albania, to improve the energy efficiency of public buildings. Greatest energy savings were achieved through thermal insulation of external walls, followed by the insulation of roofs and terraces (Recover, 2005).

Retrofitting of two multi-apartment buildings, Lviv, Ukraine

This project funded by the Alliance to Save Energy (ASE) retrofitted the heating systems of two multi-apartment buildings with hot water and heating controls for each apartment and accompanying metering systems. This resulted in considerable reductions in hot water and heating consumption with combined pay-back times for the tenants and the municipality of 1.5 and 5.9 years for the two buildings (MUNEE, 2006).

Box 6.12 Establishment of residents associations in EECCA and SEE

Strengthening of residents' associations, Gabrovo, Bulgaria and Almaty and Kokshetau, Kazakhstan

A GEF-funded, demand-based, energy-efficiency demonstration project started operation in the late 1990s in Bulgaria. The project included strengthening and mobilising housing associations to make possible a number of concrete retrofitting projects (UNDP, 2004). This approach is to be adapted for implementation in Kazakhstan during 2007 (UNDP *et al.*, 2006).

Overcoming barriers to energy efficiency in residential buildings, Vladimir, Russia

This GEF- supported project from the mid-1990s established tenants' associations and developed billing incentives to encourage efficiency improvements in existing buildings (UNDP and GEF, 2004).

associations (Box 6.12), but these are considered a weak substitute for legally required bodies.

In the final analysis, the economic incentive for retrofitting will exist only if energy tariffs are set high enough ([27]). Pay-back times for the projects identified in Uzhgorod in all cases exceeded ten years due to low tariffs and the high cost of imported insulation. When the full cost savings are included, with reduced costs for municipalities, retrofit projects have much shorter payback periods, e.g. 1.5–5.9 years for the Lviv projects (Box 6.12).

Governments have additional opportunities for reducing pay-back times by providing incentives to establish domestic insulation production which would offer the advantage of both diminishing costs and providing jobs ([28]).

Metering and payment by use

Introducing control, metering and payment by use for apartments can have an immediate effect on heating and hot water consumption in apartments even without any associated retrofit or weatherisation projects ([29]). It seems that increased control and awareness are not sufficient on their own, and economic measures constitute a crucial component. A case in point is a USAID project which installed apartment level radiator controls in a multi-apartment building in Kazakhstan, but without payment by use. Despite distribution of information on the importance of energy conservation, residents continued to control temperature in winter by opening windows rather than switching off their radiators (UNDP, 2004).

The ineffective controls over heat use at apartment level can be solved in the long term by including mandatory obligations in building codes for metering in new buildings. In existing buildings, retro-fitting programmes can gradually introduce metering or heat cost allocation devices and control at apartment level. For example, in Poland heat metering began to increase rapidly when the obligation for installation was transferred from building owners to district heating companies ([30]). In the short term building-level meters could be installed and residents' associations established to discourage wasteful habits.

Provision of information

Economic incentives should be accompanied by information on how and why to carry out apartment level weatherisation and stop wasteful practices. The Centre for Energy Efficiency in Moscow produced a pamphlet, Plus 20, for distribution to individual families with information on cost and payback time for improvements and providing do-it-yourself advice.

6.3.4 Project financing

Lack of available financing is one of the chief barriers in EECCA and SEE countries to achieving energy efficiency improvements in water and energy distribution systems, housing and buildings.

International funding

The majority of energy efficiency projects to date, including DH system refurbishment, combined heat and power plants and retrofitting of large buildings, have been funded or co-funded by international donors. It has been estimated that in Russia alone, retrofitting of DH networks and residential buildings requires over EUR 50 billion of investment (Regional Enterprise Partnership, 2005). This is more than 2.5 times the entire capital base of the EBRD, the largest single investor in the region (EBRD, 2002). If all the potential energy efficiency projects are to be carried out, other sources of funding will have to be found. In the case of the resource-rich EECCA countries, national funding could increasingly be used.

A future major source of funding for four countries in the region (Russia, Belarus, Ukraine and Croatia) could be the Joint Implementation (JI) scheme under the Kyoto Protocol. The main focus for JI is likely to shift from the new EU Member States to Ukraine and Russia. Russia has the largest potential for JI projects among all eligible countries (ICFI, 2006).

There are, however, considerable institutional barriers in many EECCA and SEE countries which can make funding unattractive to donors and international investors. These obstacles and possible solutions are investigated in detail by the Alliance

([27]) The fact that DH companies and water utilities are often state- or municipally-owned means that public institutions are both suppliers and consumers of these services and they have a say in tariffs and an interest in keeping them low.

([28]) Rockwool Denmark recognises the huge potential for insulation materials in Eastern Europe. They have a factory in Moscow but demand has consistently exceeded the capacity of the factory. In response, a second factory has been established close to St. Petersburg, employing 150 people. It began production in 2006 (Rockwool, 2004). Factories are also being established in SEE in Romania and Croatia (Andresen, 2006).

([29]) In the Lviv project (Box 11) average heat and hot water consumption was reduced by 28–38 %.

([30]) Personal communication Anatoliy Kopets, MUNEE.

to Save Energy ([31]). UNDP has also produced a guide for alternative financing of energy efficiency projects (UNDP, 2005).

To date JI financing has only been used for large projects. The mechanism is very suited to refurbishment and modernising of DH systems, but may be less appropriate for financing retrofitting of multi-apartment buildings. An alternative mechanism under the Kyoto protocol is emissions trading of so-called Assign Amount Units (AAU). There may be possibilities for the Annex I countries of Russia and Ukraine to sell AAUs generated by retrofit projects to Annex I countries in Western Europe or elsewhere.

Improving the finances of energy and water enterprises

Financing improvements can be particularly difficult for energy and water enterprises as state subsidies are reduced. Tackling non-payment is a critical step in improving the finances of energy and water enterprises (see Box 6.13).

Funding building retrofits

Many retrofit projects to date have been partly funded by international donors, but alternative sources of funding are required to achieve the enormous potential. When the full socio-economic costs of large retrofit projects are considered, most would pay for themselves in less than ten years, and many in less than five.

Bank loans are unlikely direct sources of funding for retrofitting of multi-apartment buildings unless the condominium or residents' association has external support. This is due to the high level of risk for the lender and correspondingly high interest rates (UNDP, 2005).

External support for residents' associations can come in the form of state or municipal collateral or grants to supplement bank loans. In return, the municipality can receive part of the energy cost savings. However, many municipalities do not have the budgetary autonomy that would enable them to keep these energy-cost savings ([32]). An alternative model is the Energy Services Company (ESCO) and performance-based contracting (Box 6.14).

Providing an environment in which ESCOs can thrive requires governments to take three key measures:

- furnish a strong legal base for energy performance contracting to protect the ESCO from the risks it assumes by financing the projects;

Box 6.13 Tackling non-payment

Service improvement programme

A promise of improvements in services is necessary to tackle non-payment problems in situations with rising tariffs. Information campaigns are necessary to convey the service improvement plan to consumers and explain why increases in tariffs are necessary. Consumers will react much more positively towards increasing tariffs if they can control their costs. This requires installation of apartment level metering.

Georgian success stories

In Tbilisi, electricity services have been considerably improved along with a quadrupling in tariffs between 1997 and 2003. By end of 2001, 94 % of households had received uninterrupted electricity in Tbilisi compared with 25 % in other cities and 7 % in rural areas (World Bank, 2003). Meanwhile, in the city of Rustavi 16-hour electricity stoppages were common during the 1990s. Four out of five households did not have electricity meters and non-payment was high. In 2003, the United Energy Electricity Company with US AID help offered residents the choice of paying USD 16 for installation of a meter or staying without electricity. Today residents in Rustavi enjoy a 24-hour electricity supply and payment rates have quadrupled. Meanwhile, consumption per household has declined by 50 % due to household electricity conservation (USAID, 2006).

([31]) Guidelines on financing energy efficiency projects to be posted at www.munee.org during 2007.
([32]) Personal communication Angela Morin, Alliance to Save Energy.

Box 6.14 The role of Energy Service Companies (ESCOs)

ESCOs and energy performance contracts have played an important role in promoting energy efficiency in many developing states including a number of transitional countries. The model has been used with considerable success in the Czech Republic, and to a lesser extent, in Ukraine and Russia (Evans, 2001).

ESCOs can provide a number of services to residential and commercial building retrofitting projects, including feasibility studies, project management, financing, installation, and follow-up with maintenance and monitoring. ESCOs will generally accept payment through energy savings following retrofit. Under energy performance contracts between ESCO and the residents, ESCO agrees to implement measures to reduce energy use, and the client agrees to pay back a certain amount of the savings from the project (Evans, 2001; UNDP, 2005).

Some ESCOs are large enough and have sufficient liquidity to finance projects themselves. An example is the state-owned Ukrainian Energy Services Company (UkrEsco) which has access to loans and grants from the EBRD and the EU's technical assistance programme (TACIS) (Evans, 2001). In most cases, however, ESCOs need third-party financing to implement the project, usually from commercial banks.

- arrange training for engineering companies, banks, government officials and consumers; and
- provide seed financing, including provision of guarantees, to stimulate the initial growth of the market (Evans, 2001).

The final point could also include state or municipal ownership of the first ESCO with privatisation once the market has become sufficiently vigorous, e.g. in Ukraine with the state-owned UkrEsco.

Support for individual households can include grants for weatherisation projects, tax redemptions on weatherisation materials, revolving leverage funds ([33]) or micro loans for lower income families to carry out these projects with back payment taken from reduced energy bills.

6.4 Conclusions

Buildings account for a significant proportion of the material and energy use of developed and transitional economies. For example, final energy consumption in buildings represents one-third of total final energy consumption across SEE and EECCA.

Annual residential final energy consumption per capita varies from 11 000 kWh in Russia to just 600 kWh in Armenia. Differences between greenhouse gas emissions related to residential energy use are even greater since most countries with low residential energy consumption also have high levels of renewable electricity production. High energy consumption in Eastern Europe and parts of Central Asia is due in part to cold climates but also to widespread but inefficient district heating, inefficient distribution systems, low thermal efficiency of buildings, low energy prices and lack of economic incentives for householders. Water consumption in buildings is high throughout the whole region.

The future is likely to bring increasing residential energy demand in cities without district heating, increasing appliance ownership and a switch from kerosene and wood to electricity for heating in SEE and Caucasus countries as incomes rise. A growing demand for electricity for appliances in SEE and the Caucasus could be met more sustainably by switching from electricity to fossil fuels or preferably solar and geothermal energy for heating and hot water.

The current construction boom presents an opportunity to improve the thermal efficiency of new building stock. This and the huge

([33]) The Alliance to Save Energy has initiated such funds in Gumri and Vazandor in Armenia with notable success. With USD 1 000 donor grants, starting revolving funds are used by housing associations to finance repairs and EE improvements to buildings. The projects so far pay back in a year or less (Alliance to Save Energy, Armenia 2006).

task of retrofitting the dominant stock of old, low- efficiency multi-apartment buildings would significantly reduce environmental and social impacts. Widespread district heating also presents a sustainability opportunity, provided it is modernised and combined heat and power (CHP) plants promoted (i.e. cogeneration of heat and electricity).

Many countries have energy efficiency strategies, but fewer have translated them into concrete action. Existing examples of implementation include new thermal building standards; building energy auditing and labelling; metering installation programmes; tariff reform; and economic incentives to encourage more CHP. Generally lacking are sustainable heating strategies, minimum efficiency standards and/or energy labelling for appliances and condominium-style privatisation contracts. Also missing are measures promoting energy efficiency technologies and the institutional capacity and political will to ensure implementation of strategies where they exist.

A large number of local initiatives have been carried out in cities in EECCA and SEE, often supported by international funding. Obstacles to their wider adoption include lack of available financing, poor tariff payment discipline, lack of locally available energy efficient technology and lack of public awareness of the environmental, economic and social benefits of decreasing residential energy use.

Use of virgin construction materials can be significantly reduced by the reuse and recycling of demolition and building waste. However, current rates of reuse and recycling are very low. Policies are needed to promote greater recycling of building demolition waste.

National governments and municipalities could promote more efficient heating systems with lower levels of primary energy use and lower carbon intensity through the following actions:

- carry out cost-effectiveness evaluations of local district heating (DH) systems, including scenarios where DH was powered by CHP or waste heat;
- where DH is potentially cost-effective, strengthen the system by requiring the linkage of new buildings to DH in relevant planning zones;
- where autonomous heating is more cost-effective, include requirements for autonomous heating systems in building codes for multi-apartment, large office/public buildings;
- encourage alternatives to electricity for heating and hot water to free up electricity capacity for the increasing demand for appliances.

They could also promote greater energy efficiency in new and existing buildings and promote lower energy buildings (both new and existing) by:

- developing packages of new thermal efficiency building codes where these are lacking, including requirements for energy audits and energy labelling of new and retrofitted buildings;
- encouraging the use of innovative building technology and design by including codes and labels for very energy-efficient buildings;
- further promoting low energy buildings by extending energy audit standards to include hot water, cooling and lighting, using tax differentials to promote low energy technology, and creating information resources for architects/contractors;
- setting up funds for retrofitting projects and/or providing strong legislative and financial environments for Energy Service Companies (ESCOs) and energy performance contracting.

National and municipal governments and energy and water enterprises could take action to encourage householders to conserve energy and water consumption, and invest in energy and water efficient technologies. Such action could include:

- establishing a short-term programme of installation of hot and cold water and heat meters at building level and strengthening the legal base for residents' associations through standard condominium contracts in multi-apartment housing. In the longer term, establishing meter installation programmes at the apartment level. Responsibility for installation of meters could be transferred to energy and water enterprises;
- continuing tariff reforms, supported by concrete commitments and timetables for service improvements;
- where apartment level metering exists, encouraging block tariff systems to provide

affordable energy services while offering an economic incentive to reduce consumption;

- providing residents with information on cheap insulation and window and door- sealing initiatives including costs and pay-back times and setting up small revolving grants or micro-loans for apartment level efficiency improvements;
- carrying out promotional campaigns on conservation measures in homes and businesses where metering does not exist or where tariffs are currently low;
- adopting energy label legislation for appliances, or setting up minimum energy-efficiency standards for appliances.

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