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Addressing

CLIMATE CHALLENGES

in ECA Cities



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Table of Contents

Cities and Climate Change/1

BUILDINGS EFFICIENCY/3

The Communist Past: Quantity over Quality in Building Construction/4

Residential Buildings – The Proliferation of Energy Inefficient Flat Panel Buildings/5

Public Buildings – Large and Inefficient/8

The Transition Present: High Transaction Costs Hinder EE Investments/8

Residential Buildings – Many Apartment Blocks with Even More Owners/9

Public Buildings – Figuring Out Who Owns What/11

Within Buildings – The Conundrum of Lower Heat Consumption/12

The Sustainable Future: Insulating, Leading by Example, Promoting EE/15

Thermal Insulation of Residential Buildings/17

Leading by Example in Public Buildings/19

Promoting Energy Efficiency at Home/20

EFFICIENCY of PUBLIC SERVICES/22

The Communist Past: Coverage Trumps Efficiency/23

Waste – Out of Sight, Out of Mind/24

Sewage – There, but Not Quite There/26

Water – Systems Designed for Continuous Population Growth/27

Street Lighting – Outages Keep Emissions Down/28

The Transition Present: Adapting to the Market and to Climate Change/28

Waste – More Trash, Improperly Disposed/29

Sewage – Crumbling Systems/31

Water – Trying to Adapt to Different Urban Change Patterns/32

Public Lighting – Changing the Bulbs, Extending the System/37

The Sustainable Future: Investing, Reducing, Professionalizing/37

URBAN FORM/41

The Communist Past: Compact Cities/43

The Transition Present: From Compact Urban Mass to Sprawl/44

The Sustainable Future: Densifying the Urban Mass/50

BIBLIOGRAPHY/53

ANNEXES/56

Cities and Climate Change

Much of the world's built environment is found in urban areas, and cities are thought to be responsible for up to 70% of global greenhouse gas (GHG) emissions, and up to 80% of primary energy demand. Most of the energy consumed in the world fuels urban industry, powers urban homes and offices, and moves people within and between cities. Thus, cities are not only engines of economic growth and innovation, but they are also responsible for much of the environmental side-effects caused by economic activity. As such, cities are key in addressing the climate challenges the world is facing. City density, for example, offers a significant potential for economies of scale, cost savings from energy efficiency and reduction in per-capita energy intensity. A more energy efficient building stock can currently reduce energy demand by up to 80% using existing technologies, and could become a net energy provider in the future through investments in passive-building technologies and smart-energy retrofits.

In this context, local authorities the world over play a key role in addressing climate change, by planning and investing in more sustainable systems, maximizing cross-sectoral synergies, and minimizing the trade-offs between 'green' and 'growth'. Some even consider that local authorities are better positioned than central government leaders to address climate change (see for example Rosenzweig, 2011). National, international, and cross-national bodies acknowledge the importance of cities in addressing climate change, and are focusing much of their efforts there. For example, the EU has set the 20-20-20 targets¹ for the year 2020, and cities are expected to provide many of the solutions for achieving these targets. To help cities take the lead in the fight against climate change, the European Commission has started the Covenant of Mayors Initiative. Other international initiatives, like the Kyoto Protocol or Local Agenda 21, also give cities a prime role in addressing climate change.

Cities in Europe and Central Asia (ECA) will consequently have to do their part. ECA is one of the most urbanized regions in the world and it has the most emissions intensive (CO₂/GDP) economy of any other part of the globe (World Development Indicators Database - WDI). At the same token, ECA is one of the regions with the most dramatic reductions in overall GHG emissions in the past 20 years (UNFCCC, WDI). Much of these reductions are passive in nature though (e.g. caused by large scale de-industrialization) and it is important that ECA countries, and ECA cities in particular, take a more pro-active role in fighting climate change. Every effort will help with this challenge, and no city is too small to do something about it.

Addressing climate change in ECA cities will not only garner benefits for the environment, but it will also bring numerous economic and social benefits. Among other things, climate change policies can reduce energy costs, improve urban quality of life, increase employment, and drive long-term economic growth. These potential benefits will be discussed in some detail below.

Reducing Energy Costs. A country's large carbon footprint is typically a sign of inefficient resource use. Promoting energy efficiency in cities can help address that and generates immediate cost savings. Overall, **energy efficiency** measures are considered to be a low-hanging fruit among sustainable development policies, as they enable economic, social (e.g. lower utility bills), and environmental gains – often without a significant upfront cost. For example, replacing inefficient light-bulbs with LED ones in public buildings offers almost immediate dividends. LED bulbs not only have a better energy performance, but also last three times longer than regular bulbs.

¹ 20% less GHG emissions, 20% of energy from renewable, and 20% less energy use.

Improving Quality of Life. Quality of life is increasingly recognized as a crucial competitiveness factor in cities' quest for human capital. As cities strive to attract the best and the brightest, they recognize that talented people pay close attention to quality of life when deciding where to live (Florida, 2007). Often, the quality of life in a city is ranked more important than the actual availability of a job. People are less and less willing to just follow jobs anywhere, and they care about congenial and walkable neighborhoods, about the existence of efficient public transportation systems, about the availability of recycling networks, and about a city's environmental policies. Many climate change mitigation measures directly or indirectly address quality of life issues (e.g. thermal insulation projects not only reduce energy requirements and expenditures, but they also help beautify neighborhoods by rehabbing buildings' facades) and work as magnets for human capital. Human capital, in turn, is considered by modern economic theory (Romer, 1990) to be the cornerstone of long-term economic growth.

Encouraging Long-Term Economic Growth. A large enough pool of human capital is the cornerstone of long-term growth, but human capital needs to be engaged in endogenous technical change activities to generate that growth. In other words, it is not enough to have talented and skilled people around, they have to also produce innovation – the type of innovation that either saves costs or generates added revenues. For an economy to maintain a healthy rate of growth, it needs to be enmeshed in a continuous process of innovation. Climate change mitigation measures can help spur the development of green growth industries, which by definition are innovative. In its *Environmental Policy Review* of 2004, the European Commission indicates that green industries are a growth engine, expanding at 5% annually, with a demand for environmental goods and services estimated at over €500 billion. Many hope that green growth industries will give the same boost to economies as the IT industry did in the 1990s.

Increasing Employment. The emergence of green growth industries ultimately also means a surge in local employment. However, employment growth can also come from simple climate change mitigation measures. For example, enforcing strict building standards and promoting energy efficiency in existing buildings can help boost the construction sector, as well as a host of connected industries (e.g. energy service companies). Khamal-Chaoui and Robert (2009) identify five main categories of green industries that could help spur employment growth in cities and metropolitan regions: renewable energy and energy efficiency; transportation efficiency, new modes of transport, and substituting transport; green manufacturing, construction, and product design; waste and pollution control, and recycling; environmental analysis, training, and consulting.

This paper is about climate change mitigation in cities, and will primarily look at how local authorities can provide a higher quality of life for their citizens while at the same time achieving higher resource efficiency. It will also look at how climate change mitigation measures could help boost local employment and drive economic growth. The focus will be on *buildings* (residential, commercial, and office), *public services infrastructure* (water, sewage, solid waste management, and public lighting), and *urban form*. Other topics of interest in this respect, such as *transport* and *industrial production*, will not be tackled here directly, although they will be discussed tangentially in relation to the other topics (e.g. urban form influences and is influenced by transport patterns and strategies).

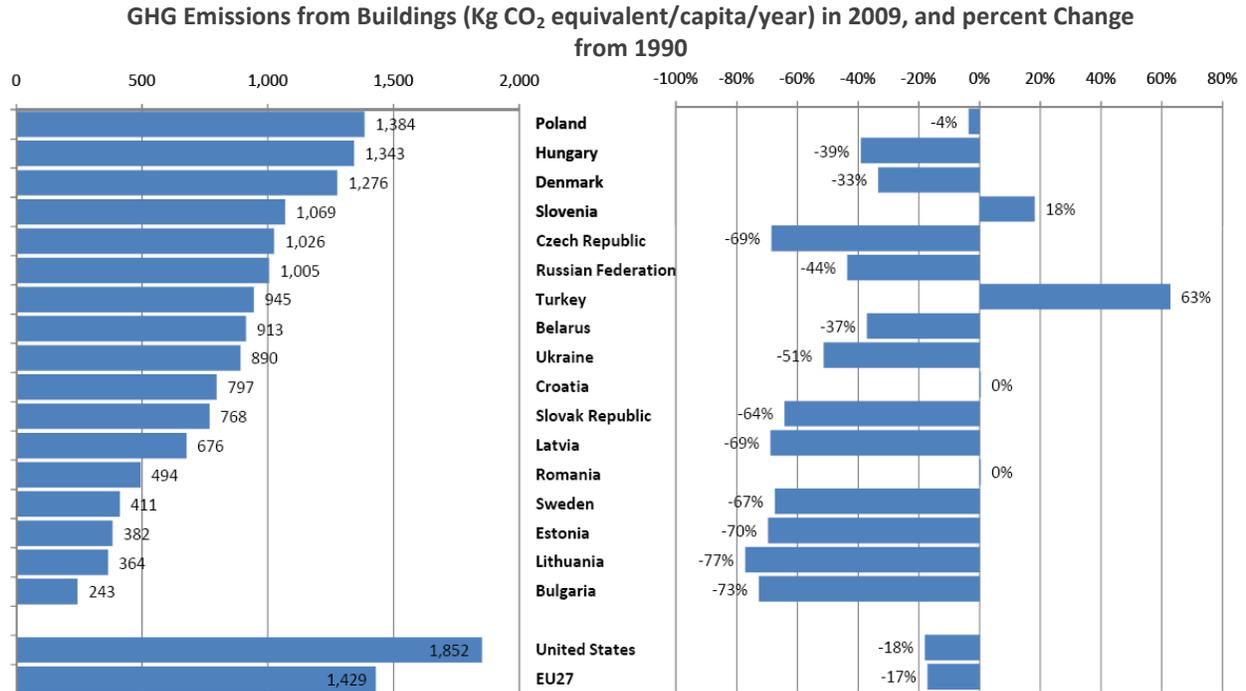
Buildings Efficiency

Buildings are responsible for around 40% of global primary energy use and for up to 30% of GHG emissions (UNEP, 2009b). Emissions in the buildings sector are generated during the manufacturing of building materials, during the transport of these construction materials to construction sites, during the actual construction of buildings, during building operation, and during building demolition. Around 80% of buildings emissions are caused by the operation of buildings, through the consumption of fossil fuels for heating, cooking, lighting, entertainment, and communications.

Organizations like the United Nations Environment Programme (UNEP), the OECD, and the European Environment Agency (EEA) estimate that the buildings sector has the highest potential for significant and cost-effective GHG emissions reductions. Using existent and proven technologies, energy consumption in new and existing buildings can be reduced by up to 80%. Moreover, the costs required to achieve these reductions can easily be covered over the life-span of the building (in effect generating a surplus), and significant co-benefits, such as increased employment and economic activity, can be generated by encouraging energy efficiency in buildings.

The UNEP Sustainable Buildings and Climate Initiative considers that countries will not be able to sustain significant reductions of GHG emissions without promoting energy efficiency in the buildings sector. Failure to tackle this challenge now, by building more energy efficient structures and by retrofitting existent buildings, can lock countries into decades of a poorly performing buildings sector. For example, Turkey has recently promoted a new legislation on energy efficiency in buildings, laying down clear standards and performance indicators for new development projects. However, between 2000 and 2008, the built mass of Istanbul (the largest city in Europe) and several other large Turkish cities, has more than doubled in size – far outstripping the pace of population growth (Turkish Statistical Institute). None of these new structures completed in such a short time frame had to abide to the new energy efficiency standards. Retrofitting these buildings will cost more than it would have cost to just incorporate the upgrades in the initial construction process.

In fact, Turkey had the highest increase in GHG emissions from buildings from any ECA country (see figure below). This can largely be attributed to the fact that Turkey was still urbanizing in 1990, while most other ECA countries had stagnating or even decreasing urbanization rates. In this respect, Turkey stands in large contrast to the ECA region, with the other countries having urbanized in a centralized, controlled fashion before 1989. Some of the idiosyncrasies of centrally planned urban growth, as well as some of the challenges of urban development in the transition years, will be discussed in the next sections.



Source: UFCCC

All in all, ECA countries, including Turkey, are considered to have the highest potential to dramatically reduce GHG emissions from buildings by 2020 (UNEP, 2009a). As the figure above highlights, ECA countries have GHG emissions from buildings that are close in value to figures registered in the EU and the US, although their development level lags behind. They have also registered significant decreases since 1990, and they are expected to continue this positive trend. However, while most of the registered emissions reductions have been passive in nature, it is hoped that reductions henceforth will represent a pro-active involvement of local and national authorities – e.g. by retrofitting the existent building stock and by promoting energy efficiency policies.

The Communist Past: Quantity over Quality in Building Construction

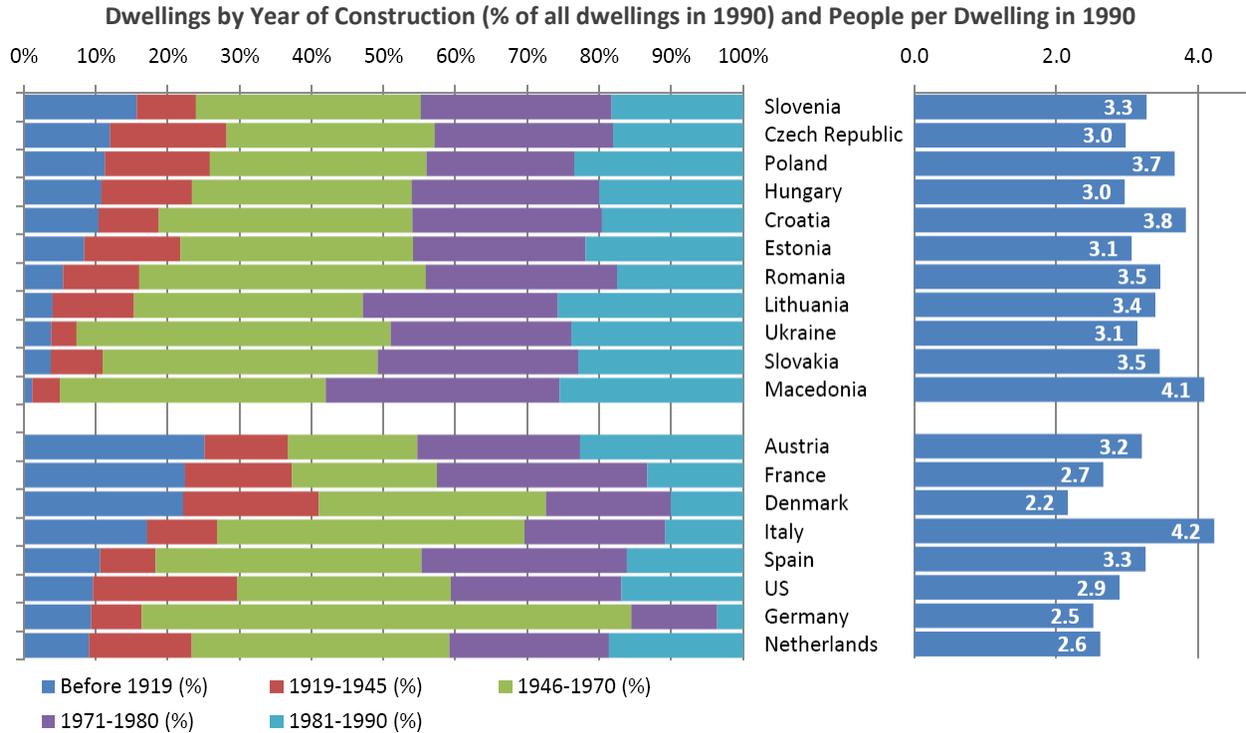
In 'The Siberian Curse', Fiona Hill and Cliff Gaddy talk about a unique way in which in-door temperature was adjusted in Russia households during the harsh Siberian winter. Since heat was often delivered at very high temperatures by district heating plants, and there was no way to regulate heat levels in individual apartments, people often resorted to opening windows to let cold air in.

Three major factors were responsible for this energy squandering. On the one hand there was often no way for people to adjust the temperature that was delivered to their homes. Every household and every public building received heat at the same temperature - equal heat for all. Since buildings tended to be of poor quality and not well insulated, heat was delivered at high temperatures to make up for all the losses. Moreover, energy was highly subsidized and there was basically no incentive to save and conserve energy. In most cases people behaved like heat and electricity were free goods. As the research arm of Allianz notes, “the luxury of cheap gas has led to poorly insulated, overheated and inefficient consumers of energy”². The Russian Center for Energy Efficiency found that on the whole, Russian buildings are either overheated or underheated, often consuming over 50% more heat and hot water than actually needed. Thus, if at a global level buildings are responsible for around 30% of GHG emissions, in Russia they are responsible for 53% - almost double the world average. Most of the energy in buildings is consumed by the residential sector.

For the analysis of the building stock in ECA cities, we will be looking at five main types of buildings: residential dwellings; educational and cultural facilities; sports facilities; health care facilities; administrative facilities. Of these, residential dwellings accrue by far the largest building stock; they also consume the most energy, generate most GHG emissions, and will be the main focus of our analysis.

Residential Buildings – The Proliferation of Energy Inefficient Flat Panel Buildings

Of the dwelling stock existent in 1990, when centralized planning systems in ECA fell apart, more than 80% was built after the Second World War. As the figure below evidences, countries in ECA had a significant building gap compared to their Western counterparts.



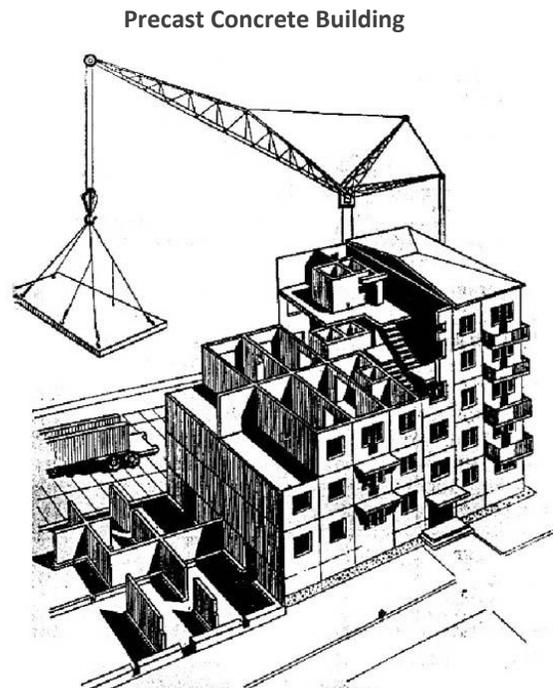
Source: UNECE and World Bank

² http://knowledge.allianz.com/en/globalissues/energy_co2/energy_efficiency/green_buildings_climate.html

New structures were built at a furious pace, and around 50% of the dwelling stock existent in 1990 was developed in the previous 20 years. Despite the high rate of development, countries in ECA did not manage to cover all housing needs. In 1990, ECA countries had a higher number of people per dwelling than countries in Western Europe. Thus, when the centrally planned regimes fell, there was a significant backlog of needed construction, and demand was quite high.

Not only were more buildings needed, but there was also a high demand for better quality dwellings. Although many of the constructions built in the 1950s and 1960s were of good quality (generally done with brick masonry), central governments soon realized that they couldn't keep up with the housing demand using these techniques and technologies. The construction industry had to be re-invented. So, they re-invented the construction industry – by adopting the Fordist model to housing development. This model allowed the same benefits as it did to the car manufacturing industry – a faster construction pace and lower costs.

Flat panel buildings were the solution of the Communist building revolution. As the image below illustrates, buildings were assembled out of prefab concrete blocks that were cheap to produce and easy to assemble. However, while using these building techniques allowed central planners to better respond to existent housing demands, they often cut corners on quality. For example, in the USSR, the Zheks (which literally were housing building combines) would build the same building with the same technologies in the Central Asian desert and in the Siberian permafrost. Such buildings were not built with thermal performance in mind, nor were they intended to respond to people's varied needs and preferences.



Source: http://www.world-housing.net/uploads/100795_055_2b.jpg

Concrete has a poor thermal performance, being almost 6 times more thermally conductive than brick, around 7 times more conductive than wood, and over 24 times more conductive than

Styrofoam (which is often used to thermally insulate buildings)³. Even in the Siberian areas, where people have traditionally built houses out of wood (which has good insulating properties), central planners insisted on raising concrete monoliths. These apartment blocks usually had flat roofs (where much of the heat losses happen) instead of insulating attics, and they had relatively thin walls (to save on construction costs). As these building got older, their thermal performance continued to decrease – at a higher rate than brick or wood buildings. Many of them have a designed lifetime of less than 15-25 years.

From the River Elbe in Easter Germany, to Vladivostock in Eastern Russia, 53 million such apartment flats were developed, housing around 170 million people (Knorr-Siedow, 2000). The share of flat panel housing among the total building stock varied from country to country, reaching 56% in the highly urban USSR, and around 26% in the more rural Romania.

Large Housing Estates in ECA, in 1990

Country	% of Dwellings Built		Floor Area (mil. m ²) of Large Housing Estates
	between 1960 - 1990	% of All Existing Dwellings, in 1990	
Bulgaria	55.00%	27.00%	64.7
Czechoslovakia	66.00%	36.00%	189.7
Poland	61.00%	35.00%	345.7
Romania	49.00%	26.00%	136.4
USSR	64.00%	56.00%	3,133.1
Hungary	52.00%	29.00%	106.1

Source: <http://www.eaue.de/Housing/housfut.htm>; UNECE; UNEP; EEA; Banjanovic, 2007; and authors' calculations

The floor area of these poorly performing buildings is staggering, covering a surface the size of a small country. Also, if one looks at individual cities, the share of large housing estates in total building stock is even larger. For example, in Romania the large rural population (45% of the total) dilutes the importance of flat panel housing in urban areas. If however one looks at the 2 million capital, Bucharest, large housing estates represent 82% of the total building stock – one of the highest shares in Europe.

Ratio of Inhabitants Living in Large Housing Estates in 1995, in Selected Cities

City	Country	Population	% in Large Housing Estates
Bucharest	Romania	2,045,000	82.00%
Bratislava	Slovakia	452,000	77.00%
Klaipeda	Lithuania	203,000	70.00%
Lublin	Poland	355,000	67.70%
Katowice	Poland	351,500	60.00%
Sofia	Bulgaria	1,192,700	60.00%
Warsaw	Poland	1,637,550	56.00%
Talinn	Estonia	434,763	55.00%
Tartu	Estonia	103,907	55.00%
Kaunas	Lithuania	418,700	51.60%
Budapest	Hungary	1,906,800	38.00%
Prague	Czech Republic	1,209,855	32.00%
Ljubljana	Slovenia	296,621	24.10%

Source: European Academy of the Urban Environment

³ See <http://hyperphysics.phy-astr.gsu.edu/hbase/tables/thrcn.html#c1>

The large number of flat panel housing is one of the main challenges to energy efficiency in ECA. On the one hand they are better performers than individual detached homes (heat in one apartment gets shared with other apartments), but on the other hand they lose a lot of heat through un-insulated walls, poorly framed wood windows, and thin un-insulated flat roofs. As we will see in subsequent chapters, even the benefits of district heating were quickly lost, with these systems becoming energy sieves, rather than energy savers.

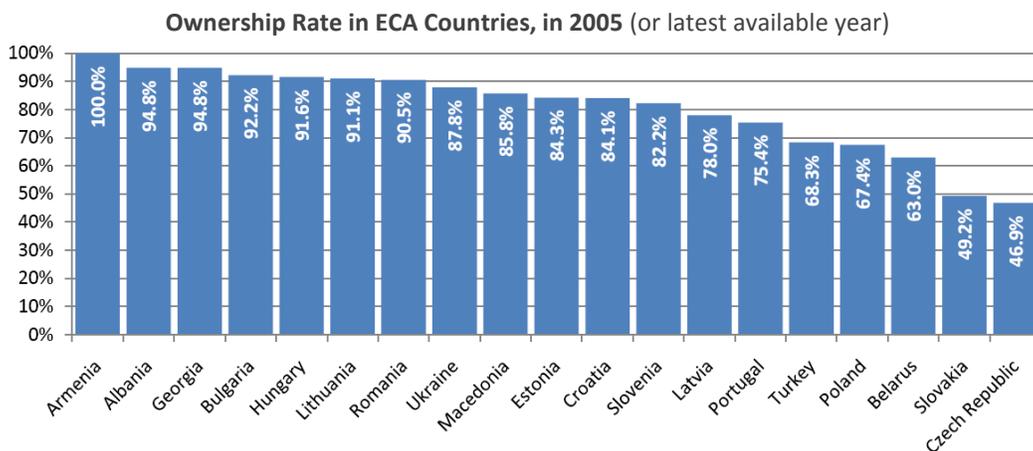
Public Buildings – Large and Inefficient

Public buildings that have been developed in the Communist years tend on average to have a better thermal performance than the flat panel apartment blocks. To begin with, public buildings were not built out of flat panel concrete sheets. For the most part, brick masonry was used, and walls were thick enough for proper insulation. As opposed to flat panel apartment blocks, public buildings were usually tailor made, and had a longer programmed lifetime – 50 to 100 years.

On the other hand, many of these public buildings were designed with a ‘show value’ in mind, aiming to demonstrate to the people the might of the regime. As such, they often tended to be over-sized, with rooms that were hard to heat and light. In addition, while walls in public buildings generally had good insulating properties, windows and roofs had a poorer performance. Windows tended to be large, were hard to replace (they were often custom-made), and had a deteriorating thermal performance over time. Roofs were usually flat, without an insulating attic. And, while a protective coating was laid over them, that coating was not replaced often enough to ensure its effectiveness.

The Transition Present: High Transaction Costs Hinder EE Investments

In almost every ECA country, the 1990s have represented a period of complex and often difficult adjustments. Trying to make the switch to a market system, these countries went through fits and starts, attempting to turn things around 180° through a trial and error process. One sector where this process happened particularly fast was the Buildings Sector. ECA countries have largely privatized their building stock in a quick swoop, offering inhabitants the option to purchase their dwelling, often at derisory prices. Thus, over night, ECA has become one of the regions with the highest housing ownership rates in the world (see figure below).



Source: UNECE

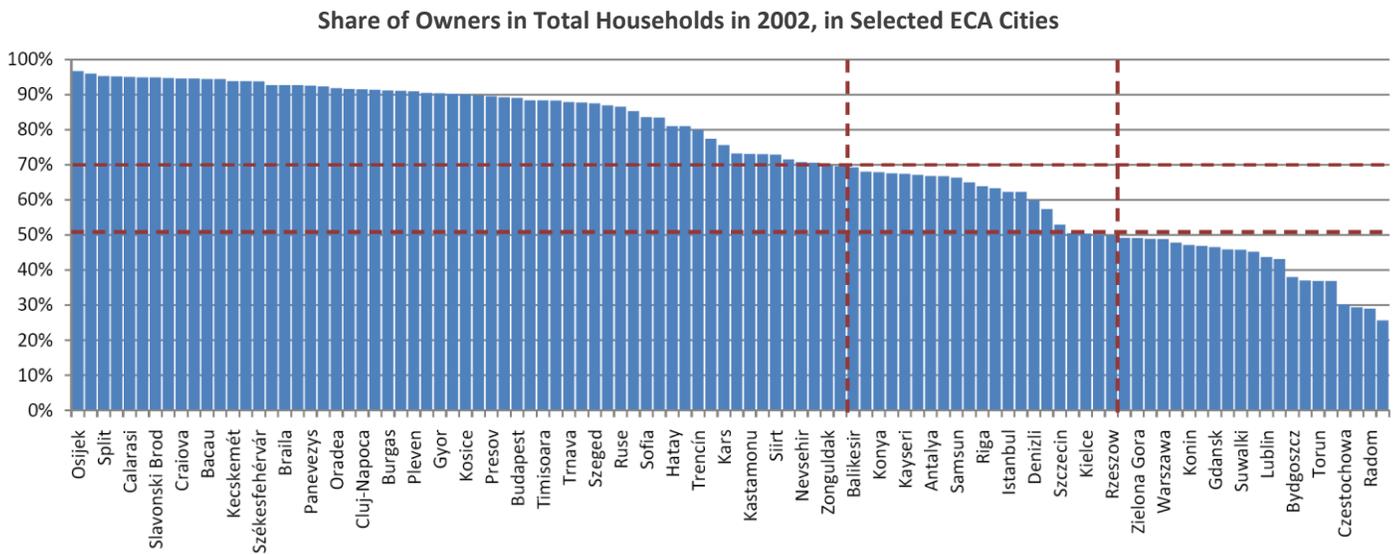
Ownership has the benefit of pushing people to build stronger roots to the city, and it provides an incentive to invest in energy efficiency improvements. Often, such investments contribute to

raising the re-sale price of their dwelling in addition to lowering their bills. On the other hand, a very high ownership rate hinders the development of rental markets, and as such makes inter-city migration harder. Inter-city migration is beneficial for the overall economy, as it allows for a more optimal allocation of resources (see World Development Report 2009). It also helps to spread and improve innovations in energy efficiency.

The public buildings stock went through a more complex process. While in the Communist past, all public buildings were centrally owned, in the Transition present they received a more eclectic ownership. Some buildings remained under the tutelage of the central government, many of them were passed under the control of local authorities, a few have been privatized or leased to private organizations.

Residential Buildings – Many Apartment Blocks with even More Owners

A look at ownership patterns at the urban level reveals similar patterns as at the national level. Rural dwellings can tweak the overall picture, as ownership rates there tend to be quite high. Even in Communist times, people in rural areas often maintained ownership over their houses and were allowed to practice subsistence farming on small plots of land. As the figure below highlights though, a majority of selected ECA cities had a home ownership rate of over 70%. Most of them had an owner-share of over 50%. As mentioned, such a high ownership rate can positively encourage investments in energy efficiency improvements. On the other hand, uncertain ownership of common property and the high number of owners in apartment flats can complicate things.



Source: EuroStat

A person that owns an individual detached home has an easier time investing in energy efficiency improvements. As long as they obtain the right permits, there are few barriers that could hinder them from making those investments. The situation is somewhat more complicated for people that own an apartment in a flat. For starters, people living in an apartment building don't only have to obtain city permits, but they also have to gain the approval of the other owners. The larger the apartment building, the higher the number of people that need to be involved, and the higher the transaction costs. For example, insulating the roof of an apartment building would benefit those living on the last floor more than it would benefit those living on the first floor.

Getting everybody to agree to contribute to the rehab work can, and often does turn into a battle of opinions, a struggle between those that have more means, and those that don't.

Since class differences were frowned upon in the Communist times, flats in ECA cities tend to be very mixed. An iron welder can live next to a doctor or a university professor. While this is highly desirable from a social point of view, it creates a number of issues when investments in the improvement of the common living space need to be done. For example, improving the thermal envelope of an apartment building is most efficient when the entire building is covered with an insulating screen. However, it often happens that some of the homeowners can't afford, or don't want to invest in a thermal insulation project. In such situations homeowners associations reach a stalemate where nothing gets done and investments are postponed indefinitely. Or, the projects get carried on, without including those that don't want to participate – with obvious efficiency and aesthetic shortfalls (see image below).

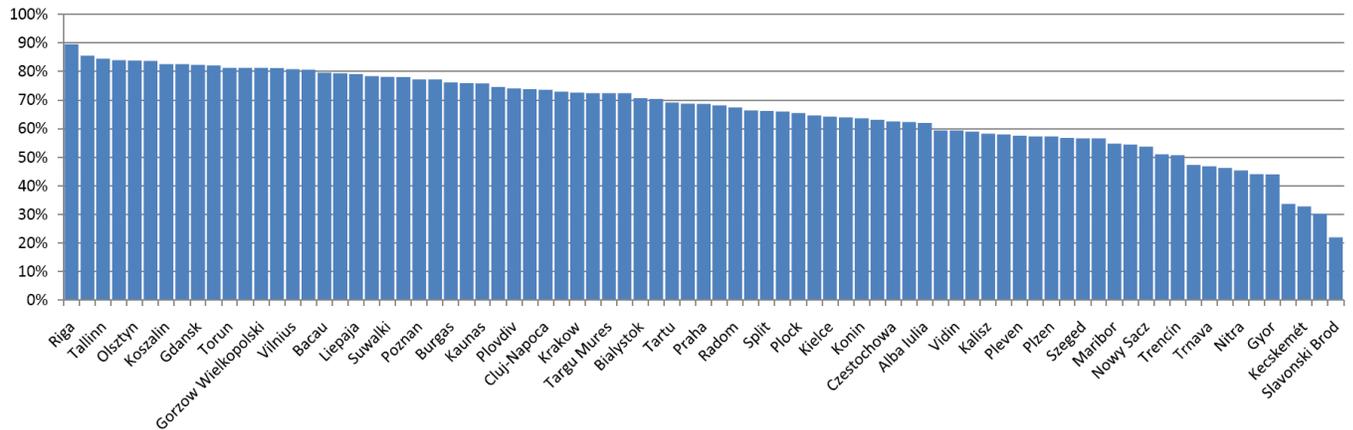
Partial Thermal Insulation Work



Situations like the one described above usually happen because there is no clear ownership of the common living space in and around a building. In fact, in some ECA countries, the common living space of buildings continues to be maintained by public local institutions, although the apartments themselves are owned by the inhabitants. The retention of these centralized structures for the management and maintenance of apartment buildings is a considerable barrier to the formation of functional and effective household associations. Russia, the country with the largest housing stock in ECA, continues to use such a system. Consequently, by 2010, only 10% of apartment buildings in the country had housing associations in place (The Institute for Urban Economics, 2010).

The high ownership rate in ECA cities can help promote energy efficiency. However, the high rate of people living in shared living spaces can negatively affect things. Regardless of how well housing associations are organized, the high transaction costs can slow down or even halt every decision that involves the common living space of a building. As the figure below evidences, people in ECA cities disproportionately live in apartment buildings, and they tend to own the apartments where they live.

Share of People Living in Apartments in 2002, in Selected ECA Cities



Source: EuroStat

There are of course renters, but they tend to be a minority in most ECA cities, even when accounting for informal renting. Nonetheless, renters do exist, and they pose the same type of challenges as renters throughout the world do, as well as a particular type of challenges. For one, renters are harder to convince to invest in energy efficiency improvements. Given that their stay in the rented unit is temporary, they are understandably unwilling to front-up cash for the upgrading of their unit. Once they move out of that unit, their investment is basically lost. On the other hand, land lords are unwilling to do such investments because they cannot benefit directly from a better energy performance. They can of course recuperate the EE investments costs by charging higher rents, but they risk losing their renters to competitors, and they are often unwilling to wait too long to amortize costs.

Upgrading rental units encounters such issues in virtually every country. There are however some peculiarities to how the rental market is organized in ECA. If in most developed countries, apartment buildings are either completely owned by the households that live there (condos) or they are completely rented out (rental flats), in ECA rental units are almost always mixed with units that are owned by the households living there. This of course tends to raise transaction costs when it comes to improvements of the common living space. For example, if in an apartment block with 10 units, two are rented out, discussions about the thermal insulation of the building would have to involve not only two potentially reluctant renters but also two potentially reluctant land lords. When negotiations and discussion don't help achieve a mutually agreeable compromise, situations like the one presented in the picture above are inevitable.

Public Buildings – Figuring Out Who Owns What

While the situation is relatively clear cut for residential buildings (most are in private ownership now and could benefit from energy efficiency improvements), public buildings are in a murkier predicament. Some have been passed on to local authorities, while some remain under the tutelage of central governments. Moreover, different countries in ECA have dealt with public buildings ownership transfer in a different ways. For example, in some countries schools and hospitals are the responsibility of central government organizations (e.g. the Ministry of Education and the Ministry of Health). In other countries, they are the responsibility of local governments. Similarly, sports halls can come under the ownership of different public institutions, but be administered by independent sport clubs.

As such, targeting energy efficiency programs at public buildings often requires to first find out who exactly is targeted. Then, one would need to find the resources and incentives to encourage the owners to proceed with energy efficiency investments. For example, if local authorities are still heavily reliant on central government transfers, EE investments are likely to not be an immediate priority for them. If however, they cover their utility bills from their own sources, they will be more inclined to focus on such measures – especially if the costs can be recovered quickly.

There are also situations where public buildings have one owner, but are administered by different organizations (either public or private). For example, sport facilities (soccer stadiums, basketball courts, in-door tracks, etc.) in ECA continue to largely be in public ownership, but are now administered by private clubs. Since these private clubs are not the direct owners of the buildings, they are less inclined to invest in improvements and upgrades. Without these private clubs however, the buildings run the risk of falling into disrepair. Over the years, many of these facilities have benefited from few upgrades, and many were left to fall apart.

Thus, when thinking about energy efficiency measures in public buildings, it is good to think beyond city hall, and it is important to consider different approaches for different buildings from the get-go. All in all, energy efficiency investments in public buildings can be quite complex, and they could have a good demonstrative function for citizens in a city. In fact, energy efficiency measures in public buildings should be done primarily for demonstrative effect given their relative small climate change mitigation potential.

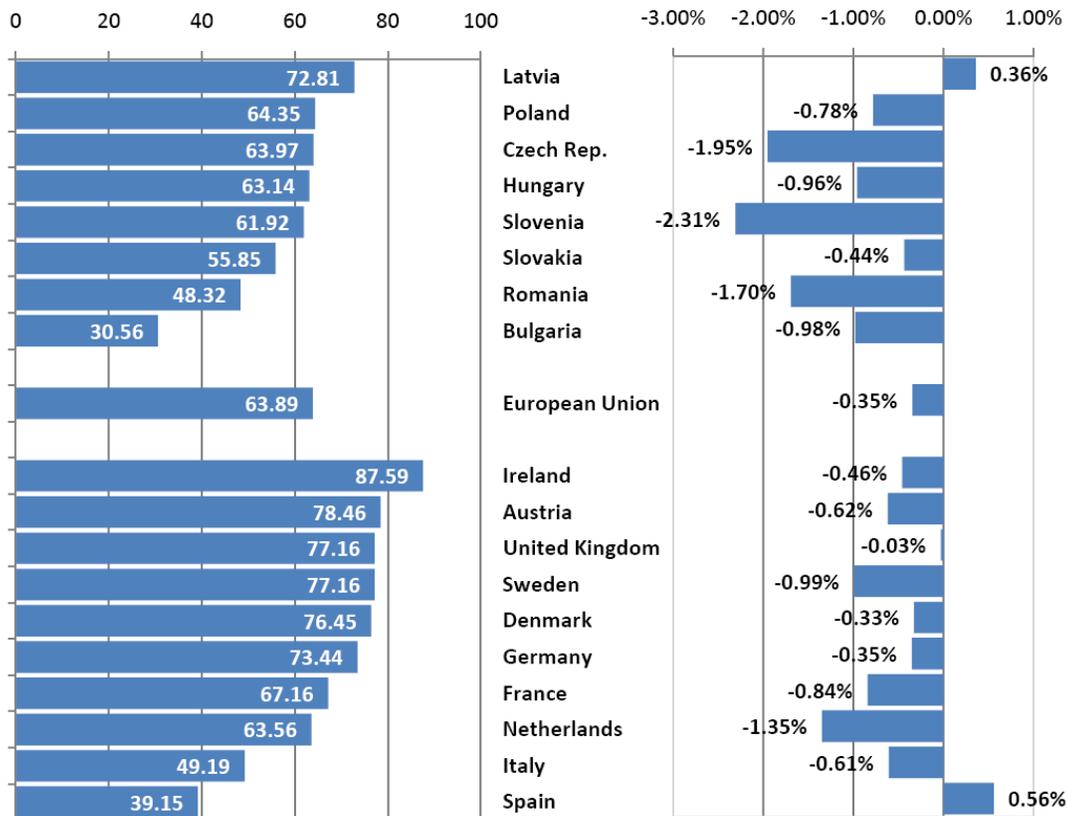
In absolute numbers, public buildings are responsible for a relatively small share of buildings GHG emissions, and an even smaller share of overall emissions. For example, in Tbilisi (Georgia), municipal buildings emitted 7,364 tons of CO₂ equivalent in 2009, as opposed to 708,580 tons in the residential sector – less than 1% of buildings emissions in the city (Covenant of Mayors, 2011). Municipal buildings cover a smaller surface area than the residential stock, and they don't consume energy throughout the day. In Skopje (Macedonia), most of the buildings are heated by a privatized district heating system, which delivers around 560,000 MW of energy every year. However, only 2.5% of this energy gets delivered to municipal buildings (Toplifikacija AD Skopje). Similarly, in Gaziantep (Turkey), municipal buildings consume only 2.5% of all electricity delivered to the city.

Within Buildings – The Conundrum of Lower Heat Consumption

To understand how to improve energy efficiency in buildings, one has to know where most of the energy goes to. Energy is used to heat the units, to generate hot water, and to provide electricity to a host of appliances. Depending on the particular trends in energy use within buildings, public interventions can be tailored to achieve the biggest impact for the lowest cost.

The surge in consumption that followed the fall of communism translated into people having more and more things that needed to be powered. To the 'boring' TVs, fridges, and cooking stoves, people started to add modern washing machines, microwave ovens, toasters, electric knives, electric toothbrushes, George Foreman grills, computers, laptops, cell phones, DVD players, cassette and CD players, coffee machines, and lava lamps. It is thus normal to expect a surge in energy use per dwelling. What happened though is the exact opposite – energy use per dwelling went down (see figure below). This seems paradoxical at first, but it can be explained by looking closer at some of the major changes that happened in the transition years.

Energy Consumption per Dwelling (GJ) in 2008, and % Annual Change of Energy Consumption between 1990 and 2008

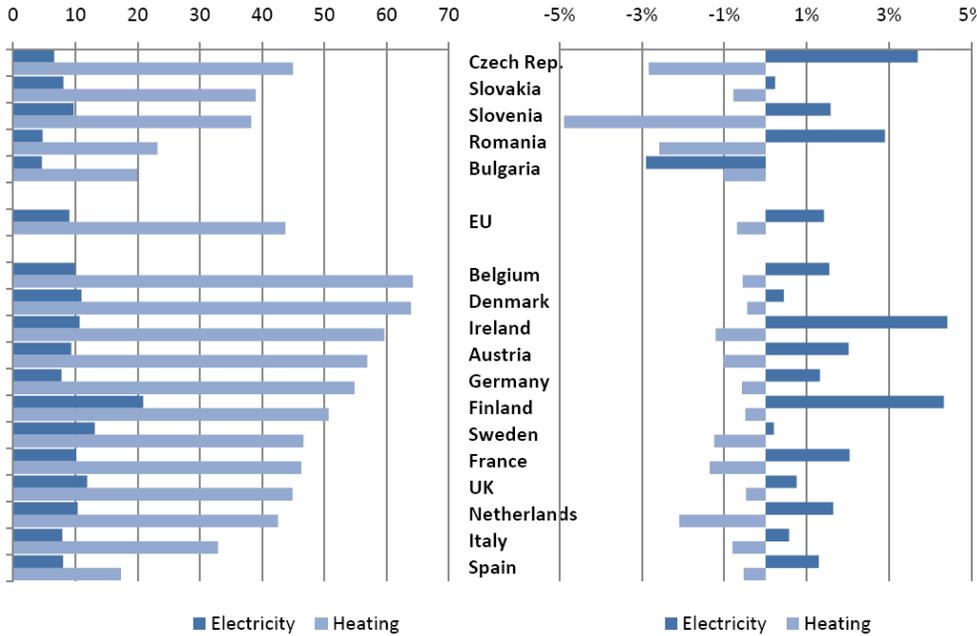


Source: Odyssee: Energy Efficiency Indicators in Europe

To begin with, as will be detailed later, there are more dwellings in ECA, housing smaller households. Even if the number of new appliances owned by households has grown exponentially, their rate of use is lower. A one-person household will use a microwave oven fewer times than a four-person household.

Going further, if energy use is broken down by electricity consumption and heat consumption, it becomes evident that electricity consumption grew, while heat consumption decreased (see figure below). Thus, all these new appliances did push electricity consumption up – in absolute terms and in relative terms (when moderating for household size), but they were far outweighed by the reductions in heating requirements. As the graph below clearly shows, heat accrues the lion share of energy consumption in a dwelling. This is a fact that is well known by energy experts, but less known by the average Joe (especially if they are not responsible for paying electricity and heating bills). In some countries, six times more energy goes to heating than to electricity. Consequently, continuing to lower heat consumption and reducing heat losses, are one of the main ways of improving energy efficiency in ECA buildings.

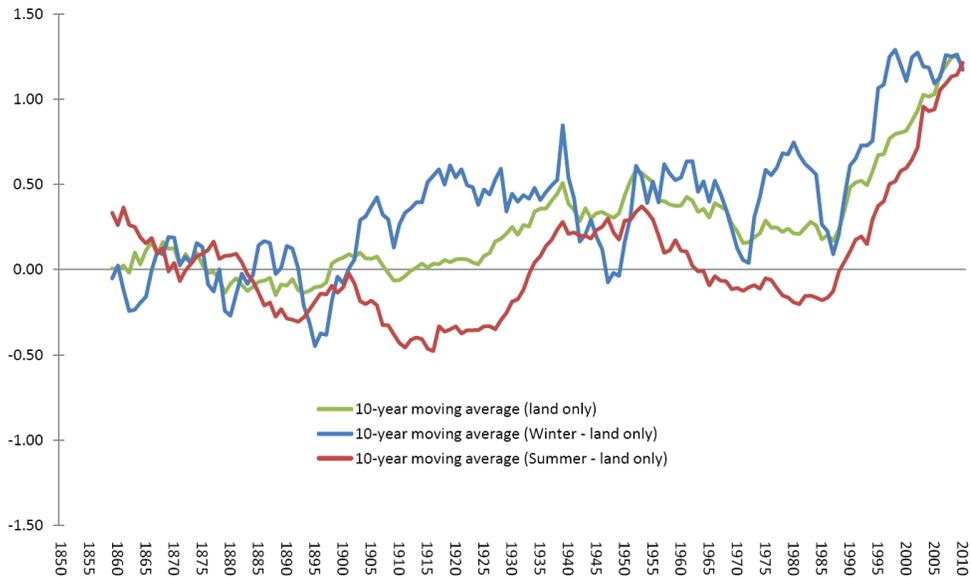
Energy Consumption (Electricity and Heating) per Dwelling (GJ) in 2008, and % Annual Change of Energy Consumption between 1990 and 2008



Source: Odyssee: Energy Efficiency Indicators in Europe

At this juncture, we are still left with the conundrum of why heat consumption went down. The decrease in household size again offers an explanation – a one-person household takes fewer showers than a four-person household. To that, we can add climate change. Starting in the 1990s, Europe has witnessed a general warming of the climate (see figure below). Winters have become milder and summers have become hotter. There is thus less need for heating in an average year. In effect, climate change is fought with climate change.

Temperature Changes in Europe: Temperature Deviation, Compared to 1850-1899 average (°C)



Source: European Environment Agency

A third factor that has contributed to the decrease in energy use is the surge in energy prices. Although subsidies persist in ECA countries, energy prices have increased consistently over the last decade (see Annex 5). Moreover, the price of gas (Euro per GJ) has generally grown faster than the price of electricity. In several ECA countries, Gas prices have grown at more than 10% per year.

A fourth factor can be attributed to the partial or complete dismantling of district heating systems. While such systems benefit from economies of scale and can help keep energy requirements down, in ECA cities they have gotten to be very inefficient. After the fall of Communism, most of these systems lost the subsidies needed for regular upkeep and improvement work, and losses in the piping were substantial. Since billing was not done based on individual use, but based on the floor area of an apartment and based on the total amount of water that got delivered to the system, people have started to de-branch themselves from the network and installed individual heating units. In some countries, like Georgia and Armenia, district heating systems have crumbled entirely once central subsidies were lost. Tbilisi, for example, has completely dismantled its district heating system, and now people rely either on electric (7.6%) or natural gas (92.4%) heaters.

Outside the district heating network, people paid for heat individually, without also covering the losses in the system and without subsidizing the high consumers. This basically meant that they also used heat more judiciously. When energy is priced at, or above market value, and when people only have to pay for what they consume, energy is likely to be used more efficiently.

While some ECA countries have taken measures to address issues in the heating sector (e.g. billing at market prices, charging individual consumption, upgrading systems to minimize losses, or privatizing the systems), some continue to run inefficient and heavily subsidized district heating systems. In Russia, for example, heating costs are borne by municipal governments not by end consumers. There is thus no incentive for households to use heat sparingly. There have been talks of shifting costs over to the end-consumers, but it is estimated that as much as 60% of the population would not be able to afford market value for their utilities – especially if they also have to cover losses in the system (Hill and Gaddy, 2009). Moreover, even if a pay-by-use system would be put in place, there is no way of enforcing service contracts. If a household does not pay heating bills, they cannot be punitively disconnected from the system on an individual basis – the whole building would have to be disconnected.

District heating systems encourage energy efficiency, but they have to be developed with the individual consumer in mind. Otherwise, they run the risk of facing issues like the ones described above. Existent district systems should be upgraded to a pay-by-use system (instead of a pay-by-floor-area system), and utility operators should invest in remediating heat losses caused by leaky and poorly insulated piping.

The Sustainable Future: Insulating, Leading by Example, Promoting EE

As the previous chapters have shown, ECA countries have made a tremendous progress in terms of addressing climate change. Many of the improvements are passive in nature, relating to demographic and economic changes. Some of the improvements can be attributed to external factors, such as increases in overall temperatures and policy changes imposed by the EU to New Member and Candidate Countries. Most ECA countries however, have also taken pro-active measures to address climate change. Many of these pro-active measures were taken in the Buildings Sector.

In fact, in its 'New Plan for Energy Efficiency' the EU indicates that the biggest gains in addressing climate change have been obtained through changes in the buildings and appliances markets (e.g. through stricter energy efficiency standards in construction). Moreover, the buildings sector is expected to deliver the biggest energy savings in the future. Through available technologies, energy savings of up to 80% could be achieved.

Potential Energy Savings from Buildings in ECA, with 2008 as a Base Year

Country	Energy Consumption in Buildings (TJ)*	Total CO ₂ Emissions (kt)	Potential Energy Savings (TJ)**	CO ₂ Emissions Abatement Potential (kt)		Percent of Total CO ₂ Emissions	
				High (Energy from Brown Coal)	Low (Energy from Gas)	High (Brown Coal)	Low (Gas)
				Albania	10,081	4,239	5,040
Armenia	8,161	5,053	4,080	412	229	8.16%	4.53%
Azerbaijan	43,938	31,749	21,969	2,219	1,232	6.99%	3.88%
Belarus	170,095	66,747	85,047	8,590	4,771	12.87%	7.15%
BiH	20,012	29,001	10,006	1,011	561	3.48%	1.94%
Bulgaria	80,996	51,739	40,498	4,090	2,272	7.91%	4.39%
Croatia	50,089	24,820	25,045	2,530	1,405	10.19%	5.66%
Czech Republic	161,830	124,862	80,915	8,172	4,539	6.55%	3.64%
Estonia	34,793	20,456	17,396	1,757	976	8.59%	4.77%
Georgia	18,392	6,027	9,196	929	516	15.41%	8.56%
Hungary	113,434	56,426	56,717	5,728	3,182	10.15%	5.64%
Kazakhstan	110,855	227,208	55,428	5,598	3,109	2.46%	1.37%
Kyrgyzstan	8,258	6,075	4,129	417	232	6.87%	3.81%
Latvia	38,589	7,819	19,294	1,949	1,082	24.92%	13.84%
Lithuania	50,190	15,268	25,095	2,535	1,408	16.60%	9.22%
Macedonia	18,201	11,267	9,100	919	511	8.16%	4.53%
Moldova	15,228	4,701	7,614	769	427	16.36%	9.09%
Poland	446,666	317,119	223,333	22,557	12,529	7.11%	3.95%
Romania	120,936	94,106	60,468	6,107	3,392	6.49%	3.60%
Russia	3,898,061	1,536,099	1,949,030	196,852	109,341	12.82%	7.12%
Slovakia	67,552	36,955	33,776	3,411	1,895	9.23%	5.13%
Slovenia	27,529	15,096	13,765	1,390	772	9.21%	5.12%
Tajikistan	12,276	7,222	6,138	620	344	8.58%	4.77%
Turkey	289,195	288,445	144,598	14,604	8,112	5.06%	2.81%
Turkmenistan	6,613	45,771	3,307	334	186	0.73%	0.41%
Ukraine	378,200	317,277	189,100	19,099	10,609	6.02%	3.34%
Uzbekistan	37,969	115,995	18,985	1,917	1,065	1.65%	0.92%
TOTAL	6,238,139	3,467,540	3,119,070	315,026	174,980	10.10%	5.61%

*Refers to electricity and heat delivered during the operational phase of a building.

**Potential energy savings are estimated at 50%.

Source: IEA and World Bank

The table above gives an overview of potential energy savings from buildings in ECA, with 2008 as a base year. The first column outlines the amount of energy consumed in buildings (TJ) in 2008. It has to be noted however, that this figure only includes the heat and electricity delivered during the operational phase of a building, and excludes energy consumed for building materials, for transport of building materials, and for building demolition. The second column gives the

total CO₂ emissions in ECA, across all sectors (including the buildings sector). The third column assumes a moderate energy savings potential of 50%. The fourth and fifth columns outline CO₂ emissions abatement potential, assuming a high margin (i.e. energy coming from the most polluting energy source – brown coal) and a low one (i.e. energy coming from the least polluting non-renewable resource – gas). The last two columns show by how much total CO₂ emissions can be reduced by investing in energy efficiency measures in the buildings sector. Basically, most ECA countries can achieve the GHG emissions targets for 2008-2012 under the Kyoto Protocol, by promoting energy efficiency in buildings. By doing so, they can also stimulate economic growth and development.

There is an abundance of measures cities and countries can take to reduce GHG emissions from the buildings sector – some more complex than others, some more costly or less costly. One of the most comprehensive and clear action lists has recently been offered by UNECE in its 'Action Plan for Energy-Efficient Housing in the UNECE Region'. The Action Plan covers a range of issues, from the importance of energy efficiency (EE) legal frameworks, to EE construction standards, taxes on inefficiency, professionalized housing management, and publicly funded retrofitting programs.

The following sections will focus on three main ways of addressing climate change in ECA buildings. The focus will be on actions that could have a high impact at a relatively low cost.

Thermal Insulation of Residential Buildings

According to EU estimates, around 67% of energy use in dwellings goes to space heating. The rest goes to lighting and electrical appliances (15%), water heating (14%), and cooking (4%). Consequently, improving the thermal performance of ECA residential buildings is one of the main measures to be considered by public authorities throughout the region.

Many ECA countries have experimented with, and have implemented thermal insulation programs, and there are many success stories others can learn from. For example, Romania has started its own thermal insulation program in March 2009. The program offered state grants for energy performance improvements (50% of total costs), and expected cost-sharing and buy-in from local authorities (30% of costs) and from beneficiaries (20%).

Initially, the program was received with some reticence. Local authorities in Cluj-Napoca, a city of around 300,000, complained about the difficulty of generating interests among local residents. They held several presentations showing the benefits of thermal insulation (e.g. potential heating bill reductions of 40%-55%), and even reached out directly to household associations. However, local interest in the program failed to materialize. In fact, a EuroStat Urban Perception Survey completed in the year the thermal insulation program was started, 2009, showed that only 11.7% of residents in Cluj-Napoca considered 'Housing Conditions' to be important to them. Other issues, such as jobs, transport, and health, ranked much higher.

In addition to a lack of interest in housing conditions, people were reluctant to pay for building improvements whose effects were uncertain. Nobody wanted to be the guinea pig for a new program. Consequently, the start was slow and the future uncertain.

Regardless of the difficult start, local authorities pushed through and eventually got a number of household associations interested in improving the thermal performance of their buildings. As in the private sector, new initiatives of the public sector need early adopters – and after that, they

need imitators. With some difficulty, the thermal insulation program found its first early adopters in Cluj-Napoca, and soon it also found its imitators. .

Once the first projects got finished, people started to notice and people started to talk. The lower heating bill is not the only element that caught people's attention. The fact that the aspect of the building changed (the aesthetic element) was also very important. An econometric analysis performed by Richard Florida (2009) showed that perceived beauty and aesthetic character play a very high role in community satisfaction. People want to live in beautiful neighborhoods, and people respond when their neighbors improve their lot.

Thermal Insulation Work – Before, During, and After



Source: Ministry of Regional Development and Tourism, Romania

As more and more projects got finished, more and more demand was generated. Thus, if in 2009, local authorities had difficulties finding willing beneficiaries, by 2010 they couldn't honor all requests, and waiting lists grew bigger by the day. It became clear that the program touched a nerve with people – their interest in lowering heating bills, and their interest in living in a building that was as beautiful as their neighbors'.

The interest built up so quickly that many household associations gave up waiting for public funding and started such projects on their own – with full private funding. More and more housing associations bypassed the public funding route, and soon, the number of projects that were started with full private initiative far outstripped publicly funded ones.

By the summer of 2011, a little over two years after the start of the program, out of the total 83,779 apartments in the city, 20,047 were thermally rehabilitated. Out of these, 4,848 were rehabilitated with public assistance, and the rest of around 15,200 were rehabilitated with full private funding. Thus, for every apartment rehabilitated with public assistance, three were rehabilitated without it. Since the average cost of thermal insulation works was around \$4,000 per apartment, this public initiative generated around \$60 million in private local investments over the course of two years. Moreover, the program has benefited over 12 local construction companies that have been severely affected by the crisis.

This is an excellent example of a public initiative with a strong local impact and a quick response from the private sector. In less than a year, the residents of Cluj-Napoca turned from not caring about housing conditions, to considering it a very important issue – all by the power of example and the leadership of the public sector. In just over two years, a quarter of the apartment stock in the city was rehabilitated – after 20 years of complete lack of initiative in the sector.

Witnessing the success of the program and the quick buy-in of the private sector, the Romanian Government started to reduce the quantum of public funding offered for such projects. In 2011 it decided to eliminate public grants altogether, and replaced those with state guarantees on loans

taken for thermal insulation works. Thus, it is hoped that private initiative will carry the program forward, with the government offering support to household associations that can't cover costs upfront. Beneficiaries need 10% of total costs as a down payment, and the rest of 90% are covered through a bank loan. The Government guarantees the loan (beneficiaries don't have to prove that they are able to pay it back) and it covers the interest rate and all commissions. The loan is paid back by beneficiaries from the saving that is obtained over the heating bill before the thermal insulation work was completed. Thus, if the heating bill in December 2010 was \$100, and the heating bill in December 2011, after building improvements, is \$50, the beneficiaries will continue to pay \$100 - \$50 of which will go towards the heating bill and \$50 towards the bank loan.

Furthermore, if the state grants program was primarily targeted to large apartment flats built between 1950 and 1990, the new program also includes buildings developed after 1990, as well as individual homes.

Obviously, the fact that the program was successful in Romania does not necessarily mean that it will be successful elsewhere. The legal framework, particularly concerning household associations, can vary greatly from country to country; people's incomes might be a barrier for the success of the program in countries with a lower GDP/Capita; and, energy efficiency might not be a priority for some countries. Furthermore, the experience of IFIs with loan guarantees for thermal insulation work in ECA shows that such programs are often hard to get off the ground. However, the fact that thermal insulation projects were successfully implemented in Romania, and in other ECA countries, indicates that these are possible throughout ECA. It is also important to note from the Romania example the power and importance of pilot projects. Getting a few demonstrative projects finished, even with significant public commitments, can not only spur interest in the projects but also lead to an immediate and significant response from the private sector.

Leading by Example in Public Buildings

As mentioned earlier, the energy consumed in public buildings, and the generated GHG emissions, are relatively low. Thus energy efficiency investments in this sector are likely to only have small mitigation effects. They can have however significant demonstration effects. For one, it is easier to convince citizens to use energy sparingly, when their elected officials live by what they preach. In addition, there are many people, firms, and organizations that acknowledge the benefits of energy efficiency projects, but they don't always know how to go about promoting such projects. For example, some companies might be interested in figuring out how to cut electricity bills by using office appliances more judiciously. Local authorities can pilot new ideas and then have private individuals and firms adopt those ideas – the way it happened with the thermal insulation projects in Cluj-Napoca (Romania).

Most often, energy efficiency investments make sense not only from an environmental point of view, but also from an economic point of view. There are for example many initiatives that are considered to be 'low-hanging-fruit', offering immediate pay-off. Replacing inefficient light-bulbs with LED bulbs in public buildings is one such initiative. For example, in Turkey, all public bodies have been mandated by the Government in 2008 to replace incandescent bulbs with more energy efficient ones. In total, 1.8 million bulbs have been replaced, for a cost of \$7.6 million. The shift to LED bulbs has reduced electricity costs for these public authorities by \$27 million, and the initial investment was amortized within 101 days.

In Macedonia, local authorities have taken charge in improving the energy performance of their public buildings. Thus, the Municipality of Karpos (part of the City of Skopje), has set out to

upgrade 20 educational facilities (primary schools and kindergartens) found within its boundaries. They plan to take a multi-layered approach, aiming to address several issues at once. All of the buildings will be equipped with solar panels to generate some of the facilities' electricity needs. Windows and doors will be replaced to improve overall thermal performance of the buildings. And, given that 16 of the 20 buildings are within 500 meters of each other, local authorities are considering the development of an integrated geothermal heating system that will serve all of them.

Such measures can also be complemented with initiatives that aim to change behavior patterns among public employees and the general citizenry. For example, local authorities could place ambient orbs (e.g. a ball that glows red when a lot of energy is used and green when energy usage is low) outside every public building, so that energy usage there can be monitored by public employees and the public at large. This is a good way for public institutions to not only present themselves as harbingers of energy efficiency, but to also provide a good monitoring mechanism of their commitment to sustainable development.

Promoting Energy Efficiency at Home

Households and cities in ECA consume less electricity than counterparts in Western Europe. The map below, with Europe at night is telling in this respect. The fact that they consume less also means that they have the potential to consume more. In fact electricity consumption has grown in almost every ECA country. To reduce GHG emissions from electricity use, it will be important to make electricity less energy intensive, and to generate more from renewable sources of energy.

Europe at Night



People in ECA cities also want to have a night sky as bright as that in Western Europe, and they have every right to have it. It is important however that they take full advantage of all the new energy efficiency technologies that are available. Cities should install more street-lights, but they should be encouraged to use efficient LED bulbs. In turn, public authorities should encourage people to use more efficient bulbs at home, to purchase more energy efficient appliances, and to use those sparingly and wise. Electricity consumption can be moderated through strict national regulations (e.g. imposing clear energy performance for appliances), through higher tariffs, and through leadership and education programs.

An innovative way of convincing people to use electricity more sparingly was found by local authorities in Bangkok, Thailand. In cooperation with local media channels they reserved a time-slot at night to send a message about energy efficiency to the local population. The message was simple. They basically encouraged people to turn off all lights and appliances they didn't really need at the moment. An indicator on the TV showed how much energy was saved by the concerted effort of all the citizens that chose to participate in the exercise. Once the exercise was

over, the indicator showed that enough energy was saved to put two coal fired power plants out of commission.

What this example shows is that it isn't too hard to save energy at home, and the results can be impressive. Moreover, the right message, delivered in an effective manner can permanently alter people's behavior. For example, the concept of "designated driver" (that person in a group that stays sober on a night out to drive the group back home) did not exist in the US in the 1980s, although most people depended on cars to move around. It was however a norm in Scandinavian countries. A public health professor at Harvard picked up this concept and decided to introduce it to the US public. However, rather than embedding it in a public advertisement campaign, he worked with TV show producers to mold the concept in different sitcoms, and use it repeatedly. The idea of a designated driver was quickly adopted by people all over the US, and in a couple of years it became a social norm.

Similarly, energy efficiency can become a social norm. For example, sitcoms in ECA can portray people always shutting off the lights when leaving the house, choosing appliances, such as TVs, not only based on size, but also based on energy efficiency performance.

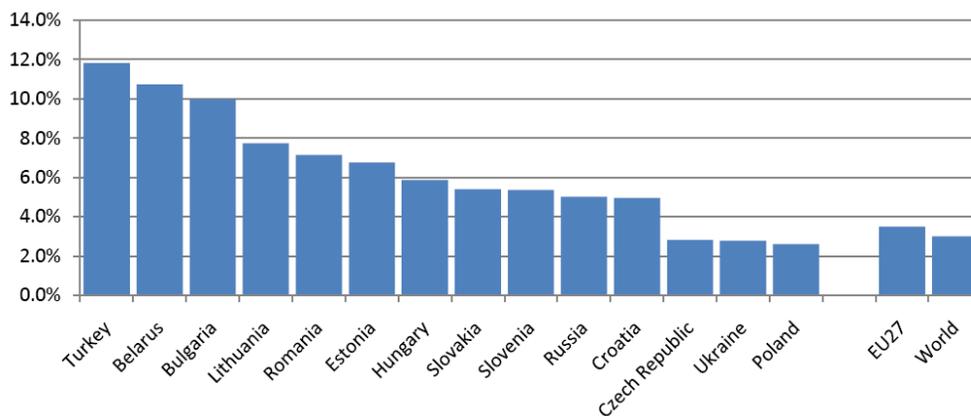
Of course, there are more straight forward ways of ensuring energy efficiency in homes, such as regulation, raising tariffs and eliminating subsidies. These policies can also have unexpected side-effects though. The dismantling of district heating systems, described earlier, is just one example in this respect.

Efficiency of Public Services

For the purposes of the following analysis four distinct sectors are considered: solid waste management, sewage, water, and street lighting. Other public services infrastructure, like transport, will not be addressed here, although it will be dealt with tangentially in the next section.

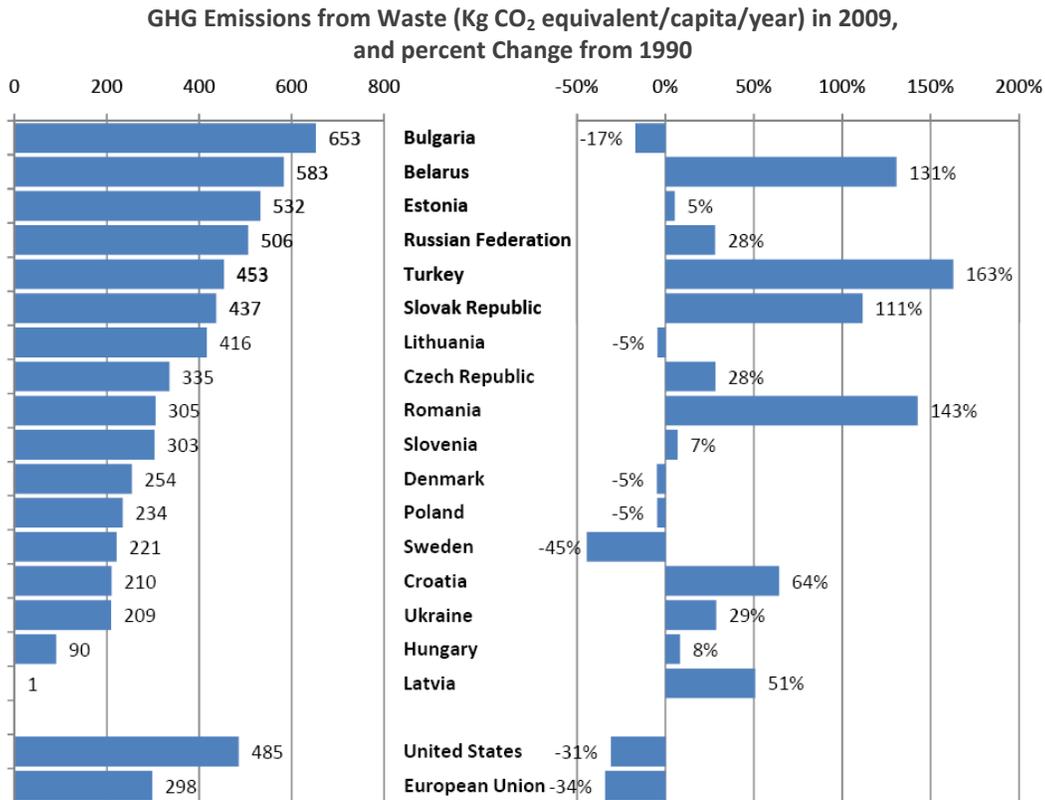
Globally, solid waste management (SWM) and sewage are responsible for around 3% of GHG emissions. Emissions mainly come in the form of gases (of which methane is the most potent) from the decomposition of organic waste, as well as from the incineration of waste. In addition, GHG gases are emitted from the transport and treatment of waste and sewage. GHG emissions from the water sector mainly come from the energy spent on pumping and treating water, while emissions from street lighting come from electricity generation. Generally, ECA countries have emissions intensive waste sectors, and tend to be above the World mean (see figure below). Shifting from a centrally planned to a market society, consumption went up in almost all ECA countries. This has led to a continuous and dramatic increase in waste generation. Consequently, GHG emissions from waste have grown in most ECA countries, and, if mitigation measures are not put in place, they are likely to grow in the future.

Share of GHG Emissions from Waste in Total Emissions, in 2009



Source: UNFCCC

Waste is following a similar trend as the transport sector, and both mimic the dramatic increase in consumption – the purchase of new cars, on the one hand, and general household consumption on the other hand (see Annex 6). Without investments in public services infrastructure, emissions from waste are likely to continue growing the way they have in the past 20 years of transition (see figure below). However, if the right investments are in place, this is the one sector where the most dramatic emissions decreases are possible.



Source: UNFCC

The Communist Past: Coverage Trumps Efficiency

When it came to providing public infrastructure, the focus in centrally planned societies was on quantity not quality. Public service providers were in a race to develop and offer more and more. They were in a race with themselves – trying to overcome last year’s quota, trying to accommodate an ever growing population. It was also a way of showing that the government was able to provide for people – better than consumerist societies could. What mattered in this context was what was most visible. It mattered that waste was collected, but it was less important how it was disposed off. It mattered that water was delivered, not how much of it got squandered in the process. It mattered that sewage was carried away, not how it was treated. It mattered that the main streets were lit, but energy efficient light bulbs were not a priority.

Public services infrastructure was mainly put up with social considerations in mind, and few people back then thought about the economic sustainability of newly developed systems. Utility prices and tariffs were derisory, and operations were heavily subsidized from the center. There was thus no incentive for people to conserve resources, and there were no incentives for utility

operators to invest in system upgrades and improvements (e.g. prevent water leaks). Since every ECA country has registered fast population growth in the years before 1989 (some grew at a very fast pace), public services infrastructure was continuously expanded, and few people paid attention to the state of the existent systems. The focus was on producing more, not on maintaining what was already there. Thus, utility systems were often run in a highly inefficient way. For example, water and wastewater systems leaked left and right, leading not only to a squandering of precious resources and pollution, but also driving up energy use and emissions.

Waste – Out of Sight, Out of Mind

Countries in ECA were not consumerist societies before 1989 – not even Turkey, which did not have a communist regime in place. As such, ECA countries produced less waste than their Western counterparts. The absence of markets and private initiative meant that there was a lower diversity of goods, and less packaging waste. Most products were produced by state owned enterprises, and “supermarkets” in those days were stocked with a very limited supply of merchandise. Small town stores often had nothing more than bread and a limited assortment of canned food. Consequently, people relied heavily on produce from surrounding villages, or on produce they themselves produced. Food packaging (such as milk bottles, pickle jars, and other glass containers) was recycled, and in many countries there was a burgeoning market for recyclables.

Waste Disposal in Selected Cities, in 1993



Source: UN Urban Global Indicators

In fact, most ECA countries managed to put recycling systems in place that many developed countries couldn't, and still can't. For example, many cities collected paper, glass, and metal. The success of these systems hinged on the cash-back people received for recyclables, and on civic education. Children at school were frequently taken on recycling drives and were encouraged to bring recyclables to school. Furthermore, the extra cash that could be generated from recyclables encouraged many families to separate waste before disposal. Most countries in the Soviet Block had urban legends circulating about people who managed to amass fortunes by collecting and selling recyclables. In fact, the success of recycling programs in developing countries today (e.g. Curitiba) hinges on teaching people that waste has value.

Despite the relatively smaller quantities of waste generated, and despite widespread recycling practices, the situation was not all rosy in solid waste management systems. For one, disposal technologies were basic at best and few central planners lost a thought about how to better manage the process. As the figure above indicates, waste was often disposed off in open dumps, and sometimes it was just openly burned.

Collection of waste was relatively good, but once it was out of people's sights, it was out of their minds too. Consequently, there were very few innovative investments in technologies devised to catch leachates and methane gas emissions. Furthermore, despite central planning, there were almost no efforts to organize solid waste management systems at the regional level, to profit from economies of scale. As a norm, every city and town had a landfill, or more often an open dump, close to their perimeter, where waste was simply discarded off – without any further treatment. As the table below indicates, even in the more affluent Soviet Union, a large part of the toxic waste was not properly treated, but simply discarded without an afterthought.

Generation and disposal of toxic waste by sector in the Soviet Union, in 1990

Sector	Volume Generated (1,000 metric tons)	Percent Recovered and Safely Disposed
Total	302,083	11.85%
Ferrous and non-ferrous metals	241,500	9.80%
Construction materials	11,100	4.50%
Fertilizer	7,200	9.50%
Chemicals and petrochemicals	5,900	32.30%
Energy	5,300	33.50%
Automobiles and farm equipment	3,800	17.20%
Lathes and instruments	1,600	7.30%
Electronics	400	3.80%
Pharmaceuticals	400	25.00%
Coal	300	30.00%
Heavy machinery	200	20.00%
Other	22,583	26.50%

Source: Peterson, 1993

Since the cost of disposing waste was insignificant (often there was no cost at all), there were few incentives to upgrade disposal facilities, and even fewer attempts to try to organize them in a more efficient way (e.g. regional landfills that could capture more waste and generate a higher volume of gate fees, which in turn would allow them to run at a profit). It also didn't help that central planners did not consider solid waste management facilities to be one of their first priorities.

To be fair however, it has to be noted that most countries in the West were not much better in their solid waste management (SWM) practices. For example, Germany, one of the most

innovative countries in SWM technologies, did not take a pro-active stance towards solid waste management until the mid-1960s - when the economic and consumption boom led to a “waste avalanche”. Up to that point, much of the waste was disposed in around 50,000 open garbage dumps. There were only 130 sanitary landfills, 16 composting plants, and 30 incinerators. Following the passing of the Waste Disposal Act in 1972, most of the 50,000 open dumps were closed, and national SWM was consolidated around a smaller number of large sanitary landfills and incinerators. BY 1984, 385 sanitary landfills were in operation, handling around 70% of the country’s municipal waste. (Bilitewski, 1997)

Sewage – There, but Not Quite There

Emissions from sewage rank relatively low in overall emissions, but this is one sector where emissions could be to a large part avoided. For example, wastewater treatment plants could be developed and designed to capture methane gas emissions, with gas emissions being put to good use (e.g. to generate heat, electricity, or to provide fuel for gas powered cars). In addition, wastewater treatment plants can be set-up in such a way, as to fully take advantage of gravity – and thus require minimal energy inputs.

If compared to Western cities, access to sanitation in ECA cities was relatively good in communist times. Access varied from country to country, but on the whole people in ECA were better serviced than people in countries of a similar development level. For example, in 1988, 85% of cities in the Soviet Union and 53% of towns were connected to some form of sewage system (Peterson, 1993). Around that time, cities like Milan and Brussels lacked such systems completely.

However, the fact that utility managers and employees were poorly incentivized translated into poorly constructed, badly maintained, and loosely monitored systems. Moreover, the drive to fulfill quotas (e.g. tons of effluent treated) acted as strong disincentives for running the system efficiently, for avoiding energy wastage, and for avoiding discharge of effluent in the ground and groundwater. As the table below highlights, only 25% of treated wastewater in the Soviet Union was treated in compliance with existent norms, and 24% remained untreated.

Performance of Wastewater Sector in the Former Soviet Union, in 1989

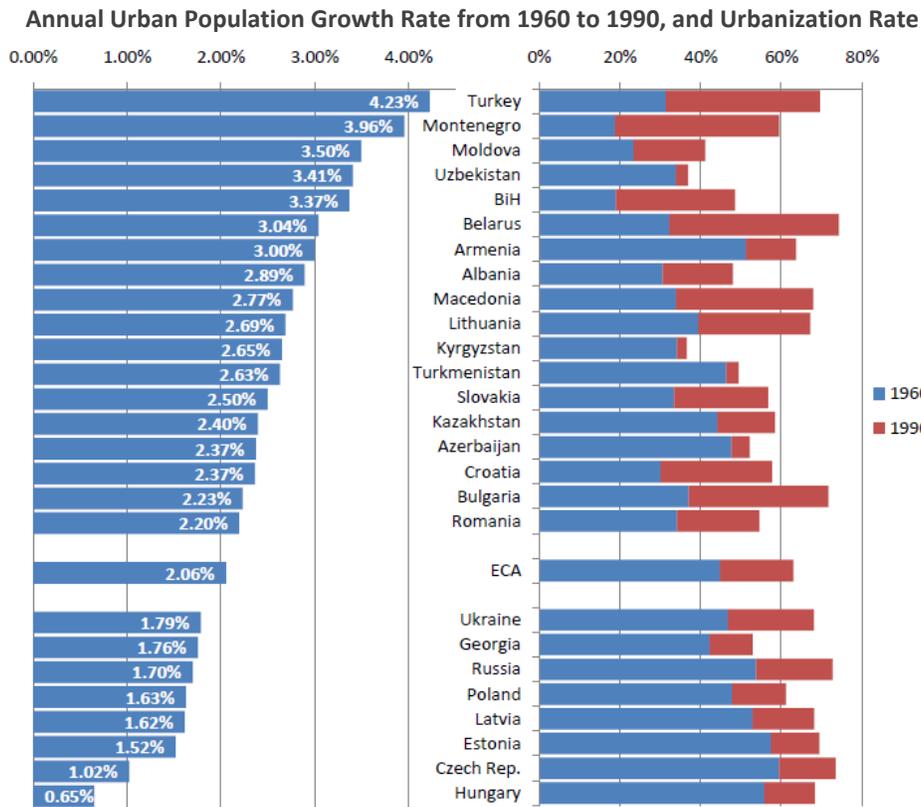
	Wastewater Requiring Treatment (millions of m ³)	Percent Treated in Compliance with Norm	Percent Treated but Not Complying with Norm	Percent Remaining Untreated
USSR average	43,564	25%	51%	24%
Armenia	557	55%	1%	44%
Azerbaijan	597	51%	12%	37%
Belarus	994	93%	7%	0%
Georgia	626	49%	9%	42%
Kazakhstan	591	43%	48%	9%
Kyrgyzstan	180	78%	17%	6%
Moldova	298	37%	48%	39%
Russia	30,633	11%	61%	28%
Tajikistan	286	62%	35%	3%
Turkmenistan	NA	NA	NA	NA
Ukraine	6,706	57%	36%	7%
Uzbekistan	762	65%	8%	27%

Source: Peterson, 1993

Within the Soviet Union, the degree to which wastewater was properly treated varied a lot. The highest achiever was Kyrgyzstan, which had to treat discharge properly, as two of the rivers that provided water for most of Central Asia had their origins within its boundaries. One of the worst performers was Russia, which due to its sheer size could not provide proper treatment across its entire territory.

Water – Systems Designed for Continuous Population Growth

Since public services were highly subsidized, there were few incentives for providers to make systems more efficient (e.g. using system designs that relied on gravity instead of pumps to deliver water). Since tariffs were in turn subsidized, there were few incentives for people to conserve resources. For example, toilets would frequently break down, allowing water to run continuously. Such toilets could easily waste over one liter per minute, or around 1,500 liters per day. This means that over the course of a year, such an inefficient toilet would waste a staggering 500,000 liters – the equivalent of 25 swimming pools, or a small lake. If this number is extrapolated to a couple of million households, it gives a frightening picture of resource wastage, and ineffective energy use. Pumping all the water that eventually went down the drain, also translated into wasted energy and more GHG emissions.



Source: WDI

Water systems were also affected by a series of misjudgments in terms of planning. As the graph above highlights, before 1990 virtually every ECA country has registered continuous and sustained population growth. Some countries have grown at over 3% yearly. This has led many

planners, and rightfully so, to assume that the trend will continue at some point in the future. Consequently, new systems were designed not for the actual population, but for the expected population growth in the service area. The fall of communism has brought however population stagnation and even decline in many of these cities. This meant that many places ended up with oversized water and wastewater systems, designed to accommodate growth that never happened.

Oversized systems have the unfortunate characteristic of having to be run in an inefficient manner. Water pumps are dimensioned to handle a higher water volume than is actually needed, pipes are dimensioned to handle a bigger water load. To avoid system damage, these oversized systems have to be run at full capacity. Without a constant water flow through them, pipes corrode much faster, and the incidence of leaks is much higher. Running these systems at full capacity translates of course into wasted energy and more emissions.

Street Lighting – Outages Keep Emissions Down

Street lighting is also a sector that generates relatively little emissions. It is however a sector where significant reductions can be achieved with highly cost-effective investments. Having the advantage of relatively dense cities, authorities in ECA were in a position to provide street lighting in quite an efficient manner. Lighting an apartment block with 100 households in it is much more efficient than lighting a street with 100 individual homes.

On the whole, major streets were generally well lit. They weren't necessarily equipped with energy efficient fixtures, but few cities in the world were at that time. However, like other public services infrastructure in centrally planned countries, street lighting was not exactly run in an efficient manner. Light bulbs that went out took a long time to be replaced, and power outages affected the system on a regular basis. In addition, many cities would not run the street lights pass a certain hour.

The fact that the street lighting system was often inefficient in ECA cities brought dividends to the environment (less energy was consumed, and less emissions were generated), but it came with a cost to the overall quality of life. Modern filmmakers attempting to recreate the feel of the era often complain that there is too much light in the streets for the film shoots. Consequently, they work with local authorities to dim the lights and give them a yellowish tint.

The Transition Present: Adapting to the Market and to Climate Change

All in all, centrally planned societies managed to provide more public services infrastructure than market societies of a similar development level. However, the subsidies that made these major constructions possible were also their Achilles Heel – without subsidies it was hard to maintain and upkeep completed works. When these countries made the shift to market societies, they soon realized they lacked the resources to keep them running efficiently.

The transition years have caught ECA countries at different levels of development, and with a public services infrastructure that was hard to run at a profit. The subsidies that were necessary to run these systems were often redirected to higher priority activities, in a context where budgets were flailing all around. Tariffs and prices that had to be raised to make the systems more efficient remained stagnant for fear of social unrest and political loss. Until economic growth was regained in these countries, investments in public services infrastructure were modest.

The first decade of the transition has witnessed a general deterioration of the public services infrastructure, with efficiency levels continually going down. Overall emissions in ECA countries went down across the board because widespread de-industrialization. However, emissions from waste, sewage, and water grew. Due to higher consumption rates, and to inefficiently run systems, the public services infrastructure in ECA was one of the few areas (along with transport) where ECA countries have registered emissions growth in the 1990s.

The second decade of the transition has seen of course an even more rapid increase in emissions. Some of the reasons for this occurrence will be discussed below. What should be mentioned though at this point is that waste, sewage, water, and public lighting, while not great emitters of green house gases, are some of the sectors where the largest emissions reductions are possible.

Waste – More Trash, Improperly Disposed

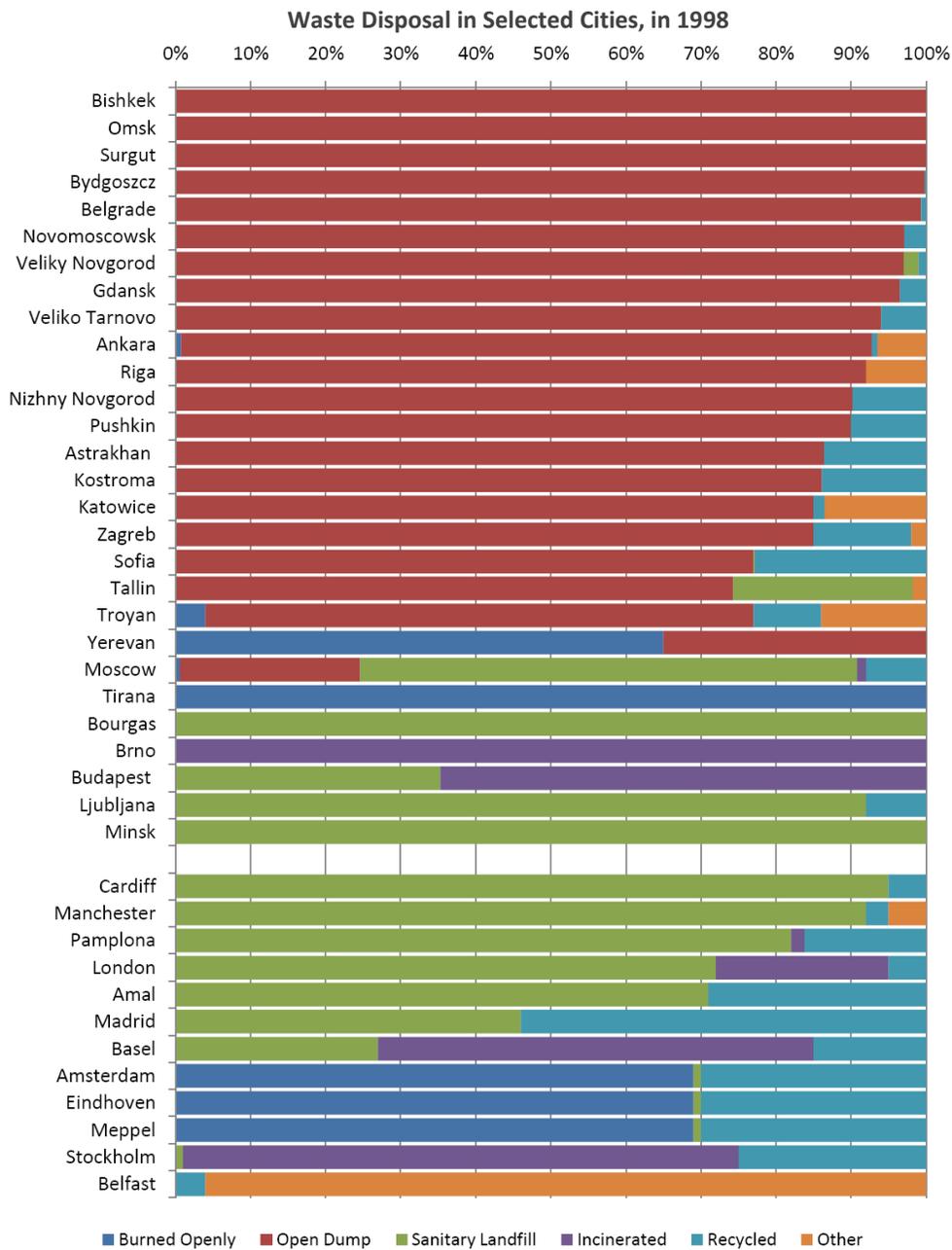
Two major trends affected GHG emissions from waste in the transition years. On the one hand consumption went up almost immediately, growing much faster than actual GDP growth (see Annex 6). On the other hand public spending went down, as budgets decreased in tandem with economic restructuring. Both of these trends had a negative effect on GHG emissions in ECA countries.

The fact that consumption went up faster than GDP growth is surprising, but to be expected. Even if their incomes did not necessarily permit it, people in ECA wanted to enjoy the panoply of goods that started to flow from Western countries. They wanted to drink Coca-Cola, eat chips, and enjoy Western movies... and they wanted to do it now. A higher consumption rate has naturally lead to more waste. More waste means more GHG emissions if improperly disposed.

Since public funds for investments in solid waste management infrastructure were scarce, much of waste was just disposed off in open dumps. Moreover, since the rate at which waste generation grew overwhelmed existent systems, there was a proliferation of wild dumps. Overnight, people went from recycling almost everything to throwing away almost everything. For example, before 1989, many households used empty jars to store home-made jams, sauces, and pickles. Food was rarely wasted and most households knew time tested ways of storing it for long periods of time. After 1989, people would just buy jams, sauces, and pickles from the supermarket, and would throw away what they didn't consume – receptacles included. Since recycling systems crumbled almost instantaneously (as soon as subsidies went away), little of the generated waste was recovered.

Collection rates inevitably went down, since necessary infrastructure was not in place. Moreover, more and more waste got improperly disposed of. Even in major cities that had a functioning SWM system in place, waste tended to either be burned or dumped (see figure below).

There is no uniform data tracking waste generation in ECA countries (apart from those that are now part of the EU), but it is known that most of the collected waste is landfilled – usually improperly landfilled (OECD, 2005). The system of landfills is moreover highly atomized, and it has been more recently complemented by wild dumps. Without adequate solid waste management plans in place, landfills (or rather open dumps) proliferated all over. Since the gate fees that were charged for disposing of waste were very small, or inexistent, and since environmental regulations were often lacking or were improperly enforced, there was no incentive to run SWM systems in an efficient manner. It made more sense for local authorities to just dump the trash in a place that was close to the city, but out of the sight of the people.



Source: UN Urban Global Indicators

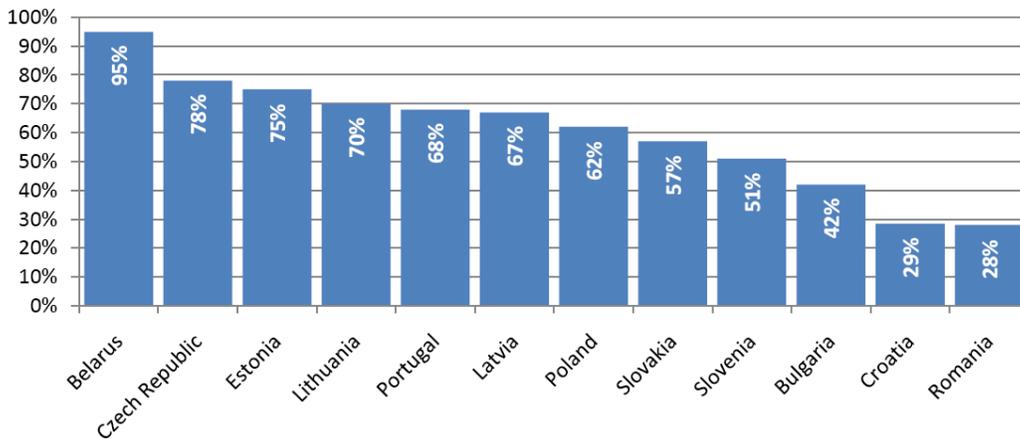
Consequently, most ECA countries had atomized SWM systems that were growing year on year, in tandem with the quantity of trash being generated. These systems were un-economical (the smaller the less profitable), but because they were un-economical they were also bad for the environment. If SWM systems would be organized at the regional level, to take advantage of economies of scale (e.g. higher revenues can be generated if a more waste can be admitted, which also helps drive gate fees down), they would also be more likely to generate profits that can be re-invested in system upgrades and improvements. All of the ECA countries that have joined the EU had to reorganize their SWM systems in accordance with sound environmental and

economic principles. Romania, for example, has to follow EU regulations and close 150 of its un-conforming landfills, and 1,500 illegal dumpsites by 2015 (World Bank, 2011). These have to be replaced with 1 to 3 regional landfills, for each of Romania’s 42 counties.

Sewage – Crumbling Systems

The GHG emissions generated by sewage represent a relatively small percentage of overall emissions. As in the case of waste however, most of these emissions can be captured and used productively. To capture emissions from sewage, ECA cities need to invest in proper wastewater treatment technologies. Such technologies however are rather expensive, and do not represent a priority for most ECA cities. Without the benefit of EU grants, or grants from IFIs, there have been almost no initiatives to invest in new wastewater treatment systems in the transition years. Moreover, although many ECA cities are served by wastewater treatment plants (see figure below), a large part of them suffer from disinvestment and are either obsolete or ineffective.

Percent of Urban Population Connected to Wastewater Treatment, in 2007 (or last available year)



Source: UN

For the most part, the existent wastewater treatment plants have not received any major upgrades and improvements in the transition years. This is particularly problematic for the particularly old systems (e.g. those built before 1980), as they often use the same technologies as when they were developed, and have received only minor patch work to keep them working. In many cases, this patch work is not enough. For example, the collector of the Tbilisi (Georgia) wastewater treatment plant crashed in 2009, leading to a situation in which 90% of the collected wastewater had to bypass the treatment plant (Covenant of Mayors, 2011). Similarly, a study done by the Kyrgyz Ministry of Health shows a direct correlation between the age of a wastewater system and the incidence of hepatitis cases in that area (ADB, 1998).

In countries like Tajikistan, Turkmenistan, and Uzbekistan, water and urban sanitation bring significant health challenges with them because of microbiological pollution. In ECA countries with a more developed industrial base, such as Russia, Ukraine, and Belarus, water pollution by industrial toxins and chemical substances are one of the main issues that have to be addressed by wastewater systems.

The ECA countries that have joined the EU, as well as the Accession States, have managed to access grants to invest in new wastewater systems. In most of the other ECA countries, there has been almost no effort to expand or improve existent systems. Moreover, many of the existent

systems do not even receive basic maintenance and upkeep. For example, among Former Soviet Union States, only Russia has a fully operational system. Larger cities like Moscow, St. Petersburg, Rostov, Ufa, Briansk have benefited from wastewater upgrades and improvements. In cities from other ECA countries, wastewater treatment has either been discontinued (e.g. Armenia and Georgia), reduced to mechanical treatment (e.g. Belarus, Kazakhstan, Ukraine), or was non-existent to begin with.

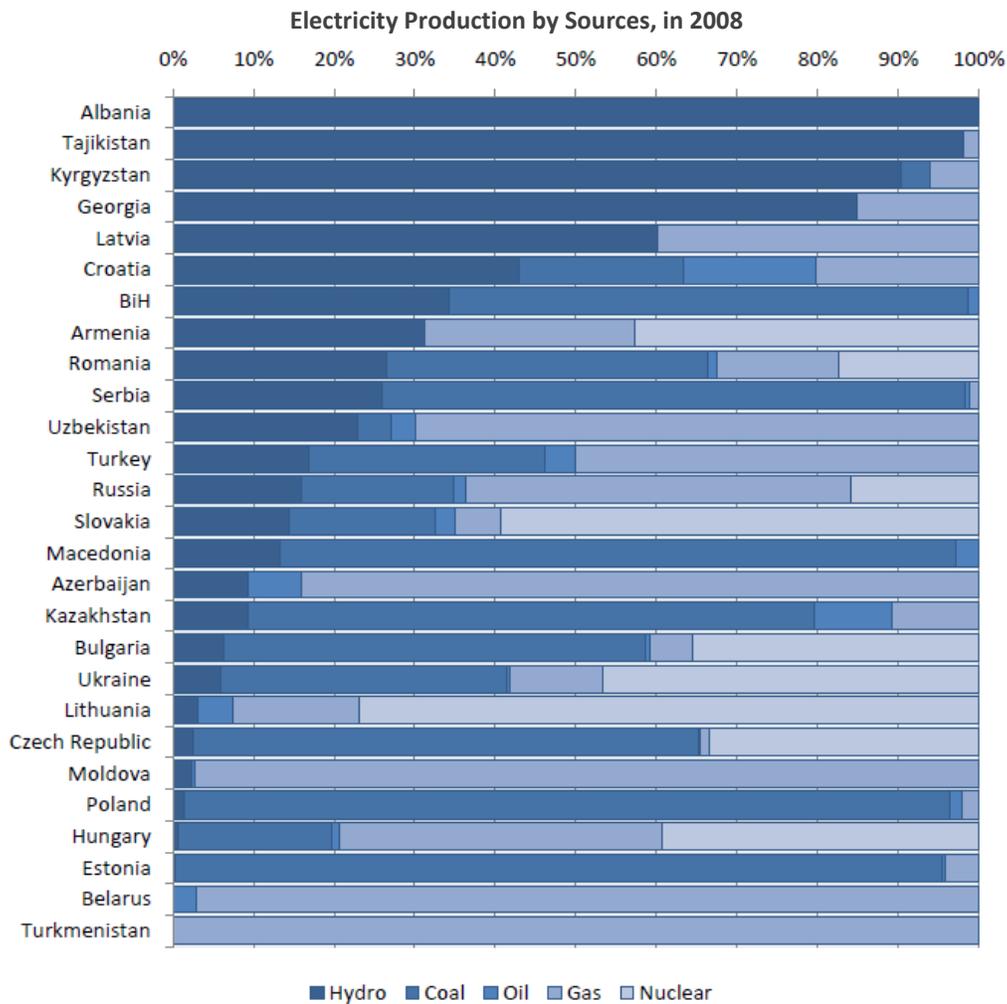
Since many of the wastewater systems in ECA were designed with a continuously growing population in mind, they tend to be over-sized. As a consequence, these utilities operate well below design capacities, leading to unnecessary energy use and emissions, and depreciation of assets. Population decline adds to the problems in many of these cities, with growing costs being hard to cover from a reduced revenue flow. Tariffs are in most cases kept artificially low, for social reasons, which limits the autonomy of the utilities and their ability to generate a profit for investment in system upgrades.

Water – Trying to Adapt to Different Urban Change Patterns

Emissions from the water sector mainly come from the energy required to run those systems. The easiest way to limit emissions from the water sector is to have systems that are run by gravity – i.e. the water is delivered from a water reservoir (natural or artificial) that is situated at a higher altitude than the treatment plant. In turn, the treatment plant should be situated at a higher altitude than end consumers. The alternative to gravity run systems are systems that are run by pumps, which either pump water at grade from a low-lying reservoir, or they pump water up from groundwater reserves.

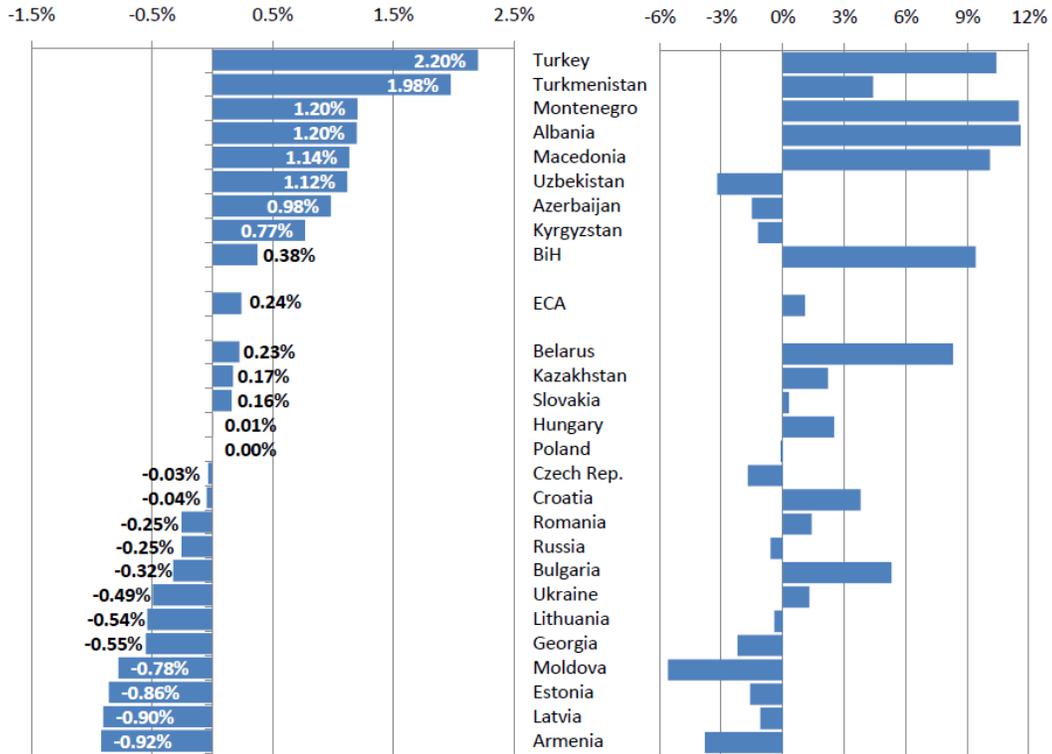
Often, gravity-run water systems operate in tandem with hydro power plants. Countries with mountainous areas and with fresh water resources, have well developed hydro generation capabilities (see figure below), and many use dams to not only generate electricity but to also provide drinking water to communities living nearby. In low-lying countries, and in countries with scarce fresh water resources (e.g. Central Asia), aqueduct systems had to be developed to deliver water from far away fresh water reservoirs. For example, Nukus (Uzbekistan), has to rely on water that is delivered from 100 km away, although the city of 260,000 is straddled along the Amu Darya River. The problem is that by the time the Amu gets to Nukus, it is so polluted (from agriculture, industry, and wastewater upstream), that it's not even fit for irrigation.

In terms of efficiency in the water sector, the story varies from city to city. Since water provision is so essential to the livelihood of every human settlement, investments in system upkeep and improvement happen more frequently than in the wastewater sector. Some water systems have been privatized, while others are run profitably by public authorities. For the most part however, the tariffs charged for water use are too small to ensure profitability. A large number of systems do not generate enough revenues to cover their operating costs, and public funding has been continuously decreasing. Consequently, in many cities, the percent of lost and non-revenue water is growing every year – which ultimately translates into squandered energy and unnecessary emissions. This is an issue that does not only affect former Communist countries, but also market driven societies like Turkey, and even developed countries like the US and the UK.



Water system efficiency is also affected by the changes in urban growth patterns in the transition years. While before 1990 virtually every ECA country had a growing urban population and water systems were designed with population growth in mind, after 1990 the situation got more complicated. As can be seen in the figure below, four major patterns of urban change emerged. On the one hand, there are the countries that not only had a growing population, but also an increasing urbanization rate (with rural to urban migration). These countries basically faced the same problems as before 1990. Having to continually expand the systems, while at the same time maintaining and upgrading existent infrastructure. More often than not, local authorities chose to spend limited investment budgets on expanding systems, to cover as many people as possible. Inevitably, the existent infrastructure got less attention and often went through a phase of degradation (e.g. leaks in the piping network and water losses). It thus became gradually less efficient.

Annual Urban Population Growth Rate and Change in Urbanization Rate, from 1990 to 2010



Source: WDI

A second urban change pattern in the transition years was a general growth of the urban population, but decreasing urbanization rates. What this means is that the population as a whole has grown, but it has grown much faster in rural areas. In addition, reverse migration to rural areas is possible. In these situations, system planning has to be done for growth, but in a cautionary way. It is quite possible that urban growth, especially in smaller cities, will reach a plateau, and it is important to not be caught at that inflexion point with an oversized infrastructure in place.

A third urban change pattern has seen an overall decrease of the urban population, but an increasing urbanization rate. This pattern signifies a general population decrease, with continuous rural to urban migration. What has most often happened in this case is a relative stabilization of the urban population, with water systems requiring more modest extensions. Larger cities, which have witnessed suburban and peri-urban growth, have had to expand their service areas, while smaller cities and towns have had to mainly maintain what they had. As will be shown later on, even cities with negative population growth have witnessed an extension of the urban mass, as people looked for better and cheaper living conditions outside cities. On the whole however, countries with such urban change patterns had to mainly maintain systems that were already in place. In situations where the systems were over-sized, being designed for a larger population, energy wastage occurred.

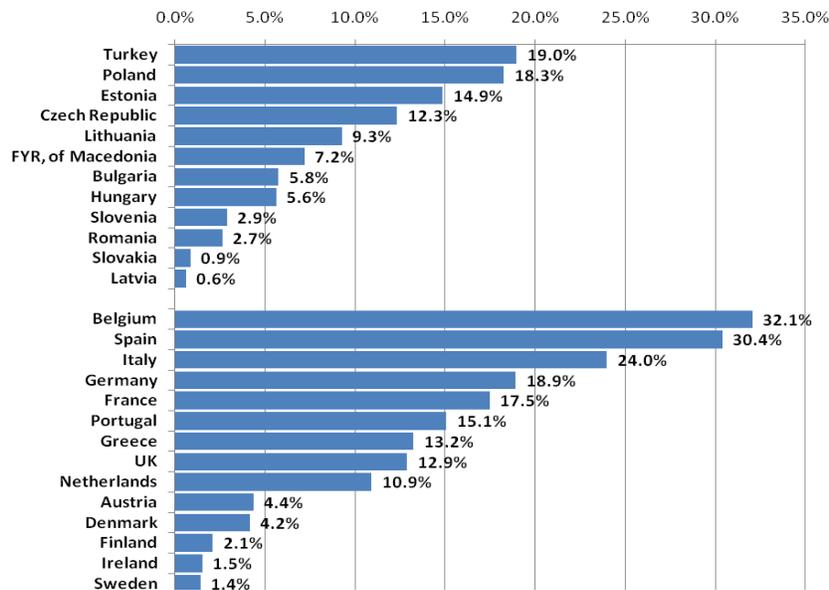
The fourth urban development pattern took the form of both urban decline, and a decrease of the urban share. This means that not only has the overall population decreased, but it was also followed by a reverse urban to rural migration. In such situations, urban water systems often had

to be scaled down. Especially in smaller cities and towns, as people have moved away, neighborhoods have emptied out. Often though, these neighborhoods have not been de-branched from the network – generating not only energy wastage, but also health hazards (because there’s no continuous water flow through parts of the system). A more frequent occurrence, has been the loss of population density within cities, which means that water has to be delivered at lower volumes. Thus, even if the water systems were not over-sized before, they become over-sized as cities lose more and more population. Scaling down these systems thus becomes imperative.

Regardless of the urban change pattern however, there is a significant backlog of needed investments in public services in almost every country. For example, the water utility company in Gaziantep (Turkey) is trying to continuously expand its system as the population is growing and as the city is expanding – while at the same time maintaining and up-keeping the existent system. As the city ballooned from 300,000 people in 1980 to 1,300,000 in 2010, it got harder and harder to fix the problems that appeared. At its worst, the Gaziantep water system had a rate of 71% of non-revenue water – much of which was lost through leaks in the system. Moreover, Gaziantep had a very energy intensive water system, having to use three pumping stations to haul water up from lower elevations. The energy intensity of the water system was three times as high as in Tokyo (Japan), and more than nine times as high than in Sydney (Australia). Much of this energy was used however to pump water that eventually got lost in the system. The wasted energy in turn generated unnecessary GHG emissions.

Squandered water does not only generate unnecessary GHG emissions, but it also leads to the depletion of a precious resource. As the figure below evidences, Turkey abstracts almost 20% of its available fresh water resources – a high rate for a country the size and the development level of Turkey. With climate change threatening fresh water resources the world over, it is that much more important to use existent resources efficiently – this is both a mitigation and adaption measure.

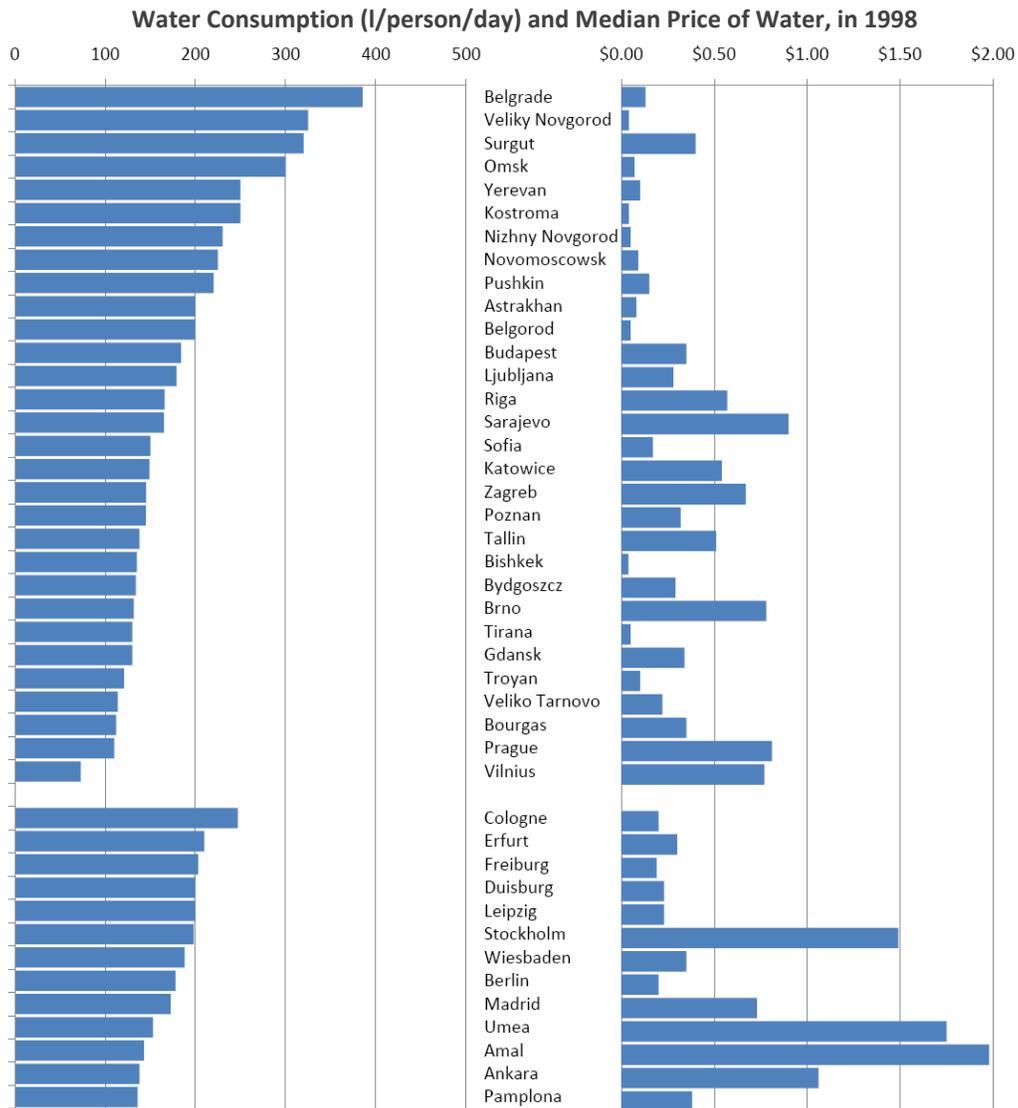
Abstraction of Fresh Water as Share of Total Renewable Water Resources, in 2007 (or latest available year)



Source: EuroStat

Other ECA countries also have a high abstraction rate, although not as high as in Western Europe. Most water is used by industry, and the de-industrialization process in ECA has helped reduce water use.

Nonetheless, water consumption per capita remains high in ECA countries, particularly in situations where tariffs are low. As the figure below shows, ECA cities with lower tariffs also tend to have a higher consumption rate than cities with higher tariffs. Subsidized tariffs are usually kept in place for social and political reasons, but, as the World Development Report 2009 stresses, they are a panacea for efficiency in public services. They hinder a clear accountability line between providers and beneficiaries, they offer little incentive for consumers to conserve resources, and they offer utility companies little incentives to invest in system improvements.



Source: UN Urban Global Indicators

Public Lighting – Changing the Bulbs, Extending the System

Things in the public lighting sector are easier and more clear-cut than in the other public services infrastructure sectors. Reducing emissions from street lights takes little more than replacing energy inefficient bulbs. Of course, as the street light system is extended, to cover more areas, energy consumption and emissions will go up. This is in fact what happened in almost ECA country. Given that investments in energy efficient street lights are amortized relatively fast, there are many examples of ECA cities that have taken on such projects. For example, in 2009, the City of Cluj (Romania) has modernized public lighting on 334 streets, replacing 5,340 inefficient light bulbs. In addition, they have extended the system to poorly lit areas (particularly the spaces between apartment blocks), and to new neighborhoods.

The Sustainable Future: Investing, Reducing, Professionalizing

To reduce GHG emissions from waste, sewage, water, and street lighting, there are three main actions that can be taken: infrastructure investments; consumption reductions; and, efficient management. The level of development of a country plays a significant role in how these measures can be undertaken. However, there are some low-hanging fruit that basically every city can afford. For example, the modernization of the street lighting system is an easy thing to do, as the upfront costs are usually amortized rather quickly, and new bulbs have a much longer lifespan (they can usually last three times longer than regular mercury vapor bulbs).

For example, public lighting systems in Macedonia primarily rely on mercury vapor bulbs, ranging in output from 100 to 400 Watts (TFCEE). Replacing these inefficient bulbs with sodium lamps, could cut down energy spending and overall costs considerably. Sodium lamps have a lifetime period three times higher than that of mercury vapor bulbs, and they generate more than double in light output – 120 lm/W as opposed to only 50 lm/W. The table below indicates the energy savings and emissions abatement potential of replacing inefficient light bulbs in a number of cities in Macedonia.

Municipalities	Electricity Savings	Number of bulbs that could be replaced	Emission reductions (t CO₂/year)*
Kumanovo	1,684	9,000	612
Gostivar	1,349	7,200	490
Prilep	1,318	5,896	479
Bitola	1,189	5,180	432
Ohrid	1,146	4,600	417
Veles	1,060	4,943	385
Tetovo	1,004	3,100	365
Strumica	967	2,922	352
Kocani	774	2,817	281
Kicevo	714	2,050	260
Stip	548	2,232	199
Kavadarci	491	1,785	179
Gevgelija	441	1,480	160
Negotino	340	1,270	124

*Assuming all energy comes from coal

Source: TFCEE and Authors' calculations

Investment costs for carrying out the interventions proposed above would be around €6.5 million, generating annual savings of around €1.16, and emissions reductions of around 4,735 tons of CO₂ yearly. The payback period of the project would be 5 to 6 years.

In the SWM sector, the most important investments for emissions reductions are investments in proper disposal methods. For a large majority of countries in ECA this would translate into investments in sanitary landfills. A large percentage of waste in ECA is disposed of in open dumps. This means that basically much of the gases that result from the decomposition of organic materials get released in the atmosphere. Sanitary landfills cover waste with a layer of soil and have gas capture devices. The gas is either flared or used to generate heat and electricity.

The second important step should focus on closing old landfills (especially wild dump sites) and building larger and better ones – i.e. landfills that don't allow seepage in the soil, and which are equipped with methane capture devices. Wealthier cities can also think about waste-to-energy incinerator facilities. Scandinavian countries offer a number of good examples in this respect.

While the switch to sanitary landfills is necessary, the construction of these needs to be engineered and implemented carefully. Environmental safeguards should minimize seepage of contaminants into the ground and methane emissions into the air. One also has to take into consideration that even the most sophisticated multi-barrier landfill systems, cannot be guaranteed to fully prevent contamination. For example, after the closure of the Georgswerder sanitary landfill in Hamburg (Germany) in 1979, soil contamination was discovered as soon as 1983, close to a number of inhabited areas. Removing the discovered leachate from the soil required several hundred million dollars. (Bilitewski, 1997)

Sanitary landfills usually require significant investments, government buy-in, and capacity at the local level. Even when the first two factors are present, finishing needed SWM investments is not easy. As a recent World Bank report shows (2011), the EU has provided New Member States with very generous funding to basically revamp their entire SWM infrastructure. Despite the available grants (85% of total costs), and despite the penalties imposed by the Acquis Communautaire, countries like Bulgaria, Poland, and Romania face significant backlogs in completing necessary works. The main difficulties that are faced are the lack of capacity at the local level – to prepare projects, to design inter-municipal agreements, to solve siting problems, to carry on complex procurement procedures, and to monitor project implementation.

Similar issues are encountered in the sewage sector. Most ECA countries have at least some of their raw sewage go untreated. In Croatia and Romania, less than 30% of the population is connected to an urban wastewater treatment system. To reduce GHG emissions from sewage, there is a need for significant investments in the sector. Ideally, sewage treatment plants should be equipped with a gas capture and processing units. The gas thus collected can be used to either produce heat and electricity, or to power buses, taxis, and private cars. Usually, the costs to put such units in place are amortized fast by selling the generated energy. For example, the City of Gaziantep (Turkey), generates electricity from sludge, and uses that electricity to power its treatment plant. The costs for the gas to energy plant have been amortized in less than two years.

Infrastructure investments in the water sector should primarily look to limit the amount of water lost in the system, and limit the amount of energy needed to pump and treat water. The panoply of options is fairly diverse in this respect, ranging from pressure valves that automatically adjust

pressure in the pipes, to investments in hydroelectric turbines along the water delivery system, or investments in systems that are run by gravity.

In addition to investments in infrastructure, it is important to think about how consumption by end-users can be reduced. The most straight forward way to do this is to increase tariffs. A sound tariff structure does not only moderate consumption by end-user, but also allows service providers to generate adequate funds for system improvements. Progressive tariff structures, which reward low consumption and tax high consumption, are used widely throughout the world. Such measures have to be doubled by individual metering, and often include assistance (e.g. subsidized tariffs) for the poorer households.

Progressive tariffs are usually used for water consumption, and flat tariffs tend to be used for SWM and sewage. However, Ireland has successfully experimented with a pay-by-weight system, which has significantly decreased the amount of waste generated by households. Such a system works efficiently only in situations where waste generated by individual households can be easily weighed. In Ireland, most people live in individual homes, and waste is collected individually from every household. In ECA cities, most people live in apartment buildings and waste is disposed off in common containers.

If the tariff structure allows service providers to generate a profit, public authorities could consider entering a public-private partnership (PPP) arrangement. PPPs have proven to be effective in the rehabilitation and efficient management of public services systems across the world – particularly when public authorities faced significant constraints.

There are three main PPP arrangements that can be considered (The Institute for Urban Economy, 2010):

Model 1: Corporatization of utility enterprises with possible partial sales of shares while a control share remains with the municipality.

Model 2: Municipal ownership of fixed assets, private management and investment (concessions).

Model 3: Privatization through sale of all shares of a utility enterprise to a private investor, after corporatization.

Of these three models, the second one seems particularly suited to the ECA context, although the other two options can also be considered. For example, the City of Tallinn (Estonia) undertook a step-by-step privatization of its water company. At first, the utility company was turned into a joint stock company, after which a control share was sold to a private investor via competitive tendering. All in all, most countries have entered PPP arrangements in the public services sector, and the trend is generally ascendant.

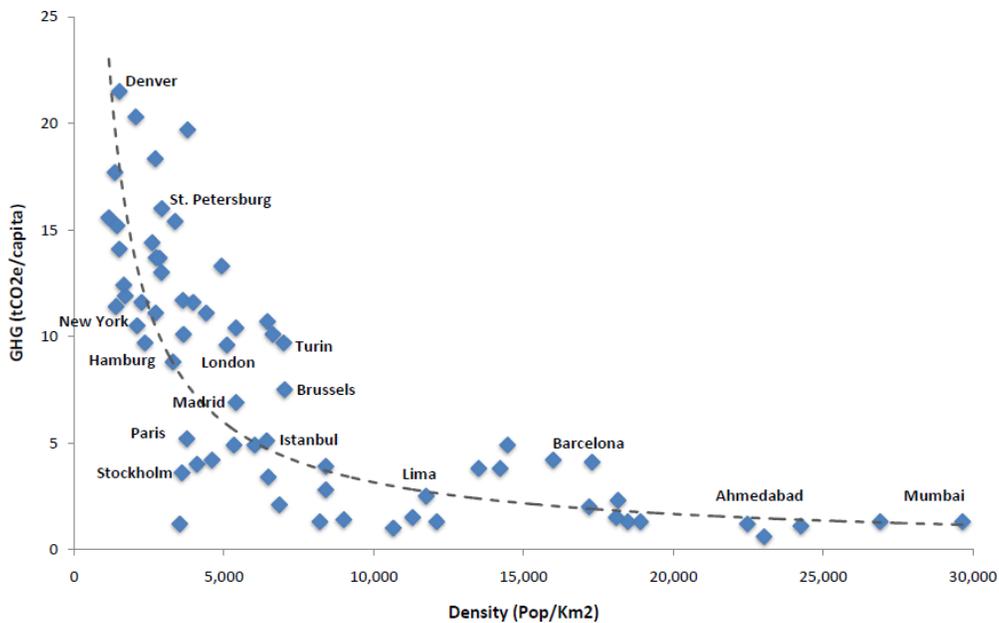
Share of Water Supply Serviced by Private Operators		
	2004	2008
Armenia	34%	53%
Kazakhstan	38%	41%
Russia	12%	27%
Georgia	0%	25%
Ukraine	2%	5%
Kyrgyzstan	0.4%	0.4%
Uzbekistan	2%	0.0%

It should be noted here that not all public services are rife for PPP arrangements. Some simply can't generate a profit and have to rely on subsidies and good management from the public sector.

Urban Form

Urban form has a bearing on energy efficiency in both buildings and public services infrastructure. The more compact a city is, the more efficient can energy be delivered to buildings, and the more efficient can public services infrastructure be operated. On the whole, dense cities tend to be lower GHG emitters than sprawling cities (see figure below).

The Impact of Density on GHG Emissions in Cities



Source: World Bank

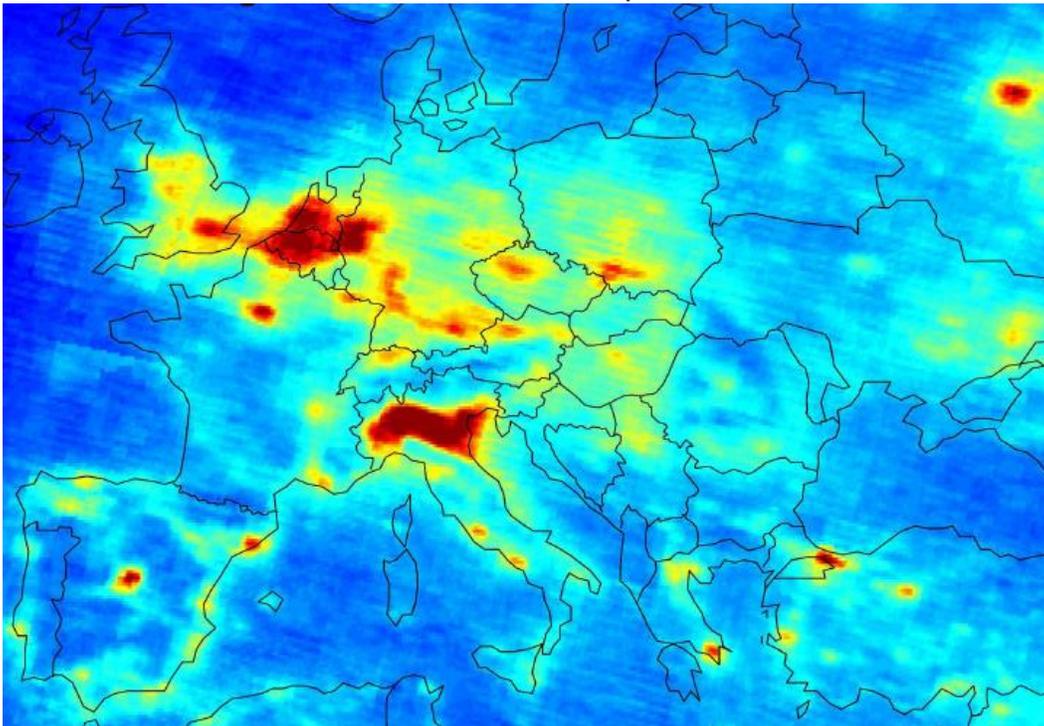
Of course, density plays a role only in the way energy is distributed and used in a city, and other factors can skew a city's emissions profile. For one, cities from poorer countries tend to be lower GHG emitters, because there is less industrial activity, and as such less pollution. These cities also

tend to be denser than cities from developed countries, because fewer people have access to private cars, and there is a premium to being located close to the urban center.

Within countries, some cities tend to be more industrialized than others, and as such they generate more pollution. For example, the City of Norilsk (Russia), with a population of around 175,000, produced more sulfur dioxide emissions (responsible for acid rain and smog) than all of Italy – or around 1% of global sulfur dioxide emissions. Similarly, some small municipalities may have big energy plants within their boundary, which generate more direct emissions than large metropolitan areas.

Cities should also be considered in context, as GHG emissions rarely are generated only from activity taken place within municipal boundaries. As the map below highlights, air pollution is large around big developed urban centers, like Moscow, Istanbul, Paris, London, and Madrid, but it is highest around large conurbations – like the ones found in Northern Italy, or in the Benelux States. Although some cities may have a relative compact urban mass, the fact that they are part of a conurbation will lead to higher emissions because of the activity that happens between cities.

Air Pollution in Europe



Source: http://www.esa.int/esaEO/SEM340NKPZD_index_1.html#subhead1

When talking about density, and about the effect density has on GHG emissions, one has to pay attention to the way density is measured. Most often, density is obtained by dividing a city's population by the surface area of the municipality. This is problematic as municipalities often have large tracts of open land within their boundaries, which skew their density profile. Similarly, some cities may have some really dense neighborhoods (like Manhattan in New York) and some neighborhoods that are less compact. Or, they could have large tracts of un-inhabited industrial land within their boundaries. St. Petersburg appears to have a relatively low density profile, but

that is the case because its historic and the centrally planned neighborhoods (both of which are quite dense), are separated by a wide industrial ring, where almost nobody lives.

A better measure of a city's density can be obtained by dividing the population of a city to the actual developed urban mass. In 1990, before suburbanization made its presence felt, the official density of Baku (Azerbaijan) was around 855 people per square kilometer. When the density was calculated using the actual urban mass instead of the entire municipal area, Baku came out to be one of the most dense cities in Europe – with over 18,000 people per square kilometer.

Even when density is calculated in such a rigorous manner, it is important to pay attention to other factors that have a say in how energy is distributed and consumed. For example, cities that are in mountainous areas with many slopes will be more energy intensive than cities developed on flat areas. Similarly, cities that have an elongated shape (e.g. developed along the ridge of a mountain), will generate more emissions, all other things being equal, than a city that has a more compact form.

The Communist Past: Compact Cities

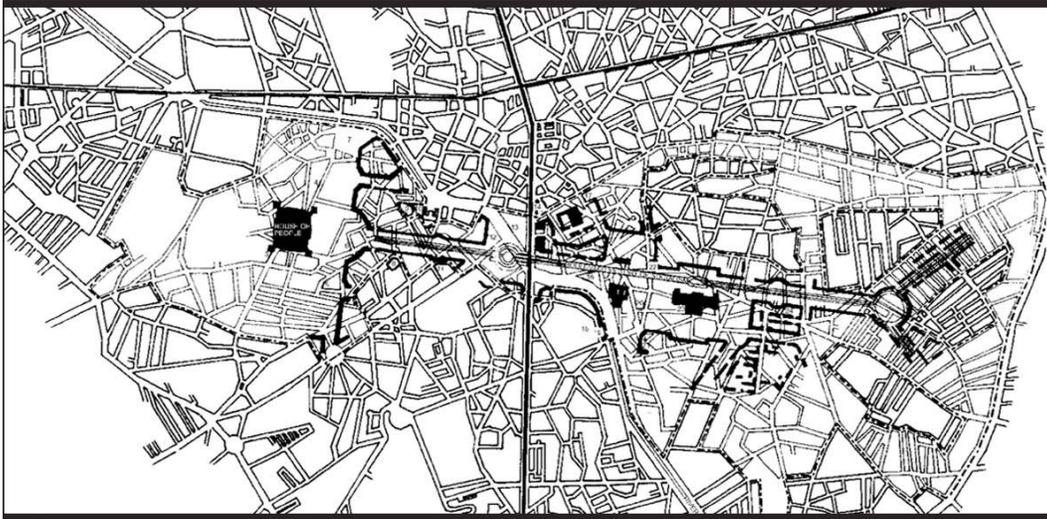
ECA cities are generally very compact and quite efficient from many points of view. They were developed around public transit hubs, were usually walkable, and disposed of a lot of parks and green areas. Since they were centrally planned and developed on centrally owned land, they extended outward in a continuous compact fashion. Often times, density was promoted at the expense of the existent urban fabric, replacing old buildings with newer and denser ones. A case in point is Bucharest, where a third of the old city center was demolished to make place for the Victory of Socialism Complex- a testament to Ceaușescu's megalomania, and a way of demonstrating the might of the communist regime (see images below).

Car ownership was low, but public transportation options were quite good, allowing people a good mobility within the city. The compact structure of cities also meant that other public services infrastructure (roads, water, sewage, solid waste management) required less investments, energy and maintenance than cities with lower densities. It also meant that they emitted less GHG emissions from moving people and resources around.

However, while ECA cities were quite efficient from some points of view, they were quite inefficient from other points of view. One of the main short-comings was the under-provision and mis-allocation of housing. Housing construction in most cities did not meet actual demand, and buildings did not always go up where people wanted them to. Trying to spread the population evenly across space, new buildings went up in secondary and tertiary urban centers, going hand in hand with forced migration. This phenomenon was particularly acute in the USSR, whose leaders went on to populate the vast Siberian expanse, but it was present to one degree or another in every ECA country – including Turkey.

Another shortcoming of the newly developed housing flats was the lack of diversity. The majority of new dwellings had fewer than 4 rooms (UNECE Database), and the construction of individual detached homes was rare in urban centers. Smaller dwellings and apartment flats allow higher energy efficiency than large individual detached homes, but they don't always meet the needs and demands of all people. As a consequence, after 1990 new construction in many ECA cities primarily consisted of individual homes with 4 rooms or more – usually built on the outskirts of cities.

Bucharest: The Victory of Socialism Complex – Plan and Implementation



Source: Cavalcanti, 1997

The Transition Present: From Compact Urban Mass to Sprawl

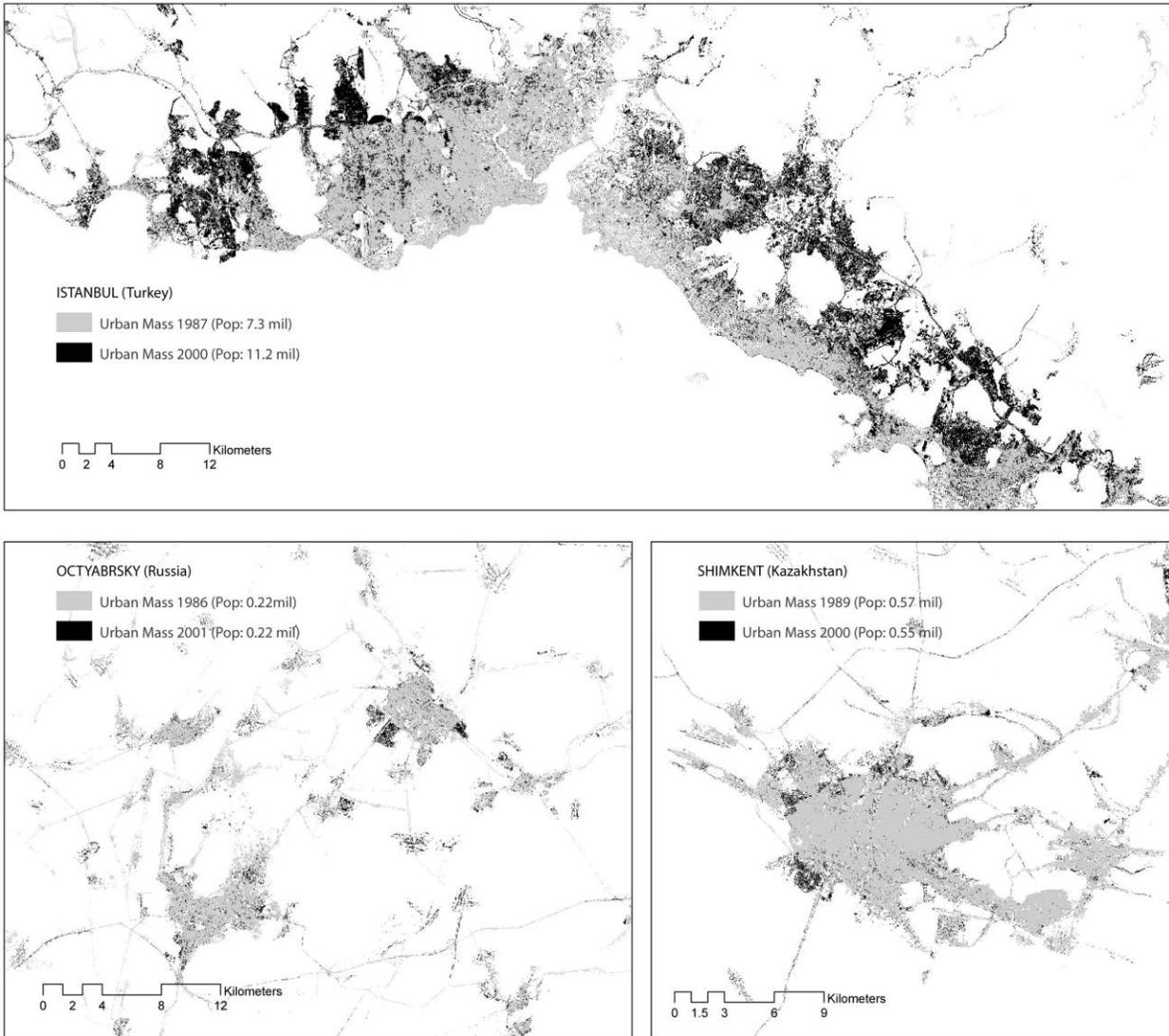
An interesting thing about city growth is that urban mass tends to grow faster than actual population growth. A World Bank study spearheaded by Solly Angel showed that irrespective of geographic location and level of development, as cities grow they become less dense. More interesting, and relevant for ECA cities, is that even stagnating and declining cities have an extending urban mass. As the figure below highlights, not only rapidly growing cities like Istanbul expanded their urban mass, but even stagnating ones, like Octyabrsky (Russia), and declining ones, like Shimkent (Kazakhstan).

There was city growth even if the first decade of the transition has witnessed little development, and a dramatic contraction of the construction industry (UNECE). Public funding for housing development projects was limited, private developers were not mature enough to take on large projects, and land markets were often dysfunctional (e.g. property rights issues were one of the biggest barrier to new developments).

Even so, the first signs of urban sprawl were felt across the ECA region. The boom years that followed 2000 saw a continuous increase in new buildings development. As the construction sector started to mature with more and more private initiative, it actually became an economic engine of the economy. As individual national statistical yearbooks show, the growth of the construction industry in the 2000s has consistently outpaced GDP growth in most ECA countries.

Many of the new developments went up on the outskirts of cities, promoting sprawl and reducing city density. Regardless of population growth or decline, virtually all ECA cities have become less dense.

Urban Mass Change in Selected Cities

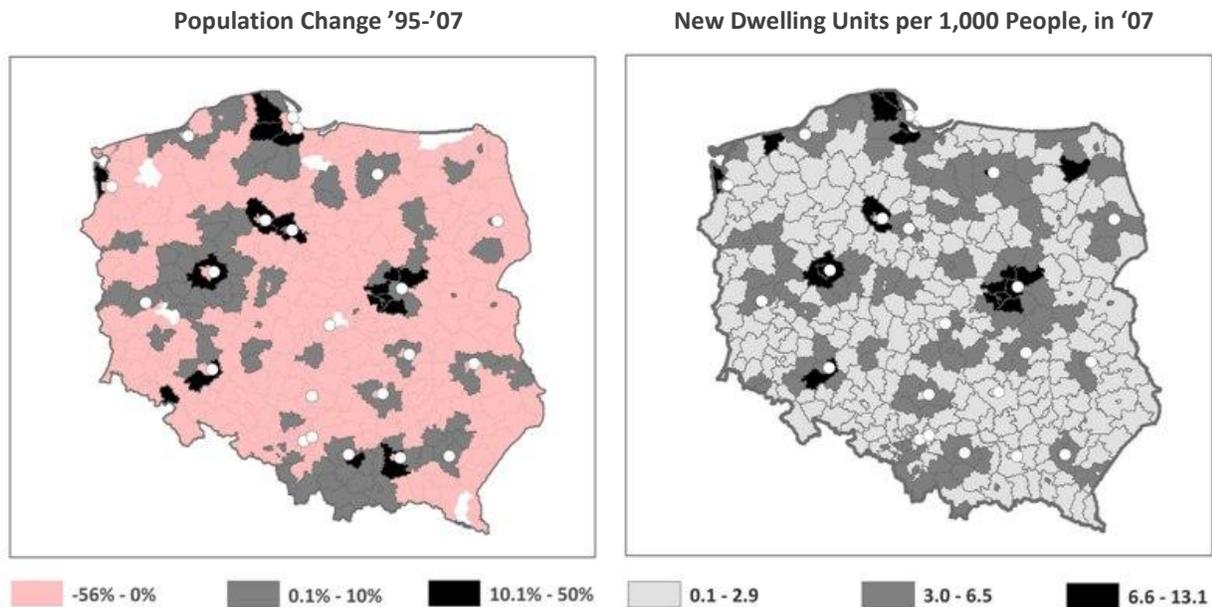


Declining densities have an important impact on energy efficiency in cities, as more energy has to be spent on transport, public services provision, and actual energy delivery. Even cities with a stagnating or declining population have witnessed a construction boom and an expansion of the urban mass. The figure in Annex 1 nicely shows that despite population decline in most ECA countries, new housing development continued unabated. Moreover, the rate of development of

new dwellings was much higher than in Western European countries, which actually had population growth. This occurrence can be explained by several factors: an existent housing dearth; people's appetite for larger dwellings (see Annex 2), and an atomization of households with a rapid increase in one-person households (see Annex 3).

As much as central planners tried to respond to housing demand before 1989, they didn't manage to house everybody and they didn't always offer housing where people wanted it. As a consequence, new housing development grew quickly in ECA, particularly in the 2000s, and it often tended to concentrate in and around a couple of growth centers. Often, this new growth was absorbed by suburban areas.

Poland highlights this trend quite nicely. As the figures below shows, not only was population growth in the country concentrated in the suburban areas of a few cities, but most other places have lost population. This has happened despite the fact that Poland is one of the few ECA countries that has had positive overall population growth in the transition years.



Data Source: Central Statistical Office of Poland

Two of the cities with rampant suburban growth are Warsaw and Poznan. As the maps below indicate, both urban areas seem to be exploding outward, as people start to look for their acre of green outside the city. Such uncontrolled or quasi-controlled patterns of urban growth have significant repercussions on the energy profile of a city. To service all of these suburban areas, water and sewage lines have to be extended, garbage trucks have to cover larger areas, and public lights have to go up on new, more sparsely populated streets. As public infrastructure networks are extended, they start to gradually lose in efficiency. More energy has to be spent on transporting water, sewage, garbage, heat, and electricity to areas with fewer and fewer people. The more spread out a city becomes, the less efficient will the public services infrastructure become.

Urban Mass in Warsaw (left) and Poznan (right)

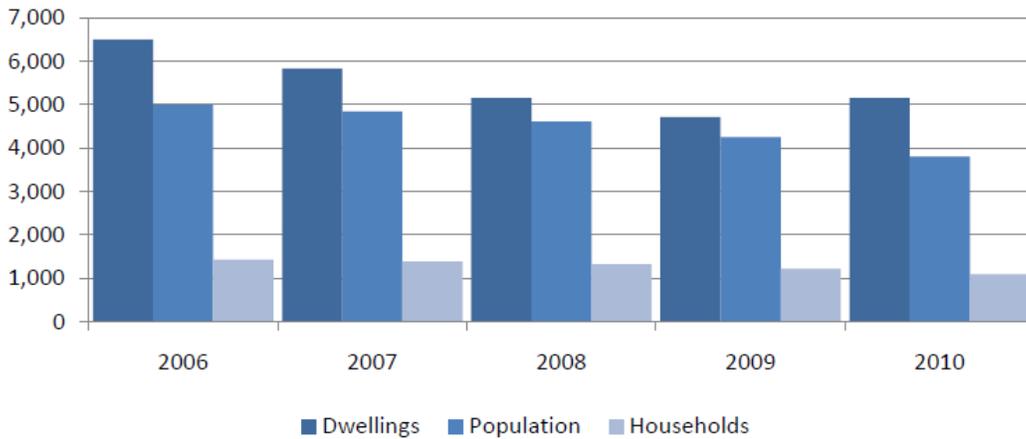


Similarly, the more a city spreads out, the harder does public transportation provision become, and the more do people rely on private cars for commuting purposes. The more people rely on cars, the more GHG emissions from transport are generated, and the harder it becomes to run existent public transit networks efficiently. All public transport networks rely on density to boost efficiency. The denser an area around a public transit hub, the more ridership can buses, trams, and subways rely on. The higher the ridership, the higher the revenues. Consequently, when densities start to fall, so do ridership numbers, and so do the revenues of public transit networks. With lower revenues, it is harder to maintain and upkeep these networks, which leads to a continued decrease in ridership numbers and to a higher reliance on private cars for commuting. As people get used to using private cars for commuting, proximity to city centers becomes less of a priority for them. Consequently, more and more people decide to move outside the city (where they can find cheaper and bigger housing), causing a further loss of density in center cities. Thus, a vicious cycle is created, with sprawl causing the deterioration of public transport networks, and with the deterioration of public transport networks causing more sprawl.

An example of this vicious cycle can be witnessed in Skopje (Macedonia), where the city almost doubled its mass in the transition years, while ridership numbers in public transport decreased from a peak of 164 million in 1988 to 64 million in 2010 – a 100 million decrease in just over 20 years. The decrease in ridership number led to a continuous shrinkage of the existent urban transport network. Thus, between 2006 and 2010, the number of transit lines in Skopje has fallen by 25%, while their total length has fallen by 42%. In the same time period, the number of public transport vehicles and overall seating capacity have went down by 16%. (Statistical Yearbook of the Republic of Macedonia, 2011)

While the public transportation network was crumbling in Skopje, the construction of new suburban and peri-urban homes continued unabated. As the figure below shows, between 2006 and 2010, the housing growth in the country has continually outstripped population and household growth. Every year in Macedonia sees four times more dwellings than actual households that could live in those dwellings.

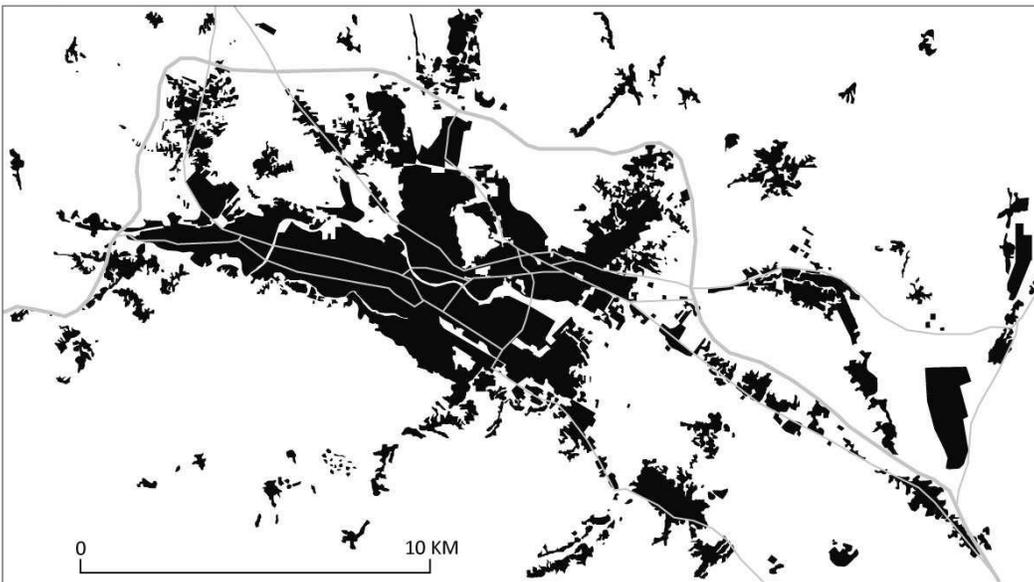
Macedonia: Annual Change in Dwellings, Population, and Households



Source: Statistical Yearbook of the Republic of Macedonia, 2011

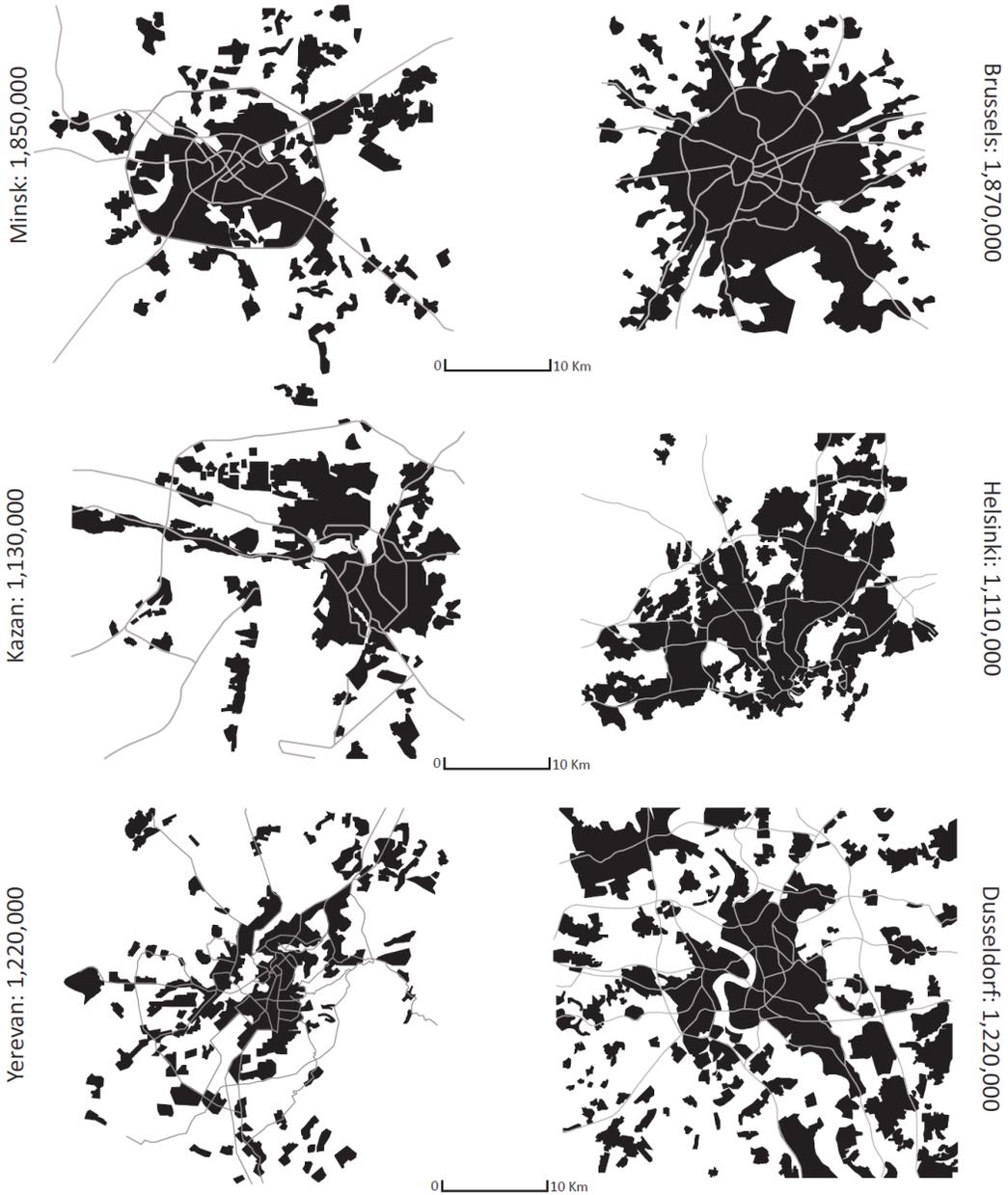
Skopje has absorbed much of this growth, with new neighborhoods and homes going up in an uncontrolled fashion on the city's outskirts (see map below). Individual detached homes account for much of this housing growth. In 2010, 47% of newly constructed dwellings in Macedonia had four rooms or more, and only 5% had one room. This pattern of growth is in itself inefficient, as single detached homes consume more energy than a dwelling in an apartment building. Moreover, they often waste a lot of energy and they don't benefit from heat sharing the way dwellings in apartment blocks do. Heating a big house in the winter time means that much energy goes to space that is unused or underused (e.g. guest rooms and bathrooms). The bigger the house, the bigger the energy requirements, and the bigger the wastage.

Skopje Urban Mass



Such a pattern of urban development is not unique to Skopje, Warsaw, or Poznan. It can be encountered in virtually every ECA city. As the maps below highlight, ECA cities have quickly lost the benefit of their hard urban cores, and have started to sprawl out covering areas similar in size to those of equally large (population wise) Western European cities. However, whereas the

population in Western European cities is more evenly spread out, covering a more compact urban mass, cities in ECA have relatively sparsely populated suburbs and city centers that are continually losing density. As Annex 4 indicates, almost every ECA city has seen a rapid decrease in household size – more rapid than actual population decrease, and present even when actual population growth was registered.



The Sustainable Future: Densitying the Urban Mass

Density plays a crucial role in reducing carbon footprint of the built environment. As shown earlier, the denser a city is, the lower emissions it will generate. A denser city simply requires less energy to function – sometimes an order of magnitude less than in sprawling cities. And, considering that cities are responsible for 70% of global GHG emissions, there is great scope for encouraging more compact urban centers.

Controlling urban density is not easy though. Cities throughout the world have tried different things to try to address density, with varying levels of success. For example Portland (OR) in the US, has tried to contain urban growth within a set boundary, only to face leap-frog development to neighboring municipalities. Stockholm and Copenhagen control the land markets and do a lot of development, but they have a huge backlog of housing demand. Other cities have attempted to put restrictive zoning and land use regulations in place, only to encourage sprawl in neighboring and more permissive jurisdictions.

To address sprawl, one has to first understand the causes of it. The first thing that has to be acknowledged is that sprawl will happen regardless of the policies in place. What can be influenced is the degree and speed at which cities are sprawling. Some people will simply prefer to have their acre of green outside the city, and no amount of policy making will prevent them from doing that. With an increase in people's means and with transport improvements, it will be impossible to counter people's desire to live in detached homes outside cities' centers. However, sprawl can be slowed down by bringing more people within the city boundary (e.g. through the strategic redevelopment of brownfields and other under-used parcels), and by offering existent residents the right incentives to stay (e.g. more amenities, better comfort, more options for spending free time, cheaper housing).

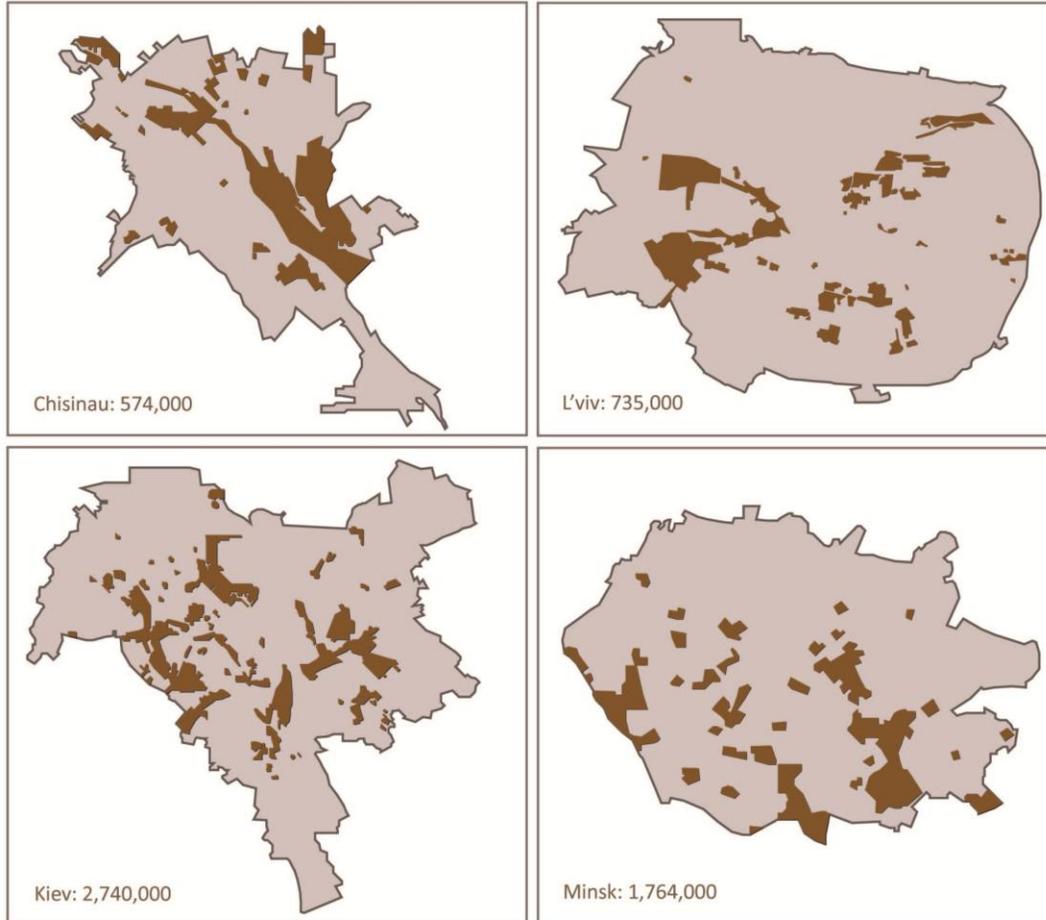
Many people move outside center cities not because they want their own acre of green, but because there are centrifugal forces within cities that push them out – e.g. congestion, pollution, a depreciation of the built stock, a loss of amenities, increasing housing prices and rents, or simply a lack of available housing. Such centrifugal forces can be countered through well crafted public policies and initiatives.

One way to counter Greenfield development in peri-urban areas is to promote brownfields redevelopment within center cities. As cities grow and develop, parts of them lose activity and become idle or underused. In most cities in ECA, the process of de-industrialization has left huge swaths of land in a state of disrepair. Often these brownfields are located in prime real estate locations (see figure below), are connected to the local public transport infrastructure, and are already branched to utilities.

These brownfields represent both problems and opportunities, and their redevelopment cannot only reduce GHG emissions (by countering urban sprawl), but they can also help generate local economic growth and revitalization. The World Bank has published a Guide on how ECA cities can undertake brownfields redevelopment work. 'The Management of Brownfields Redevelopment' offers simple and practical advice on how former industrial platforms can be transformed again into active parts of the city.

In addition to encouraging brownfields redevelopment, local authorities can use land-use and zoning laws to densify the existent urban mass. For example, they can allow flat-roofed buildings to be developed upward. They can encourage the redevelopment of parking lots found between buildings. They can allow developments over existent railway lines.

Industrial and Similar (e.g Transport, Warehousing) Uses, in Selected Cities (in 2009)

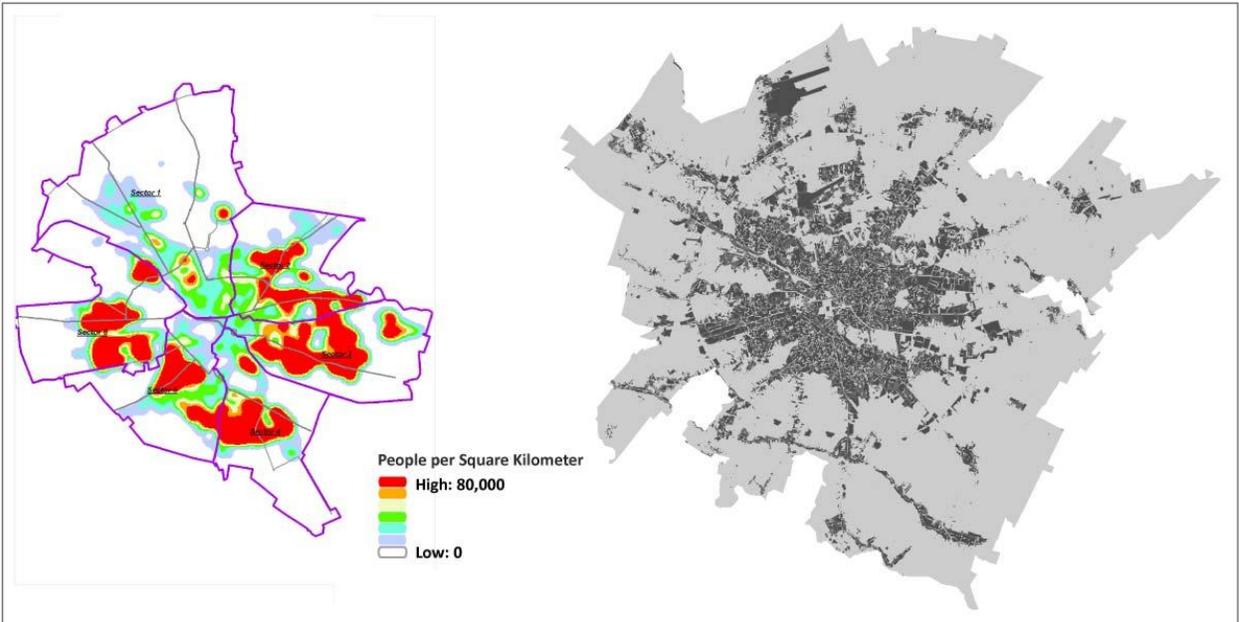


Source: Corresponding City Land-Use Maps

Measures to develop and redevelop available and under-used in-city real estate can be doubled by measures to prevent the de-densification of city centers. To a large extent this is a process of re-alignment to market rules, with better transport allowing people to commute in from further out (where land tends to be cheaper too). It is also an indication of mis-allocation of land uses during Communist times, with land parcels not always being assigned their highest possible use. For example, the centers of many ECA cities are dominated by residential areas, whereas in Western cities they tend to be dominated by office and commercial uses.

Nonetheless, as the recent Bucharest maps below show, ECA cities continue to have relatively dense centers (particularly in the centrally planned neighborhoods), despite rapid suburbanization. People leave centrally planned neighborhoods for various reasons, some of which can be countered by public authorities.

Density Profile of Bucharest City and Urban Mass of Bucharest Metropolitan Area (in 2009)



Source: Micro Mapper (www.micromapper.ro) and European Environment Agency

There isn't much that can be done about people that want a bigger home, or their acre of green – short of course of taxing them (e.g. congestion charges) for the externalities they generate. There is however something that can be done about people wanting to be closer to jobs, closer to affordable transportation, closer to schools, closer to amenities (e.g. supermarkets, entertainment, parks), and closer to other people. Much can be achieved if cities focus on quality of life investments, offering people as many reasons as possible to stay in the city. They can of course penalize those that commute in from outside, but such measures often have unwanted side-effects (e.g. companies move to the suburbs to make it easier and cheaper for their employees to get to work).

Land-use and zoning regulations can be used creatively to guide city development in a sustainable fashion. Examples in this respect abound, from transit-oriented development to the use of mixed-use zoning. Mixed-used zoning is particularly important in centrally planned neighborhoods, which have a fairly uniform land-use pattern and did not anticipate the changes cities would go through (e.g. there were almost no spaces assigned for bars, restaurants, entertainment options, or large supermarkets that would cater to a consumerist society).

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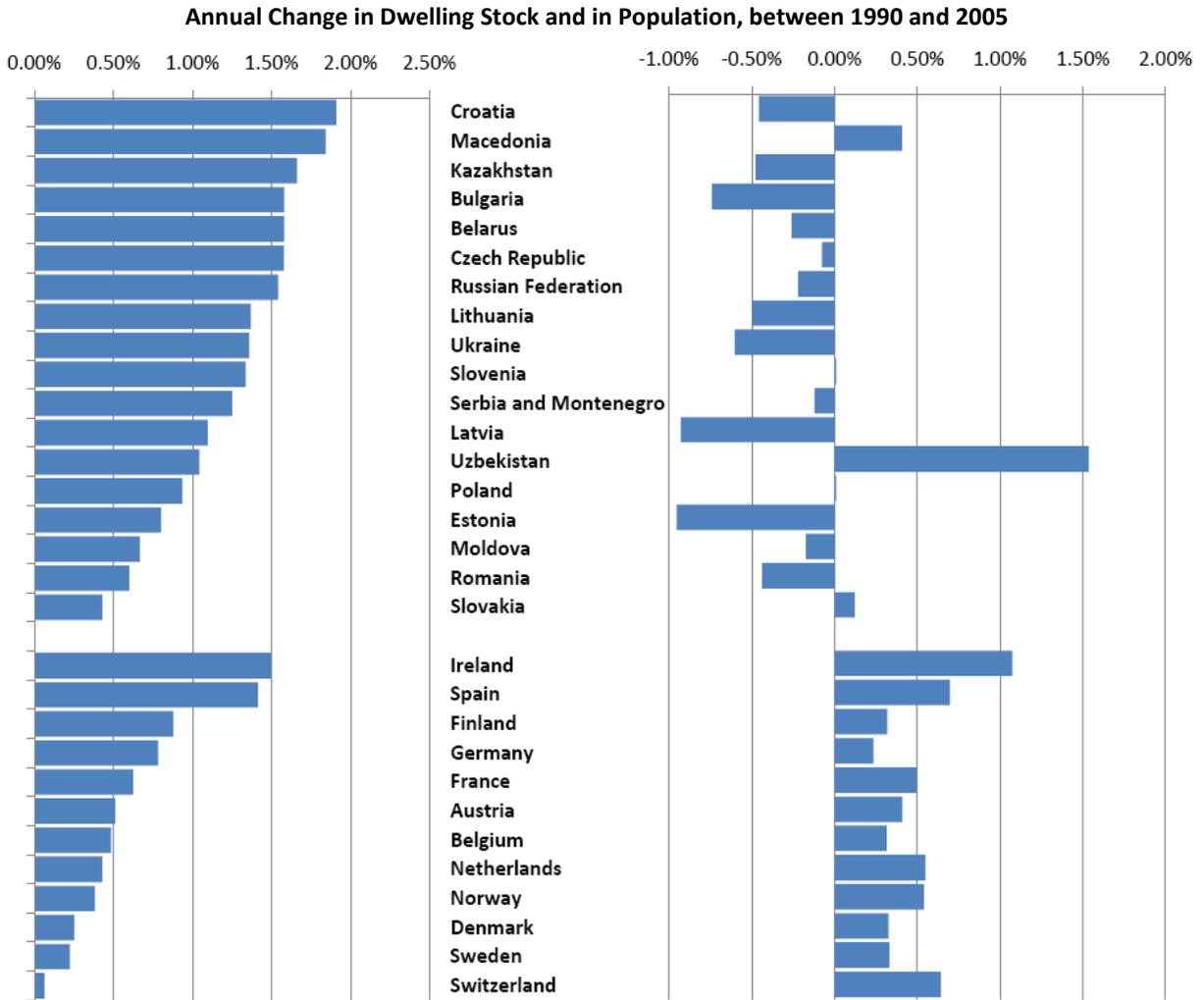
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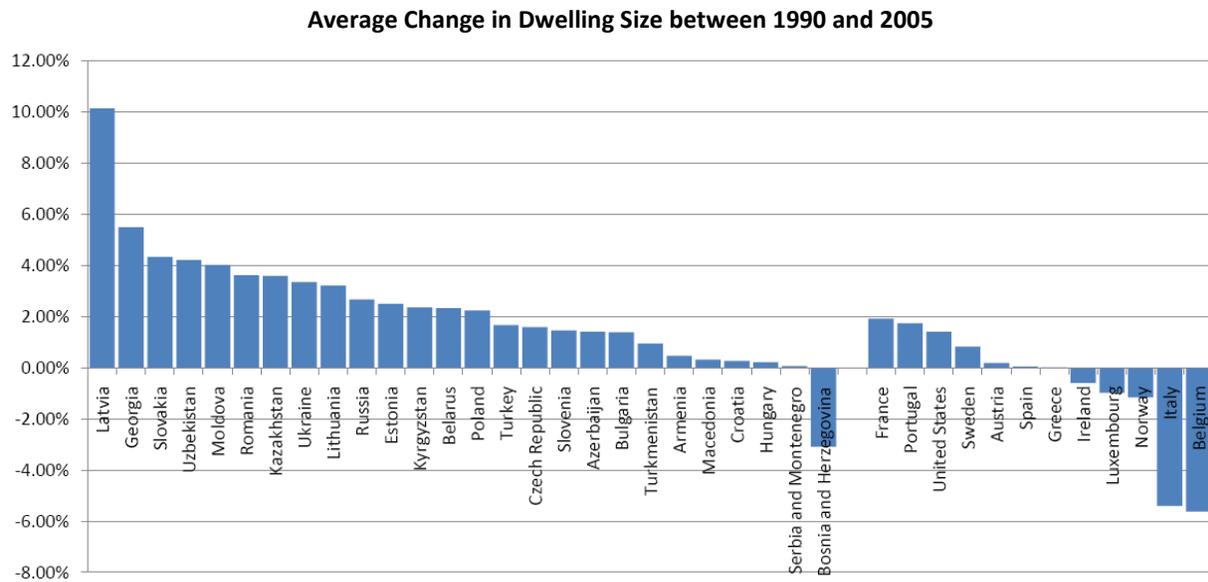
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Annex 1



Source: UNECE

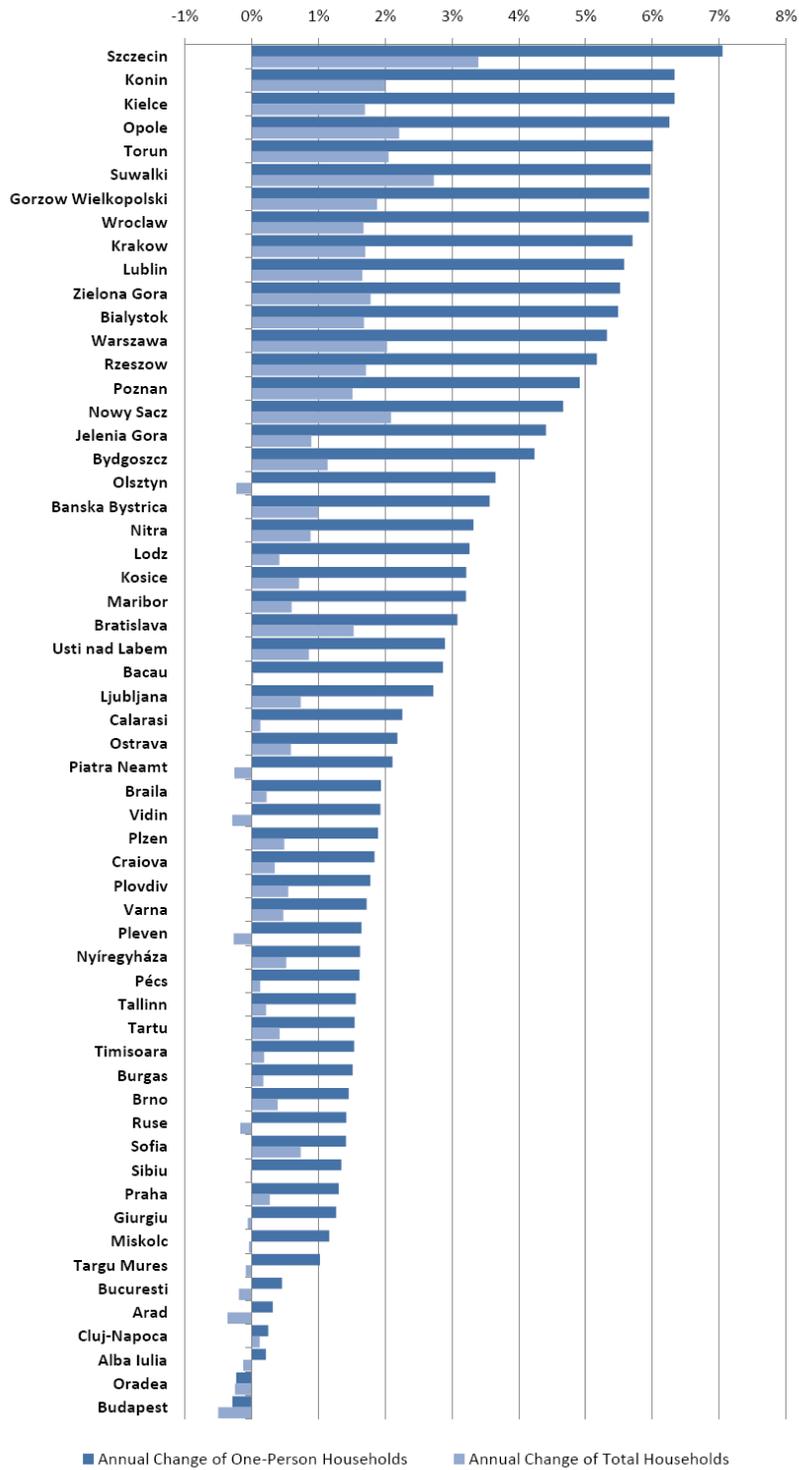
Annex 2



Source: UNECE

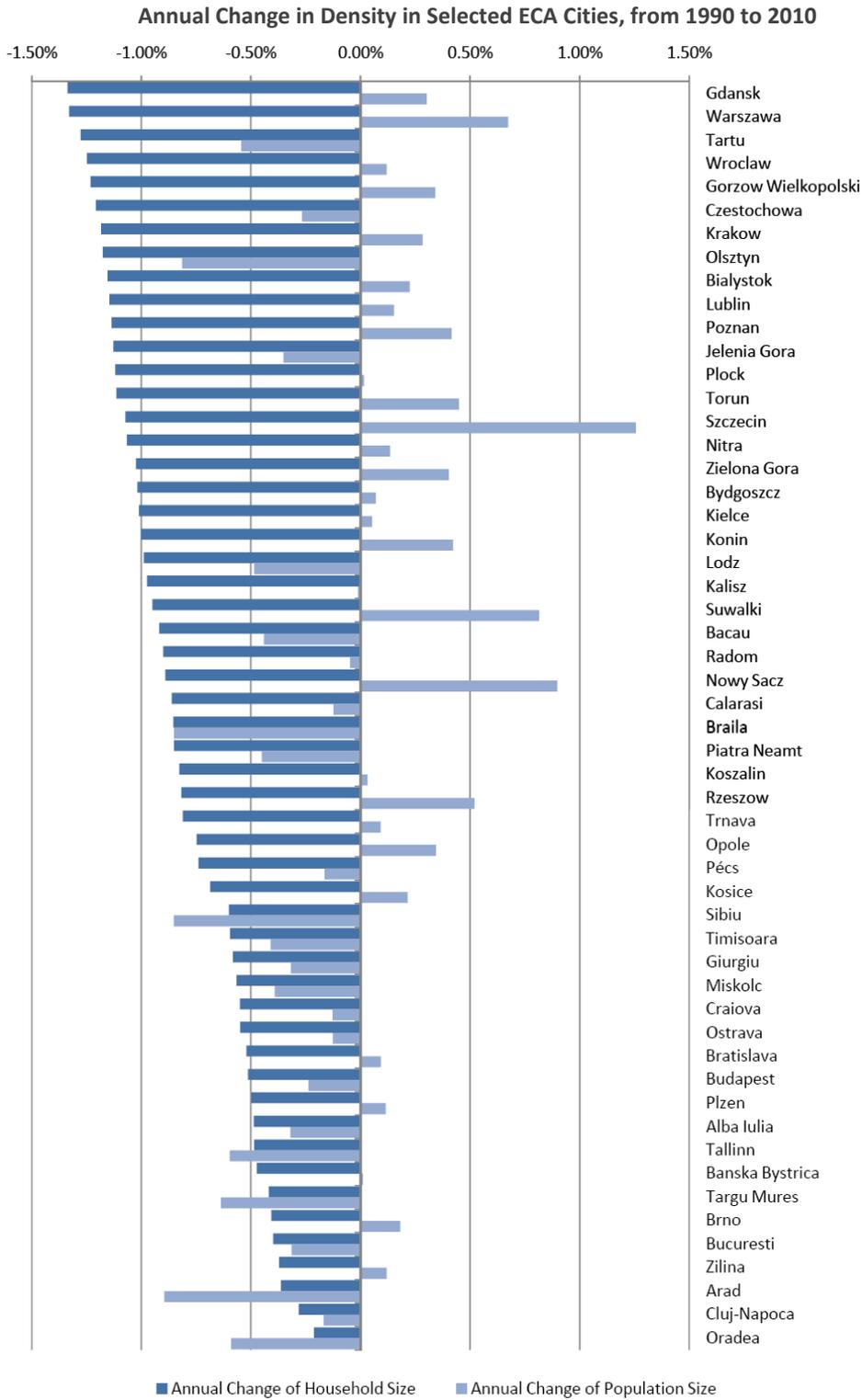
Annex 3

Annual Change of One-Person Households and Total Households, between 1990 and 2010



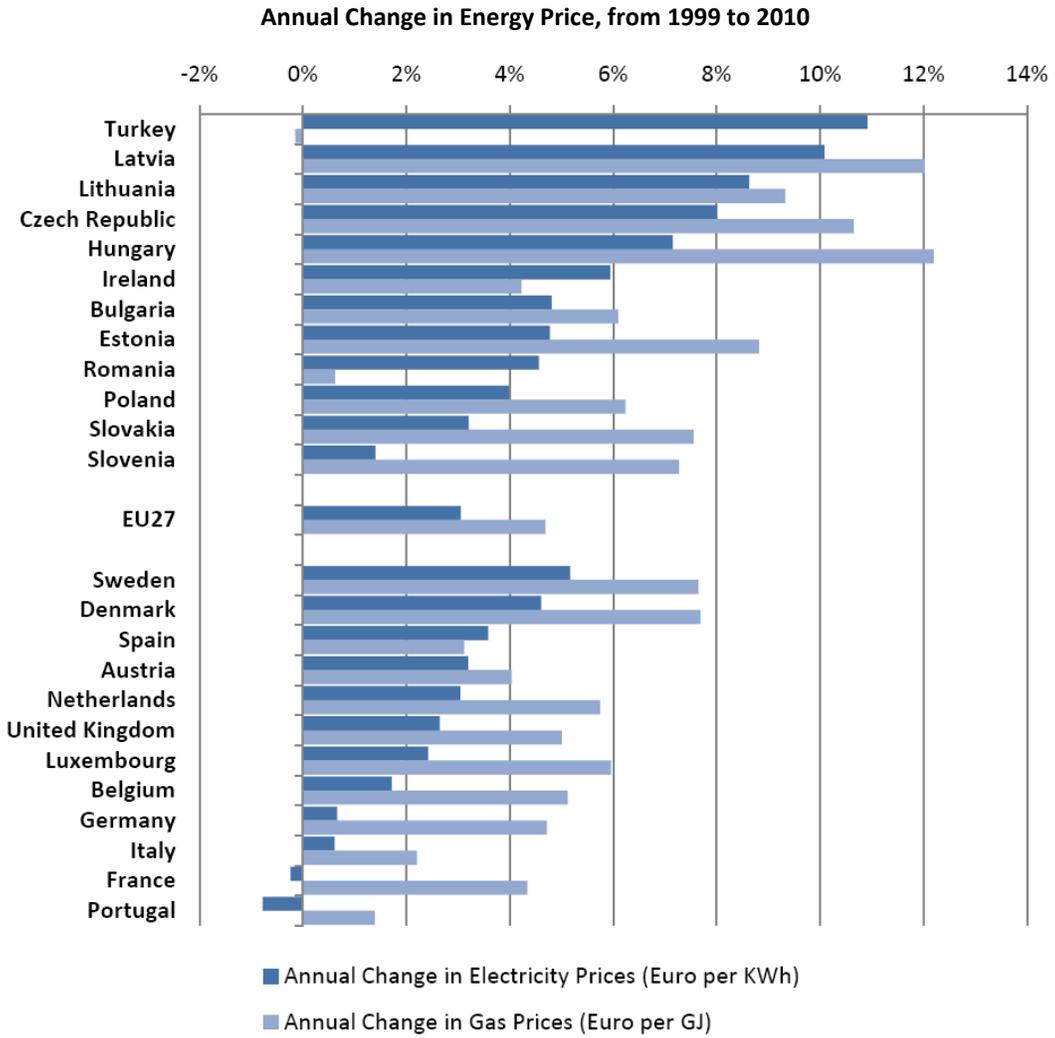
Source: EuroStat

Annex 4



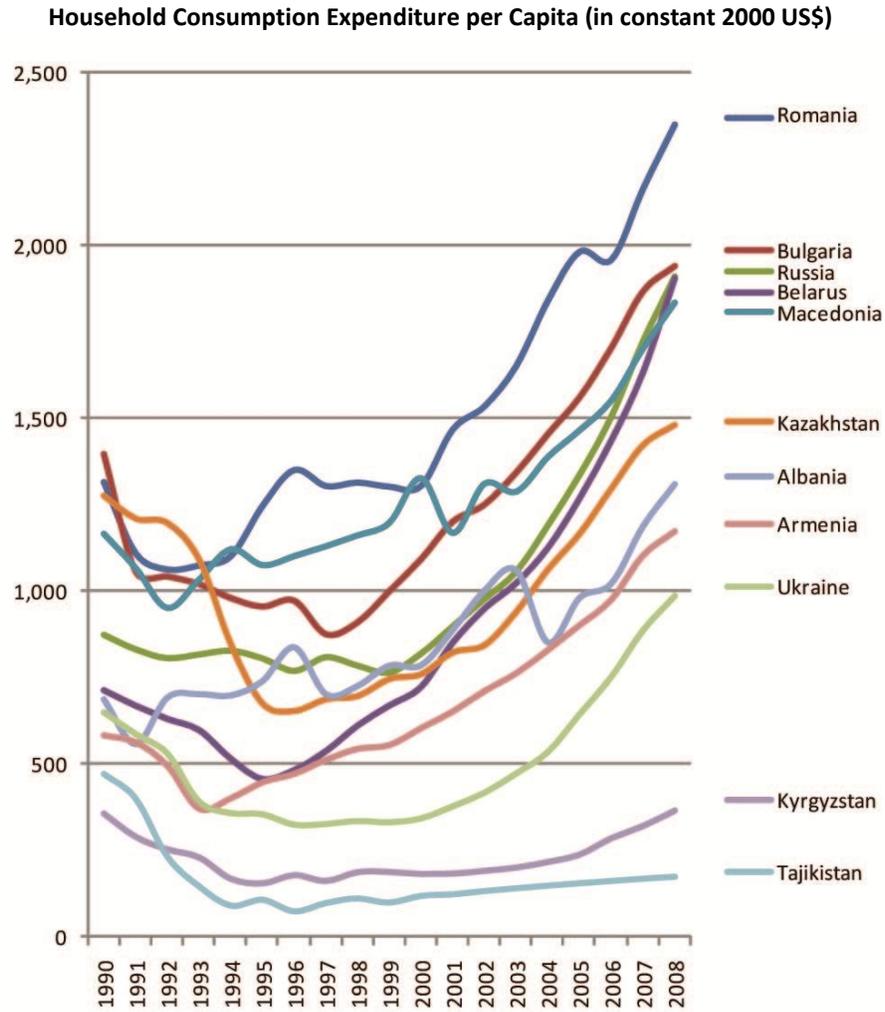
Source: EuroStat

Annex 5



Source: EuroStat

Annex 6



Source: World Bank