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The new industrial revolution making it sustainable

GENERAL CONFERENCE Fourteenth Session 28 November-2 December 2011, Vienna, Austria

Promoting innovative industries and technologies for a sustainable future in the Europe and NIS region

Compendium of Background Papers

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Europe and NIS Programme

Promoting innovative industries and technologies for a sustainable future in the Europe and NIS region

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Vienna, 2012

Foreword

The transition economies in the Europe and NIS region require new innovative industries and technologies to modernize, and to realize sustainable development objectives. This Compendium highlights that the prevailing production and consumption patterns in the region are not only incompatible with these objectives but fail to reap the dividends from rapidly growing markets for more sustainable goods and services. There is an urgent need for the region to move towards a new industrial growth model that is resource and energy efficient, low-carbon, low-waste, low-polluting and safe, while at the same time improving productivity, creating jobs and producing wealth across their societies. The challenge is how to overcome the numerous market failures and barriers inhibiting uptake of these technologies and goods.

The public good that derives from many new environmentally-sound technologies and services often means that current market forces fail to provide the scale of innovation and development needed to address environmental challenges. In response, countries need to implement innovative industrial strategies and polices that mobilize science, technology and finance for the new growth model of the future. In transition economies, obstacles to the uptake of new environmentally-sound technologies and products can be even more pronounced because of institutional, governance and behavioral failures coexisting with market failures and barriers. A policy framework must therefore be tailored to the contextual specificities of countries in the region. Concerted collective actions, at national and regional levels, are also called to promote technological transfer in the region.

The new EU Member States have shown that it is possible to achieve impressive levels of growth, develop high-tech innovative industries and technologies, and raise energy and resource efficiency. This is the goal. But Europe and NIS countries are highly divergent in terms of economic structure, institutions, innovation capabilities and income levels. Catching up with the best performing countries and meeting ambitious targets for cutting greenhouse gas emissions and for increasing renewable sources of energy will require substantial investment and assistance. This is a big challenge at a time when many countries are facing financial/economic crisis.

Another challenge is how to monitor and evaluate progress towards a green industrial transition in the region. Benchmarking energy and material productivity as well as eco-innovation capabilities requires comparable datasets to provide a baseline for assessment of where the region stands in terms of energy and resource efficiency, and eco-innovation. Such datasets have been compiled for the first time in this Compendium, and their analysis is provided in five working papers. Main findings from these working papers and key issues are summarized in the issue paper which is prepared for the UNIDO Europe and NIS Round Table on the theme ***Promoting innovative industries and technologies for a sustainable future in the Europe and NIS region,*** held on 30 November 2011 in Vienna, during the Fourteenth Session of the UNIDO General Conference. The Round Table had an excellent panel, including representatives of governments, business, academia and international organizations. It was attended by around one hundred and fifty participants. This Compendium also includes the Agenda of the Round Table, a list of panelists with biographies, the aide-memoire in Russian, a key note presentation, and a summary of the Round Table discussion. The papers in this compendium have been updated to reflect comments and questions that arose during the Round Table discussion.

Acknowledgments

This Compendium was prepared by Olga Memedović, Chief, UNIDO Europe and NIS Programme.

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Issue paper

Promoting innovative industries and technologies for a sustainable future in the Europe and NIS region[1]

Summary of the findings and main issues

Olga Memedovic, UNIDO

Introduction

Estimates of global trends in population growth and resource consumption indicate that the earth's natural resource base is in severe danger of overexploitation and collapse, threatening prospects for pursuing sustainable development in the 21st century. The global use of energy is set to rise by 84 per cent by 2050, and energy-related CO_2 emissions could double (IEA, 2010). Faced with these scenarios, efforts are growing to develop multilateral solutions to forestall an impending crisis, to decarbonize the global economy, to increase resource efficiency, and to reduce the environmental impact of economic activities (UNIDO, 2011a). The 'green growth' model aimed at stimulating investment in new innovative industries and technologies could lead to radically different production and consumption patterns, the so-called 'third industrial revolution' (Rifkin, 2011). This model, with energy and resource efficiency at its centre, it is believed, can reconnect the three pillars of sustainable development: environmental, economic and social.[2]

For the emerging Europe and Central Asia region, the green-economy transition presents a window of opportunity: targeted investments in new environmental technologies and projects will boost qualitatively different structural transformations with green technologies and products leading to the emergence of innovative industries, new jobs and new markets; it will increase energy and resource efficiency and drive production costs down; and it will change conceptions of production and consumption at all levels, including for consumers, firms and cities (see Box 1).

Box 1 The Green Economy and Green Industry approach

Central to the global debate on sustainability in the 21st century is the Green Economy, characterized by competitive, low carbon and resource efficient industry, eco-innovation, and job creation in 'greentech' sectors. Under such a system, industry is oriented towards green technologies and environmental goods and services. This can take place in a variety of areas, such as: waste management and recycling; energy efficiency technology and equipment; environmental services, including advice and monitoring (for instance Energy Service Companies); and pollution control technologies and equipment. Industry can mitigate emissions in other sectors by designing and delivering low-carbon products and services; reducing, recycling and recovering waste from its own operations and those of its supply chains, and reducing associated transportation requirements. Several studies have argued that greening industry can benefit firms in several ways, including by increasing production efficiency and enhancing competitiveness.

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1 This issue paper was prepared by Olga Memedović, Chief, Europe and NIS Programme, UNIDO Programme Development and Technical Cooperation Division. UNIDO consultant Shabnam Marboot Sadegh and UNIDO intern Thomas Jackson provided valuable input. Proof-reading and English language editing was provided by Georgina Wilde and Penelope Plowden.

2 The 'Europe 2020' Strategy, adopted in June 2010, envisages a transition towards a greener and more competitive economy through a significant increase in resource efficiency and a further decoupling of economic growth from the use of natural resources. Resource efficiency is one of seven flagship initiatives of this EU 10-year strategy for smart sustainable and inclusive growth and jobs.

Ambitious strategies and action plans call for a drastic restructuring in the region, throughout society and in all economic sectors, including industry, agriculture and transport. The new EU member states (NMS) have shown that it is possible to achieve impressive levels of growth, develop high-tech innovative sectors, and raise energy and resource efficiency. Combining these achievements with a net reduction in environmental pressures is the goal. But Europe and NIS countries are highly divergent in terms of economic structure, institutions, innovation capabilities and income levels (see Annex 1). Catching up with the best performing countries and meeting ambitious targets for cutting greenhouse gas (GHG) emissions and for increasing renewable sources of energy will require substantial investment and assistance, at a time when many countries are facing financial/economic crisis.[3]

Renewable energy sources such as wind, solar and hydro, so far underexploited, are a way for Europe and NIS countries to reduce energy import dependency. There is also scope for new economic sectors to emerge around renewables. The region is at a stage where investment decisions in new infrastructure should be aligned to cutting edge technologies such as virtual power plants, and energy networks of smart and micro-grid type; while in manufacturing, priorities should be waste management and recycling, water management, biotechnology, material efficiency, cleaner production, and industrial energy efficiency, for example by using methods of industrial ecology.[4]

Benchmarking energy and material productivity as well as eco-innovation capabilities is necessary for monitoring and evaluating progress towards a green economy and green industrial transition in the region. Such comparable data sets, which provide a baseline for the evaluation and benchmarking of where the region stands in terms of energy efficiency, resource efficiency and eco-innovation, have been compiled for the first time for the purpose of this Round Table and their analysis is provided in five background papers. This issue paper gives a summary of the findings of these background papers and highlights the main issues to be addressed at the UNIDO Round Table.

Where does the Europe and NIS region stand in terms of energy and resource efficiency, and eco-innovation?

Still one of the most energy-intensive regions in the world

The Europe and NIS region as a whole remains one of the most energy intensive regions in the world and, although its energy intensity has been falling and converging with the global average since 2005, it still has some way to go before it reaches European Union (EU-15) averages (Figure 1).[5] Improvements in energy productivity have been almost equally driven by industry, energy conversion and households.[6]

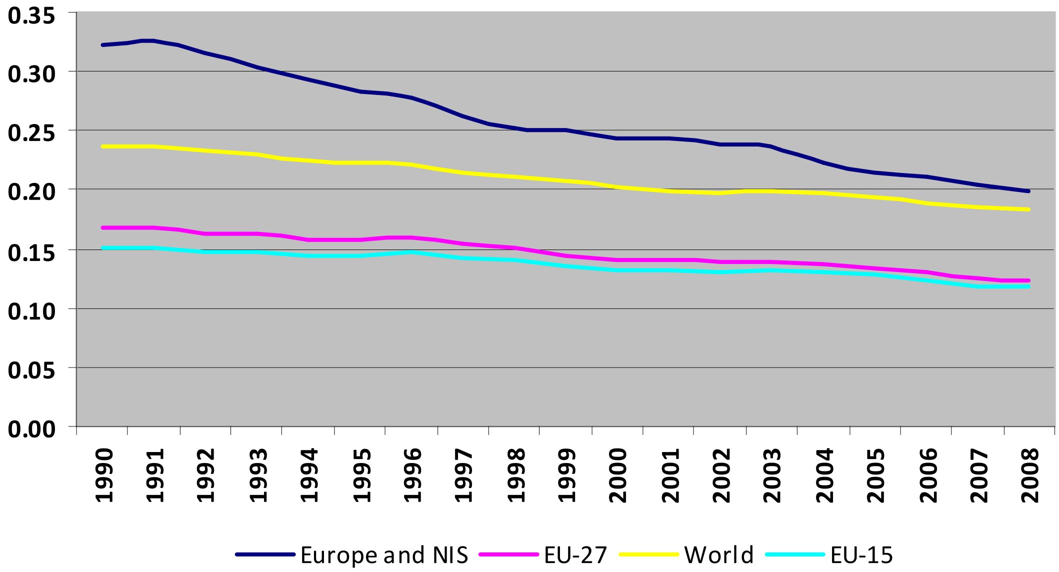
3 For instance, as part of 'Europe 2020', the European Commission (EC) has set targets in the European Union for 2020 for a) a 20 per cent reduction in greenhouse gas emissions from 1990 levels; b) 20 per cent of energy to come from renewables, and c) a 20 per cent increase in energy efficiency (http://ec.europa.eu/europe2020/targets/eu-targets/index_en.htm).

4 Industrial ecology describes the study of material and energy flows through industrial systems. Applying its methods/tools (i.e. input-output analysis, full-cost auditing, etc) would e a way to achieve the afore-mentioned priorities.

5 The findings from this section come from UNIDO (2011b).

6 In industrialized countries, energy intensity reductions have been driven by industry since 1990, while reductions in developing countries and regions are due to households (WEC, 2010).

Figure 1 Energy intensity of GDP, (1990-2008) Units of energy use, kg of oil equivalent per US$1000 GDP



Source: UNIDO calculations based on MDG database of the UN Statistics Division.

Carbon intensity of energy is falling

The carbon intensity of energy in Europe and NIS has been well above the EU-15 average but it is converging with the global average (Figure 2). Energy-related CO_2 emissions fell by around 28 per cent between 1990 and 2008 because of the growing use of less carbon-intensive energy sources, structural and technological changes and the recent economic downturn (EBRD, 2011). However, despite this trend, it is estimated that CO_2 emissions in the region will exceed 1990 levels by 2015 (World Bank, 2010).

There is considerable divergence by country in terms of carbon intensity. The national endowment of natural resources has affected CO_2 emissions. Carbon-energy intensive countries have much higher emissions than the EU-15 average despite their lower economic activity. Conversely, countries with a higher share of energy from renewable sources, but which are less affluent, such as Tajikistan and Kyrgyzstan, emit low levels of CO_2 per capita.

By sector, electricity and heat production contributed around 49 per cent of energy-related CO_2 emissions, and manufacturing and construction around 16 per cent from direct combustion of fuels, followed by transport (14 per cent) and other energy industries (4 per cent) in 2008.[7]

Energy intensity in manufacturing is high but falling

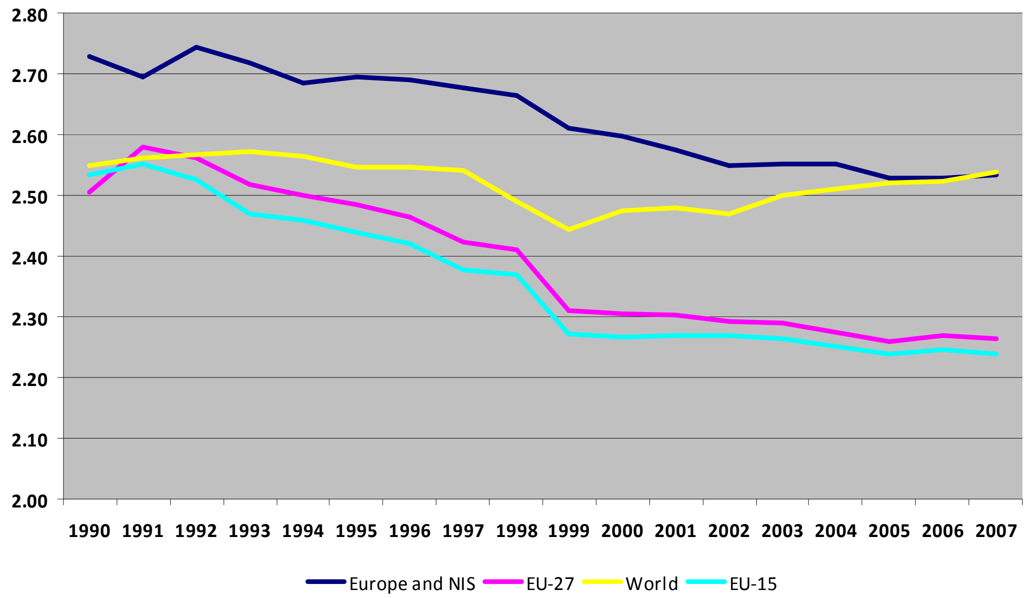
In general, there has been a downward trend in manufacturing energy intensity in the pan-European region as a whole, but if efforts made by countries to reduce energy intensity are considered, the Europe and NIS region has experienced the greatest improvements in reducing manufacturing energy intensity (Table 1). In other words, a convergence process of energy intensity between Western Europe, new EU members (NMS), and the rest can be observed.

In terms of structure, high energy-intensive sectors still account for 30 per cent of total manufacturing value-added (Figure 3). This manufacturing structure affects the overall

7 UNIDO calculations derived from IEA (2010b).

standing of the region in energy intensity, contributing to its poor performance in comparison with other regions and the global average.

Figure 2 CO_2 intensity of energy (energy related CO_2 emissions), (1990-2008), kg per kg of oil equivalent energy use



Source: UNIDO calculations based on MDG database of the UN Statistics Division.

What is driving increased energy efficiency in manufacturing?

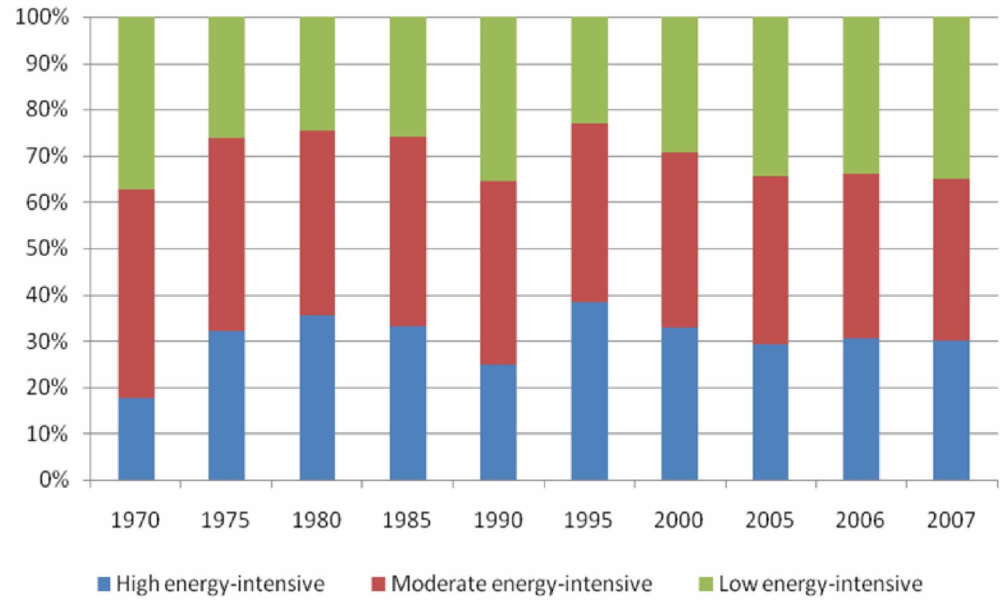
Although the energy intensity of an economy can be measured as the ratio of energy used to GDP, it is more instructive to look at underlying structural change trends, as these can better highlight 'true' efficiency improvements. The tertiarization process, involving a structural shift to less energy-intensive sectors with lower energy use per unit of value added, can contribute to lower overall energy intensity of the economy. An additional impact can come from structural shifts in industrial value added. Countries that have more energy intensive industries will, all things being equal, see a rise in industrial energy intensity, whereas countries in which services are of growing importance will see a decline in energy intensity.

Table 1 Change of manufacturing energy intensity (1996-2006), in per cent, countries in descending order

Country	2006/1996 energy intensity reduction
Hungary	246.99
Slovakia	171.19
Bulgaria	143.19
Poland	128.94
Czech Republic	73.84
Greece	70.72
Latvia	69.67
Sweden	31.63
Norway	27.46
FYR Macedonia	24.92
Denmark	7.34
Finland	0.70
France	-5.07
Turkey	-6.99
Spain	-7.12
Belgium	-9.25
Austria	-16.98
Italy	-19.49

Source: Cantore (2011).

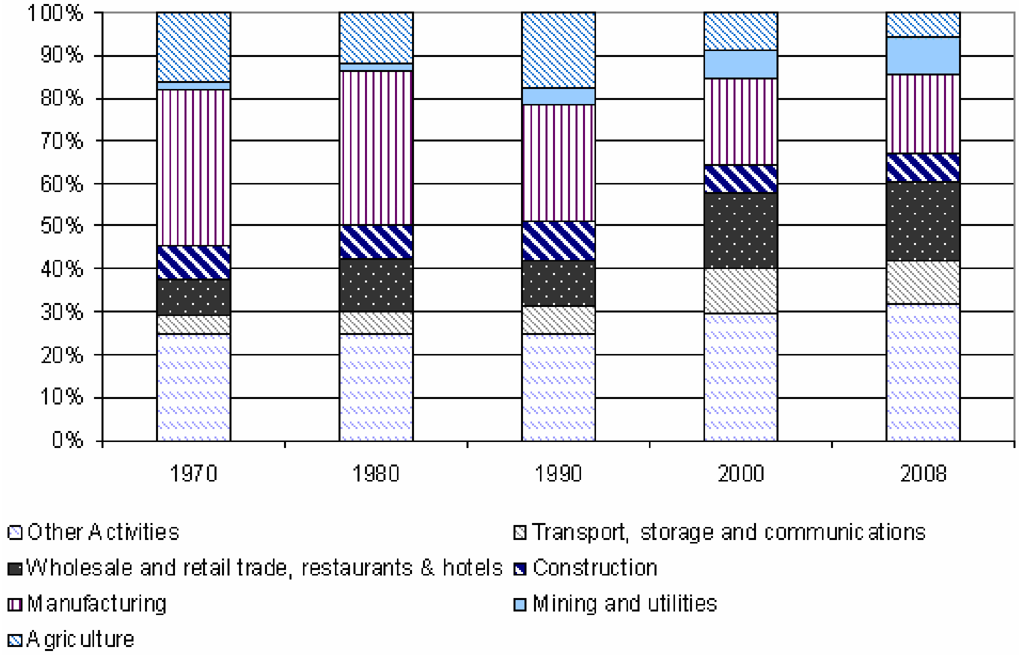
Figure 3 Shares of sectors by energy intensity in manufacturing value-added in Europe and NIS



Source: UNIDO calculations.

In Europe and NIS, industry continues to make up a significant part of economic activity, although with a declining contribution to value added (Figure 4). Mining and utilities and advanced services, such as transport, logistics and communications, show growing importance, while the share of agriculture and manufacturing value added in total output declined between 1970 and 2008. In the 1990s and 2000s, the most important drivers of structural change were transport and communications, followed by 'other activities', which include research and development, computer activities, financial intermediation and public administration. The share of non-tradable services such as wholesale and retail trade, restaurants and hotels decreased in the early period of transition (early 1990s), but later became a major element in the displacement of industry and agriculture in the overall economic structure.

Figure 4 Value added by sub-sectors in Europe and NIS, (1970-2008)



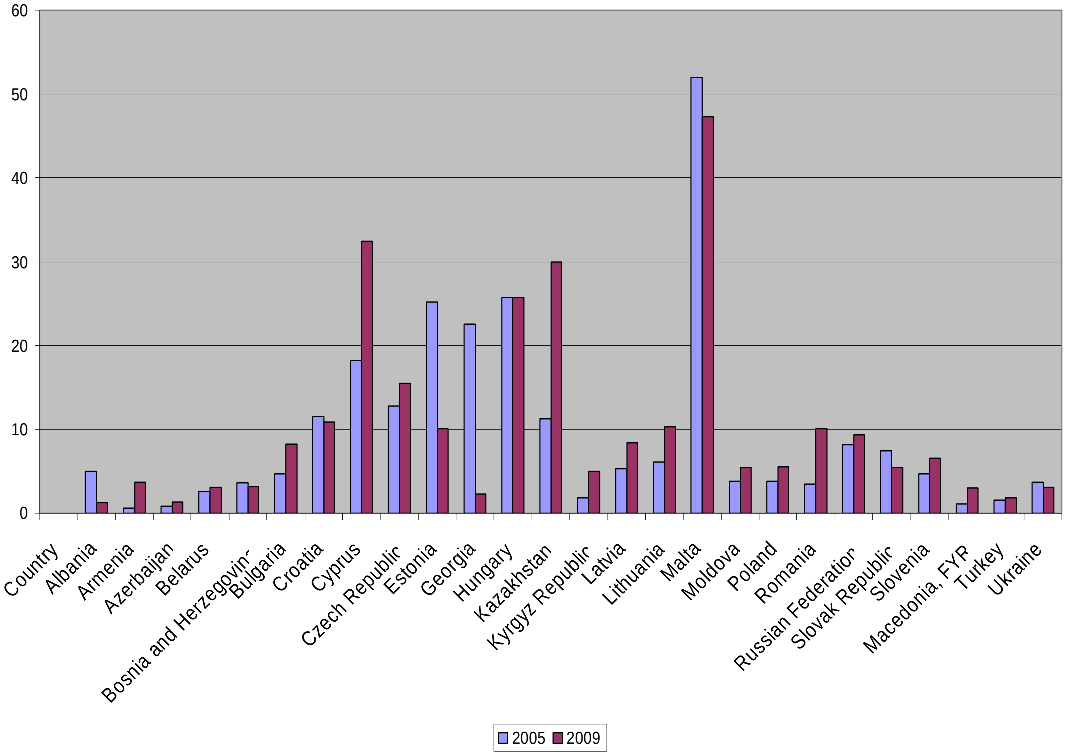
Source: Memedović and Iapadre (2009) based on UNIDO database (INDSTAT2 2011).

Note: shares in current prices and exchange rates, in US$.

Structural changes in manufacturing

Structural shifts in manufacturing vary greatly across countries, but broad patterns can be observed according to income level. In low and lower-middle income countries, low value-added manufacturing sectors, such as basic metals, still dominate manufacturing sub-groups, although on a declining trend, and the share of high-tech sectors remains small. For this country group, economic diversification and growth based on competitive high value added sectors in manufacturing remain elusive development goals. In the upper-middle income group, which produces around 60 per cent of the region's industrial output, shifts in the manufacturing structure towards high and medium technology-intensive activities have been much greater. The shares of electrical and communications equipment, medical instruments and transport equipment have all seen growth, while those of chemicals, refined petroleum products and basic metals, which were the basis of industry before market transition, remain high. In NMS, high-tech sectors have grown over the last decade, and the shares of nearly all advanced manufacturing sectors are higher than in other high income Europe and NIS countries. The export structure confirms patterns of specialization in the region; NMS typically have larger shares of medium and high technology products in manufactured exports over the reported period 2005-2009 (Figure 5).

Figure 5 Share (in per cent) of Medium and High Technologies in exports from Europe and NIS, (2005, 2009)



Source: UNIDO calculations based on UNIDO INDSTAT2 database.

By looking at patterns of specialization through the lens of trade in intermediate goods, namely imports of intermediate goods and exports of final goods, Europe and NIS's share of world intermediate manufactured goods trade more than doubled from 4.2 per cent to 9.2 per cent, between 1995 and 2008 (Table 2). This shows the rising industrial capabilities of local economies to transform intermediate goods into final products that are competitive on the world market.[8] Countries with the highest shares of the global intermediate goods trade in 2008 were Russia (1.4 per cent), Poland (1.4 per cent) and Turkey (1.2 per cent).

Concerning investment patterns, many countries need to adopt more creative and innovative industrial policies to attract foreign direct investment (FDI) to manufacturing sectors other than raw materials extraction—the most attractive industrial sectors for foreign investors in most countries over the period 2007-2009 (except for services in SEE and the EECCA) (Table 3). They also need to establish new institutions to support these policies.

8 For economic development, the expansion of intermediate goods and services and their suppliers are crucial for the progressive division of labour and thus for economic growth. See Rodriguez-Clare (1996). Low levels of diversification in the intermediate goods trade can lead to low rates of return on investment and to an underdevelopment trap in which foreign and domestic investments may not materialize.

Table 2 Country intermediate manufactured goods trade as a share of the global intermediate manufactured goods trade (per cent)

Country	1995	2008
Albania	0.009	0.02
Armenia	0.001	0.02
Azerbaijan	0.003	0.03
Belarus	0.0004	0.2
Bosnia and Herzegovina	0.006	0.06
Bulgaria	0.09	0.2
Croatia	0.1	0.1
Cyprus	0.03	0.03
Czech Republic	0.5	1.2
Estonia	0.04	0.1
Georgia	0.002	0.02
Hungary	0.3	0.8
Kazakhstan	0.04	0.2
Kyrgyzstan	0.008	0.02
Latvia	0.03	0.08
Lithuania	0.05	0.1
FYR Macedonia	0.02	0.03
Malta	0.07	0.02
Moldova	0.007	0.01
Montenegro	N/A	0.1
Poland	0.5	1.4
Romania	0. 1	0.4
Russian Federation	0.9	1.4
Serbia	N/A	0.1
Slovenia	0.2	0.25
Slovakia	0.29	0.5
Tajikistan	0.03	0.01
Turkey	0.55	1.2
Turkmenistan	0.003	0.02
Ukraine	0.14	0.52
Uzbekistan	0.2	0.05
Europe and NIS total	**4.2**	**9.2**

Source: Sturgeon and Memedović (2010).

Table 3 World inward FDI flows by sector, (1990-1992 and 2007-2009) (per cent shares)

	1990-1992				2007-2009			
Sector/Industry	Developed countries	Developing countries	EECCA & SEE	World	Developed countries	Developing countries	EECCA & SEE	World
Primary	65.8	28.3	5.9	100	47.7	40.1	12.2	100
Agriculture, hunting, forestry and fishing	1.8	98.2	0.0	100	6.9	84.3	8.8	100
Mining, quarrying and petroleum	68.9	24.9	6.2	100	49.3	38.3	12.3	100
Manufacturing	65.6	33.9	0.5	100	61.3	35.9	2.8	100
Services	79.9	19.9	0.2	100	69.5	26.4	4.1	100
Total share	72.7	26.5	0.8	100	65.5	30.0	4.5	100

Source: UNIDO calculations based on UNCTAD/WEF (2011).

Energy efficiency in manufacturing and technological change

A key issue for understanding developments in energy efficiency in manufacturing is the extent to which the changes in energy intensity are because of technological change within manufacturing sectors and how much because of structural change, that is, a shift from more to less energy-intensive manufacturing sectors (Cantore, 2011). The structural shift contribution to energy efficiency can be gauged by estimating what the energy intensity would have been had the structure of industry stayed constant, and then by comparing this estimate with the actual development of energy intensity. The good news is that the energy performance of the Eastern Europe, Caucasus and Central Asia (EECCA) countries and the NMS is driven by energy efficiency improvements rather than by structural change effects.

The BRICS[9] are particularly successful at reducing energy intensity. Among high income countries, the NMS are achieving significant improvements due to technical change. The BRICS group's performance is driven by China and Russia, and in these countries the energy intensity reductions are mainly led by energy efficiency (use of more energy efficient technologies and methods) rather than by structural change (shifts away from energy-intensive economic sectors).

Prospects for structural change in energy sectors

In the pan-European region, the renewables mix is dominated by hydro as a source for power generation. In 2008, 56.4 per cent of total renewables generation in the EU-15 was hydro. In other regions the proportion was even higher: 80.9 per cent in the New EU Member States (NMS); 96.9 per cent in South East Europe (SEE); and 98.7 per cent in Eastern Europe, the Caucasus and Central Asia (EECCA) (see Technopolis, 2011 in this publication). Wind, and biomass and waste are also alternative sources of renewable energy although on a smaller scale and mainly in the EU-15 and the NMS. Biomass and waste represents 15 per cent of energy generation in NMS and over 19 per cent in the EU-15. In general, wind, biomass and waste, geothermal, solar and tidal represent smaller shares in total energy generation, but they demonstrate linear, and in some cases even exponential, growth patterns for some country groups. NMS have been performing better in introducing renewables such as biomass, solar and wind, while in EECCA and SEE there is no evidence of structural shifts towards renewables.

Promotion of non-hydro renewables (wind, solar, tidal, biomass, geothermal) has occurred only in the last couple of decades. The largest growth has been in West European countries. Most of the new technologies and smart solutions for greening the power sector will come with high initial price tags, as Europe and NIS economies are technologically weak and hence dependent on West European countries' supply of these new green technologies.

Achieving the ambitious targets for cutting greenhouse gas (GHG) emissions set by the EU for its member states and potential members and dealing with the energy security challenge have become major policy concerns for economies in the region. Growing populations, urbanization and economic growth will raise demand for energy and other resources further, putting additional pressure on energy and resource security.

Renewable sources of energy such as wind, solar and geothermal (and new technologies) have yet to be exploited, despite the potential they offer countries to meet EU targets without sacrificing geopolitical and economic security. Diversification and localization of energy

9 Brazil, Russia, India, China and South Africa

supply and energy networks that connect the pan-European region would involve millions of local micro producers sharing energy from renewable sources, such as wind and solar, in the same way that information is produced and shared on the Internet through open source (Rifkin, 2011). A decentralized energy network of micro producers requires intelligent approaches to distribution and storage, such as the use of 'smart grids' involving microprocessor technology, whereby energy that is generated locally can be fed into an 'inter-grid' and consumed where and when it is needed, increasing efficiency, reliability and flexibility in foreign supply. Advanced energy storage can also be used to reduce the variability of generation associated with renewable energy sources. At present, however, there is little evidence of investment in smart grids in the region, and there are insufficient positive incentives for private sector investments (WEF, 2009).[10]

Moving away from fossil fuels to the increased use of renewable energy sources, carbon capture and storage technologies, and the development of energy networks, will require the promotion of low energy demand lifestyles and investment in new energy efficient technologies and supporting systems, including new infrastructure to transmit, store and produce energy, which can raise energy efficiency, diversify production and cut energy demand. This will require substantial external financial and technical assistance.

Resource use and resource efficiency

Analysis of the development of resource use and efficiency in Europe and NIS between 1995 and 2008 can be divided into the categories of material extraction, material trade, material consumption, and material productivity.[11] Absolute material consumption in Europe and NIS increased significantly from 2000 (Figure 6). Average per capita consumption increased by 25 per cent between 1995 and 2008 (from 9.8 to 12.2 tonnes) surpassing the global average (10.4 tonnes), but was still below the EU-15 per capita average (18.6 tonnes) in 2008. Apart from fossil fuels, minerals constituted the second largest category of extraction, with remarkable growth.

Most Europe and NIS countries have experienced a relative decoupling between per capita GDP and per capita material consumption (UNEP, 2011).[12] Material productivity rose continuously, in total by 42 per cent between 1995 and 2008, as GDP increased more than material consumption (Figure 7). Growth and a positive relationship between GDP and domestic material consumption (DMC) can be seen across the NMS, EECCA and SEE, but at widely differing paces as measured in absolute numbers.

For the EU-15, a small but absolute decoupling effect is observable, but at a very high level of material consumption. For the most part, the absolute decoupling effect is due to the closing down of domestic industries and the substitution of domestic production of highly material- and energy- intensive products by imports from abroad (EEA, 2010). As most countries in the Europe and NIS region still have large domestic heavy industry sectors, the direction of development is characterized by a closer link between GDP and DMC.

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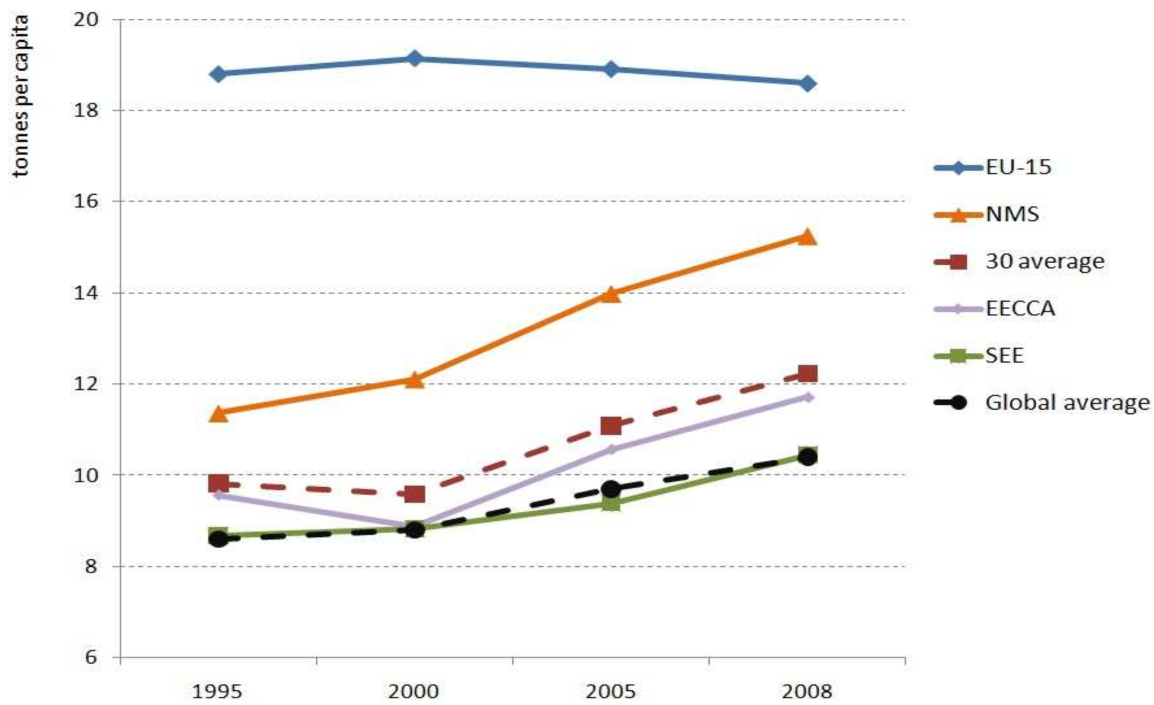
10 It is estimated that €200 billion is needed to upgrade Europe's gas and electricity grids by 2020, with half of the sum coming from government budgets (EurActiv, 2010).

11 The findings in this section come from SERI (2011).

12 The UNEP (2011) report defines decoupling in two ways. First, decoupling is the use of fewer quantities of resources per unit of economic output, i.e. less materials, energy, water and land to produce one dollar or euro of GDP. Second, decoupling is the reduction of the environmental impact of any resources that are used for economic activities that are undertaken (i.e. emissions, waste production or land and ecosystem degradation).

Figure 6 Domestic Material Consumption (DMC) per capita, three groups and global and EU-15 averages, (1995-2008)

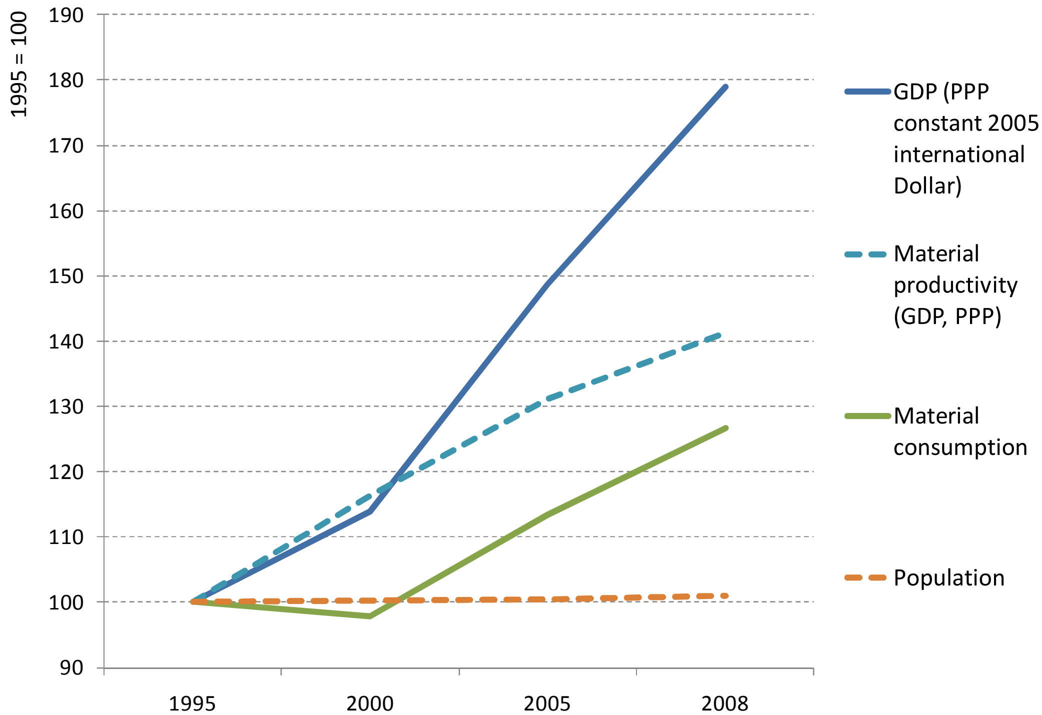


Source: SERI (2011).
Note: The '30 average' group equals the Europe and NIS region, but Serbia and Montenegro are included as one country.

The volume of material trade doubled in the region between 1995 and 2008. Export growth was stronger than import growth. In physical terms, only EECCA countries are net exporters of materials, especially of fossil fuels. The NMS and SEE countries are net importers (Figure 8). The three country groups are significantly less dependent on material imports than the EU-15. For the EU-15, ensuring stable access to resources outside the EU territory is a major policy issue, whereas the main issue for the three groups of countries, EECCA, NMS and SEE, is how existing industries can be maintained and transformed into more highly resource-efficient industries.

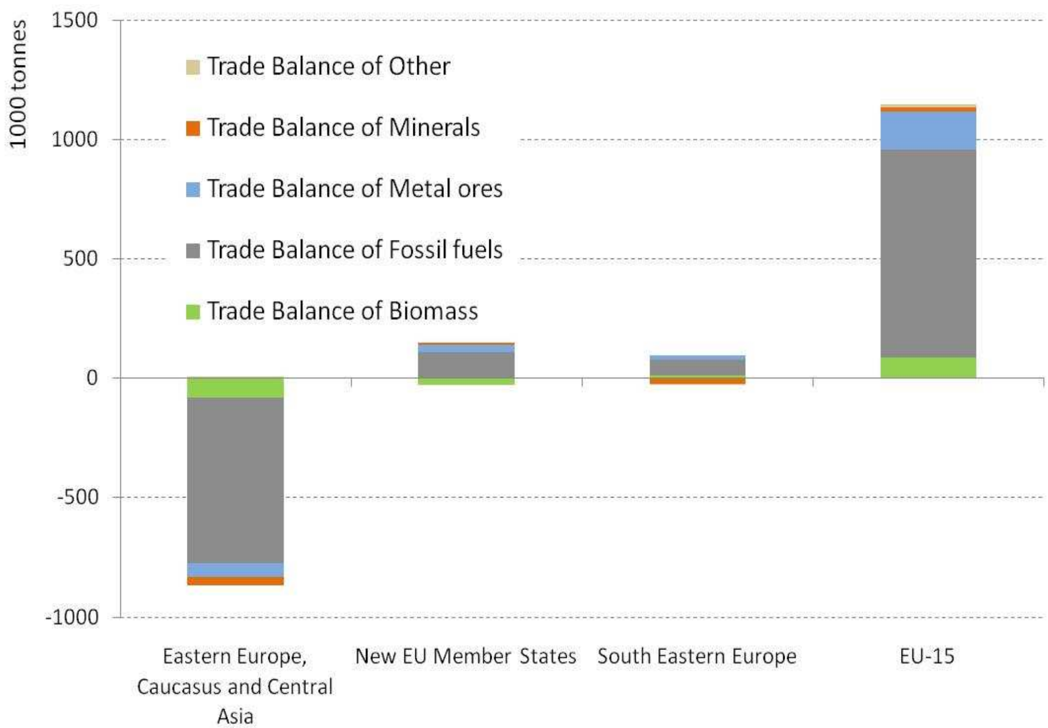
In terms of imports and exports, the EECCA countries are net exporters of fossil fuels while the SEE and NMS states are net importers. However, net imports in the latter sub-regions are massively overshadowed by imports to the EU-15. Overall, the Europe and NIS region is far less import dependent than the EU-15 (Table 4). However, when broken down, the EECCA countries have the lowest percentage share of imports in domestic material consumption (11.5 per cent), compared to SEE (19.7 per cent), the NMS (27 per cent) and the EU-15 (57.7 per cent); for fossil fuels this is 102.6 per cent for the EU-15, in contrast to 27 per cent for Europe and NIS.

Figure 7 GDP (PPP constant 2005 US$), population, domestic material consumption and material productivity in Europe and NIS, (1995-2008)



Source: SERI (2011).

Figure 8 Physical trade balances of SEE, EECCA, NMS and EU-15 in 2008



Source: SERI (2011).

Table 4 Average import dependencies of three groups and EU-15 in contrast in 2008 (per cent share of imports in Domestic Material Consumption)

	All materials	Biomass	Minerals	Fossil fuels	Metal ores
New EU Member States	27.0	25.2	8.8	41.2	65.2
South East Europe	19.7	12.9	4.9	39.9	96.1
Eastern Europe, Caucasus and	11.5	6.6	6.4	17.8	15.5
Group of 30*	17.1	11.7	6.8	27.0	32.6
EU-15	57.7	44.5	9.8	102.6	210.9

Source: SERI (2011).
* The '30 average' group equals the Europe and NIS region, but Serbia and Montenegro are included as one country.

Eco-innovation for green industry

The promotion of eco-innovation will allow the region to become more competitive through cutting production costs, creating new green jobs and penetrating green markets, and thereby bringing its economic performance to the levels of the EU-15 (see Box 2). Increasing material, energy and water resource efficiency will significantly improve the environmental performance of industries in terms of air and water emissions, waste production and negative impacts on ecosystems.

Box 2 What is eco-innovation?

Eco-innovation is the implementation of a new or improved product (good or service), process, organizational change or marketing technique that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle of the product. It can be a new good or service, process, organizational change, marketing method within a company, or a wider change with systemic socio-economic implications for the economy, leading to structural economic and social transformation. As a way of pursuing sustainable change, it offers a framework for promoting a green growth model.

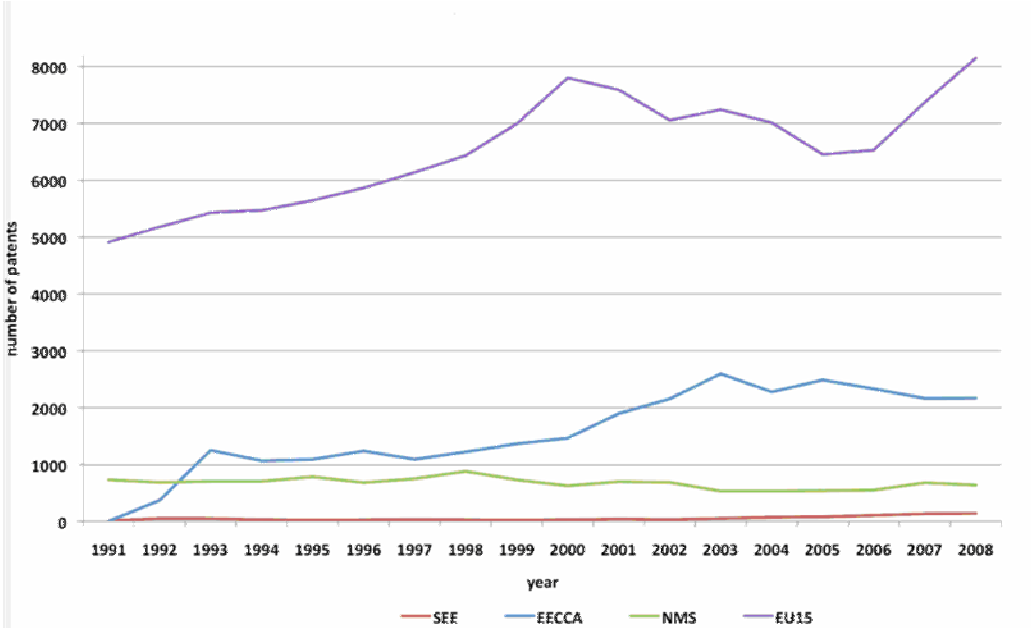
Source: Technopolis (2011).

Proxy indicators of eco-innovation capabilities such as scientific publications, patenting, environmental management in companies, and trade in environmental goods, as well as development of some renewable energy sources, such as wind, solar and geothermal energy, show positive trends in Europe and NIS.[13] The growth rates of these indicators, however, remain relatively low, often lower than the growth rates in the high income countries of Western Europe. The region continues to lag behind highly industrialized countries and there are no indications that the gap with top eco-innovation performers is being closed.

On the sub-regional level, the most significant eco-innovation performance improvements have been in the NMS. Just as in their performance in energy efficiency and in structural transformation towards high-technology manufacturing and tertiarization, the NMS have also outperformed the rest in eco-innovation, probably by virtue of their closer interaction with the EU-15 (Figure 9). The gap in the number of ISO14001[14] certifications between the EU-15 and NMS country groups is gradually closing while for the SEE and EECCA this gap has been growing (Figure 10).

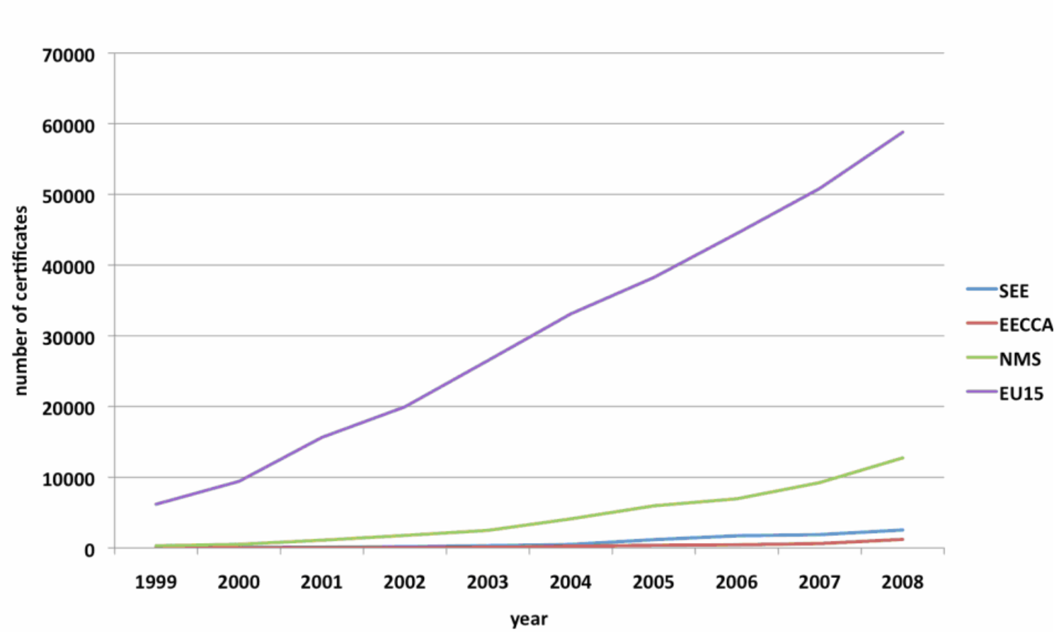
13 The findings in this section come from Technopolis (2011).
14 ISO14001 certificates deal with various aspects of environmental management. The number of ISO certificates is used as a proxy for the level of environmental management.

Figure 9 Environmental patents, (1991-2008), Total number of environmental patents filed in SEE, EECCA,NMS and EU15



Source: Technopolis (2011) calculations based on the data sources from UN COMTRADE.

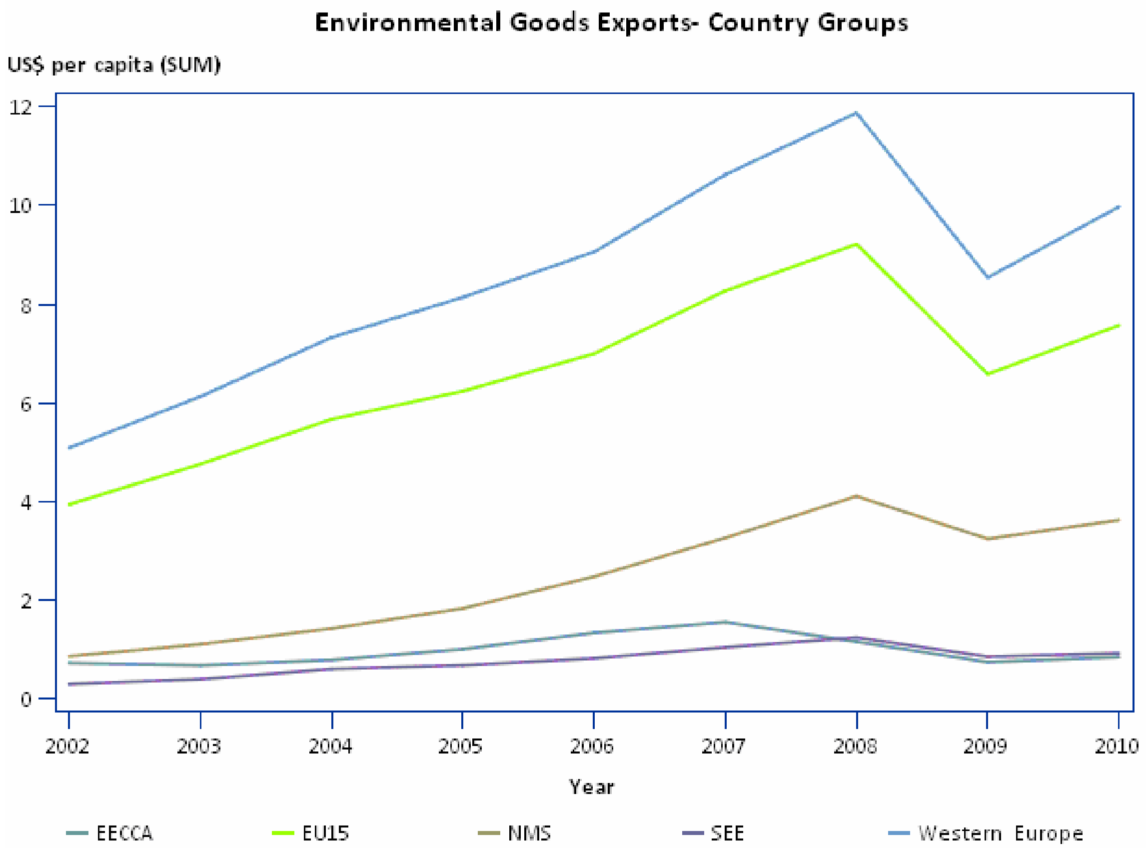
Figure 10 ISO14001 certificates, (1999-2008), Number of ISO14001 certificates registered in SEE, EECCA, NMS and EU15

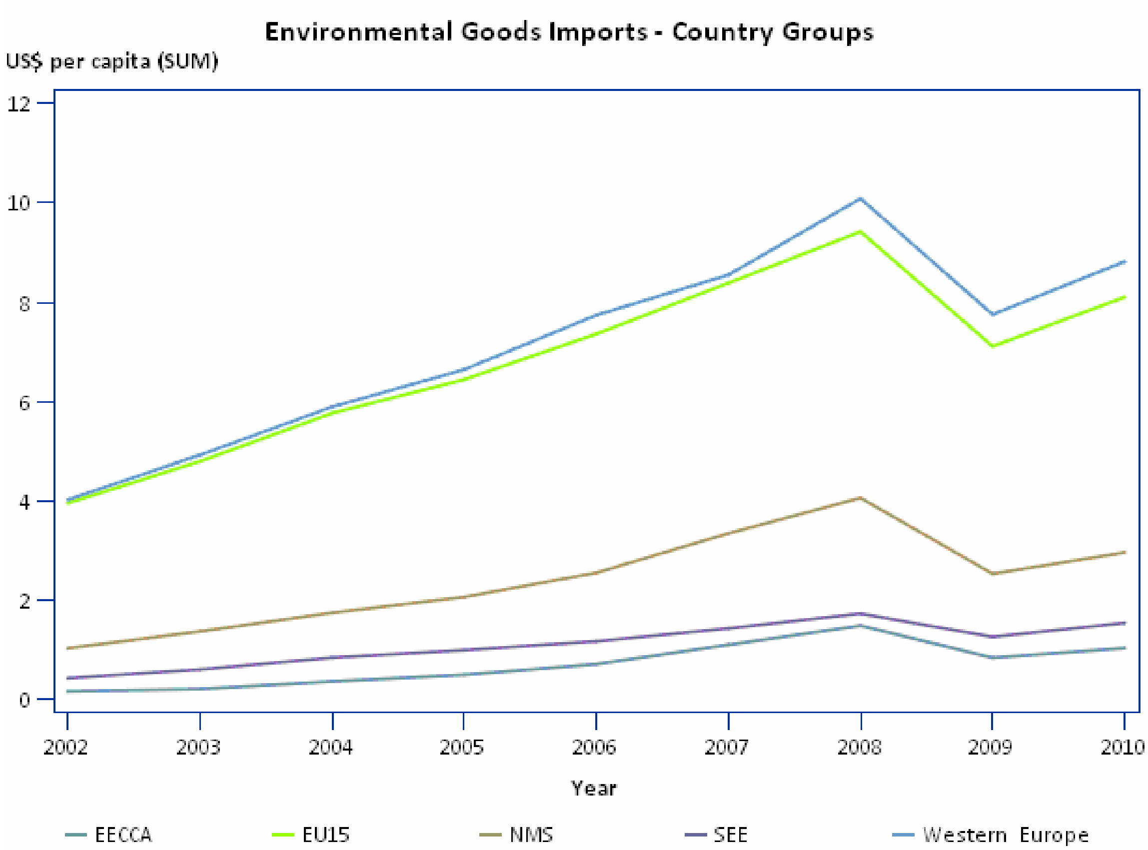


Source: Technopolis (2011) calculations based on the data sources from UN COMTRADE.

Figures 11 shows that in the last decade all country groups followed a similar pattern of growth in trade in environmental goods. This observation is valid for trade flows of both exports and imports. In particular values per capita for both exports and imports experienced uninterrupted growth until 2008, the year of the financial crisis. The less pronounced pattern for EECCA and SEE countries is due to scaling, a result of the much higher values per capita for the EU-15 and Western Europe. This is valid for both export and import trade flows.

Figure 11 Trade in environmental goods, (2002-2010)





Source: Technopolis Group (2011) calculations based on the data sources from UN COMTRADE.

Why is Europe and NIS not achieving its potential?

Barriers to enhanced industrial energy efficiency abound in Europe and NIS and vary by country. How can transition economies overcome these market and behavioural barriers? A useful lesson from newly industrializing economies is that obstacles to energy and resource efficiency are typically the result of transaction costs, information asymmetries, behavioural failures, and a lack of modern collective actions to deal with interdependencies. As such, institutional arrangements ought to be designed to reduce or eliminate these costs and information gaps, and to exploit interdependencies.

Eco-entrepreneurs face a particular problem in convincing potential investors of the attractiveness of the growing market in eco-technologies. Surveys of small and medium enterprises (SME) have found that critical barriers include a lack of finance tailored to SMEs' investment needs, and inadequate synergies between the technological and commercial aspects of eco-technology projects. Private sector reluctance might be overcome by public sector investment and procurement, but this is often lacking. The particular needs of SMEs can be met through participation in global and regional value chains and these practices are becoming more pronounced in Europe and NIS. Lead firms in the value chain can be important agents, providing access to new knowledge, skills and technology, and can also demand compliance with internationally-agreed standards.

Environmental management issues are slowly being integrated into private sector strategies. But potential industrial users are often unaware of the advantages and opportunities arising from investments in efficient technologies, or if they are aware of them, cannot readily obtain the necessary funding. Decision makers do not always benefit directly from their choices and it is not easy to estimate the costs, benefits, risks and duration of industrial energy efficiency investment projects. Moreover, current government subsidization of energy prices makes these investments less attractive.

Governments in many Europe and NIS countries face budgetary constraints that limit the provision of finance to eco-entrepreneurs, while there are only a few investors in 'cleantech' ventures (ETAP, 2010). A recent trend is for clean-tech FDI to target emerging markets but the leap from R&D to commercialization requires further development and an innovation-conducive environment. The local knowledge to absorb new technology and to help create demand in new markets is also lacking.

As a legacy of previous energy regimes there is also an undeveloped culture in support of energy efficiency in Europe and NIS societies and economic sectors. Cultural predispositions and social and institutional norms can strongly influence firms' decision making and can lead to path dependency that can limit or facilitate firms' response to public policies to raise energy efficiency. But these norms can also change over time in response to awareness building and good policy making. Developing and encouraging responsible behaviour through energy efficiency strategies, and devising policies and programmes to support national objectives for energy security and environmental sustainability are therefore important. As and when climate change, energy and resource efficiency concerns are embedded in national and regional policy-making, this will not just lead to eco-innovation, but will also change the way industry, business and government work together to manage resources better.

Although established in many Europe and NIS countries, dedicated government bodies charged with the implementation of industrial energy and other natural resource-saving programmes still lack the necessary capacity and technical skills to design, implement, and evaluate these programmes, to interact with concerned stakeholders at the national level (such as firms and local governmental authorities), and to ensure coordination with other government bodies, foreign donors, and international financial institutions. In many countries, including those that are natural-resource rich, international technical assistance to assist with the design and implementation of national energy strategies, policies and programmes is still critical.

A new ecological industrial policy?

Overcoming the institutional, market and behavioural barriers to sustainable industrial development requires a new ecological industrial policy that encompasses all aspects of modern industrial production (Schepelmann, 2011). This model, based on knowledge and resource efficiency, societal consensus and international competitiveness, envisages a managed transformation of industry taking into consideration the functional and geographical fragmentation of value chains and building capabilities to adjust to the kaleidoscopic nature of comparative advantage (Bhagwati and Deheja, 1994), so that, for instance, where jobs are lost new ones are created in sustainable industries (Mikfeld, 2011).

Policies and tools for an ecological industrial policy are not particularly new in themselves: those to foster renewable energy sources, like subsidies or lowering legal thresholds on emissions from cars, have been used for many years. What is new is an approach bringing measures together in a holistic toolbox that can be applied to all industrial sectors and which at the same time tackles supply and demand issues. National technological capacities influence countries' ability to 'leapfrog' to the most up-to-date environmental technologies and to lead on innovation and development, rather than adopting and adapting sub-optimal equipment from industrialized countries. As part of a competitiveness policy, low income countries especially should therefore promote the diffusion of environmental technologies as a means of accelerating technological catch-up, with a focus on export maximization.

Governments are coming round to the realization that ecological considerations in industry are an opportunity to create jobs, and new markets for technological products and services. Developed countries in the EU have come up with a range of tools comprising an ecological-industrial governance framework for the uptake of new environmentally-friendly technologies and practices in industry, such as energy efficiency, waste management and recycling services, renewable energy technologies, energy efficiency and environmental analytical and advisory services.[15] A preliminary step involves establishing long term goals and quantifiable and achievable efficiency targets through appropriate strategies. In turn, this step requires benchmarking the performance of a given sector or country along the value chains, followed by identification of opportunities to develop and improve energy and raw material productivity and the contribution of renewable energy sources in power generation.

The instruments summarized below can be used by countries in Europe and NIS to build an appropriate ecological-industrial policy framework. Such a policy framework should contain a mix of policies and processes such as ecological regulatory, fiscal, financial and information measures, with each country adopting a mix that corresponds to its national competitive and natural advantage.

15 This section draws on UNIDO (2011).

- **Eco-industrial regulatory framework**. Regulations that set performance and technology standards should be adjusted in line with green growth objectives. These are eco laws and regulations, codes, standards, and labeling, all designed to remove the least-efficient equipment and practices from the market, to cut GHG emissions and set ecological limit values. Environmental policies can encourage companies to review each stage of the production chain and identify where energy, water and material efficiency savings can be made, including mandatory energy eco audits, and resource and energy consumption saving plans. Minimum Efficiency Performance Standards (MEPS) for industry can be used to increase demand for energy efficient equipment, and Energy Management Standards (EMS) to improve energy performance through changes in how energy is managed in an industrial facility. The National Energy Efficiency Action Plans (NEEAPS) adopted by EU member states are models that countries can emulate, combining a range of tools including, financial incentives, technical assistance tools, information provision, recognition programmes, mandatory auditing, and R&D support.

- **Voluntary agreements.** Industrial resource and energy efficiency targets can be set through mandatory measures. Alternatively they can be negotiated with governments under so-called 'voluntary agreements' (VA). These industry agreements, implemented in developed countries since the 1990s, are typically accompanied by financial rewards or exemption from mandatory measures if implemented successfully. They tend to receive greater support from industry and are more flexible and faster to implement than mandatory measures. However, if compliance is low, these agreements may be replaced by mandatory alternatives.

- **Fiscal and market-based policies.** Market-based policy instruments such as ecological taxes are useful instruments to correct for negative externalities such as natural resource depletion or GHG emissions. Carbon taxes, for instance, aim to reduce the demand for carbon-intensive energy by increasing its price (by adding the external cost from GHG emissions to the energy price), thereby providing an incentive to reduce its consumption. In principle, a carbon tax creates an incentive to reduce GHG emissions up to the point when the marginal cost of additional abatement is equal to the level of the tax, thereby minimizing the cost of reducing emissions (static efficiency). Compared to standards and product bans, eco taxes provide greater flexibility in choosing the level and method of cutting GHG emissions and resource depletion, and in principle, they should also provide greater incentives for technical innovation (dynamic efficiency). A related market-based corrective instrument is a tradable quota or permit, most notably in the form of a carbon emission trading scheme (cap-and-trade scheme). International schemes of this type were established by the Kyoto Protocol and have since been followed by several regional and national schemes.

- **Financial policy.** A crucial factor is the need to provide readier access to finance to increase the attractiveness of returns on environmental investments for the private sector. Public funding and official development assistance can play a major role in stimulating private sector investment. An important measure is to increase the transparency and accountability of public revenue and expenditure. Countries also need to be more proactive in tapping into global climate-related funds, and the capacity for project and programme identification and preparation needs to be further developed. Public funds have a critical role to play in leveraging private financial flows and investment, as well as attracting support from donors and international financing institutions. Working with international financing institutions and local banks to enable private-sector green investment will also be important. Instruments such as soft loans, guarantees and revolving funds, and venture capital funds, help increase the capital available, and decrease perceived risk. Public finance and technical cooperation programmes are needed to address the lack of capital and capacity until green technology has reached the diffusion stage. Public and development financing institutions can set up loan programmes (soft loans, credit lines, publicly-backed guarantees) to fill the financing gaps in immature financial markets.

- **Information policy.** At a national level, governments can encourage companies to establish Energy Management Standards (EMS) by providing information on best practices (industrial system optimization libraries), training on how to comply with standards, and recognition of industrial firms that meet standards. Public standardization policy allows businesses to overcome information and agency constraints. International cooperation in standardization makes it possible to cut the transaction costs associated with introducing equipment. Information and awareness campaigns and offices to disseminate energy efficiency information increase awareness of industrial energy efficiency benefits at various levels of production. They make it possible to choose between possible technical options and make the costs of available technologies transparent. They have no direct impact on GHG emissions or production costs, but they do have the potential to change stakeholders' perceptions. Though relatively easy to implement, they do require public funding and the presence of pre-existing institutions for the organization and implementation of campaigns.

- **R&D and innovation policy.** One of the key obstacles to energy efficiency is the low emphasis given to environmental policies in national development, competition and poverty reduction strategies. Mainstreaming pro-innovation regulations and incentives into environmental policy making encourages value-creation responses to the goal of decoupling economic growth from natural resource (energy, materials and water) use. Governments can enact several policies, such as providing government-funded and performed research, subsidizing research in the private sector, developing a minimum level of technology infrastructure both in terms of skilled human and physical capital, through government procurement and by fostering the development of clusters and networks by which tacit and codified knowledge can be transmitted and green regional innovation systems for stimulating commercialization of new technologies can emerge. Public procurement is an important means of addressing the demand-side weaknesses of innovation. Incorporating a green growth agenda into government procurement and green criteria in all tender processes is particularly important in emerging economies where the state has a greater role in boosting demand in order to make up for weaknesses in the private sector.

- **Demand side management and Energy Service Companies (ESCOs).** Demand side management (DSM) programmes are voluntary or mandatory initiatives by energy utilities to encourage end-users (including industrial clients) to improve energy efficiency. Utilities are in a unique position to influence energy efficiency behaviour owing to their financial, organizational, and technical capacity, as well as their unique "connection" to virtually all energy users (UNECE, 2009). DSM aims to change the level or pattern of customer consumption by providing rebates, loans, subsidized audits, free installation of equipment and energy awareness programmes to industrial firms (Gillingham *et al.*, 2006). Utilities' ability to provide support through the entire economy, however, may be quite limited. Hence regulatory mechanisms and government support are required to create mandates or incentives to pursue DSM programmes (Violette and Sedano, 2006). DSM programmes can provide a powerful and effective basis for other regulatory tools and financial mechanisms, and are a useful way for utilities to limit consumption without compromising profitability. ESCOs can play a similar role to that of utilities in the provision of energy-management services and creative financing tools to industrial firms. ESCOs and end-user industrial firms usually stipulate an energy performance contract (EPC), in which the two parties set the terms for sharing the risk and co-financing of industrial energy efficiency projects. Depending on the contract, ESCOs assume the project performance risk (ESCO guarantees a minimum level of energy savings), design, provide or arrange financing for the energy efficiency project (and receive a payment based on energy services provided by the project), install and maintain the energy efficiency equipment involved, and may take credit risks.

- **Monitoring, evaluation and reporting.** Environmental monitoring and reporting systems should be established to identify violations and to assess whether policies have been effective over the long-term. Indicators should form part of all monitoring and enforcement regimes, as a tool to simplify, quantify, and communicate environmental data. Effective compliance regimes should include a combination of promotion, monitoring, and enforcement tools, which are mutually supportive. Methods to promote compliance, such as education, training and outreach, are an important feature of enforcement and compliance regimes. At the national level and sub-national level, responsibility for the public management of energy and environmental strategy and policy often lies with a dedicated body, such as energy and material efficiency agencies or environmental agencies at national and sub-national levels. To implement national energy policies, as well as dedication, this government body requires strong technical and coordination skills to reduce contradictions and overregulation, and foster coherence and efficiency. It should also be able to collaborate closely with local industry players, academia, and local intermediary institutions (such as energy and information centres), in implementing ecological industrial policies and programmes.

In sum, with reference to the areas identified in this issue paper, following specific questions are to be considered at the Round Table discussion:

- What is the potential in the region to pursue a new industrial growth model that is both resource efficient and knowledge-based, and also boosts eco-innovation, green jobs and competitiveness?

- How should the benefits from importing eco-innovation technologies and methodologies be balanced against investing in endogenous R&D potential?

- How can countries identify current innovative activities in the region which are encouraging innovative technologies and eco-innovation?

- What are the global and regional market trends for sustainable products and services and how are they evolving?

- What are the barriers to uptake of new innovative industries and technologies in the region? Are they sub-region or country specific? How well are they understood? What are the regional approaches to resolving them?

- Why do some companies go green despite numerous market barriers?

- What financial tools can be used to increase capital for eco-innovation and reduce perceived risk?

- What governance and policy frameworks are most appropriate for promoting innovative industries and technologies for the region?

- Is it sufficient to 'green' industry or are more far-reaching reforms necessary? Are comprehensive data and tools available to monitor progress towards sustainable production and consumption patterns at global and national levels?

- How can governments, the private sector and international organizations engage in collective efforts to bring about a new industrial growth model? What business models should be used to create new green markets and jobs?

- What lessons can be learned from the new EU member states and used for the region?

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Annex 1 Europe and NIS region by sub-regional definitions

South East Europe (SEE)
Albania
Bosnia and Herzegovina
Croatia
Macedonia, FYR
Montenegro
Serbia
Turkey
Eastern Europe, Caucasus and Central Asia (EECCA) = Commonwealth of Independent States (CIS)
Armenia
Azerbaijan
Belarus
Georgia
Kazakhstan
Kyrgyzstan
Moldova
Russian Federation
Tajikistan
Turkmenistan
Ukraine
Uzbekistan
New EU Member States (NMS)
Bulgaria
Cyprus
Czech Republic
Estonia
Hungary
Latvia
Lithuania
Malta
Poland
Romania
Slovakia
Slovenia
Europe and NIS region = SEE + EECCA + NMS

- Europe and NIS region is also used in the literature Emerging Europe and Central Asia.
- Pan-European Region = EECCA + NMS + SEE + Western Europe.

Classification of EECCA, NMS and SEE countries by income and sub-regions

Low income (US$1,005 or less)	Lower-middle income (US$1,006 to US$3,975)	Upper-middle income (US$3,976 to US$12,275)	High-income (US$12,276 or more)
Kyrgyzstan	Armenia	Albania	Croatia
Tajikistan	Georgia	Azerbaijan	Cyprus
	Moldova	Belarus	Czech Republic
	Turkmenistan	Bosnia and Herzegovina	Estonia
	Ukraine	Bulgaria	Hungary
	Uzbekistan	Kazakhstan	Latvia
		Lithuania	Malta
		Macedonia, FYR	Poland
		Montenegro	Slovakia
		Romania	Slovenia
		Russian Federation	
		Serbia	
		Turkey	

Source: World Bank (2011) classifications (GNI per capita).
http://data.worldbank.org/about/country-classifications

Background Papers

Changing production and investment patterns in Europe and the Newly Independent States[16]

Olga Memedovic, UNIDO

Introduction

Estimates of global trends in resource consumption indicate that the earth's natural resource base is in severe danger of over exploitation and collapse, threatening prospects for pursuing sustainable development in the 21st century (Giljum and Polsten, 2009). The global use of energy is set to rise by 84 per cent by 2050, and energy-related CO_2 emissions could double (IEA, 2010: 48). Faced with these scenarios, efforts are growing to develop multilateral solutions to forestall an impending crisis, to decarbonize the global economy, and to reduce the environmental impact of economic activities (UNIDO, 2011). Ambitious targets for reducing greenhouse gas emissions and for increasing renewable sources of energy have been established at both the global and regional level.[17] 'Green growth' models are discussed, aimed at stimulating investment in new innovative industries and technologies that could lead to radically different production and consumption patterns, the so-called 'third industrial revolution' (Rifkin, 2011). The green growth development model, it is believed, can reconnect the three pillars of sustainable development: environmental, economic and social (see Box 1).

In the Europe and Newly Independent States (Europe and NIS) region,[18] due to divergences in levels of economic development, many countries are still witnessing dramatic shifts in economic structure, as heavy industries make way for less carbon- and resource-intensive activities. Low-carbon transition presents a window of opportunity: targeted investments in new environmental technologies and projects will boost qualitatively different structural transformations with new green technologies leading to the emergence of new innovative industries, new jobs and hence diversification of the economic base; it will increase the energy and resource efficiency of the economy; and it will change conceptions of production and consumption at all levels, including for consumers, firms and cities. The region has great potential for energy efficiency (see Box 2) and for tapping renewable energy sources, which can be integrated into a diversified pan-European energy market.

This paper presents a quantitative analysis of structural change, and the changing patterns of energy demand and consumption in the Europe and NIS region over the past two decades. The paper addresses the following questions:

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16 This working paper was prepared by Olga Memedović, Chief, Europe and NIS Programme, UNIDO Programme Development and Technical Cooperation Division. UNIDO consultant Shabnam Marboot Sadegh and UNIDO interns Emina Alic, Thomas Jackson, Divna Popov, and Denis Subbotnitskiy provided valuable inputs during various stages of the preparation of this paper. Valuable comments were provided by Patrice Robineau. Proof-reading and English language editing was provided by Georgina Wilde.

17 For instance, as part of 'Europe 2020', the European Commission (EC) has set targets for the European Union for 2020 to achieve a) 20 per cent reduction in greenhouse gas emissions of 1990 levels; b) 20 per cent of energy from renewables, and c) 20 per cent increase in energy efficiency (http://ec.europa.eu/europe2020/targets/eu-targets/index_en.htm).

18 The UNIDO Europe and NIS Programme cover countries from Eastern Europe, Caucasus and Central Asia (EECCA) + EU New Member States (NMS) + South East Europe (SEE), and also Malta and Cyprus.

1. What are the energy performances of the countries in the region?
2. To what extent have energy (resources) and economic growth become decoupled in the region?
3. What were the structural change trends in economy and industry over the past two decades?
4. To what extent have structural change and technological progress contributed to regional energy conservation?
5. What is the link between changes in energy efficiency, energy intensity and industrial investment in the region?
6. What polices are suitable for promoting a sustainable growth model in the region?

Box 1 The Green Economy and Green(ing) Industry

The Green Economy and Green Industry are central to the global debate on sustainability in the 21st century. In the Green Economy, industry is more competitive and resource efficient with lower carbon emissions and a greater recognition throughout society and industry of the need to decouple economic growth from resource consumption. Furthermore, the Green Economy approach stimulates eco-innovation, 'greentech' and job creation in 'green' sectors (UNIDO, 2011a). While the Green Economy is a macroeconomic view of green transition across economic systems and sectors, Green Industry looks at the activities that provide environmental goods and services. These can be in a variety of areas, such as waste management and recycling; energy efficiency technology and equipment; environmental services, including advice and monitoring (for instance Energy Service Companies-ESCOs); and pollution control technologies and equipment.

Greening industry is the process whereby all industries improve their environmental performance and resource and material efficiency (UNIDO, 2011a). Through their role in improving environmental product design, firms have an important role in greening industry. Products can be designed to contain fewer materials (dematerialization), and to consume less energy, less water, and less detergent. The relative importance of these aspects depends on products' life cycles of energy and material use. Automobiles and white goods, for example, typically consume more energy and materials during their life cycle than during the production process. It is therefore important that firms focus on designing energy-efficient products. At the same time, it is also important to recognize that firms in developing countries are rarely involved in the design process of products they manufacture. In global value chains, for instance, design and manufacture take place in different countries. In many developing countries, there is very little product-design capacity, let alone environmentally responsible product design (UNIDO, 2011a).

The use of certain instruments can highlight the true resource cost of products. Life-Cycle Assessments (LCA), for instance, are used to assess resource use and environmental impact throughout the product life cycle (i.e. from resource extraction to recycling or disposal). They can show intense spots of resource use and point to where efficiency savings should be made (UNIDO, 2009c). Life-cycle assessment focuses on the entire life cycle of production sites and manufacturing processes, accounting for all environmental, social and economic impacts. The environmental impacts of industrial energy use differ across energy sources. Direct impacts arise during energy use in industrial processes, while indirect impacts result from production and supply of the energy used by industry (such as at power stations in the case of industrial electricity consumption). Life-cycle assessment quantifies the use of materials and energy and the generation of waste and emissions at each stage of a product's life cycle, applying the same methods used for materials and energy flow analysis and balances at the unit operation level.

Industry can mitigate emissions in other sectors by designing and delivering low-carbon products and services; reducing, recycling and recovering waste from its own operations and those of its supply chains, and reducing associated transportation requirements. Several studies have argued that greening industry can benefit firms in several ways. It can increase production efficiency and enhance competitiveness (see IFC (2011) for a case study on the potential for savings and increased competitiveness in the Russian ferrous foundry industry).

The focus of this report is on 31 countries in Central, Eastern, and South East Europe, the Western Balkans, the Caucasus and Central Asia. The country coverage extends over 25 million square km and has a population of around 400 million people. The countries diverge widely in several dimensions, including income levels, economic structure, energy use and ecological impact. For the purpose of this paper countries are classified by income groups and sub-regions (see Box 3).

Box 2 What is energy efficiency?

Energy efficiency refers to an activity or product that can be produced with a given amount of energy. It is measured as the ratio of useful outputs to energy inputs for a system, where the latter may be an individual energy conversion device, a boiler, a building, an industrial process, a firm, a sector or an entire economy (Sorrell, 2010). Energy intensity is the amount of final energy (or end-use energy) used to produce a certain amount of physical output.[19] Similarly, CO_2 intensity is a rough measure of a country's potential to switch from high carbon fuels to low carbon fuels (gas or renewable energy) (World Bank, 2010).

The notion of energy efficiency is closely related to energy productivity, or "the level of output achieved from the energy consumed". Whereas energy efficiency is the overarching idea of doing more or the same with less energy, energy productivity refers to increasing the cost effectiveness of the use of fuel or electricity services either through raising the technical efficiency of fuel conversion, or lowering the cost of energy input (Brookes, 2000). Energy productivity combines energy efficiency and curbing energy demand (or energy conservation).

At the level of a specific technology, the difference between efficiency and energy intensity is insignificant — one is simply the inverse of the other. High levels of energy efficiency are associated with low levels of energy intensity. The level of energy intensity can be influenced by the "economic structure", (i.e. the contribution of various sectors to GDP), the primary energy mix (i.e. the share between coal, oil, gas, biomass, other renewables and nuclear), climate conditions, the level of economic development and lifestyles, the transport and logistics sector capabilities and by the technical energy efficiency.

The paper is organized as follows. Sections 2 and 3 analyze energy intensity and energy-related CO_2 emissions by country and for the group of countries a whole. The paper finds that the region continues to have some of the highest rates of energy intensity in the world, even though these have steadily decreased since the early 1990s. This progress can be attributed to the combined effects of changing production patterns, namely structural changes in economy away from carbon intensive activities, increased use of less carbon-intensive energy sources such as gas and nuclear, improved energy efficiency in manufacturing and households, and economic downturn. The region is converging with the world average, but still has some way to go to before it reaches EU-15 averages. Closing the gap with the best performing countries in the pan-European region and meeting ambitious carbon reduction and efficiency targets will require additional efforts from governments, industry and international organizations. At the same time, the region remains heterogeneous in its energy consumption patterns; some countries are still reliant on coal and oil while others derive the majority of their energy from nuclear and renewable sources.

Turning to the factors explaining changes in manufacturing energy intensity, Section 4 discusses the relative importance of structural factors (shifts away from energy intensive economic sectors) versus the technological effect (use of more energy efficient technologies and methods). The decomposition analysis finding points out that the good manufacturing energy performances in the new member states (NMS) and CIS were driven by the technology effect rather than by structural changes; upper middle income countries appear more effective than low middle income countries in improving energy efficiency. Section 5 presents the main structural change trends in the global economy and in the pan-European region over the last

19 Freeman et al. (1997) define energy intensity as "the ratio of energy input to useful output." Nicholas Stern (2007) similarly states that "energy intensity is the energy input divided by the economic or other desired output."

four decades. Analysis shows that since 1970 tertiarization was the dominant feature of structural change in the global economy, and that not only agriculture but also the industrial sector was growing more slowly. In the pan-European region, the tertiarization process slowed slightly between 2005 and 2008 to the advantage of "mining and utilities" and the construction industry. Industry continues to make up a significant part of economic activity in Europe and the NIS, although with a declining contribution to value added. The section also shows that national private investment and FDI have become important forces in the development of local industries.

Box 3 Country Coverage

Classification of countries by income and sub-regions

Low income (US$1,005 or less)	**Lower-middle income (US$1,006 to US$3,975)**	**Upper-middle income (US$3,976 to US$12,275)**	**High-income (US$12,276 or more)**
Kyrgyzstan	Armenia	Albania	Croatia
Tajikistan	Georgia	Azerbaijan	Cyprus
	Moldova	Belarus	Czech Republic
	Turkmenistan	Bosnia and Herzegovina	Estonia
	Ukraine	Bulgaria	Hungary
	Uzbekistan	Kazakhstan	Latvia
		Lithuania	Malta
		FYR Macedonia	Poland
		Montenegro	Slovakia
		Romania	Slovenia
		Russian Federation	
		Serbia	
		Turkey	

Source: World Bank classifications; 2011 World Bank classification (GNI per capita). http://data.worldbank.org/about/country-classifications

Country Groups:

South East Europe (SEE):
Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Montenegro, Serbia and Turkey

Eastern Europe, Caucasus and Central Asia (EECCA):
Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan

EU New Member States (NMS)
Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia

Emerging Europe and Central Asia = EECCA + NMS + SEE

Pan European Region = EECCA + NMS + SEE + Western Europe

UNIDO Europe and NIS = EECCA + NMS + SEE + Malta and Cyprus

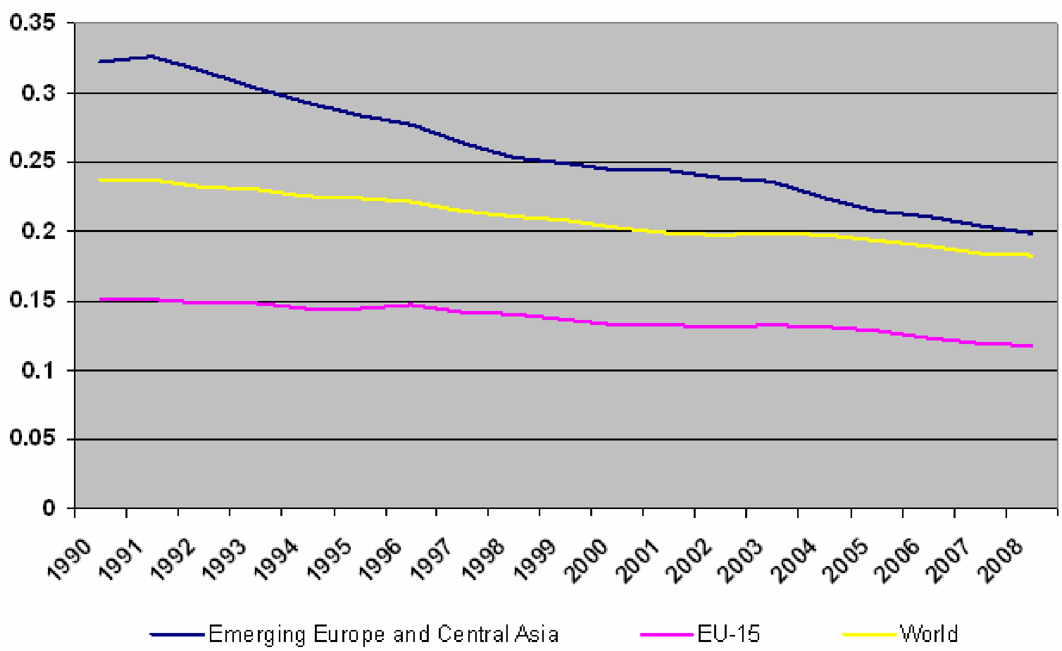
Sections 6 and 7 discuss patterns of specialization in manufacturing using industrial intensity indices and trade in intermediate goods. The analysis reveals a stark divergence between countries. In the low and lower-middle income group, food and beverages and basic metals still dominate manufacturing, but their importance is declining while that of non-metallic mineral products and textiles and apparel, leather and footwear has risen significantly. The importance of high-tech sectors remains small. In the upper-middle income group, which produces around 60 per cent of the region's industrial output, shifts in the manufacturing structure towards high and medium technology-intensive activities are much more visible while South East Europe (SEE) states are still struggling to make an impact in medium and high technology exports compared with upper middle income countries. The region as a whole is gradually being integrated into the global economy and becoming more internationally competitive, through an increasing share of the intermediate goods trade and by using foreign intermediate goods for local production. This is an important issue to address since the region's countries must diversify their economies and reduce their vulnerability to external shocks (for instance, the fluctuating global prices of raw materials). High energy-intensive sectors continue to represent more than 30 per cent of manufacturing value-added in Europe and the NIS.

Section 8 addresses prospects for structural change in the energy sector. Many countries in the region were motivated to diversify energy sources because of energy security worries relating to their energy import dependence. This has prompted the construction of new energy infrastructure, as well as the exploitation of domestic resources, which are not always low-carbon. Current data on national energy mixes show that development of alternative energy sources is still nascent in most countries, despite vast potential. Finally, Section 9 provides conclusions.

Still one of the most energy-intensive regions in the world

Despite improvements over the past two decades, the region as a whole remains one of the most energy intensive regions in the world, and still has some way to go before it reaches European Union (EU-15) averages (Figure 1). However, the region managed to reduce energy intensity by around 2.7 per cent per year over the period 1990-2008, compared with a global annual decline of 1.4 per cent during the same period (see Appendix 1), and has been converging with the global average since 2005 (Figure 1).

Figure 1 Energy intensity of GDP, (1990-2008), Units of energy use (kg of oil equivalent): per US$1000 GDP



Source: World Bank database, UNIDO calculations Note: GDP at PPP exchange rates and 2005 prices.
Note: Emerging Europe and Central Asia excludes Montenegro and Serbia and includes Cyprus and Malta.

The World Energy Council (2010) reports that in most world regions, except in the Middle East where energy consumption has been increasing faster than GDP, the amount of primary energy used per unit of GDP is decreasing. This is the result of the combined effect of higher energy prices, energy efficiency and CO_2 abatement policies and programmes, and the structural change towards tertiarization. According to regional breakdown by the WEC, in Europe and the Commonwealth of Independent States (CIS)[20], the primary intensity including biomass has decreased less rapidly than the primary intensity of conventional energies, because of the broader use of biomass. The CIS uses 2.7 times more primary energy per unit of GDP than Europe, the world region with the lowest energy intensity. This can be explained by the dominant role of energy intensive industries and low energy prices. Industry is driving energy intensity reduction in industrialized countries, households in developing countries and regions, while energy productivity improvements were almost equally driven by industry, energy conversion and households in China and the CIS (WEC, 2010a).

Carbon intensity of industry

Since 1990, the EU-15 carbon intensity of energy has been well below the global average and has decreased significantly over the period, diverging from the global average since 1999 (Figure 2). Between 1990 and 2008, carbon emissions in Europe and NIS fell by around 28 per cent due to both the growing use of less carbon-intensive energy sources, such as gas, structural and technological changes and the recent economic downturn (EBRD, 2011:2). The reduction in the carbon intensity of energy has been driven by a shift from coal and oil towards natural gas and to nuclear power and renewable sources (EBRD, 2011:11). The principal driving factor has been the changing demand of industry and power generation for carbon-intensive fuels, namely coal-based power and heat generation. However, despite this trend it is predicted that CO_2 emissions in the region will exceed levels of the 1990s by 2015 (World Bank, 2010: 30).

Within the region, there is considerable divergence by country in terms of carbon intensity. In 2008, the carbon intensities of Uzbekistan, Kazakhstan and Turkmenistan were the highest in the region (see Appendix 2). The national endowment of natural resources has influenced CO_2 emissions. Carbon-energy intensive countries such as Russia and Kazakhstan have much higher emissions than the EU-15 average, despite their lower economic activity. Conversely, countries with a higher share of energy from renewable sources, but which are less affluent, such as Tajikistan and Kyrgyzstan, emit low levels of CO_2 per capita (UNEP/EEA, 2007: 24).

By sector, the generation of electricity and heat is the largest source of global GHG emissions, followed by transport, manufacturing and construction, and other energy industries. In Europe and NIS, electricity and heat production contributed around 49 per cent of energy-related CO_2 emissions and manufacturing and construction around 16 per cent from direct combustion of fuels, followed by transport (14 per cent) and other energy industries (4 per cent) in 2008 (IEA, 2010 database, UNIDO calculations). Figure 3 shows changes in the energy-related CO_2 emissions of industry. Among the New EU Member States, the smallest decrease was in Poland, which is still 95 per cent dependent on coal-fired electricity.

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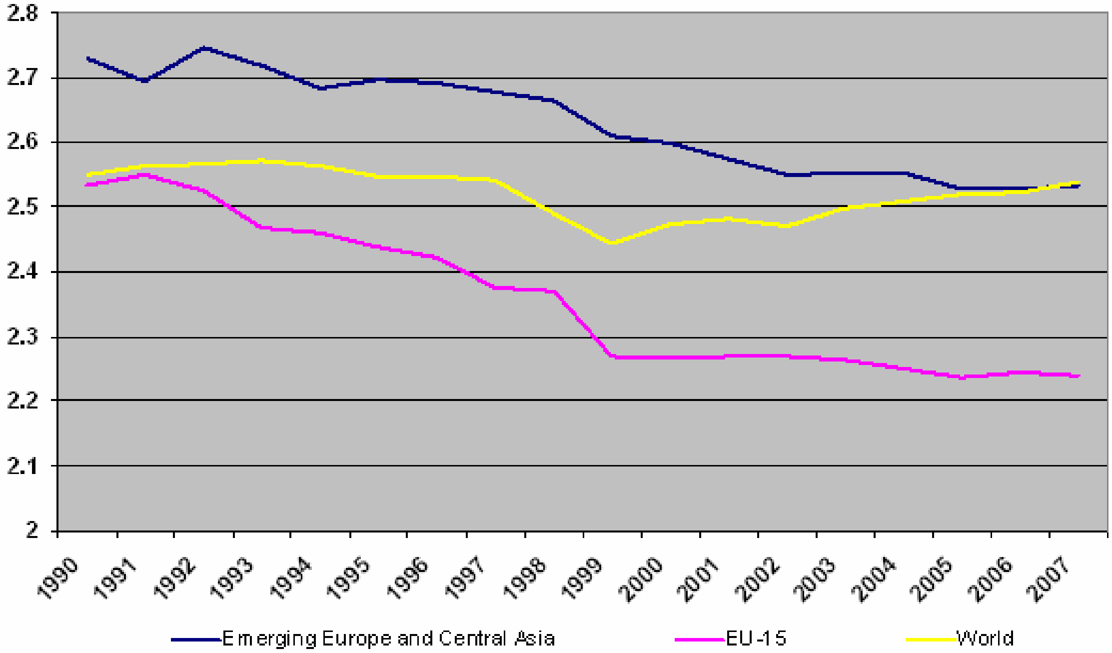
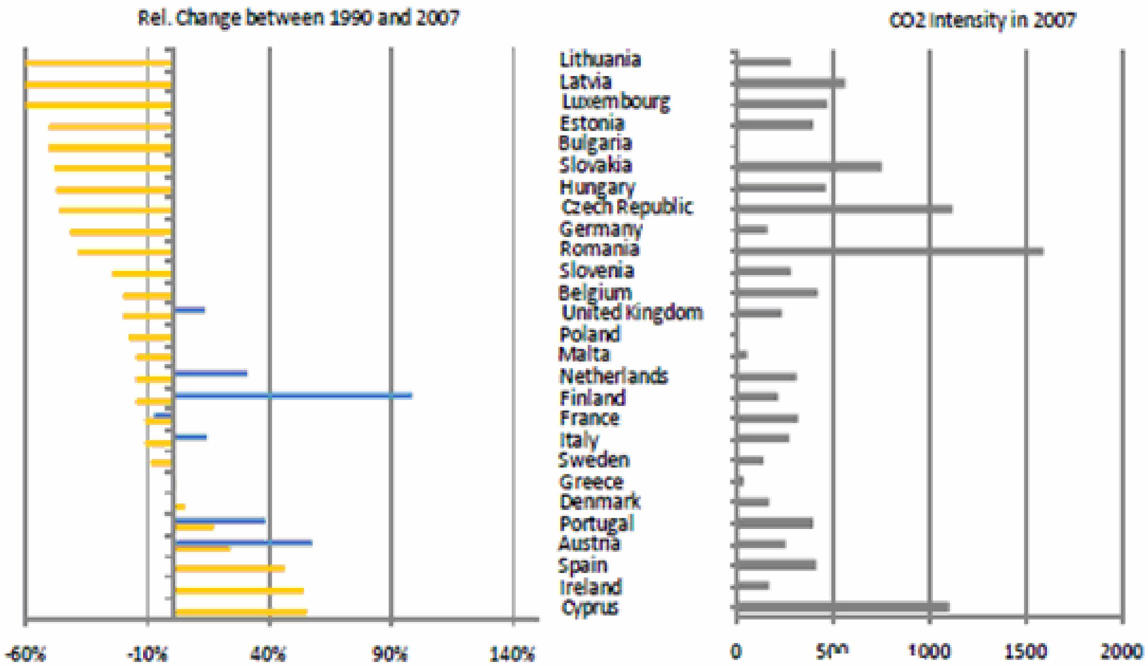
20 Europe: EU, Albania, Bosnia, Croatia, Iceland, Macedonia, Norway, Serbia, Switzerland and Turkey; CIS (Commonwealth of Independent States): Azerbaijan, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine (WEC, 2010: 10).

Figure 2 CO_2 intensity of the economy (energy related CO_2 emissions), (1990-2008), (kg per kg of oil equivalent energy use)



Source: UNIDO calculations based on MDG database of the UN Statistics Division.
Note: Emerging Europe and Central Asia excludes Montenegro and Serbia and includes Cyprus and Malta.

Figure 3 Energy-related CO_2 intensity of industry, (1990-2007), (per Euros 1 million of output)



Source: European Environment Agency (2009).

Energy intensity in manufacturing

There is a downward trend of manufacturing energy intensity in the region and in the pan-European region as a whole. Table 1 shows that within Europe and NIS, Bulgaria, Slovakia, FYR Macedonia, Hungary, the Czech Republic and Poland were at the bottom of the energy performance list in both 1996 and 2006.

Table 1 Energy intensity in manufacturing by selected countries, (1996, 2006) (ktoe/millions of 1995 US$); Countries are in ascending order)

	1996		2006
Israel	0.052	Israel	0.065
Denmark	0.113	Denmark	0.105
Austria	0.134	South Korea	0.150
South Korea	0.144	Austria	0.162
France	0.154	France	0.163
Italy	0.155	Italy	0.193
Spain	0.194	Hungary	0.205
Belgium	0.205	Spain	0.209
Slovenia	0.215	Sweden	0.222
Turkey	0.265	Belgium	0.226
Sweden	0.293	Greece	0.256
Finland	0.332	Slovenia	0.272
Norway	0.374	Turkey	0.285
South Africa	0.411	Norway	0.293
Greece	0.437	Finland	0.330
Czech Republic	0.600	Czech Republic	0.345
Hungary	0.711	Poland	0.389
Poland	0.891	South Africa	0.414
FYR Macedonia	0.980	Slovakia	0.697
Slovakia	1.889	China	0.707
China	2.054	FYR Macedonia	0.785
Bulgaria	2.572	Bulgaria	1.058

Source: Cantore (2011), elaborated from UNIDO and IEA data.

However, if the efforts made by countries to reduce energy intensity are considered, Europe and NIS have experienced the largest improvements in reducing energy intensity in manufacturing, as shown in Table 2. In broad terms, Table 2 shows the highest reduction in energy intensity in recent EU accession countries, and increases in energy intensity in Turkey and West European countries such as France, Austria, Italy, Belgium and Spain. In other words, a convergence process of energy intensity between Western Europe, new EU members and the rest can be observed.

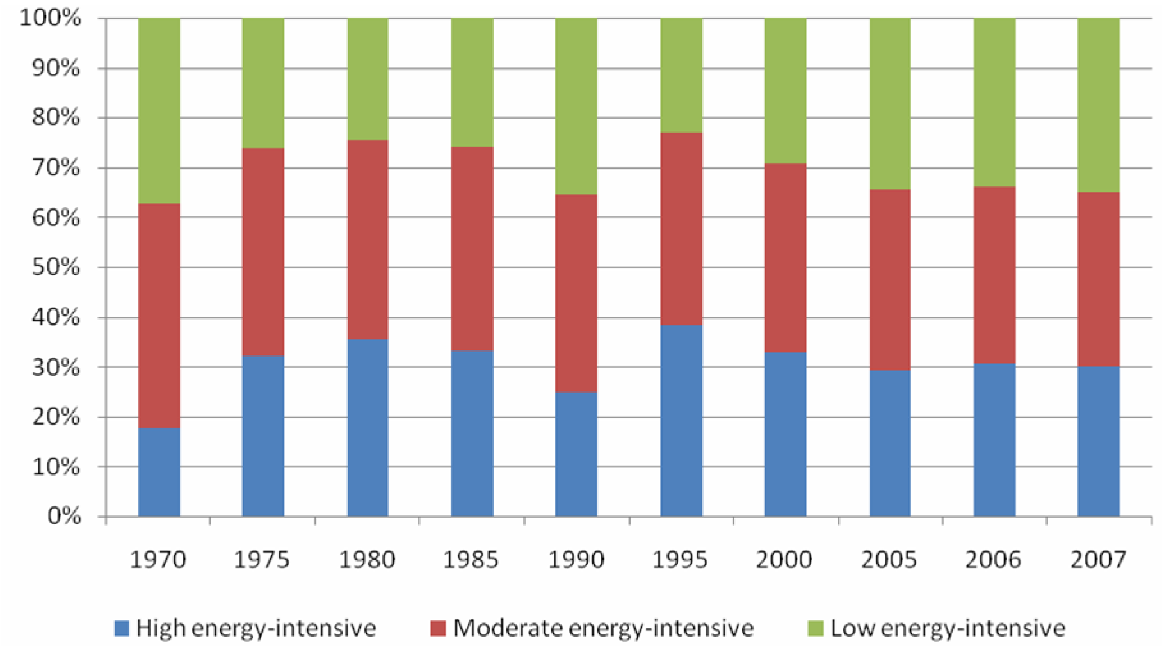
Manufacturing energy intensity classifications developed by UNIDO show that in Europe and the NIS, high energy-intensive sectors continue to represent more than 30 per cent of manufacturing value-added (Figure 4). Around 30 per cent of manufacturing value-added is produced in moderate energy-intensive sectors. During the 1970s and 1980s, the share of high and medium energy-intensive sectors gradually increased but fell after 1990, following the collapse of central planning that led to a reduction in heavy industrial activity. The maximum share (nearly 80 per cent) of high and moderate energy-intensive sectors was achieved in 1995, as regional economies started to recover. Subsequently, the share of those sectors started to decline, caused by structural transformation in manufacturing. However, low energy-intensive sectors still account for less than 35 per cent of total manufacturing value-added. This manufacturing structure affects the overall standing of the region in energy intensity, contributing to its poor performance in comparison with other regions of the world and the global average.

Table 2 Change of energy intensity, (1996,2006), (in Per cent)

Country	1996/ 2006 energy intensity reduction
Hungary	246.99
Slovakia	171.19
Bulgaria	143.19
Poland	128.94
Czech Republic	73.84
Greece	70.72
Latvia	69.67
Sweden	31.63
Norway	27.46
FYR Macedonia	24.92
Denmark	7.34
Finland	0.70
France	-5.07
Turkey	-6.99
Spain	-7.12
Belgium	-9.25
Austria	-16.98
Italy	-19.49

Source: Cantore (2011) elaborated from UNIDO and IEA data.

Figure 4 Shares of sectors by energy intensity in manufacturing value-added in Europe and the NIS, (1970-2007)



Source: UNIDO database, UNIDO calculations.

Structural changes: main trends

Although the energy intensity of an economy can be measured as the ratio of energy used to GDP, it is more instructive to look at underlying structural change trends, as these can better highlight ‘true’ efficiency improvements (EIA, 2003). The most common meaning of the concept of structural change refers to long-term and persistent shifts in the sectoral composition of economic systems that form the economic structure (Chenery *et al.*, 1986; Syrquin, 2007).[21] Structural change is thus associated with shifts in the relative importance of different economic sectors over time, measured by their share of output, employment or energy use. The tertiarization process, involving a structural shift to less energy-intensive sectors with lower energy use per unit of value added, can contribute to low overall energy intensity of the economy. An additional impact can come from structural shifts in industrial value added. Countries that have more energy intensive industries will, all things being equal, see a rise in industrial energy intensity whereas countries where services are of growing importance will see decline in energy intensity (WEC, 2010b).

Analysis of the world economy since 1970 in Table 3 shows that tertiarization was the dominant feature of structural change, and that not only agriculture but also industry was growing more slowly.[22] Although this has sometimes been described as a “dangerous” de-industrialization phenomenon, the most recent data show a reversal of this process, with the growth of world value added being slower in the service sector than in agriculture and industry. This can be partly explained by recent increases in the relative prices of agricultural and mineral products, which have sustained their share of world value added. In addition, the shares of manufacturing and construction have also risen, reversing a long-standing downward trend. In the pan-European region, the tertiarization process, shown by the rising value-added share of services from 47 to 71 per cent between 1970 and 2005, receded slightly in the last three reported years between 2005 and 2008 to the advantage of “mining and utilities” and the construction industry, the only non-service sector in which Europe appears specialized. The shares of agriculture and manufacturing, with declining trends in the previous decades, had stabilized at 2 and 17 per cent respectively by 2008.

Industry continues to make up a significant part of economic activity in Europe and the NIS, although with a declining contribution to value added (Figure 5). In the 1990s, the share of services increased significantly from 41.9 per cent in 1990 to 57.9 per cent in 2000. During the 2000s the share of services stabilized, reaching 65.9 per cent in 2008. Advanced services such as transport, logistics and communications as well as mining and utilities show growing importance while agriculture and manufacturing shares of total output by added value declined between 1970 and 2008 (Figure 6).

21 In development economics and in economic history, economic structure is commonly understood as “the different arrangements of productive activity in the economy and different distributions of productive factors among various sectors of the economy, various occupations, geographic regions, types of product, etc …” (Machlup, 1991: 76; Silva and Teixeira, 2008: 273-275, quoted in Memedović and Iapadre, 2009:1).

22 In terms of value added at current prices and exchange rates (Memedović and Iapadre, 2009), the service sector was already dominant in 1970, representing 52 per cent of world production, and 68 per cent in 2008. The respective shares of agriculture were 10 per cent in 1970 and 3.6 per cent in 2008, and those of industry 38 per cent and 29 per cent (*Ibid*.).

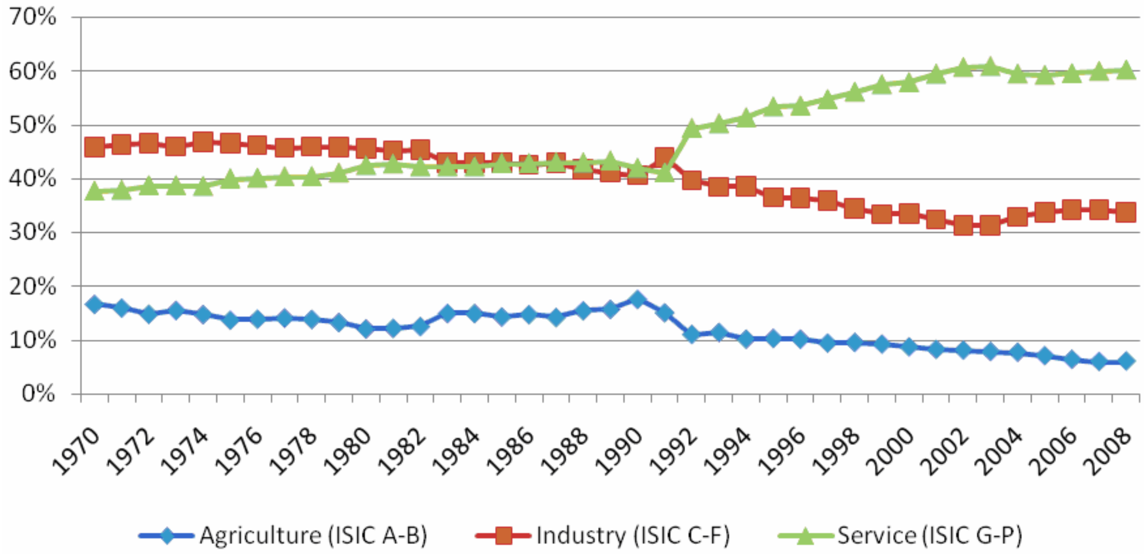
Table 3 Sector distribution of total value added in World and pan-European region (percentage shares at current prices), (1970-2008)

	1970	1975	1980	1985	1990	1995	2000	2005	2008
World									
Agriculture	10.0	8.9	7.3	6.8	5.6	4.3	3.6	3.6	4.0
Industry	38.3	38.3	38.4	35.0	33.3	30.5	29.1	28.8	30.1
Mining and utilities	4.0	5.5	7.1	6.3	5.2	4.3	4.5	5.5	6.2
Manufacturing	27.7	25.9	24.6	23.0	21.7	20.3	19.2	17.8	18.1
Construction	6.5	6.9	6.7	5.8	6.3	5.9	5.4	5.5	5.7
Services	51.7	52.8	54.3	58.2	61.1	65.2	67.3	67.7	65.9
Wholesale and retail trade, restaurant and hotels	14.6	14.5	14.3	15.1	14.5	15.4	14.8	14.3	14.2
Transports, storage and communications	6.4	6.3	6.4	6.4	6.7	6.9	7.0	6.9	6.9
Other activities	30.7	32.0	33.6	36.7	39.9	42.8	45.5	46.4	44.8
Pan-European region									
Agriculture	10.4	8.0	6.3	6.9	5.1	3.3	2.6	2.2	2.2
Industry	43.0	41.0	39.4	37.3	34.1	30.1	28.5	27.2	27.9
Mining and utilities	2.5	2.6	3.5	3.8	4.3	3.7	3.6	4.1	4.4
Manufacturing	32.4	30.3	28.5	26.9	23.0	20.3	19.3	17.2	17.2
Construction	8.1	8.0	7.4	6.6	6.8	6.2	5.6	5.9	6.4
Services	46.7	51.1	54.3	55.8	60.8	66.6	68.9	70.6	69.9
Wholesale and retail trade, restaurant and hotels	11.5	12.2	13.2	13.5	13.5	14.6	14.9	14.6	14.7
Transports, storage and communications	5.9	6.1	6.2	6.1	7.0	7.0	7.0	7.2	7.2
Other activities	29.3	32.8	34.9	36.2	40.3	45.0	47.0	48.8	48.1
TOTAL	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

Source: Memedović and Iapadre (2009).

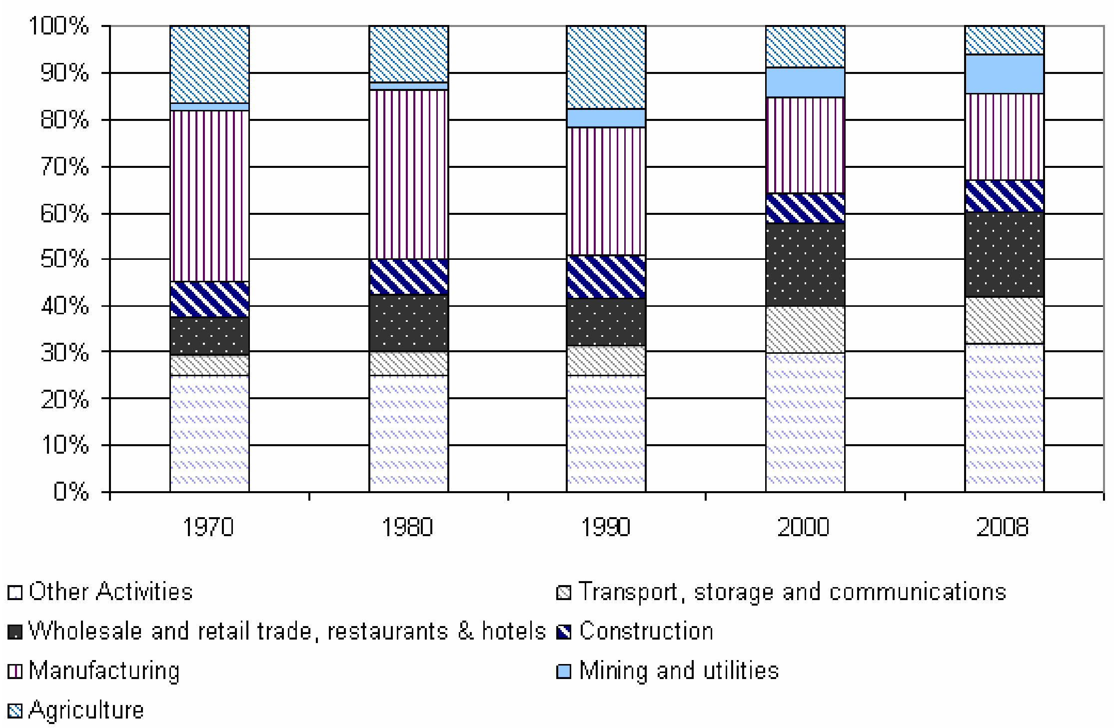
In the 1990s and 2000s, the most important drivers of structural change were transport and communications, followed by 'other activities', which include research and development, computer activities, financial intermediation and public administration (Figure 6). The share of non-tradable services (wholesale retail trade, restaurants and hotels) decreased in the early period of transition in the early 1990s but later became a major element in the displacement of industry and agriculture in the overall economic structure.

Figure 5 Value added by agriculture, industry and services in EECA region, (1970- 2008)



Source: UNIDO database (INDSTAT2 2011), UNIDO calculations.

Figure 6 Value added by sub-sectors in Europe and NIS, (1970-2008)



Source: UNIDO database (INDSTAT2 2011), UNIDO calculations, cited in UNIDO (2009).
Note: shares in current prices and exchange rates, in US$.

Structural changes in manufacturing

Trends in structural changes in manufacturing over the 1970-2007 period (Figure 7) show a falling value added share on the part of technologically-advanced sub-sectors in manufacturing, such as machinery, electrical, medical and transport equipment in the early 1990s, but a recovery after 2000. Since 2000, the sub-sectors with rising shares have been the rubber and plastic products industry, fabricated metals, machinery and equipment including office, electrical and communication.

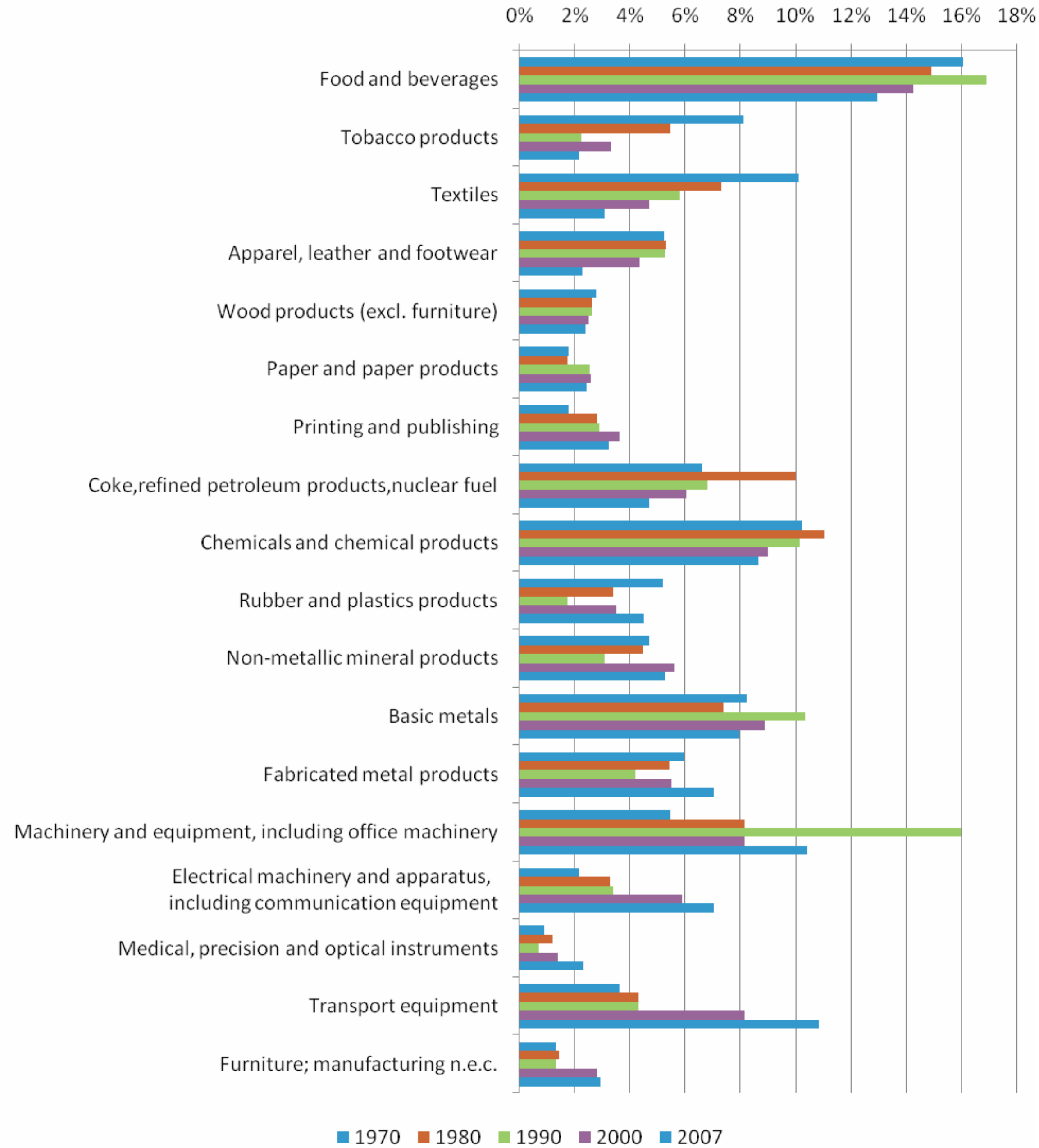
Structural shifts in manufacturing vary greatly by individual countries. In the low and lower-middle income group, food and beverages and basic metals still dominate manufacturing sub-groups, but these are declining (Appendix 3 and 4), while those of non-metallic mineral products have nearly doubled, and the shares of textiles and apparel, leather and footwear have risen significantly. The shares of high-tech sectors remain small, while no machinery production sector has a share in manufacturing greater than 3 per cent.

In the upper-middle income group, shifts in the manufacturing structure towards high and medium technology-intensive activities are much more visible (see Appendix 4). The shares of electrical and communication equipment, medical instruments and transport equipment all show growth, while those of chemicals, refined petroleum products and basic metals, which were the basis of industry before market transition, remain high. Chemicals and basic metals production, which were leading manufacturing industries in the high-income group from 1970 to 1990, have also seen their share of manufacturing industry fall between 1970 and 2007 (see Appendix 4).

In the new EU member states of the region, high-tech sectors have grown and the shares of nearly all advanced manufacturing sectors are higher than they are in the high income countries in the region. More than half of regional industrial output is still produced by the upper-middle income group of countries, although the growth rate of the high income group has been higher and therefore its share has risen from 21 per cent in 1990 to nearly 40 per cent in 2010 (see Appendix 4). As a result, the share of the upper-middle income group fell from 61 per cent in 2001 to 56 per cent in 2010, and the share of the low and lower-middle group remained around 4-5 per cent.

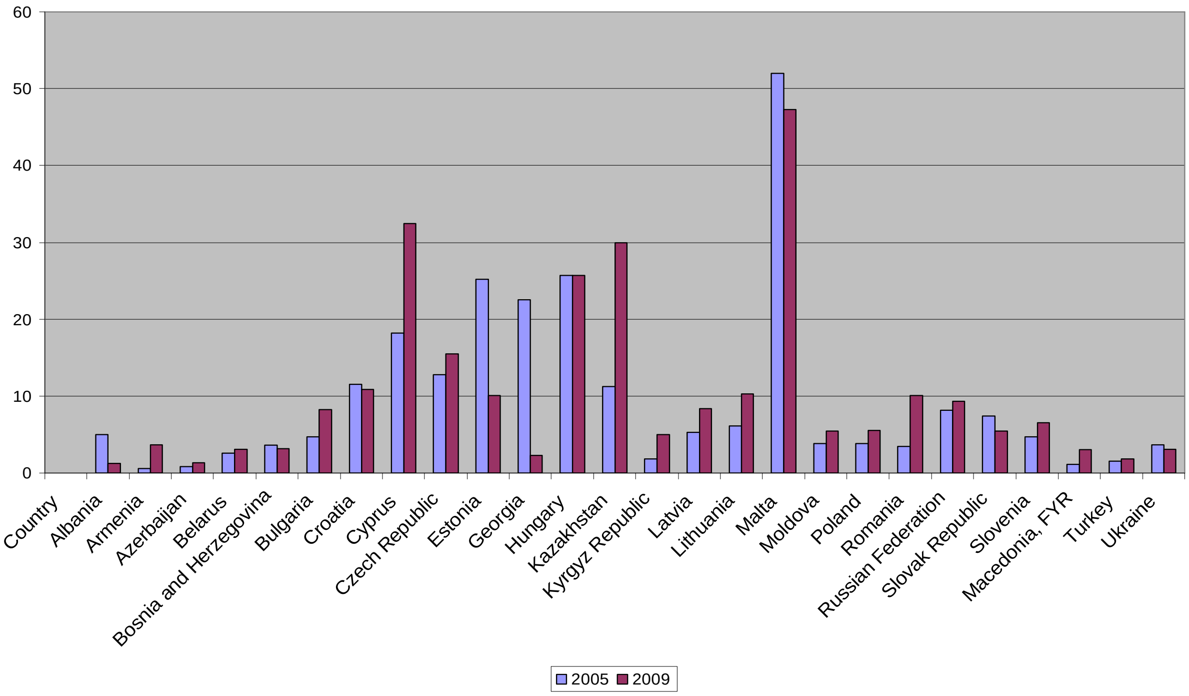
The changing export structure illustrates patterns of specialization in the region. New EU members had the highest share of medium and high technology products (MHT) in manufactured exports while Albania, FRY Macedonia and Bosnia and Herzegovina had the lowest share in 2009 (Figure 8). The shares of MHT products in most of the EU member states show increasing values over the period 2005-2009 (the Czech Republic, Bulgaria, Romania and Lithuania), while non-EU states, such as Albania, Bosnia and Herzegovina and Croatia, saw cuts in MHT exports' shares. Kazakhstan, meanwhile, saw the biggest jump in share in MHT exports among the non-EU states.

Figure 7 Value added by manufacturing sub-sector in Europe and NIS, (1970-2007)



Source: UNIDO database (INSTAT2), UNIDO calculations.

Figure 8 Share of Medium and High Technologies in exports from Europe and NIS, in 2005 and 2009, (in per cent)



Source: UNIDO calculations, UNIDO database (INDSTAT2).

The region's share of global production can also be analyzed by looking at imports of intermediate goods and exports of final goods, which indicate the ability of local economies to transform intermediate goods into final production that is competitive on the world market and to diversify domestic production (Table 4).[23] Europe and NIS's share of world intermediate manufactured goods trade more than doubled from 4.1 per cent to 9.2 per cent, between 1995 and 2008, demonstrating a substantial improvement in global economic integration (Table 4). Countries with the highest share of the global intermediate goods trade in 2008 were Russia (1.4 per cent), Poland (1.4 per cent) and Turkey (1.2 per cent).

In summary, for many countries in the region, economic diversification and growth based on competitive high value-added sectors in manufacturing still remain elusive development goals. Several countries, particularly in Central Asia, are mainly oriented towards low value-added agriculture and extractive industries such as oil, gas and metals, which are vulnerable to global price shocks and variable demand. Resource-rich countries in the region will find it increasingly difficult to maintain the high growth rates of the last decades, which drew on unemployed reserves of capital and labour and which were accompanied by little investment in innovation and technological development. As these countries move from factor endowments-based growth to an efficiency-driven stage, they will need to rely on different levers of growth, such as human capital, quality institutions and regulatory systems and more efficient labour, capital and natural resource markets (OECD, 2011b: 96).

23 For economic development, the expansion of intermediate goods and services and their suppliers are crucial for the progressive division of labour and thus for economic growth. Low levels of diversification in intermediate goods trade can lead to low rates of return on investment and to an underdevelopment trap in which foreign and domestic investments may not materialize (Rodriguez-Clare, 1996).

Table 4 Country intermediate manufactured goods trade as a share of the global intermediate manufactured goods trade (in per cent), (1995, 2005)

Country	Share of intermediate manufactured goods total trade in world intermediate manufactured goods trade in 1995 (%)	Share of intermediate manufactured goods total trade in world intermediate manufactured goods trade in 2008 (%)
Albania	0.009	0.02
Armenia	0.001	0.02
Azerbaijan	0.003	0.03
Belarus	0.0004	0.2
Bosnia and Herzegovina	0.006	0.06
Bulgaria	0.09	0.2
Croatia	0.1	0.1
Cyprus	0.03	0.03
Czech Republic	0.5	1.2
Estonia	0.04	0.1
Georgia	0.002	0.02
Hungary	0.3	0.8
Kazakhstan	0.04	0.2
Kyrgyzstan	0.008	0.02
Latvia	0.03	0.08
Lithuania	0.05	0.1
FYR Macedonia	0.02	0.03
Malta	0.07	0.02
Moldova	0.007	0.01
Montenegro	N/A	0.1
Poland	0.5	1.4
Romania	0. 1	0.4
Russian Federation	0.9	1.4
Serbia	N/A	0.1
Slovenia	0.2	0.25
Slovakia	0.29	0.5
Tajikistan	0.03	0.01
Turkey	0.55	1.2
Turkmenistan	0.003	0.02
Ukraine	0.14	0.52
Uzbekistan	0.2	0.05

Source: Sturgeon and Memedović (2010).

In order to reduce vulnerability to external economic shocks countries should shift their current specialization pattern based on the comparative advantage of inherited wealth of natural resources towards an economy based on long term dynamic comparative advantage.[24] They can use modern services such as telecommunications and new green technologies to modernize other services and manufacturing, which remains critical for innovation, technological learning and development. Many countries need to adopt more creative and innovative industrial policies to attract FDI to new manufacturing sectors, rather than raw material extraction, which was the most attractive sector for foreign investors in most of the region over the period 2007-2009 (except for services in SEE and CIS) (Table 5). They also need to establish new institutions to support these policies.

24 The European emerging economies were particularly hard hit by the global financial and economic crisis of 2007/2008, experiencing a sharp decline in output during the global financial crisis and recession period, thus demonstrating high vulnerability to external shocks (UNECE, 2010).

Table 5 shows that the share of FDI flows in primary sectors in developing countries and EECCA and SEE countries increased from around a third of world total FDI inflows in 1990-1992 to nearly two-thirds in 2007-2009. The share of FDI inflows in manufacturing and services also saw growth, but this was much smaller. It is likely that foreign investors are more interested in short-term returns than longer-term projects, which is symptomatic of ongoing political instability, high levels of corruption and shortages of skilled labour in some countries.

Table 5 World inward FDI flows, by sector, (1990-1992 and 2007-2009), (% shares)

	1990-1992				2007-2009			
Sector/Industry	Developed countries	Developing countries	EECCA & SEE	World	Developed countries	Developing countries	EECCA & SEE	World
Primary	65.8	28.3	5.9	100.0	47.7	40.1	12.2	100.0
Agriculture, hunting forestry and fishing	1.8	98.2	0.0	100.0	6.9	84.3	8.8	100.0
Mining, quarrying and petroleum	68.9	24.9	6.2	100.0	49.3	38.3	12.3	100.0
Manufacturing	65.6	33.9	0.5	100.0	61.3	35.9	2.8	100.0
Services	79.9	19.9	0.2	100.0	69.5	26.4	4.1	100.0
Total share	72.7	26.5	0.8	100.0	65.5	30.0	4.5	100.0

Source: UNIDO calculations based on UNCTAD/WEF (2011).

Drivers of manufacturing energy efficiency improvements

How much of the change in manufacturing energy intensity has come from energy efficiency improvements due to technological change within manufacturing sectors and how much from structural change, that is, a shift from more to less energy-intensive manufacturing sectors? This section will address this question.

The structural shift contribution to energy efficiency can be gauged by estimating what the energy intensity would have been had the structure of industry stayed constant, and then comparing this estimate with the actual development of energy intensity. The Fisher Ideal Index decomposition technique is applied to see if energy intensity variations depend on the energy efficiency effect (measured in terms of a decrease or an increase of energy consumption per unit of value added), or the structural effect (measured in terms of an increase or decrease of the value added share of low-carbon intensive sectors). When the energy efficiency component is < 1 the consumption of energy per unit of value added (while the structural composition of the economy being constant over time) reduces and energy efficiency improves. An analogous interpretation can be attributed to the structural component of energy intensity.

The tables in Appendix 5 show that the good performance of Europe and CIS countries and NMS is driven by energy efficiency improvements rather than by the effects of structural change. Within the developing country groups, the BRICS are particularly successful in reducing energy intensity, and among the high income countries, the new EU member states are achieving significant improvements due to energy efficiency. The BRICS group's performance is driven by China and Russia and in these countries energy intensity reduction is mainly led by energy efficiency (use of more energy efficient technologies and methods) rather than by structural change (shifts away from energy intensive economic sectors) (Appendix 5 and the findings on the Caucasus and Central Asia region in Table 6).

Table 6 Decomposition technique application for 12 world regions (detailed findings)

Country	East Asia & Pacific	BRICS	Latin America	MENA	Caucasus & Central Asia	New EU member States
Structural Effect	1.210	1.147	1.072	1.033	1.173	1.089
Energy efficiency effect	0.981	0.418	1.510	2.834	0.227	0.341
Fisher Ideal Index	1.187	0.480	1.619	2.928	0.267	0.371
Time horizon	1995 – 2006	1995 – 2007	1995 – 2007	1995 – 2008	1995 – 2006	1995 – 2007
Sectors						
Metal	yes	yes	yes	no	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	no	yes
Non metallic minerals	no	yes	yes	no	yes	yes
Transport equipment	yes	no	no	no	no	no
Machinery	yes	no	no	no	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	no	no	yes
Wood and wood products	no	no	no	no	no	yes
Textiles	no	yes	yes	yes	yes	yes

Country	Europe & CIS	South East Europe	Low middle income	Upper middle income	High income	Developing economies
Structural Effect	1.193	0.991	0.985	1.211	1.042	1.015
Energy efficiency effect	0.584	1.233	0.901	0.485	0.983	0.598
Fisher Ideal Index	0.696	1.222	0.887	0.588	1.024	0.607
Time horizon	1995 – 2008	1995 – 2007	1995 – 2006	1996 – 2006	1998 – 2006	1995 – 2005
Sectors						
Metal	yes	yes	no	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	no	yes	no	no	yes	yes
Transport equipment	yes	yes	no	no	no	no
Machinery	yes	yes	yes	no	yes	no
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	no	yes	no	no	no	no
Textiles	no	yes	yes	yes	yes	yes

Source: Cantore and D. W. te Velde, (2011), based on UNIDO and IEA data.

In this context upper middle income countries appear more effective than low middle income countries in improving energy efficiency and this may explain heterogeneous results in developing economies in the light of the Environmental Kuznets Curve hypothesis,[25] as a higher environmental performance of emerging countries versus low income ones would be explained by higher income levels.

Prospects for structural changes in energy sectors

The share of renewables in the energy mix varies considerably among countries in the region, from close to 100 per cent in Albania and Tajikistan, to negligible contributions in Poland (Appendix 6). Estonia, Poland and FYR Macedonia are the most heavily reliant on coal. Others have a more diverse energy mix. Hungary gets a quarter of its electricity from coal, a quarter from natural gas, nearly 40 per cent from nuclear power and 10 per cent from oil. Hydroelectric represents only 1 per cent of the country's electricity supply. Turkey relies on imports for more than half its energy and has been trying to diversify its energy sources, for instance by recently introducing natural gas. Its energy demands are predicted to grow substantially, as they have for several decades, due to a fast growing population, urbanization and economic growth, while there are also plentiful renewable sources of energy in hydro, solar, wind, geothermal and biomass. Both Western and Eastern Europe (including Armenia, Bulgaria, Hungary, Lithuania, Slovakia, Slovenia and Ukraine) remain dependent on nuclear power.

The energy sector in many countries in the region is reliant on imports of natural gas, oil and electricity from Russia. Growing populations, urbanization and economic growth in some countries will raise energy demand further, putting additional pressure on energy security in the region. How to meet the ambitious targets for cutting GHG emissions set out by the EU for its members and potential members and how to deal with the issue of energy security have thus become major policy concerns for dynamic economies in the region.

If countries are to gain maximum potential from renewable energy, they will require investment in new technologies (see Box 4). Already, electricity systems in many countries are under stress from ageing infrastructure and growing demand. The vision of an era of clean energy, as described by proponents of the 'third industrial revolution' involves the transformation of millions of buildings into power stations, linked to 'smart grid' networks that regulate the flow and supply of energy. Smart grids are an essential element of the transition to a carbon free economy, enabling efficient and reliable energy delivery (see Box 5). At present, however, there is little evidence of investment in the region and there are insufficient positive incentives for private sector investments (WEF/Accenture, 2009).

In the Russian Federation, despite the vast potential of renewable energy (thanks to a geography that suits wind, geothermal and solar energy generation), mineral resources continue to dominate the energy sector. In 2009, around 1 per cent of power was generated from renewables. The Russian leadership has, however, shown interest in high-value and high-technology sectors, such as the manufacture of wind turbines. The latest government energy strategy aims for 4.5 per cent of energy to come from renewables by 2020.

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25 The Kuznets Curve hypothesis is that countries with low levels of income tend be more polluting than rich countries at the early stages of growth but they then tend to become "cleaner" at later stages of growth become they are more willing to pay for environment friendly technology improvements (energy efficiency effect) and because they would tend to invest in less polluting intensive sectors (structural effect).

Box 4 Tripling renewable energy's share comes with costs

According to estimates of the United States Energy Information Administration (USEIA), tripling renewables' share of the global energy mix by 2035 will require US$5,700 billion in subsidies, while displacing the expected growth in nuclear power will double the requirements. In this case, the subsidization by governments of non-fossil fuel alternative energy sources or the use of high feed-in tariffs may be difficult to achieve.

Source: UNECE (2011: 9-10).

Box 5 Smart grids

A decentralized network of micro producers requires intelligent approaches to distribution and storage, such as the use of 'smart grids' involving microprocessor technology. Renewable energy sources like solar and wind, and micro power sources located in buildings, factories and offices, can feed the grid efficiently and when needed. Locally generated energy can feed into an 'intergrid' and be consumed where and when it is needed, increasing flexibility and efficiency. Advanced energy storage can also be used to reduce the variability of generation associated with renewable energy sources.

Renewable energies and smart grids go hand in hand. As more and more countries diversify their energy sources to include solar, hydro, biomass and wind, grids must adapt to manage variability issues (wind is not 100 per cent constant). Smart grids are becoming more sophisticated and intelligent, and many foresee an expansion towards energy storage facilities in electric vehicles, which will help to accelerate the expansion of renewables (REN21, 2011). The market in Europe in smart grids is predicted to represent almost US$10 billion in 2015.

Smart grids represent a solution to two critical challenges. They encourage renewable power while helping to prevent blackouts and revolutionize energy production, distribution and use, enabling developing countries without conventional grids to fast track development. They promise to increase the supply of energy and provide an opportunity to invest in ageing infrastructure. Investment can also be used to boost innovation, jobs and green growth, increasing the reliability, security and diversification of energy sources.

The following factors are contributing to the development of smart grids (EC-DGR, 2006: 11):

- Targets at European and national levels to reduce carbon emissions and expand renewable energy sources:
- The need to tackle technical challenges and limitations of existing grid networks
- Existing grids are nearing the end of their operational and functional lifespans
- Grids are becoming 'congested' due to rising demand
- Desire to bring benefits to customers at the earliest possible point
- Reducing the risk associated with investment decisions
- Technological improvements are lowering costs

Smart grids also have an important role to play in sustainable development, and in connecting regions. The European Commission predicts that smart grids will connect different but complementary energy sources from regions, allowing for trading opportunities and exchange between EU states, countries in the EECA region and even with Africa (EC-DGR, 2006: 22). The development of smart grids is likely to be incremental with OECD states leading the way (WEF/Accenture, 2009), but the massive potential for renewable energy production in the region is likely to lead to rapid expansion into the region.

Renewable energy sources and new technologies allow countries to meet EU targets without sacrificing geopolitical and economic security in the region. There are calls for the diversification and localization of energy supply linked to pan-European energy networks, involving millions of local micro producers sharing energy from renewable sources, such as wind and solar, in the same way that information is produced and shared on the Internet through open source (Rifkin, 2011). A decentralized network of micro producers will require intelligent approaches to distribution and storage, such as the use of 'smart grids' (see Box 5) involving microprocessor technology, whereby energy that is generated locally can be fed into an 'inter-grid' and consumed where and when it is needed, increasing efficiency and flexibility in foreign supply. Advanced energy storage can also be used to reduce the variability of generation associated with renewable energy sources.

Most of the new technologies and smart solutions for greening the power sector will come with high initial price tags, as economies in the region are technologically weak and hence dependent on West European countries' supply of these new green technologies. OECD data on patents and government expenditure show that from a relatively low starting point, investment in green technologies is expanding rapidly, although in countries in the region for which there are data, there is substantially less innovative activity than in market leaders. Russia, for instance, spent around 2 per cent of its budget on energy and environmental priorities, compared with 14 per cent in New Zealand (OECD, 2011b: 122).

Moving away from fossil fuel to increased use of renewable energy sources, such as nuclear, carbon capture and storage, and developing energy networks, will therefore require the promotion of low energy demand lifestyles and investment in new energy technologies and supporting systems, including new infrastructure to transmit, store and produce energy, which can raise energy efficiency, diversify production and cut energy demand. But this will require substantial external financial and technical assistance.

Conclusions

This paper has highlighted the fact that the Europe and NIS region as a whole has succeeded in reducing energy intensity and CO_2 emissions. These gains are the result of a mixture of factors such as structural shifts characterized by deindustrialization, technological improvements in manufacturing in some countries, expansion in renewable energy sources and the recent slowdown associated with the economic crisis.

Despite declining trends, energy and carbon intensity in the region remain above the EU-15 average, although there has been convergence with global averages. There is considerable divergence between countries' carbon intensities. In 2008, the carbon intensities of Uzbekistan, Kazakhstan and Turkmenistan were the highest in the region. The Russian Federation and Kazakhstan have much higher emissions than the EU average despite their lower levels of economic activity. Conversely, countries with higher shares of energy from renewable sources but less affluent, such as Tajikistan and Kyrgyzstan, are low CO_2 per capita emitters. In contrast, the new EU member states have the best energy performance in the region, because of their integration with Western Europe. However, it is predicted that CO_2 emissions in the region will exceed the levels of the 1990s by 2015, as populations and demand for manufactured exports increase, which puts additional pressure on the region to decouple economic growth from resource use.

Almost half of emissions come from electricity and heat production, with manufacturing and construction at 16 per cent, followed by transport (14 per cent) and other energy industries (4 per cent). There is hence great potential for energy savings to be made through improving energy efficiency in buildings, industry and transport. Data show that the region is lagging behind developed countries in energy efficiency and initial gains could be made at relatively little cost. Moreover, a cultural shift towards energy conservation at both household and industrial level will incentivize energy consumers to invest in energy (and money) saving technologies.

The proportion of manufacturing value added is significantly lower than in the rest of the world and most of the countries of the region are failing to move into medium and high technology manufacturing. New member states typically have more sophisticated manufacturing structures and have made greater progress towards establishing a post-industrial and service-based economy based on high-technology intensive activities. More than half of regional industrial output is still produced by the upper-middle income group of countries. In this group, shifts in the manufacturing structure towards high and medium technology-intensive activities are much more visible. In the low and lower-middle income group, food and beverages and basic metals still dominate manufacturing sub-groups, but these are declining. The most competitive countries are the Czech Republic, Slovakia and Hungary, plus Turkey.

Industry also remains relatively energy inefficient in the region. Investment in industrial energy efficiency could mean substantial costs for the region's economies per year. Further, NMS are the most developed in expanding high-tech sectors, thus increasing their absorptive capacity for external knowledge and technologies, and hence building their capabilities to innovate. In this regard, the region has great potential for further improvements in green technologies.

Finally, the chapter has shown that the energy mix varies widely among the region's countries. Half are net energy exporters, some are highly dependent on high carbon fuels such as oil and coal, and several are heavily reliant on energy imports. For these countries the energy-related green growth agenda is closely linked to energy security issues and they are being driven to diversify energy sources, primarily due to a need to reduce reliance on external supplies.

Supply-side prospects for renewable energy are good for the region because carbon reduction targets, where they have been set, will be met by wind, solar and hydro sources, rather than gas and nuclear, which will require substantially more investment and time to rebuild reactors.

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Appendix 1 Energy intensity in the region, units of energy use per GDP (kg of oil equivalent per constant 2005 PPP)

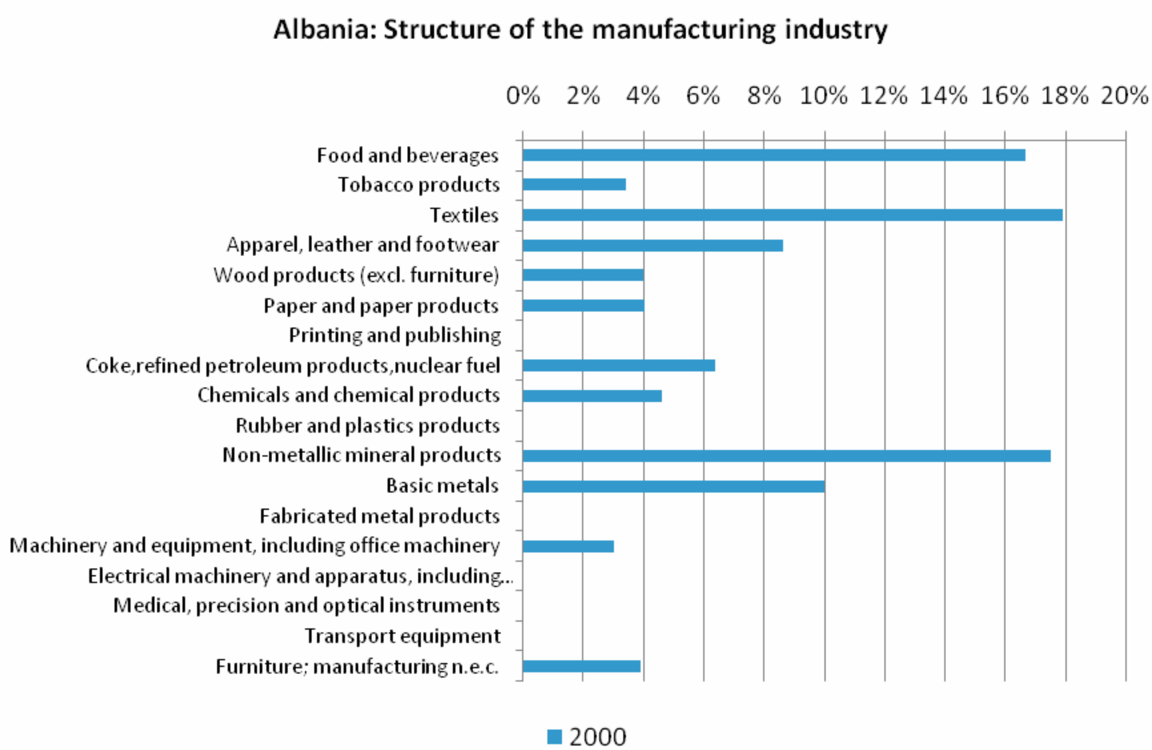
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Albania	0.21	0.21	0.16	0.14	0.14	0.12	0.11	0.11	0.10	0.13	0.12
Armenia	0.74	0.88	0.77	0.45	0.27	0.30	0.30	0.31	0.29	0.27	0.28
Azerbaijan	0.76	0.78	0.63	0.76	0.98	0.89	0.81	0.73	0.70	0.61	0.57
Belarus	0.68	0.67	0.62	0.57	0.55	0.57	0.57	0.51	0.46	0.43	0.42
Bosnia and Herzegovina					0.33	0.28	0.17	0.20	0.21	0.19	0.24
Bulgaria	0.44	0.37	0.37	0.40	0.38	0.40	0.44	0.40	0.37	0.33	0.32
Croatia	0.14	0.14	0.15	0.17	0.16	0.15	0.15	0.15	0.15	0.15	0.14
Cyprus	0.13	0.13	0.14	0.14	0.16	0.13	0.15	0.14	0.14	0.13	0.14
Czech Republic	0.29	0.30	0.29	0.28	0.27	0.25	0.25	0.26	0.25	0.23	0.23
Estonia	0.60	0.60	0.55	0.46	0.49	0.45	0.47	0.41	0.37	0.35	0.31
Georgia	0.41	0.42	0.67	0.83	0.57	0.45	0.40	0.32	0.29	0.26	0.26
Hungary	0.22	0.24	0.23	0.24	0.22	0.23	0.23	0.22	0.21	0.20	0.18
Kazakhstan	0.63	0.72	0.80	0.74	0.75	0.73	0.63	0.54	0.55	0.49	0.50
Kyrgyz Republic	0.68	0.66	0.57	0.52	0.47	0.42	0.46	0.39	0.41	0.34	0.33
Latvia	0.29	0.31	0.38	0.35	0.31	0.30	0.28	0.25	0.24	0.21	0.18
Lithuania	0.35	0.39	0.32	0.31	0.31	0.33	0.34	0.30	0.29	0.25	0.21
Macedonia, FYR	0.16	0.16	0.19	0.21	0.20	0.20	0.22	0.20	0.22	0.20	0.18
Malta	0.14	0.13	0.12	0.15	0.13	0.11	0.11	0.11	0.09	0.10	0.08
Moldova	0.58	0.58	0.68	0.58	0.69	0.65	0.72	0.69	0.66	0.55	0.47
Poland	0.33	0.35	0.33	0.33	0.30	0.29	0.28	0.26	0.23	0.21	0.20
Romania	0.34	0.32	0.33	0.31	0.28	0.28	0.28	0.28	0.27	0.24	0.24
Russian Federation	0.47	0.49	0.52	0.54	0.54	0.55	0.56	0.53	0.55	0.53	0.49
Serbia	0.22	0.21	0.26	0.31	0.28	0.31	0.34	0.33	0.32	0.26	0.27
Slovak Republic	0.32	0.34	0.35	0.35	0.33	0.31	0.30	0.28	0.26	0.26	0.26
Slovenia	0.17	0.19	0.18	0.19	0.18	0.19	0.19	0.19	0.18	0.17	0.16
Tajikistan	0.33	0.34	0.39	0.36	0.35	0.36	0.42	0.41	0.41	0.39	0.35
Turkey	0.12	0.12	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Turkmenistan	1.43	1.29	0.91	0.96	1.46	1.62	1.52	1.73	1.60	1.62	1.39
Ukraine	0.60	0.66	0.63	0.66	0.72	0.82	0.83	0.82	0.79	0.79	0.74
Uzbekistan	1.13	1.18	1.25	1.33	1.38	1.28	1.30	1.26	1.34	1.32	1.26
Region Total	0.32	0.33	0.32	0.30	0.29	0.28	0.28	0.26	0.25	0.25	0.24
European Union	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.14	0.14
High income: OECD	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.17	0.17
World	0.24	0.24	0.23	0.23	0.23	0.22	0.22	0.21	0.21	0.21	0.20

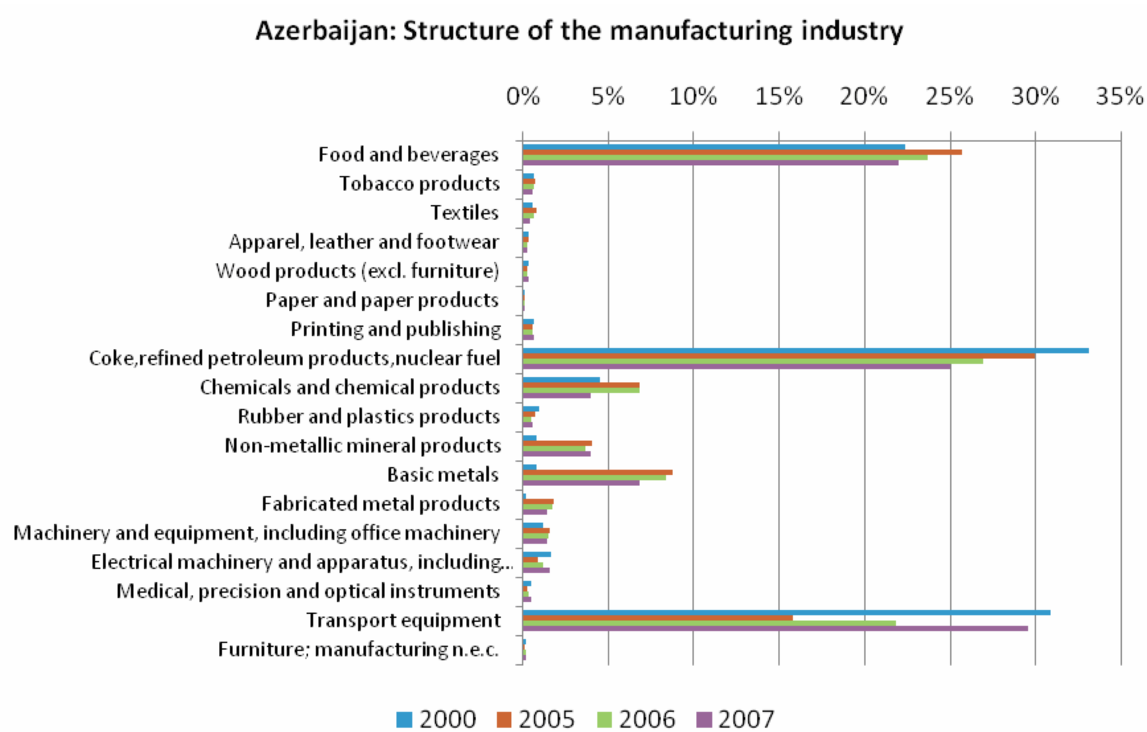
Energy intensity	2001	2002	2003	2004	2005	2006	2007	2008	Average growth rate
Albania	0.11	0.12	0.12	0.11	0.12	0.11	0.10	0.09	**-4.46%**
Armenia	0.26	0.21	0.20	0.19	0.20	0.18	0.18	0.17	**-7.74%**
Azerbaijan	0.52	0.47	0.44	0.42	0.35	0.27	0.19	0.19	**-7.40%**
Belarus	0.40	0.39	0.37	0.35	0.32	0.31	0.28	0.25	**-5.45%**
Bosnia and Herzegovina	0.22	0.22	0.21	0.21	0.21	0.22	0.21	0.21	**-3.02%**
Bulgaria	0.32	0.30	0.29	0.26	0.26	0.25	0.23	0.22	**-3.81%**
Croatia	0.14	0.14	0.14	0.14	0.13	0.13	0.12	0.12	**-0.97%**
Cyprus	0.13	0.13	0.14	0.12	0.12	0.12	0.12	0.12	**-0.24%**
Czech Republic	0.23	0.23	0.24	0.23	0.22	0.21	0.19	0.18	**-2.45%**
Estonia	0.31	0.27	0.28	0.26	0.23	0.20	0.21	0.21	**-5.60%**
Georgia	0.22	0.21	0.20	0.19	0.18	0.18	0.17	0.15	**-5.41%**
Hungary	0.18	0.17	0.17	0.16	0.16	0.15	0.15	0.15	**-2.36%**
Kazakhstan	0.45	0.44	0.44	0.42	0.43	0.44	0.42	0.43	**-2.05%**
Kyrgyz Republic	0.28	0.32	0.32	0.31	0.30	0.29	0.31	0.27	**-5.06%**
Latvia	0.19	0.17	0.17	0.16	0.15	0.14	0.13	0.13	**-4.52%**
Lithuania	0.23	0.23	0.22	0.20	0.18	0.16	0.16	0.16	**-4.38%**
Macedonia, FYR	0.19	0.18	0.19	0.18	0.19	0.18	0.18	0.17	**0.58%**
Malta	0.10	0.09	0.10	0.10	0.10	0.09	0.10	0.09	**-2.68%**
Moldova	0.49	0.43	0.45	0.43	0.42	0.38	0.36	0.32	**-3.29%**
Poland	0.20	0.19	0.19	0.18	0.18	0.17	0.16	0.16	**-4.09%**
Romania	0.23	0.22	0.22	0.20	0.19	0.18	0.17	0.16	**-4.28%**
Russian Federation	0.47	0.45	0.43	0.41	0.38	0.37	0.34	0.33	**-1.98%**
Serbia	0.28	0.29	0.29	0.29	0.24	0.24	0.22	0.21	**-0.12%**
Slovak Republic	0.26	0.25	0.24	0.22	0.22	0.20	0.17	0.17	**-3.69%**
Slovenia	0.17	0.16	0.16	0.16	0.16	0.15	0.14	0.14	**-1.18%**
Tajikistan	0.31	0.29	0.26	0.26	0.24	0.23	0.23	0.21	**-2.50%**
Turkey	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.11	**-0.41%**
Turkmenistan	1.20	1.05	1.01	0.78	0.73	0.66	0.65	0.60	**-4.66%**
Ukraine	0.68	0.65	0.63	0.56	0.54	0.49	0.45	0.44	**-1.75%**
Uzbekistan	1.22	1.22	1.13	1.02	0.90	0.87	0.79	0.75	**-2.22%**
Region Total	**0.24**	**0.24**	**0.24**	**0.22**	**0.21**	**0.21**	**0.20**	**0.20**	-2.65%
European Union (27)	**0.14**	**0.14**	**0.14**	**0.14**	**0.13**	**0.13**	**0.12**	**0.12**	-1.73%
High income: OECD	**0.17**	**0.17**	**0.16**	**0.16**	**0.16**	**0.15**	**0.15**	**0.15**	-1.39%
World	**0.20**	**0.20**	**0.20**	**0.20**	**0.19**	**0.19**	**0.18**	**0.18**	-1.43%

Appendix 2 Carbon dioxide emissions, kg per $1 GDP (PPP)

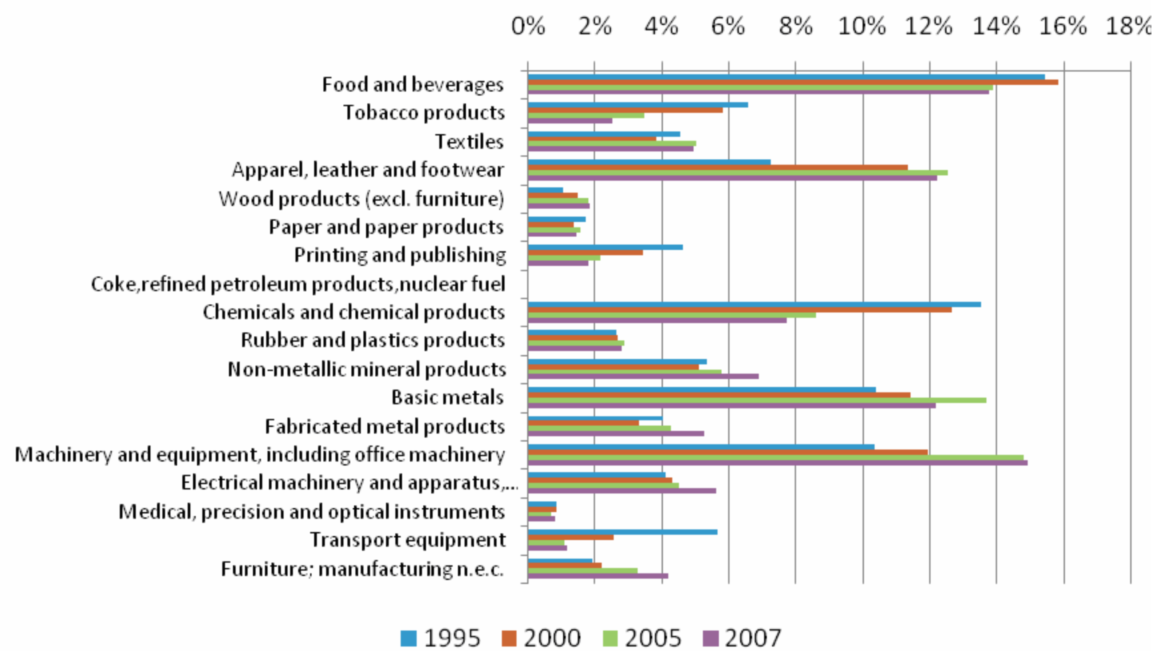
Country	1995	2000	2005	2009
Eastern Europe, Caucasus and Central Asia				
Armenia	0.64	0.49	0.35	0.32
Azerbaijan	2.36	1.52	0.91	0.67
Belarus	1.43	0.91	0.71	0.56
Georgia	0.28	0.41	0.30	0.26
Kazakhstan	2.34	1.59	1.35	1.44
Kyrgyzstan	0.80	0.61	0.58	0.58
Moldova	1.65	0.58	0.58	0.48
Russian Fed.	1.35	1.17	0.90	0.77
Tajikistan	0.40	0.36	0.24	0.26
Turkmenistan	4.04	3.41	1.85	1.54
Ukraine	2.22	1.76	1.29	1.04
Uzbekistan	3.03	2.98	2.09	1.86
South Eastern Europe				
Albania	0.18	0.21	0.24	0.18
Bosnia and Herzegovina	0.65	1.26	1.09	1.11
Croatia	0.38	0.36	0.34	0.30
Montenegro			0.40	0.29
Serbia			0.74	0.66
Macedonia, FYR	0.86	0.83	0.72	0.66
Turkey	0.34	0.35	0.30	0.32
EU-15				
Austria	0.29	0.26	0.29	0.24
Belgium	0.46	0.40	0.37	0.33
Denmark	0.42	0.33	0.29	0.28
Finland	0.52	0.40	0.35	0.33
France	0.26	0.24	0.23	0.20
Germany	0.41	0.36	0.33	0.30
Greece	0.46	0.46	0.41	0.36
Ireland	0.45	0.36	0.30	0.27
Italy	0.31	0.29	0.30	0.28
Luxembourg	0.47	0.33	0.39	0.32
Netherlands	0.39	0.32	0.31	0.28
Portugal	0.30	0.30	0.30	0.26
Spain	0.31	0.30	0.31	0.26
Sweden	0.27	0.21	0.18	0.16
United Kingdom	0.38	0.32	0.28	0.26
New EU accession states				
Bulgaria	1.14	0.87	0.72	0.61
Cyprus	0.44	0.43	0.41	0.41
Czech Republic	0.82	0.73	0.60	0.50
Estonia	1.63	1.03	0.75	0.69
Hungary	0.54	0.42	0.36	0.31
Latvia	0.59	0.35	0.26	0.23
Lithuania	0.59	0.37	0.30	0.26
Malta	0.43	0.26	0.32	0.27
Poland	1.05	0.71	0.61	0.52
Romania	0.79	0.62	0.52	0.42
Slovakia	0.79	0.60	0.48	0.36
Slovenia	0.47	0.39	0.35	0.33

Appendix 3 Manufacturing structure, Europe and NIS region, by country

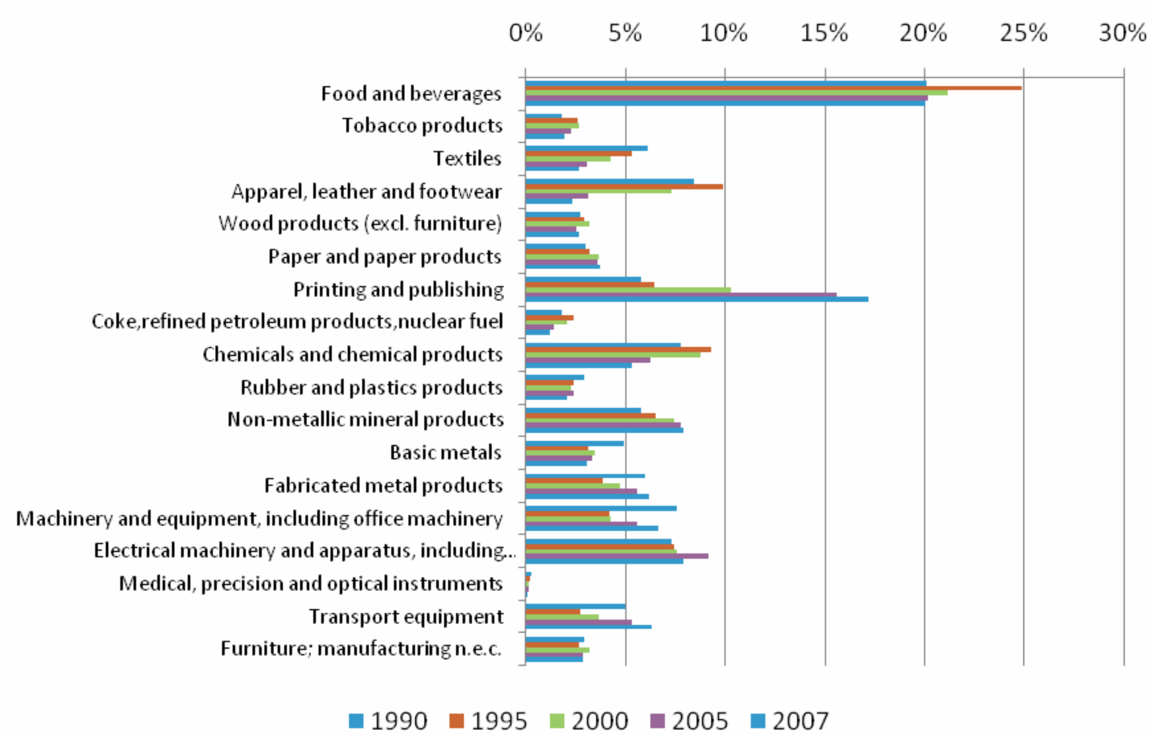


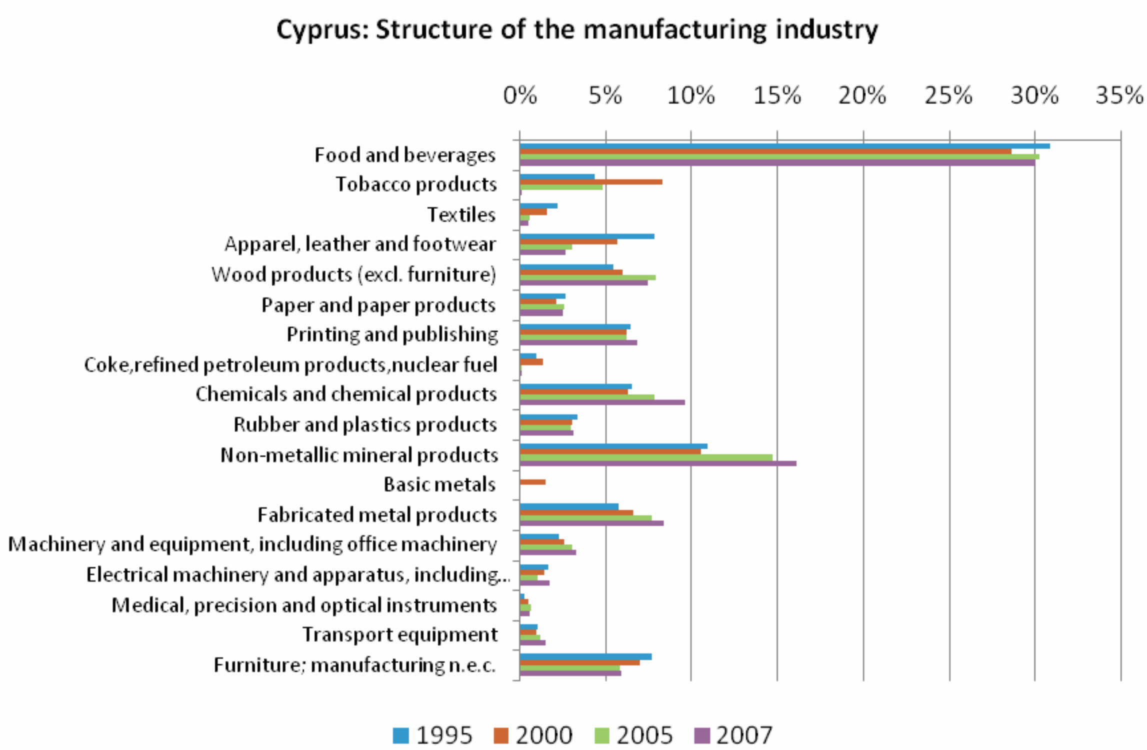


Bulgaria: Structure of the manufacturing industry

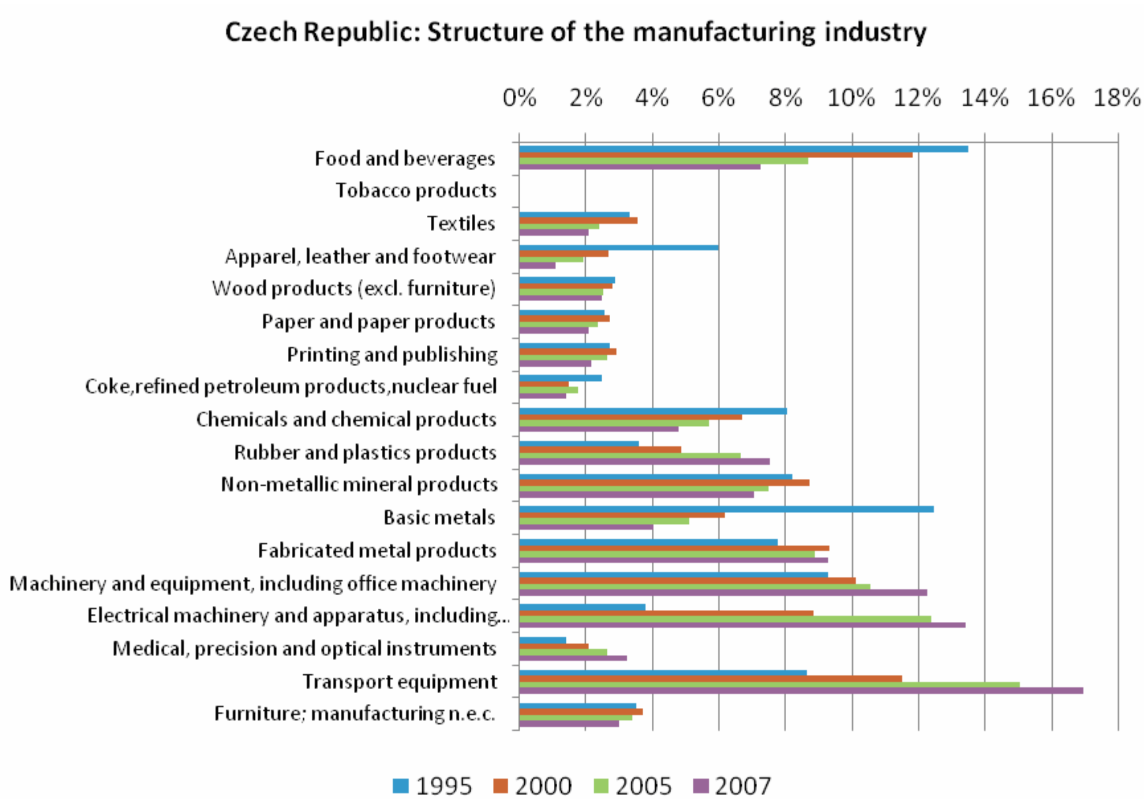


Croatia: Structure of the manufacturing industry

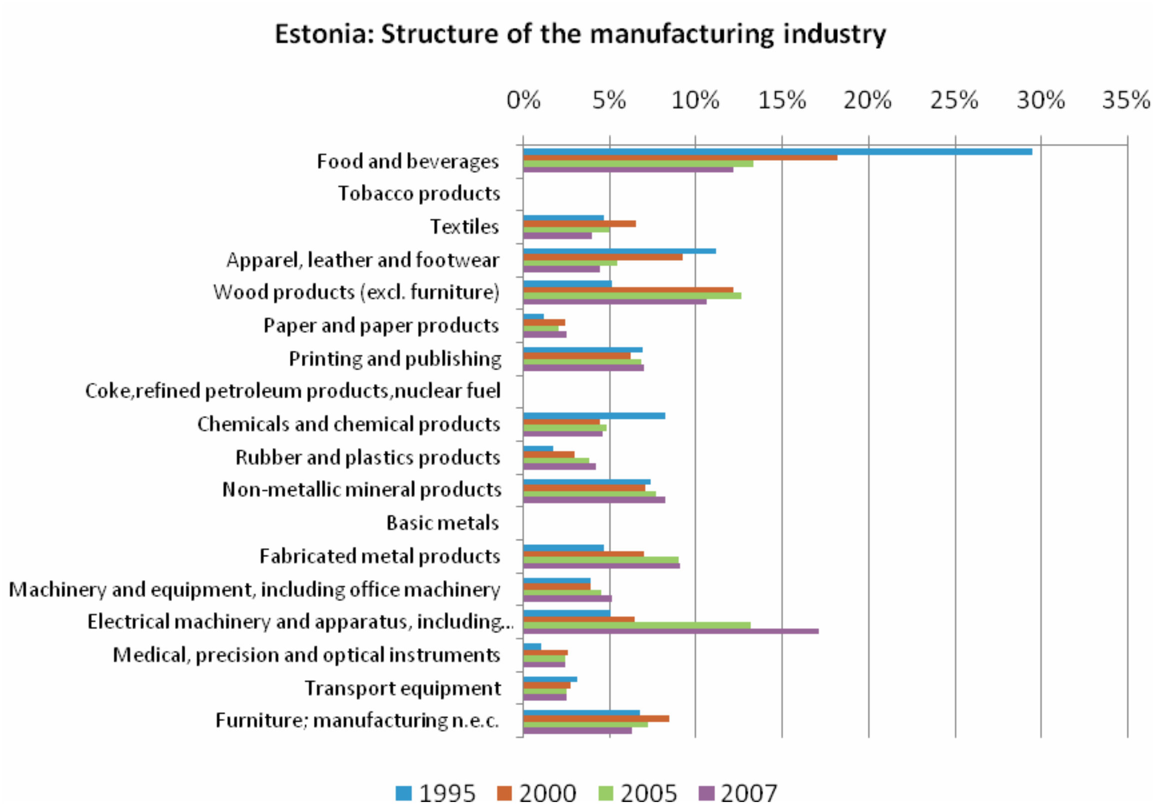


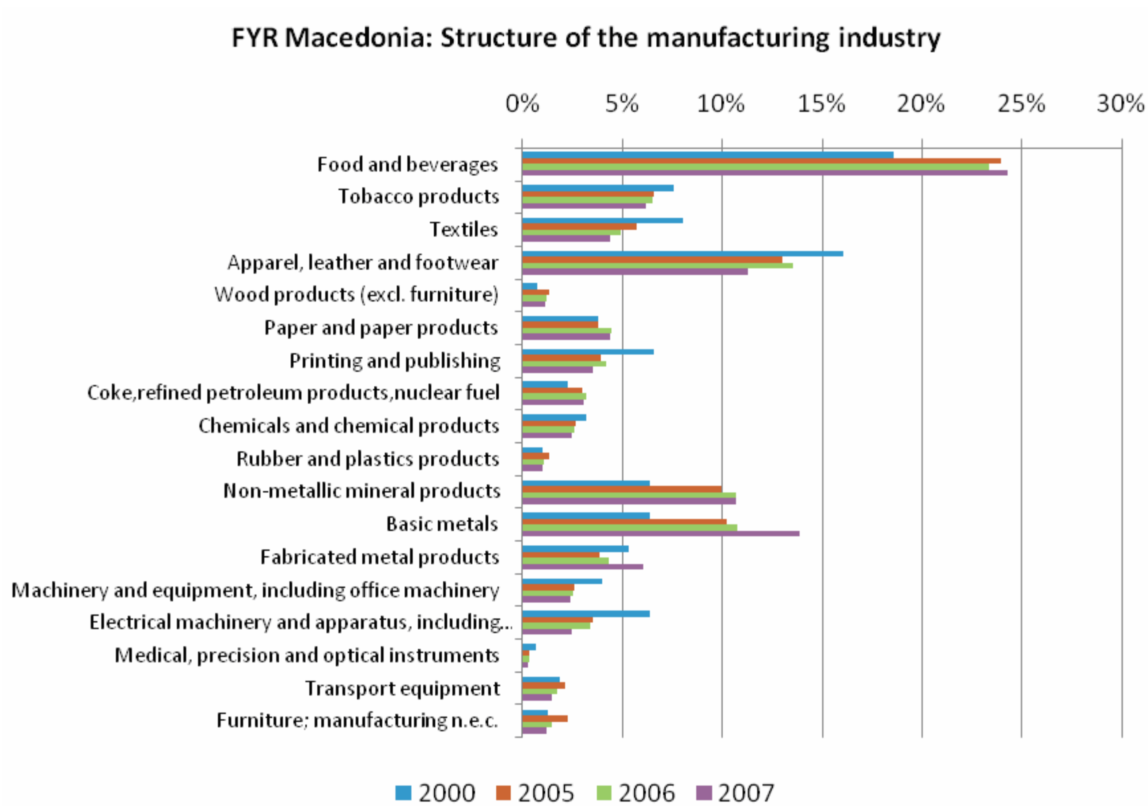


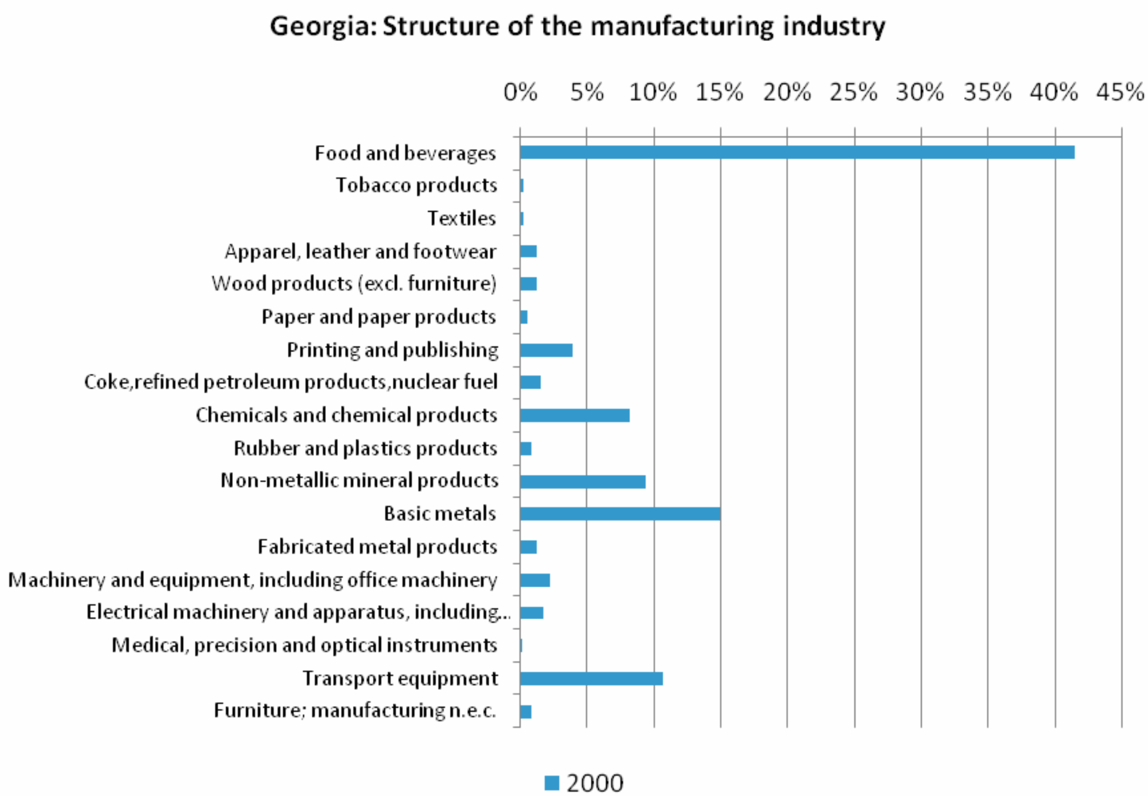
Cyprus: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
35%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1995
2000
2005
2007

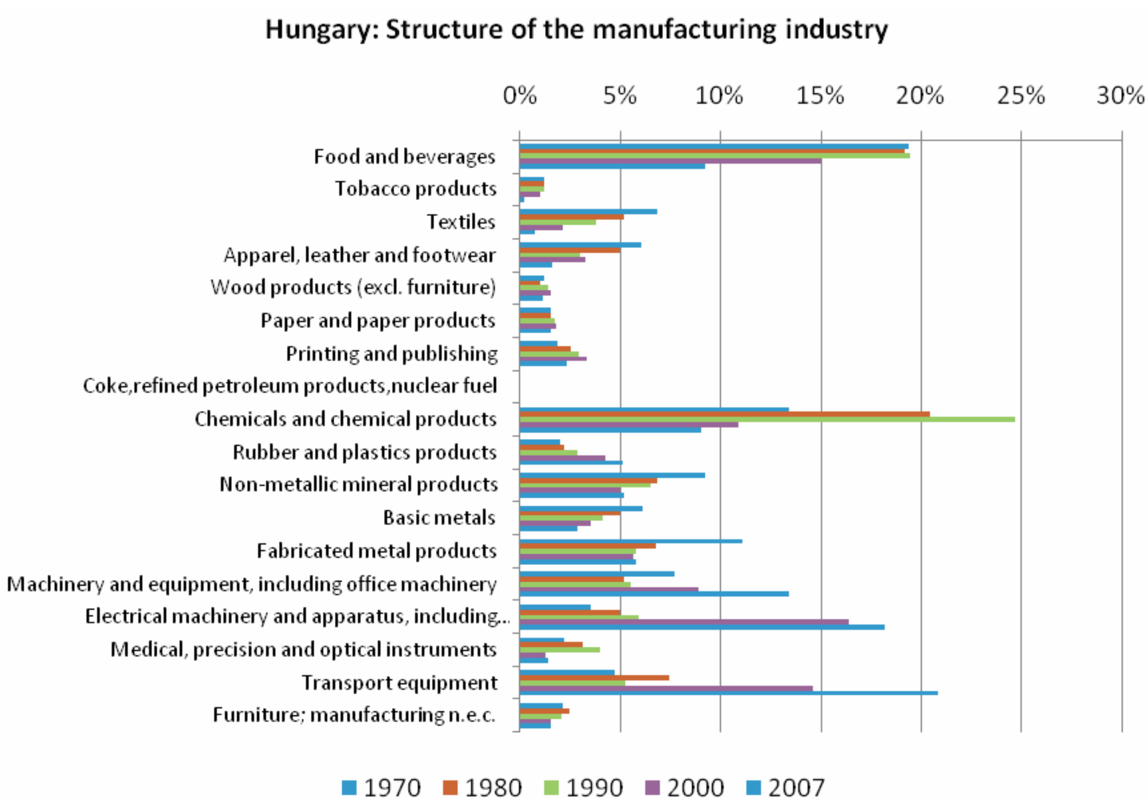


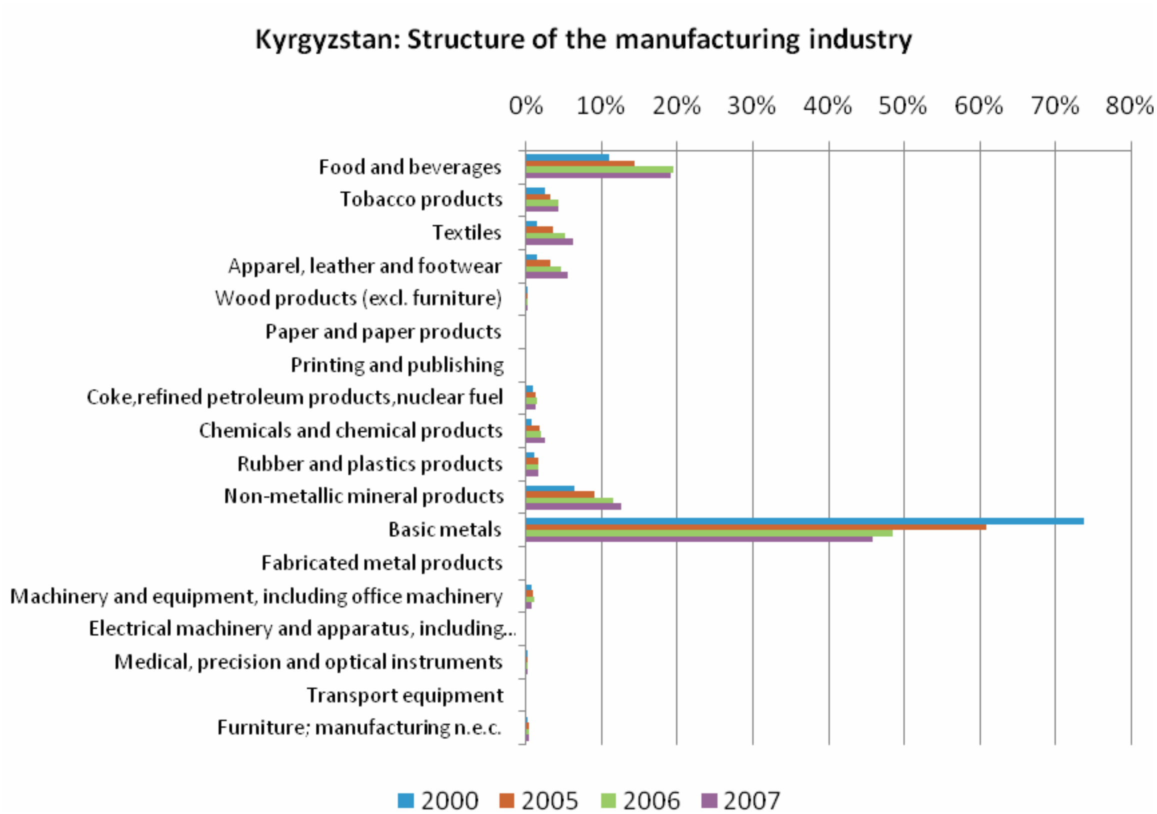
Czech Republic: Structure of the manufacturing industry
0%
2%
4%
6%
8%
10%
12%
14%
16%
18%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1995
2000
2005
2007


Estonia: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
35%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1995
2000
2005
2007

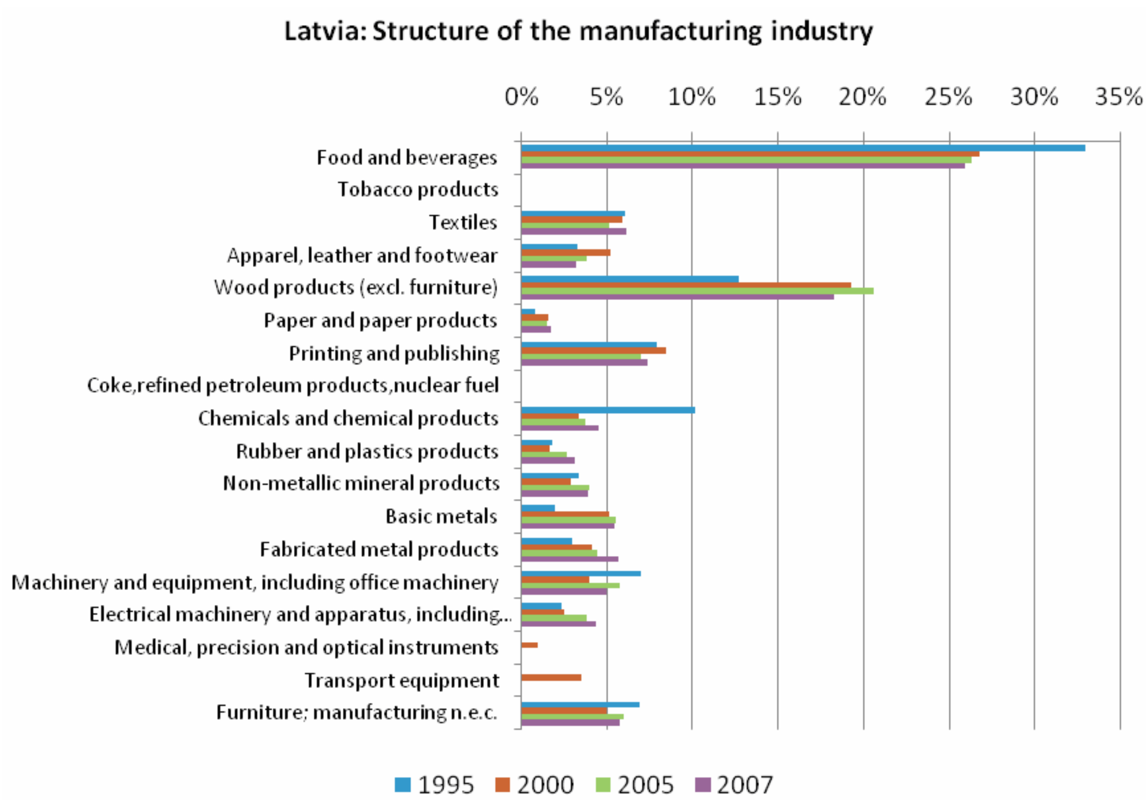

FYR Macedonia: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
2000
2005
2006
2007


Georgia: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
2000

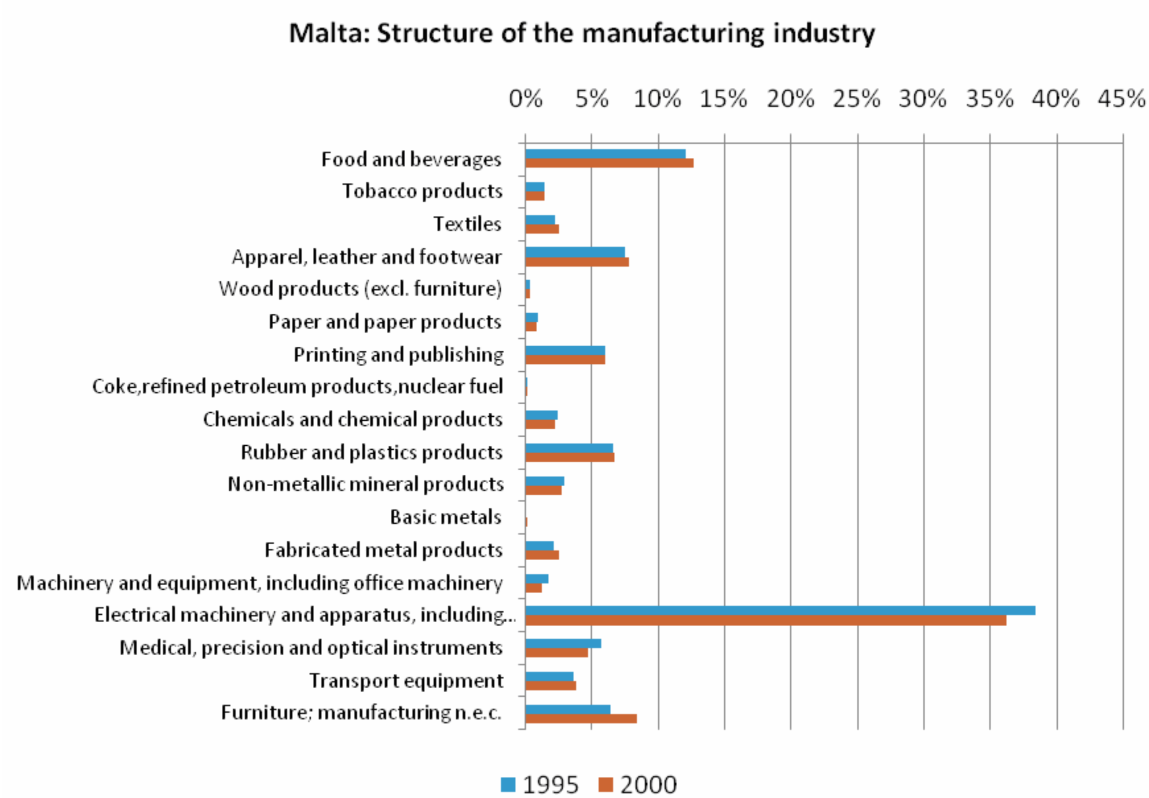

Hungary: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1970
1980
1990
2000
2007



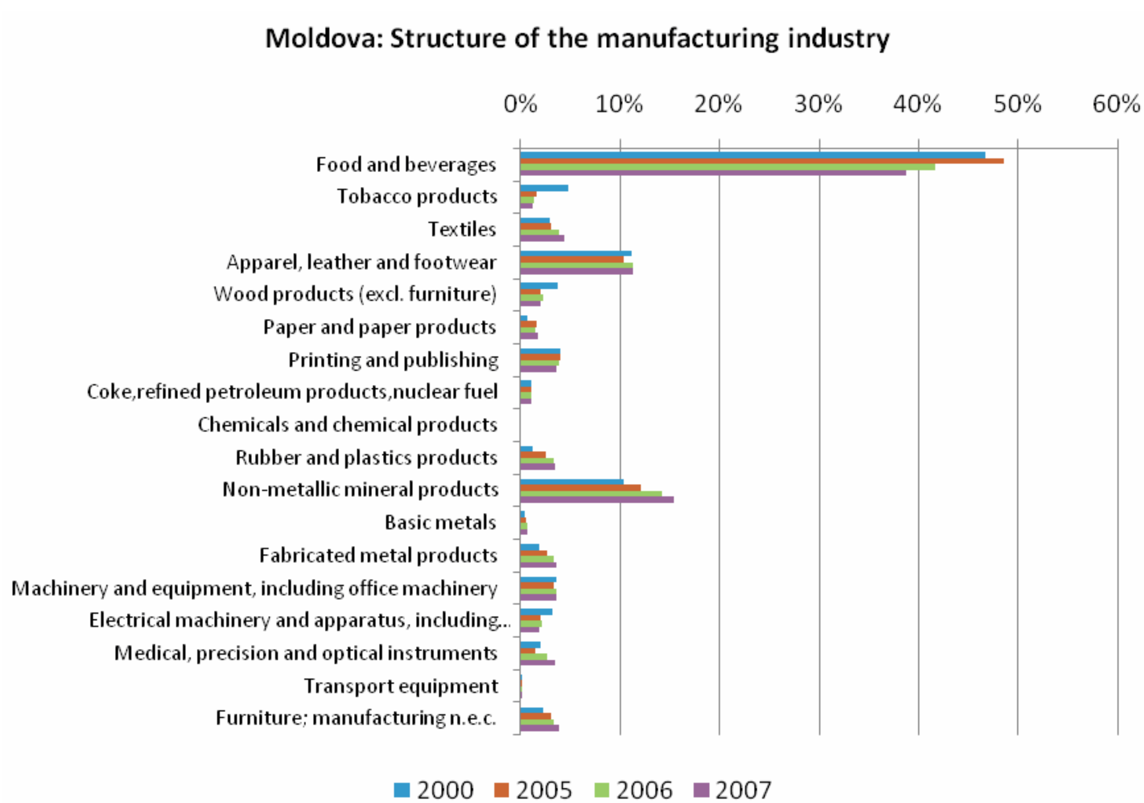
Kyrgyzstan: Structure of the manufacturing industry
0% 10% 20% 30% 40% 50% 60% 70% 80%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
2000 2005 2006 2007



Latvia: Structure of the manufacturing industry
0% 5% 10% 15% 20% 25% 30% 35%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1995 2000 2005 2007

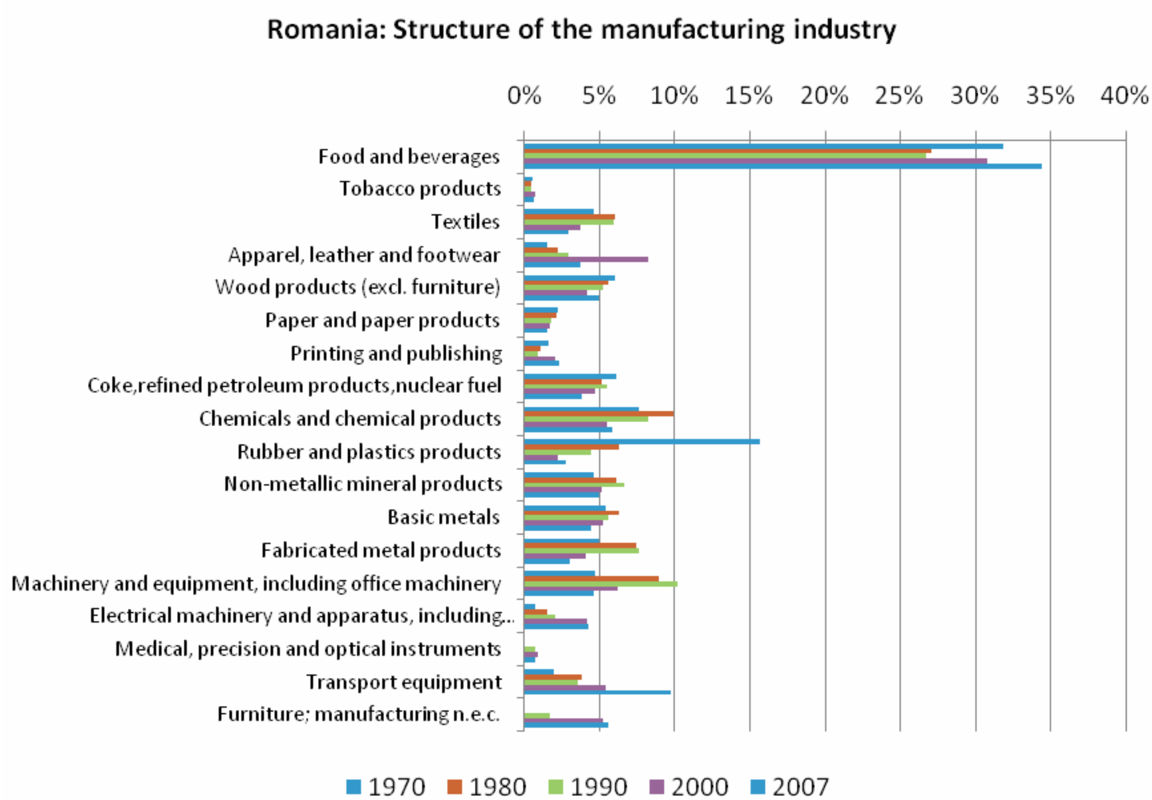


Malta: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1995
2000

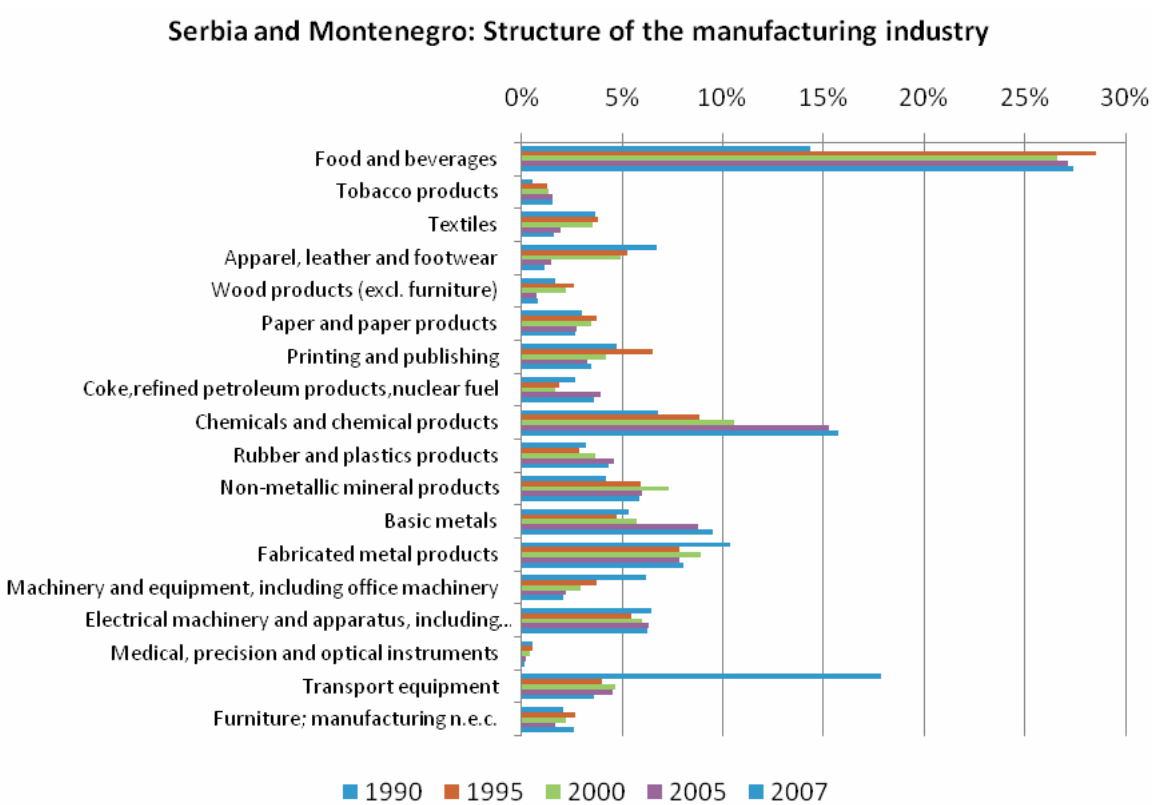


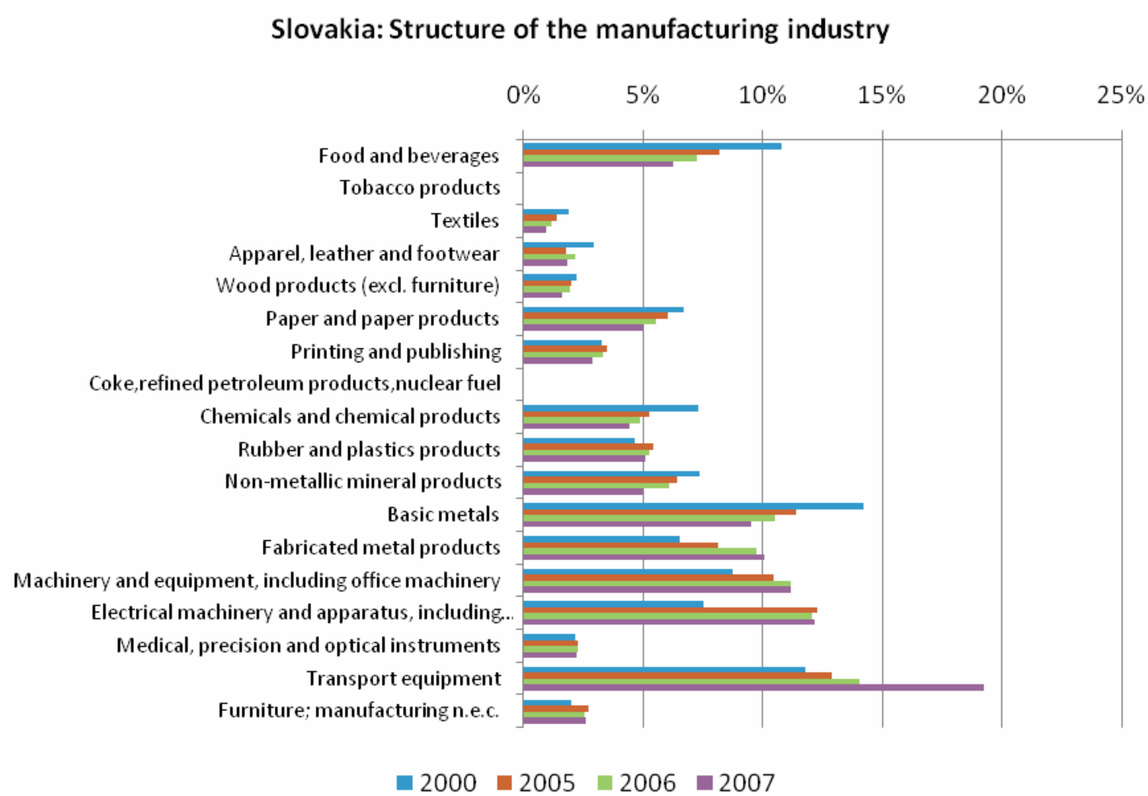
Moldova: Structure of the manufacturing industry
0%
10%
20%
30%
40%
50%
60%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
2000
2005
2006
2007

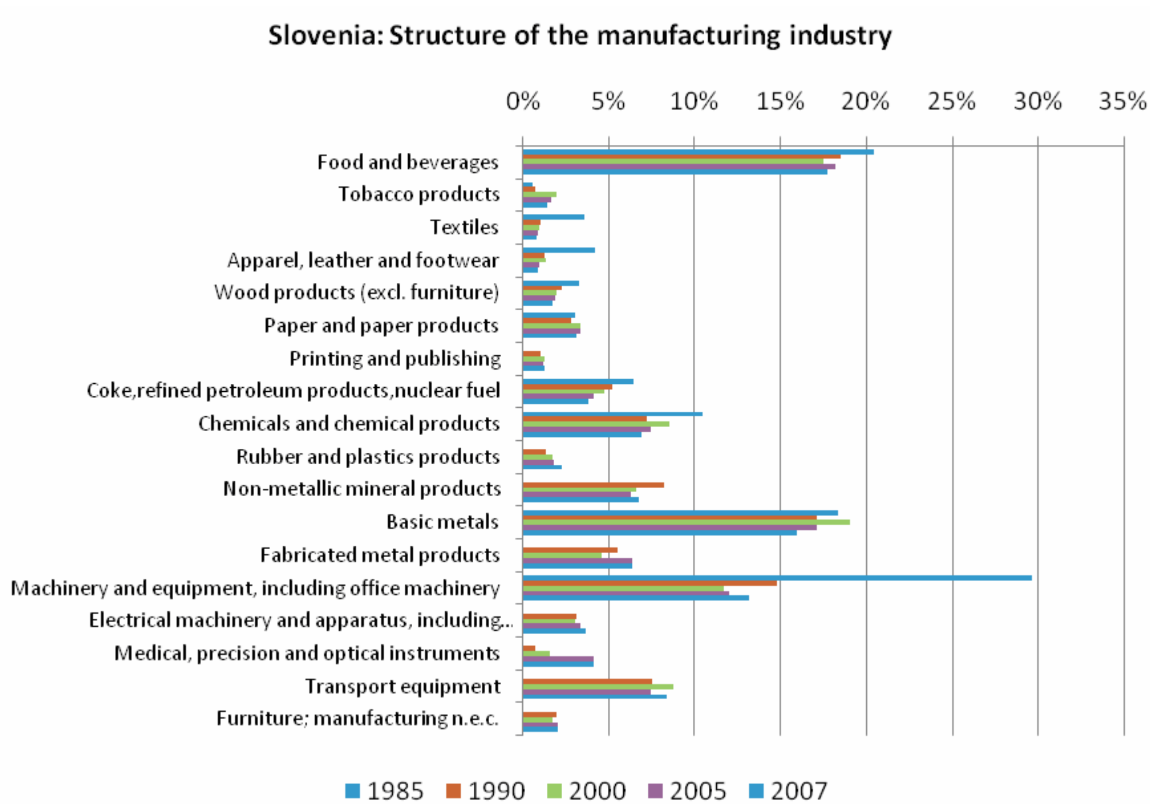

Poland: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1970
1980
1990
2000
2007

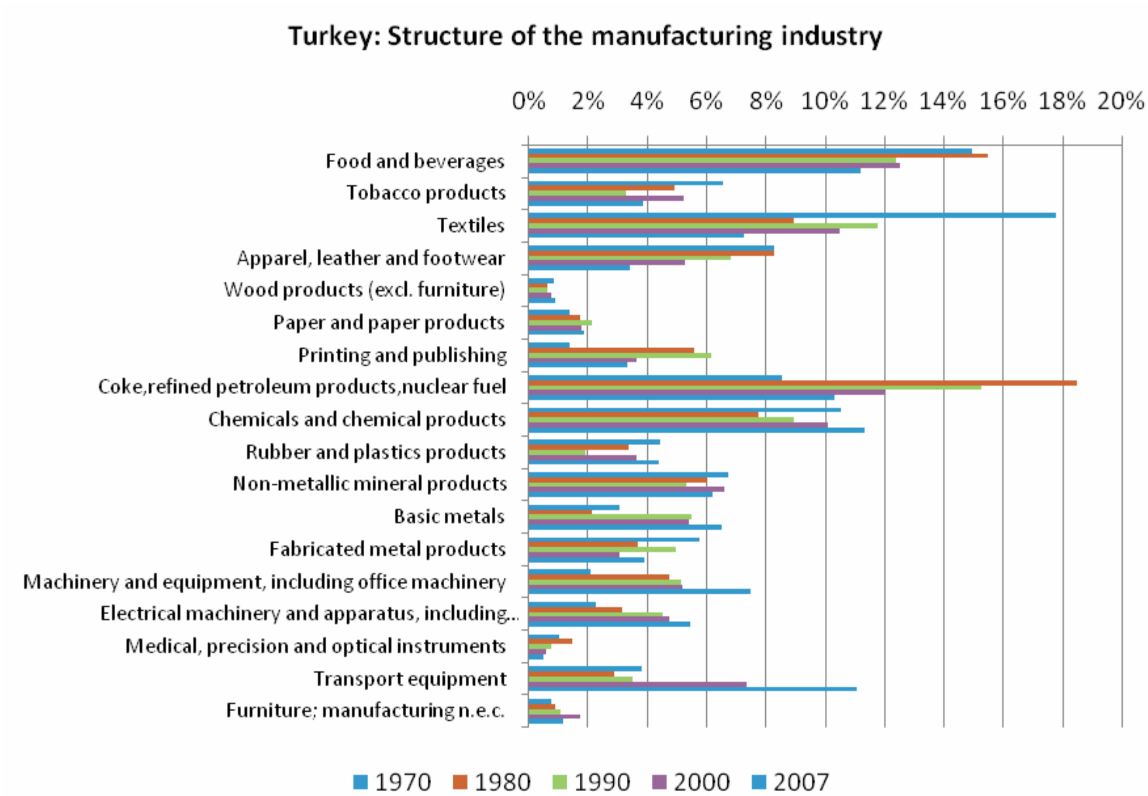

Romania: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
35%
40%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1970
1980
1990
2000
2007


Russia: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
35%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1990
1995
2000
2005
2007


Serbia and Montenegro: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1990
1995
2000
2005
2007

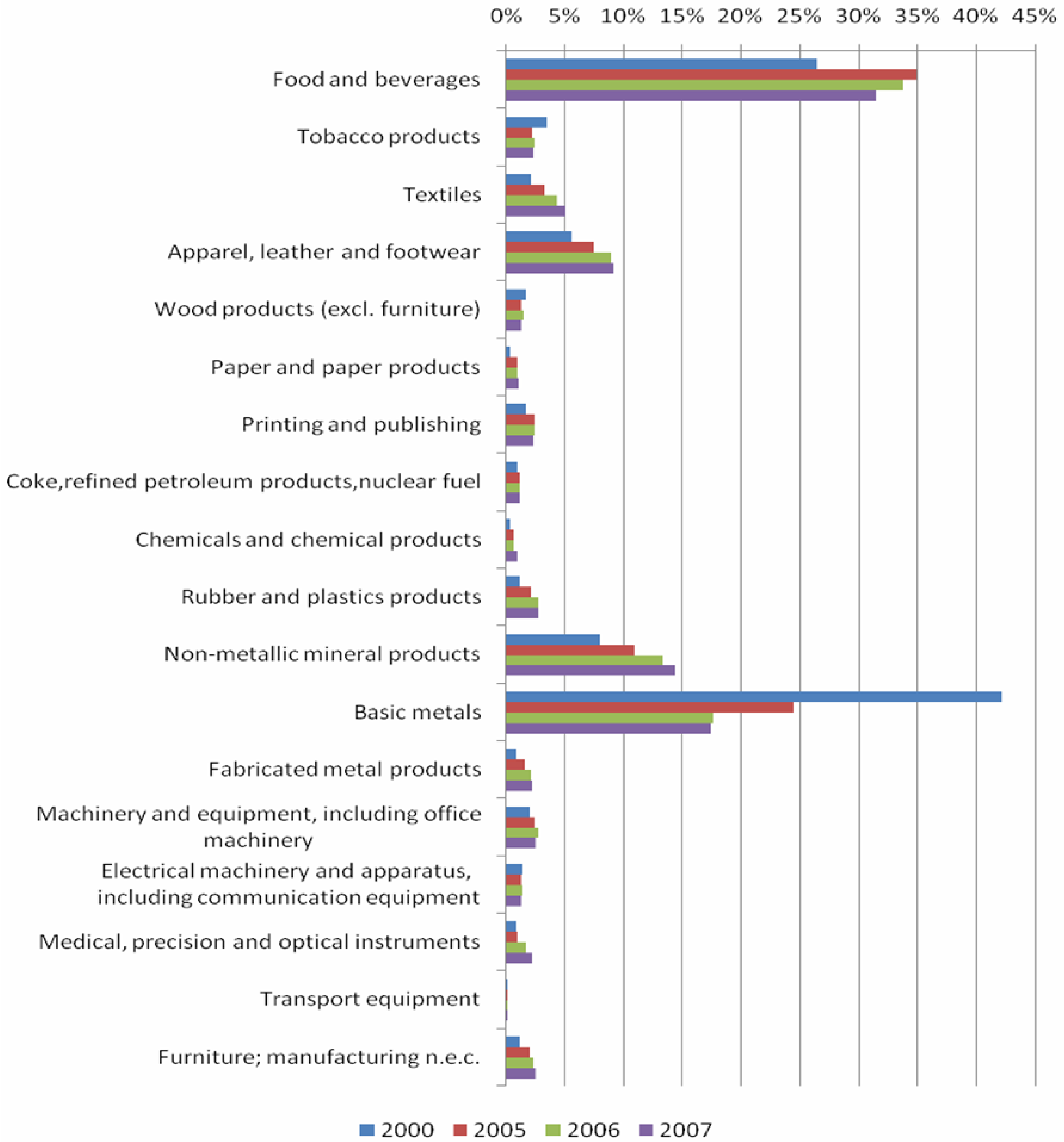

Slovakia: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
2000
2005
2006
2007


Slovenia: Structure of the manufacturing industry
0%
5%
10%
15%
20%
25%
30%
35%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1985
1990
2000
2005
2007


Turkey: Structure of the manufacturing industry
0% 2% 4% 6% 8% 10% 12% 14% 16% 18% 20%
Food and beverages
Tobacco products
Textiles
Apparel, leather and footwear
Wood products (excl. furniture)
Paper and paper products
Printing and publishing
Coke,refined petroleum products,nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, including office machinery
Electrical machinery and apparatus, including...
Medical, precision and optical instruments
Transport equipment
Furniture; manufacturing n.e.c.
1970 1980 1990 2000 2007

Appendix 4 Structure of manufacturing industry, by income group

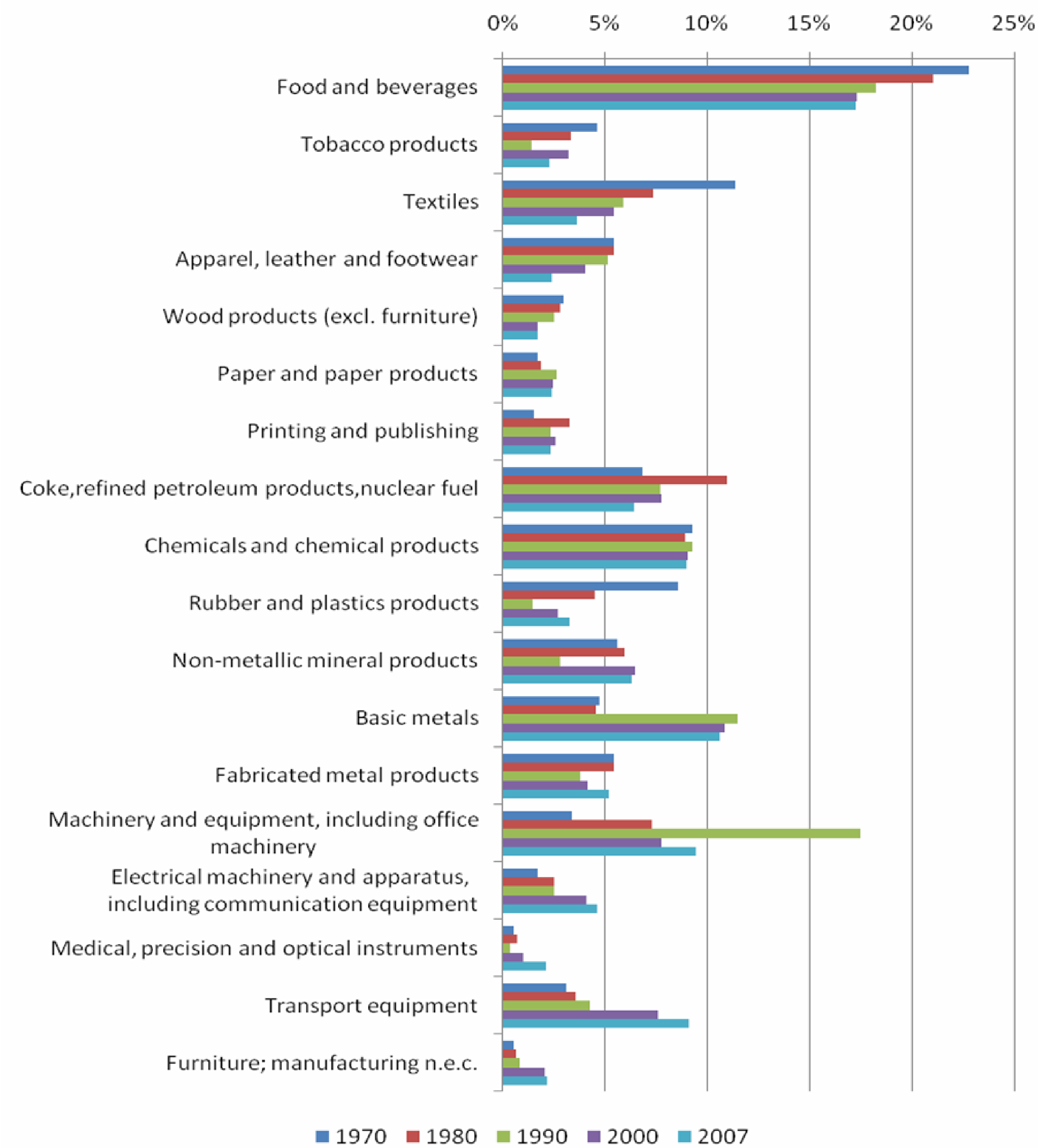
Low and lower-middle income countries in Europe and NIS region: Structure of the manufacturing industry, (2000-2007)



Source: UNIDO database (Indstat2 2011),[26] UNIDO calculations.

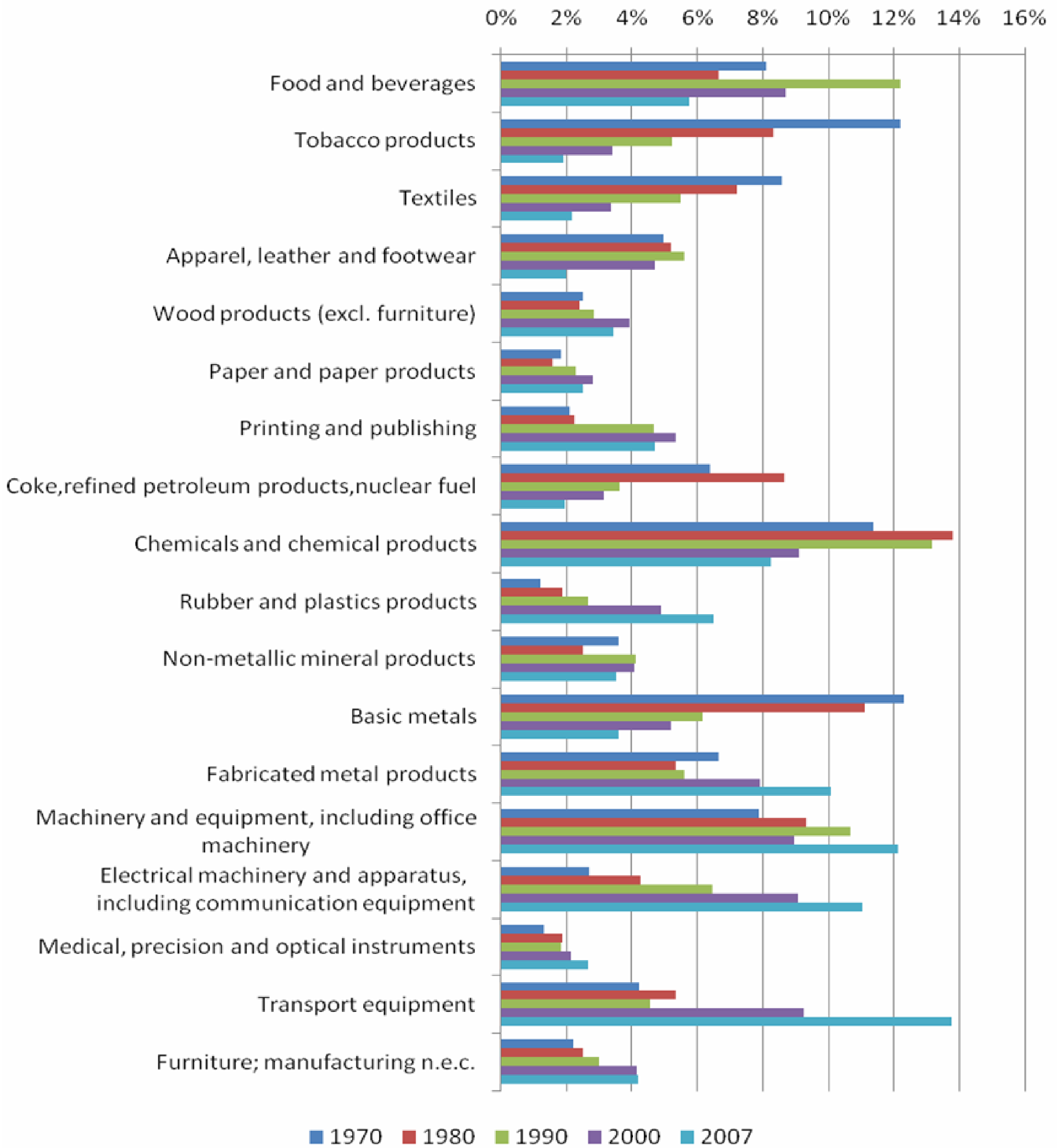
[26] Data available only for Moldova and Kyrgyzstan.

Upper-middle income countries in Europe and NIS: Structure of the manufacturing industry, (1970-2007)



Source: UNIDO database (Indstat2 2011), UNIDO calculations.

High-income countries in Europe and NIS region: Structure of the manufacturing industry, (1990-2007)



Source: UNIDO database (Indstat2 2011), UNIDO calculations.

Appendix 5 Decomposition technique application for selected countries: Detailed findings

Country	Azerbaijan	Bulgaria	Cyprus	Czech Republic	Estonia	Hungary
Structural effect	1.465	0.532	1.526	1.107	0.945	0.746
Energy efficiency effect	0.376	0.515	0.434	0.400	0.420	0.356
Fisher Ideal Index	0.551	0.274	0.663	0.443	0.397	0.266
Time horizon	2001 - 2008	1996 - 2008	1995 - 2008	1995 2007	2000 - 2008	1995 - 2007
Sectors						
Metals	yes	yes	no	yes	yes	yes
Chemicals and petrochemicals	yes	yes	no	yes	yes	yes
Non metallic minerals	no	yes	yes	yes	yes	yes
Transport equipment	no	yes	yes	yes	no	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	no	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes

Country	Kyrgyzstan	Latvia	Lithuania	Macedonia	Moldova	Poland
Structural effect	1.738	1.047	1.512	2.742	0.866	1.011
Energy efficiency effect	0.573	0.396	0.261	0.302	0.533	0.358
Fisher Ideal Index	0.996	0.414	0.395	0.828	0.461	0.362
Time horizon	2002 - 2007	1999 - 2008	2000 - 2008	1995 - 2007	2002 - 2008	1995 - 2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	no	yes
Non metallic minerals	no	yes	yes	yes	yes	yes
Transport equipment	no	yes	yes	yes	no	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	no	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes

Country	Romania	Russia	Slovenia	Slovakia	Turkey	Austria
Structural effect	0.983	1.076	1.342	0.805	0.973	0.970
Energy efficiency effect	0.318	0.278	0.969	0.389	1.267	1.233
Fisher Ideal Index	0.313	0.299	1.300	0.313	1.232	1.196
Time horizon	1995 - 2008	1995 - 2008	1995 - 2008	1995 - 2007	1995 - 2006	1995 - 2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	no	no	yes	no	yes	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes

Country	Belgium	Canada	Denmark	Finland	France	Germany
Structural effect	1.027	0.954	0.987	0.639	1.012	0.972
Energy efficiency effect	1.139	0.929	0.830	1.698	0.929	0.811
Fisher Ideal Index	1.170	0.886	0.819	1.084	0.941	0.788
Time horizon	1995 - 2007	1995 - 2007	1995 - 2007	1995 - 2007	1996 - 2007	1998 - 2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	yes	no	yes	yes	yes	yes
Machinery	yes	no	yes	yes	yes	yes
Food and tobacco	yes	no	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	no	yes	yes	yes	yes

Country	Greece	Iceland	Ireland	Italy	Netherlands	Norway
Structural effect	0.974	1.540	0.963	0.986	0.929	0.920
Energy efficiency effect	0.664	0.893	0.656	0.951	1.068	0.861
Fisher Ideal Index	0.647	1.376	0.632	0.938	0.993	0.792
Time horizon	1995 - 2007	1995 - 2005	1995 - 2007	1995 - 2007	1995 - 2007	1995 - 2006
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	yes	yes	yes	yes	yes	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes

Country	Portugal	Spain	Sweden	Switzerland	UK	USA
Structural effect	1.256	0.813	1.002	0.976	0.957	1.014
Energy efficiency effect	1.021	0.859	0.932	1.133	0.824	1.068
Fisher Ideal Index	1.282	0.699	0.934	1.106	0.788	1.083
Time horizon	1995 - 2007	1995 - 2007	1995 - 2007	1997 - 2007	1995 - 2008	1995 - 2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	yes	yes	yes	no	yes	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	no	no	yes
Textiles	yes	yes	yes	yes	yes	yes

Source: Cantore (2011) elaborated from UNIDO and IEA data.

Appendix 6 Electricity production sources (% of total annual average 1993-2007)

	Coal	Hydroelectric	Natural gas	Nuclear	Oil
Albania		97			3
Armenia		32	36	30	2
Austria	12	64	16		4
Azerbaijan		10	37		52
Belarus			87		12
Belgium	18		20	57	2
Bosnia	44	55			1
Bulgaria	44	7	5	42	2
Croatia	11	52	16		21
Cyprus					100
Denmark	59		18		4
Estonia	92		6		1
European Union	33	11	15	32	6
Finland	18	18	13	30	1
France	5	12	2	78	1
Georgia		80	17		4
Germany	53	4	10	28	1
Greece	65	7	9		17
Hungary	25	1	25	39	10
Iceland		85			
Kazakhstan	71	13	10		7
Kyrgyzstan	5	83	12		
Latvia		66	26		6
Lithuania		3	10	80	6
Luxembourg	15	14	60		1
Malta	5				95
Moldova	12	3	82		3
Montenegro	n/a	n/a	n/a	n/a	n/a
Netherlands	29		58	4	4
Norway		99			
Poland	96	1	1		1
Portugal	34	27	13		21
Romania	36	29	21	7	7
Russian Fed.	18	19	44	14	5
Serbia	64	33	1		1
Slovakia	22	15	8	51	3
Slovenia	36	25	1	37	1
Spain	33	14	13	27	9
Sweden	2	45		47	2
Switzerland		55	1	41	
Tajikistan		98	2		
FYR Macedonia	82	16			2
Turkey	30	31	33		6
Turkmenistan	n/a	n/a	n/a	n/a	n/a
Ukraine	32	6	17	43	2
United Kingdom	38	1	32	24	3
Uzbekistan	5	13	72		11

Source: World Bank, World Bank Indicators, quoted in UNECE (2011/4: 8-9).

A decomposition analysis of energy intensity for world countries and regions in the manufacturing sector[27]

Nicola Cantore, ODI

Introduction

The global warming emergency prompted a long debate on the best policies and most cost-effective ways to reduce greenhouse gas emissions. Energy efficiency is one of the most pertinent issues analyzed by economists and policy makers within the climate change debate. As ambitious international global emissions reduction targets are unlikely to be agreed by developed and developing countries (as shown by the failure of the Cancun and Copenhagen negotiations), a key priority is to investigate the most suitable domestic policy levers available to control greenhouse gases. Especially in developing countries, it is necessary to find ways of reconciling the environmental and development debates. The evidence shows that energy efficiency may boost profits and promote development at the same time as improving the environment (Farrell and Remes, 2009).

In this paper, we analyze the UNIDO INDSTAT dataset for value added and the IEA data for energy consumption, and investigate the evolution of energy intensity in manufacturing sectors over time. We also assess the extent to which changes in the energy intensity index depend on structural shifts in the economy (the extent to which the economy propels production towards "dirty" or "green" sectors) or on energy efficiency (interpreted here as energy consumption for each unit of value added production) through the Fisher Ideal Index decomposition technique.

As outlined by Ang and Zhang (2000), many techniques have been adopted in the published literature, such as the Laspeyres index method and the Arithmetic Mean Divisia Index method. The authors stress that these techniques allow the decomposition of shifts in energy intensity into a "structural component" and an "energy efficiency" component, but they leave a residual component whose interpretation is complex. To solve the residuality problem, Ang and Liu (2001) and Ang (2005) propose the use of the Logarithmic Mean Divisia Index (LMDI) technique, whereas Boyd and Roop (2004) advocate the Fisher Ideal Index technique. In this paper we use the Fisher Ideal Index technique because it is easy to comprehend from a conceptual point of view as it is based on the Laspeyres and Paasche Indices, both of which are usually introduced in the consumer theory chapters in microeconomics textbooks.

As stressed by Hoekstra and van den Bergh (2003), a reliable decomposition technique should be robust to completeness, time reversal and zero value tests. The completeness test evaluates whether a decomposition technique has a residual component. The zero-value robustness test assesses how the method performs when there are zero values in the data set used to calculate the index. The time reversal test, as first proposed by Fisher (1922), requires that if the time sequence between the first and last years being analyzed is reversed, the new index should be the reciprocal of the original. The Fisher Ideal Index is robust to all three tests, whereas the

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27 This working paper was prepared by Nicola Cantore, Research fellow, Overseas Development Institute, in cooperation with Olga Memedović, Chief, Europe and NIS Programme, UNIDO Programme Development and Technical Cooperation Division.

LMDI index presents computational problems with zero values that can be handled by replacing the zeroes with small positive values.

As outlined by Cahill *et al.* (2009), another source of distortion in the decomposition technique may come from the use of value added to calculate energy intensity. Changes in value added may be unrelated to production output, and measures of energy intensity based on physical output rather than on value added have been proposed, such as ODEX. However Cahill *et al.* (2009) also show that the ODEX technique fails to satisfy the time reversal technique and does not incorporate an approach to handle zero values.

The limitations of other techniques and its ease of use and interpretation are the key reasons for our choice of the Fisher Ideal Index technique for this paper. Moreover, it is the index of choice for the contributors to the recent UNIDO Industrial Development Report on Energy Efficiency (UNIDO, 2011).

Descriptive statistics about energy intensity

We use the INDSTAT2011 Rev 3 dataset for value added (where sectors are expressed as 2 digit ISIC categories) and the IEA Energy Balance for energy consumption.[28] We examine all countries contained in the IEA and INDSTAT datasets, and we then apply the analysis to a limited set of countries. The set we select consists of countries that are covered by IEA and INDSTAT data.

We then "clean data" by eliminating from the dataset countries for which we find inconsistencies (e.g. 0 for value added in X sector and a positive value for energy consumption and vice versa) and outliers.[29] We also exclude countries for which data are temporally inconsistent (e.g. 0 value for the periods 0...t-1 and a positive value at the time t).

In particular we search those countries where for all nine sectors we find full data over the period 2003-2006 with no missing values in either the IEA or INDSTAT dataset. In other words we extract the maximum level of information we can get from the IEA and INDSTAT datasets by using just original data and without resort to estimated data to fill missing values. After this data polishing process we are ready to present results for 29 countries. Data for energy consumption are expressed in ktoe (kilotons of oil equivalent), whereas value added data are taken in US current dollars from the INDSTAT dataset and then transformed into 1995 US dollars.

Table 1 shows that Emerging Europe & Central Asia countries like Georgia, Bulgaria and Romania rank lowest among the listed countries in both 2003 and 2006. But, as Table 2 shows, it is Emerging Europe & Central Asia countries that have experienced the largest absolute improvement in energy intensity between the two years. Results at the aggregate level are confirmed at sector level. Tables 3 and 4 show results for Albania, Moldova, Azerbaijan, Russia and Kyrgyzstan for which there are some missing data for some sectors. Again, in both 2003 and 2006 in many sectors, Emerging European & Central Asian countries (in particular Bulgaria, Russia and Georgia) are among those countries with the highest levels of energy intensity, even though between the two years they had undergone huge improvements in energy intensity (see Tables 3 and 4).

28 Consistency between the INDSTAT data and IEA data is shown in Appendix 1.
29 Outliers also include UNIDO and IEA dataset editing mistakes, such as value added data with a negative sign.

Table 1 Energy intensity in different countries (ktoe/millions of 1995 US$ in ktoe/ 1995 US$ millions). Countries are ranked in ascending order

Ranking	2003		2006	
1	Israel	0.062	Israel	0.065
2	Denmark	0.111	Denmark	0.105
3	Germany	0.124	Germany	0.109
4	Austria	0.173	Rep. Korea	0.150
5	France	0.191	Austria	0.162
6	United States	0.200	France	0.163
7	Rep. Korea	0.207	United States	0.191
8	Italy	0.211	Italy	0.193
9	Belgium	0.265	Hungary	0.205
10	Hungary	0.267	Spain	0.209
11	Sweden	0.270	Sweden	0.222
12	Spain	0.282	Belgium	0.226
13	Slovenia	0.297	Greece	0.256
14	Turkey	0.331	Slovenia	0.272
15	Greece	0.335	Turkey	0.285
16	Norway	0.376	Norway	0.293
17	Finland	0.378	Finland	0.330
18	South Africa	0.464	Czech Republic	0.345
19	Czech Republic	0.468	Poland	0.389
20	Latvia	0.526	Estonia	0.402
21	Poland	0.531	South Africa	0.414
22	Estonia	0.550	Latvia	0.432
23	Lithuania	0.587	Lithuania	0.463
24	Macedonia	0.863	Georgia	0.629
25	China	0.954	Slovak Republic	0.697
26	Slovak Republic	1.302	China	0.707
27	Romania	1.355	Macedonia	0.785
28	Bulgaria	1.742	Romania	0.853
29	Georgia	2.229	Bulgaria	1.058

Source: Author's calculations from UNIDO and IEA data.

The data are then aggregated into appropriate groupings: high-income countries (Austria, Belgium, Denmark, Finland, France, Germany Greece, Hungary, Israel, Italy, Republic of Korea, Norway, Poland, the Slovak Republic, Slovenia, Spain, Sweden, United States, the Czech Republic, and Estonia); upper- and low-middle income economies (Bulgaria, Latvia, Lithuania, Romania, China, South Africa, Macedonia, Turkey, and Georgia); South East Europe, the Caucasus and Central Asia (Macedonia, Turkey, and Georgia); new EU member States (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia); and Emerging Europe & Central Asia countries (Macedonia, Turkey, Georgia, Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic and Slovenia).

Table 2 Change of energy intensity in % (the sign + is energy intensity reduction, - is energy intensity increase; countries are ranked in descending order)

Ranking	Country	2006/2003 energy intensity reduction
1	Georgia	+71.768
2	Slovak Republic	+46.487
3	Bulgaria	+39.290
4	Romania	+37.059
5	Rep. Korea	+27.330
6	Estonia	+26.900
7	Poland	+26.674
8	Czech Republic	+26.245
9	Spain	+25.936
10	China	+25.876
11	Greece	+23.636
12	Hungary	+23.252
13	Norway	+21.860
14	Lithuania	+21.210
15	Latvia	+17.923
16	Sweden	+17.676
17	France	+15.022
18	Belgium	+14.473
19	Turkey	+13.969
20	Finland	+12.712
21	Germany	+12.655
22	South Africa	+10.839
23	Macedonia	+9.045
24	Slovenia	+8.701
25	Italy	+8.653
26	Austria	+6.182
27	Denmark	+5.427
28	United States	+4.658
29	Israel	-4.292

Source: Author's calculations from UNIDO and IEA data.

Table 3 Energy intensity in 2003 (ktoe/millions of 1995 US$) for different countries in different sectors (in bold the two most energy intensive countries for each sector)

In 2003	Metal	Chemical	Non-met. min.	Transport	Machinery	Food	Paper	Wood	Textiles
Albania	1.636	2.719	0.448	-	0.000	**1.532**	**2.185**	-	0.561
Austria	0.416	0.357	0.334	0.044	0.032	0.124	0.434	0.202	0.114
Azerbaijan	4.808	**29.678**	0.551	0.033	0.098	0.069	0.051	-	0.165
Belgium	1.089	0.339	0.659	0.058	0.039	0.180	0.191	0.160	0.159
Bulgaria	**7.397**	5.219	4.157	0.272	0.282	0.716	1.495	**1.546**	0.327
China	2.681	1.606	3.916	0.208	0.219	0.325	0.773	0.697	0.421
Czech R.	1.995	1.523	0.796	0.148	0.128	0.395	0.409	0.295	0.311
Denmark	0.293	0.081	0.597	0.058	0.046	0.139	0.070	0.143	0.104
Estonia	1.321	2.238	0.992	0.149	0.168	0.389	0.424	0.766	0.411
Finland	0.990	0.454	0.382	0.045	0.018	0.112	1.251	0.379	0.104
France	0.864	0.328	0.556	0.057	0.045	0.183	0.224	0.337	0.216
Georgia	**9.708**	6.615	**5.721**	**0.439**	0.313	0.485	0.126	0.111	0.816
Germany	0.663	0.247	0.510	0.040	0.023	0.133	0.168	0.102	0.101
Greece	1.569	0.326	0.958	0.058	0.045	0.249	0.124	0.213	0.142
Hungary	1.706	0.487	1.150	0.091	0.049	0.267	0.238	0.273	0.099
Ireland	3.359	0.022	0.607	0.065	0.040	0.072	0.014	0.320	0.177
Israel	0.398	0.143	0.175	0.036	0.004	0.067	0.037	0.088	0.079
Italy	0.946	0.377	0.701	0.034	0.074	0.199	0.221	0.077	0.124
Kyrgyzstan	0.174	**9.737**	0.832	-	**12.151**	0.350	-	0.860	**1.926**
Latvia	1.952	0.407	2.356	**0.313**	0.175	0.457	0.087	0.366	0.439
Lithuania	0.457	2.865	2.077	0.237	0.239	0.431	0.277	0.811	0.297
Macedonia	6.747	0.264	1.815	0.156	0.122	0.243	0.077	0.297	0.178
Moldova	0.472	-	0.662	-	0.330	**1.100**	0.654	0.962	0.334
Norway	2.132	0.867	0.532	0.035	0.049	0.086	0.413	0.229	0.099
Poland	3.569	1.452	1.149	0.161	0.127	0.231	0.557	0.632	0.207
Romania	3.905	8.121	1.421	0.235	0.510	0.747	1.598	0.445	0.265
Russia	5.065	4.606	**4.216**	-	**2.140**	0.848	0.184	**7.467**	**1.241**
Slovakia	3.335	4.036	2.287	0.177	0.249	0.775	**2.141**	1.169	0.499
Slovenia	2.219	0.225	0.979	0.127	0.085	0.244	0.592	0.280	0.191
South Africa	2.315	0.584	1.443	0.004	0.015	0.021	0.099	0.037	0.038
Rep. Korea	0.673	0.373	0.837	0.077	0.050	0.122	0.262	0.235	0.296
Spain	1.263	0.419	0.783	0.091	0.056	0.188	0.283	0.259	0.153
Sweden	0.772	0.200	0.477	0.046	0.026	0.135	0.908	0.350	0.131
Turkey	1.317	0.525	0.506	0.008	0.059	0.253	0.413	0.193	0.234
USA	0.766	0.364	0.455	0.054	0.054	0.119	0.454	0.387	0.150

Source: Author's calculations from UNIDO and IEA data.

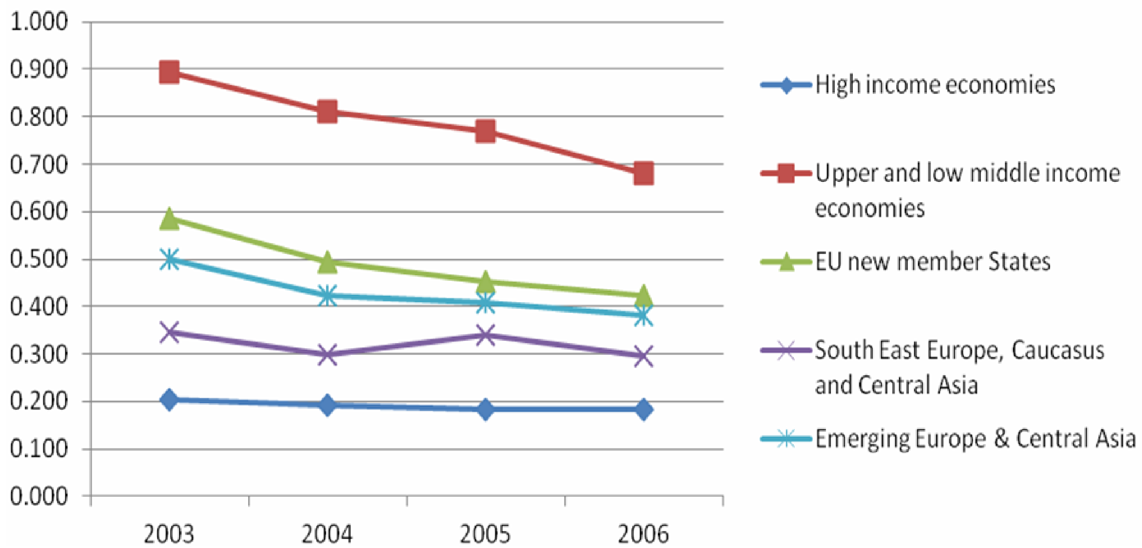
Table 4 Energy intensity for different countries in different sectors (in bold the two most energy intensive countries for each sector) in 2006

In 2006	Metal	Chemical	Non-met. min.	Transport	Machinery	Food	Paper	Wood	Textiles
Albania	1.636	2.719	0.448	-	0.000	**1.532**	**2.185**	0.000	**0.561**
Austria	0.325	0.299	0.342	0.044	0.034	0.137	0.432	0.235	0.115
Azerbaijan	**4.423**	**23.644**	0.309	0.022	0.070	0.276	0.076	0.088	0.388
Belgium	0.643	0.296	0.545	0.054	0.031	0.176	0.218	0.313	0.165
Bulgaria	2.176	**3.994**	1.933	0.108	0.169	0.500	0.933	**0.916**	0.261
China	1.719	1.054	**3.037**	0.176	0.156	0.232	0.605	0.476	0.326
Czech Rep.	1.149	1.214	0.643	0.094	0.092	0.295	0.514	0.261	0.260
Denmark	0.224	0.072	0.494	0.058	0.035	0.170	0.064	0.130	0.079
Estonia	1.498	1.372	0.753	0.161	0.105	0.330	0.315	0.431	**0.518**
Finland	0.469	0.404	0.341	0.054	0.017	0.100	1.236	0.171	0.096
France	0.696	0.250	0.439	0.048	0.041	0.149	0.211	0.336	0.078
Georgia	3.235	1.071	1.085	**0.488**	0.065	0.172	0.033	0.043	0.114
Germany	0.546	0.203	0.424	0.035	0.020	0.116	0.176	0.097	0.085
Greece	0.944	0.286	0.811	0.050	0.022	0.190	0.086	0.195	0.104
Hungary	0.916	0.351	0.869	0.064	0.048	0.250	0.220	0.221	0.057
Ireland	**3.637**	0.033	0.529		0.041	0.092	0.009	0.412	0.313
Israel	0.576	0.086	0.182	0.030	0.022	0.067	0.048	0.095	0.102
Italy	0.644	0.398	0.678	0.032	0.067	0.178	0.201	0.082	0.108
Kyrgyzstan	0.118	3.270	0.859	-	**7.702**	0.285	-	0.086	0.233
Latvia	1.444	0.269	1.031	0.229	0.130	0.376	0.085	0.502	0.217
Lithuania	0.573	1.798	1.310	0.098	0.113	0.319	0.170	0.537	0.238
Macedonia	2.396	0.186	1.770	0.113	0.095	0.233	0.082	0.053	0.115
Moldova	0.104	-	0.544	0.000	0.271	**1.709**	1.459	**0.777**	0.238
Norway	1.428	0.609	0.393	0.029	0.031	0.082	0.377	0.164	0.072
Poland	1.012	0.850	0.639	0.081	0.059	0.208	0.393	0.300	0.088
Romania	2.659	3.783	1.153	0.213	0.272	0.343	0.536	0.644	0.171
Russia	1.719	2.537	**2.215**	**0.938**	**0.437**	0.428	1.332	0.698	0.515
Slovak Rep.	1.524	1.818	1.383	0.170	0.100	0.469	**1.586**	0.443	0.262
Slovenia	1.065	0.190	1.001	0.082	0.089	0.231	0.577	0.323	0.165
South Africa	2.011	0.999	0.709	0.003	0.012	0.016	0.107	0.030	0.036
Rep. Korea	0.439	0.356	0.650	0.056	0.040	0.090	0.215	0.199	0.228
Spain	0.619	0.407	0.569	0.055	0.040	0.118	0.204	0.212	0.109
Sweden	0.483	0.123	0.382	0.042	0.016	0.114	0.999	0.291	0.084
Turkey	0.895	0.813	0.316	0.009	0.035	0.216	0.249	0.185	0.208
USA	0.510	0.269	0.445	0.057	0.049	0.131	0.523	0.358	0.160

Source: Author's calculations from UNIDO and IEA data.

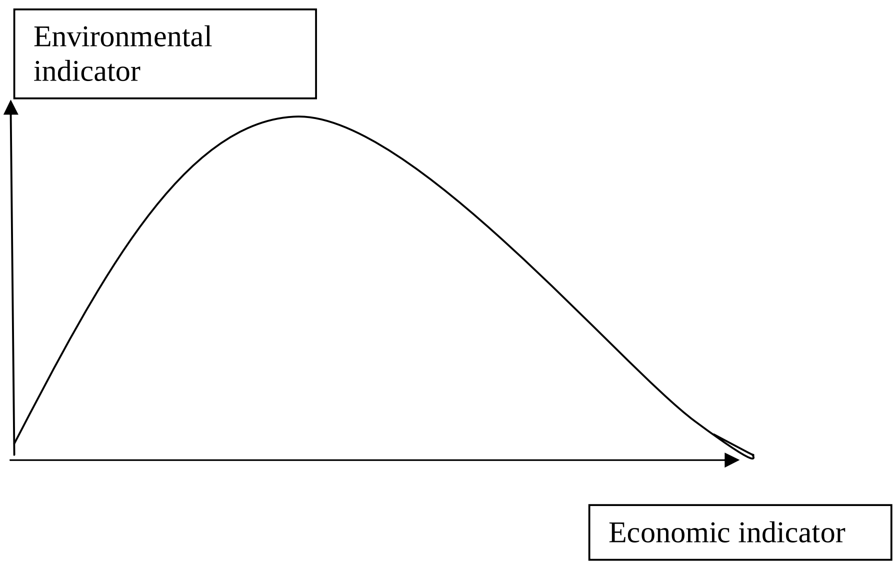
In broad terms, there is a higher level of energy intensity in upper- and low-middle income economies than in rich economies (Figure 1 and Table 5). At the same time, a relatively stable level of energy intensity can be seen in high-income economies and a tendency for energy intensity to decline in upper- and low-middle income economies. In other words, there is a convergence process in energy intensity. This would be consistent with the Environmental Kuznets Curve hypothesis (for a survey see Cantore, 2005), arguing that countries with low levels of income tend be more polluting than rich countries at the early stages of growth (see Figure 2), but they then tend to become "cleaner" at later stages of growth because they are more willing to pay for environment friendly technology improvements (energy efficiency effect) and because they tend to invest in less pollution-intensive sectors (structural effect).

Figure 1 Energy intensity in different regions (ktoe/ millions of 1995 US$)



Source: Author's calculations from UNIDO and IEA data.

Figure 2 The Environmental Kuznets Curve hypothesis



Of course, these interpretations are made cautiously given the limited available data. First, the pattern of upper- and low-middle income countries is particularly affected by China, which is the biggest economy in a limited set of nine countries composing the group. Second, there is marked heterogeneity in the upper and low middle income group. The members of that group in South East Europe, the Caucasus and Central Asia, comprising Macedonia, Turkey and Georgia, already have a level of energy intensity very similar to that of the high-income economies, whereas other members of the upper- and low-middle group lag behind the latter.

Table 5 Energy intensity for different world regions in different sectors (in bold the most energy intensive region for each sector) in 2003 and 2006

2003	High income economies	Upper and low middle income economies	EU new member States	South East Europe, and EECCA	Emerging Europe & Central Asia
Metal	0.851	2.620	**2.980**	1.434	2.309
Chemical and petrochemical	0.359	1.580	**1.679**	0.533	1.183
Non metallic minerals	0.577	**3.452**	1.211	0.570	1.019
Transport equipment	0.055	**0.179**	0.151	0.010	0.099
Machinery	0.049	**0.210**	0.140	0.060	0.120
Food and tobacco	0.139	0.308	**0.321**	0.255	0.286
Paper, pulp and print	0.394	**0.696**	0.614	0.399	0.591
Wood and wood products	0.308	**0.564**	0.511	0.196	0.492
Textiles	0.163	**0.377**	0.252	0.233	0.232
2006	**High income economies**	**Upper and low middle income economies**	**EU new member States**	**South East Europe, Caucasus & Central Asia**	**Emerging Europe & Central Asia**
Metal	0.568	**1.710**	1.445	0.957	1.262
Chemical and petrochemical	0.282	1.083	**1.139**	0.805	0.963
Non metallic minerals	0.506	**2.666**	0.900	0.346	0.684
Transport equipment	0.051	**0.154**	0.101	0.009	0.073
Machinery	0.043	**0.150**	0.091	0.036	0.075
Food and tobacco	0.136	0.223	**0.283**	0.216	0.254
Paper, pulp and print	0.420	**0.551**	0.510	0.243	0.440
Wood and wood products	0.283	**0.436**	0.418	0.180	0.409
Textiles	0.142	**0.308**	0.177	0.207	0.184

Source: Author's calculations from UNIDO and IEA data.

We can now apply the Fisher Ideal Index decomposition technique to understand if energy intensity variations depend more on the energy efficiency effect (decrease/increase of energy consumption per unit of value added) or on the structural effect (increase/decrease of the value added share in green sectors).

The decomposition analysis technique

The first step is to calculate energy intensity for each country as the ratio between energy consumption (expressed as kilotons of oil equivalent) and value added. After the calculation of energy intensity for each country we apply the Fisher Ideal Index Technique. This technique is based on the Laspeyres and Paasche indices. The Laspeyres index can be expressed as follows:

1) $$L_{str} = \sum_i S_{i,T} I_{i,0} / \sum_i S_{i,0} I_{i,0}$$

2) $L_{eff} = \sum_i S_{i,0} I_{i,T} / \sum_i S_{i,0} I_{i,0}$

Where L_{str} is the Laspeyres structural effect, and L_{eff} is the Laspeyres energy efficiency effect, S is the share of sector i in total value added at time t and I is energy intensity of sector i at time t. The Paasche index can be expressed as follows:

3) $P_{str} = \sum_i S_{i,T} I_{i,T} / \sum_i S_{i,0} I_{i,T}$

4) $P_{eff} = \sum_i S_{i,T} I_{i,T} / \sum_i S_{i,T} I_{i,0}$

Where P_{str} is the Paasche structural effect and P_{eff} is the Paasche energy efficiency component. The overall Fisher Ideal Index can be calculated as follows:

5) $FII = (L_{str} P_{str})^{1/2} * (L_{eff} P_{eff})^{1/2}$

Where the Fisher structural effect is $(L_{str}P_{str})^{1/2}$ and the Fisher energy efficiency effect is $(L_{eff}P_{eff})^{1/2}$ The Fisher Ideal Index is a multiplicative energy intensity index as the ratio between the levels of energy intensity in a country in two different periods, t and t+1 can be calculated by multiplying the Fisher Ideal Index structural and energy efficiency effects. In other words, if in the period t+1 energy intensity is 20 per cent higher than in the period t the Fisher Ideal Index is 1.20 and by multiplying the Fisher Ideal Index structural and energy efficiency components the result will be 1.2. Energy efficiency and the structural component at time t are lower (higher) than the one in a previous periods t-i <t-1>when their value is < (>) 1. The interpretation is trivial: when the energy efficiency component is < 1 (> 1) the consumption of energy per unit of value added (being constant over time the structural composition of the economy) reduces (increases) and energy efficiency improves (worsens). An analogous interpretation can be attributed to the structural component of energy intensity.

Data cleaning for the decomposition analysis and results

In section 2, energy intensity was presented only for countries with full data coverage over the period 1996-2006 for all sectors. In the case of the Fisher Ideal Index technique, a slightly different process of data cleaning is applied. The restriction that no missing data should exist for a certain period of time, for all sectors and for each country is relaxed. Where data are found to be missing (or inconsistent) for one sector in a specific country, they are excluded just for that sector and the decomposition technique is applied to all the other sectors. But only those countries for which data are available for at least five sectors (as in the UNIDO 2011 Industrial Development Report on Energy Efficiency (UNIDO, 2011)) are selected. It is acknowledged that results should be read cautiously, as the final dataset contains data for countries with differing time horizons and a different number of sectors. However, the advantage of this more flexible technique of data polishing is that we can interpret much more data than was used to calculate energy intensity. The time period for this exercise is 1995-2008. Data for 56 countries (33 high income countries and 23 upper/low middle income and low income economies) are reported and the results are shown in Table 6. The results refer to the first and last period of the indicated time horizon. For example, in the case of the Fisher Ideal Index value of 1.252 for Australia means that energy intensity in 2006 is about 25 per cent higher than energy intensity in 1996 in that country.

Table 6 Decomposition technique application for 56 countries: the detailed findings

Country	Australia	Japan	Rep. Korea	N. Zealand	Israel	Indonesia
Structural effect	1.017	1.039	0.859	0.943	0.963	0.843
Energy efficiency effect	1.232	1.788	1.277	0.918	1.480	0.747
Fisher Ideal Index	1.252	1.859	1.097	0.866	1.424	0.630
Time horizon	1996-2006	1995-2007	1995-2006	1996-2007	1995-2006	1995–2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	no	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	no
Transport equipment	no	no	yes	no	yes	no
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	no	yes	yes	yes	no
Textiles	yes	no	yes	no	yes	yes

Country	India	Morocco	Philippines	Argentina	Brazil	China
Structural effect	1.239	1.168	0.776	1.240	1.081	0.926
Energy efficiency effect	0.458	3.385	2.241	2.144	1.280	0.269
Fisher Ideal Index	0.568	3.952	1.738	2.659	1.383	0.249
Time horizon	1995-2007	1995-1998	1995-2006	1995-2002	1995–2007	1995–2007
Sectors						
Metal	yes	no	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	no	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	no	no	no	yes	no	yes
Machinery	yes	yes	yes	no	no	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	no	no	yes	yes	no	yes
Textiles	yes	yes	yes	yes	yes	yes

Decomposition technique application for 56 countries: the detailed findings (continued)

Country	Colombia	Costa Rica	Mexico	South Africa	Thailand	Tunisia
Structural effect	1.052	1.040	0.977	1.023	0.757	1.192
Energy efficiency effect	1.006	1.912	0.563	0.928	1.812	1.538
Fisher Ideal Index	1.058	1.988	0.550	0.949	1.371	1.834
Time horizon	1995-2005	1995-2008	1995-2006	1996-2008	1996–2006	1995-2006
Sectors						
Metal	yes	no	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	no	yes	yes	yes	yes
Transport equipment	no	no	no	yes	no	no
Machinery	yes	no	yes	yes	yes	no
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	no
Wood and wood products	yes	yes	no	yes	yes	no
Textiles	yes	yes	yes	yes	yes	yes
Country	**Azerbaijan**	**Bulgaria**	**Cyprus**	**Czech Rep.**	**Estonia**	**Hungary**
Structural effect	1.465	0.532	1.526	1.107	0.945	0.746
Energy efficiency effect	0.376	0.515	0.434	0.400	0.420	0.356
Fisher Ideal Index	0.551	0.274	0.663	0.443	0.397	0.266
Time horizon	2001-2008	1996-2008	1995-2008	1995-2007	2000-2008	1995-2007
Sectors						
Metal	yes	yes	no	yes	yes	yes
Chemical and petrochemical	yes	yes	no	yes	yes	yes
Non metallic minerals	no	yes	yes	yes	yes	yes
Transport equipment	no	yes	yes	yes	no	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	no	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes

Decomposition technique application for 54 countries: the detailed findings (continued)

Country	Kyrgyzstan	Latvia	Lithuania	Macedonia, FYR	Moldova	Poland
Structural effect	1.738	1.047	1.512	2.742	0.866	1.011
Energy efficiency effect	0.573	0.396	0.261	0.302	0.533	0.358
Fisher Ideal Index	0.996	0.414	0.395	0.828	0.461	0.362
Time horizon	2002-2007	1999-2008	2000-2008	1995-2007	2002-2008	1995-2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	no	yes
Non metallic minerals	no	yes	yes	yes	yes	yes
Transport equipment	no	yes	yes	yes	no	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	no	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes
Country	**Romania**	**Russia**	**Slovenia**	**Slovakia**	**Turkey**	**Austria**
Structural effect	0.983	1.076	1.342	0.805	0.973	0.970
Energy efficiency effect	0.318	0.278	0.969	0.389	1.267	1.233
Fisher Ideal Index	0.313	0.299	1.300	0.313	1.232	1.196
Time horizon	1995-2008	1995-2008	1995-2008	1995-2007	1995-2006	1995-2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	no	no	yes	no	yes	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes
Country	**Belgium**	**Canada**	**Denmark**	**Finland**	**France**	**Germany**
Structural effect	1.027	0.954	0.987	0.639	1.012	0.972
Energy efficiency effect	1.139	0.929	0.830	1.698	0.929	0.811
Fisher Ideal Index	1.170	0.886	0.819	1.084	0.941	0.788
Time horizon	1995-2007	1995-2007	1995-2007	1995-2007	1996-2007	1998-2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	yes	no	yes	yes	yes	yes
Machinery	yes	no	yes	yes	yes	yes
Food and tobacco	yes	no	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	no	yes	yes	yes	yes

Decomposition technique application for 54 countries: the detailed findings (continued)

Country	Greece	Iceland	Ireland	Italy	Netherlands	Norway
Structural effect	0.974	1.540	0.9619	0.986	0.929	0.920
Energy efficiency effect	0.664	0.893	0.6582	0.951	1.068	0.861
Fisher Ideal Index	0.647	1.376	0.6331	0.938	0.993	0.792
Time horizon	1995-2007	1995-2005	1995-2007	1995-2007	1995-2007	1995–2006
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical & petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	yes	yes	yes	yes	yes	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	yes	yes	yes
Textiles	yes	yes	yes	yes	yes	yes

Country	Portugal	Spain	Sweden	Switz.	UK	USA
Structural effect	1.256	0.813	1.002	0.976	0.957	1.014
Energy efficiency effect	1.021	0.859	0.932	1.133	0.824	1.068
Fisher Ideal Index	1.282	0.699	0.934	1.106	0.788	1.083
Time horizon	1995-2007	1995-2007	1995–2007	1997-2007	1995-2008	1995–2007
Sectors						
Metal	yes	yes	yes	yes	yes	yes
Chemical & petrochemical	yes	yes	yes	yes	yes	yes
Non metallic minerals	yes	yes	yes	yes	yes	yes
Transport equipment	yes	yes	yes	no	yes	yes
Machinery	yes	yes	yes	yes	yes	yes
Food and tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes	yes
Wood and wood products	yes	yes	yes	no	no	yes
Textiles	yes	yes	yes	yes	yes	yes

Country	Albania	Georgia
Structural effect	1.0798	1.6814
Energy efficiency effect	0.1430	0.1452
Fisher Ideal Index	0.1544	0.2440
Time horizon	1999-2007	2001-2008
Sectors		
Metal	yes	yes
Chemical & petrochemical	yes	yes
Non metallic minerals	yes	yes
Transport equipment	no	yes
Machinery	no	yes
Food and tobacco	yes	yes
Paper, pulp and print	yes	yes
Wood and wood products	no	yes
Textiles	yes	yes

Source: Author's calculations from UNIDO and IEA data.

Some (tentative) findings:

1) If we divide the sample into high-income countries and upper- and low-middle income and low-income economies, we find that the average structural change effect, energy efficiency effect and Fisher Ideal Index for developed countries are slightly below one (Table 7).

2) For upper- and low-middle income and low-income countries, on average, the energy efficiency effect, the structural effect and the Fisher Ideal Index are above one. In spite of the good performance of countries like China and Bulgaria, which have shown strong improvements, other countries, such as Morocco, Argentina and Colombia, are worsening in terms of both the energy efficiency and the structural effects.

3) The good performance of the countries of Emerging Europe & Central Asia has been driven by improvements in energy efficiency rather than by structural effects.

Table 7 Average of the Fisher Ideal Index components for relevant groups

	Average structural effect	Average energy efficiency effect	Average Fisher Ideal Index
High income countries	0.962	0.833	0.837
Upper/low middle income and low income economies	1.176	0.948	1.024
Emerging Europe & Central Asia	1.109	0.436	0.500
EU New Member States	1.003	0.438	0.448
South East Europe	1.598	0.571	0.738
Caucasus & Central Asia	1.365	0.381	0.510

Source: Author's calculations from UNIDO and IEA data.

These findings would broadly confirm the view that high-income economies perform slightly better than the group of middle- and low-income economies in terms of energy efficiency, but that upper/lower-middle income and low-income countries follow very heterogeneous paths towards a decarbonized economy. This aspect can probably be clarified by a further experiment, in which the 56 countries are aggregated by summing value added and energy consumption values in order to create the following groups:

1) East Asia and Pacific (Australia, China, Indonesia, Japan, Republic of Korea);

2) Middle East and North Africa (MENA) (Israel, Morocco, Tunisia);

3) Latin America (Brazil, Colombia);

4) BRICS (Brazil, Russia, India, China, South Africa);

5) Low Middle Income Countries (Indonesia, India, Morocco, Philippines);

6) Upper Middle Income Countries (Brazil, Bulgaria, China, Macedonia, Romania, Russia, South Africa, Turkey);

7) High Income (Australia, Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Republic of Korea, the Netherlands, Norway, the Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, United States);

8) South East Europe (Macedonia, Turkey);

9) Eastern Europe, the Caucasus and Central Asia (EECCA) (Azerbaijan, Kyrgyzstan, Moldova, Russia);

10) EU New Member States (Bulgaria, the Czech Republic, Hungary, Latvia, Poland, Romania, the Slovak Republic, Slovenia);

11) Emerging Europe & Central Asia (Bulgaria, the Czech Republic, Hungary, Latvia, Poland, Romania, the Slovak Republic, Slovenia, Macedonia, Turkey and Russia).

Table 6 shows that data are heterogeneous across different countries. For each group, aggregation across countries is made only for the sectors and years where data are available. (So, for example, if countries X and Y have data coverage for different years and different sectors, only those years and sectors for which there are data for both countries are selected.)

Table 8 shows that BRICS have been particularly successful in reducing energy intensity. Among high income countries, New EU Member States are achieving significant improvements due to energy efficiency. Table 6 and Table 8 make it clear that the good performance of the BRICS group has been driven by China and Russia and that in these countries the reduction in energy intensity is more the result of energy efficiency than structural change. In this context upper-middle income countries appear more effective than low-middle income countries in improving energy efficiency and this may explain the heterogeneous results in the groups that include both sets of countries.

This exercise suggests that the performance of high-income countries is poor; it shows energy intensity increasing slightly, whereas in Table 7 the average Fisher Ideal Index is decreasing. This difference reflects the fact that in Table 7 an average Fisher Ideal Index is calculated across countries, so there is no weighting for size. In the exercise reported in Table 8 energy consumption and value added for different countries are aggregated before the Fisher Ideal Index is calculated. Using this method increases the weighting of large economies, such as the USA, where there is an increasing level of energy intensity. Table 2 showed that high-income economies have experienced the lowest levels of energy intensity decreases and Figure 1 shows that these economies also have the lowest energy intensity levels. An interpretation of these results is that improvements in energy intensity are more difficult for those high income countries which have already reached low energy intensity levels.

But a key message from the above analysis is that in those areas where energy intensity is decreasing very rapidly, the driver for reduction is energy efficiency rather than structural change as shown by Table 9.[30]

30 See Appendix 2 for a detailed explanation of the methodology used for this table and for a breakdown by individual countries.

Table 8 Decomposition technique application for 12 world regions: the detailed findings

Country	East Asia & Pacific	BRICS	Latin America	MENA	EECCA	New EU Member States
Structural effect	1.210	1.147	1.072	1.033	1.173	1.083
Energy efficiency effect	0.981	0.418	1.510	2.834	0.227	0.355
Fisher Ideal Index	1.187	0.480	1.619	2.928	0.267	0.385
Time horizon	1995 - 2006	1995 - 2007	1995 - 2007	1995 - 2008	1995 - 2006	1996 - 2007
Sectors						
Metal	yes	yes	yes	no	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	no	yes
Non metallic minerals	no	yes	yes	no	yes	yes
Transport equipment	yes	no	no	no	no	no
Machinery	yes	no	no	no	yes	yes
Food & tobacco	yes	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	no	no	yes
Wood and wood products	no	no	no	no	no	yes
Textiles	no	yes	yes	yes	yes	yes

Country	Emerging Europe & Central Asia	South East Europe	low middle income	upper middle income	High income
Structural effect	1.1322	0.991	0.985	1.211	1.042
Energy efficiency effect	0.4308	1.233	0.901	0.485	0.983
Fisher Ideal Index	0.4878	1.222	0.887	0.588	1.024
Time horizon	1995 - 2008	1995 - 2007	1995 - 2006	1996 - 2006	1998 - 2006
Sectors					
Metal	yes	yes	no	yes	yes
Chemical and petrochemical	yes	yes	yes	yes	yes
Non metallic minerals	no	yes	no	no	yes
Transport equipment	yes	yes	no	no	no
Machinery	yes	yes	yes	no	yes
Food & tobacco	yes	yes	yes	yes	yes
Paper, pulp and print	yes	yes	yes	yes	yes
Wood and wood products	no	yes	no	no	no
Textiles	no	yes	yes	yes	yes

Source: Author's calculations from UNIDO and IEA data.

Table 9 Importance of energy efficiency and structural change to explain energy intensity variations

	Region	Energy intensity variation	% due to structural change	% due to energy efficiency
1	BRICS	-52	10	-62
2	Latin America	62	9	53
3	MENA	193	6	187
4	EECCA	-73	9	-82
5	EU New member states	-63	5	-68
6	Emerging Europe and Central Asia	-30	15	-45
7	South East Europe	22	-1	23
8	Low middle income	-11	-1	-10
9	Upper middle income	-41	15	-56
10	High income	2	4	-2
11	Upper and low middle income	2	4	-2

Source: Author's calculations from UNIDO and IEA data.

Conclusions

Despite the already mentioned limitations in terms of data availability and consistency, the foregoing analysis supports the following conclusions:

1) Energy intensity values vary across countries and regions, but the evidence suggests that convergence processes could already be in place;

2) The energy efficiency effect (where energy efficiency is expressed as the consumed energy per unit of value added) rather than structural change seems to be the key to major improvements in energy intensity;

3) Reductions in energy intensity and in particular improvements in energy efficiency have been very large for emerging economies (in particular for China and Russia), for New EU Member States and for countries in the Caucasus;

4) Some countries with high energy intensity have experienced strong improvements in the last decade (e.g. Georgia, Bulgaria).

These findings also suggest than better policies must be implemented to stimulate the most challenging component of energy intensity movements: structural change. The results clearly indicate that the most difficult task for policy makers is to orient the growth process, especially in developing countries, towards green sectors. The challenge will be for developing countries to avoid repeating the growth pattern experienced by the current developed countries, which was characterized by a strong pollution footprint from the early stages of development. Much must be done in terms of practice and research in this field. Moreover energy-efficiency-enhancing technological innovation must be promoted in countries where it still meets many barriers.

In terms of further research robust econometric analysis is needed to test the very preliminary evidence for the existence of the Environmental Kuznets Curve hypothesis (a bell shaped relationship between income levels and energy intensity) that we have found in this paper.

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Appendix 1 Consistency between corresponding categories in the IEA Energy Balance dataset and the INDSTAT 2009 Rev 3 dataset

IEA data	INDSTAT ISIC Divisions
Metal (iron and steel + non ferrous metals)	Division 27
Chemical and petrochemical	Division 24
Non metallic minerals	Division 26
Transport equipment	Divisions 34 and 35
Machinery	Divisions 28, 29, 30, 31, 32
Food and tobacco	Divisions 15 and 16
Paper, pulp and printing	Divisions 21 and 22
Wood and wood products	Division 20
Textiles and leather	Divisions 17, 18 and 19

Appendix 2 Decomposition analysis results expressed in % energy intensity increase/reduction due to structural change and energy efficiency

Decomposing the data derived through employing the Fisher Ideal Index technique gives the percentage increase/decrease in energy intensity, the percentage increase/decrease in the energy efficiency effect if the structural change effect is held constant and, conversely, the percentage increase/decrease of the structural change effect when the energy efficiency effect is held constant. Comparing the energy efficiency and structural change effects gives information on the relative importance of the energy efficiency and structural change components in determining variations in energy intensity.

However, to calculate the percentage shares of energy intensity variation due to energy efficiency and structural change effects, we need to apply the LMDI (Logarithmic Mean Divisia Index) to the results derived through the Fisher Ideal Index decomposition technique (Ang and Liu, 2001), as was done in the UNIDO Industrial Development Report 2011 (UNIDO, 2011). We use this technique to present the results shown below for individual countries.

Decomposition analysis results expressed in % energy intensity increase/reduction due to structural change and energy efficiency

	Country	Energy intensity variation	% due to structural change	% due to energy efficiency
1	Australia	25	2	23
2	Japan	86	5	81
3	Rep. Korea	10	-16	26
4	New Zealand	-13	-5	-8
5	Israel	42	-5	47
6	Indonesia	-37	-14	-23
7	India	-43	16	-60
8	Morocco	295	33	262
9	Philippines	74	-34	108
10	Argentina	166	37	129
11	Brazil	38	9	29
12	China	-75	-4	-71
13	Colombia	6	5	1
14	Costa Rica	99	6	93
15	Mexico	-45	-2	-43
16	South Africa	-5	2	-7
17	Thailand	37	-33	70
18	Tunisia	83	24	59
19	Azerbaijan	-45	29	-74
20	Bulgaria	-73	-35	-37
21	Cyprus	-34	35	-68
22	Czech Rep.	-56	7	-63
23	Estonia	-60	-4	-57
24	Hungary	-73	-16	-57
25	Kyrgyzstan	0	55	-56
26	Latvia	-59	3	-62
27	Lithuania	-60	27	-87
28	Macedonia	-17	92	-109
29	Moldova	-54	-10	-44
30	Poland	-64	1	-64
31	Romania	-69	-1	-68
32	Russia	-70	4	-74
33	Slovenia	30	34	-4
34	Slovakia	-69	-13	-56
35	Turkey	23	-3	26
36	Austria	20	-3	23
37	Belgium	17	3	14
38	Canada	-11	-4	-7
39	Denmark	-18	-1	-17
40	Finland	8	-47	55
41	France	-6	1	-7
42	Germany	-21	-3	-19
43	Greece	-35	-2	-33
44	Iceland	38	51	-13
45	Ireland	-37	-3	-34
46	Italy	-6	-1	-5
47	Netherlands	-1	-7	7
48	Norway	-21	-7	-13
49	Portugal	28	26	2
50	Spain	-30	-17	-13
51	Sweden	-7	0	-7
52	Switzerland	11	-3	13
53	UK	-21	-4	-17
54	USA	8	1	7
55	Albania	-85	3	-88
56	Georgia	-76	28	-103

Eco-innovation in Europe and NIS: general trends and policy challenges for a sustainable future[31]

Alasdair Reid, Asel Doranova, Paresa Markianidou and Michal Miedzinski, Technopolis Group

Introduction

This paper is an input to the Round Table session on "Promoting innovative industries and technologies for a sustainable future in the Europe and NIS region" at the UNIDO General Conference held from 28 November–2 December 2011 in Vienna. It provides a comprehensive overview of selected topics and trends relevant for understanding the eco-innovation landscape in the Europe and the Newly Independent States (NIS) region. The main questions addressed include:

- What is meant by eco-innovation and what are the main challenges for developing and implementing eco-innovation in the region?
- What are the main eco-innovation trends in the region?
- What are the trends in scientific publications and patenting trends?
- What are the investment trends, notably in terms of public R&D, in the region as regards energy and environmental research?
- What is known about the diffusion of eco-innovation, notably renewable energy, energy efficiency, waste management and environmental technologies, in the region?
- What are the trends in trade (exports and imports) in environmental goods?
- What types of policies could be considered to support eco-innovation and sustainable future in the NIS?

In order to give a comprehensive overview of trends, the paper is based on a number of data sources, including PATSTAT (patent data: trends in technology development), SCOPUS (bibliometrics: proxy for research activity), COMTRADE (trade data: trade volumes, proxy for technology transfer), IEA (renewable energy in the energy mix: trends in technology application) and Eurostat (investments in R&D, including environmental and energy GBOARD). The discussion covers the concept of non-technological innovations and transformative innovation, which may not be captured with available data sources, but are relevant for the debate. In order to frame the discussion, the paper introduces a policy framework to capture eco-innovation challenges including a typology of policy measures and different levels of policy deployment relevant for sustainable innovation.

Eco-innovation and the promise of sustainable industry

What is eco-innovation?

Since the mid-2000s, innovation is increasingly viewed in the context of the shift towards a green economy. Eco-innovation emerged as a key concept capturing both economic and environmental value resulting from novel solutions.

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31 This working paper was prepared by Alasdair Reid, Asel Doranova, Paresa Markianidou and Michal Miedzinski, Technopolis Group, Brussels, in cooperation with Olga Memedović, Chief, Europe and NIS Programme, UNIDO Programme Development and Technical Cooperation Division.

Eco-innovation can be defined as "the introduction of any new or significantly improved product (good or service), process, organizational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle" (EIO, 2011). The understanding of eco-innovation has broadened from end-of-pipe solutions to include resource and energy productivity solutions as well as system level changes that take into account a full life-cycle perspective.

Eco-innovation can be a new good or service, process, organizational change, marketing method in a company, but also a wider change with systemic implications for an economy and society (e.g. new urban design, transportation systems) (EIO, 2011). Eco-innovation can range from incremental to disruptive changes. The latter can trigger more profound structural economic and social shifts. System innovation may include elements or combinations of all types of innovations (product, process, marketing, organizational or social) and is, by definition, developed and implemented by many actors. This view of eco-innovation makes it a relevant perspective from which to analyze trends towards a more sustainable future for industry and economy.

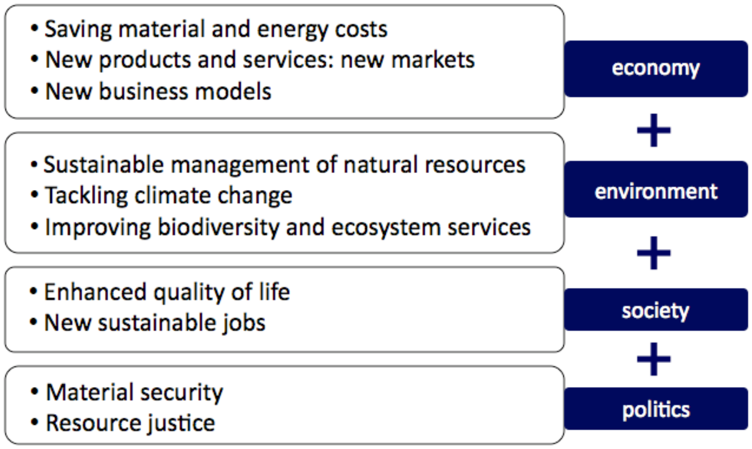
Eco-innovation in the context of developing and emerging economies

Eco-innovation is about pursuing sustainable change in production systems and society. It offers a strategic framework, which allows for strengthening long-term economic competitiveness without compromising environmental performance. The promise of eco-innovation is universal and is equally relevant for the developed and developing regions of the world. In the context of developing economies, eco-innovation has a special relevance as it reconciles the need for both economic development and ecological modernization. Figure 1 presents key potential economic, environmental, societal and political benefits from eco-innovation.

It can be argued that developing countries have a unique opportunity to benefit from eco-innovation as they can apply eco-innovation principles and anticipate future benefits in the process of designing and constructing their basic infrastructures (e.g. energy grids, transportation systems, city design). Eco-innovation can become a baseline for strategies and policies guiding profound structural changes in developing countries as well as contribute to creating greener and more competitive economies.

The promise of a "green economy" has been recognized by both national and international organizations. Clearly, the shift requires investment. The 2011 UNEP Green Economy Report (GER) argues that a transition to a green economy is possible by investing 2 per cent of global GDP per year (currently about US$1.3 trillion) in a green transformation of key economic sectors between 2011 and 2050. Interestingly, UNEP makes a link between poverty alleviation and the wise management of natural resources and ecosystems, due to the benefit flows from natural capital that are received directly by the poor (UNEP, 2011).

Figure 1 The promise of eco-innovation



Eco-innovation trends and challenges in Europe and NIS

Introduction: How to read this chapter

This section offers an at-a-glance overview of national eco-innovation trends and potential. The basket of indicators has been constructed to offer a series of snapshots of data and trends following a generic innovation value chain, from scientific research and R&D investments to technology diffusion and trade, relevant to eco-innovation and environmental technology.

Measuring eco-innovation is a substantial challenge, as it requires the creation of metrics drawing on different research traditions and measuring approaches, including innovation studies and environmental economics. Eco-innovation is not a standard economic sector and thus it eludes established statistical classifications. The challenge is thus to bring together a unique and comprehensive set of proxy indicators that describe the eco-innovation landscape. The paper should be regarded as a first step towards a more comprehensive measurement system, which should, first, allow for, comparative analysis and the benchmarking of countries and, second, contribute to a better evidence base for policies on the national and international level.

The basket consists of four components covering indicators on "inputs" (science and technology and R&D investments), "capabilities and absorption capacity" (environmental management and Internet penetration), "outputs" (green patents) and "outcomes" (diffusion of renewable energy technologies, trade in environmental goods and waste management). The results are aggregated in UNIDO country groups and, whenever possible, show a trend over the last decade. Table 1 presents an overview of the main components and indicators used in this section. The following sections offer snapshots of trends data and trends in the above-mentioned areas.

Inputs: scientific research and R&D investments

Scientific publications

A commonly used indicator to examine the knowledge base within a country is scientific output in the form of academic journal papers. The idea behind this indicator is that researchers and scientists share research outcomes mainly via publications, such as books or articles. There are several approaches to measuring the stock of research knowledge in eco-innovation: one approach is to define a set of journals and run an analysis; a second is to use key words to conduct a search over the whole publications database. A search was made using keywords such as ‘eco-innovation’, ‘environmental innovation’, ‘energy efficiency’ ‘eco AND technology’, ‘sustainab* AND technology’ or ‘environment* AND technology’. Eco-innovation is a relatively rarely used keyword in the title or abstract of an article; the highest number of hits can be found for ‘environment* AND technology’ with more than 130,000 articles from 2000-2011.[32]

Of the publications featuring environment* AND technology, the largest single country source was the United States of America with almost 30,000 publications, followed by China with almost 16,000. The United Kingdom (8,600) Germany (6,060) and Japan (4,700) followed. The contribution of Eastern Europe countries and the NIS region is limited, ranging from zero to 800 per country. Hence, in comparison to the world leaders, the indigenous knowledge base within SEE, EECCA and NMS is modest:

- Among **SEE countries**, the number of publications ranges from eight (Albania) to more than 700 in Turkey, with an average of 197 per country. In general, the environmental publication output has been growing over the last decade; this is particularly true of Croatia, Montenegro, Serbia and Turkey.
- Although **NMS** countries are heterogeneous, the overall trend is upwards. On average, NMS have 270 publications per country related to the topic. Poland leads with 741 publications, followed by Romania (513), Hungary (367) and the Czech Republic (320). Latvia props up the ranking with 36 publications.

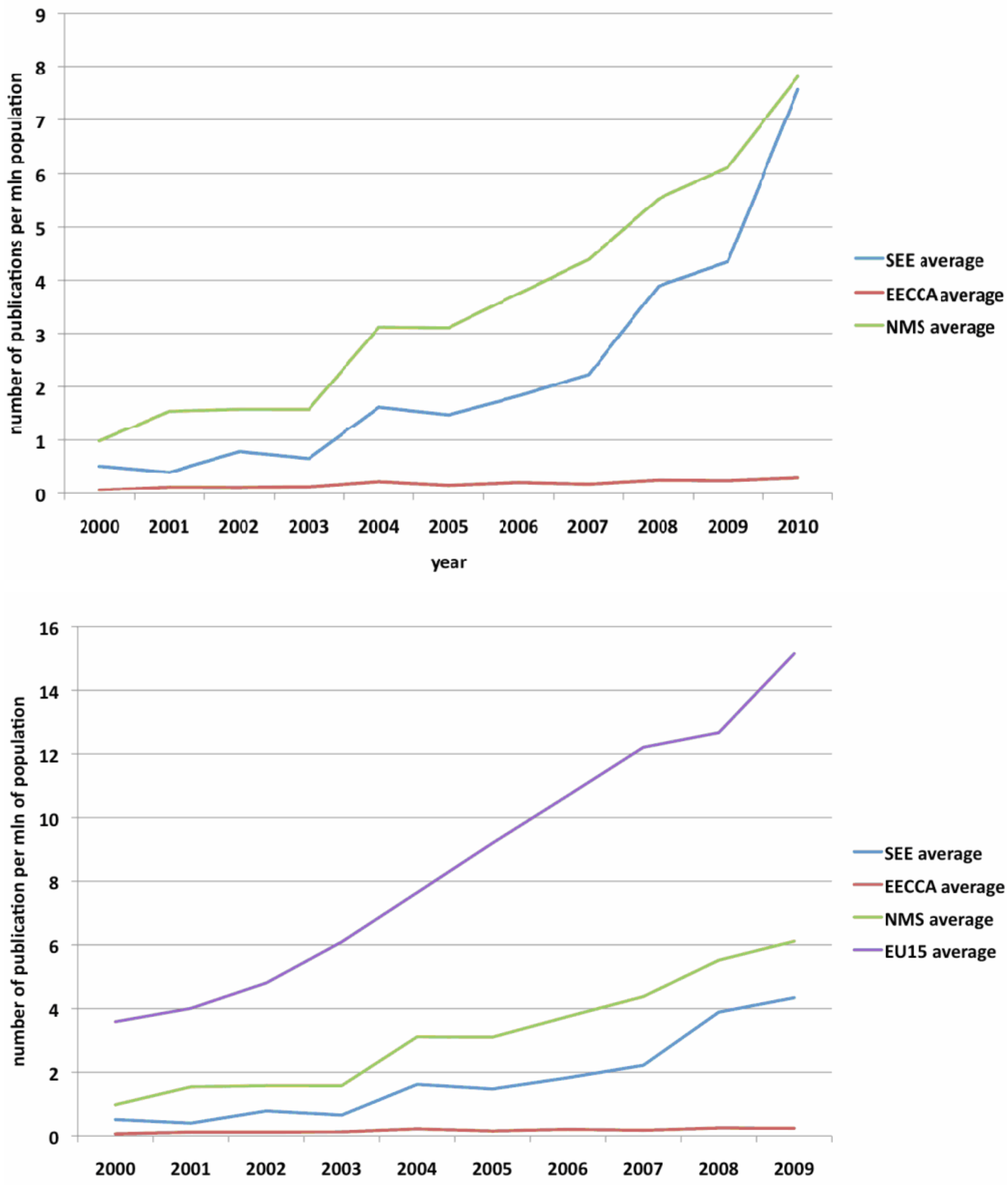
The **EECCA** sub-region includes three countries (Tajikistan, Turkmenistan and Kyrgyzstan) with one or no publications. Indeed, only the Russian Federation (with 800 publications) and Ukraine (with 164) have a respectable output. The other countries’ contributions are small with up to 22 publications over the ten year period. There is no clear growth trend for environmental publications in the EECCA region.

Figure 2 compares relative trends in publication outputs (per million population) in the three sub-regions and the EU-15. The trend for NMS and SEE countries has been constantly upwards, although with a lower growth rate than in the EU-15. In contrast, the EECCA sub-region has flat-lined over the last ten years at a very low level.

Table 2 provides an overview of the main organizations in the NMS with the highest number of publications related to environmental technology and the top three co-operation countries. The United States is the number one co-operation partner when it comes to scientific publications in the field, followed by the UK and Germany. Interestingly, a similar overview for China suggests that so far most of the Chinese co-publications are national, but China is already among the most important co-operation partners for the United States and Japan.

32 Given the propensity for co-publications, the calculation of aggregates by group of countries is not advised, thus the following figures provide either the totals per country or averages per group of countries.

Figure 2 Trends in environmental publication output, (2000-2010)



Source: Authors' calculations based on queries from SCOPUS database.

Table 1 Publications on environmental technology, main contributing national organization and main co-operating countries

Country	Main publishing organization in field	Main cooperating countries		
Bulgaria	Bulgarian Academy of Sciences	US	DE	UK
Czech Republic	Ceské vysoké ucení technické v Praze, Vysoké ucení technické v Brne	US	UK	DE
Estonia	Tallinn University of Technology	US	DE	UK
Hungary	Budapesti Muszaki és Gazdaságtudományi Egyetem	US	UK	DE
Latvia	Riga Technical University	US	DE	SE
Lithuania	Kaunas University of Technology	UK	DE	US
Poland	Politechnika Warszawska	US	UK	DE
Romania	Universitatea Politehnica din Bucuresti	US	UK	DE
Slovakia	Slovak University of Technology in Bratislava	US	DE	CZ
Slovenia	University of Ljubljana	US	UK	DE

Source: Authors' calculations based on queries from SCOPUS database.

Key findings

- Within the region, NMS countries count for the largest stock of environmental publications followed by the SEE and EECCA. Within the sub-regions the largest discrepancy is in the EECCA where Russia accounts for 80 per cent of the publications. Russia is also the region's overall leader.
- NMS and SSE countries have seen substantial growth over the last decade, while EECCA countries have experienced almost no change in scientific publishing in areas related to environmental technology.
- Despite exponential growth, NMS and SEE countries are still far behind the world's leading countries (EU-15, USA, China, Japan) in scientific activities; the gap between the EU-15 and the NMS/SEE/EECCA region has been increasing over the last ten years.

Eco-innovation investments: focus on public R&D funding

Eco-innovation is often supported by specific government investment measures. Figure 3 provides a cross-regional comparison of trends in governmental allocation in environmental and energy R&D over the 2004-2010 period. Data availability for government R&D funding in specific fields is limited for non-European countries. The "governmental allocation in environmental and energy R&D" (Environmental and energy GBOARD) provided by EUROSTAT allows for a cross-regional comparison of trends for the EU-15 countries and to some extent the NMS countries. Within the EECCA countries only Russia reported GBOARD data, and within SEE countries there are only data for Croatia. In both cases the data were reported for a limited number of years.

The available data suggest that EECCA and SEE are investing relatively less in R&D in the energy and environment sectors than the EU-15. The same is true for NMS where it is observed that the targeted sector specific investments are lower per capita than the EU-15. Further data collection and research is needed before more robust conclusions can be drawn.

Public sector investment data should be accompanied by data on investments made by private capital. The availability of data on private financing of eco-innovation in the region is even more limited than in the case of public sector financing. In general, according to the Cleantech database (www.cleantech.com), business investment in cleantech projects is growing globally. Available data suggest that venture capital investment in cleantech in East European countries is low. By 2009, Cleantech tracked closed investment deals in Cleantech venture capital in only the Czech Republic and Poland.

Key findings:

- In NMS, there are some positive trends in public and private investments in energy and environmental research, and environmental innovation. Observations on environmental investments in SEE and EECCA are inconclusive due to lack of data.
- The evidence on private Cleantech investments and higher public expenditures on environmental and energy R&D may suggest, however, that the gap between the EU-15 and NMS sub-regions may be increasing.

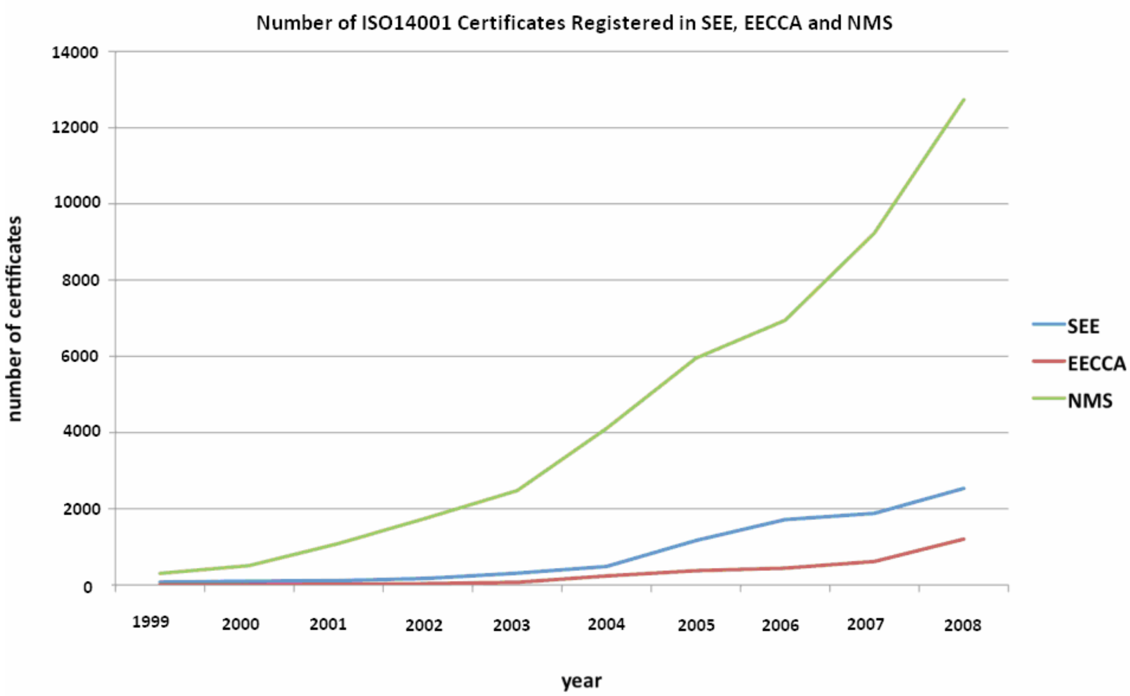
Capabilities: Environmental management and ICT

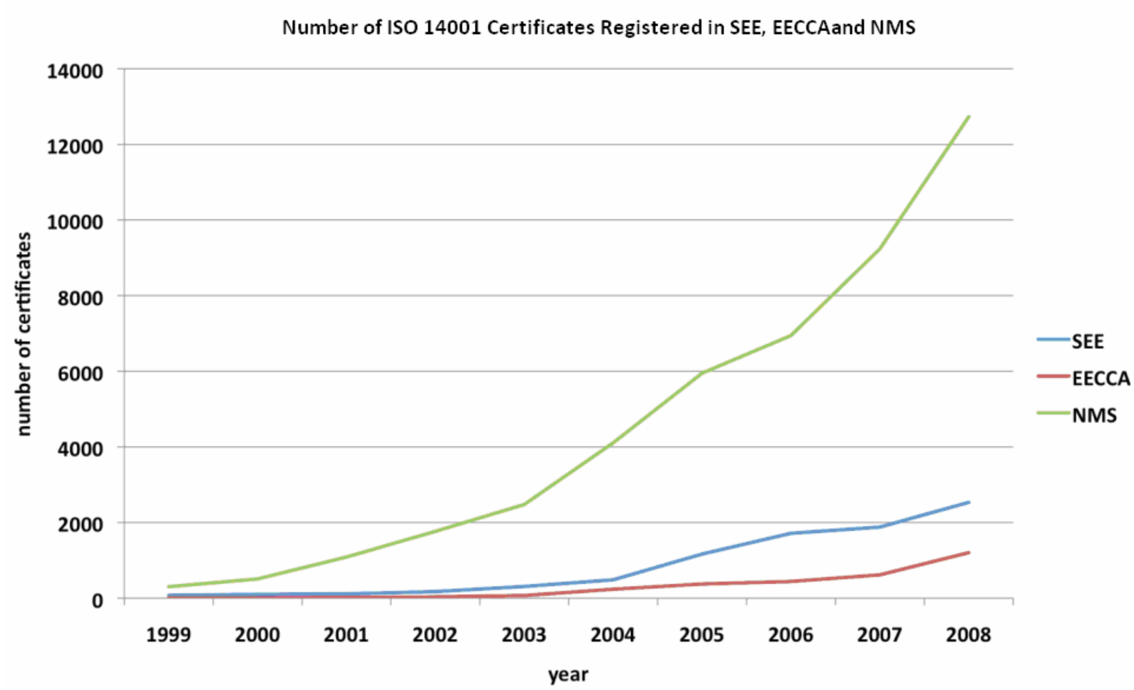
Environmental management

Eco-innovations at the company level are not necessarily measured through R&D activities. Many eco-innovative activities can be integrated in management and organizational practices. The two decades since 1990 have seen a massive growth in business concern about the environment and sustainability. Environmental management standards for organizations have been institutionalized by ISO14001 standard, which aims to assist companies in reducing their environmental impact, comply with applicable laws, regulations, and other environmentally oriented requirements (Figures 3 and 4). ISO14001 can be a very effective tool to promote eco-innovative practices, such as energy, material and resource saving, and cutting waste and emissions. Additionally it can help to achieve cost savings. ISO14001 is now used by over 220,000 organizations in 159 countries.

Europe and East Asian countries account for around 90 per cent of the global ISO14001 pool. Particular growth has been observed in the new EU member states in the last decade. In 2009 Romania and the Czech Republic were among the top ten countries in terms of both growth rates and the number of registered certificates. Other NMS countries have been performing as well or better than West European countries. In the EECCA region, Russia has seen rapid growth in green certification activities; it is also among the top ten countries for growth according to the ISO survey for 2009. In SEE, Turkey, Croatia and Bosnia and Herzegovina account for the highest growth in ISO14001.

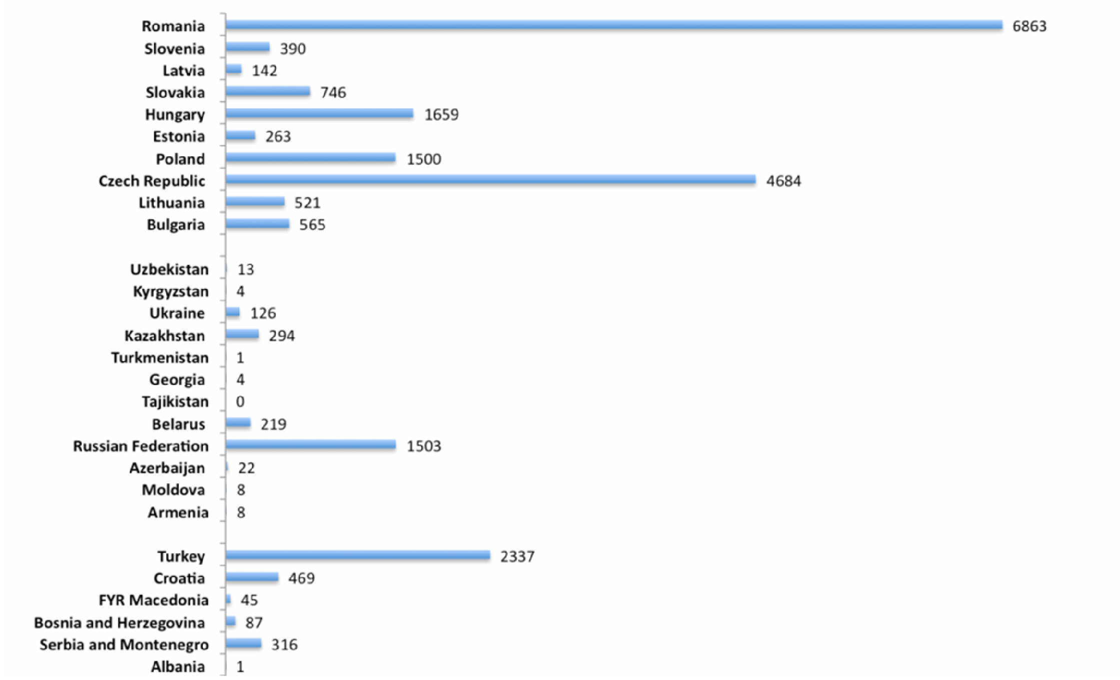
Figure 3 ISO14001 certification trends, (1999-2008)





Source: Authors' calculations based on the data from ISO survey of certifications (1993-2009).

Figure 4 Number of ISO14001 certificates per country, in 2009



Source: Based on data from the ISO survey of certifications (1993-2009).

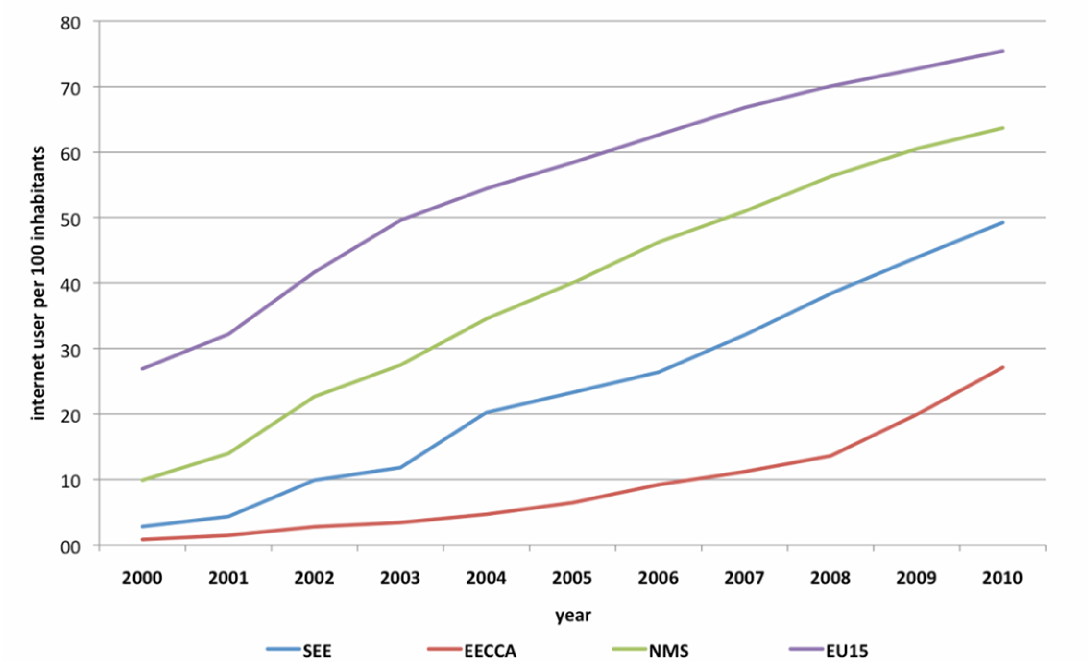
ICT diffusion

Information and communication technologies (ICT) play an important role in economic development and integration in the global economy. ICT are also a necessary prerequisite for knowledge diffusion about environmental innovations, with the Internet playing a significant role. Many eco-innovations depend on specifically designed software, automated monitoring programmes or GPS to function.

Rapid expansion of ICT developments, including mobile telecommunications, computer use and Internet, in the last decade have reached many parts of the world. Figure 5 shows the comparative trend in Internet penetration in different regions and countries. It has grown in all transition economies. In the last ten years, the NMS have caught up with economically developed countries; in all these countries 60-79 per cent of the population is connected to the Internet, with the exception of Bulgaria and Romania (46 and 19 per cent respectively). South Eastern Europe has experienced similar growth in Internet penetration; in ten years the share of population with Internet access has increased from below 5 per cent to 50 per cent (over 60 per cent in Croatia). In the NIS Internet penetration is lower at 27 per cent on average, with large cross-country differences, from 2.2 per cent in Turkmenistan to 43 per cent in Russia.

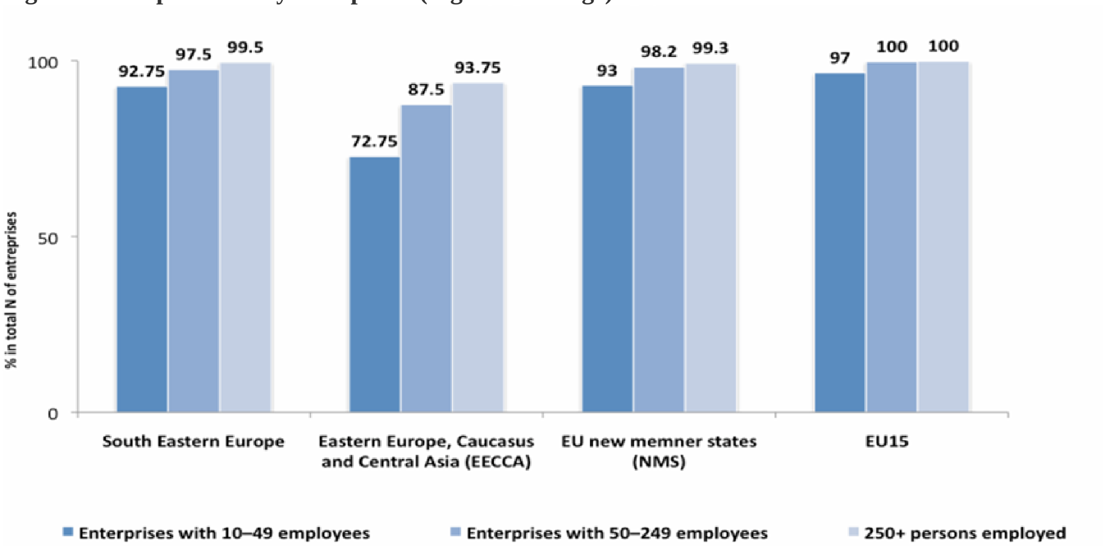
Figure 6 presents data on computer use in companies in SEE, EECCA, NMS and EU-15. It shows that computers are used by the majority of companies in all sub-regions. While for large companies employing over 250 people cross-regional statistics are high and do not differ much (93-100 per cent), there are visible differences for micro- and small-scale enterprises (around 73 per cent for EECCA, 93 per cent for SEE and NMS, and 97 per cent for EU-15). However, within the regional categories of EECCA and SEE countries there are large variations, ranging between 35 per cent for Azerbaijan and around 90 per cent for Russia.

Figure 5 Internet penetration, (2000-2009)



Source: Authors' calculations from ITU World Telecommunication/ICT Indicators database.

Figure 6 Computer use by enterprises (regional average)



Source: Authors' calculations based on data from UNCTAD Information Economy report 2011.[33]

33 UNCTAD reported the latest available data. EU-15 and NMS data refer to 2010; SEE and EECCA data is less harmonized and refer to different years ranging from 2007 to 2010. There are no data for enterprises with less than 10 employees for most countries.

Key findings:

- There are clear improvements in the capabilities of the business community in environmental management and ICT in the region. Particular progress has been observed for the NMS and SEE countries in environmental certification.
- Within the NMS, Romania and the Czech Republic are among the world leaders in absolute number of ISO14001 certificate registrations as well as in growth rates. High growth is also observed in most of SEE and Russia, but not in other EECCA countries.
- At the moment, the gap in the growth rate of ISO14001 certification between the EU-15 and NMS country groups is not very high and there is convergence. The SEE and EECCA sub-regions are lagging far behind and the gap between EU-15 and NMS has been growing.
- Internet and computer technology penetration has grown rapidly in the last ten years, although the NMS and SEE have made more progress than the EECCA countries. There is evidence of convergence with EU-15 economies in these indicators for all country groups.

Outputs: patenting activity

Patents measure inventive output is often used as a proxy for innovation, both at company and country levels. Patent classification systems allow patenting statistics in various technological areas to be tracked. With increasing concern about environmental problems, more attention is being paid to monitoring environmental patenting activities. International patenting agencies have introduced new classes of patents, including inventions, aimed at addressing environmental issues. A number of methodologies have been proposed for tracing environmental patent account (Dechezleprêtre *et al.*, 2008; Johnstone *et al.*, 2008). The patent statistics analysis here adopts the World Intellectual Property Organization (WIPO) categorization of environmentally sound technologies.[34]

Environmental patents

Figure 7 presents the evolution of environmental patents from 1991 to 2009. There are marked differences in patenting outputs across the three regions. EECCA has the largest number of patents and its patenting activities increased in 2004-2005, after which they remained stable. Over 92 per cent of the region's patents have been filed in the Russian Federation, compared to 5.5 per cent in Ukraine and 2 per cent in Moldova. Most EECCA countries have no patents in environmental technologies and, indeed, their overall patenting activity has been close to zero.

Among the NMS, Poland accounts for over half of environmental patents, Hungary for 22 per cent and Bulgaria and the Czech Republic for 9.6 and 9 per cent, respectively. Other NMS are responsible for shares ranging from 0.2 to 2 per cent of the regional green patent pool. The statistics suggest that the patenting output in the region did not change much over the period and even declined in the mid 2000s.

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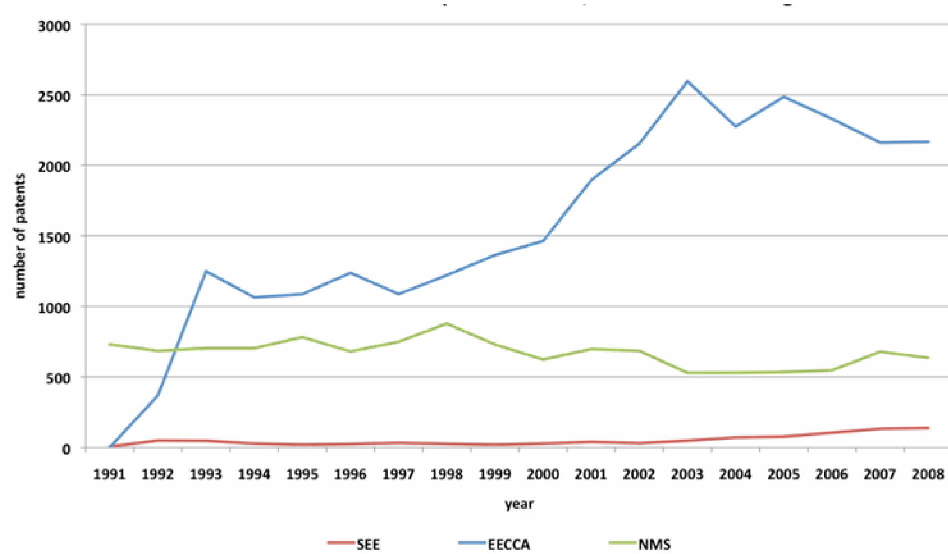
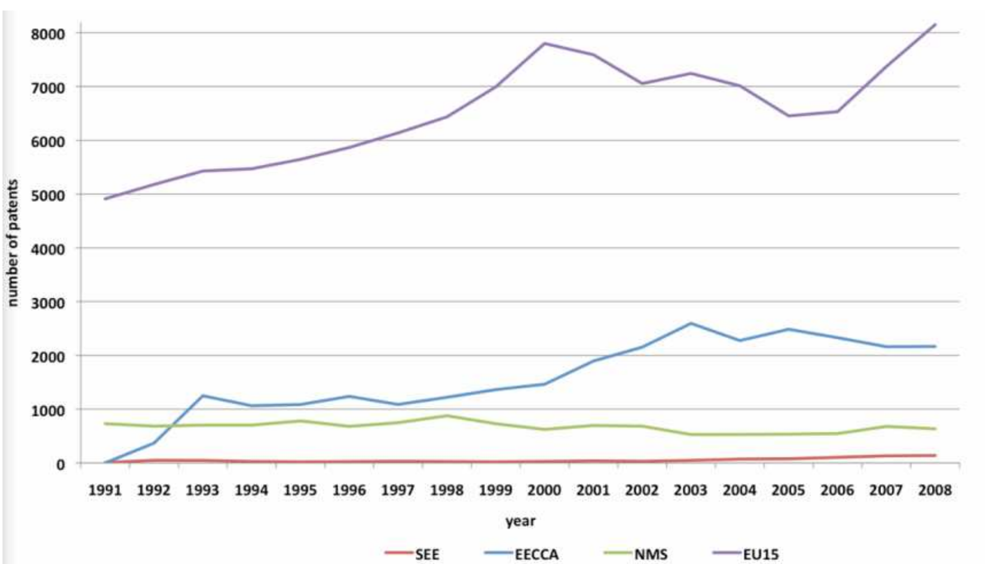
34 Statistics for nuclear technologies which fall into WIPO's categorization of environmentally sound technologies were excluded in the patenting statistics presented in this paper.

Disaggregation of the patent statistics total for the SEE, EECCA and NMS by technology area (Figure 8) indicates that the most significant groups are in renewable energy and waste management, which includes inventions in solid waste and wastewater treatment. These two areas account for 60 per cent of all environmental patenting statistics. Rates of invention in energy conservation, transportation, and agriculture have been at comparable levels (between 9 and 11 per cent) and follow rather similar patterns of development. It is important to note that in all technology areas there has been a steady growth of patenting over the last two decades.

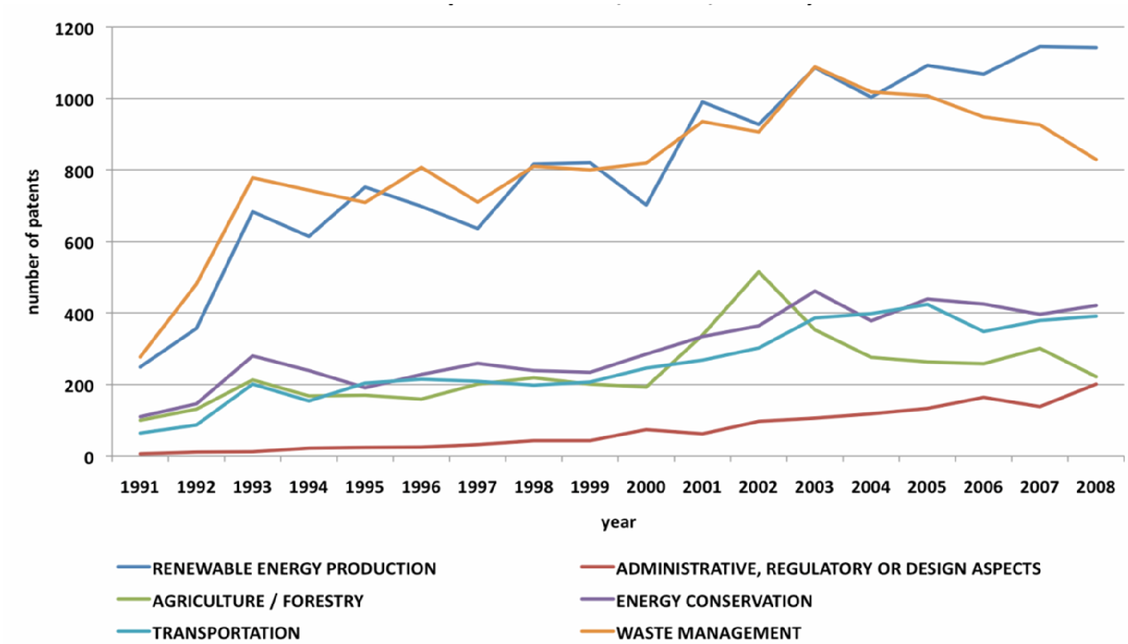
Figure 7 Evolution of environmental patents: absolute numbers, (1991-2008)





Source: Authors' calculations based on EPO PATSTAT data.

Figure 8 Evolution of environmental patents: disaggregation by area: absolute numbers, (1991-2008)



Source: Authors' calculations based on EPO PATSTAT data.

Renewable energy technology patents

Table 3 demonstrates the evolution within the groups of renewable energy patents. The cross-country and cross-regional analysis of the renewable energy patents shows trends similar to those in general environmental patenting discussed above. Roughly half of the whole patent pool for all three regions is due to Russia. Other regional leaders are Poland and Hungary (11-12 per cent each). Several countries in both the SEE and EECCA regions have had no patenting activity in renewable energy technologies, while the performance of other countries varies from 0.1 per cent (Tajikistan) to 5 per cent (Bulgaria and Czech Republic). Since 1991 the renewable energy patent output has been increasing. However the trends for some countries have been fluctuating from year to year. A decline has been observed only in the case of Latvia.

Table 2 Renewable energy patents in 1991-2009 and aggregated patents filed in the period (1980-2010), (in absolute numbers)[35]

	1991	1996	2001	2005	2009	Accumulated over 1980-2010
South East Europe (SEE)						
Turkey	2	4	4	9	21	160
Croatia	0	11	12	9	8	191
Serbia	0	0	1	13	6	74
Bosnia and Herzegovina, Albania, Serbia, Montenegro, FYR Macedonia	0	0	0	0	0	0
Eastern Europe, Caucasus and Central Asia (EECCA)						
Russian Federation	0	371	533	702	413	8495
Ukraine	0	0	27	76	0	520
Moldova	0	15	38	32	10	361
Tajikistan	0	0	1	1	0	16
Georgia, Armenia, Azerbaijan, Belarus, Kyrgyzstan, Kazakhstan, Turkmenistan, Uzbekistan	0	0	0	0	0	0
EU New Member States (NMS)						
Poland	86	88	101	84	164	2418
Hungary	117	85	129	20	35	2433
Romania	21	71	20	20	6	1086
Bulgaria	41	5	13	24	0	808
Czech Republic	0	35	44	47	41	771
Slovakia	0	11	12	7	8	182
Slovenia	0	13	11	8	17	144
Lithuania	0	2	4	3	12	101
Latvia	0	25	9	1	0	101
Estonia	0	1	6	6	4	46
Reference countries						
EU15 average	85	99	124	105	171	3390
EU15 (min-max)	0-630	3-836	)35	)-727	8-1382	

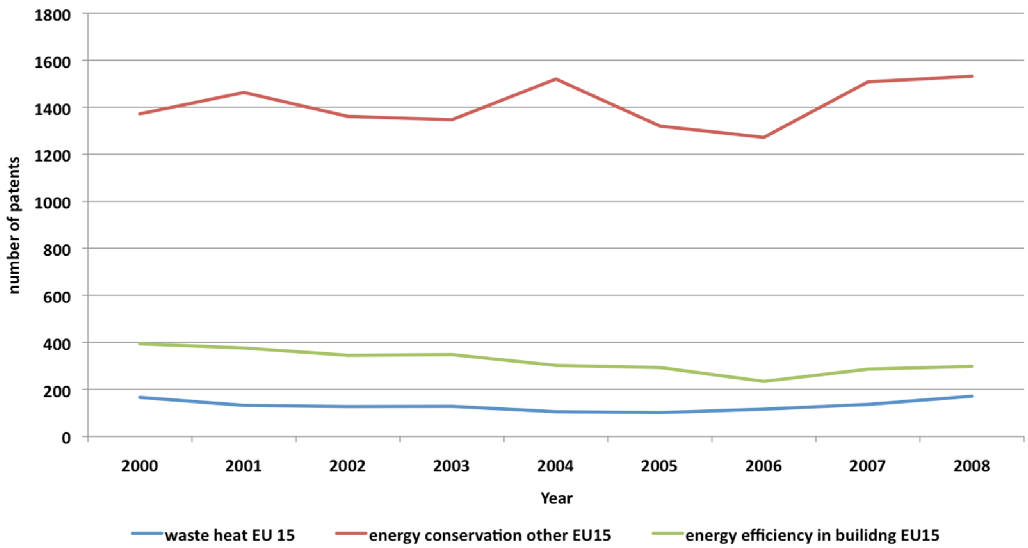
Source: Authors' calculations based on EPO PATSTAT data.

Patenting in energy efficiency technologies

Energy efficiency related patenting activities in the region, as in the EU-15, showed some fluctuations over the last decade, but overall did not show an increase in annual output (Figure 9). The main thematic focus has been on energy conservation measures (e.g. in lighting, electrical equipment, etc), followed by energy saving in buildings and using waste heat. Somewhat similar trends have been observed in the EU-15 while their patents pool and per capita output in each field is two to four times higher than the aggregated pool of the SEE, EECCA and NMS. Over 60 per cent of the overall patent pool belongs to Russia, around 12 per cent to Poland while Ukraine with 6 per cent ranks third. However, in per capita terms Slovenia has the highest performance with 5.2 patents per million people, while Russia and the Czech Republic have 1.9 and 1.7 patents per million inhabitants respectively.

35 EPO PATSTAT data for 2009 and 2010 are still incomplete. Thus, declining trends for 2009 are most probably due to incomplete data for that year.

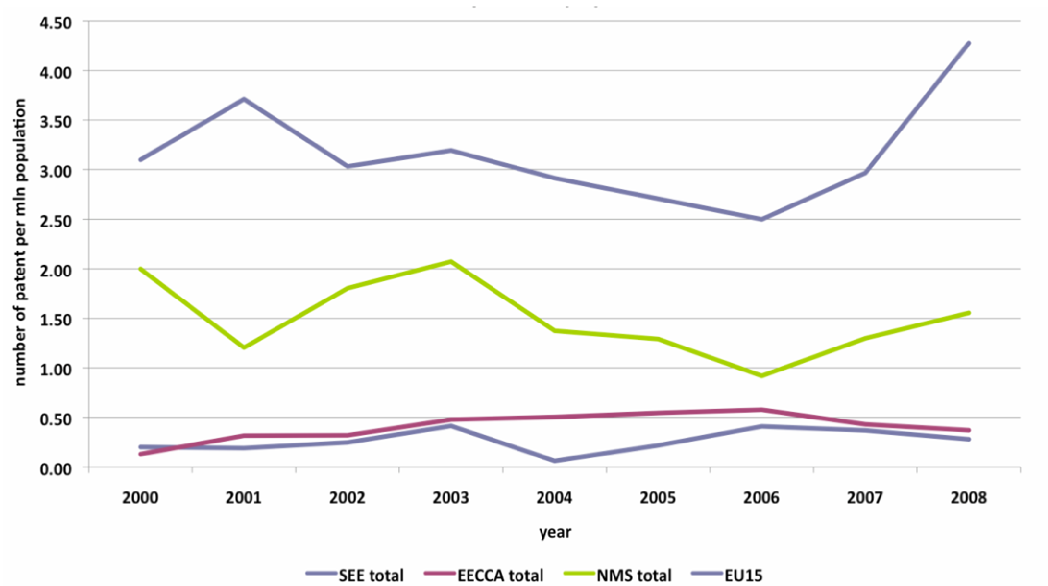
Figure 9 Energy efficiency patenting output in the region, (2000-2009)



Source: Authors' calculations based on EPO PATSTAT data.

In the cross-regional comparison it can be seen that the average performance of the NMS is much higher than in SEE and EECCA (Figure 10). Within the NMS group, performance ranges between 0.4 and 5.2 patents per million population. In the EECCA group, only Russia, Moldova and Ukraine filed patents in energy efficiency in the last decade. In the SEE region, only Turkey, Serbia and Croatia filed patents.

Figure 10 Energy efficiency patenting trends, (2000-2009)



Source: Authors' calculations based on EPO PATSTAT data.

Key Findings:

- At an aggregated level, there has been steady growth in the number of environmental patents in the region. Higher levels of output and growth have been observed in renewable energy and waste management while no overall increase has been observed in energy efficiency technologies;
- In aggregated environmental patenting performance, the EECCA group is the leader (due to Russia's input), followed by the NMS. Russia, Poland and Hungary historically have been the largest holders of environmental patents.
- In patenting activities measured per population, country groups on average perform two (EECCA), three (MNS) and five (SEE) times worse than the EU15. The potential for closing the gap with EU-15 in patenting performance has not yet been seen.

Outcomes: diffusion of environmental technologies and goods

Environmental technologies and products are already a part of our lives and are constantly being introduced to the market. Examples include renewable energy and waste recycling practices. The diffusion level of environmental technologies can be associated with production capacities and practical experience in these technologies. Numerous environmental goods and products are being produced, sold and applied. Comparative country statistics on these technologies and products show trends in their diffusion and application, which can also indicate a country's knowledge base or technological capabilities in applying certain technologies. The assumption here is that the higher the level of diffusion of technology, the better the practical knowledge of this technology in the country (Doranova *et al.*, 2010).

Renewable energy

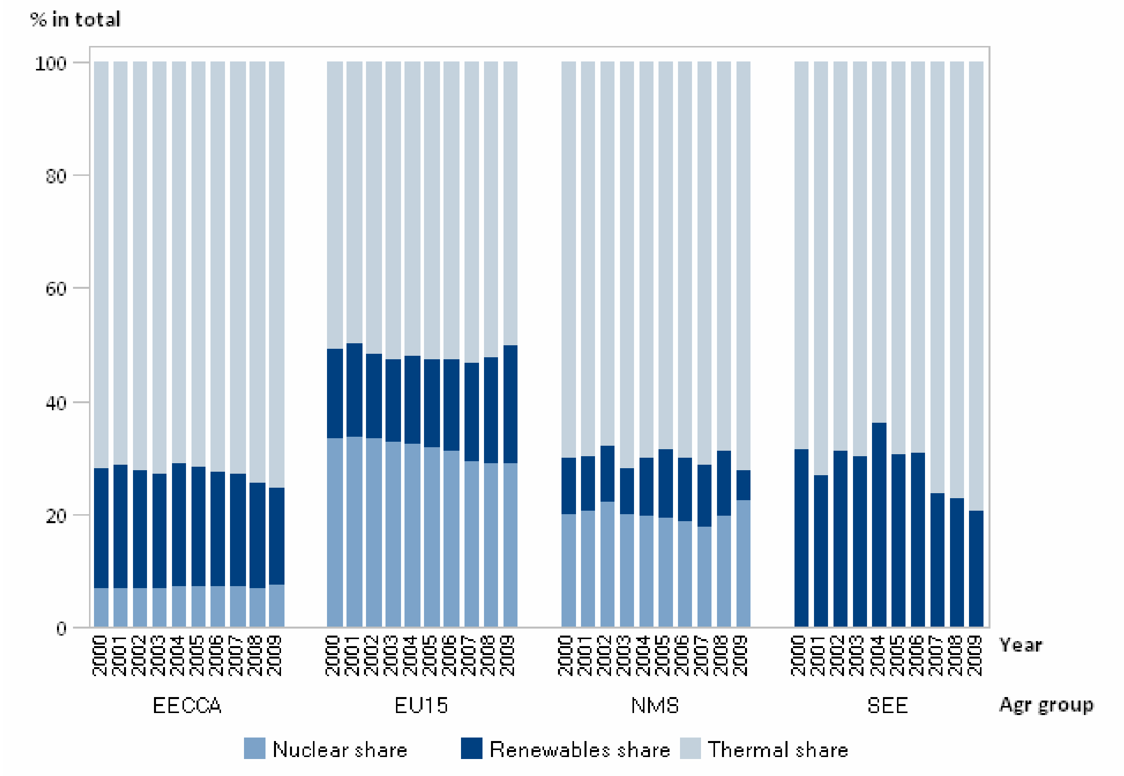
Each country relies on a different combination of energy sources to sustain its economic activities. The national energy mix is often a major determinant of the country's carbon emission level. Higher reliance on cleaner energy sources, and larger renewable energy generation capacities are associated with higher diffusion levels of renewable energy technologies.

Figure 11 shows regional average data for the electricity mix in EECCA, SEE, NMS and EU-15 country group. It is notable that the use of thermal power[36] for the generation of electricity is dominant in the EECCA, SEE and NMS country groups. Furthermore, the pattern of thermal power reliance in these groups has not changed in the last decade: the mean share of nuclear is 7.2 per cent in the EECCA group and 20 per cent in the NMS, while SEE countries do not use nuclear. The mean share of nuclear energy in EU-15 is 31.7 per cent.

The mean renewables share is 20.6 per cent for EECCA, 29.4 per cent for SEE and 10.4 per cent for the NMS. In general, reliance on renewable energy in electricity generation is higher in the SEE and EECCA countries.

36 Total conventional thermal power for electricity generation includes electricity generation from coal, gas, and crude oil.

Figure 11 Energy mix in the overall electricity generation: regional aggregated statistics, (2000-2010)



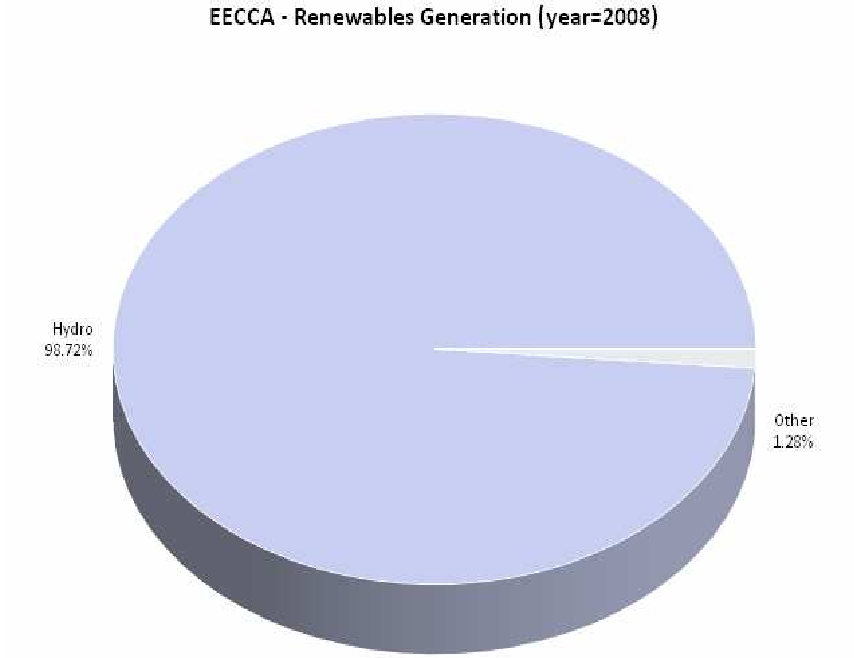
Source: Author's calculations based on IEA data

The mix within the renewables is dominated by hydro as a source for power generation (Figure 12). Wind, and biomass and waste, are also alternative sources of renewable energies although on a smaller scale and specifically for the NMS and EU15. Biomass and waste represents 15 per cent of energy generation in the NMS and over 19 per cent in the EU-15. Although in general, wind, biomass and waste, geothermal, solar and tide wave represent smaller shares in total energy generation, they have demonstrated linear, and in some cases even exponential growth, patterns in some countries.

The reliance on renewable energy sources differs from country to country depending on resource endowment, as well as historical developments in the national energy sectors. For example, countries with large fossil fuel resources (coal, oil, gas) have limited or almost no renewable energy in their electricity mix. Conversely, countries with rich hydro resources (e.g. Albania, Tajikistan, Kyrgyzstan and Georgia) have largely relied on large-scale hydropower plants.

Promotion of non-hydro renewables (wind, solar, tidal, biomass, geothermal) has occurred only in the last couple of decades. The fastest growth has been in West European countries. In the region, the NMS have been performing better in introducing renewables (e.g. biomass, solar and wind). At the same time, small-scale wind energy capacities have been developed in Croatia, Turkey, Ukraine, Belarus and Russia. Turkey and Russia have also initiated geothermal energy production.

Figure 12   Renewable energy mix in the renewable electricity generation in 2008



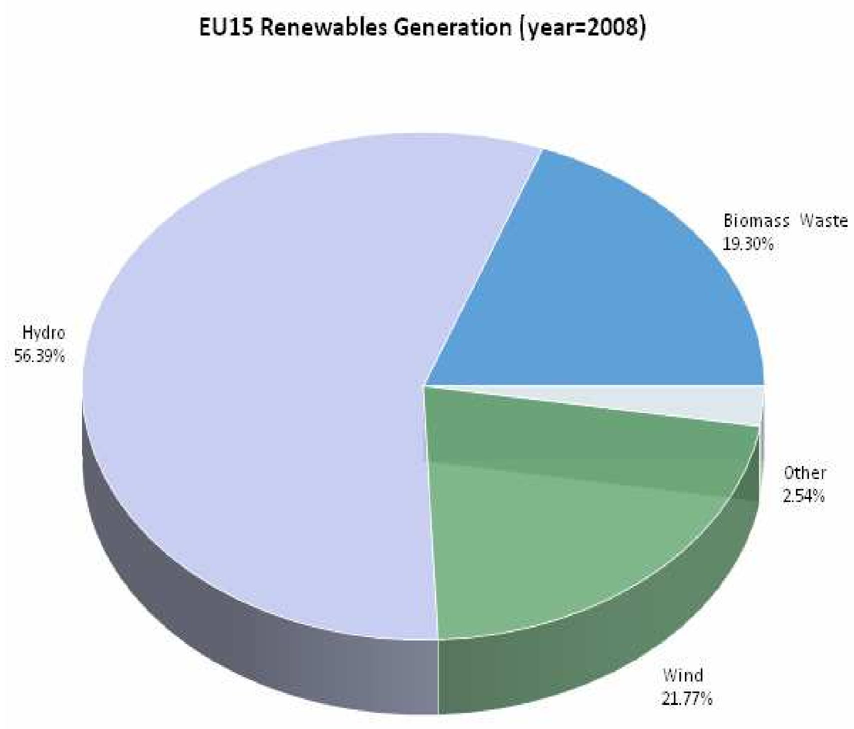
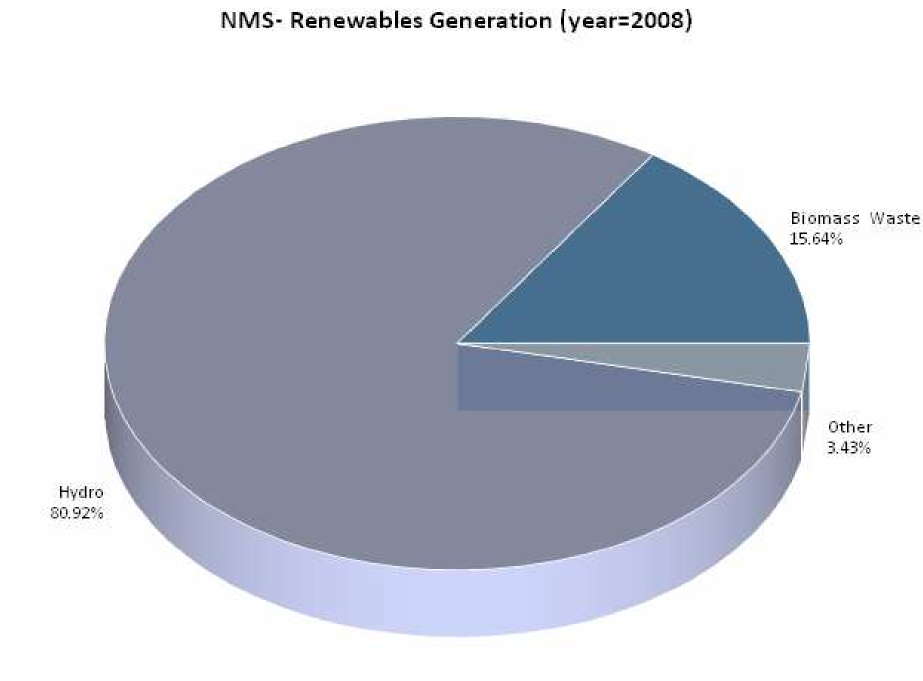
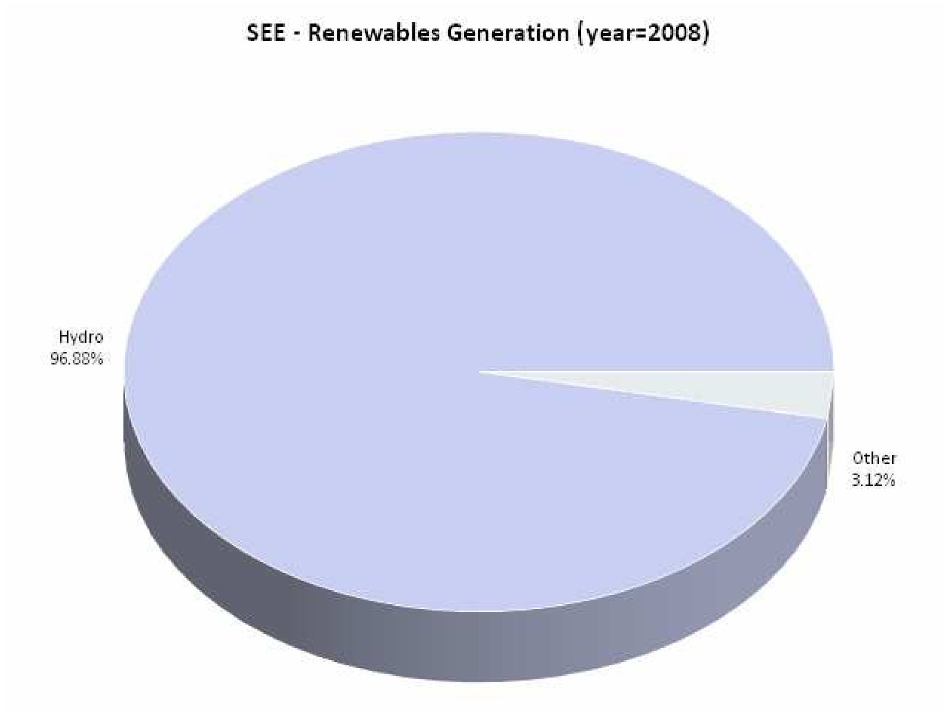


Figure 12 continued





Source: Authors' calculations based on data sourced from IEA.

Key findings

- Thermal power generation of electricity dominates in the EECCA, SEE and NMS groups.
- The mean share of renewables is 20.6 per cent for EECCA, 29.4 per cent for SEE and 10.4 per cent for the NMS.
- West European countries are particularly reliant on nuclear with a mean share of 45.6 per cent. The EU-15 share of nuclear is lower at 31.7 per cent.
- Non-hydro renewables (wind, solar, tidal, biomass, geothermal), although still representing no more than a niche in total energy generation, are experiencing strong growth patterns on a case by case basis. Examples include biomass and waste in the NMS, geothermal in SEE, and solar, wind and tidal in the EU-15.

Waste management

The waste management industry is an important eco-industry. The main municipal waste management practices are land-fill, incineration, recycling and composting. The statistics on the waste management in Table 3 illustrate the diffusion of waste-recycling technologies and point towards clear-cut regional trends and differences.

With EU accession many new member states have started to improve their waste management practices by introducing recycling and composting. Slovenia and Estonia have achieved good performance in recycling. However, there is still a big gap with the best practice examples in EU-15 economies, where up to 70 per cent of municipal waste is recycled, while landfilling practices have been reduced almost to nil (e.g. in Austria, the Netherlands and Germany). In SEE, there are only municipal recycling practices in Turkey and Croatia, although these are limited to the composting of organic waste and represent 1.1 and 1.8 per cent of the total waste stream. A lack of data in many EECCA countries prevents observation of a regional trend, but it is likely that waste recycling schemes are practically non-existent.

Table 3 Waste: trends in recycling and land filling municipal waste in 2009

Region and countries	Municipal waste landfilled, %	Municipal waste incinerated, %	Municipal waste recycled, %	Municipal waste composted, %	Recycle rate
South Eastern Europe					
Albania	n/a	n/a	n/a	n/a	**...**
Serbia and Montenegro	100,0	0,0	0,0	0,0	**0,0**
Bosnia and Herzegovina	100,0	0,0	0,0	0,0	**0,0**
FYR Macedonia	100,0	0,0	0,0	0,0	**0,0**
Croatia$_{2008}$	96,8	1,8	...	1,8	**...**
Turkey	84,8	0,0	0,0	1,1	**1,1**
Montenegro	...	...	0,0	...	**0**
Eastern Europe, Caucasus and Central Asia (EECCA)					
Armenia	100,0	0,0	0,0	0,0	**0,0**
Belarus	100,0	0,0	0,0	0,0	**0,0**
Kyrgyzstan	100,0	0,0	0,0	0,0	**0,0**
Azerbaijan, Georgia, Moldova, Ukraine, Turkmenistan, Kazakhstan, Tajikistan, Russian Federation, Uzbekistan	n/a	n/a	n/a	n/a	**n/a**
EU New Member States (NMS)					
Bulgaria	96,1	0,0	0,0	0,0	**0,0**
Lithuania	90,6	0,0	3,1	1,3	**4,4**
Czech Republic	72,2	10,5	2,1	2,0	**4,1**
Poland	65,2	0,8	11,8	5,6	**17,4**
Estonia	61,9	0,2	11,2	9,3	**20,5**
Hungary	74,5	9,4	13,4	2,1	**15,4**
Slovakia	75,4	9,0	2,2	5,1	**7,3**
Latvia	92,2	0,1	7,4	0,3	**7,7**
Slovenia	68,8	1,5	27,8	2,2	**30,0**
Romania	76,9	0,0	0,9	0,0	**0,9**
Reference countries					
EU15 average	30,8	24,7	25,9	18,2	**44,1**
EU15 (lowest-highest)	0,7 – 81,3	0 – 48,4	8,2 – 46,6	1,4 – 39,7	**17,8 – 69,9**
United States$_{2005}$	54,3	13,6	23,8	8,4	**32,1**
China	56,6	12,9	...	1,1	**1,1**
Japan$_{2003}$	3,4	74,0	16,8	...	**16,8**

Source: Authors' calculations from UNSD Environmental Indicators (http://unstats.un.org)

Key findings

- Most countries in the region lack waste recycling practices. Only the NMS and a few countries in SEE have made some modest progress in introducing recycling practices.
- There is still a big gap with best practice examples in the EU-15 (e.g. Austria, Germany, the Netherlands)
- Despite a lack of data on the EECCA countries, it is unlikely that waste recycling schemes are widespread.

Exports and imports of environmental goods

Statistics on the trade in environmental goods are a good indicator of the extent to which environmental goods and technologies are used in a specific country and point to the level of diffusion. On the other hand, countries with higher exports of environmental goods and technologies are those producing these technologies. Production requires strong and sophisticated knowledge and investment in R&D. Therefore, a country's export performance can also be a good indicator of local knowledge and capabilities in these technologies.

Figure 13 shows that in the past decade all country groups followed a similar pattern of growth in trade in environmental goods. This observation is valid for trade flows of both exports and imports. In particular values per capita for both exports and imports experienced uninterrupted growth until 2008, the year of the financial crisis. The less pronounced pattern for EECCA and SEE countries is due to scaling, a result of the much higher values per capita for the EU-15. This too is valid for both export and import trade flows.

In 2009, all sub-regions were affected by the global financial and sovereign debt crisis, resulting in a similar growth pattern of sharp declines. The level of exposure to the crisis was high for all sub-regions and particularly pronounced in EECCA.

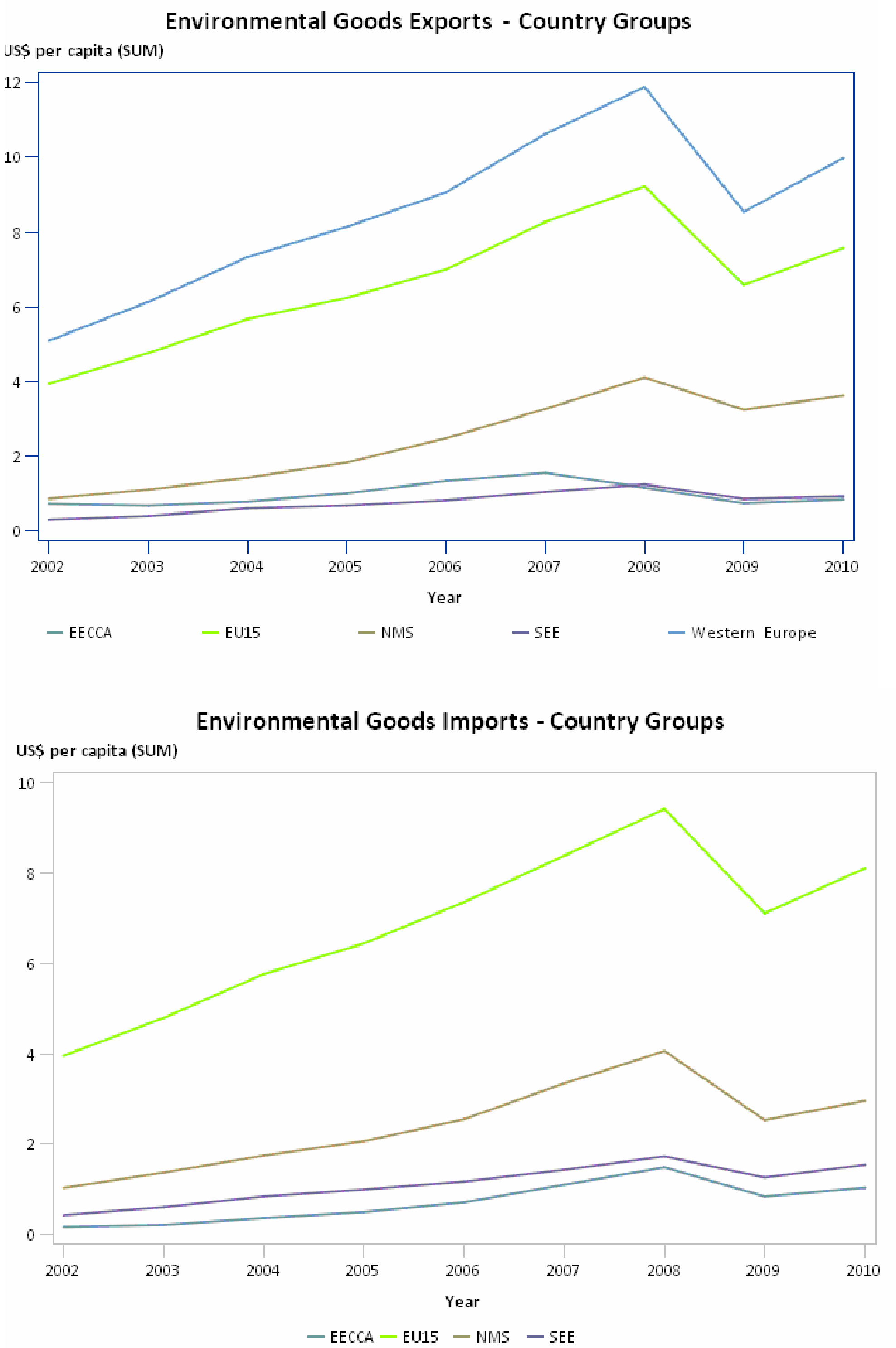
The share of environmental goods' exports and imports in total exports and imports remains relatively stable for the majority of the countries (Figure 14). The exception, with a declining share of environmental goods in exports and a growing share in imports, is the EECCA group. A slight growth of the share of environmental goods in total exports can be observed in the NMS. Further investigation is needed in order to establish the reasons for this trend. A possible explanation is that exports and imports of other goods were increasing at a much higher rate than the rate of growth of environmental goods. Increasing prices of energy products also have an impact on the results since i) the unit of measurement utilized in this report is US dollars and ii) countries in EECCA include major traders of energy products.

Figures 15a and 15b present disaggregated trends in the export and import of environmental goods. From the six major disaggregated categories of environmental goods, air pollution control, environmental technologies and others[37] are traded the most. This is true for both export and import trade flows. An exception is the category of "other environmental goods" which is strongly represented in EECCA exports. EECCA in particular is a significant importer of environmental technologies and a significant exporter of other environmental goods, as already mentioned. Furthermore the EECCA's import share of pollution control products was

37 The category 'Others' includes: Others, Environmentally preferable products based on end-use or disposal characteristics and Others, Natural resources protection.

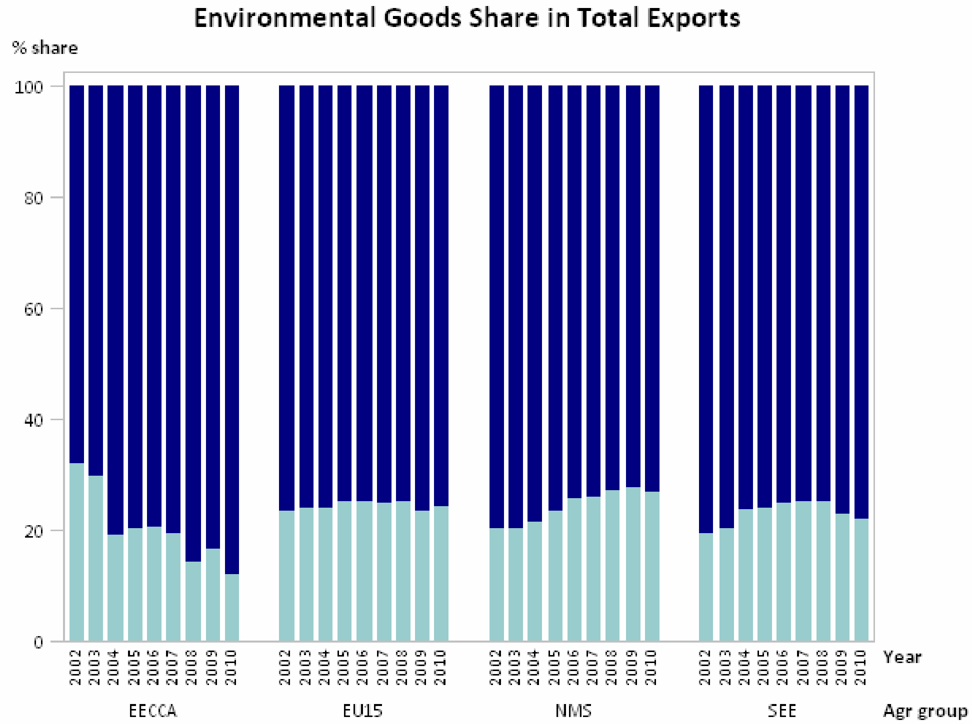
increasing exponentially before the crises. SEE appears to be experiencing declining shares of environmental technologies in both exports and imports. Additionally, declining shares are observed in imports of air pollution controls. The NMS do not appear to be seeing any noticeable growth in the shares of specific product groups.

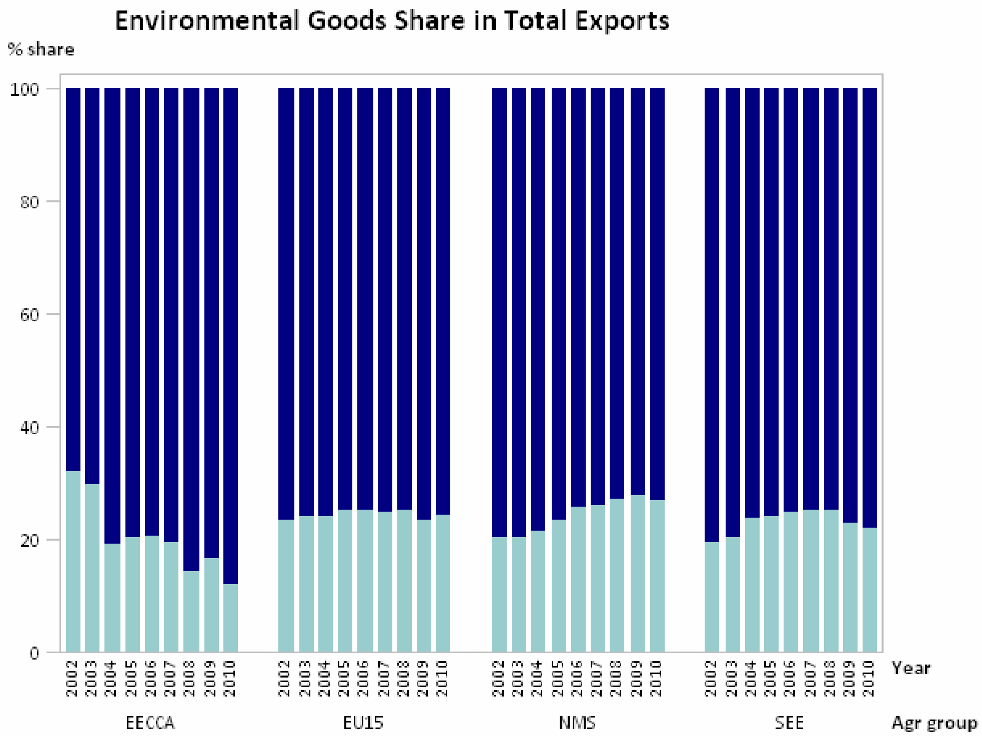
Figure 13 Developments in exports and imports of environmental goods in, (2000-2010)



Source: Authors' calculations based on data from UN COMTRADE.

Figure 14 Share of environmental goods Exports/Imports – Aggregated in, (2000-2010)





Source: Authors' calculations based on data from UN COMTRADE.

Figure 15a Share of environmental goods in exports – disaggregated, (2000-2010)

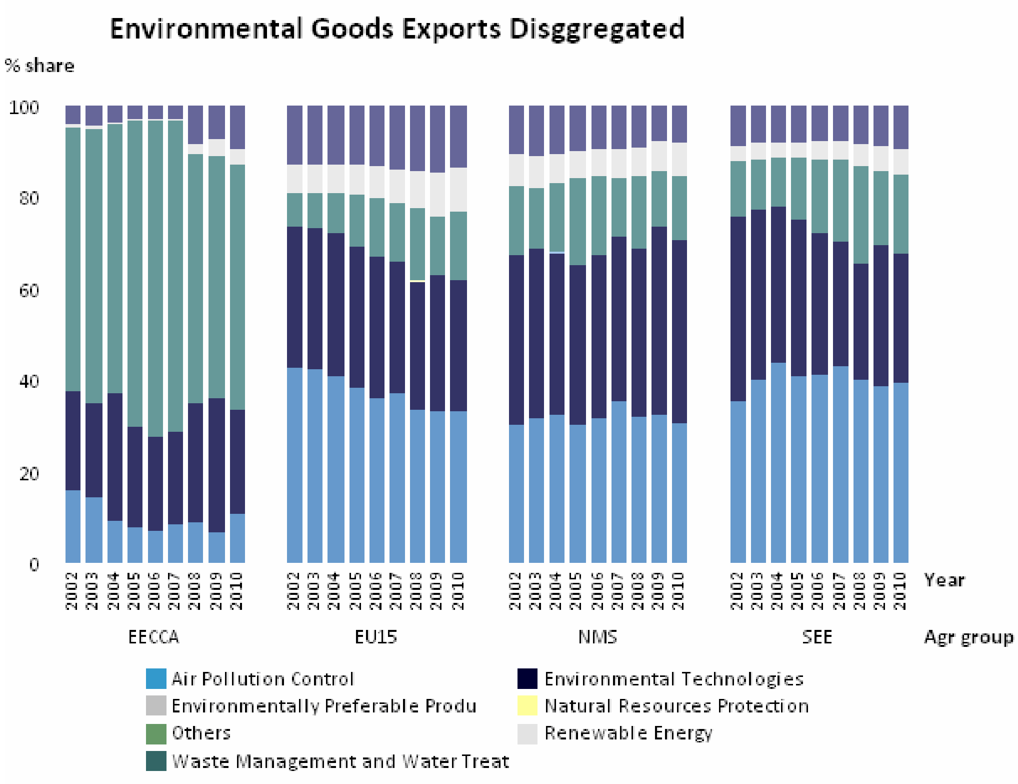
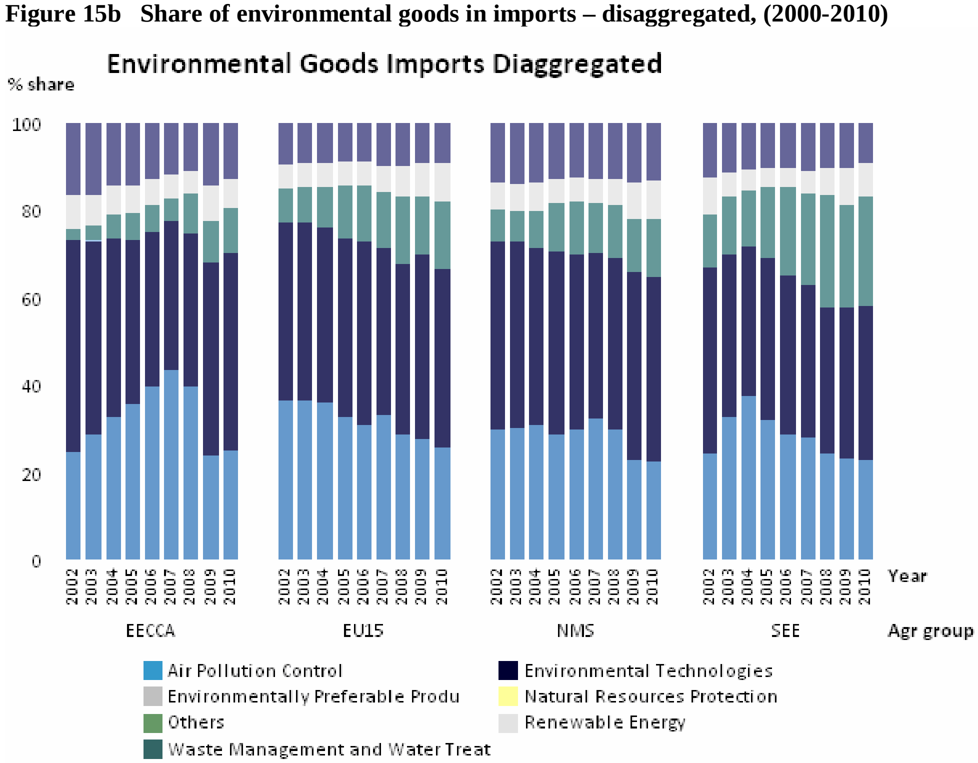


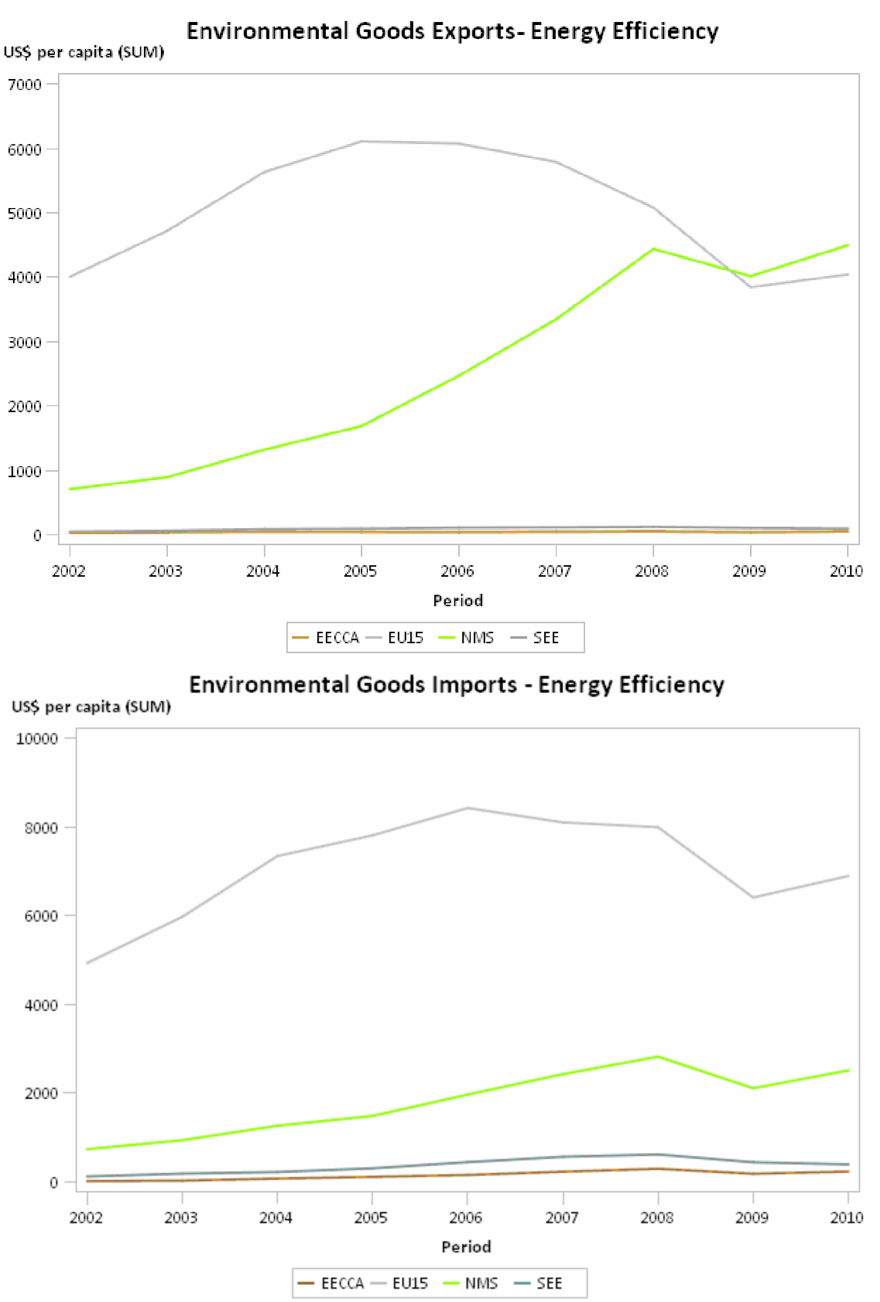
Figure 15b Share of environmental goods in imports – disaggregated, (2000-2010)



Source: Authors' calculations based on data from UN COMTRADE.

The category of environmental technologies incorporates goods oriented towards achieving greater efficiency, including energy efficiency, cleaner and more efficient technologies and products, and environmental monitoring, analysis and assessment equipment. Figure 16 shows trends of imports and exports in Europe and NIS region. The NMS countries not only export, but also show a growing trend in their exports of energy efficiency goods. The EECCA and SEE groups, on the other hand, do not appear to be exporting energy efficiency related goods. In the case of imports, all countries show clear evidence of growth, in particular EECCA, SEE and the NMS. The EU-15 group has demonstrated slower growth in recent years. The trends identified for all groups of countries seem to have been strongly influenced by the economic crisis since 2008.

Figure 16 Imports and exports of energy efficiency goods, (2002-2010)



Source: Authors' calculations based on data from UN COMTRADE.

Key findings

- Positive growth patterns of total exports and imports of environmental goods across country groups can be seen.
- The financial and debt crises have had a noticeable impact on the growth patterns of imports and exports of environmental goods. The level of exposure is expressed by the sharp declines since 2008 experienced by all country groups.
- The share of environmental goods within total trade (both exports and imports) remained relatively stable.
- Of the six major disaggregated categories of environmental goods, air pollution control and environmental technologies are the most traded.

Public policies to support eco-innovation

Public policy and eco-innovation: the framework

Given the transversal character of eco-innovation, effective innovation policy needs to include multiple policy areas (Table 4). In this context, policy studies underline the need for a horizontal (or cross-cutting) approach to policy intervention, the so-called 'third-generation' of innovation policy.[38] Innovation policy is thus expected to transcend traditional vertical policies and interlink with other policies such as scientific research, education and training, environmental policy, transport, health, etc.

Table 4 A taxonomy of innovation policy – the MONIT approach

Goals	Sectoral innovation policy	Multi-sectoral innovation policy
Innovation policy, i.e. aimed primarily at innovating industries and economic growth	Innovation policy in a limited sense (basically technology and industrial policies)	Integrated science, technology and innovation (STI) policies
Innovation policy in a wider sense, i.e. aimed at economic growth and quality of life	Innovation policies in other sectoral domains, e.g. in health, in the environment, etc.	Horizontal/comprehensive /integrated or coherent/ systemic innovation policies

Source: OECD (2005).

Hence, eco-innovation policy is working towards improving the competitiveness of enterprises, but in doing so it seeks to avoid negative environmental side effects. Table 5 compares rationales and objectives of policies involving protection of the environment and support for innovation activities.

The above classification offers a framework that can be applied in both developed and developing countries, even in the absence of a formal innovation policy in many countries in EECCA and SEE. The need to regard sustainability and innovation as indivisible in policy design is equally relevant whatever the stage of development.

38 The so-called "third generation innovation policy" stresses the need for innovation to become an integrated dimension of other traditional policies (Louis Lengrand *et al*., 2002; OECD, 2005c).

Table 5 From environmental protection to eco-innovation

Policy	Rationale	Main objective
Environmental policy	- account for negative production externalities for natural environment	- protect natural environment (in this context: against industrial pollution)
Innovation policy	- provide incentives for enterprises to engage in innovation activity	- contribute to competitiveness of economy and growth
Policies in favour of eco-innovation	- provide incentives for enterprises to engage in innovation activity - account for negative production externalities for natural environment - reduce resource consumption in economic activity to minimum levels taking into account long-term sustainability (including dematerialization, reducing energy consumption and pollution)	- promote environmentally friendly solutions and economic competitiveness

Source: Reid and Miedzinski (2008).

Eco-innovation policy: the building blocks

Policy instruments supporting eco-innovation

The public sector instruments for eco-innovation can be divided into six broad types of measures (Reid and Miedzinski, 2008, see also Ekins, 2010):

- Market-oriented schemes (e.g. fiscal measures, emissions trading schemes)
- Regulatory and normative frameworks (e.g. standards and norms, permits and bans, energy regulations, labelling, voluntary instruments, tariffs)
- Public procurement (green public procurement)
- Direct support for eco-innovation (e.g. subsidies, financial schemes)
- Awareness raising and demonstration measures (e.g. education and training)
- Strategic planning and foresight (sustainability foresight, spatial planning)

These instruments can be applied within many government policies (e.g. fiscal policy, science policy, environmental policy, innovation policy). The eco-innovation measures are designed, implemented, monitored and controlled at different levels of policy making and with the participation of various stakeholders. Examples of concrete policy measures and relevant policy fields are outlined in Table 6.

Different measures and policy portfolios (comprising various measures) require different degrees of political effort and stakeholder consensus. For example, introducing radical changes to the taxation system requires a strong political will and broad cooperation between many stakeholders. Some of the measures can be developed and introduced by the public and private sectors acting in collaboration (e.g. voluntary agreements on standards and norms, eco-labels).

Policy coordination and coherence

As a complex policy challenge, support for eco-innovation requires a coordinated approach, most notably between innovation, research and environmental policy. Implementation of eco-innovation measures has to be done in close collaboration between different policies and the levels of policy delivery following a common vision, that is, a set of objectives and a strategy shared by all concerned stakeholders. Introducing any of the above measures alone may lead to highly unsatisfactory results.

In the context of coordination, the policy design should take into account the need for vertical, horizontal and temporal coherence (OECD, 2003):

- Horizontal coherence - ensuring that individual objectives and policies developed by various entities are mutually reinforcing;
- Vertical coherence - ensuring that the practices of agencies, authorities and autonomous bodies, as well as the behaviour of various levels of government mutually reinforce overall policy commitments;
- Temporal coherence - ensuring that policies continue to be effective over time and that short-term decisions do not contradict longer-term commitments. Temporal coherence pertains to how policies work as they interact with other policies or forces in society, including whether future costs are taken into account in current policy-making.

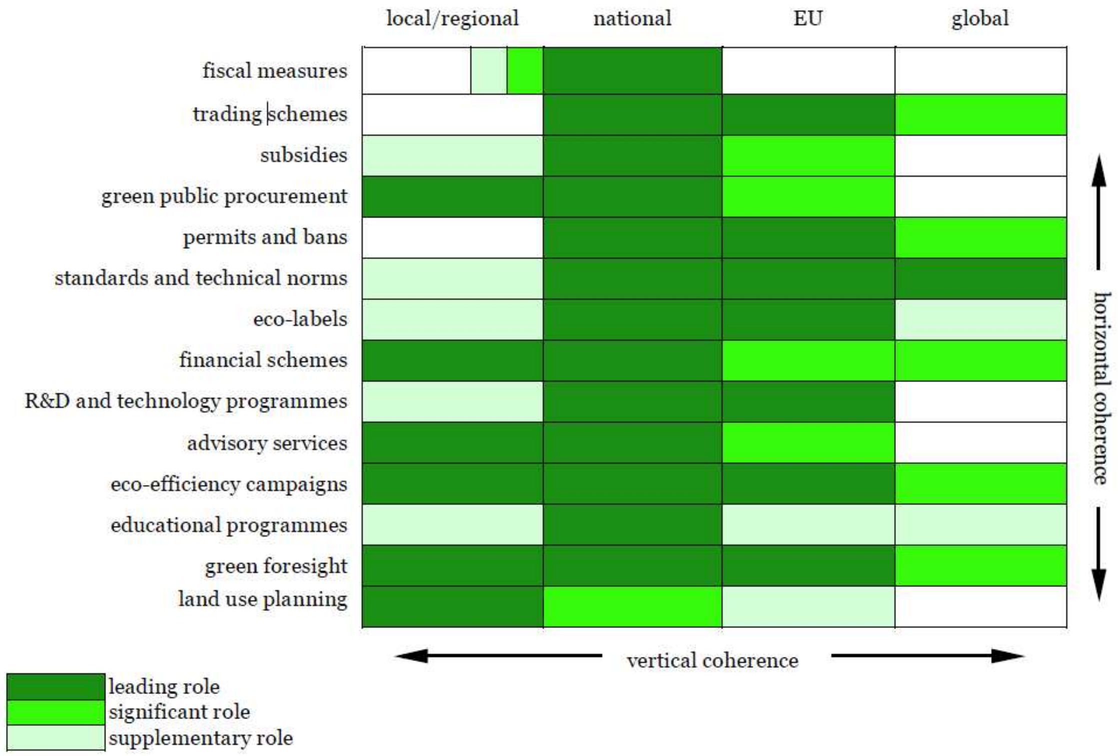
Table 6 Examples of eco-innovation measures

Type	Examples of measures	Policy fields
Market-oriented instruments	- fiscal measures (e.g. energy tax, resource tax, CO2 emissions tax, tax reductions, investment tax credits, VAT) - emissions trading schemes	fiscal policy trade policy
Public procurement	- green public procurement	relevant for all policy fields with public procurement capacity (notably transport policy, construction and housing policy, defence policy)
Regulatory and normative framework	- energy (de)regulation standards and norms (including technology regulations, quota-based schemes, energy saving requirements) - permits and bans - land use regulations - environmental management systems eco-labels and other soft standardization instruments (including voluntary agreements)	environmental policy industrial policy energy policy trade policy local development policy
Direct support for innovation activity	- financial schemes (loans and credits) subsidies (e.g. renewable energy infrastructure subsidies) - venture capital funds - business incubation programmes - targeted R&D and technology programmes - targeted business advisory services eco-cluster policies (cluster involved in eco-innovation development and support for eco-innovative solutions in existing clusters e.g. advanced on-site industrial ecology solutions)	economic policy energy policy innovation policy entrepreneurship policy research policy regional policy
Capacity building and demonstration measures	- professional training (eco-efficiency capacity building for enterprises) - changes in educational programmes	education and training policy
Strategic planning and foresight	- green foresight - strategic spatial planning	foresight is relevant for all policy fields

Source: Reid and Miedzinski (2008).

Figure 17 offers a framework combining different types of eco-innovation measures in the context of multi-level governance. The approach provides an example of a policy canvass including notions of vertical and horizontal coherence.

Figure 17   Eco-innovation measures and multi-level governance



Source: Reid and Miedzinski (2008).

Key findings and issues for discussion

Overall findings

1. There are signs of improved performance and development trends in selected eco-innovation areas and technology fields in SEE, EECCA and, notably, the NMS. These are confirmed by trends in scientific publications, patenting activity, environmental management in companies, and trade in environmental goods as well as the development of some renewable energy sources (e.g. fast growth of wind, solar and geothermal energy).
2. A number of indicators suggest positive trends in eco-innovation performance in both highly industrialized and developing countries. The growth rates of the analyzed indicators remain relatively low in SEE and EECCA and are often significantly lower than in the highly industrialized countries (e.g. patenting activity, exports of environmental goods).
3. Furthermore, the analyzed data do not yield any evidence of structural shifts (e.g. towards renewable energy sources) or substantial improvements in local eco-innovation performance in the SEE and NIS region. The region continues to lag behind highly industrialized countries and there are no indications that the gap with top eco-innovation performers is being closed.
4. The Europe and NIS region is internally diverse, characterized by different economic and social structures and diverse technology and innovation profiles. The analysis suggests that the NMS are benefiting from more favourable trends than the EECCA and SEE groups, which tend to be flatlining. There is no evidence of catch-up within the region; EECCA and SEE countries continue to lag behind the NMS.

5. The methodology revealed significant gaps in available data across the region. The lack of evidence creates a significant challenge for both researchers and policy makers as the evidence base for policy decisions is limited.

Inputs: scientific research and R&D investments

Scientific research

6. Within the region, the NMS account for the largest stock of environmental publications followed by SEE and EECCA. Within the sub-regions the largest discrepancy is in the EECCA where Russia accounts for 80 per cent of the publications.
7. NMS and SEE countries have experienced substantial growth over the last decade, while EECCA countries have seen almost no change in their scientific publishing in environmental technology areas.
8. Despite exponential growth, NMS and SEE countries still lag far behind the world's leading countries (EU-15, United States, China, Japan) in scientific activities; the gap between the EU-15 and the NMS/SEE/EECCA region has been increasing over the past ten years.

Public R&D expenditures on energy and environment

9. In the NMS, there are some positive trends in public and, to a lesser extent, private investment in energy and environmental research, and environmental innovation. Observations for SEE and EECCA on energy and environmental investments are inconclusive due to the lack of data.
10. The evidence on private cleantech investments and higher public expenditure on environmental and energy R&D suggest, however, that the gap between the EU-15 and NMS may be increasing.

Capabilities: environmental management and ICT

11. There are clear improvements in the capabilities of the business community in environmental management and ICT in the region. Particular progress has been observed for the NMS and SEE countries in environmental certification statistics.
12. Within the NMS, Romania and the Czech Republic are among the world leaders in the absolute number of ISO14001 certificate registrations as well as in growth rates. Good growth is also observed in most SEE countries and Russia, but not in EECCA.
13. The gap in the growth rates of ISO14001 certification between the EU-15 and the NMS country groups is not large and it is narrowing. SEE and EECCA are lagging behind and the gap with EU-15 and the NMS has been growing.
14. Internet and computer technology penetration has grown rapidly in the last ten years, although the NMS and SEE have made greater progress than EECCA. There are clear patterns of potential convergence with EU-15 in these indicators for all country groups.

Outputs: patenting activity

15. At the aggregate level, there has been a steady growth in the number of environmental patents in the entire region. Higher patenting and growth activities have been observed for patenting in renewable energy and waste management.
16. In aggregated environmental performance, EECCA is the leader (mainly due to Russia), followed by the NMS. Russia, Poland and Hungary historically have been the largest holders of environmental patents.
17. In patenting activities measured per population, country groups on average perform two (EECCA), three (MNS) and five (SEE) times worse than the EU-15. The potential for closing the gap with EU-15 in patenting performance is not yet observed.

Outcomes: diffusion of environmental technologies and goods

Renewable energy

18. Thermal power generation of electricity dominates in EECCA, SEE and the NMS. The mean share of renewables is 20.6 per cent for EECCA, 29.4 per cent for SEE and 10.4 per cent for the NMS.
19. Western Europe is particularly reliant on nuclear energy with a mean share of 45.6 per cent. The EU-15 share of nuclear is lower (31.7 per cent).
20. Non-hydro renewables (wind, solar, tidal, biomass, geothermal), although still representing no more than a niche in total energy generation, are experiencing strong growth patterns on a case by case basis. Examples include biomass and waste in NMS, geothermal in SEE, solar, wind and tidal for EU-15.

Waste management

21. Most of the countries in the region lack recycling practices. Only NMS and isolated countries in SEE have progressed modestly in introducing recycling practices.
22. There is still a big gap with the best practice examples in the EU-15 (e.g. Austria, Germany, the Netherlands).
23. Lack of data on EECCA prevents the identification of a regional trend but it is likely that waste recycling schemes are non-existent.

Imports and exports of environmental goods

24. Positive growth patterns of total exports and imports of environmental goods across country groups can be observed.
25. The financial and debt crises have had a noticeable impact on the growth pattern of imports and exports of environmental goods. The level of exposure is expressed by sharp declines in 2009 experienced by all country groups.
26. The share of environmental goods within total trade (both exports and imports) has remained relatively stable.
27. Of the six major disaggregated categories of environmental goods, air pollution control and environmental technologies are the most traded.

Issues for discussion

1. The analyzed data do not yield any strong evidence of major structural shifts towards more sustainable development in the region over the last decade.
    - Can eco-innovation support leap-frogging and turn path-dependencies into opportunities? Should eco-innovation become a key element of economic and innovation strategies in the region?
2. To acquire eco-innovative technologies and products (e.g. water treatment systems, renewable energy technologies), the transition countries are import dependent.
    - Taking into account all economic, social and environmental benefits, how to balance benefits from importing environmental innovations and investing in the endogenous R&D potential?
3. The public sector can apply a range of measures to support eco-innovation.
    - What are the key measures policy makers in the region should pursue in order to support a shift towards more sustainable development?
4. Several eco-innovation indicators in the NMS suggest that transition countries can make relatively fast progress in their development.
    - What lessons from the NMS can be learned and used for the region?

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Appendix A: Country Groups

Groups	Countries
South East Europe (SEE)	Albania Bosnia and Herzegovina Croatia Macedonia, FYR Montenegro Serbia Turkey
Eastern Europe, Caucasus and Central Asia (EECCA)	Armenia Azerbaijan Belarus Georgia Kazakhstan Kyrgyzstan Moldova Tajikistan Russian Federation Turkmenistan Ukraine Uzbekistan
EU-15	Austria Belgium Denmark Finland France Germany Greece Ireland Italy Luxembourg Netherlands Portugal Spain Sweden United Kingdom
Western Europe	Austria Belgium France Germany Luxembourg Netherlands Switzerland Liechtenstein (included with Switzerland) Monaco (included with France)
New EU Member States (NMS)	Bulgaria Czech Republic Estonia Hungary Latvia Lithuania Poland Romania Slovakia Slovenia

Appendix B: Data and calculation methods

Knowledge base: eco innovation research

DATA OVERVIEW		
DATA	Counts of publications per country	A keyword was used for the making of the queries: Environment and technology
SOURCE	SCOPUS	
FORM	Disaggregated	Per Country group
Time series	2000 – 2011 (last available data)	

Finance: eco innovation investments
INVESTMENT IN ENERGY AND ENVIRONMENT RESEARCH

DATA OVERVIEW		
DATA	Government budget appropriations or outlays on R&D (GBAORD) for Energy and Environment	GBAORD means all appropriations by central government allocated to R&D in central government budgets. Data on government R&D appropriations therefore refer to budget provisions, not to actual expenditure.
SOURCE	EUROSTAT	
FORM	Aggregated	Total GBAORD for Energy and Environment
	Disaggregated	Per Country group
Time series	2004 – 2010 (last available data)	

Business capabilities: environmental management and ICT
ENVIRONMENTAL MANAGEMENT

DATA OVERVIEW		
DATA	ISO14001 certifications	The number of ISO certificates is used as a proxy for environmental management
SOURCE	ISO survey of certifications (1993-2009)	
FORM	Aggregated	Total number of certificates
	Disaggregated	Per Country group
		Per country
Time series	1999- 2009 /(last available data)	

ICT

DATA OVERVIEW		
DATA	Internet penetration Computer use by enterprises	Proxies are used for ICT diffusion.
SOURCE	ITU world Telecommunication/ICT Indicators Database UNCTAD Information Economy report 2011	
FORM	Disaggregated	Per country group
		Per size of enterprises
Time series	2000-2009 2010 (majority of the countries) /(last available data)	

Innovation frontiers: patenting activity

PATENTS

DATA OVERVIEW		
DATA	Patents	Patent data can be used as an output measure of innovation. As with any measure, there are limitations. Not all inventions are patented, and the (economic) value of patents is heterogeneous. Also, interpretation of patent statistics is made difficult because each patent office may have its own rules and procedures for handling patent applications.
SOURCE	Our data source is the October 2011 edition of the “EPO Worldwide Patent Statistical Database”, also known as PATSTAT.	Counts of patents
FORM	Aggregated	Total environmental patents
	Disaggregated	Per environmental area
		Per country group
Time series	1991-2008	

Data grouping: Patent Groups

Environmental Patents – AGGREGATION	
1	Renewable energy production
2	Agriculture and forestry
3	Transportation
4	Energy conservation
5	Waste management
6	Administrative regulatory or design aspects

Technology diffusion: innovation on the ground

ENERGY

DATA OVERVIEW		
DATA	Total carbon dioxide emissions from consumption of energy	Million metric tons
	Energy mix	Billion kilowatt hours
SOURCE	U.S. Energy Information Administration (EIA)	International Energy Statistics
FORM	Aggregated	Total CO_2
		Total renewables
	Disaggregated	Country groups
		Country groups-UNIDO
		Electricity source
Time series	2000-2008 / (last available data)	

Data grouping: Electricity generation disaggregation

ELECTRICITY MIX				
Total electricity Net generation	Nuclear			Billion kilowatt hours
	Thermal			
	Total renewables	Hydro		
		Total Non Hydro	Geothermal	
			Wind	
			Solar, tide & wave	
			Biomass & waste	

WASTE MANAGEMENT

DATA OVERVIEW		
DATA	Recycle rate	Recycle rate is used as a proxy of trends in recycling and landfilling municipal waste
SOURCE	UNSD Environmental Indicators	
FORM	Disaggregated	Per waste processing
		Per country group
Time series	Latest available data	

ENVIRONMENTAL GOODS

DATA OVERVIEW		
DATA	Values of environmental goods exports and imports	WTO Annex II.A: Reference universe of environmental goods of interest to WTO Members Based on HS-6 lines submitted by Members as they were reflected in Annex III of the March 2010 Report to the TNC, also JOB/TE/3/Rev.1 (5 January 2011) and any subsequent submissions.
SOURCE	UNCOMTRADE	HS2002
FORM	Aggregated	Total EG
	Disaggregated	Per EG groups
		Per partner
		Per Country Group
		Per UNIDO Country Group
Time series	2002-2010 (last available data)	

Data grouping: EG Groups

Environmental Goods – AGGREGATION	
1	Air pollution control
2	Renewable energy
3	Waste management and water treatment,
4	Environmental technologies
5	Carbon capture and storage
6	Others

Resource use and resource efficiency in Central and Eastern Europe and the Newly Independent States[39]

A pilot study on trends over 13 years

Stefan Giljum, Barbara Lugschitz, Christine Polzin, and Stephan Lutter and Monika Dittrich, SERI

Introduction

Current trends in global consumption of natural resources, including materials, energy, water and land, are not sustainable. Between 1980 and 2008, the volume of global material consumption per year grew from 38 to 70 billion tonnes. However, the distribution between different world regions remains unequal. The average North American citizen, for example, consumes about 100 kg of materials per day, whereas the average African citizen only consumes about 10 kg of materials per day. Rapidly growing consumption is causing severe damage to the world's ecosystems (e.g. climate change; shrinking fresh water reserves, fish stocks and forests; destruction of fertile land; species extinction), and affecting the quality of life of people. Industrialized countries with high levels of per capita resource consumption must reduce their global resource use in absolute terms, while developing, emerging and transition countries will need further economic growth in order to satisfy demand for higher consumption, economic welfare and higher quality of life. This will increase the share of those groups of countries in global resource use. For low-consuming countries it implies a growth in absolute per capita material use.

In light of increasing scarcities, intensifying international competition over resources, rising prices for them and growing environmental problems related to resource use, economic growth will have to follow new patterns that are significantly more resource efficient than in the past – to the extent that overall material consumption levels on the global scale decline. Largely because of technological progress, resource efficiency has already improved considerably in the past three decades. For example, resource efficiency on the global level improved by around 50 per cent between 1980 and 2008 (SERI, 2010). However, these gains have hitherto always been more than offset by an increase in overall material consumption (also known as the "rebound effect").

The countries in Central and Eastern Europe (CEE) and the Newly Independent States (NIS) are a diverse group in terms of their economic and social structures, and technology and innovation profiles, as well as in their patterns and extent of resource use. Many of them still require industrial growth to realize their national development objectives and to reduce the income gap with industrialized countries. The challenge for them is to find and implement a model of industrial growth that is more resource and energy efficient, and is low carbon and low waste (Schäfer, 2005; Ürge-Vorsatz *et al.*, 2006; Buchan, 2010; Memedović, 2011). At the same time, those countries need to create jobs, and raise the productivity and welfare of their

39 This working paper was prepared by Stefan Giljum, Barbara Lugschitz, Christine Polzin and Stephan Lutter of the Sustainable Europe Research Institute (SERI), and Monika Dittrich, independent scientist; in cooperation with Olga Memedović, Chief, Europe and NIS Programme, UNIDO Programme Development and Technical Cooperation Division.

societies. In order to monitor progress towards these goals and to find appropriate policies for reaching them, it is essential to create a provisional benchmark to facilitate analysis of resource use and resource efficiency. This is the aim of this study.

In contrast to many industrialized countries, where national statistical offices and agencies have increasingly collected and published data and indicators on resource consumption and resource efficiency in the past 10 years, a comprehensive empirical basis for performing comparative assessments of resource efficiency is still missing for CEE and the NIS. So far, material flow data only exist for the New EU Member States for the period 2000-2007, available from EUROSTAT.[40]

In order to fill this gap, this study of 30 countries in CEE and the NIS in Asia was undertaken by the Sustainable Europe Research Institute (SERI) and the independent scientist M. Dittrich. It builds on two previous studies of resource use and efficiency in Asia and in the emerging economies, which were also commissioned by UNIDO as part of the Green Industries Programme. These projects were able to provide the first comprehensive indicators for resource consumption and resource efficiency for Asian countries and emerging economies by integrating the global database on resource extraction developed and maintained by SERI (www.materialflows.net) and the global database on resource trade developed by M. Dittrich at the University of Cologne and the Wuppertal Institute in Germany, which establishes global accounts of imports and exports in physical (weight) units (see Methodology section below for details).

In this study, the same methodology as in the previous studies was used to calculate national resource consumption indicators and resource efficiency indicators for 30 countries in CEE and the NIS (henceforth called the "Group of 30"), covering the years 1995, 2000, 2005 and 2008. In order to allow a comparative assessment, data for the aggregated EU-15 are also provided.

The paper will answer the following questions:

- How did resource extraction and consumption develop between 1995 and 2008?
- How much and which types of resources do different economies extract and consume, in absolute and per capita terms?
- How did the physical trade volume in CEE and the NIS develop between 1995 and 2008?
- To what extent does the Group of 30 depend on imports of different types of resources to maintain national production and consumption?
- What types of resources do CEE and NIS supply to world markets?
- How did resource efficiency develop between 1995 and 2008?
- To what extent are income and material consumption linked to each other?

The region is interesting to look at, as it comprises a large number of countries that have undergone the challenging process of transition from centrally planned to market economies. This process happened at different speeds and with varying success across the region, which is not only reflected in economic indicators, such as GDP per capita, but also in terms of material flows (as exemplified through extraction, consumption and physical trade data).
For analytical purposes, CEE and the NIS are divided into three sub-regions. These regions were not chosen on the basis of structural similarities but rather on the basis of their geographical position and historical situation after the collapse of communism.

40 See www.appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_mfa&lang=en.

1. New EU Member States (NMS): Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia. These countries have managed the transition most successfully – largely due to their geographic position, relative stability, relatively large flows of foreign direct investment (FDI), strong financial and institutional frameworks for a market economy, and support from the European Union, which most joined in 2004 (Bulgaria and Romania joined in 2007). These countries are marked in orange in the figures and tables of this paper.

2. South East Europe (SEE): Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Serbia and Montenegro, and Turkey. With the exception of Turkey, this group of countries has experienced great difficulties since the 1990s, often marked by (ethnic) conflicts and national break-up processes. Their possible entry into the European Union has only become a topic for discussion in recent years. These countries are marked in green in the figures and tables of this paper.

3. Eastern Europe, Caucasus and Central Asia (EECCA): Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. This group comprises countries with very different levels of development. Moldova, for example, was considered to be the poorest country in Europe in terms of GDP in 2009, while Russia's per capita GDP is significantly higher than that of the other countries in this group (by up to a factor of 13). Some of the European countries in EECCA (notably Russia, Ukraine and Belarus) still have comparatively large industrial sectors, whereas poorer southern and Asian neighbours have lower shares. Since the collapse of communism and as a response to the profound restructuring of the ex-Soviet economy, many of the EECCA countries have been facing strong growth in emigration because of unemployment. Some of them aspire to join the European Union. These countries are marked in purple in the figures and tables of this paper.

For clarity and easy comparison, the figures and tables in the paper only show data on the individual countries comprising these three groups, as well as data on the EU-15, the global averages and averages across the Group of 30. For each of the three sub-regions, two representative countries were chosen to illustrate certain developments. Croatia and Turkey represent South East Europe; the Russian Federation and Ukraine represent the group of Eastern Europe, Caucasus and Central Asia; and Lithuania and Hungary represent the New EU Member States.

The paper has the following structure: Section 2 briefly summarizes the methodology that was used to compile the resource use and resource efficiency data, as well as the main data sources used. Section 3 illustrates and analyzes resource use in terms of material extraction, material trade and material consumption, and resource efficiency. Section 4 contains conclusions and provides a short prospectus for future research.

Methodology

This pilot study is based on the methodological framework of material flow accounting and analysis (MFA, see Box 1). MFA builds on earlier concepts of material and energy balancing, introduced in the 1970s. The MFA concept was developed as a reaction to the fact that many persistent environmental problems, such as high material and energy consumption and related negative environmental consequences (such as climate change), are determined by the overall scale of industrial metabolism (as defined in Box 1) rather than the toxicities of specific substances.

Box 1 Material Flow Analysis (MFA) and Industrial Metabolism

The principal concept underlying the economy-wide MFA approach is a simple model of the interrelation between the economy and the environment, in which the economy is an embedded subsystem of the environment and – similar to living beings – dependent on a constant throughput of materials and energy. Raw materials, water and air are extracted from the natural system as inputs, transformed into products and finally re-transferred to the natural system as outputs (waste and emissions). To highlight the similarity to natural metabolic processes, the terms "industrial metabolism" (Ayres, 1989) and "societal metabolism" (Fischer-Kowalski, 1998) have been introduced.

According to these concepts, society and the economic system are social units functioning to reproduce the human population, in physical, economic and cultural terms. Besides the human population itself, societies and economic systems comprise bio-physical structures that "belong" to them and also have to be reproduced. Examples of such bio-physical structures are livestock, built infrastructure or man-made capital, such as machines and manufacturing sites. In order to perform this reproduction, metabolic exchange with the environment is a basic requirement.

The scale and composition of the industrial metabolism of a country is determined by many factors (UNEP, 2011), including demography, economic structures (the main sectors contributing to GDP), eco-efficiency of the technologies applied in key sectors such as energy, transport and manufacturing, as well as integration in the global economic system (patterns of imports and exports).

Material flow analysis (MFA) is so far the most widely applied methodology used to operationalize the concepts of industrial or societal metabolism and to quantify trends and analyse developments in countries around the world.

Since the beginning of the 1990s, when the first material flow accounts on the national level were presented (for example, in Environment Agency Japan, 1992), MFA has been a rapidly growing field of scientific and policy interest and major efforts have been undertaken to harmonize methodological approaches developed by different research teams. Today, the MFA methodology is internationally standardized and methodological handbooks are available, for example from the European Statistical Office (EUROSTAT, 2007a) and the OECD (2007).

For MFAs on the national level, two main boundaries for resource flows can be defined. The first is the boundary between the economy and the domestic natural environment from which raw materials are extracted. The second is the frontier to other economies with imports and exports as accounted flows.

In general, four major types of resources are considered in MFA studies. All types are accounted in terms of their weight (tonnes). This pilot study will also present data in this level of aggregation:

- Biomass (from agriculture, forestry, fisheries, and hunting)
- Fossil energy carriers (coal, oil, gas, peat)
- Minerals (industrial and construction minerals)
- Metal ores

This study focuses on economically used resources and does not consider so-called "unused extraction", which is not further processed but becomes waste during mining, quarrying, agriculture, forestry and fisheries, such as overburden, crop residues or by-catch. Globally, unused extraction exceeds used extraction by two to three times.

A large number of resource use indicators can be derived from economy-wide material flow accounts. These comprise indicators on material inputs, material outputs, material consumption and physical trade. In this pilot study, the following MFA-based indicators are mainly used:

- Domestic extraction (DE), reflecting all renewable and non-renewable raw materials extracted within the borders of a country (including mining, fishing, harvesting and logging).
- Domestic Material Consumption (DMC), which is calculated as DE plus imports minus exports.
- Physical Trade Balance (PTB), which is calculated as imports minus exports.

The compatibility of MFA with data from the System of National Accounts (SNA) enables material flow indicators to be directly related to indicators of economic performance, such as GDP. These interlinkage indicators quantify the eco-efficiency (or resource efficiency) of an economic system by calculating economic output (measured in monetary units) generated per material input (in physical units), for example GDP/DMC. Resource efficiency indicators are thus suitable tools to monitor processes of de-linking or de-coupling of resource use from economic growth.

The calculations in this study build on the integration of two databases. First, the global database on resource extraction developed and maintained by SERI, which is based on international statistics including those of the International Energy Agency (for fossil fuels), the UN FAO (for biomass) and the US and British Geological Surveys (for metals and industrial minerals). This database is accessible in an aggregated form on the webpage www.materialflows.net, where a detailed technical report can also be downloaded (SERI, 2010). Data quality varies for the different types of materials. It is generally good for the extraction of fossil fuels and metal ores, although, in some cases, estimations have to be applied regarding the concentration of metals in crude ore extraction. It can be assumed that part of the biomass extraction for subsistence purposes is not covered in official statistics, so biomass values might be underestimated, particularly for poor countries. It is important to note that statistics about mineral use are poor in nearly all the investigated countries. Thus, for the extraction of construction minerals an estimation method was used, where the physical production of cement and bitumen was used to estimate overall levels of extracted construction minerals, in particular limestone, sand and gravel. Where no reliable data on cement and bitumen production were available the estimations were carried out using per capita income as proxy, assuming that demand for construction minerals per capita increases when countries become richer. The exact amounts of mineral extraction may therefore be over- or underestimated in some of the countries. A more detailed study would be needed to develop more accurate estimation methods.

As the second major data source, the global database on resource trade developed at the University of Cologne and the Wuppertal Institute in Germany is applied; this is based on UN Comtrade data and includes global accounts of imports and exports in physical (weight) units. All missing weight values in UN Comtrade have been filled using the global annual price for each commodity group starting with the most differentiated level, then summed up according to the classification structure, and repeated at the next higher differentiation level up to the total sum. Values of direct trade flows of major outliers are corrected by adjusting the relevant values with regard to global prices, amount of global imports and exports and – as far as available – bilateral trade data as well as national sector statistics. A detailed methodological description is given by Dittrich (2010) and Dittrich and Bringezu (2010). Trade information on the 30 countries in the UN Comtrade database mostly begins some years after their formation; and the earlier years are generally less complete and less reliable than data for later years. Thus, trade data for 1995 for the EECCA countries and most of the East European countries are of poor quality: a large number of physical values had to be estimated using the method already explained and a notable number of outliers had to be corrected; in some cases, when trade data started in 1996, data had to be extrapolated using, as far as possible, available bilateral data of importing countries and/or further statistics such as IEA or FAO. The most important data for trade in fossil fuels is provided by the IEA. In 2000 and later, the data quality of almost all investigated countries is good or even excellent with the exception of Tajikistan and Turkmenistan where trade data are available for a few years only.

Integrating data from these two sources allows the calculation of national resource consumption, considering both domestic extraction and use of resources as well as traded resources. Based on these resource consumption indicators, which include international trade, indicators on resource efficiency were calculated. This pilot study was the first time that these calculations were performed for the selected countries in Eastern Europe and the region of the Newly Independent States.

Results

This section presents the main results of the calculations and is divided into sub-sections on material extraction, material trade, material consumption and material productivity.

Material extraction

The extraction of used materials in the Group of 30 grew by 33 per cent between 1995 and 2008, compared with the global average of 42 per cent in the same period (see Table 1). Between 1995 and 2000, in both the 30 countries and the EU-15 there was almost no growth in extraction (1 per cent in both regions). This rather sluggish growth in the region was largely a result of a decline in Eastern Europe, Caucasus and Central Asia (EECCA) (down 2 per cent). Both South East Europe (SEE) and the New EU Member States (NMS) experienced positive growth in extraction (of 7 per cent and 4 per cent respectively). The one-third growth in extraction in the Group of 30 between 2000 and 2008, by contrast, was much higher than the global average, largely driven by EECCA (38 per cent), followed by SEE (31 per cent) and the NMS (18 per cent). As global growth in extraction was higher over the entire period between 1995 and 2008 than in the Group of 30 over the same period, in large part caused by extraction in the emerging economies, in particular in Asia (see Dittrich *et al.*, 2011), the share of the Group of 30 in global resource extraction fell slightly.

The composition of used material extraction for the Group of 30 has changed over the years under consideration. Figure 1 illustrates the development of its domestic extraction in more detail, divided into used biomass, minerals, fossil fuels and metal ores. Between 1995 and 2008, the share of biomass (from agriculture, forestry and fishing) shrank from 27 to 22 per cent, the share of mineral extraction in overall material extraction increased from 27 to 34 per cent, the share of metal ores remained constant at 10 per cent, and the share of fossil fuels shrank slightly to 33 per cent. Patterns of extraction are thus markedly different from those observed in the EU-15 countries, which have a share of 23 per cent for biomass, a large share of 65 per cent for minerals (higher than in the other three regional groups), only 1.4 per cent for metal ores and 10 per cent for fossil fuels in the year 2008. In the EU-15, the composition and amount of extraction hardly changed between 1995 and 2008.

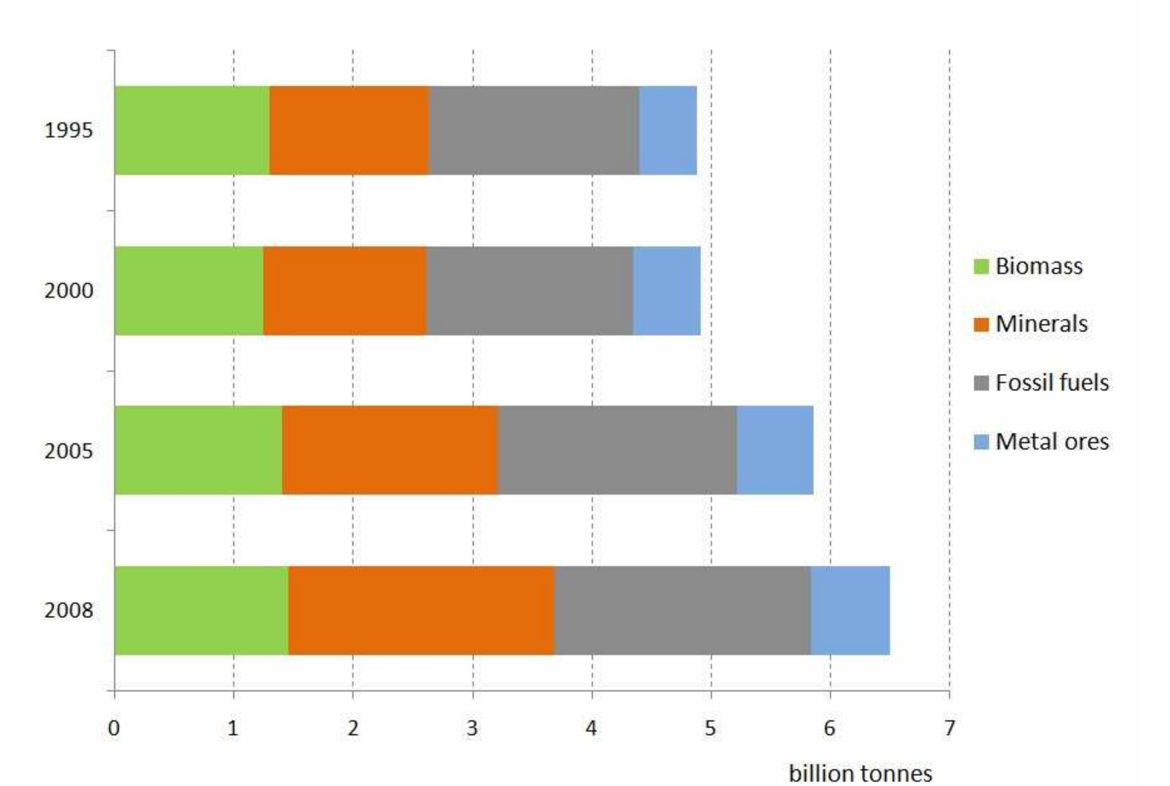
Table 1 Used material extraction – globally and in the Group of 30, (1995-2008)

	Global extraction, billion tonnes	Global extraction, 1995 = 100	Group of 30, billion tonnes	Group of 30, 1995=100	Share of Group of 30 in global extraction
1995	47.9	100	4.9	100	10.2%
2000	52.7	110	4.9	101	9.4%
2005	61.6	129	5.9	120	9.5%
2008	68.1	142	6.5	133	9.6%

Source: SERI (2011).

In the Group of 30, the extraction of construction and industrial minerals increased by 67 per cent between 1995 and 2008, a rate of expansion that was reflected in all of the three sub-regions; metal ore extraction increased by 35 per cent. Apart from fossil fuels, minerals not only constituted the second largest category of extraction in the Group of 30, but their extraction also experienced remarkable growth, especially for construction purposes.

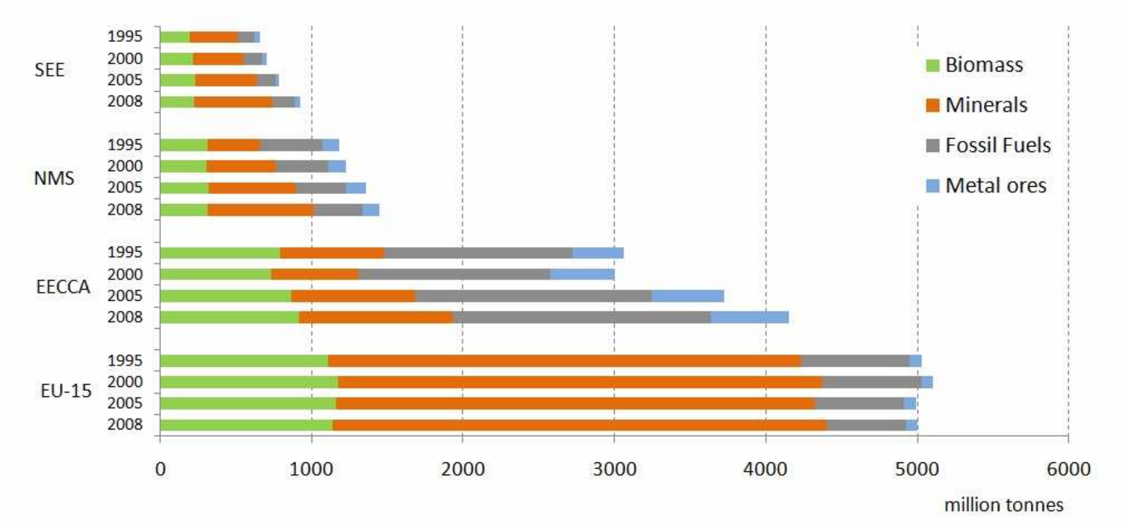
Figure 1 Material extraction by material category in the Group of 30, (1995-2008)



Source: SERI (2011).

Figure 2 illustrates the development of domestic extraction of used biomass, minerals, fossil fuels and metal ores for the different regional groups between 1995 and 2008. The strongest growth in extraction took place in mineral extraction in the New EU Member States (104 per cent). In 2008, almost half of their overall material extraction was in minerals, largely dominated by extraction activities in Poland. In South East European countries, mineral extraction constituted 56 per cent of overall material extraction. In SEE, mineral extraction, mostly construction minerals, increased by 67 per cent between 1995 and 2008. In this group, the extraction of construction minerals is clearly dominated by Turkey, which is also responsible for the significant increase. The share of minerals in total material extraction in the NMS and SEE sub-groups is therefore comparable to the share observed in the EU-15. In EECCA mineral extraction increased by 78 per cent between 1995 and 2008, and minerals made up a quarter of overall extraction in 2008. This increase was mostly driven by the Russian Federation, which at first (from 1995 to 2000) experienced a decline in minerals extraction, followed by a substantial increase of 75 per cent between 2000 and 2008. By 2008, Russia extracted about 600 million tonnes of construction minerals.

Figure 2 Materials extraction by material category in SEE, NMS, EECCA and EU-15, (1995-2008)

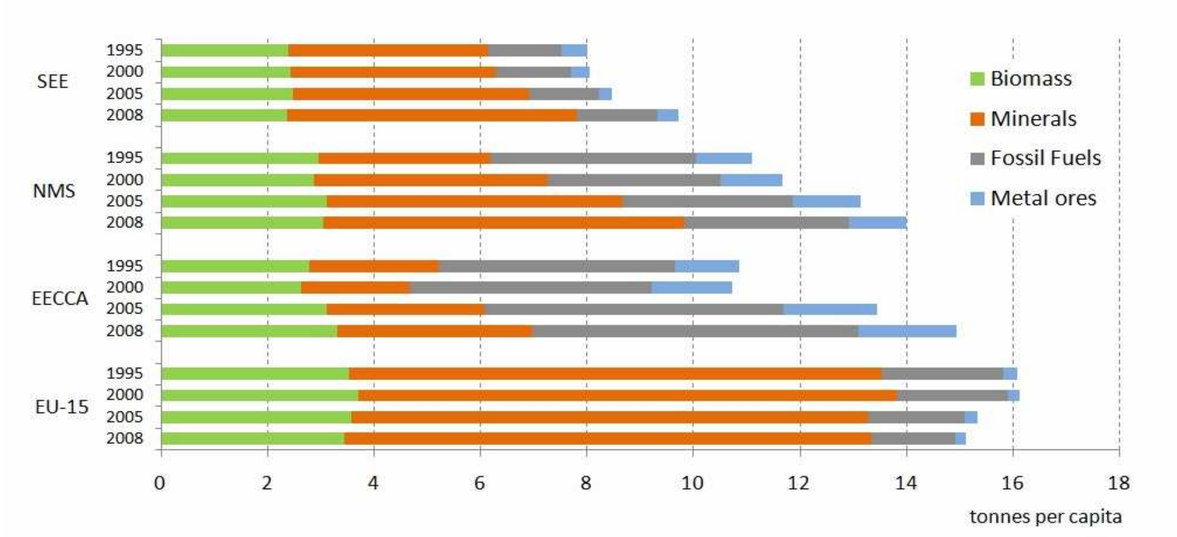


Source: SERI (2011).

Compared with other material categories, biomass lost importance; its share in overall material extraction shrank in all three country groups between 1995 and 2008 (e.g. from 27 to 22 per cent in the New EU Member States).

The evolution of fossil fuel extraction differs significantly between the different groups. In the New EU Member States, fossil fuel extraction, which is almost exclusively coal, fell by 22 per cent. Here, the share of fossil fuel extraction in overall extraction dropped from 35 to 22 per cent between 1998 and 2005, mostly due to the decrease in the extraction of hard coal in Poland and the Czech Republic, a consequence of the restructuring in their energy and electricity generation sectors. In the EECCA and South East Europe, the share of fossil fuel extraction in overall extraction hardly changed over the same period (41 and 16 per cent respectively). The share of metal ore extraction also did not change markedly over time, with increases only observed in the EECCA group (up 34 per cent). Figure 3 shows the material extraction of the different regions in per capita terms.

Figure 3 Per capita material extraction by material category in SEE, NMS, EECCA and the EU-15, (1995-2008)



Source: SERI (2011).

The biggest increase of material extraction per capita (by approximately 4 tonnes) between 1995 and 2008 is seen in the EECCA, with a general increase in all material categories, but especially in minerals and fossil fuels. By 2008, the EECCA countries thus extracted about the same quantity of materials per capita as did the EU-15. The NMS also increased their per capita material extraction considerably (from 11 to 14 tonnes) over the same period.

The increase in material extraction in the region had both positive and negative implications. Positive impacts of extraction are generally connected to investment and economic growth. Thus, the exploitation and processing of fossil fuels, minerals and metals formed the material basis for industrial growth in many countries across the region. Negative impacts, however, typically occur on the environment. Mining metals, non-metallic minerals and fossil fuels can cause structural changes to the landscape, harming land, air and water ecosystems and causing a loss of biodiversity. Extraction activities also increase local demand for water and electricity and lead to the contamination of surface and ground waters (Miranda *et al.*, 2003, cited in Giljum *et al.*, 2005; UNEP, 2011). Thus, the overall and continuing increase in extraction in this world region poses challenges from the environmental perspective.

Resource trade

Between 1995 and 2008, the Group of 30 doubled its material trade volume in physical terms from almost 664 million tonnes in 1995 to more than 1.3 billion tonnes in 2008 (see Table 2). During the same period, world trade volume increased by a factor of 1.7, resulting in an overall increase of the share of the Group of 30 countries in global trade volume from 10.8 per cent in 1995 to 13.0 per cent in 2008. Compared with the growth in physical trade volume at the global level between 1995 and 2008 (69 per cent), growth in physical trade was lower in the NMS (64 per cent), but higher in the EECCA (118 per cent) and SEE (138 per cent) (see Table 3). The relatively high share of the former Soviet states in the global trade volume (8 per cent) is mainly due to the Russian Federation, which held a share of 4.8 per cent of material trade volume in 2008.

Table 2 Physical trade volume[1] globally, of the EU-15 and of the 30 selected countries, (1995-2008)

	Global trade volume[1]	Global trade volume	EU-15 trade volume	EU-15 trade volume	Group of 30 trade volume	Group of 30 trade volume	Group of 30 share in global trade volume
	billion tonnes	1980=100	billion tonnes	1980=100	billion tonnes	1980=100	%
1995	6.11	100	1.67	100	0.66	100	10.8
2000	7.60	124	1.95	117	0.81	123	12.1
2005	9.64	153	2.18	131	1.14	171	11.8
2008	10.32	169	2.31	139	1.34	202	13.0

[1]Trade volume = (imports+exports)/2.
Source: Dittrich (2011).

Table 3 Physical trade volume of the NMS, SEE and EECCA, (1995-2008)

	New EU-Member States			South East Europe			Eastern Europe, Caucasus and Central Asia		
	million tonnes[1]	1980=100	Share in global trade (%)	million tonnes	1980=100	Share in global trade (%)	million tonnes	1980=100	Share in global trade (%)
1995	220	100	3.6	67	100	1.1	377	100	6.2
2000	232	105	3.0	82	121	1.1	501	133	6.6
2005	307	140	3.2	130	193	1.4	698	185	7.2
2008	360	164	3.5	161	238	1.6	823	218	8.0

[1]Trade volume = (imports+exports)/2.
Source: Dittrich (2011).

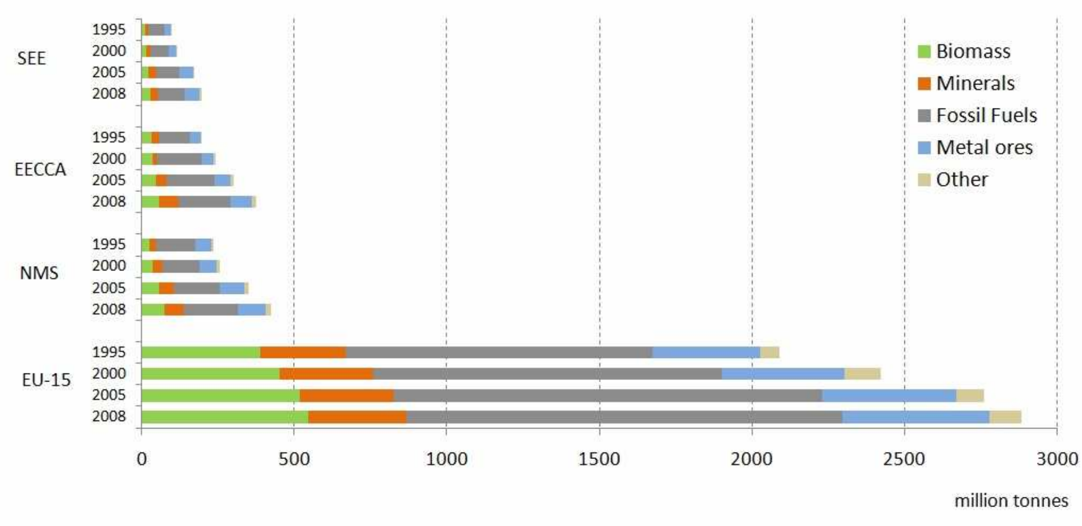
Both imports and exports increased in the 30 countries between 1995 and 2008. Export growth was about 20 per cent stronger than import growth, with exports more than doubling (by 111 per cent, from 803 million tonnes in 1995 to 1.69 billion tonnes in 2008), and imports growing by 89 per cent (from 526 to 996 million tonnes). Imports are similar in all the three country groups, but exports differ significantly both in size and composition. Figure 4 shows that the NMS had the highest imports in 2008 of 425 million tonnes (1995: 234 million tonnes; up 82 per cent), followed by EECCA with 375 million tonnes (1995: 196 million tonnes; up 91 per cent) and South East Europe with 196 million tonnes (1995: 96 million tonnes; up 104 per cent). By contrast, the EECCA had by far the highest exports with almost 1.27 billion tonnes in 2008 (1995: 557 million tonnes; up 128 per cent), followed by the NMS with 295 million tonnes (1995: 206 million tonnes; up 43 per cent) and SEE with 125 million tonnes (1995: 39 million tonnes; up 219 per cent).

Fossil fuels, which include petroleum, gas, coal and products mainly made of fossil energy carriers, are the dominant imported product group in all three country groups. Although imports of fossil fuels increased by more than half (by 53 per cent, from 285 to 436 million tonnes in absolute terms), the share of fossil fuels in total imports of the 30 countries declined continuously from 54 per cent in 1995 to 44 per cent in 2008. In 2008, the NMS had the lowest share of imports of fossil fuels in total imports of around 42 per cent compared with 44, 46 and 50 per cent in SEE, the EECCA and the EU-15, respectively. In 2008, Ukraine and Turkey were the largest importers of fossil fuels among the selected 30 countries with around 65 million tonnes each, followed by Poland (44 million tonnes) and the Russian Federation (41 million tonnes).

Metals, including ores and concentrates, semi-manufactures and products mainly made of metals, constitute the second highest share in total imports in the 30 countries together (1995: 20 per cent, 2008: 21 per cent). In 2008, the new EU-Member States had the highest metal imports (92 million tonnes), followed by the EECCA (71 million tonnes) and South-East Europe (50 million tonnes). From 1995 to 2008, the highest overall growth in metal imports occurred in South East Europe (147 per cent), followed by the EECCA (118 per cent) and the NMS (78 per cent). The main importers were the Russian Federation with 40 million tonnes in 2008 (94 per cent up on the 20.6 million tonnes of 1995) and Turkey with 39 million tonnes (1995: 17 million tonnes; up 129 per cent). The major metal products of both countries were iron and steel as well as motor vehicles, including parts thereof. In the Russian Federation, metals are used in the basic metals industry, one of its main industries (alongside non-metallic mineral products, energy sources, and to a lesser extent, the food sector). Real value-added data show that the output of the Russian manufacturing sector was relatively stable between 1995 and 2007, after the transition to a market economy (Memedović and Iapadre, 2009).

In 2008, the 30 countries imported around 159 million tonnes of biomass, including products mainly made of biomass. Biomass thus made up 16 per cent of total imports (1995: 70 million tonnes or 13 per cent of total imports). The NMS were the largest importers of biomass with 73 million tonnes in 2008 (1995: 25 million tonnes; up 192 per cent), followed by the EECCA with 56 million tonnes (1995: 33 million tonnes; up 70 per cent) and by SEE with 30 million tonnes of imported biomass (1995: 12 million tonnes; up 150 per cent). The main importers in 2008 were the Russian Federation, Poland and Turkey with imports of around 29, 24 and 20 million tonnes respectively (1995: 22, 7, and 8 million tonnes respectively). The major biomass products imported by the Russian Federation were fruits, meat and paper, including pulp and paperboard. Poland's main biomass imports were cereals, timber and beverages and Turkey's were mainly cereals, paper including pulp and paperboard, and timber.

Figure 4 Physical imports of SEE, EECCA, NMS and the EU-15, (1995-2008)



Source: Dittrich (2011).

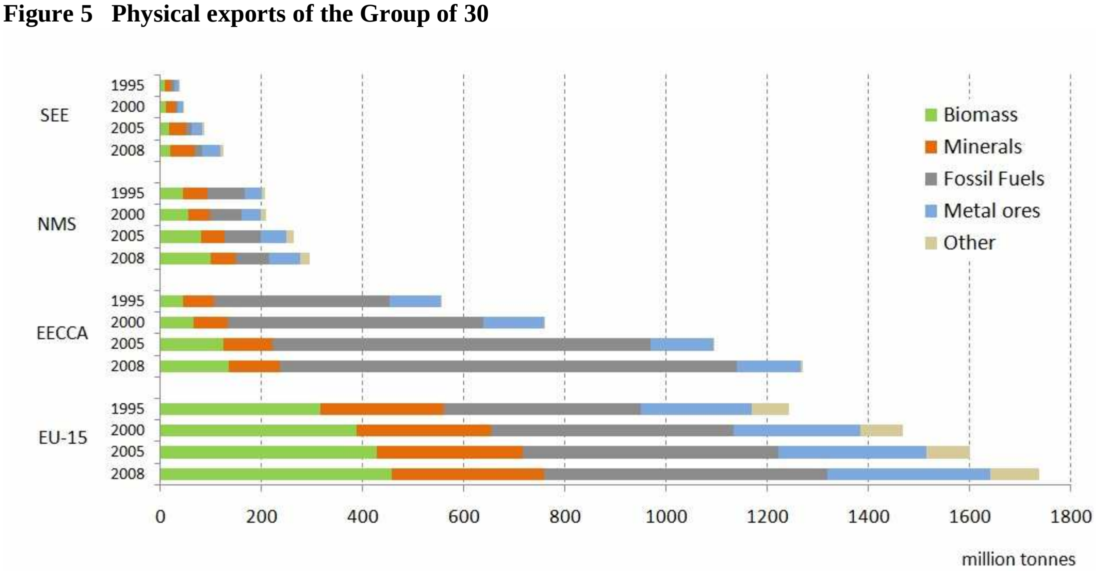
Imports of non-metallic minerals of the 30 selected countries amounted to 150 million tonnes in 2008 compared with 55 million tonnes in 1995 (up 173 per cent). In each country group, minerals constituted the lowest share of total imports in 2008, at 12 per cent in South East Europe, 15 per cent in the NMS and 17 per cent in the EECCA. Minerals are usually traded less as they are considered to be ubiquitous (Weisz *et al.*, 2006). In 2008, the main importers were the Russian Federation, Poland and Turkey. The Russian Federation imported mainly gravel and sand while Poland and Turkey imported mainly fertiliser minerals.

The export structures of the sub-regions differ significantly from each other (Figure 5). Fossil fuels were the dominant type of exports in the Group of 30 as a whole (1995: 427 million tonnes, 2008: 986 million tonnes; up 131 per cent). Fossil fuels were predominantly exported by the EECCA countries (903 million tonnes); this group is clearly dominated by the Russian Federation which is the largest supplier of fossil fuels (oil, gas and coal and products made by fossil energy carriers, exports of which totalled 638 million tonnes in 2008), followed by Kazakhstan, the tenth largest supplier of fossil fuels globally (115 million tonnes in 2008). By contrast, fossil fuel exports from the New EU Member States decreased by 8 per cent during the period under consideration (from 73 million tonnes to 67 million tonnes).

Between 1995 and 2008, the biomass exports of the Group of 30 increased by a factor of 2.6 and constituted the second largest export category (1995: 99 million tonnes; 2008: 253 million tonnes). The EECCA countries had the largest biomass exports in absolute terms (around 134 million tonnes in 2008) partly as a result of Russia's exports of timber and Ukraine's exports of cereals. This group is followed by the NMS (99 million tonnes in 2008) where wood and timber from the Czech Republic and Poland are important exports.

Metal exports from the Group of 30 increased by 54 per cent between 1995 and 2008 (from 145 to 224 million tonnes). The EECCA-countries exported the largest amount of metals (1995: 102 million tonnes, 2008: 128 million tonnes; up 25 per cent), followed by the NMS (1995: 33 million tonnes, 2008: 61 million tonnes; up 83 per cent). The largest growth in metal exports occurred in SEE, from 10 million tonnes in 1995 to 36 million tonnes in 2008 (up 249 per cent). Ukraine, the Russian Federation and Turkey were the largest exporters of metals, in particular of iron and steel at different stages of processing.

Figure 5 Physical exports of the Group of 30

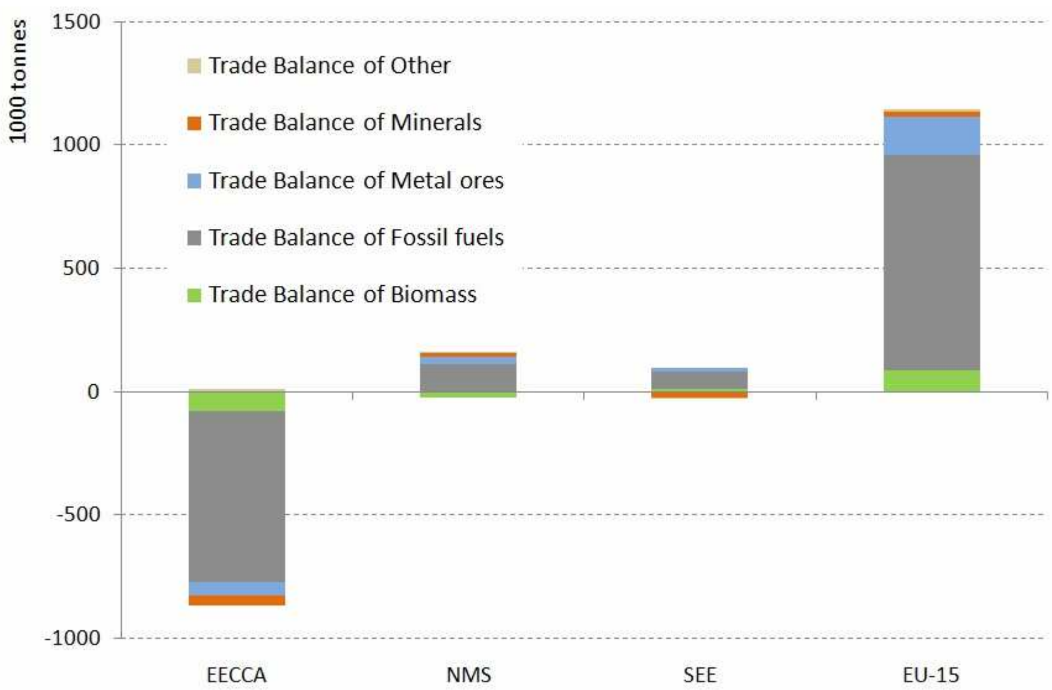


Source: Dittrich (2011).

Interesting dynamics can be observed in the trade in minerals. Mineral exports from South East Europe quadrupled between 1995 and 2008 (from 12 to 48 million tonnes). The largest amounts of minerals were exported by the EECCA-states (1995: 60 million tonnes; 2008: 102 million tonnes; up 70 per cent), with large exports of fertilizer minerals from the Russian Federation and Ukraine, and of gravel and sand from Ukraine. Mineral exports from the new EU-member states at first declined (from 50 million tonnes in 1995 to 43 million tonnes in 2000) and later rose again slightly (to 45 million tonnes in 2008).

The physical trade balances of the region show a mixed picture (see Figure 6). The balances make it possible to identify the net redistribution of resources and the net consumers and net suppliers of resources at the global level. In contrast to standard monetary trade balances, which are calculated as exports minus imports, the physical trade balance is calculated as imports minus exports. Positive values therefore signify net imports of materials and negative values imply net exports. The Group of 30 overall is an important net-exporter of materials (1995: 277 million tonnes, 2008: 660 million tonnes). But, within the Group, it is only the EECCA countries that are net exporters. As a sub-group, they are net exporters of all material categories, but among these, fossil fuels dominate. The EU-15, by contrast, has large net imports of all materials, also dominated by fossil fuels. The NMS and the SEE countries have a mixed trade structure: the NMS are net exporters of biomass, but net importers of fossil fuels, metals and non-metallic minerals. The SEE countries together are net exporters of non-metallic minerals, but net importers of fossil fuels, metals and biomass.

Figure 6 Physical trade balances of SEE, EECCA, NMS and the EU-15 in 2008

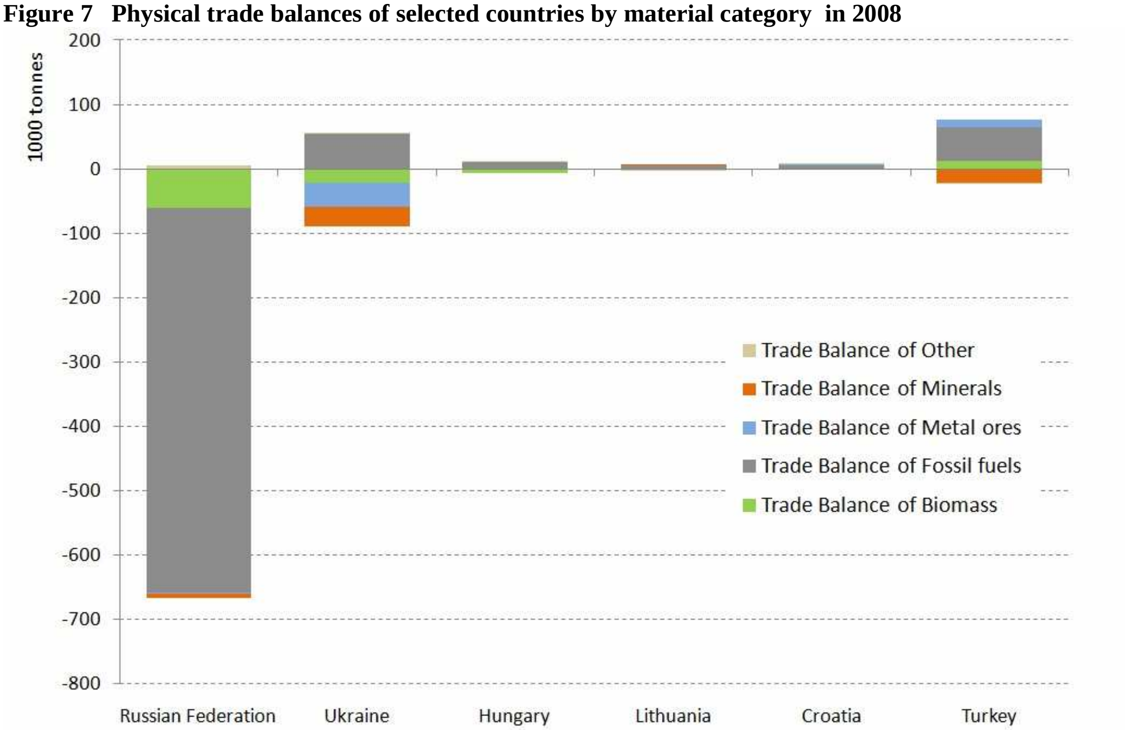


Source: Dittrich (2011).

Observation of individual countries in the different regional groups (Figure 7) reveals that the exports as well as net exports of EECCA are dominated by the Russian Federation, the largest supplier of resources in physical terms of all countries worldwide.

Fossil fuels make up the highest share of net exports from the Russian Federation, Kazakhstan, Azerbaijan and Turkmenistan, whereas Ukraine and all other EECCA-members are net importers of fossil fuels. Ukraine, however, is a net exporter of all other material categories. Hungary, Lithuania and almost all other NMS, except for the two islands of Cyprus and Malta, are net exporters of biomass. All NMS are net importers of fossil fuels and almost all of them are net importers of metals, with the exception of Estonia, which was a net exporter of metals in 2008. Estonia is an interesting case. According to trade data, Estonia is a net exporter of metals, although it does not extract metals. The same held true for the other Baltic States in various years during the 1990s. The exported metal products of all of the three countries are mainly iron and steel waste, which could originate from dismantled infrastructure or industrial complexes or from non-recorded trade, such as trade in cars (see Öko-Institut *et al.*, 2011). SEE is also dominated by net exporters of materials, as illustrated by the examples of Croatia and Turkey below.

Figure 7 Physical trade balances of selected countries by material category in 2008



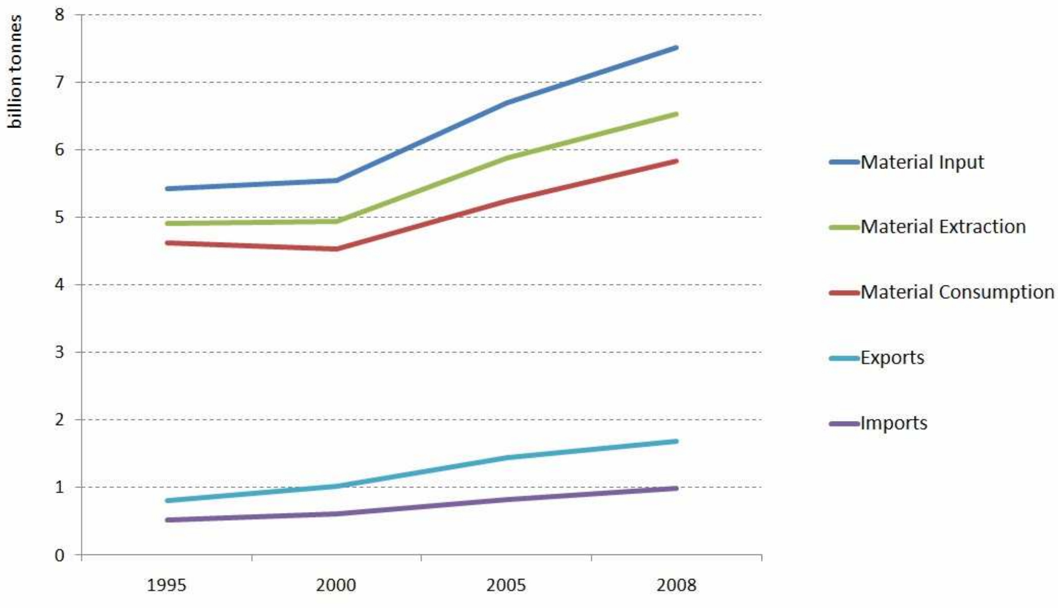
Source: Dittrich (2011).

Material consumption

Domestic Material Consumption (DMC) is a measure of consumption within a country. In economic terms, this indicator is closely related to GDP (EUROSTAT, 2001), and in environmental terms, it indicates potential pressures associated with the disposal of residual materials to the domestic environment.

Figure 8 shows the 30 countries' extraction, imports and exports at a glance as well as the material input (extraction plus imports) and material consumption (extraction plus imports minus exports) from 1995 to 2008. During the 1990s, extraction remained nearly constant and exports increased more than imports. A very slight reduction in material consumption between 1995 and 2000 (from 4.6 to 4.5 billion tonnes) was followed by a strong increase until 2008 (to 5.8 billion tonnes).

Figure 8 Extraction, trade, material input and material consumption in the Group of 30, (1995-2009)



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

Import dependency is usually measured by the share of imports in material consumption of a country. Shares of 100 per cent or below show to what extent material is imported for consumption, and shares above 100 per cent indicate that imports are re-exported. In general, import dependencies of countries with large domestic resource endowments are minor or negligible, whereas islands and small countries with a very specialized economy typically have high import dependencies. Some studies show that in Europe domestic raw materials (such as metals) are increasingly substituted by imports from other regions (e.g. EUROSTAT, 2007b). This development has made Europe heavily dependent on imports from other countries, in particular fossil fuels and metal ores.[41] Increasing imports can also reflect an "outsourcing" of the environmental burden, which is connected to resource extraction and processing activities (Bringezu *et al.*, 2004; Bruckner *et al.*, in press).

Table 4 shows the import dependencies of the three regional groups and of selected countries within these groups, as well as of the Group of 30 and the EU-15. The three regional groups of countries under investigation are significantly less dependent on imports than the EU-15. On average, around 17 per cent of the 30 countries' material consumption was imported in 2008 (up from 11 per cent in 1995). The import dependency of the 30 countries in Central and Eastern Europe and the Newly Independent States in 2008 was thus nearly as high as in Asia in 2005 (Giljum *et al.*, 2010) and higher than in the emerging economies in 2005 (Dittrich, 2011). EECCA countries, in particular the Russian Federation, are nearly self sufficient; Russia's imports of biomass, minerals and fossil fuels (mainly products such as plastics and chemicals) are negligible. The highest overall dependencies can be observed in the NMS, notably with regard to fossil fuels and metal ores (for the latter, SEE is even more dependent on imports), a pattern that is even more pronounced for the EU-15, which has very low endowments of those two material groups within its territory. The values above 100, especially for metal ores, indicate further processing of metal ores in domestic industries. Hungary, for example,

41 According to the European Commission, the import dependency of the EU is 83 per cent for iron ores, 80 per cent for bauxite, and 74 per cent for copper (European Commission, 2006).

extracted around 841,000 tonnes of metals in 2008 and imported 6.298 million tonnes, predominantly in the form of semi-processed products (e.g. parts of vehicles). It exported 6.254 million tonnes of metals, mostly in the form of products mainly made of metals (such as passenger vehicles). Thus, Hungary's import dependency of 710 per cent reflects the fact that the country is importing, processing and exporting more than seven times the volume of its own consumption of metals.

Table 4 Import dependencies (% share of imports in DMC) of selected countries and regional groups in 2008

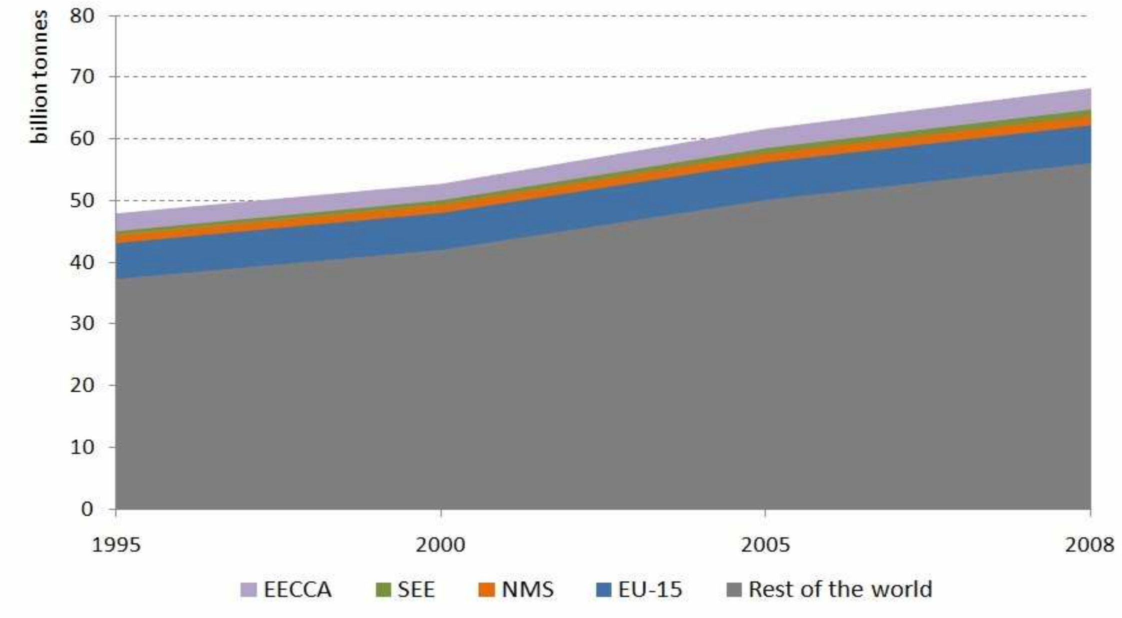
	All materials	Biomass	Minerals	Fossil fuels	Metal ores
Hungary	33.4	25.0	9.3	65.9	710.6
Lithuania	35.6	13.4	15.1	228.1	1178.0
NMS, average	27.0	25.2	8.8	41.2	65.2
Croatia	44.1	28.9	26.8	95.9	254.4
Turkey	18.3	11.3	2.4	47.4	129.2
SEE, average	19.7	12.9	4.9	39.9	96.1
Russian Federation	7.7	6.8	5.1	6.4	18.6
Ukraine	24.4	5.0	7.3	49.0	39.5
EECCA, average	11.5	6.6	6.4	17.8	15.5
Group of 30, average	17.1	11.7	6.8	27.0	32.6
EU-15, average	57.7	44.5	9.8	102.6	210.9

Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

On the global level, material consumption grew by a factor of 1.4 between 1995 and 2008, to around 68 billion tonnes (Figure 9). In the 30 selected countries, absolute material consumption increased by a factor of 1.26 during the 13 years, which is lower than the global average but higher than in the EU-15 where absolute material consumption was virtually stagnant. In 1980, around 10.6 per cent of the world population lived in the 30 countries and consumed 9.6 per cent of all globally consumed materials. By 2008, only 7.1 per cent of the world's population resided in the Group of 30, but it consumed 8.5 per cent of all globally consumed materials.

In almost all countries directly affected by the collapse of Communism, absolute material consumption decreased during the 1990s. Collapse of industries, (re-)organization of the economic systems and sometimes civil strife resulted in economic decline, which is reflected in the falling values of absolute material consumption in Table 5. The highest decreases in absolute terms were found among the EECCA countries where the amount of consumed materials shrank from 2.7 billion tonnes to 2.5 billion tonnes between 1995 and 2000 (by 8.2 per cent). In the Russian Federation material consumption decreased by around 10 per cent and in Ukraine by 22 per cent. In most of the other EECCA countries absolute material consumption stagnated or increased. Kazakhstan's material consumption, for example, grew by 2.4 per cent during the second half of the 1990s. From 1995 to 2000, material consumption also decreased (by 4.4 per cent) across South Eastern Europe (except for Turkey), most notably in Albania (down 31 per cent) and Serbia and Montenegro (down 13 per cent).

Figure 9 Domestic Material Consumption of EECCA, SEE, NMS, EU-15 and globally, (1995-2008)



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

Table 5 Domestic material consumption of the Group of 30, EECCA, SEE, NMS and EU-15, (1995–2008), (million tones)

	1995	2000	2005	2008
Hungary	93	91	146	104
Lithuania	41	45	64	73
NMS, total	1208	1274	1448	1577
Croatia	28	27	49	51
Turkey	530	596	654	749
SEE, total	717	775	869	996
Russian Federation	1702	1533	1742	1976
Ukraine	389	304	383	405
EECCA, total	2702	2480	2932	3255
Group of 30, total	4627	4529	5249	5827
EU-15, total	5876	6059	6151	6144

Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

Most NMS countries increased their absolute material consumption after 1995, but some decreases of absolute material consumption can still be observed between 1995 and 2000, in particular in Hungary and Romania (down 2.3 and 25 per cent respectively). In Hungary, the consumption of all material categories declined between 1995 and 2005, most notably of construction minerals (down 36 per cent), which still made up 54 per cent of total extraction in 2008. This marked decline in Hungary's material consumption between 2005 and 2008 can largely be explained by a decline in the extraction of construction minerals compared to the peak extraction observed in 2005. It is important to note that Poland, the Czech Republic, Slovakia, Slovenia and the Baltic states also show significant falls in absolute material consumption during the years before 1995 as far as reliable data for that time are available. In Poland, for example, materials used fell from around 522 to 437 million tonnes between 1990 and 1995, the Czech Republic from around 185 to 162 million tonnes between 1993 and 1995 and Lithuania from 35 to 22 million tonnes between 1992 and 1995.

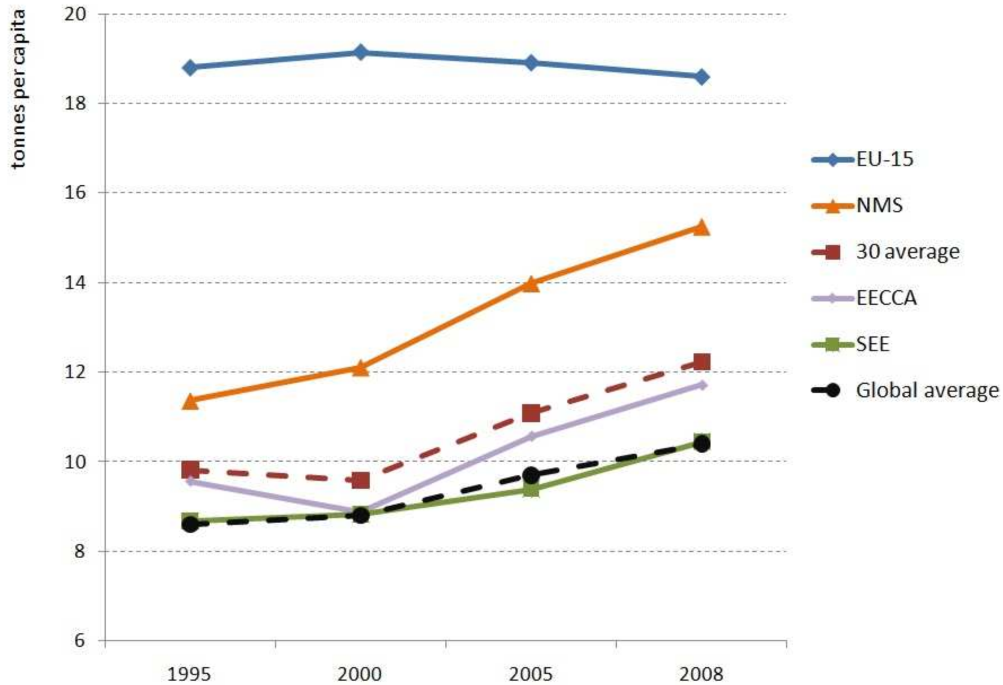
The pattern of material consumption in the selected countries looks different when the focus is on per capita numbers. Average per capita consumption of the 30 countries rose from 9.8 tonnes in 1995 to 12.3 tonnes in 2008 (up 25 per cent). Thus, average per capita consumption is above the global average of 10.4 tonnes, but clearly below the EU-15 average of 18.6 tonnes per capita in 2008 (see Figure 10).

Material consumption by the new EU members grew most strongly, from 11.4 tonnes per capita in 1995 to 15.3 tonnes in 2008 (up 34.3 per cent). This is below the EU-15 average, which decreased slightly on a per capita basis during the period, from 18.8 to 18.6 tonnes. The new EU members are thus converging towards the EU-15 patterns of material consumption. South East European average material consumption per capita was about the same as the global average or below. During the whole period under investigation South East European countries increased their per capita material consumption by 20.5 per cent, to 10.4 tonnes in 2008. By contrast, EECCA average material consumption per capita was always above the global average and reached 11.8 tonnes in 2008, an increase of around 23.7 per cent. Due to the fact that population size decreased in the EECCA countries, the rise in average material consumption per capita was in part the result of the fall in population. Those trends are in contrast to developments in other developing and emerging world regions, such as in Asia or Africa, where absolute amounts of material consumption are increasing, but per capita amounts have been declining because of high population growth.

In most of the 30 countries, average material consumption increased between 1995 and 2008. Georgia and Bosnia and Herzegovina had the highest growth in per capita consumption (172 per cent and 126 per cent respectively), whereas Tajikistan and Serbia/Montenegro had the lowest (down 0.002 per cent and up 0.5 per cent respectively). In 2008, the highest material consumption per capita could be found in Slovenia (27.0 tonnes), Cyprus (26.6 tonnes), Estonia (25.0 tonnes), Kazakhstan (22.7 tonnes) and Lithuania (21.6 tonnes). The lowest material consumption was among the poor Central Asian countries, Tajikistan and Georgia with less than 3.5 tonnes per capita in 2008 (see Annex 1).

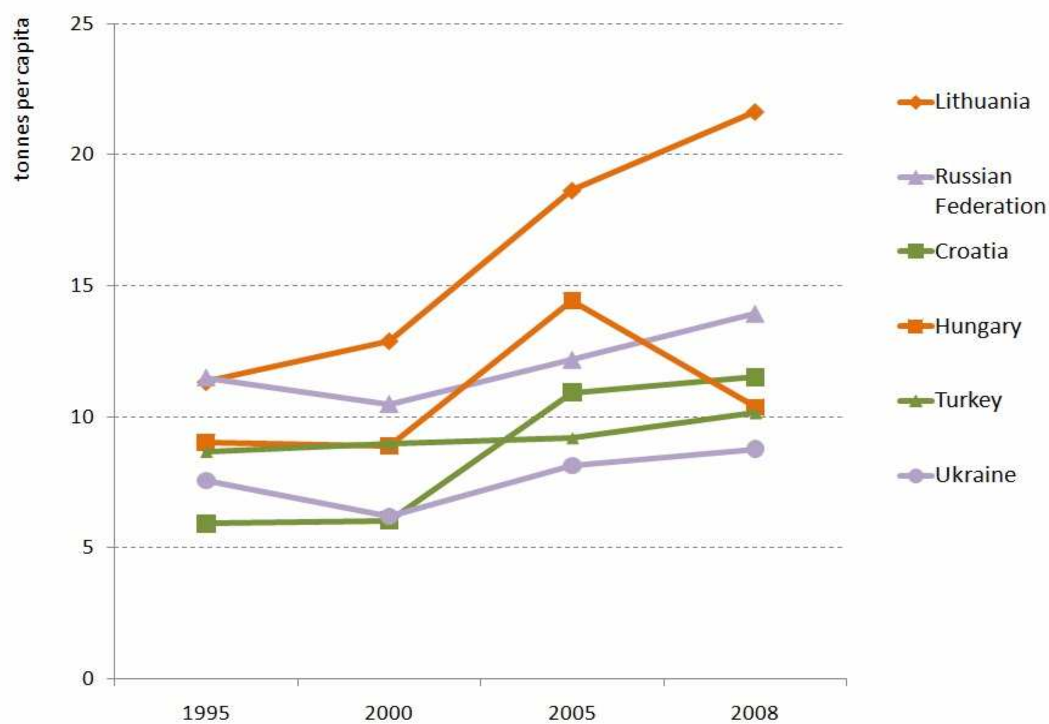
In general, per capita material consumption grew most rapidly between 2000 and 2005, and then growth slowed after 2005 in nearly all of the 30 countries. While in most of the new EU-members per capita consumption increased continuously after 1995, in nearly all of the South East European countries directly affected by the collapse of Communism as well as the EECCA countries, per capita material consumption fell, as absolute material consumption levels decreased even faster than population. For example, in the Russian Federation the reduction in material consumption clearly outweighed the fall in population size (down 9.9 per cent versus 3.0 per cent) between 1995 and 2000; thereafter, population size kept on shrinking while absolute material consumption grew, resulting in an average per capita consumption of 13.9 tonnes in 2008 (see Figure 11). After 2005, in most of the countries, per capita material consumption continued to grow but more slowly than before. The decrease in Hungary is clearly exceptional and mainly a result of the outstandingly high extraction of industrial minerals in 2005.

Figure 10 Domestic Material Consumption per capita of EECCA, SEE, NMS, EU-15 globally, (1995-2008)



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

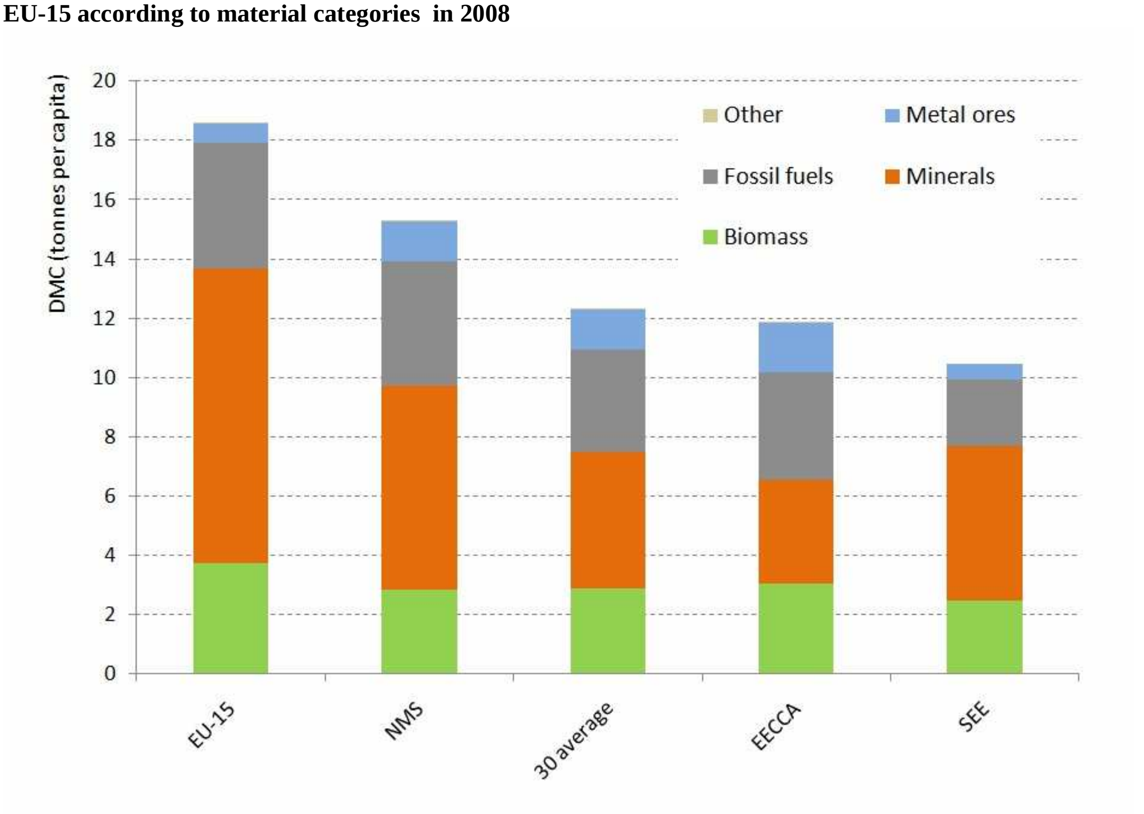
Figure 11 Domestic Material Consumption per capita of selected countries, (1995-2008)



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

The composition of material consumption in the 30 countries confirms a pattern already observed in Asian and other emerging economies; richer countries consume larger amounts of minerals and fossil fuels, resulting in low shares of biomass in DMC, while poorer countries have higher shares of biomass in material consumption (see Figures 12 and 13). The EU-15 and the NMS have a significantly higher per capita consumption of non-metallic minerals of 9.9 tonnes and 6.9 tonnes respectively, compared with 5.2 and 3.5 tonnes in SEE and EECCA respectively. These minerals are predominantly construction minerals, reflecting higher construction activities both for building new and maintaining existing infrastructure in all EU countries.

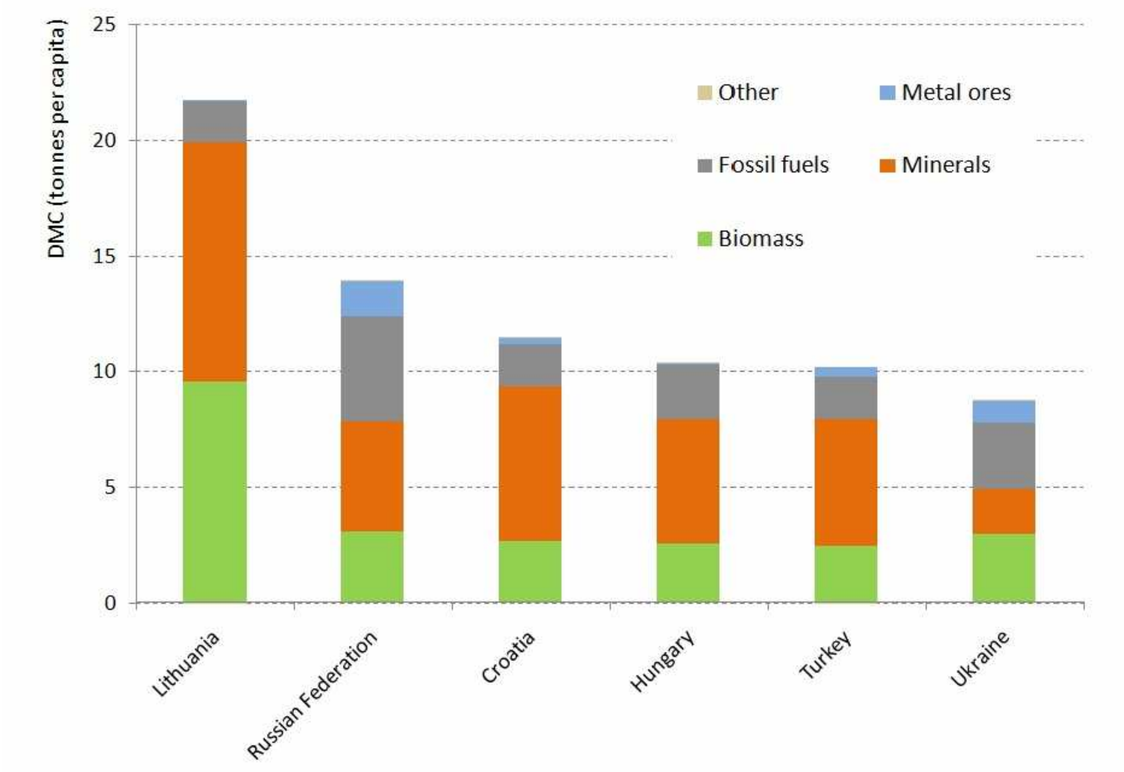
Figure 12 Domestic Material Consumption per capita of the Group of 30, EECCA, SEE, NMS, and the EU-15 according to material categories in 2008



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

Generally, richer countries consume larger amounts of metal ores than poorer ones, reflecting comparatively greater demand for infrastructure, more industrial activities (production and maintaining stock of investment goods, such as machines) and higher consumption (machines and electronics in private households). However, average per capita metal consumption in EECCA countries is higher than in South East Europe and the new EU countries (1.7 tonnes in EECCA countries compared to e.g. 1.4 tonnes in the NMS), which is mainly because of the high values of consumption in Russia and Kazakhstan. But these particularly high values are themselves more a reflection of a deficiency in the methodology than of genuinely higher consumption by the populations of countries with high net exports of metals; metal extraction is counted as gross metal ore with concentrations usually below 10 per cent. The remaining 90 per cent of extracted materials, which remain as excavated materials and (often toxic) mining waste in the extracting country, are counted as domestic metal consumption.

Figure 13 Domestic Material Consumption per capita of selected countries according to material categories in 2008



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

This picture would change if indirect or upstream-flows were considered, which would allocate the mining waste to the consumption of the importing country and thus subtracted from domestic material consumption in the metal exporting country. Such methods are still rare and are not yet available for the Russian Federation and Kazakhstan; the case of copper-exporting Chile has shown that including all indirect or upstream flows results in a reduction of material consumption of up to 50 per cent (Dittrich *et al.*, 2011; Estrada Calvo, 2007; Giljum, 2004; Munoz *et al.*, 2009). In the Russian Federation and Kazakhstan, metal consumption holds shares of 11 per cent and 39 per cent respectively, of DMC. It can be assumed that a considerable part of this is excavation waste rather than actual metal consumption in both countries.

In sum, the collapse of Communism and the changes in the economic systems resulted in a remarkable fall of absolute and per capita material consumption during the 1990s. While the economies of the new EU members recovered faster and earlier, the process took longer and the declines were even deeper in most of the other South East European and EECCA countries.

Material productivity

Combining data on GDP and Domestic Material Consumption (DMC) produces a material productivity indicator (GDP/DMC), which illustrates how much economic value is being generated per unit of material consumption. Countries with large, resource-intensive primary sectors typically have low material productivity (e.g. Uzbekistan, Kyrgyzstan), whereas those with large service sectors tend to have high material productivity (e.g. Malta, Hungary).

Box 2 De-coupling and its economic driver

According to the latest report by the UNEP International Resource Panel (UNEP, 2011), de-coupling can be defined in two ways. First, decoupling means using fewer resources per unit of economic output, i.e. less material, energy, water and land to produce one dollar or euro of GDP. Second, de-coupling refers to reducing the environmental impact of any resources that are used or economic activities that are undertaken. Examples for those environmental impacts are emissions (e.g. of greenhouse gases), waste production, or land and ecosystem degradation.

It is important to distinguish between so-called “relative decoupling” and “absolute de-coupling”. Relative de-coupling of resources or impacts means that the environmental indicator (e.g. material consumption) is growing more slowly than the economic indicator (e.g. GDP). This implies that in a situation of relative de-coupling, environmental pressures can still increase. Relative de-coupling has been a quite common phenomenon with regard to several environmental indicators (including air emissions, energy use and material consumption), and will also be described in this study. Absolute de-coupling, by contrast, means that the environmental pressure decreases irrespective of the development of GDP. Absolute de-coupling can thus only be achieved when resource productivity increases faster than GDP. Trends of absolute de-coupling are rare in reality. On the global level, absolute de-coupling must be the objective, given that humanity is already using more resources than the global ecosystems can provide in a sustainable manner (WWF *et al.*, 2010).

De-coupling trends are determined by several economic driving factors:

- GDP growth rates: As GDP per capita correlates with resource productivity, resource productivity trends are closely linked to the affluence or income of a country (Steinberger and Krausmann, 2011).

- Sectoral economic structures: primary resource extraction activities (such as agriculture and mining) as well as basic industries (such as metal or chemical industries) are typically more resource-intensive than higher value-added manufacturing industries (e.g. ICT) or activities in the service sectors (e.g. communications, banking, insurance). At the same time, service sectors typically produce higher value-added than the basic industrial sectors. The economic structures thus determine to a large extent the resource productivity and de-coupling potentials of a country.

- Energy systems: energy production is one of the most resource-intensive economic activities and the structure of the energy sector often influences national environmental performance. Countries heavily dependent on coal for electricity production typically have lower resource productivities and slower de-coupling trends compared to countries producing larger shares with natural gas, water power or renewable energy forms.

- Integration into the global economy: outsourcing material and energy-intensive production to other regions and substituting domestic production with imports can also lead to an apparent improvement in resource productivities and accelerating de-coupling of a country. Those developments have been particularly discussed in the context of the Kyoto protocol on GHG emissions (see, for example, Peters and Hertwich, 2008).

General recommendations for accelerating de-coupling trends (see, for example, UNEP, 2011):

- Support the development and transfer of resource-efficient technologies, in particular in the areas of mobility, housing and food.

- Foster eco-innovation not only at the product and process levels, but also at the macro level (e.g. switching urban transport systems from private cars to public transport).

- Integrate resource efficiency aspects into policy impact assessments.

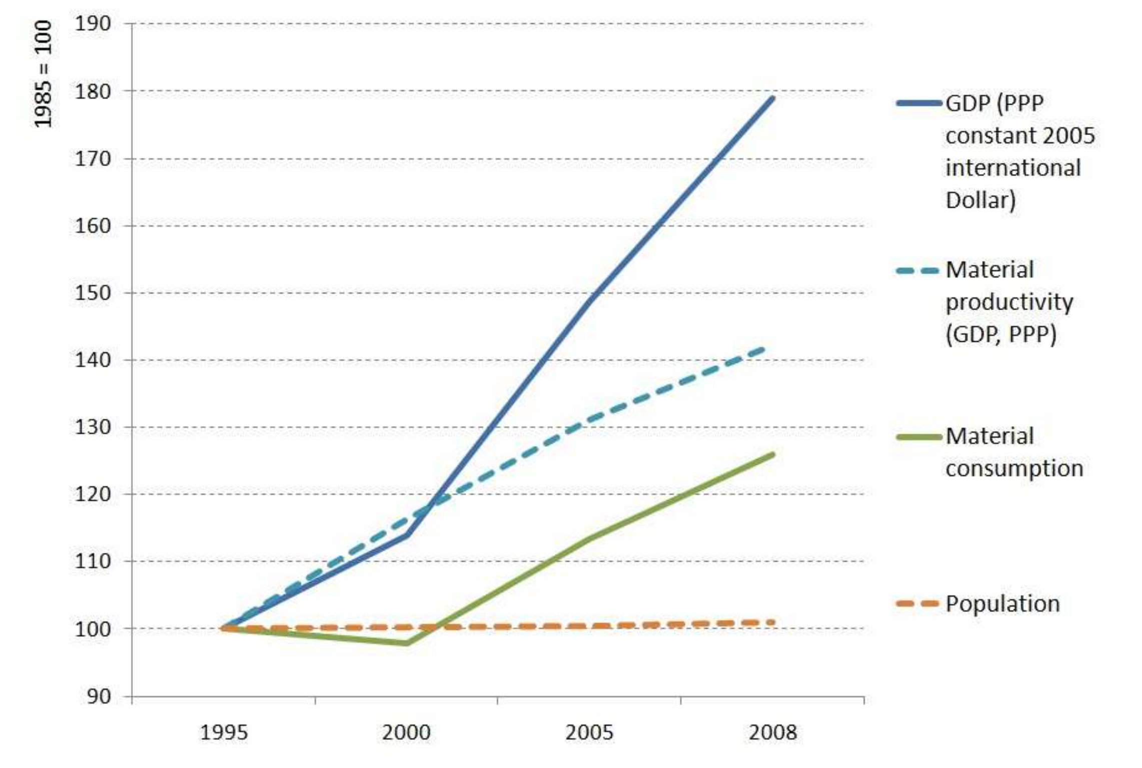
- Elaborate so-called “circular economy” strategies, which aim at reducing primary resource requirements and minimising waste through a circular use of materials, such as minerals and metal ores

- Support changes in lifestyles away from resource-intensive consumption

Figure 14 illustrates the overall trends in GDP, material productivity, material consumption and population across the Group of 30. Accelerated economic development after 2000 in the region is clearly reflected in the graph. Between 1995 and 2000, GDP (based on purchasing power parity, PPP) rose significantly more slowly than after 2000 (an average of 2.6 per cent per annum between 1995 and 2000 compared to 4.8 per cent per annum between 2000 and 2008).

During the same period, material consumption decreased, followed by a strong increase between 2000 and 2008 (126 per cent). As growth in GDP was continuously higher than growth in material consumption, material productivity also rose continuously, by 42 per cent between 1995 and 2008. The population of the Group of 30 stayed almost constant.

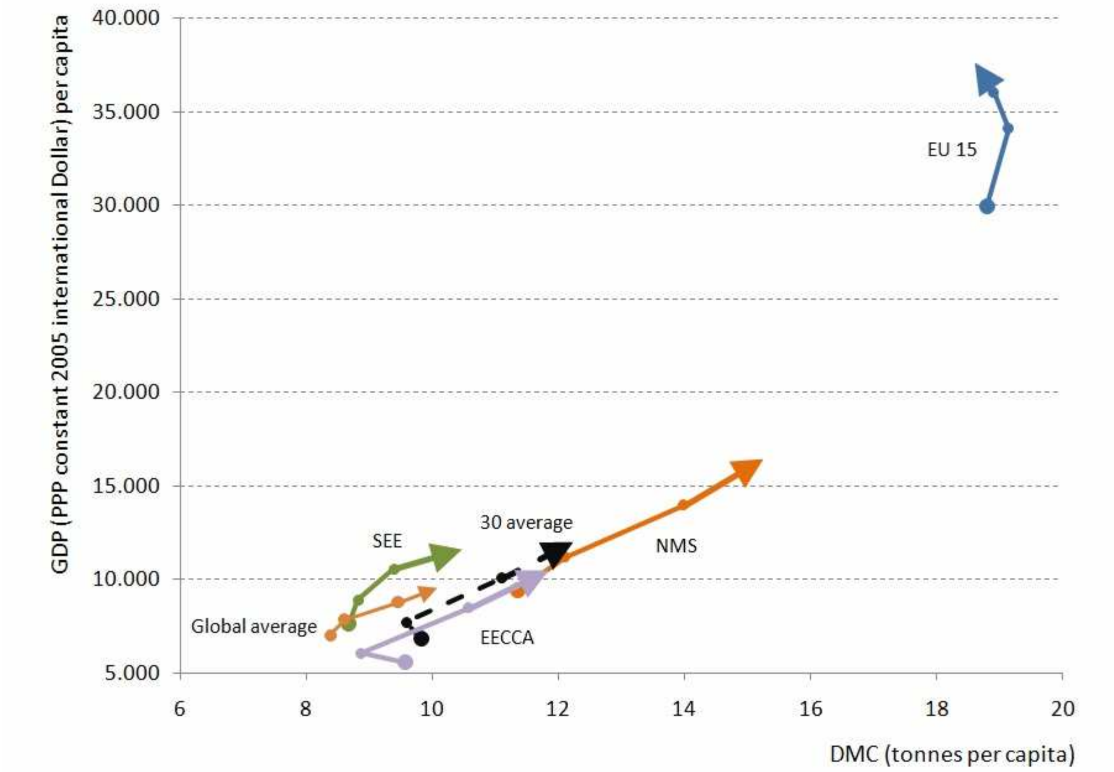
Figure 14 GDP, population, material consumption and material productivity in the Group of 30, (1995-2008)



Source: Authors' calculations based on Dittrich (2011); SERI (2011); UN (2011); World Bank (2011).

Figure 15 shows this link between GDP and DMC for the averages of the Group of 30, the three sub-regions and the EU-15. The relationship between per capita GDP and DMC is similar for the Group of 30 and the three sub-regions. Growth and a positive relationship between GDP and DMC can be seen across the NMS, the EECCA and the SEE, although they are at very different stages in absolute numbers. For the EECCA countries an absolute de-coupling effect (see Box 2 for definition of decoupling) between per capita GDP and per capita material consumption can be observed (as the former has grown whereas the latter has declined) between 1995 and 2000. For the EU-15 a small but absolute de-coupling effect is observable, but at a very high level of material consumption. It is important to note, however, that a major part of this absolute de-coupling effect is due to the closing down of domestic industries and the substitution of domestic production of highly material- and energy intensive products by imports from abroad (EEA, 2010). As the three groups under consideration still have large domestic heavy industry sectors, the direction of development is characterized by a closer link between GDP and DMC.

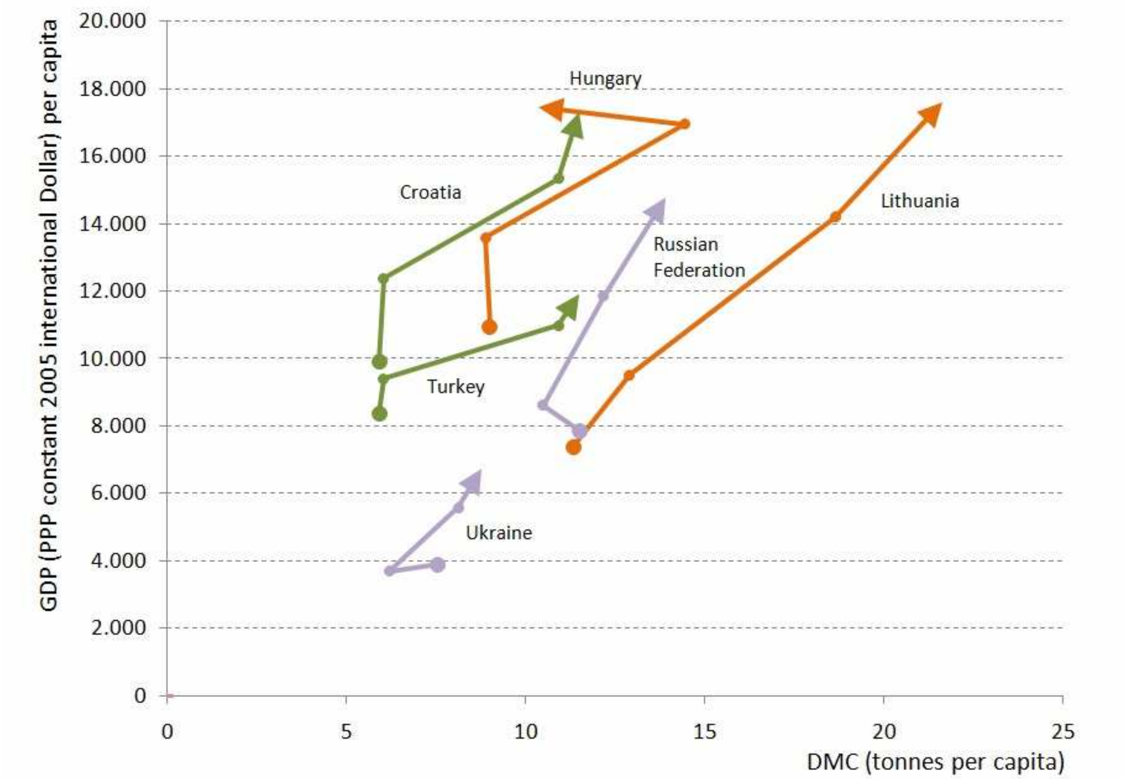
Figure 15 Per capita GDP and DMC in the Group of 30, EECCA, SEE, NMS and EU-15, (1995-2008)



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

Figure 16 depicts the relationship between per capita GDP and DMC for six countries, two from each group. The Russian Federation and Ukraine show the same relationship between per capita GDP and DMC, with very low values for both indicators for the Ukraine and GDP per capita of about twice as much for the Russian Federation. Following a very strong decline in output during the early 1990s (before 1995), the Russian Federation began to experience an upswing in per capita GDP in the second half of the 1990s, which led to an overall small increase between 1995 and 2000. Lithuania and Hungary show diverging relations between per capita GDP and DMC. Interestingly, there is an absolute de-coupling between GDP and DMC in Hungary between 2005 and 2008 (DMC per capita declined and GDP increased), which can mainly be explained by a decline in the extraction of construction minerals. Lithuania's per capita GDP and DMC both showed strong levels of growth. Hungary had about the same GDP per capita as Lithuania but significantly smaller DMC values, especially in 2008. Turkey did not even achieve a relative de-coupling between per capita GDP and DMC between 1995 and 2008 (DMC grew at about twice the rate as GDP). Croatia combines high GDP values with low DMC values compared with the five other countries illustrated.

Figure 16 Per capita GDP and DMC in selected countries in EECCA (Lithuania, Ukraine, Russian Federation), SEE (Croatia, Turkey), and the NMS (Hungary, Lithuania), (1995-2008)



Source: Authors' calculations based on Dittrich (2011) and SERI (2011).

Table 6 provides an overview of DMC and GDP growth between 1995 and 2008. Most countries in the Group of 30 experienced a relative de-coupling between per capita GDP and per capita material consumption, as the former has grown faster than the latter. Many countries show this development for the entire period of time, for example Armenia, Estonia, Kazakhstan, Latvia and Turkmenistan. This trend is in line with recent developments in industrialized regions (for an overview see Bringezu and Bleischwitz, 2009). For some countries an absolute de-coupling can be seen, as GDP per capita increased and DMC per capita decreased. Examples of absolute de-coupling are Hungary and Azerbaijan between 2005 and 2008.

Figure 17 shows material productivity per capita in the Group of 30, EECCA, SEE, the NMS and the EU-15. On average, material productivity in the Group of 30 improved by 42 per cent between 1995 and 2008 (from 692 to 984 US$/tonne in constant 2005 PPP terms). Material productivity thus increased faster (albeit from a much lower level) than in the EU-15 (27 per cent over the same period: from 1,593 to 2,027 US$/tonne). The average for EECCA shows a remarkable increase of 53 per cent in this period of time. Material productivity also improved in South East Europe between 1995 and 2005, followed by a slight decline until 2008.

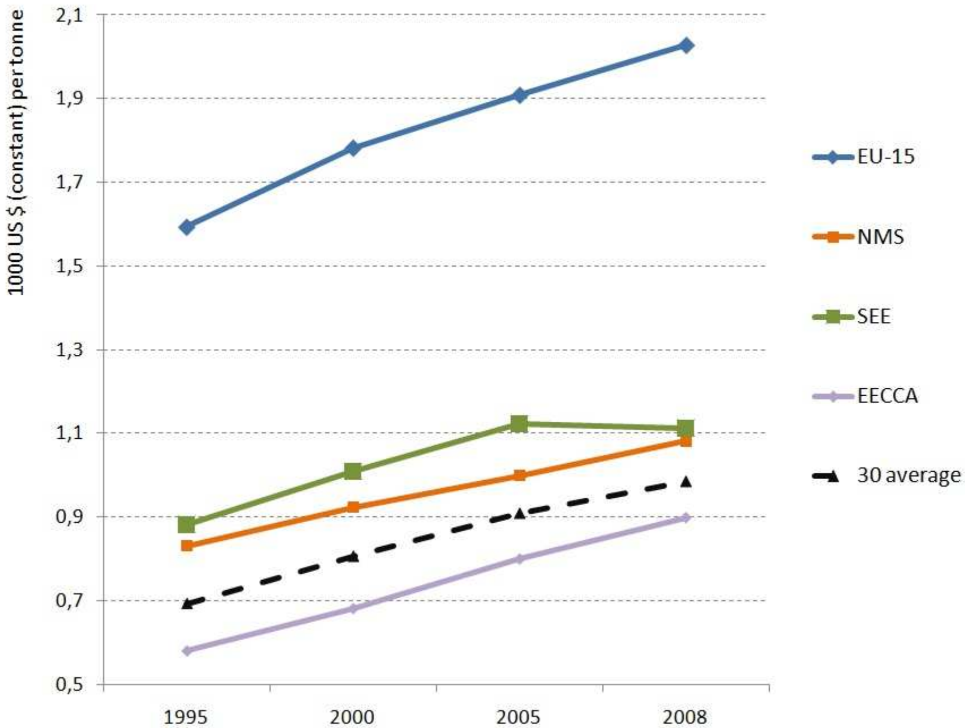
Table 6 Growth rates of per capita DMC and per capita GDP, (PPP constant 2005 international Dollars)

	1995-2000		2000-2005		2005-2008		1995-2008	
	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)	DMC growth (%)	GDP growth (%)
Albania	-29.48	33.26	87.94	28.23	31.30	18.51	74.02	102.50
Armenia	30.83	34.54	17.97	78.62	26.47	37.11	95.20	229.50
Azerbaijan	9.46	34.32	89.93	80.57	-5.35	80.17	96.77	336.97
Belarus	2.61	38.37	4.79	44.82	41.61	36.42	52.26	173.36
Bosnia and Herzegovina	72.14	206.21	5.57	24.42	24.37	19.87	126.01	356.68
Bulgaria	5.69	5.41	7.78	35.96	23.22	22.27	40.36	75.23
Croatia	1.97	24.64	81.19	23.94	5.33	12.84	94.61	74.31
Cyprus	23.51	12.14	33.78	10.27	15.93	9.20	91.56	35.04
Czech Republic	4.23	8.25	6.70	20.59	6.06	14.05	17.95	48.88
Estonia	11.81	40.69	37.91	50.41	3.00	12.68	58.82	138.43
Georgia	20.52	42.23	83.16	44.30	23.38	25.08	172.36	156.71
Hungary	-1.51	24.11	62.60	24.82	-28.23	2.87	14.94	59.38
Kazakhstan	8.84	20.15	23.30	60.92	5.16	20.34	41.12	132.67
Kyrgyzstan	4.76	22.68	11.67	15.05	16.34	18.22	36.11	66.87
Latvia	32.48	39.69	38.56	52.83	5.06	19.99	92.86	156.16
Lithuania	13.79	28.97	44.64	49.16	16.10	23.96	91.09	138.47
Macedonia, FYR	-12.94	13.12	3.34	5.75	38.62	14.78	24.71	37.30
Malta	28.47	22.42	7.42	2.10	0.67	7.97	38.92	34.96
Moldova	-19.65	-10.31	63.67	42.52	7.15	17.20	40.92	49.81
Poland	21.72	30.60	4.59	17.28	10.51	19.37	40.69	82.84
Romania	-24.64	-5.21	24.14	36.90	26.03	25.86	17.90	63.33
Russian Federation	-8.80	9.70	16.11	37.62	14.40	24.59	21.14	88.10
Serbia and Montenegro	-10.96	24.71	4.91	29.12	7.60	20.83	0.50	94.56
Slovakia	5.33	20.31	23.83	27.09	-1.79	26.92	28.10	94.07
Slovenia	8.66	23.83	0.01	19.14	23.99	15.74	34.74	70.77
Tajikistan	-17.79	-6.27	28.46	52.92	-5.31	17.66	0.00	68.65
Turkey	3.55	12.30	2.44	16.67	10.38	8.44	17.08	42.08
Turkmenistan	8.05	13.44	21.87	101.02	8.76	32.15	43.21	201.35
Ukraine	-18.15	-5.19	31.36	51.05	7.79	20.37	15.89	72.39
Uzbekistan	0.31	11.67	12.45	22.58	4.45	22.69	17.83	67.95
Global Average	2.33	11.79	10.23	11.85	7.22	9.42	20.93	36.81

Sources: Authors' calculations based on SERI (2011), UN (2011) and World Bank (2011).

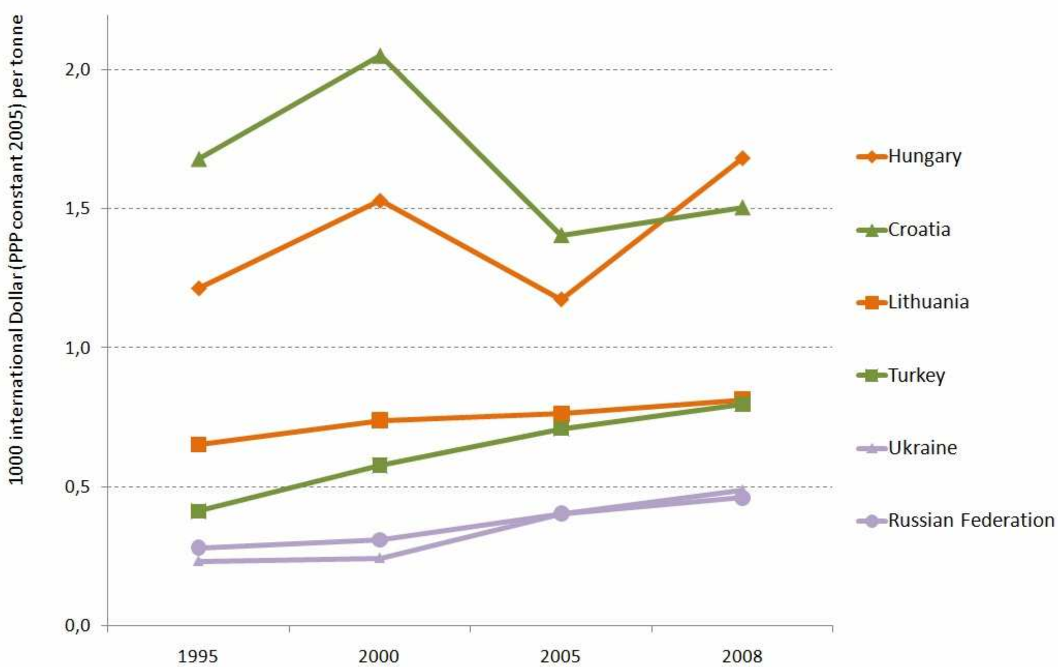
Although the three group averages show a similar picture of material productivity growth rates – despite being at slightly different levels in value terms – important variations appear from a country perspective (Figure 18). Countries with low levels of material productivity have shown remarkable increases, such as the Russian Federation, Ukraine and Turkey. Ukraine more than doubled its productivity between 1995 (230 US$/tonne) and 2008 (490 US$/tonne). The material productivity of the Russian Federation increased by 64 per cent in the same period (from US$280 to 460 US$/tonne). Turkey almost doubled its material productivity, reaching 800 US$/tonne in 2008. Croatia and Hungary started at higher levels of material productivity in 1995 and showed a strong increase until 2000. Between 2000 and 2005 Croatia's material productivity declined by 32 per cent and Hungary's by 25 per cent. In the following three years Hungary's productivity rose by 43 per cent up to a value of US$1,680 /tonne whereas Croatia could only stabilize its value at US$1,500 /tonne.

Figure 17 Material productivity per capita in the Group of 30, EECCA, SEE, NMS and EU-15, (1995-2008)



Sources: Authors' calculations based on SERI (2011); UN (2011); World Bank (2011).

Figure 18 Material productivity in selected countries, (1995-2008)



Sources: Authors' calculations based on SERI (2011); UN (2011); World Bank (2011).

Drawing comparative conclusions based on the material productivity indicator (GDP/DMC) across a large set of countries, as selected for this study, is generally difficult, as values are strongly dependent on the economic structure of a country, its level of affluence and the amount of material-intensive production it has outsourced through international trade. Material efficiency can improve through strong GDP growth in non-material-intensive sectors (e.g. service sectors), or when resource consumption falls (e.g. by shifting material-intensive production abroad). If indirect material flows were taken into account, economies with a strong resource base and large primary sectors would generally have higher resource productivities, whereas industrializing and transition economies with bigger manufacturing and service sectors would have lower productivities. Because of the current lack of robust data on indirect material flows, however, a comprehensive evaluation of a country's resource productivity, which avoids distortions resulting from international trade and outsourcing of industrial production, is currently not possible for most countries.

Main findings and outlook

Before addressing the guiding questions posed in the introduction, a few general observations can be drawn from this study about resource use and resource efficiency in Central and Eastern Europe and the Newly Independent States.

The development of the 30 countries investigated in this study has been very diverse in the investigated time period. Many of them have gone through processes of economic transition and market liberalization, with varying effects on their use of natural resources. The collapse of Communism and the transition towards market economies was initially (between 1989 and 1995) accompanied by high rates of inflation, a marked decline in output (on average by 40 per cent) (IMF, 2000), a stagnation in material extraction and a decline in resource consumption until the year 2000. During the first half of the 1990s, this development was exacerbated by conflicts in SEE and the Caucasus and extended in some parts of EECCA by the Russian currency crisis in 1997/98. The pattern and extent of the collapse differed across countries, largely depending on their initial conditions at the start of transition in 1989, such as the degree of industrialization and the share of agriculture in the economy, skill levels, the extent of conflict, and the number of years under Communism. These initial years of economic decline were swiftly followed by a period of strong economic growth, which was also reflected in a rise of resource use and resource efficiency.

Returning to the questions posed in the introduction, the main findings are summarized below.

- **How did material extraction and consumption develop between 1995 and 2008?**

Between 1995 and 2008, material extraction grew significantly in all three groups under investigation, with a major increase in the extraction of construction minerals, especially due to a construction boom in the building sector. Economic restructuring and the ensuing economic decline that affected almost all countries resulted in a remarkable decrease of absolute and per capita material consumption during the early and late 1990s. Absolute material consumption of the 30 countries together decreased slightly between 1995 and 2000 (from 4.6 to 4.5 billion tonnes), but thereafter increased significantly to 5.8 billion tonnes in 2008. While the economies of the new EU-members recovered faster and earlier, the process took longer and the falls were even deeper in most of the South East European and EECCA countries. The average per capita consumption of the 30 countries increased by 25 per cent between 1995 and 2008, from 9.8 to 12.2 tonnes. This is above the global average of 10.4 tonnes but still below EU-15 average of 18.6 tonnes per capita in 2008. Given that discussed targets for a sustainable level of average global resource consumption are far below the EU-15 level (for example, Ekins *et al*., 2009 and BIO IS *et al*., 2011, suggest around 6 tonnes per capita for the year 2050), the objective for the region of Central and Eastern Europe and the Newly Independent States is to avoid a development path which further increases material consumption. Domestic Material Consumption (DMC) of the 30 states investigated reflects a strong focus on extraction, which increased much more strongly than imports and exports. This suggests that these countries have generally become more self-sufficient in resource supply, making them less vulnerable against price changes and supply restrictions on the world markets.

- **How much and what types of materials do different economies extract and consume, in absolute and per capita numbers?**

After fossil fuels, minerals constitute the second largest category of extraction in the Group of 30. Mineral extraction has also experienced a very remarkable growth, especially for construction. In per capita terms, the new EU member states are clearly in the process of catching up with EU-15 countries, while the other investigated groups show lower levels of material consumption. The EECCA region has significant exports of materials and significant up-stream material flows (in particular, metal ores). If those up-stream material flows related to exports were considered and not allocated to the extracting country, but to the country consuming the metal ore, per capita material consumption in those countries would be lower.

- **How did physical trade volume in Central and Eastern Europe (CEE) and the Newly Independent States (NIS) develop between 1995 and 2008?**

The Group of 30 doubled its material trade volume between 1995 and 2008. Export growth was stronger than import growth. Especially resource-rich EECCA countries strongly increased their exports of raw materials. The export structures of the three groups differ significantly. Fossil fuels were the dominant type of exports in the Group of 30. Biomass exports of the Group of 30 increased most between 1995 and 2008 (by a factor of 2.6).

- **To what extent do CEE and NIS depend on imports of different types of materials to maintain national production and consumption, and what types of materials do CEE and NIS supply to the world markets?**

In physical terms, only the EECCA countries are net-exporters of materials, (especially of fossil fuels). The New EU Member States and South East European countries are net importers. The three country groups (EECCA, NMS, and SEE) are significantly less dependent on imports than are the EU-15. The EECCA and in particular Russia are nearly self-sufficient.

The situation in terms of resource dependencies in these three groups is therefore different from the EU-15, which is heavily reliant on imported fossil fuels and metal ores. While for the EU-15, ensuring stable access to resources outside the EU territory is a major policy issue, the main issue in the investigated groups of countries is how the existing industries can be maintained and transformed into higher value-added and more resource-efficient industries.

- **How did material productivity develop between 1995 and 2008?**

Material consumption decoupled from economic growth for the whole period under consideration in the 30 countries. Thus, material productivity rose continuously, by 42 per cent altogether between 1995 and 2008. This general improvement in resource efficiency across the region partly reflects the economic restructuring that has taken place since the early 1990s and is partly due to increased production efficiency in some sectors. The share of services now exceeds 50 per cent in SEE and in the European part of the EECCA countries, whereas the agricultural sector has stagnated or declined (EEA and UNEP, 2007). Further supporting structural change towards resource-light service activities is thus a strategy to ensure further decoupling of economic growth in the region from the use of natural resources.

In general, the New EU Member States are the group that recovered fastest from the collapse of Communism. Due to their geographical position and political, as well as economic orientation towards the West, they attracted more FDI and established stronger trade links. After relatively short-lived declines in the 1990s they managed to recover comparatively quickly. In terms of resource use it is clear that they are generally more industry- and service-oriented than the other groups in this study.

Compared to the other country groups, Eastern Europe, Caucasus and Central Asia have taken longest of all to recover since the early 1990s. Most of these countries are still grappling, with various degrees of intensity, with the transition from centrally planned to market economies. This is reflected in their patterns of material use and material productivity, which are very different from those in the NMS. Countries in this group are mostly resource-based economies, many of which have largely de-industrialized.

The countries of South East Europe (with the exception of Turkey) took the longest of all to recover, largely due to conflicts and instabilities in the region and a lack of FDI. Their development in terms of material consumption still lags behind the other two regions, and it remains to be seen how they will progress in the future.

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Annex 1 DMC, DMC per Capita and Material productivity (GDP/DMC) (tonnes)

	1995			2000			2005			2008		
	DMC	DMC per Capita	Material productivity (GDP/DMC)	DMC	DMC per Capita	Material productivity (GDP/DMC)	DMC	DMC per Capita	Material productivity (GDP/DMC)	DMC	DMC per Capita	Material productivity (GDP/DMC)
Bulgaria	103,632,512	12.34	0.55	105,096,613	13.04	0.55	108,771,331	14.05	0.70	132,009,736	17.32	0.69
Cyprus	10,168,860	13.90	1.29	13,506,001	17.17	1.17	19,203,468	22.97	0.96	22,966,969	26.63	0.91
Czech Republic	162,373,176	15.72	0.99	168,303,476	16.38	1.03	178,917,665	17.48	1.16	193,246,294	18.54	1.25
Estonia	22,626,577	15.75	0.50	24,110,620	17.61	0.62	32,681,687	24.28	0.68	33,526,637	25.01	0.75
Hungary	93,051,279	9.01	1.21	90,603,269	8.87	1.53	145,535,126	14.43	1.18	103,938,333	10.35	1.68
Latvia	14,464,771	5.75	1.06	18,073,783	7.62	1.12	24,287,671	10.56	1.24	25,135,298	11.09	1.41
Lithuania	41,139,004	11.33	0.65	45,103,991	12.89	0.74	63,650,424	18.64	0.76	72,683,095	21.64	0.81
Malta	3,599,071	9.52	1.76	4,770,458	12.23	1.68	5,301,813	13.14	1.60	5,448,901	13.23	1.71
Poland	451,124,183	11.69	0.77	547,215,085	14.23	0.83	568,020,896	14.88	0.93	627,094,809	16.45	1.00
Romania	217,276,916	9.58	0.75	162,019,570	7.22	0.95	193,885,441	8.96	1.04	242,992,111	11.29	1.04
Slovakia	48,906,263	9.12	1.16	51,752,343	9.60	1.32	64,063,892	11.89	1.36	63,149,363	11.68	1.76
Slovenia	39,935,842	20.07	0.79	43,373,230	21.81	0.90	43,627,865	21.81	1.08	54,657,981	27.04	1.01
Albania	13,387,518	4.27	0.84	9,241,541	3.01	1.60	17,612,025	5.66	1.09	23,367,215	7.43	0.98
Bosnia and Herzegovina	14,713,710	4.42	0.37	28,076,153	7.60	0.66	30,342,871	8.02	0.78	37,655,447	9.98	0.75
Croatia	27,594,535	5.91	1.68	26,674,146	6.03	2.05	48,504,583	10.92	1.40	50,997,876	11.50	1.50
Macedonia. FYR	24,152,452	12.30	0.52	21,515,233	10.71	0.68	22,554,386	11.07	0.69	31,485,812	15.34	0.57
Serbia and Montenegro	107,293,885	12.83	0.41	93,409,342	11.42	0.58	96,658,169	11.98	0.71	102,802,984	12.89	0.80
Turkey	530,042,727	8.66	0.97	595,988,769	8.97	1.05	653,774,008	9.19	1.19	749,443,873	10.14	1.17
Armenia	13,764,077	4.27	0.40	17,184,351	5.59	0.41	20,201,209	6.59	0.62	25,649,382	8.34	0.67
Azerbaijan	25,882,494	3.37	0.55	29,671,469	3.69	0.68	58,757,751	7.00	0.64	24,301,423	2.80	2.89
Belarus	75,943,708	7.45	0.57	76,480,013	7.64	0.77	78,304,338	8.01	1.07	109,811,431	11.34	1.03
Georgia	5,734,208	1.21	1.45	6,450,125	1.46	1.71	11,661,415	2.67	1.35	14,461,776	3.30	1.37
Kazakhstan	254,698,474	16.10	0.28	260,873,882	17.53	0.31	327,360,897	21.61	0.40	356,222,472	22.73	0.46
Kyrgyzstan	21,933,825	4.78	0.26	24,607,276	5.01	0.30	28,754,441	5.59	0.31	34,328,183	6.50	0.31
Moldova	13,530,258	3.68	0.50	10,766,599	2.96	0.56	17,407,137	4.84	0.49	18,522,077	5.19	0.53
Russian Federation	1,702,466,462	11.49	0.68	1,533,411,522	10.48	0.82	1,742,023,076	12.17	0.97	1,976,249,645	13.92	1.06
Tajikistan	6,221,680	1.08	0.96	5,466,690	0.89	1.09	7,435,042	1.14	1.30	7,364,127	1.08	1.62
Turkmenistan	37,034,048	8.84	0.23	43,017,348	9.56	0.24	56,403,316	11.65	0.40	63,881,824	12.67	0.49
Ukraine	389,353,685	7.56	0.52	304,239,647	6.19	0.60	382,817,776	8.13	0.69	405,204,965	8.76	0.77
Uzbekistan	154,941,540	6.80	0.21	168,149,548	6.82	0.24	200,720,488	7.67	0.26	218,845,972	8.01	0.31
EU-15	5,875,546,237	18.79	1.59	6,059,270,360	19.14	1.78	6,150,658,488	18.91	1.91	6,144,122,399	18.59	2.03

Where does the Europe and NIS region stand in promoting energy efficiency?[42]

Olga Memedovic, UNIDO

Introduction

Mainstreaming environmental, energy and resource efficiency issues into overall institutional reforms can help countries in the Europe and NIS region pursue a low carbon and resource-efficient transition, in line with the broader goal of pursuing sustainable development. Successful countries have improved the energy and resource efficiency of their economies by creating an enabling governance framework for the uptake of new environmentally friendly technologies and practices across different sectors. This governance framework includes: legislation such as laws related to energy efficiency, renewable energy sources and carbon capture and storage (CCS); performance targets, auditing, codes and standards; market-based systems of incentives through taxation, carbon pricing, trading schemes and feed-in-tariffs; public provision of finance, knowledge and information-sharing programmes; support for R&D and knowledge networks. Securing effective policy implementation also requires the establishment of coordination and cooperation mechanisms.

While some progress has been made in the region towards creating such an enabling governance framework, and the functioning of market forces has improved significantly over the last two decades, the energy efficiency gap between developed and transition economies in the region persists. Why does this gap remain? Numerous case studies carried out by UNIDO and other international organizations point to the existence of various market and institutional barriers and failures that are inhibiting progress towards green growth. These have also called for policy action in response.

This paper draws on existing literature and official policy documents to review current national and international green governance frameworks in the region, focusing on climate and energy/resource efficiency concerns as important pillars of sustainable development. As Table 1 shows, a vast toolbox of policy instruments has been used in the region. Many countries have adopted national energy strategies, programmes and action plans with the purpose of integrating energy and environmental goals with developmental goals, but an effective governance framework to deliver these goals is still lacking. Further, the capacity to transform vision into policy action and to manage implementation of policies and programmes is limited and a system of monitoring, revenue collection and enforcement remains a key challenge in many countries.

42 This working paper was prepared by Olga Memedović, Chief, Europe and NIS Programme, UNIDO Programme Development and Technical Cooperation Division, for the UNIDO Research Project. Valuable contributions were provided by Solomiya Omelyan and Dalibor Kysela, UNIDO consultant Shabnam Marboot Sadegh and interns Emina Alic, Andrew Bell, Thomas Jackson, Tatiana Kaliniuk and Divna Popov.

Table 1 Summary of energy policies applied in selected countries of the region

		Type of policy instruments for energy efficiency technology development and diffusion									
		Regulatory		Market based: Financial incentives			Other market based instruments		Knowledge and Information based		
		Obligations	Standards	Subsidies	Tax incentives	Loan facilities	Pricing	Cap & trade	R&D	Training	Capacity building
Countries	EU 25	**x**						**x**	**x**		**x**
	France	**x**		**x**	**x**	**x**		**x**		**x**	**x**
	Germany	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**
	Netherlands		**x**	**x**	**x**	**x**		**x**	**x**	**x**	**x**
	UK	**x**		**x**	**x**	**x**		**x**	**x**	**x**	**x**
	Russian Fed.	**x**	**x**			**x**			**x**		**x**
	Ukraine	**x**				**x**					
	Armenia	**x**	**x**	**x**	**x**	**x**			**x**	**x**	**x**
	Bulgaria	**x**		**x**		**x**				**x**	**x**
	Croatia	**x**		**x**				**x**		**x**	**x**
	Czech Rep.	**x**		**x**				**x**		**x**	**x**
	Estonia	**x**		**x**	**x**			**x**		**x**	**x**
	Hungary	**x**		**x**		**x**		**x**		**x**	**x**
	Latvia	**x**		**x**	**x**			**x**		**x**	**x**
	Poland	**x**		**x**		**x**		**x**		**x**	**x**
	Romania	**x**		**x**		**x**				**x**	**x**
	Slovakia	**x**		**x**				**x**		**x**	**x**
	Slovenia	**x**		**x**	**x**	**x**		**x**		**x**	**x**

Sources: IEA Policy Database, available at http://www.iea.org/textbase/pm/index_effi.asp.

Although established in several Europe and NIS countries, government bodies charged with the implementation of energy-saving programmes still lack the necessary capacity and technical skills to design, implement, and evaluate energy efficiency programmes and measures, to interact with concerned stakeholders at firm and local governmental levels and to ensure coordination with other government bodies, foreign donors, and international financial institutions. In many countries in the region, including those that are resource rich, international technical assistance in the design and implementation of national energy strategies, policies and programmes is still critical. Environmental management issues are slowly being integrated into private sector strategies, but access to finance, and lack of awareness of potential savings to be made from energy efficiency investments are preventing firms from investing in profitable energy efficiency projects.

The paper is organized as follows: Section 2 discusses the regulatory framework; Section 3 market-based policy instruments; Section 4 demand side management programmes; Section 5 financial tools for addressing liquidity and risk; Section 6 information policies; Section 7 innovation policies; Section 8, polices for promoting renewable energy supply; Section 9 discusses mechanisms of cooperation, coordination and implementation; and Section 10 concludes.

Most countries in the region have laws covering energy issues, but the objectives, scope, and coverage vary by country (Box 1). Many countries have also incorporated quantitative energy efficiency (EE) targets and provisions in their national energy laws and programmes. Energy targets have been proposed for the economy as a whole and for individual sectors (final consumers), and have been expressed mainly as a specified rate of energy saving per year and a reduction of energy intensity to a target value in percentages (Table 2).

The adoption of energy laws symbolizes the political commitment of these countries to implement energy efficiency and to provide a strong incentive for investment in green technologies and practices in the whole economy and at the sectoral level. Setting targets is considered a useful instrument for diversifying the current economic regime. Targets for 2020 have also been established at the European Union level to mobilize action and commitment among member states. The package focuses on three areas to be achieved by 2020: 20 per cent cuts in GHG emissions compared with 1990 levels; 20 per cent expansion in the supply of renewables in the energy mix; and 20 per cent and 36 per cent cuts in energy consumption and energy intensity respectively between 2005 and 2020.[43] The European Commission (EC) also aims to develop an energy infrastructure that allows, for instance, gas to be sold and bought anywhere in the EU (EC, 2010: 11). The expansion of renewable energy grids to bordering Europe and NIS countries, particularly in South East Europe, is also included as an infrastructure priority.

In 2006, Romania approved the Energy Strategy for 2007-2020. The strategy covers present and future energy demands, and at the same recognizes the principle of sustainable development. The strategic objectives involve energy security, sustainable development and competitiveness. Policy measures have been introduced for industry, transport and renewable energy sources in order to reduce energy intensity and achieve the targets set by the National Energy Efficiency Strategy and the Action Plan, corresponding to EC Directive 2006/32/ on efficiency (ICEMENERG, 2009).

43 Legislation related to the EU targets can be found in Jaegar *et al.* (2011: 91).

Box 1 Examples of energy efficiency legislation and target setting from SEE and CIS

As a member of the European Union, Romania has incorporated the EU directive and the 20 per cent energy efficiency target into national legislation. The following governmental institutions have been assigned responsibility for energy policies: the Ministry of Economy (through its General Energy, Oil and Gases Division); the Ministry of Environment; the Ministry of Regional Development and Housing (for energy efficiency in buildings); the Romanian Agency for Energy Conservation (ARCE); and the Romanian Energy Regulatory Authority (ANRE). Additionally, ICEMENERG, a national institute for energy research and modernization (www.icemenerg.ro) is directly involved as a technical consultant to the Ministry of Economy and ARCE.

In Croatia, the key documents for energy efficiency are the Energy Act (OG 68/01, 177/04, 76/07), and the Energy Sector Development Strategy of Croatia (OG 38/02), which set out basic energy policy and provided a basis for the Environmental Protection and Energy Efficiency Fund, an extra-budgetary fund for financing projects and activities in three areas: environmental protection; energy efficiency; and the use of renewable energy sources (EIHP 2009). The 2008 Law on Rational Use of Energy in Final Consumption covers a range of aspects related to energy consumption, including EE programmes and measures (and their enforcement), and energy audits. Other related documents are the National Energy Efficiency Programme (NEEP) and the National Energy Efficiency Action Plan (NEEAP). The NEEAP sets a 2016 energy savings target of 0.47 Mtoe (5.47 TWh), equivalent to 9 per cent of average final energy consumption in buildings, transport and small industries. Croatia is also committed to 20 per cent renewable energy in its total consumption by 2020. Monitoring remains a key challenge, but this can be remedied through special procedures for measurement and verification.

The 2020 Energy Efficiency Strategy (EES) of FYR Macedonia (2004), currently under review, will develop a framework for accelerating the adoption of EE through programmes and initiatives aimed at reducing dependence on energy imports, and cutting energy intensity and non productive use of electricity, as well as maximizing the involvement of the private sector through the provision of information and training programmes. Further, a 9 per cent savings in average energy consumption by 2018 is set in the EES. The Government of Montenegro adopted an EES in 2005, an Energy Development Strategy in 2007, an Energy Efficiency Action Plan for 2010-2012 in 2010, and a Decision on Indicative Energy Savings Target in 2011. A target of 58.9 ktoe or 9 per cent of final primary energy consumption has been set for 2010-2018.

A law on energy conservation in Ukraine has been in place since 1994. The law combines economic stimulation and financial responsibility to promote rational and efficient use of fuel and energy resources. It also seeks to raise public awareness of fuel and energy resources. It is obligatory to conduct energy conservation assessments for: Ukrainian construction investment projects; imports of new energy consuming machinery, technologies and material; equipment, household appliances, heating appliances and illumination tools produced in Ukraine. Recently Ukraine adopted a programme on energy efficiency for 2010-2015 (November 19, 2008 # 1446 “On Approving the Concept of the State Target Economic Programme on Energy Efficiency for 2010-2015”). The programme targets include: raising GDP levels to those found in developed countries; reducing the energy intensity of GDP by 20 per cent (from 2008 levels); increasing the efficiency of fuel-energy resource use; and boosting economic competitiveness. The programme also seeks to reduce the share of natural gas in the energy mix and replace it with alternative sources. The Ukrainian National Energy Strategy for the period up to 2030 calls for significant energy savings (specifically a 50 per cent reduction in energy intensity compared to 2005).

The Russian Federation’s 2009 Law on Energy Saving and Energy Efficiency envisages the gradual phase-out of certain energy-intensive products, energy efficiency labeling for goods, and improved building standards. Consumer tariffs are to be differentiated depending on time and metered use. It also focuses on energy efficiency in buildings and introduces the installation of compulsory meters, the establishment of a federal energy efficiency information network and energy efficiency certificates (“energy passports”). In June 2008, President Medvedev signed a decree for a 40 per cent reduction in energy intensity (relative to 2007) by 2020. The government’s 2009 energy strategy for the period until 2030 prioritizes energy efficiency but only in the second stage of programme implementation.[44] In 2007 the government approved an amendment to the Federal Law on Electricity, which outlines the general framework for the use of renewable energy sources. This includes possible mechanisms for renewable energy support, such as feed-in tariff premiums, subsidies for grid connection, and obligatory off-take by grid companies. The government has set a target of 4.5 per cent renewable energy production of total power production by 2020 (EBRD, 2011).

44 See Energheticheskaya strategiya Rossii na period 2030 - goda; www.minenrgo.ru.

In Kazakhstan**,** the draft of the Law "On Energy Saving and Enhancing Energy Efficiency" (2009) stipulates a reduction of the energy intensity of GDP by 10 per cent in 2015 and by 25 per cent by 2020 (USEA, 2011). The law regulates the use of renewable energy sources, and establishes the legal, economic and organizational grounds to facilitate the generation, transportation and consumption of electricity and (or) heat produced by renewable energy sources.

Table 2 National targets on energy efficiency from official programmes or law

Country	Name of the programme/law	Nature of target	Target value
Bulgaria	National Long Term Energy Efficiency Programme, 2005-2015	Energy intensity reduction	-8%
	National Long Term Energy Efficiency Programme, 2005-2016	Energy intensity reduction	-17%
	National Energy Efficiency Action Plan	Energy savings (rate)	9%
Cyprus	National Energy Efficiency Action Plan	Energy savings (rate)	10%
Croatia	National Energy Efficiency Action Plan	Energy savings (rate)	14%
Czech Rep	State Energy Policy	Energy intensity reduction	-3.22% / year
	National Energy Efficiency Action Plan	Energy savings (rate)	9%
Estonia	National Energy Efficiency Action Plan	Energy savings (rate)	9%
Hungary	Energy Saving and Energy Efficiency Action Programme 1999- 2010	Energy intensity reduction	-3.5% / year
	National Energy Efficiency Action Plan	Energy savings (rate)	9%
Latvia	National Energy Efficiency Action Plan	Energy savings (rate)	9%
Lithuania	National Energy Efficiency Action Plan	Energy savings (rate)	9%
	National Energy Strategy	Energy intensity reduction	EU average intensity
Malta	National Energy Efficiency Action Plan	Energy savings (rate)	9%
Poland	National Energy Efficiency Action Plan	Energy savings (rate)	9%
	Obligation of energy savings for energy companies (white certificates)	Energy savings (value)	
Romania	National Strategy for Energy Efficiency (2004-2015)	Energy intensity reduction	-40%
	National Energy Efficiency Action Plan	Energy savings (rate)	14%
Russia	Energy Strategy of the Russian Federation (2009)	Energy intensity reduction	-40%
	Federal Law on Energy saving and energy efficiency improvement (2009)	Energy savings (rate)	
	Federal programme Energy Efficient Economy (project)	Energy savings (rate)	
Serbia	Energy Strategy Implementation Programme	Energy savings (rate)	-15%
Slovakia	National Energy Efficiency Action Plan	Energy savings (rate)	9%
Slovenia	National Energy Efficiency Action Plan	Energy savings (rate)	9%
	National Energy Efficiency Action Plan	Energy savings (rate)	18%
	Energy Act		
Turkey	Energy Efficiency Law	na	-20% between 2011-2023
	Draft Energy Efficiency Strategy	Energy intensity reduction	

Source: Adapted from WEC (2009).

In certain industrial sectors, targets in some countries are set through the use of voluntary or negotiated agreements between industry and government (Box 2). These types of agreements have been implemented in developed countries since the 1990s (Worrell *et al*., 2009), and have served as tools for raising awareness of industrial energy efficiency and the engagement of all relevant stakeholders, such as firms' top management and engineers, industry associations, financial institutions and governments, in combined efforts to deploy the best available technologies, implement benchmarking and monitoring schemes, and foster innovation through long-term strategic EE plans. If considered ineffective, these agreements are replaced by mandatory alternatives (Price, 2005 cited in Worrell *et al.*, 2009; McKinsey, 2009: 85).

Participation can be reinforced through the strengthening of regulations, taxation, or other financial penalties for non-compliance.

In the Netherlands, voluntary agreements were negotiated between the government and industrial sectors (whose products and processes represent 90 per cent of Dutch industrial energy consumption) in 1989 (UNIDO, 2008). These Long-Term Agreements (LTAs) agreed EE targets, with participating sectors committing to a 20 per cent improvement between 1989 and 2000 (Nuijen, 1998; Kerssemeeckers, 2002). The 22.3 per cent average efficiency improvement over this period exceeded this target (Kerssemeechers, 2002).

Box 2 Voluntary agreements

Industrial energy efficiency targets can be set through mandatory measures or be negotiated voluntarily with governments. Voluntary agreements include targets to meet specific energy-efficiency goals (generally over 5 to 10 years) so that investments can be planned and implemented (Worrell *et al.*, 2009; Price, Wang and Yun, 2010). Voluntary agreements have been implemented in developed countries since the 1990s and typically come with financial rewards or exemption from mandatory measures if implemented successfully. They tend to receive greater support from industry and are more flexible and faster to implement than mandatory measures. However, if compliance is low, these agreements may be replaced by mandatory alternatives (Price *et al.*, 2005; McKinsey, 2009).

Setting targets under negotiated agreements involves assessing the energy-efficiency potential of each industry and identifying economically feasible measures that could be implemented. This assessment can be made by an independent third party and used as a basis for the negotiation. Industries and firms can be motivated to participate by using rewards and sanctions, such as auditing, benchmarking, monitoring, disseminating information and offering financial incentives.

Voluntary agreements can increase awareness of industrial energy efficiency and engage stakeholders but experience suggests that such agreements require substantial commitment from firms. The agreements can be difficult to implement, especially for small and medium-size firms, unless targets are realistic, guidelines are clear and information from experience is sufficient (UNIDO, 2011).

The use of voluntary agreements is not widespread in the Europe and NIS region, and where they do exist, they are rarely effective. The Armenian government, for instance, has announced voluntary energy efficiency standards, but has not successfully incentivized firms to take action. Whilst voluntary agreements have been successful in some countries, it is argued that they are unsuitable to countries without a culture of business responsibility, such as the Russian Federation. Indeed, trust between the government and industry is a pre-requisite, but this is also missing in the Russian Federation (IFC, 2011). A general problem in the region is a lack of follow-up legislation or pressure that would encourage industry to improve.

The programme's success was due to several factors. First, they focused management attention on low cost efficiency investment options (Korevaar *et al*., 1997; Rietbergen *et al*., 1998; UNIDO, 2008). Second, they pre-empted the need for subsequent energy regulation (Price and Worrell, 2002). Third, they created legally-binding contracts (Price and Worrell, 2002). Fourth, they provided supporting policies (such as tax rebates, subsidies and audits) (Nuijen, 1998; Price and Worrell, 2002). Following the success of the initial LTA scheme, a follow-up was initiated for 2001–2012 (LTA2), with an extension to reach 2020 (LTA3). Results so far show a 2 per cent improvement per year (SenterNovem, 2007).

The most prominent examples of negotiated agreements (Box 2) are those reached in the Netherlands, Finland and Denmark. Voluntary agreements (VAs) have also been used in Slovenia and Serbia and there are plans to use them in the Czech Republic. In Serbia VAs are used in industry, construction and transport. In Slovenia, there are VAs involving 250 industrial companies with specific CO_2 emissions reduction targets of at least 2.5 per cent per year for the period 2005-2008. Companies that sign up to VAs are not obliged to pay CO_2 tax. In the Czech Republic, the “Operational Programme Enterprise and Innovation 2008-2015” and “Operational Programme Environment 2008-2015”, currently the most important initiatives supporting energy savings in industry, place high expectations on the use of VAs.

For these policies to be effective, annual monitoring and reporting of progress toward the targets is required, and this should include a real threat of increased government regulation or energy/GHG taxes if targets are not met (Vine and Sathaye, 1997).

Mandatory energy audits, managers, consumption plans, and energy savings plans

Many national programmes for energy efficiency include legislation on energy audits, energy consumption plans, and energy savings plans. These mandatory measures are an important means of improving energy efficiency in some countries in the region (Table 3). In the Czech Republic, for instance, energy audits in the public sector are obligatory if energy consumption is above 1,500 GJ per year. For private facilities, energy audits are mandatory if energy consumption is above 35,000 GJ per year.

In the Russian Federation, the 2009 Federal Law on Energy Conservation and Increase of Energy Efficiency includes energy audits and energy efficiency standards for industry. Large consumers (with an energy expenditure exceeding 10 million roubles/year (US$330,000)) must submit to mandatory energy audits. The law also stipulates incentives and tax benefits for heavy industry to replace inefficient equipment by energy-efficient machinery The Russian Federation also has energy efficiency programmes for energy-intensive industries such as steel, cement, paper and aluminium. For instance, the Federal Targeted Programme for an Energy Efficient Economy (2002-2010) promotes high-efficiency technologies in these sectors. Energy audits are conducted in power plants, heat and electricity transmission companies, and municipal facilities. The 2003 federal code “Thermal Engineering for Buildings” requires buildings to have a completed ‘Energy Passport’, a document intended to verify energy performance in design, construction and operation (ABB, 2011; Matrosov, 2005).

These measures help to better understand the current status of energy use in industrial firms and to identify potential energy savings (Box 3). The knowledge that firms gain through compliance with these measures allows them to improve the efficiency of their industrial processes. But firms often face barriers in the form of limited technical and financial resources. Firms also frequently lack sufficient information and knowledge of best practices. To bridge the information gap, a guidebook on energy auditing and benchmarking data can be published and disseminated.

Table 3 Mandatory regulations: Audits, energy managers, energy consumption plans, energy savings plans in selected countries

Country	Residential buildings	Commercial buildings	Public buildings	Industry	Transport companies
Bulgaria			MEA		
Croatia	MEA	MEA	MEA	MCR	
Czech Rep		MEA, MCR	MEA, MCR	MEA, MCR	MCR
Estonia				MCR	
Hungary				MCR, MEA (planned)	
Lithuania	MEA	MEA	MEA	MCR,MEM	
Malta	MEA	MEA	MEA		
Poland	MEA		MEM, MSP, MEA	MEM,MSP	
Romania	MEA		MEA, MEM, MSP	MEA, MEM, MSP	MEM, MSP
Russian Fed.	MCR		MCR	MCR, MEM, MSP	MCR
Slovakia	MCR			MCR	MCR
Serbia	MCR	MCR	MCR		

Source: WEC (2010).

Note: Mandatory energy audits (MEA), Mandatory energy managers (MEM), Mandatory energy consumption reporting (MCR), Mandatory energy savings plans (MSP).

Box 3 Energy efficiency measures in the CIS

A comparative study conducted by the International Finance Corporation (IFC) of managers in firms in Armenia, Azerbaijan, Belarus, Georgia, the Russian Federation and Ukraine noted the existence of a range of energy efficiency initiatives and a high degree of recognition by managers of the value of such measures. The most common form of investment is energy-efficient lighting and energy metering systems and heat systems. However, most measures adopted in recent years are typically low cost, such as the appointment of a specific employee responsible for energy efficiency. The survey illustrated divergence among the countries in terms of the measures taken at the government and firm level to raise energy efficiency.

The study found that Belarus had made the most progress, despite facing specific challenges - not least outdated equipment and infrastructure. At the same time, the attention given by the government to raising energy efficiency makes it stand out in the region. The government has been active in designing and implementing a policy on energy efficiency, including encouragement of energy audits and reform of procedures to obtain licences and permits. Like most other countries, the government has passed legislation on energy efficiency (the 1998 Law on Energy Saving), but 50 per cent of those surveyed thought that current laws encouraged energy efficiency, compared to only 19 per cent in the Russian Federation. As a result, incentives for energy efficiency are relatively developed. For instance, 42 per cent of managers surveyed responded that they reward energy savings with a bonus – by far the highest in the region. Almost 50 per cent of firms have conducted an energy audit. Further, 81 per cent of surveyed firms indicated that they have developed and realized an energy efficiency plan, almost double the figure for the next highest country, highlighting the more general recognition of energy efficiency in firms' business plans. This is partly attributed to the proactive role played by the government. In other countries, poorly designed or insufficient policies have had negligible impacts. In Azerbaijan, the government has yet to pass secondary legislation to create a legal framework to ensure that energy efficiency measures are implemented. In Ukraine, fines for exceeding energy use caps are criticized for being too low to ensure compliance. Managers in the region tend to regard tax benefits and public funding for energy efficiency projects as the most promising form of government action. The latter in particular is relevant for countries such as Belarus, where there is a high level of state ownership of industry.

Source: IFC (2010).

Energy labels

Other regulatory tools used in the region are mandatory labels, performance standards and codes of conduct (Table 4). For instance, in the European Union, the Energy Labelling Directive requires all products that have an impact on energy use, whether low-energy or high-energy products, to feature energy labels. In many countries, labeling programmes are usually accompanied by minimum performance standards-MEPS (Table 5) (WEC, 2010).

Energy labels can significantly lower the transaction costs for assessing the energy performance of equipment. If clearly designed and accompanied with information campaigns, labels can promote uptake of green technologies by filling the information and knowledge gap, thereby allowing consumers to make rational decisions and incentivizing manufacturers to design products that achieve higher ratings than the minimum standard.

Minimum Efficiency Performance Standards (MEPS)

Two complementary policies exert pressure on energy efficiency. Labels can help to shift the market towards the production of high energy efficiency equipment while energy efficiency performance standards can reduce or cut the market share of the least efficient equipment (Nadel, 2002). Setting Minimum Efficiency Performance Standards (MEPS) for industry can increase demand for this equipment. Electrical motors alone account for between 60 and 70 per cent of industrial electricity consumption (Fleiter *et al.*, 2010), and the implementation of MEPS, as part of a national policy framework, has been proven to be the most effective tool in improving the EE of motors in industry. Table 5 gives an overview of MEPS applied in selected countries of the region and across different sectors.

Although MEPS are considered highly cost-effective tools, technological advances can reduce their benefits. Rigid mandates can also limit flexibility in production processes, forcing firms to make decisions that they might not otherwise make (New York Times, 2011). MEPS therefore need to undergo periodic (if not continuous) review in order to match the pace of technological progress (IEA, 2007). Benefits from MEPS also need to be weighed against the challenges arising from implementation, such as high engineering costs, and the limited speed of deployment and life-time of this equipment. Standards on specialized process equipment can be even more difficult to impose and are possibly not cost-effective when there is a low volume and case-specific usage of this equipment (McKinsey, 2009: 85).

Regulatory policy might also force the early retirement of capital goods when more energy efficient options are available but this entails facing the costs associated with making upgrades. These costs include the capital cost of the more efficient equipment, but also a portion of the old equipment's full cost – the returns that the old equipment would have earned over its remaining years had it not been retired early. Some of these costs will be offset by the net profits associated with the acquisition of more efficient equipment.

However, a firm is worse off financially if these profits do not completely compensate the value lost due to a capital good's premature retirement. Regulatory policy concerned with the early retirement of capital goods would therefore need to overcome this disincentive to upgrade equipment (Stern, 2006: 232).

Table 4 Energy efficiency labels for electrical appliances, cars, buildings in the EU and selected countries

Country	Refrigerators	Washing machines	Air conditioning	Lamps	Water heaters	Total number of appliances with label:	Cars	Existing buildings	New buildings
EU	LB (1995)	LB (1996)	LB (2002)	LB (1999)		9	LB		
Bulgaria	LB(2003)	LB(2003)	LB(2003)	LB(2003)		9			
Croatia	LB(2007)	LB(2007) Freezers and combination, dishwashers (2007,M)	LB(2007)	LB(2007)			LB	LB(2009)	LB(2009)
Cyprus	LB	LB	LB	LB		9	LB		
Czech Rep.	LB(2004)	LB(2004)	LB(2004)	LB(2004)		9		LB(2009,V)	LB(2009)
Estonia	LB (2001	LB (2001)	LB (2004)	LB (2004)		9	LB		
Hungary	LB	LB	LB	LB	LB (P)	9	LB		LB
Latvia	LB(2002)	LB(2002)	LB	LB(2002)		9	LB	LB(2009)	LB(2009,V)
Lithuania	LB(2003)	LB(2003)	LB	LB(2003)	LB(2003)	9		LB(2006)	LB(2006)
Malta	LB(2004)	LB(2004)	LB(2004)	LB(2004)		9	LB	LB	
Poland	LB(2003)	LB(2003)	LB(2003)	LB(2003)		9	LB	LB	
Romania	LB(2001)	LB(2001)	LB(2003)	LB(2001)		9	LB	LB(2010)	LB(2010)
Russian Fed	LB(2001,V	LB(200V)	LB(2000,V)						
Slovakia	LB(2002)	LB(2002)	LB(2003)	LB(2002)		9	LB		
Slovenia	LB (2001	LB (2001)	LB (2004)	LB (2001)		9	LB	LB(2009,P)	LB(2009,P)
Turkey	LB(2002)	LB(2003)	LB (2007)	LB (2003)	LB (2008)	9	LB	LB (2011-2017) V	

Source: WEC (2010), Annex 2.

Notes: Planned =P; Voluntary=V; LB= labels.

EU: electrical appliances: Nine appliances covered (refrigerator 1995, freezer & combination 1997, washing machine 1996, electric dryer 1995, combined washer-drier 1996, dishwasher 1997, lamps 1998, AC 2002, electric oven 2002); buildings (residential & public). The EPBD Directive has been designed by the European Commission to improve the energy performance of all buildings across the EU. The Directive will require that energy certificates be produced for buildings on construction, sale and lease. Large public sector buildings will be required to display energy certificates to the public. The Directive also targets boilers and air conditioning as major sources of energy consumption. In Croatia and the Czech Republic: electrical ovens, dishwashers, electric tumble dryers (2004); Poland: labels amended in 2005; labels also cover 6 other appliances (freezers, refrigerators-freezers, tumble driers, washing machines-driers, dishwashers, ovens); Slovenia: tumble dryers, electric ovens, dishwashers (2001); Latvia: dishwashers, dryers (2002), ovens (2004).

Table 5 Minimum energy efficiency standards for new buildings, new appliances and cars

Country	Residential buildings	Commercial public buildings	Refrigerators	Washing machines	Air conditioning	Lamps	Water heaters	Cars	Electric motors
EU	MS	MS	MS (1996)				MS (1992)		
Bulgaria	MS (2005)	MS (2005)	MS (2001)				MS		
Cyprus	MS	MS	MS				MS		
Czech Rep.	MSc (2007)	MSc (2007)	MSc (2004)	MS (P;V)	MS (P;V)	MS (P;V)	MS (P;V)	MS	MS (P;V)
Estonia	MS (1999/2007)	MS (1999/2007)	MSc (2004)			MSc (2004)	MS		
Hungary	MS (2007)	MS (2007)	MSc (2002)	MSc (2002)	MSc (2004)	MSc (2002)	MS		
Latvia	MSc (2009)	MSc (2009)	MS (2002)	MSc (2002)		MSc (2002)	MS		
Lithuania	MS (2006)	MS (2006)	MS (2004)				MS		
Malta	MS (2006)	MS (2006)	MS(1997)				MS		
Poland	MS (2008)	MS (2008)	MS (2001/2003)			MS (2005)	MS		
Romania			MS (1997)	MS (2001)	MS (2003)	MS (2001)		N	N
Russia	MS (2003)	MS (2003)	MS (1987, V)	MS (1984, V)	MS (1988, V)	MS (2001, V)	MS (1996, V)		
Serbia	MSc	MSc							
Slovakia	MS (2005)	MS (2005)	MS				MS		
Slovenia	MS (2002/08)	MS (2002/08)	MS (2001)				MS		
Turkey			MS(2003)			MS (2006)	MS (2006)	MS	N

Source: WEC (2010), Annex 2

Note: MS= minimum energy efficiency standards; c= measures backed by legislation.

EU stands for EU countries; directives exist defining mandatory labels for most appliances and mandatory standards for some appliances: refrigerators and freezers (Directive 96/57/EC); a law has to be passed in each country to make it effective. For washing machines, there is a voluntary agreement to improve the efficiency, signed with the association of manufacturers (CECED). New requirements based on the EU EcoDesign directive (adopted in November 2009) will be implemented due to EU specific regulations.

Achievements (WEC, 2010): Czech Republic, Dwellings & buildings: 16% savings compared to the previous period; Estonia, Dwellings & buildings: 26% savings compared to the previous period; Hungary, Dwellings & buildings: 15% savings compared to the previous period; Lithuania, Dwellings & buildings: 25% savings compared to the previous period; Slovenia, Dwellings & buildings: 15% savings compared to the previous period; Croatia, Dwellings & buildings: 20-25% savings compared to the previous period.

Energy Management Standards

Most of the improvements in energy performance are achieved through changes in how energy is managed in an industrial facility rather than through the installation of new equipment. Evidence from national and international programmes shows that while efficient components may bring about gains in the range of 2 to 5 per cent in industry, system optimization measures can attain average EE gains in the range of 20 to 30 per cent with a payback period of less than two years.

Energy management systems (EnMS) take into account the entire system and are effective in achieving industrial system optimization and ensuring the monitoring of process system efficiency. The cost-effectiveness of EnMS will vary with the size of the firm and their energy intensity. On a national level, governments can play a role in encouraging companies to establish an EnMS, by providing information on best practices (such as an industrial system optimization library), training on how to comply with standards, and recognizing industrial firms that meet standards.

Examples in Europe of countries introducing specifications on EnMS standards include Denmark, Sweden, Ireland, Belarus, the Netherlands, Germany and the United Kingdom. (Examples of EnMS standards in the region are given in Table 5). An example of a regional EnMS standard is EN 16001 – European Energy Management Standard introduced on 1 July 2009. At the international level, a newly proposed international management standard is ISO-50001, which aims to make energy management an integral part of industrial operation practices on a par with other management practices related to safety, quality, waste reduction and inventory management. ISO-50001 aims to help organizations make better use of existing energy-consuming assets; prioritize the implementation of new EE technologies; offer guidance on benchmarking, measuring, documenting, and reporting energy intensity improvements; and create transparency in energy resource use (Piñero, 2009). The new standard should also promote best practices in energy management and reinforce these by encouraging EE along the supply chain. ISO-50001 was completed by the end of 2010 and according to some estimates, could influence as much as 60 per cent of world energy demand. However, incorporating ISO-50001 within national and regional energy policy will also require careful planning, government funding and public recognition through certification programmes along with the inclusion of relevant personnel (who will be responsible for implementation) (McKane *et al.*, 2009).

In sum, public standardization policy allows businesses to overcome information and agency constraints (McMahon and Wiel, 2003; Ferrell and Remes, 2008). By facilitating the broader use of energy efficiency equipment and system optimization, standards can result in cutting per-unit cost of more efficient product lines. International cooperation in standardization enables firms to cut the transaction costs associated with introducing equipment, especially relevant for new plants or natural upgrades (Nadel, 2002). Stringent standards, however, can raise manufacturers' anxiety about shrinking profit margins and market consolidation, and the erection of non-trade barriers. Hence, where credit is limited, a range of fiscal policies may be necessary to help companies meet the demand for new technologies that meet standards. Standards and labels need to be updated at regular intervals, so that they do not become a burden by adding to production costs, limiting consumer choice, or preventing innovation and energy efficiency improvements (McMahon and Wiel, 2003).[45] Even though standards are preferable to other instruments when information or other barriers prevent producers and consumers from responding to price signals, as they may create demand for energy efficiency, they do not solve the public good problem associated with investment in the R&D into, and the adoption of, new EE technologies (IPCC, 2007).

Market-based policy instruments

Market-based policy instruments are used in environmental policy to capture the spillover effects of an agent's action—that is, to internalize the externality. Possible instruments to do this are fiscal ones such as corrective taxes for negative externalities and subsidies for positive externalities. A related market-based corrective instrument is a tradable quota or permit, most notably in the form of a carbon emissions trading scheme (cap-and-trade scheme). International schemes of this type were established under the Kyoto Protocol and have since been followed by several regional and national schemes. Market-based policy instruments such as carbon taxes aim to reduce the demand for carbon-intensive energy by increasing its price (by adding the external cost from GHG emissions to the energy price), thereby providing an incentive to reduce its consumption. In principle, a carbon tax creates an incentive to reduce GHG emissions up to the point when the marginal cost of additional abatement is equal to the level of the tax, thereby minimizing the cost of reducing emissions (static efficiency).[46] Compared to standards and product bans, carbon taxes provide more flexibility in choosing the level and method of cutting GHG emissions and in principle, they should also provide greater incentives for technical innovation (dynamic efficiency). In addition, managing taxes requires less administrative work than regulation and hence leads to lower administrative costs, thus saving money for taxpayers and cutting costs for businesses and consumers (Jaffe *et al.*, 2004; Kosonen and Nicodème, 2009).

Taxes on products and services that are directly or indirectly linked to GHG emissions such as, for instance, taxes on energy inefficient appliances or products, contribute revenues that can go directly to the government budget or to special-purpose public energy efficiency funds. These government funds can be used to provide finance for industrial energy efficiency investment at a lower cost relative to those from commercial banks (Gillingham *et al.*, 2006). They can also be used for financing information and auditing programmes, for providing tax reductions to industries that meet negotiated energy efficiency targets, and for funding research on energy efficiency technologies. These funds can be administered through private organizations, government agencies, or international organizations. Successful implementation of

45 If not adjusted to new technological developments, however, regulatory standards can lead to 'lock-in' to inferior technologies. According to Peridas (2007), the requirement for high standards from the beginning need not be inconsistent with the need for the regulatory framework to evolve with scientific understanding, as long as proper attention is paid to the degree of confidence or uncertainty in each case, to the magnitude of the risks involved, and the precautionary principle is used where uncertainty is high. To address this challenge, all relevant stakeholders must be involved in the development of the regulatory framework, and transparency and disclosure of information in regulations is a precondition. The technical competences of the regulatory agencies are also crucial.

46 To assess the amount of energy savings from such an emissions price policy, the price elasticity of energy demand can be examined, which is usually done by using a computable general equilibrium model. These modelling exercises reveal that a significant portion of cost-effective emissions cuts can be reached through energy efficiency and conservation, and alternative sources of energy (Clarke *et al.*, 2006; Weyant *et al.*, 2006).

market-based policy instruments requires a system of monitoring, revenue collection and enforcement.

Getting prices of natural resources right

Adequate carbon pricing is a necessary precondition for creating market incentives to change consumer behaviour and promote investment in energy efficiency.[47] Firms' decisions to invest in energy efficiency will be distorted when market forces fail to provide signals to internalize environmental externalities such as GHG emissions from using carbon-intensive energy (market failure), or when carbon-intensive energy is under-priced because of subsidies (public policy failure) (Box 4).

Subsidization of natural resources can also encourage overuse and misuse of scarce natural resources, and can inhibit the development of more environmentally friendly substitutes (UNEP, 2004: 20). Carbon pricing policy thus needs to be carefully designed to ensure that it does not accelerate the pace with which carbon-intensive energy can be used. More realistic energy prices for electricity and oil also have the potential to mitigate energy rebound effects resulting from greater energy efficiency uptake. Taxing energy use to account for negative environmental externalities would also help improve the terms-of-trade of the energy-importing countries and would cut wealth transfer to oil-exporting countries, but can also be in conflict with other policies targeting vulnerable population groups and SMEs through subsidies for energy consumption.

Removing direct and indirect (e.g. reduced VAT rates) subsidies on carbon-intensive energy (fuel and electricity) becomes another priority when designing adequate carbon pricing. Subsidy removal will create demand for energy efficiency technologies and it will be in line with climate policy. An OECD and World Bank study (OECD and World Bank, 2010) suggests that a gradual multilateral removal (by 2020) of existing energy subsidies in non-OECD countries would lead to a substantial drop in GHG emissions from fossil-fuel combustion by 2050, amounting to more than 20 per cent in non-EU East European countries and in Russia (Figure 1). But, as with taxing energy use, removal of subsidies for final consumption can have negative effects where they are used to promote energy affordability for poor households and SMEs.[48] Although energy prices of the New EU Member States from the region have converged fast with those from other EU member states, leading to less waste of resources, fuel poverty has become a major concern in EU-10 and also in Balkan countries (Table 6).[49]

Removal of these subsidies, and consequent carbon-intensive energy price increases, are likely to have a significant impact on the adoption of energy efficiency because of the long lifetimes and slow turnover of energy-intensive appliances and capital equipment. Energy producing countries with subsidized prices for some fuels would also benefit from removing subsidies: carbon-intensive energy sources could be sold at a much

47 Higher carbon prices can, however, come with opportunity costs for industrial firms in terms of cutting output of desired products, in extra costs for the purchase of superior EE equipment, and in loss of competitiveness.

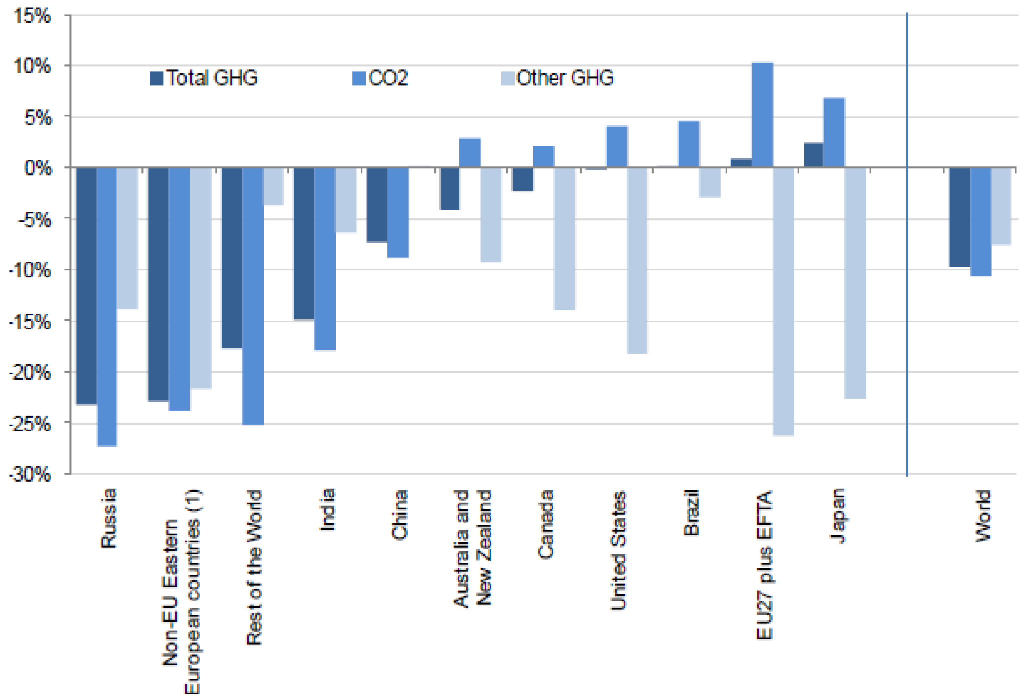
48 The World Bank has called energy subsidies "a first priority of energy policies aimed at alleviating poverty" (World Bank, 2000: 61). Well-targeted subsidy regimes can create a more inclusive network by helping marginalized populations and SMEs overcome initial barriers to energy access and may help reduce poverty and enhance rural development.

49 The fuel poverty concept, as developed by Brenda Boardman in the UK context, is defined as "the inability to obtain adequate energy services for 10 per cent of a household's income" (Buchan, 2010: 17).

higher price on the international market, and could have positive impacts on their public budgets and export earnings, especially in the recent years of soaring fuel prices.

According to the OECD and World Bank Joint Report (OECD and World Bank, 2010), phasing-out fossil fuel subsidies would lead to a real increase in GDP relative to the baseline. Over the long term, some oil-importing OECD countries will experience real income gains of around 1 per cent as their terms-of-trade improve. Most fossil-fuel producing countries are projected to incur real income losses that are substantial in some cases, such as Russia and the non-EU East European countries (Figure 2).

Figure 1 Long-term impact of a multilateral phasing-out of fossil fuel subsidies on GHG emissions by 2050



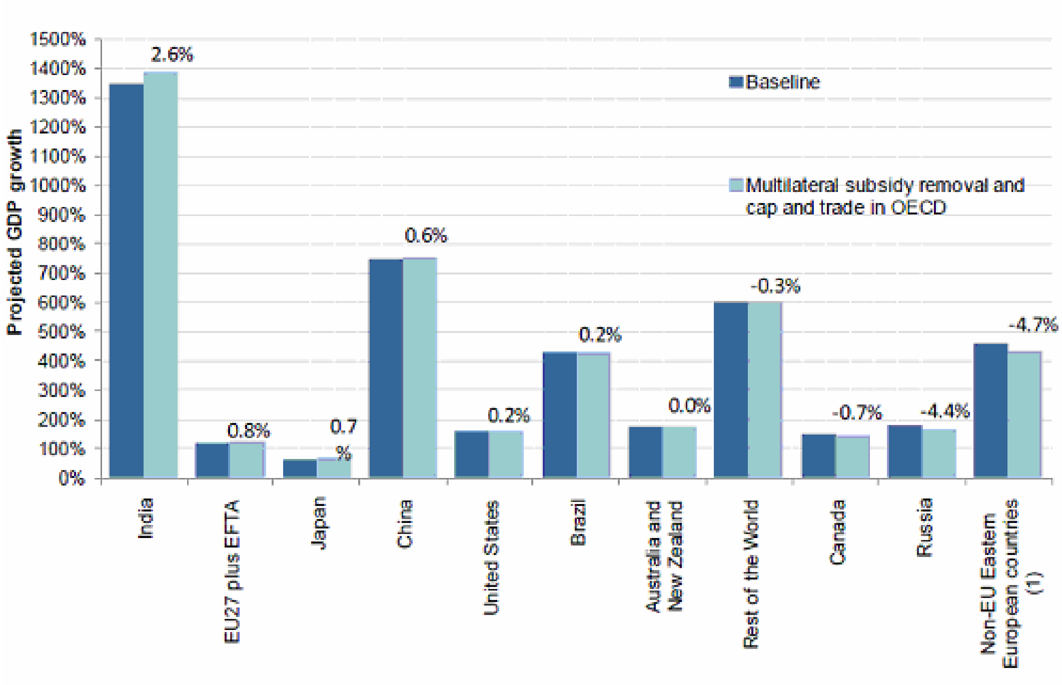
Source: OECD ENV-linkages model based on IEA subsidies data (OECD and World Bank, 2010).
Note: Non-EU East European countries include Armenia, Azerbaijan, Belarus, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine and Uzbekistan, according to the data aggregation in the Global Trade Analysis Project (GTAP) database.

Table 6 Share (%) of population reporting energy-related household problems: in 2008

	Inadequate heat	Energy bills arrears	Energy related housing defects
Bulgaria	34	33	30
Czech Republic	6	3	14
Estonia	1	7	17
Hungary	10	14	31
Latvia	17	12	26
Lithuania	22	6	25
Poland	20	10	23
Romania	25	24	24
Slovenia	6	14	30
Slovakia	6	4	9
EU-27 average	9	8	17

Source: Eurostat (2008).

Figure 2 Long term impact on GDP of a multilateral phasing out of fossil-fuel subsidies by regions in 2050 (percentage changes indicate GDP change in 2050 relative to the baseline)



Source: OECD ENV-linkages model based on IEA subsidies data (OECD and World Bank, 2010).
Note: Non-EU East European countries include Armenia, Azerbaijan, Belarus, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine and Uzbekistan, according to the data aggregation in the GTAP database.

From a policy perspective, designing an effective energy subsidy is a major challenge. Considering the means to eliminate, or at least to cut, carbon-intensive energy subsidies as a way to encourage energy efficiency should therefore take into account measures to assist vulnerable parts of the population (Ayres, 2010). Strategic re-targeting of subsidies, based on leveraging the *free-rider effect* of energy subsidies, can free up money for new energy efficiency investment support regimes, which are more successful and reduce budget expenditures.[50]

In sum, adequate pricing of carbon-intensive energy should involve tradeoffs of all possible benefits and costs such as marginal costs of natural resource extraction, scarcity costs for non-renewable resources, and social costs. Also, the effect of adequate carbon pricing through various mechanisms (such as imposition of taxes, or removing subsidies, or through emission trading systems) on long term investment in energy efficiency in buildings and industry, or on decarbonizing energy production, can be too slow to reach established targets for GHG emissions or energy efficiency. Hence these instruments need to be combined with others that stimulate investment in R&D in new green technologies, as will be discussed later below. Carbon pricing is also not sufficient to address other market failures such as information failure, behavioural failures and technology creation and diffusion failures. Therefore other policies that complement carbon pricing are needed to address these failures.

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50 Sometimes a significant portion of subsidies are captured by firms and households to help pay for efficiency improvements they were going to make anyway (improvements which are part of the natural rate of efficiency gain).

One of the drivers of efficiency improvements in the region has been price increases for electricity, which is an on-going process as countries in the region phase out subsidies, and phase in carbon taxes. There is variance in the region with electricity prices in new EU accession countries approaching West European levels, while those in the non-EU countries have lagged behind. In general higher prices have led to less waste (Buchan, 2010: 15).

Emission Trading Schemes

The European Union Greenhouse Gas Emission Trading System (EU ETS) is a multi-country, multi-sector policy for climate change mitigation. The EU ETS aims to achieve cost-effective emission reductions by setting emission targets for operators of selected large sources (including the energy-intensive manufacturing industry) in the EU (plus Liechtenstein and Norway). It covers over 10,000 (mostly industrial) installations that are collectively responsible for nearly half of the EU's CO_2 emissions, with a common cap or emission cut applying to all the EU-27. In the third phase 2013-2020, the goal is to cut emissions down to 21 per cent below the 2005 level by 2020.

The EU ETS has faced a number of challenges. Notably, compliance has been difficult to plan given that the price of emission allowances has been relatively volatile (Wara and Victor, 2008). It is a relatively new scheme, with large complexities in measurement, reporting, and verification, and it requires a large and well-trained human resource complement and robust legislative procedures. There have also been concerns about international competitiveness and "carbon leakage", but only a few sectors have faced significant cost increases and most appear to have benefited from the scheme.

The impact of the EU ETS on energy efficiency is difficult to ascertain, since the scheme began only a couple of years ago, and is not focused on efficiency *per se*. The ETS made it hard to differentiate between old new and new member states. This has created some tension among Europe and NIS countries, the new EU members, due to what they considered to be pan-European targets for emissions reductions that fail to take into consideration the higher proportion of their GDP that derives from industry than that of old member states.

Some concessions to the new member states are envisaged for the third phase. First, new members are given slightly more (12 per cent) carbon allowances to auction than their share in overall EU emissions represents (and old member states correspondingly less). Second, those new member states with power sectors heavily reliant on a single fossil fuel and/or with relatively low income per head are granted the right to phase-in the auctioning of carbon allowances for their power sectors gradually. This was a particular issue for Poland, where the government insisted upon exemption from paying for pollution permits for the country's coal-powered electricity generators due to fears of the impact upon industry and households (Buchan, 2010: 9-10).

The scheme has an important role to play in the development of renewables. The new member states were given less demanding targets, from their basic point of renewable energy share in 2005, in recognition of the extra cost of switching to renewable energy (e.g. Romania is asked to make only a 6.2 percentage point increase in its renewable share compared with the 13.2 percentage point increase required of the UK). It has already been predicted that Bulgaria, Estonia, Lithuania, Poland and Slovakia will exceed the EU targets for renewable sources, creating surpluses in green energy that can be sold to EU countries that fall short of the targets (Buchan, 2010: 27-28).

In transport, agriculture and services, the new member states are to be allowed to continue increasing emissions, in contrast to the older member states that will have to cut theirs. But, if the total emission cap is set at a 30 per cent reduction on 1990 levels, the new member states are then likely to find their targets for other sectors squeezed. This could be a particular problem in transport, because over the past 15 years the shift from public to private transport, from rail to road, and from bus to car has been more marked in the new member states than in the older ones (Buchan, 2010: 9-10).

Cap-and-trade scheme

Trading in permits to pollute is one way of stimulating GHG emission cuts cost effectively, because it allows for flexibility in where and how firms make their cuts. If properly designed, this scheme can be a source of funding for GHG emission cuts.

The EU trading scheme is an instrument for reducing emissions. This focuses on strengthening the emissions trading scheme, developing carbon capture, and identifying adaptation measures. The European Commission's legislation includes airlines in the trading scheme in order to cut the GHG emissions from road fuels and also CO_2 emission cuts from new cars. The potential sellers of carbon credits in the region are Bulgaria, the Czech Republic, Hungary, Latvia, Romania, Russia and Ukraine.

Subsidies to producers and consumers of green technologies and products

Economic incentives that directly reduce the costs associated with investment in EE include direct subsidies and tax allowances. These are applied in order to mobilize consumers, to prepare for new regulations, or to promote new environmentally friendly products, final consumer products and technologies by creating a larger market than would otherwise exist. Subsidies can be given directly from public funds to producers and consumers investing in energy efficiency or related services, such as audits, or they can be given via direct corporate income taxation (tax credits and allowances) and differentiated indirect tax rates (value added tax reductions) for achieved energy performance. Public and commercial financial institutions can offer soft loans or subsidized interest rates on loans to industries that invest in energy efficient technologies and equipment; they can also grant an interest-free grace period until the borrower starts receiving revenues from energy savings to make payments. Table 7 summarizes subsidies, soft loans and tax allowances applied in selected countries.

Several countries subsidize the purchase of energy efficient equipment in an effort to accelerate their uptake. Ireland's Accelerated Capital Allowances (ACA) scheme allows companies to write off 100 per cent of the purchase value of qualifying EE equipment against their profit in the year of purchase (SEAI, 2010).

Table 7 Subsidies (S), Soft Loans (SL), and tax deductions applied in Europe and NIS

Country	Residential Buildings (dwellings)	Low income households	Commercial public buildings	Industry	Transport companies	Efficient/ low CO_2 emission cars	Efficient electrical appliances	CFL (Compact Fluorescent Lamps)	Solar water heater	Wood stove	Electric motors
Croatia	S, SL (40%) EA none	None	EA (50%)	S, SL (40%) EA (50 %)	EA none						
Czech Republic	S, SL (50%) EA (up to 30%)	S (50%)	EA (up to 50%)	S (40%) EA none	EA none	None	None	None	S 1 500 solar water heaters and 475 wood stove		
Hungary	S (33%), SL (30%)			SL (5%)	SL (5%)	TRE	Tax cut planned	informing campaigns			
Lithuania	S	S	EA	None		None	None	None	None	None	None
Malta	S			S, SL	S	TRE (PT) (15.75% electric vehicles (up to US$ 1425))		S	S (66% for solar water heaters (up to €465))		
Poland	SL with premium (16%)	None		None	None	None	None	None	None	None	None
Romania	S (80%)	None		None	None	None	None	None	S	S	None
Russia	SL			ECA					ECA		ECA
Serbia	SL	None		SL	SL	None (S/SL) TRE (IT)	None S	SL	SL	None (S/SL)	None (S/SL)
Slovakia				S (75%), SL		TRE (AT)					
Slovenia	SL, S (25%) EA (50%)	None	EA (50 %)	SL EA (50 %)		S TRE (PT)	S		S		
Turkey	None	None	None	S EA (20 %)	None		None				

Notes: EA: Subsidies for energy audits (% of subsidy); S: Subsidies for energy efficiency investments/equipment (% of subsidy); SL: Soft loan for energy efficiency investment/equipment (soft loan = subsidized loan at a rate lower than the market rate); TRE=Tax reduction for energy/CO_2 efficient equipment/investments; ECA=Enhanced Capital Allowances; Malta; Amount of subsidies: 66% for roof thermal insulation (up to €300), 50% for photovoltaic (PV) systems (up to €3000), 20% for wind systems (up to €233).

Role of utilities: Demand side management (DSM) programmes

Demand side management (DSM) programmes[51] are voluntary or mandatory initiatives by energy utilities to encourage end-users (including industrial clients) to improve EE. Utilities are in a unique position to influence EE behaviour owing to their financial, organizational and technical capacity, as well as their unique “connection” to virtually all energy users (UNECE, 2009). Many utility providers, in particular in rapidly expanding markets in developing countries, are motivated to do so because they face load-capacity limitations, black-outs and unreliable supply. DSM aims to change the level or pattern of customer consumption by providing rebates, loans, subsidized audits, free installation of equipment and energy awareness programmes to industrial firms (Gillingham *et al.,* 2006). Utilities will not implement changes and their ability to provide support through the entire economy, however, may be quite limited; hence legal mechanisms and government support are required (Violette, 2006; Gillingham *et al.*, 2006) to create mandates or incentives for the pursuance of DSM programmes (Box 4).

Box 4 Electricity consumption in Uzbekistan

Uzbekistan has one of the highest rates of electricity consumption to GDP in the world. It also suffers from heavy transmission and distribution losses, with the state-owned power utility, Uzbekenergo, estimating total losses of around 20 per cent, nearly four times the levels seen in advanced countries. Most electricity meters are old, unreliable, and easy to tamper with.

The Asian Development Bank (ADB) will co-fund the installation of modern, accurate, theft-proof digital meters for 1 million residential and small commercial power users in the cities of Bukhara, Jizzakh and Samarkand. The Government of Uzbekistan and Uzbekenergo will provide counterpart funding. Uzbekenergo will carry out the project, which is due for completion in December 2014. The expected impact is greater energy efficiency and a more financially viable power sector in Uzbekistan. The new electricity meters employ a ‘smart’ two-way communication technology that gives customers more frequent and detailed information on usage. Smart metering allows the utility company to read meters remotely, and detect commercial losses. It also provides accurate information for load management to improve its operations.

The project will also fund skills training for Uzbekenergo staff to install the meters and run the system, along with an information component to make the public aware of the new meters. The billing system loan, from ordinary capital resources, has a 25-year term with a grace period of five years and annual interest determined in accordance with the ADB’s LIBOR-based lending facility.

DSM programmes rely heavily on macro issues of governance, the structure of energy markets and systems, and monitoring and verification efforts. They can, however, provide a powerful and effective basis for other regulatory tools and financial mechanisms, and are a useful way for utilities to limit consumption without compromising profitability.

There are a number of potential obstacles to successful utility programmes, including mixed incentives for utilities to implement DSM; inconsistent management support of DSM; staffing changes and inappropriate skills within DSM units; sector reforms that might affect the medium- to long-term impacts of DSM; unfair competition within existing private sector companies; and unclear implementation arrangements (World Bank, 2005). Additional barriers

51 DSM programmes are particularly well established in California, where they contain provisions to help lower-income consumers to deal with electricity price hikes. These programmes have helped reduce per-capita electricity consumption to well below the US average. The main rationale for pursuing DSM was concern about energy security in the aftermath of the oil shocks of the 1970s. Some have criticized the Californian programmes for increasing the average costs of electricity and increasing electricity imports (which are more carbon-intensive) (Shaw, 2009).

have been pointed out which may also hamper utility programmes; for instance, subsidized energy prices that make investments in many EE activities unattractive; inadequate information for and skepticism from end-users, equipment manufacturers and suppliers, and service providers about potential improvements, potential low-cost measures and new technology/practices; high project development costs, due to the audits and technical studies required to properly determine investment requirements and ensure appropriate project design; lack of affordable financing due to a weak commercial lending culture. To counter these difficulties, it should be a priority to ensure effective incentives for the utility companies.

Energy Service Companies (ESCOs)

In general, the ESCO market is growing across Europe, even if it is stagnant or even slowly declining in some countries (Boxes 5 and 6). The European Union (EU) and some national governments in Europe and the NIS region have taken important steps to promote ESCOs and energy performance contracting (EPC) markets. Policies and programmes include the Energy Service Directive, the Energy Performance of Buildings Directive,[52] the combined heat and power (CHP) Directive,[53] the GreenLight,[54] Motor Challenge and Green Building and a number of European projects.[55]

Many national governments have placed the promotion of energy savings through ESCOs on their priority list, and have established public ESCOs, together with wide-scale information collection and dissemination, carrying out demonstration activities, capacity building, and developing guidelines and model contracts. There are also a number of countries that have a very successful energy efficiency market, but without an ESCO contribution, like Lithuania.

The public sector has been the most important customer of ESCOs, but recently the residential sector is becoming attractive for ESCOs in some countries. This sector was believed to be a difficult market for ESCOs because of its complexity in decision making, small project sizes and large transaction costs. Where ESCOs have been able to deal with these problems, their key to success often lies in combining the ESCO guarantee with a national subsidy or other support programme for domestic buildings.

Common barriers to ESCOs in the Europe and NIS region are:

- Low awareness and lack of information about the ESCO concept.
- Mistrust and scepticism on the clients' side in the ESCO offer.
- High perceived risk of the ESCO investment.
- Non-supportive procurement rules, and other legal and regulatory frameworks.
- Lack of and limited understanding of established measurement and verification protocols for assuring performance.
- Administrative hurdles and high transaction costs that keep ESCOs away.
- Split incentives are still extremely important in the building and the public sector.
- A high level of aversion to outsourcing energy management tasks and allowing an outsider (the ESCO) to intervene in common practices and/or change equipment that the users are used to.

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52 Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.
53 Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending. Directive 92/42/EEC.
54 http://www.eu-greenlight.org/
55 Intelligent Energy Europe Program; http://ec.europa.eu/energy/intelligent/index_en.html.

- Lack of finance that matches the specifics of EE projects.
- Small project sizes were also important barriers to energy saving investments in 2004-2005. This is still an important issue, although different solutions have been applied (such as pooling, obligatory audits, and grants).

Box 5 What are ESCOs?

Energy Service Companies (ESCOs) can play a similar role to that of utilities in the provision of energy-management services and creative financing tools to industrial firms (Vine, 2005). ESCOs and the end-user industrial firms usually stipulate an energy performance contract (EPC), in which the two parties set the terms for sharing the risk and co-financing of industry energy efficiency (IEE) projects. Depending on the contract, ESCOs assume the project performance risk (the ESCO guarantees a minimum level of energy savings), design, provide or arrange financing for the EE project (and receive a payment based on energy services provided by the project), install and maintain the EE equipment involved, and may take credit risks (MacLean *et al.,* 2008).

For EPC, traditional project-financing rules may not apply as this contract can be treated as on- or off-balance sheet. Payment for ESCOs is linked to the energy performance of the firm (Satchwell *et al.,* 2010). If the EE project does not realize energy savings the ESCO will not be paid. Payments to ESCOs are not to exceed savings and industrial firms do not make capital investments or capital commitments to the project. The monthly payments to ESCOs may vary depending on the savings, or savings can be shared between ESCOs and firms. The monthly payments to ESCOs are considered in the same way as expenses for utilities. Since EE projects are considered as off-balance-sheet financing, no assets accrue to ESCOs and the equipment is left to firms. For industrial firms, this approach can be looked at as a creative and innovative way to finance large IEE projects without paying cash up front.

Success factors in the ESCO industry in Europe and NIS region include:

- Increasing energy prices as a result of subsidy removal and/or subsidy rationalization in many countries has significantly increased interest in energy efficiency and EPC.
- Dissemination of information and capacity building, if done effectively and for the appropriate audience.
- Accreditation of ESCOs has been referred to as one of the most effective tools to increase trust in the quality of ESCO work, although it is not widely used.
- Improving legislation and a supportive regulatory background have been emphasized to be especially important.
- Obligatory audits have been found to be an effective way to facilitate the ESCO markets.
- Energy Efficiency Certificates (White Certificates) are considered a significant enabling factor for ESCOs.
- The growing success of ESCOs is also largely due to increased climate consciousness, and the increasing level of obligations related to climate change politics.

Box 6 ESCOs in Hungary and the Czech Republic

The development of the **Hungarian ESCO** industry has been celebrated as a unique success story not only in Central Europe, but also across the EU (Ürge-Vorsatz *et al.*, 2004). Based on a registry held by the Energy Center, there are about 30 ESCOs or ESCO-type companies in Hungary, but only five or six companies cover 80 per cent of the market. The ESCOs approximate a 150-200 million EUR market size, excluding large power plant investment opportunities (Bertoldi *et al.*, 2007).

The ESCO industry in Hungary dates back to the early 1990s. Projects in the beginning were primarily focused on public lighting, co-generation and district heating system improvements. Later other technologies started to gain increasing importance, such as heating and hot water system interventions, industrial water and steam supply, air conditioning, automatization and RES (biomass) (Rodics, 2005).

The industrial sector has been gaining more attention lately, and recent figures suggest that the distribution of ESCO projects is around 30 per cent in industry, 30 per cent in district heating retrofits and development, and 30 per cent in the municipal sector. Renewable energy investments have been started, although these have not gained a major role yet (Rodics, 2005). Projects have typical pay-back times of between five and seven years (Rodics, 2005), one of the major challenges facing ESCOs.

The Czech Republic is regarded as the frontrunner in developing a local ESCO market. The development of the ESCO market was slow until the beginning of the past decade when the Czech ESCO market reached a clear turning point due to critical changes in the legal framework: adoption of the Energy Management Act 406/2000 that has provided a strong push for investments in energy efficiency. Additional framework changes were a new State Energy Policy, adopted in 2004, which emphasizes the role of energy efficiency, and a National Programme for Energy Effective Management in which energy performance contracting (EPC) is mentioned as one of the main mechanisms for tapping energy savings. In addition, early, widely spread awareness-raising was one of the most effective instruments in promoting ESCOs in the Czech Republic.

Experts estimate that currently 10-15 ESCOs operate in the Czech market and provide ESC and/or EPC services to various buildings, other public sectors, as well as industry. It is estimated that the total potential of economically viable energy savings through EPC in the Czech Republic is about 100 million Euros/year. So far, 70 EPC projects have been realized and the market size is estimated to be in the range of 10-20 million Euros/year.

However, ESCOs have not been ready to take on projects with a long pay-back period. Typical projects take four to six years, and the majority of ESCO investment interest is for heating equipment (heat delivery regulation, piping, pipes insulation, boilers replacement, fuel switching), or power factor management.

Financial tools for addressing liquidity and risk

Despite the considerable flow of financial aid dedicated to EE by multilateral financial institutions and through Official Development Assistance (ODA)—and the financial profitability of many projects—access to finance remains a considerable barrier for transition economies (Worrell, 2010; te Velde, 2010). One frequently stated reason is that the technical complexity of energy efficiency projects and their relatively small size contribute decisively to high transaction costs. Public finance and technical cooperation programmes are still needed to address the lack of capital and capacity until green technology has reached the diffusion stage.

The most widespread financial mechanism used to promote investment in new green technologies is **soft loans**—often in the form of special purpose **EE funds and credit lines**. Other mechanisms include credit lines, revolving funds, publicly backed guarantees and project loan facilities. Most of these financial programmes are backed by multilateral financial institutions or by ODA, and some of them include technical assistance.

Soft loans are subsidized interest rate loans offered to industries that invest in EE technologies and equipment; they can also grant interest-free grace periods until the borrower starts receiving revenues from the energy savings. Most public and development financing institutions set up loan programmes to fill the financing gaps in immature financial markets. Creating debt-financing mechanisms is important to develop new markets, especially for small EE ventures.

An example of a successful soft loans programme in the region is the Hungary Energy Efficiency Co-financing Programme (HEECP). The IFC, the private sector arm of the World Bank Group, and the Global Environment Facility (GEF) HEECP work in partnership with local financial institutions (FIs) to build a sustainable commercial lending business in Hungary for energy efficiency investment across a range of sectors. The programme supports the development of the Hungarian energy efficiency lending market through the establishment of specialized financial products and the building of new capabilities among Hungarian FIs and project developers to undertake energy efficiency investments.

HEECP consists of three different phases, each of them characterized by different parameters. Two FIs participated actively in the pilot phase HEECP1, which received US$5 million of GEF financing. After a positive experience with the HEECP1 pilot, the IFC contributed an additional US$12 million to a second phase of the HEECP, and an additional US$0.7 million of GEF funds was provided for technical assistance (TA) purposes. Additional TA funds of US$0.35 million also were granted by the IFC’s Austrian and Dutch Trust Funds. Six FIs, making up more than 50 per cent of the Hungarian FI market in terms of assets, were involved in this phase. By the end of 2006, the US$55 million loan portfolio that HEECP directly supported with US$17 million of guarantees represented US$93 million worth of energy efficiency investments with a total of 331 energy efficiency projects and 1,500 contracts in the gas retail portfolio.

The original HEECP project was extended to 2008 within the framework of the IFC’s Commercializing Energy Efficiency Finance (CEEF) project with the aim of transferring lessons learned, extending the programme into additional markets, and refining the financial products initially used based on experience. Among the new markets and products in HEECP3 are blockhouse portfolios, an SME facility and some programmes for renewable energy, reflecting the need for specialized financial products that address undeveloped niche markets. A further modification in HEECP3 includes a new credit approval system to encourage FIs to develop standardized energy efficiency products, and build loan portfolios based on these products, backed by the programme’s guarantees. The first standardized product has been developed for Raiffeisen Bank in Hungary.

HEECP’s overall contribution to the development of the energy efficiency finance market in Hungary goes well beyond the direct influence of approved guarantees. The programme facilitated the expansion of the energy efficiency market to new end users, and the development of new technologies and new financial products. FIs have gained considerable knowledge and experience from the programme, allowing them to develop new financial products and thus to take market opportunities that would otherwise be ignored. Particularly successful have been new types of lending for blockhouse renovation, cogeneration, and street-lighting projects.

Closely related to soft loans are ***revolving funds***, where repaid loan funds are reused through the fund for financing new EE projects. Revolving funds can be fully or partially publicly funded, and they may be established in cooperation with commercial banks. Thus, EE projects seeking funding through the revolving loan fund do not need to compete against more traditional investments for bank funding. The public funds are provided to commercial banks at zero or well below market interest rates, which enables the banks to provide loans for EE projects at below market rates. In return for receiving public funds, banks can be asked to assume some or all of the risk of repayment associated with the loans. An example of a revolving energy efficiency loan fund is the Romanian Energy Efficiency Fund ((Fundul Roman pentru Eficienta Energiei - FREE), a free-standing fund supported by the World Bank and GEF. The Fund has facilitated the improvement of energy efficiency through financial support for investment projects designed to reduce energy demand by financing energy efficiency projects in industry with subsidies from the national budget. Since 2004, the FREE has concluded 25 financing agreements with a total value of US$13,198 million.

Credit lines can be offered at concessional rates in markets with high interest rates. Guarantees or other risk sharing structures involving the development financial institution and the local commercial banks can also be set up to reduce a project's credit risk (Mostert, 2010). In April 2009, the Czech Republic's Ministry for Environment introduced the Green Light for Savings Programme. This focuses on support for heating installations using renewable energy sources but also on investment in energy savings in reconstruction and new buildings. The programme will support quality insulation of family houses and multiple-dwelling houses, the replacement of environmental unfriendly heating for low-emission biomass-fired boilers and efficient heat pumps, the installation of these heat sources in new low-energy buildings, as well as the construction of new houses to high energy standards. The Czech Republic has raised funds for this programme from the sale of emission credits under the Kyoto Protocol on greenhouse gas emissions. The overall anticipated programme allocation is up to 25 billion CZK (Czech crowns). The Green Light for Savings support has been set up so that the funds can be used throughout the period from the programme's launch until 31 December 2012.

Publicly-backed guarantees (PBGs) are three-party contracts in which a public institution (national or international) guarantees compensation to a lender in case of default on a loan to which a third party is bound. These instruments mitigate the risks associated with financing EE projects with a medium to long term loan.[56] Related schemes are partially credit and partially risk guarantees (see e.g. Mostert, 2010). Guarantees have contributed decisively to mobilizing private sector resources and facilitating access to capital in developing countries. The Programme Eco-Energy (E-E) in the Czech Republic is an ongoing EU funded programme (coordinated and run by Czechinvest under the Operational Programme for Enterprise and Innovation) to stimulate business activities in the field of reducing the energy intensity of production and consumption of primary energy sources. The programme provides support for the use of renewable and secondary energy sources as well as for increasing efficiency in the production, transmission and consumption of energy. The programme is designed for SMEs as well as large enterprises.. Two calls for grant applications (involving a 40 per cent subsidy for energy saving and secondary energy sources projects) have been issued, with CZK1.7 and 2 billion being allocated for the calls respectively. In the first call (2007), 138 applications for energy savings projects were received with subsidy demand of CZK1,122 million and total investment cost of CZK3,208 million. Of these 67 were approved for an ex-ante savings of 511,234 GJ/year.

Project loan facilities are special financial vehicles created by governments and development financial institutions to fill the financing gaps in markets where commercial institutions are not

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56 The loan recipient pays a fee of 1-3 per cent of the total outstanding balance on the loan per annum to the guarantor for obtaining such a guarantee.

able or willing to provide financing. Such facilities can be effective public finance mechanisms—if designed carefully—as debt financing or guarantees. They can be economic and efficient ways of mobilizing resources for EE projects, and can engage local commercial banks (MacLean *et al.*, 2008).

An example of a project loan facility is The Eastern Europe Energy Efficiency and Environment Partnership (E5P) Fund. E5P is a €90 million multi-donor fund managed by the EBRD, designed to promote energy efficiency investments in Ukraine, Armenia, Azerbaijan, Belarus, Georgia and Moldova, and was set up under the initiative of the Swedish government during its presidency of the European Union in 2009. The fund will complement energy efficiency loans provided by financial institutions including the EBRD, the European Investment Bank, the Nordic Investment Bank, the Nordic Environment Finance Corporation and the World Bank Group. Grants under E5P will be allocated to four priority areas: district heating, other energy efficiency projects, environment projects in Ukraine as well as additional projects in other East European countries. In addition to promoting energy efficiency in district heating projects, funding will also support other investments aimed at making substantial energy savings. Environmental projects, such as wastewater or renewable energy, will also be within the scope of the grant funding.

EU financing

If countries in the region are to achieve reductions in energy intensity by investing in technological advancements, they will require access to finance, expertise and technical assistance from outside. Among new EU accession states, it has been argued that richer Western countries should provide assistance to new member states through EU structural funds and subsidies for national renewable energy subsidies (Buchan 2010: 41-42). If the EU wants to extend energy efficiency across the region, including smart grids for tradable renewable energy, it should also consider developing portfolios of measures to assist these countries. The number of participating institutions in research and technology development projects funded under the 7th Framework Programme (FP7) and the ICT Policy Support Programme (ICT PSP) of the EU (since 2007) is presented in Table 8.

The important finding based on the data in the Table 8 is that participation in the EU-funded R&D projects is biased towards the old EU-15. The new EU countries get only one participation for ten participations from the EU-15 (less than 9 per cent of the total participation) although the new EU member states represent around 20 per cent of the EU's population.

Information policies

Lack of awareness of green technologies may result from a combination of inadequate metering of energy consumption at the production level, insufficient information on the energy performance of different technologies, lack of information on resource-efficiency and cleaner production, and pollution control and lifecycle management opportunities. Lack of information frequently coexists with inadequate skills and training, with the two factors tending to reinforce each other. These problems may be particularly acute in developing and transition economies owing to lack of Internet access and language barriers. The consequence of limited knowledge is often that quick-fix options are implemented, rather than options that address the root cause of the problem (te Velde, 2010). As a result, information and awareness raising programmes are repeatedly identified as priorities for public policy.

Table 8 EU-funded R&D projects in EE

Country	Number of RDT Projects/ Number of Participating Institutions				
	Buildings (27)	Data Centres (2)	EE Manufacturing (3)	Grids (10)	Total
Austria	10	0	0	5	15
Belgium	6	0	3	7	16
Denmark	2	0	0	1	3
Germany	33	5	6	24	68
Finland	16	1	1	2	20
France	32	0	1	5	38
Greece	7	0	0	5	12
Ireland	6	0	0	0	6
Italy	28	6	3	8	45
Netherlands	12	1	0	11	24
Portugal	15	0	0	2	17
Spain	45	1	6	17	69
Sweden	5	0	1	4	10
UK	21	1	2	7	31
EU-15	**238**	**15**	**23**	**98**	**374**
Monaco	1	0	0	0	1
Norway	3	0	0	2	5
Switzerland	3	0	0	4	7
EEA	**7**	**0**	**0**	**6**	**13**
EU-15+EEA	**245**	**15**	**23**	**104**	**387**
Bulgaria	3	0	0	0	3
Czech Republic	2	0	0	0	2
Cyprus	1	0	0	0	1
Estonia	0	0	0	0	0
Hungary	0	0	0	0	0
Latvia	1	0	0	0	1
Lithuania	0	0	1	0	1
Malta	0	0	0	0	0
Poland	10	0	1	2	13
Romania	2	0	0	1	3
Slovakia	2	0	0	0	2
Slovenia	1	0	1	2	4
EU-12	**22**	**0**	**3**	**5**	**30**
Israel	2	1	0	3	6
Serbia	2	0	0	0	2
CEE	**4**	**1**	**0**	**3**	**8**
EU-12+CEE	**26**	**1**	**3**	**8**	**38**

Source: Research & Technology Development projects in the field of Energy Efficiency funded by the 7th Framework and ICT Policy Support programmes of the EU.

Countries with strong energy efficiency programmes provide information on energy efficiency opportunities through a variety of technical information sources including fact sheets, brochures, guidebooks, technical publications, energy efficiency databases, energy efficiency assessment and self-auditing tools, case studies, and industry- and technology-specific energy efficiency reports and benchmarking tools (see Box 7).

Box 7 Increasing energy efficiency in Azerbaijan

Azerbaijan has large natural endowments of oil and gas that have given the country some of the highest economic growth rates in the world. At the same time it is one of the most energy-intense countries in the region. The government has recognized the problem of high levels of energy intensity and sought to develop policies to encourage enterprises to invest in improving energy efficiency, and increase competitiveness. Firms operating in competitive sectors such as food processing invest more in energy efficiency in order to maintain their market position. Other industries like metal-processing have not made energy efficiency a business priority.

Therefore, government has created a legal framework to promote energy efficiency, raised awareness among company managers, promulgated national standards of energy use from various technologies, and introduced monitoring to ensure compliance with these standards. Studies have shown that companies are increasingly aware of the benefits of energy efficiency and are planning to invest.

Source: McKinsey Global Institute (2008).

Public awareness and education campaigns can boost industries' capability and willingness to adopt what had previously been seen as high cost and risk technologies (Box 7). To be effective, such campaigns must simultaneously target: (i) management and technical personnel within firms; (ii) the broader range of stakeholders involved in particular sectors (such as industry associations and government departments); (iii) the financial sector (on topics such as the profitability of IEE projects); and (iv) the community at large.

Efforts to convey this information can take a variety of forms, including: workshops, training courses, and seminars; best practice publications; and mass media campaigns through television, radio, and the Internet (te Velde, 2010).

The financial sector needs to be explicitly targeted for awareness campaigns in developing and transition economies, informing this sector of the fact that green projects are profitable and can result in major economic opportunities. Concrete cases, informed by figures and 'hard' data, are needed to help convince different stakeholders of the advantages of adopting green technologies.

Training for firm personnel and improvement of absorptive capacity

Training and information programmes can also help to improve a firm's 'absorptive capacity', defined as the ability to utilize available information and knowledge that comes through interacting with other firms, users, or knowledge providers such as research institutions (Cohen and Levinthal, 1990; Giuliani and Bell, 2005). It is a firm's absorptive capacity that shapes its ability to benefit from the technological knowledge available in global and local networks. Firms in developing countries are typically characterized by very low levels of absorptive capacity.

Governments can also launch programmes that promote energy management practices in industry through establishing and supporting various technical assistance programmes, providing energy management guidelines by government agencies, giving incentives to utilities, and augmenting markets for provision of energy management services through contracting ESCOs (see Box 8).[57]

57 Governments can also launch programmes that promote energy management practices in industry through establishing nationwide voluntary standards and labelling programmes, and energy management guidelines. For

Box 8 Manage Energy Initiative

Launched in 2002 by the Intelligent Energy - Europe (IEE) programme of the European Commission, the ManagEnergy initiative [1] provides training, workshops and online events targeting energy professionals and managers of energy agencies at the local and regional level. ManagEnergy also offers free Internet broadcast facilities including more than 1,000 individual video presentations, speeches and interviews on topical energy matters. Since 2005, ManagEnergy has placed an increasing emphasis on education. For example, the KidsCorner website features energy and transport pages including games, downloads, animations, videos, statistics, photos and other teaching resources aimed at 7-11 year olds, 12-16 year olds and their teachers in 23 languages.

Source: www.managenergy.net.

Recognition and reward programmes

Recognition programmes are government-led programmes to reward firms which make an effort to implement EE solutions or to achieve significant energy savings. These programmes, which can consist of a contest and awards ceremony, a media event and consequent exposure, and a recognition certificate, have proven to be effective incentive instruments (Mallett *et al.*, 2010). They also promote a more positive perception of EE by highlighting the potential benefits and publicising successful outcomes. Using EE rewards to garner a competitive advantage can assist in embedding the pursuit of EE into an organizational culture. In addition, at the company level, energy awards provide a platform for companies to audit their energy usage, identify possible energy savings projects, and ultimately increase company profitability and productivity.

As a policy option, recognition programmes can be quite attractive due to the performance-based nature of awards, the low levels of investment necessary and their potential as stimuli for future energy savings. Experience with recognition programmes in the early stage of policy setting can serve to inform policy-makers of successful options in the country or regional context. McKane *et al.* (2008) suggest that these lessons are frequently integrated into policy.

Cultural predispositions can also determine the choice of policy instruments. European countries rely more on mandatory measures while the United States of America relies more on market-based instruments. Publicizing successes and failures can also act as a strong incentive to comply with EE programmes. In some Asian countries, such as Japan and China, public exposure can also act as a strong incentive to comply with IEE programmes. In Japan, the Top Runner Programme relies heavily on the idea of saving face: if an enterprise fails to comply with the programme goals and commitment, this will be publicized as a public failure. So even if standards are voluntary, there will be strong incentive to comply.

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example, the United States ENERGY STAR Programme and the United States Department of Energy (DOE) Industrial Technology Programme “Save Energy Now” have contributed to a 25 per cent reduction in energy intensity in 10 years (McKinsey, 2009c). The ENERGY STAR Programme achieved the status of a market standard, contributing to the spread of the programme to other countries like Japan, Australia and Korea. In 2001, the EU signed an agreement with US Environmental Protection Agency (EPA) to introduce the ENERGY STAR in Europe as well (although only for office equipment), whereby each side recognized the other as a partner in the programme. This allows potential partners in the European Union to sign up through the European Commission, which is responsible for the EU ENERGY STAR Programme.

Innovation Policies

Pro-innovation regulations and incentives are being mainstreamed into environmental policy making, encouraging value-creation responses to the goal of decoupling economic growth from energy use (OECD, 2011a: 12). Policies and programmes to encourage the adoption and diffusion of the best available EE technologies must consider domestic market conditions, along with the technical, managerial, and financial capacity of domestic industries to take up these technologies.

While some measures may be more suitable for emerging economies in the region with the potential to develop an indigenous technology base, other measures may be more suitable for countries relying primarily upon technology transfer. For smaller and less developed economies, it makes little economic sense to develop their own technology supply chain. It is particularly important to direct incentives for innovation at the private sector, which is typically the main source of innovative activity and expenditure in developed countries. For 'catch up' countries in the region, this will require appropriate policy mixes that reflect local circumstances. However, there are certain general approaches that all governments can follow.

Countries should seek to learn from and incorporate foreign knowledge and technology upgrading. The creation of new technology is complex, resulting from scientific advances, learning-by-doing, and directed and spillover technology R&D efforts in both the private and the public sectors (IPIECA, 2006). This can complement indigenous areas of scientific expertise where appropriate. It is vital that innovation policies are adapted to local environmental requirements.

Encouraging R&D efforts

The key question is how to promote R&D efforts that provide the strategic options necessary to accelerate energy intensity reductions in industry. A government may pursue its own R&D efforts and strengthen industry activities. Policymakers valuing the role of technological innovation may develop and strengthen national and multinational strategic R&D programmes. Governments may choose to focus on *demand pull*, where improvements are realized by setting efficiency standards and regulations, or on *technology push*, where improvements are encouraged by R&D funding and technology transfer. They may also focus on a combination of both.

Public policy to foster innovation may take various forms. On the supply side (technology push), options include:

- *Government-funded research*: publicly funded institutions such as research centres including the training of qualified people; public research institutions with expertise on energy efficiency; and jointly funded industry-government research; such efforts may adapt existing R&D institutes to reflect the needs of an innovative green growth economic approach (Boxes 9, 10 and 11).
- *Subsidized research in the private sector*: private firms may have better information than the government about the commercial feasibility of EE technologies. This may include subsidies in the form of tax credits or matching funds to firms for research proposals. These can be complemented with subsidies for training scientists and engineers.

- *Government-introduced regulations on intellectual property rights*: this includes regulations on intellectual property rights that create incentives to invest in the generation of new knowledge.

Box 9 Government-funded research in the Russian Federation

In Russia, R&D financing is dominated by government funding. In 2007, 55.3 per cent of R&D in business came from the government, compared to 7 per cent in OECD countries. As part of a goal to accelerate modernization and development, the government has set 12 federal target programmes (FTPs) in priority areas, including in high-tech areas where Russia had traditionally high levels of expertise, such as in nuclear technology and space programmes. In 2010, the government launched 14 'Technology Platforms', which are designed to avoid duplication in research and to focus on investments with market potential. These include energy and gas and oil production and processing. Compared to enterprises in other countries, Russian energy companies like Rosneft and Gazprom are not reaping technological benefits from their investment in R&D. The failure to invest in energy efficiency is regarded as a consequence of a compromise between energy companies and the government to increase profits and keep prices low. More generally, the demand for graduates from Russia's most prestigious universities and institutes appears to be low and the brightest and best are picked up by foreign companies (OECD, 2011a).

In some resource-rich countries in the region, innovation is an important means of overcoming the boom and bust cycle associated with commodity prices. The Federal Agency for Science and Innovation is responsible for the Russian Federation's programme of "Research & Development in Priority Fields of Russia's S&T Complex for 2007-2012" including 'rational nature management' and 'energy and energy saving.' In Serbia, the Scientific and Technological Development Strategy 2010-2015 (MSTD, 2009) also flags 'environmental protection and countering climate change' and 'energy and energy efficiency' as two of seven national priorities in science and technology.

Encouraging technology adoption and diffusion in industry

In most OECD countries, the traditional approach to innovation policy has evolved to reflect the changing needs of society, including orientation towards green growth (OECD, 2009: 190-211). Government should consider its role as the final consumer of some environmental goods, which can help to generate demand for new green technologies among local firms, and encourage investment. This can also form a basis upon which to increase productivity and boost innovation in state owned firms, particularly in SMEs that are too small to lead on high technology investment. Public procurement is an important means of addressing demand side weaknesses of innovation. Incorporating a green growth agenda into government procurement and green criteria in all tender processes is particularly important in emerging economies where the state has a greater role in boosting demand in order to make up for weaknesses in the private sector.

In September 2011, the power technology company ABB expanded its operations in Estonia by opening a new production line and engineering centre for solar technology, anticipating that solar energy will be an increasing part of the global energy mix. The company already operates a wind power production facility in the country and the new solar facility establishes Estonia as a production hub for environmental technologies. ABB praised the Estonian government for its adoption of new technology, citing the example of 500 ABB electric car chargers bought by the government export agency (ABB, 2011).

Box 10 Buy Smart – EU Green Procurement for Smart Purchasing

The objective of the "Buy Smart-project" is to promote, implement and further develop the procurement of energy efficient products (office equipment, household appliances, lighting, green power, building components, vehicles) in private and public institutions. Eight partners from seven European countries (Austria, the Czech Republic, Germany, Italy, Latvia, Slovenia and Sweden) cooperate to trigger green procurement for smart purchasing. Among others, the following activities are carried out:

- supporting information through specific guidelines, performance sheets and calculation tools
- consultations, in-house consultations, training events, pilot projects
- a good-practice database with at least 200 European examples
- information about energy labels and new labeling schemes

Project website: http://www.buy-smart.info/.

There are other examples from successful countries of articulated green innovation supply-side policy mixes that can be used in the region to encourage green technology adoption and diffusion by stimulating demand for these technologies:

- Provide equity support. Countries can take measures to facilitate access to finance for firms that are developing eco-technologies, particularly SMEs who suffer most from financial obstacles.
- Supporting public-private partnerships (PPPs) to promote scaling up of funding for R&D, and establishing regional technology centres.
- Provide the infrastructure (such as for instance high-speed digital networks) to support innovations in clusters and regional innovation systems.
- Provide education and training to close the human resource gap. Mainstreaming government education and training policies towards developing specific eco-innovation thinking that can produce a new generation of environmental scientists and innovators. Provide programmes to stimulate knowledge exchange, encourage cooperation between among firms and between institutes and firms.
- Provide information services. Governments have a role to play in diffusing information on environmental issues, energy efficiency and innovation; support energy data collection and dissemination. Information centres would also be a valuable resource for SMEs, allowing them to access the latest news on eco-innovations
- Introducing legislation such as mandatory laws and standards to force the exclusion of those technologies that are proven to be less EE. Standards for industrial equipment and system optimization can make it easier for firms to trade off capital and energy costs, but can also impose limits to product choice and undesirable costs to adopters.

Demonstration projects

The adoption of many new technologies, especially those which are capital intensive, requires public investment or the creation of public-private partnerships (PPPs). Typically a first-of-a-kind plant is several times as expensive per unit of capacity as an *n*th-of-a-kind plant. These initial high costs can represent a substantial barrier, especially if the technology is “chunky” and billions of dollars are involved.

By demonstrating actual applications, it is possible to show that substantial benefits can accrue and need not be costly. The use of case studies to demonstrate the potential cost savings of introducing EE projects has an encouraging effect on other companies with similar characteristics. They provide inspiration on how to handle implementation, and encourage staff training on knowledge within the field. Demonstration projects also help provide ideas for further innovations, the confidence to replicate, and when promoted, have a considerable impact in the sector, thus creating a multiplier effect.

Box 11 Supporting ECO-INNOVATION in Europe

Within the framework of the EU's Competitiveness and Innovation Framework Programme (CIP), the CIP Eco-innovation Initiative addresses European companies that have come up with new ways of reducing industry's ecological footprint and making better use of natural resources. This initiative supports the market entry and further market uptake of new "green" products, services and technologies. Nearly €200 million will be available between 2008 and 2013 to co-fund eco-innovation projects across Europe and thus contribute to the implementation of the Environmental Technologies Action Plan (ETAP). Under this scheme, Community funding covers 50 per cent of the eligible project costs; applications from SMEs are particularly encouraged. The first call for proposals launched in April 2008 received 130 project applications, of which 40 projects were approved.

Organizations from the 27 EU Member States, as well as from Norway, Iceland, Liechtenstein, Croatia, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Israel, Turkey and Albania may table a proposal under annual calls for proposals. To qualify under this scheme, projects must be innovative, replicable, technically proven, show a strong European dimension, and be supportive of the EU's environmental policies.

Source: http://ec.europa.eu/ecoinnovation\.

In 2009, Tata steel decided to test a new iron-making technology, called "Hisarna", by developing a pilot plant project at the IJmuiden steelworks in the Netherlands. The technology is expected to generate a 20 per cent improvement in steel industry energy efficiency and also reduce CO_2 emissions in blast furnace steelmaking by more than 50 per cent. The plant technology enables iron making from raw materials in a single step, eliminating two steps in the blast furnace iron making process. The project is part of an initiative being conducted by Ultra-Low CO_2 Steelmaking (ULCOS), a consortium of European steelmakers that has the goal of developing measures to reduce the industry's carbon footprint. The project total investment is €20 million, of which 25 per cent is funded by the Dutch government and the remainder from the European Commission research funds and the ULCOS consortium. The plant should be commissioned by the end of 2010.

Network building

The government can facilitate the building of networks on EE among firms, academia, trade and industry associations, not-for-profit organizations, other relevant groups, and government itself (see Box 12). These networks are particularly important in developing and transition economies, as a number of studies highlight how the organizational culture of a firm can help or hinder the adoption of green technologies.

Box 12 The European technology network "OPET RES-r"

The European technology network "OPET RES-e" promotes energy technologies for the generation of electricity from renewable energy sources (RES-e). Eighteen partners - many of which are regional energy agencies - from 13 countries were members of this network which was coordinated by the O.Oe. Energiesparverband. The project participants included Spain (Catalonia, Andalusia, Basque country), France (Rhône-Alpes), United Kingdom (Wales), Germany (Berlin, Saarland, Brandenburg), Belgium (Flanders), Austria (Upper Austria), the Czech Republic (South Bohemia), Poland (Gdansk region), Slovenia, Finland, Sweden (West Sweden), India and China. The project responded to local conditions (which vary significantly) and facilitated implementation by bringing together regional actors and know-how from European research bodies by combining a local technology-oriented approach with international co-operation.

The network carried out a number of projects, including "regional technology mapping", best practice reports on public acceptance, case studies on financing and other targeted dissemination activities. Three international events, more than 30 local events and over 30 publications ensured that a large number of market actors benefited from the exchange of know-how.

Source: http://www.esv.or.at/esv/index.php?id=218&L=0.

Policies targeting SMEs

Governments in the region should consider developing and implementing a package of policies and measures to promote green technologies uptake in SMEs. This package should include:

- A system for ensuring that energy audits, carried out by qualified engineers, are widely promoted and easily accessible for all SMEs.
- The provision of high quality and relevant information on EE best practice in different technologies and sectors.
- The provision of energy performance benchmarks, ideally structured to allow for comparisons both internationally and within national economies.
- Appropriate incentives to adopt least-life-cycle acquisition and procurement procedures.
- Support energy conservation centres offering extension services to SMEs as well as encouraging utilities and ESCOs to provide services to SMEs.
- Fiscal targeting: subsidies, tax rebate schemes, free auditing and other financial incentives can be a key facilitator for IEE uptake in SMEs. Subsidies, for instance, would reduce the capital restrictions and opportunity costs associated with these investments, along with reducing the level of risk involved (IEA, 2010; SEAI, 2010; Ellingson *et al.*, 2010).

Policies for promoting renewable energy supply

Governments can support renewable energy supply in three main ways: through regulatory policies, fiscal incentives and public financing. The following examples from Turkey, Russia and Kazakhstan give an indication of the approaches taken by some countries in the region.

The key policy tools are listed below (REN21, 2011: 53-54).

Regulatory policies

- Feed-in tariffs that ensure a minimum price for renewable energy
- Electricity quota obligation/Renewable Portfolio Standard (RPS)
- Net metering
- Biofuels obligation/mandate
- Heat obligations mandate
- Tradable renewable energy certificated (REC)

Fiscal incentives

- Capital subsidies, as grants or rebates
- Investment or production tax credits
- Reductions in sales, energy, CO_2, VAT or other taxes
- Energy production payment

Public financing

- Public investment, loans, or grants
- Public competitiveness bidding

In the Russian Federation, despite the vast potential of renewables (thanks to geography that suits wind, geothermal and solar energy generation) mineral resources continue to dominate the energy sector. In 2009, around 1 per cent of power was generated from renewables. The Russian leadership has, however, shown interest in high-value and high-technology sectors, such as the manufacture of wind turbines, and the latest government energy strategy aims for 4.5 per cent of energy from renewables by 2020. In Turkey's case, imports represent more than half of energy supply. The government has been trying to diversify its energy sources, for instance by recently introducing natural gas. It has also set a goal of producing 30 per cent of its energy from renewables by 2023. To reach this target, feed-in tariffs for wind have been established, which have already had an impact on applications for wind power projects (ABB, 2011). However, the growth in carbon-free sources has not kept up with the demand for energy and the share of carbon fuels has increased since the 1990s as a percentage of total energy production, whilst that of hydroelectricity has fallen from 40 per cent in 1990 to 18 per cent of overall energy production in 2009 (ABB, 2011: 3).

In Kazakhstan, rich in oil and gas, and coal, the energy sector is one of the most developed economic sectors, and there is sufficient supply to meet domestic needs. The country has the second largest oil reserves as well as the second largest oil production among the former Soviet republics after Russia. Moreover, Kazakhstan possesses significant renewable energy resources, such as hydro, solar and wind energy. At present, renewables represent only a small part of Kazakhstan's energy balance. The availability of cheap coal, the tradition of centralized, fossil fuel-based power generation and low tariff levels have so far discouraged investment in wind resources. Thus, one of the important pillars of the energy strategy of Kazakhstan is the development of carbon-free energy. Wind and concentrated solar thermal are particularly well suited to this country. In this regard Kazakhstan has set a goal of building 500 MW of wind capacity by 2030. The National Programme for Accelerated Industrial and Innovation Development of Kazakhstan for the period 2010-2014 aims for 1 per cent of electricity consumption produced from renewable energy sources by 2015, and the national programme for transition to sustainable development calls for increasing renewables' share in Kazakhstan's energy balance to 5 per cent by 2024.

The Energy Sector Development Programme adopted in 1999 sets out the country's energy policy until 2030. The main goal is to achieve self-sufficiency in energy resources, by improving the energy efficiency of existing power plants and by constructing and commissioning new ones. The plan also introduces renewable energy resources into the country's energy balance. The key strategic directions of the programme, which will cost an estimated US$12 billion to implement, can be summarized as:

- Establishing a common energy system in Kazakhstan
- Restoring a common energy system with Russia and other Central Asian Republics
- Developing an open, competitive power market
- Maximizing existing energy resources and commissioning new capacities
- Improving the structure of power production by means of non-traditional (renewable) energy resources.

Kazakhstan has repeatedly declared its intention to reduce the share of traditional energy sources in the energy sector. The 2009 law "On Supporting the Use of Renewable Energy Sources" defines the main targets and directions for renewable energy sources. The law regulates public relations in the area of the usage of renewable energy sources, sets legal, economic and organizational grounds to facilitate generation, transportation and consumption of the electricity and (or) heat produced by renewable energy sources (see Box 13).

Box 13 Targets for Renewables

Large natural resource endowments have typically discouraged energy efficiency. Yet, Russia and Kazakhstan have set renewable energy targets, whilst in Azerbaijan, the sovereign wealth fund (based on the Norwegian oil fund) is used to finance green projects (OECD, 2011b: 4).

In Ukraine, the Energy Strategy specifies an increase in the use of renewable and non-traditional sources of energy from 10.9 mtce in 2005 to 40.4 mtce (18.3 per cent from total energy consumption, including 9.2 per cent from biomass in 2030. This will require investments in this sector of approximately 60.4 billion UAH. (EnerceeNet, 2011).

The Russian Energy Strategy for the period up to 2030 plans a progressive liberalization of energy prices on the domestic market to promote more rational energy use, and the establishment of a market for energy services. New standards, tax incentives and penalties, as well as energy audits will be adopted. The Energy Strategy also aims to increase the energy efficiency of buildings by 50 per cent between 2005 and 2030 (and by 10 per cent between 2005 and 2015). It will also implement new mandatory construction standards (ABB, 2011).

Kazakhstan has pledged to reduce its emissions by 15 per cent based on 1992 levels. But it will be difficult to achieve this goal only by reducing the energy intensity of its economy. Therefore, the role of renewables in the reduction of Kazakhstan's greenhouse gas emissions will be significant. In addition, the Ministry of Energy and Mineral Resources (MEMR) has announced its intention to raise the share of renewable energy (excluding hydropower) from its current level of 0.02 per cent to 5 per cent by 2024.

Mechanisms of cooperation, coordination and implementation

International experience suggests that countries that have succeeded in improving their energy and environmental performances have done so through creating an enabling institutional framework for environmental management. They have established a dedicated government body, or agency, such as an energy agency at the national level and similar dedicated bodies at regional and local government levels, to coordinate the engagement of concerned stakeholders in designing and implementing energy policies through partnerships. Partnerships between government, industry and academia are also essential to accelerate technology diffusion and absorption. Reflecting the public good character of green technologies, there is also a need for collective actions and institutional innovations at the international level to motivate national policymaking toward reaching internationally agreed energy and environmental goals.[58] The collective response at the supranational level has been initiated through various voluntary coordination and cooperation agreements among countries, mainly on supra-national regional levels. This international governance framework is a consultative process to engage key stakeholders on green growth issues and to coordinate green policies and programmes across various levels of government, mainly though soft legislation and non-binding rules, norms and action plans.

Role of national institutions

At the *national level*, the central responsibility for the public management of energy and environmental strategy and policy is often held by a *dedicated government body*, such as a national energy or environmental agency. This government body requires strong technical skills and dedication to implement national energy policies. In some countries these agencies are financed partially by the private sector, and in developing countries they are often financially supported by official development assistance (ODA) funds. The mission of these agencies is to design, implement, monitor and evaluate EE programmes and measures, to interact with concerned stakeholders at the national level (such as firms and local governmental authorities), and to ensure coordination with other government bodies, foreign donors, and international financial institutions on all EE initiatives. Many countries in the region recognize these agencies as necessary to foster green policies and to support managing green programmes (Table 9).

Table 9 Energy efficiency institutions and agencies in Europe and NIS region

Country	National Energy Efficiency measure			Ministry Department for energy efficiency		Number of regional/local EE agencies		
	Name of the agency	Budget M US$ or €	Staff	(Yes /No)	Staff number	L for local/ R for regional	Regional agencies	Local agencies
Bulgaria	EEA	0,89M$ (2009)	70	Y	11	R/L	5	5
Croatia	EPEEF / EIHP	189 M€	100	Y	2	R/L	3	1
Estonia	KredEx			Y	3			
Hungary	Energy Centre	3,68 M€	60	Y	**8**	R/L	1	150
Latvia	None			Y		L		2
Lithuania	Energy Agency	0,44 M€	29	None	None	R/L	1	1
Malta	MRA	1.65 M€	49	Y	2	R	1	
Montenegro	None							
Poland	KAPE	1,5 M€	32	Y	4	R	11	
Romania	ARCE	9M$	62	None		R/L	3	6
Slovakia	SIEA	3,05 M€	106			R/L	2	1
Slovenia				Y	12	R	6	

Source: WEC (2010).

58 As a public good, EE can simultaneously address four global challenges: energy security, energy and development, energy and environment and energy poverty.

At the *sub-national* level, many countries have also set up local or regional government bodies to provide more targeted measures and to collaborate closely with local industry players, academia, and local intermediary institutions (such as energy and information centres), when implementing IEE programmes and projects (Box 14). In the EU there are around 900 agencies and energy and information centres, dealing with EE issues and providing technical expertise to industry (WEC, 2010: 46).

Box 14 Dedicated government bodies concerned with energy efficiency and renewable energy in Ukraine

The Ukraine National Agency for Ensuring the Effective Use of Energy Resources (NAER) was established in 2005. Its mission is to shape state policy on energy efficiency issues. The Agency is subordinate to the Cabinet of Ministers as a state body with a special status. The NAER is responsible for:

- Implementation of state policy on energy consumption and energy conservation;
- Ensuring growth in the share of energy derived from non-traditional and renewable sources;
- Establishment of a state system for monitoring the production, consumption, export and import of energy; and
- Overseeing the operation of a system for setting energy consumption norms for industry.

NAER has developed and introduced a range of normative-legal acts on energy efficiency, and is involved in the elaboration of a tariff policy for setting the level of the green tariff charged for electricity from certain renewable sources.

Other bodies include the State Inspectorate on Energy Conservation, subordinated to NAER, which supervises the performance of regulatory acts, establishes standards on energy consumption for production processes and supervises the adherence of enterprises to these standards. The Inspectorate also carries out technical analysis and monitors adherence to energy consumption codes in construction. Based on the initiative of the State Committee of Ukraine on Energy Conservation (the precursor of NAER), each regional administration has also established subdivisions on energy conservation.

Specialized departments or divisions devoted to industrial EE within the relevant ministry can also be created to serve as a focal point for industry to turn to for a number of issues regarding IEE and coordinate relevant industry players in policy formulation and implementation. This unit can also act as the focal point of a network of departmental policy units involved in designing and implementing a country's EE policy (Clark, 2000).

Role of intermediary institutions

An array of *intermediary organizations and institutions* can also help firms implement green projects and meet nationally established targets. Support institutions—such as industry associations, energy conservation centres, cleaner production centres (Box 15), energy research and development laboratories, energy technology and information centres, and cluster development institutions, as well as metrology, standards, testing, and quality control centres—together can create a business environment rich with information and EE relevant knowledge. These institutions can provide technology extension services to industrial firms, such as EE and conservation assessments; technology information dissemination; management and financial services; and provision of training and data collection; as well as facilitating international cooperation and exchange of experts. Many of these institutions initially depend on government subsidies or support from international organizations, but over time they can become administratively and financially independent.

The National Cleaner Production Centre (NCPC) Programme highlighted the potential in industries in developing and transition countries to reduce energy intensity and pollution. This has an additional benefit of raising productivity and competitiveness (UNIDO/UNEP, 2010).

Box 15 National Cleaner Production Centre

Following the United Nations Conference on Environment and Development (UNCED) in Rio in 1992, UNIDO and UNEP jointly launched a programme to establish National Cleaner Production Centres (NCPCs). The NCPCs were set up to deliver services to business, government, and other stakeholders in their home countries and to assist them with adapting and adopting Cleaner Production (CP) methods, practices, policies and technologies. UNIDO and UNEP incorporated the lessons learned from the NCPCs in their joint Resource Efficient and Cleaner Production (RECP) programme strategy. The strategy supports the global imperative to decouple economic development from further environmental degradation and resource depletion. The programme aims to improve the resource productivity and environmental performance of businesses and other organizations in developing and transition countries. The NCPCs promote and facilitate industrial energy efficiency in tandem with pollution prevention, water and materials.

There are currently NCPCs or similar programmes in almost 50 countries (www.unido.org/cp) including 14 countries in the region: Armenia, Albania, Bulgaria, Croatia, the Czech Republic, Hungary, FYR Macedonia, Moldova, Montenegro, Romania, the Russian Federation, Serbia, Slovakia and Ukraine. The NCPCs provide the following core services: training, technical assistance and in-plant assessments; information dissemination; technologies and investment promotion and policy advice.

In close cooperation with the already established NCPCs, UNIDO has undertaken several thematic and sectoral projects for promoting the dissemination of RECP:

- Enabling activities to facilitate early action on the implementation of the Stockholm Convention on persistent organic pollutants (POPs) in Armenia, Azerbaijan, Croatia, the Czech republic, Hungary, FYR Macedonia, Poland, Romania and Turkey
- Energy Efficiency project for “Reducing greenhouse gas emissions through improved energy efficiency in the industrial sector” in Moldova
- Network building

The UNIDO-UNEP Programme on Resource Efficient and Cleaner Production (RECP) (2009-2014) in developing and transition economies foresees thematic cooperation among NCPCs on a geographic basis as one of the main mechanisms for up-scaling RECP activities and achievements and fostering technical and institutional excellence in NCPCs. During the meeting of the 45 member countries of the UNIDO/UNEP Resource Efficient and Cleaner Production Global network held in Lucerne on 19-23 October 2009, the NCPCs in the Europe region stressed their need for support and guidance on how to create communication and information channels with stakeholders and increase active cooperation and exchange of knowledge and experience with other NCPCs. Since then, some initiatives have already taken place, under the joint UNIDO/UNEP Global RECP Programme, including meetings with other European networks and bilateral and regional exchange of experts for supporting the establishment of new NCPCs in the region.

At a coordination meeting held in Macedonia in April 2010, three priorities were identified for the formulation and implementation of joint regional projects: low carbon/climate resilience industries, sustainable tourism and sound chemicals management. As a follow up, surveys were conducted on the activities and results achieved in the region. As a step forward, it was agreed to establish a regional networking mechanism for South and Eastern Europe to promote close cooperation between the NCPCs in the region and foster dissemination of RECP techniques and technologies and joint implementation of the above-mentioned RECP projects.

Chemical Leasing in Serbia

Chemical leasing (ChL) is an innovative service-oriented business model for the sound management of chemicals and is part of the overall RECP approach. It responds to global changes in international policies of the chemical sector. The key element of ChL is a shift of focus from increasing sales volume of chemicals towards a more service-oriented and value-added approach. The producer mainly sells the benefits associated with the chemical. This relates to conditions of use, recycling concepts and disposal. In addition, while in the traditional model the responsibility of the producer stops when the chemical is sold, in the current approach, the producer remains responsible throughout the use and treatment, disposal and recycling phases.

UNIDO launched in 2004 a series of pilot projects to promote ChL in developing and transition countries, in close cooperation with the National Cleaner Production Centres in Egypt, Russia and Mexico. Since late 2007, the NCPCs of Colombia, Morocco, Serbia and Sri Lanka have actively promoted the application of ChL business models to their national industries. It has organized three national workshops with more than 400 participants from government, industry and academia. In addition, 24 national chemical leasing experts were trained.

To date, the Serbian NCPC has been working with a number of national companies on the introduction of ChL and facilitated the start-up and implementation of two major ChL contracts. Seven projects are in the process of being signed. Within its ChL work, the Centre provides technical assistance in process optimization, and advises on legal matters and match-making of companies.During the Global ChL Award Ceremony in Prague in 2010, the Serbian NCPC obtained the Gold Award for its excellent work in promoting ChL. Two national companies, Knjaz Miloš and Ecolab, received the Silver Award for their outstanding work that resulted in water consumption reduction of 1500m^3 per year.

Slovak National Cleaner Production Centre
The Slovak National Cleaner Production Centre, established in 1994, is composed of a non-profit organization and a business enterprise, thereby enabling the centre to deliver value-adding services to businesses and act as a public advocate for clean production (CP), while retaining the added value from close collaboration and joint efforts. The Slovak NCPC is active in networking and maintaining links with strategic partners and stakeholders, and emphasis is placed on the establishment of long-term cooperation and partnerships. The Slovak NCPC is active in all stages of CP project design and implementation—from the early stages of investment preparation and selection of sites, through construction, start-up, operation, modifications, shut down, and decommissioning. One success factor has been ensuring that the centre is a leader in CP, which requires continuous education, training of staff, and an effective knowledge management system.

Source: http://www.scpc.sk/.

Role of network building

A review of firm behaviour by Blackman and Kildegaard (2003) finds that private-sector trade and industry associations and input suppliers are critical sources of technical information about clean technologies. They can be especially important for supporting IEE uptake at the industrial cluster and firms' network levels. Industrial firms' networks can also establish network institutions to collect energy use data and perform benchmarking by comparing a facility to its peers (see Box 16).

Box 16 Examples of the role of network building

Connecting Energy Clusters across Europe- CENCE

Within the CENCE project, established in 2005, a new concept of clustering was introduced: the construction of new, cooperative, relationships between European Energy Clusters focusing on knowledge, know-how, and transfer of experience. Cooperation projects and best practice in three fields were investigated: Renewable Energy Sources, Energy Efficiency, and Distributed Energy Resources.

The overarching goal of the CENCE project was to support cooperation between participant energy clusters for establishing, at EU level, a cooperation and learning platform that facilitates the promotion of entrepreneurial innovation through the exploitation of synergies, the exchange of knowledge, and the transfer of best practice.
Project website: http://www.europe-innova.org/.

The government can facilitate the building of networks on energy efficiency among firms, academia, trade and industry associations, not-for-profit organizations, other relevant groups, and government itself, thus forming a regional innovation system. These networks are particularly important in transition economies, as numerous studies highlight how the organizational culture of a firm can help or hinder the adoption of green technologies (see Box 17).

Box 17 Companies adopting energy efficiency measures

Cash & Carry

The Metro Cash & Carry wholesale store in Brunnthal near Munich uses the waste heat from its commercial air-conditioning system to cover its heating and hot water needs. The reduction in purchases of heat capacity means a corresponding drop in the store's energy costs. The location covers its remaining heat requirements by means of long-distance heating, which comes from a biomass-fired heating plant operated by the local energy supplier Bio Energie Taufkirchen. For fuel, the power plant relies exclusively on wood chippings, made from scrap wood from forestry. Moreover, the store rents its roof for the operation of a photovoltaic system. This system uses sunlight to generate electricity and thus makes a positive contribution to climate protection.
Source: http://www.metrogroup.de/Internet/site/metrogroup/node/14025/Len/index.html.

Energy efficiency in shopping centres

In August 2009, Metro Group opened Meydan Merter, a shopping centre in Istanbul incorporating state-of-the-art technologies in its construction. The 45,000 sq m building is fitted with a solar chilling plant, a 1,200 sq m collector field that captures radiant solar energy. The energy is used to generate warm water that can be employed for both heating and cooling the building. In summer, the energy is used to power an absorption refrigeration system that takes over from the air-conditioning system. Using the solar energy, 770 MWh of heat is generated. This enables the centre to save approximately 475,000 kWh of primary energy and reduce CO_2 emissions by 308 tons per year. Further, the centre has a roof covering the main mall, which can be opened or closed depending on weather conditions, eliminating the need for air conditioning.
Source: Metro Group (2009: 36).

Biodegradable plastic bags at Real in Russia

In Russia, since July 2010, the hypermarket chain Real has been exclusively offering its customers carrier bags made from biodegradable plastics. While carrier bags from conventional plastics such as polyethylene pollute the environment for many decades, the new ecological variant will completely decompose after two years. Moreover, the carrier bags now have to be purchased. This will encourage customers to use the bags more sparingly.
Source: http://www.metrogroup.de/Internet/site/metrogroup/node/14057/Len/index.html.

Toyota aims for zero emissions

To ensure environmental risk management and compliance across all business activities, Toyota developed a consolidated Environmental Management System (EMS), which sets specific requirements for each of the company’s business activities. EMS enables Toyota to reduce environmental impacts such as energy, waste and water, and raises awareness across the company.

Toyota’s Production System (TPS) eliminates waste, reduces energy usage, minimizes the use of raw materials, and delivers standardized quality. Toyota’s vehicle plants in both the UK and France have eliminated landfill entirely, by applying TPS principles and examining how production waste is created. Staff then develop appropriate solutions to reduce, reuse or recycle all generated waste materials. In addition, since 2001 the following reductions have been achieved:

• 37 per cent reduction in total energy usage per car across all the company’s European manufacturing plants.
• 34 per cent reduction in water usage in Europe.
• Reduction of packaging waste through the full use of returnable or recyclable packaging.
• 21 per cent reduction in volatile organic compound emissions per square metre of painted surface.

Source: Toyota (2006: 10).

Lead firms in global and local value chains and production networks can be instrumental in speeding-up green technology uptake in the region by setting an example for local firms.

Acting as sophisticated buyers in global and local value chains, they can also demand that their suppliers pursue energy efficient policies.

Lead firms can also work with local suppliers (and SMEs in particular) to transfer technical skills, prescribe new technology, offer financing options, and provide incentives and recognition programmes for pursuing energy management standards in their subsidiaries or suppliers. This is often done by identifying “packages” of energy solutions common to many industries (such as lighting, air conditioning and waste heat recovery), so that a number of similar IEE projects can be implemented using the same approach and technology

Metro Group, a wholesaler, uses an effective waste management system. It focuses on the principles of a modern and sustainable closed loop recycling programme. The principal aim is to reduce total waste accumulation as much as possible. Where waste cannot be prevented, Metro Group is committed to recycling it in an environmentally-friendly manner. In 2009, the utilization quota amounted to 76.2 per cent. Especially in Eastern Europe, substantially less "waste for disposal" was generated owing to the successful establishment of national recycling structures. In 2008, Metro Group reduced its specific waste volume by just over 6 per cent to 43.2 kg per square metre of selling space, with double-digit decreases achieved in Eastern Europe and Asia. Optimized transport packaging solutions played a key role in this process. For example, reusable packaging is increasingly used in international logistics flows, particularly for fruit and vegetable shipments. In addition, rising commodity prices are causing manufacturers to pay increasing attention to optimal packaging-product proportions.

Conclusions

While significant progress has been made in the pan-European region towards reducing energy intensity and increasing energy efficiency, the energy efficiency gap between the EU and the other countries in the region persists, as shown by this chapter. Why does this gap remain?

Numerous case studies point to the existence of various market and institutional barriers and failures that are inhibiting firms from investing in profitable energy efficiency projects. Environmental management issues are slowly being integrated into private sector strategies. But, all too often potential industrial users are not aware of the advantages and opportunities arising from investments in efficient technologies, or when they are, cannot easily obtain the funding required to acquire the new equipment or introduce the necessary plant modifications. Decision makers do not always benefit directly from their choices and it is not easy to estimate all the costs, benefits, risks and duration of industrial energy efficiency investment projects. Moreover, government subsidies of energy prices do not make these investments more attractive. It is important to recognize that these barriers exist in developed countries, but they are more pronounced in transition economies because of weak institutions, budgetary constraints and lack of skills in government administration.

Budgetary constraints limit the ability of governments in many countries to provide eco-entrepreneurs with the finance they need, while there is only a small number of investors in ‘clean-tech’ ventures (ETAP, 2010). It is particularly difficult for SMEs to access funds. An emerging trend is for clean-tech FDI to target emerging markets but the leap from R&D to commercialization requires further development and an innovation-conducive environment. Local knowledge is also lacking to absorb new technology and to help with expansion into new markets.

Eco-entrepreneurs face a particular problem in convincing potential funders of the attractiveness of the growing market in eco-technologies. SME surveys have found that critical barriers include a lack of finance tailored to SMEs' investment needs, and inadequate synergies between the technology and commercial aspects. Private sector reluctance might be overcome by public sector investment and procurement, but this is often lacking in low and middle income countries in the region. The particular needs of SMEs can be met through participation in global and regional value chains and these practices are becoming more frequent in the region. Lead firms in the value chain can be important agents providing access to new knowledge, skills and technology and can also demand compliance with standards.

Despite political support for addressing environmental and energy issues at national and regional levels, barriers to industrial energy efficiency abound in the region and vary according to country context. How can transition economies overcome these market and behavioural barriers? A useful lesson from newly industrializing economies is that all obstacles to energy and resource efficiency result from transaction costs, information asymmetries, behavioural failures, and lack of modern collective actions to deal with interdependencies. As such, institutional arrangements ought to be designed to reduce or eliminate these costs and information gaps, and to deal with interdependencies.

Box 18 EU 20/20/20 targets

The European Union (EU) exemplifies how to use energy efficiency targets to align energy and environmental policies at the regional and national levels. The EU 20/20/20 targets call for a 20 per cent cut in GHG emissions by 2020, compared with 1990 levels; a 20 per cent increase in the share of renewable energy sources in the energy mix; and a 20 per cent cut in energy consumption from 2005-2020.

A multitude of different policy approaches can be used to deal with these barriers and to encourage better green technology uptake, but a holistic approach is needed to overcome them in the region. This will require an inventory of barriers specific to the region and policies to address them at the national and international level. Development of a regional strategy on how to address these barriers and a draft joint work and action plan are also called for.

Developed countries in Europe that have successfully improved greening of their industries have created an enabling governance framework for the uptake of new environmentally-friendly technologies and practices in industry such as energy efficiency, waste management and recycling services, renewable energy technologies, energy efficiency services, and environmental analytical and advisory services. This framework includes a mix of policies and processes, such as regulatory, fiscal, and financial and information policy, and various mechanisms for securing effective policy formulation and implementation. Each country needs to adopt an appropriate policy mix that reflects the specificities of its national competitive and natural advantages.

A preliminary step to overcoming barriers involves establishing long term goals and quantifiable and achievable efficiency targets through strategies (see Box 18). In turn, this step requires benchmarking the performance of a given sector or country, followed by identifying opportunities to develop and improve energy efficiency. Once realistic and measurable targets are set, their attainment can be enforced or encouraged through a coordinated set of regulatory and government policies and programmes that provide strong economic incentives for green technology uptake in industry.

Many countries have adopted national energy strategies, programmes and sectoral action plans with the purpose of integrating energy and environmental goals with developmental goals. But an effective policy framework to deliver these goals is still lacking, and the capacity to transform vision into policy action and to manage implementation of policies and programmes is limited. A system of monitoring, revenue collection and enforcement, which is necessary for successful implementation of market-based policy instruments, remains a key challenge in many countries.

Although established in many countries in the region, government bodies charged with the implementation of industrial energy-saving programmes still lack the necessary capacity and technical skills to design, implement, and evaluate energy efficiency programmes and measures; to interact with concerned stakeholders at the national level (such as firms and local governmental authorities); and to ensure coordination with other government bodies, foreign donors, and international financial institutions. In many countries in the region, including those that are resource rich, international technical assistance to assist with the design and implementation of national energy strategies, policies and programmes is still critical.

Environmental management issues are slowly being integrated into private sector strategies but access to finance, and lack of awareness of potential savings to be made from energy efficiency investments are preventing firms from investing in profitable energy efficiency projects. For industrial eco-innovation to take-off in the region there needs to be political commitment through setting realistic and measurable targets, and designing a coherent policy framework to support market forces, R&D and innovation efforts, provision of infrastructure, and public funding. Innovation and R&D have been gaining momentum on the back of debates on knowledge-based industrial development, the notion that new technologies and their combination thorough smart policies are the main drivers of the third industrial revolution and are contingent on levels of skills and innovative activity.

Recent EU accession states from the region demonstrated a reluctance to accept pan-European carbon reduction targets, demanding instead that their energy security needs be met first. They were also concerned that energy efficiency targets would constrain their ambitions for economic ‘catch-up’. But, these countries are also coming to see the opportunities that target setting presents, in terms of increased competitiveness, reduced energy costs and profits from investing in renewable energy.

Studies on industrial energy efficiency and conservation in the region highlight that, even without major changes in lifestyles, it will be possible for countries to realize high levels of growth without concomitant increases in GHG emissions. These studies often present a variety of scenarios for cutting CO_2 that countries can follow by using low-carbon energy supplies, improved energy efficiency, or carbon capture and storage. Poland, for instance, could realize a 31 per cent reduction in 2005 levels of CO_2 emissions by 2030 (McKinsey 2009a: 9). Similarly Russia, with its huge natural resources and potential for raising energy efficiency in industry and buildings, could double its GDP by 2030 while keeping its GHG emissions close to 1990 levels (McKinsey 2009b: 5).

Energy security and energy diversification are also consistent with the goal of a pan-European energy and resource efficient economy, in combination with the infrastructure to trade in renewable energies. Countries with huge potential in this area have much to gain. Indeed the prospects for energy and resource efficiency and the application of eco-technologies are considerable in the region given its population and demand for new technologies. There is evidence that these technologies are diffusing into the region, for instance in the steel industry, but there is great variance among countries.

Developed countries in the region are currently leading the way in green technological advancements. But with focused strategy development, targeted knowledge transfer, and improved access to finance, other countries could leapfrog the transitional stage by leveraging high-tech eco-innovation and information and communication technology to achieve greater industrial diversification and productivity.

As a legacy of previous energy regimes there is also an undeveloped culture of energy efficiency in many Europe and NIS societies and economic sectors. Cultural predispositions, social and institutional norms can strongly influence firms' decision-making that can lead to path dependency and can limit or facilitate firms' response to public policies to raise industrial energy efficiency (see Box 19). But these norms can also change over time in response to awareness building and good policy making. Developing and encouraging concepts of responsible behaviour through energy efficiency strategies, policies and programmes for supporting national objectives for energy security and environmental sustainability are therefore important. As climate change, energy and resource efficiency concerns are embedded in national and regional policy-making, this will lead not just to eco-innovation, but will also change how industry, business and government work together to better manage resources (McKinsey, 2009b: 11).

Box 19 Conducting research on environmental damage in Ukraine and Kazakhstan

Reducing environmental damage in the coal sector in Ukraine

For several decades, coal mining has fuelled industrial growth and supported jobs in the Donbass region of Ukraine. However, these benefits have come with heavy cumulative environmental costs arising from inefficiencies in the mining process, including the poor disposal of spoil, water and slurry. In addition, there has been no attempt to capture and use methane gas released from the mines.

In 1998, the EU financed a study of the coal sector in Ukraine designed to improve performance and reduce environmental externalities. The study employed a "Business as Usual" analysis tool to test various scenarios of operational practices and produce forecasts for the period 2010 to 2030 that could provide guidance for policy options.

The study recommended a wholesale transformation of the institutional framework and a revised business plan for the mining sector which would enable Ukraine to move into a new era of sustainable coal production, and achieve significant environmental gains. In July 2010, the government reacted to the policy recommendations of the study, issuing a Programme for the Sector 2010-2014, prescribing key institutional changes. A further development was the closure of the Ministry of Coal in December 2010. However, progress has since stalled and it is not clear when the Government will fully enact the recommended institutional framework and business plan for the sector.

Environmental Publications and Reports: Kazakhstan

Over the past decade, countries in Central Asia and the Caucasus have seen many changes and developments in environmental management. In Kazakhstan, the Country Environmental Analysis (CEA) is an attempt to formulate and improve institutional structures and strengthen capacities. The analysis outlines the impact of the Soviet and post Soviet legacy of industrialization and agricultural policies. It analyses the underlying reasons for environmental degradation, provides an assessment of the economic implications of this degradation and discusses the challenges and priorities for the country. From the analysis, twelve priority issues have been identified, including air quality improvement, urban waste management and poverty alleviation.

Sources: Puri, S., A. Demydenko, T. Hoencamp, and D. Sukhinina (2010); Puri (2003).

Many countries in the region have established dedicated bodies that are charged with developing strategies and policies to boost eco-innovation, or have produced action plans on science and technology. At the supra-national regional level, the European Commission has established an eco-innovation initiative, as part of its Competitiveness and Innovation Framework Programme, designed to bridge the gap between R&D and commercial application. The initiative is based on the idea that the best eco-innovation products or processes are those that can be replicated across the whole EU. In line with EU efforts, similar efforts are underway in the region. Eco-innovation is increasingly incorporated in national strategies for economic competitiveness and growth (for example in the Russian Federation and Serbia). With increasing environmental awareness across the region, there is likely to be an attitude change at the firm level towards energy and resource efficiency.

In conclusion, the experiences of successful countries suggest an outline of the key components of a successful policy mix to stimulate Green Industry.

- ***Regulatory policy*** such as laws and regulations, codes, standards, and labelling, to remove least-efficient equipment and practices from the market and to cut GHG emissions, because industry must comply with the laws enacted. Developing comparative labels and introducing information labels on goods and services to fill the information and knowledge gap, thereby allowing consumers to make rational decisions and incentivizing manufacturers to design products that achieve higher ratings than the minimum standards.

  Introduce Minimum Efficiency Performance Standards (MEPS) for industry to increase demand for energy efficient equipment as well as Energy Management Standards (EMS) to improve energy performance through changes in the way energy is managed in an industrial facility. Evidence from national and international programmes shows that while efficient components may bring about gains in the range of 2-5 per cent in industry, system optimization measures can attain average energy efficiency gains in the range of 20-30 per cent with a payback period of less than two years. On a national level, governments can play a role in encouraging companies to establish an EMS, by providing information on best practices, training on how to comply with standards, and recognizing industrial firms that meet standards. Public standardization policy allows businesses to overcome information and agency constraints. International cooperation in standardization makes it possible to cut the transaction costs associated with introducing equipment.

  Introduce energy efficiency targets for the economy as a whole and for different sectors to create incentives for investment in green technologies and practices. Look at the model of National Energy Efficiency Action Plans (NEEAPS) adopted by EU member states which combine a range of tools including financial incentives, technical assistance tools, information provision, recognition programmes, mandatory auditing and R&D support. In Action Plans, combine issues of sustainability, energy security and competitiveness.

  Within sectors, targets can be negotiated between government and industry based on assessments of energy efficiency and energy conservation potentials at the firm level. These agreements can be used to raise awareness of industrial energy efficiency and secure engagement of all relevant stakeholders, including firms, industry associations, financial institutions and governments, in joint efforts to deploy the best available technologies, implement benchmarking and monitoring schemes and foster innovation through the development of a long-term strategic plan to increase energy efficiency in industry. If considered ineffective, these agreements can be replaced by mandatory alternatives.

Consider the drawbacks of legislation: the targets set by the law may be unrealistic; legislation is typically copied from developed countries and not adequately adjusted to local or country contexts; and enacted legislation may be in conflict with other economic and social goals. Stringent standards can raise manufacturers' anxiety about shrinking profit margins and market consolidation, and amount to the erection of non-trade barriers. The economic costs per unit of energy reduced are often higher for legislative measures than for other instruments. There is also a risk of technology "lock-in" at levels decided upon in regulation, and typically insufficient funds are allocated to implement, enforce, and monitor enacted energy efficiency legislation.

- ***Fiscal and market-based policies***

Use carbon pricing carefully as a precondition for creating market incentives to change consumer behaviour and promote investment in industrial energy efficiency.

Remove direct and indirect (e.g. reduced VAT rates) subsidies on carbon-intensive energy (fuel and electricity) to create demand for energy efficiency technologies and to be in line with climate policy. Removal of these subsidies and consequent carbon-intensive energy price increases, are more likely to have a significant impact on the adoption of energy efficiency because of the long lifetimes and slow turnover of energy-intensive industrial appliances and capital equipment.

Carbon pricing is not sufficient to address market failures such as information failure, behavioural failures and technology creation and diffusion failures. Therefore complementary policies are needed. Some countries in the region will benefit from emission trading schemes (ETS). Bulgaria, Estonia, Lithuania, Poland and Slovakia are predicted to exceed targets for renewable sources, creating surpluses in green energy that can be sold to EU countries that fall short of the targets.

Apply direct subsidies and tax allowances to mobilize customers, to prepare for new regulations, or to promote new environmentally friendly products, final consumer products and technologies by creating a larger market than would otherwise exist.

Give subsidies directly from public funds to producers and consumers or via direct corporate income taxation and indirect taxation for achieved energy performance. Public and commercial financial institutions can offer soft loans or subsidized interest rate loans to industries that invest in energy efficient technologies and equipment.

Support demand side management (DSM) schemes – voluntary or compulsory initiatives by energy utilities to encourage end-users to improve energy efficiency. Utilities are in a unique position to influence energy efficiency behaviour owing to their financial, organizational and technical capacity. DSM aims to change the level or pattern of customer consumption by providing rebates, loans, subsidized audits, free installation of equipment and energy awareness programmes to industrial firms.

Promote energy savings through Energy Service Companies (ESCOs), together with wide-ranging information collection and dissemination, carrying out demonstration activities, capacity building, and developing guidelines and model contracts. Consider that programmes targeting energy management systems face obstacles, namely a lack of incentives for utilities to implement DSM, and the need to establish the requisite legal and financial settings required for widespread ESCO use.

- ***Financial policy*** instruments such as soft loans, guarantees and revolving funds, and venture capital funds, help increase the capital available, and decrease perceived risk.

  Public finance and technical cooperation programmes are needed to address the lack of capital and capacity until green technology has reached the diffusion stage. Public and development financing institutions can set up loan programmes (soft loans, credit lines, publicly-backed guarantees) to fill the financing gaps in immature financial markets.

  West European countries should provide assistance to new member states through EU structural funds and subsidies for national renewable energy subsidies. If the EU wants to extend energy efficiency across the region, including smart grids for tradable renewable energy, it should also consider developing portfolios of measures to assist the various countries.

- ***Information policies*** such as information and awareness campaigns and establishing offices to disseminate energy efficiency information increase the awareness of industrial energy efficiency benefits at various levels of production. They create possibilities for choice among all possible technical options and make the costs of available technologies transparent. They have no direct impact on GHG emissions or production costs, but they do have the potential to change stakeholders' perceptions. Though relatively easy to implement, they do require public funding and the presence of pre-existing institutions for the organization and implementation of campaigns—again, a major obstacle for many developing countries.

  Provide information on energy efficiency opportunities through a variety of technical information sources including fact sheets, brochures, guidebooks, technical publications, an energy efficiency database, energy efficiency assessment and self-auditing tools, case studies and industry- and technology- specific energy efficiency reports and benchmarking tools.

  Public awareness and education campaigns can boost industries' capability and willingness to adopt what had previously been seen as high cost and risk technologies. Training and information programmes can also help to improve industrial firms' absorptive capacity.

- ***Training and recognition programmes***
  Governments can also launch programmes that promote energy management practices in industry through establishing and supporting various technical assistance programmes.

  Recognition programmes should reward firms that make an effort to implement energy efficiency. These programmes, which consist of a contest and awards ceremony, a media event and exposure, and a recognition certificate, have been proven to be effective in promoting a more positive perception of energy efficiency by highlighting the potential benefits and publicising successful outcomes. Using energy efficiency rewards to garner a competitive advantage can assist in embedding the pursuit of energy efficiency in an organizational culture. And, at the company level, energy awards provide a platform for companies to audit their energy usage, identify possible energy savings projects, and ultimately increase company profitability and productivity.

- ***R&D and innovation policies*** such as providing government-funded and performed research; subsidizing research in the private sector; developing a minimum level of technology infrastructure both in terms of skilled human capital and physical capital; and fostering the development of clusters and networks by which tacit and codified knowledge can be transmitted and regional innovation systems for stimulating commercialization of new technologies can be established.

  Mainstream pro-innovation regulations and incentives into environmental policy making, encouraging value-creation responses to the goal of decoupling economic growth from energy use.

  Seek to learn from and incorporate foreign knowledge and technology upgrading. The creation of new technology is complex, resulting from scientific advances, learning-by-doing, and directed and spillover technology R&D efforts in both the private and the public sectors. This complements indigenous areas of scientific expertise where appropriate. It is vital that innovation policies are adapted to local environmental requirements.

  Foster innovation on the supply side (technology push), through government-funded research, subsided research in the private sector and government-introduced intellectual property rights (IPR).

  Promote diffusion of energy efficiency technology in industry through considering the government's role as the final consumer of some environmental goods, which can help to generate demand for new green technologies among local firms, and encourage investment. This can also form the basis for increasing productivity and boosting innovation in state owned firms, and particularly in SMEs that are too small to lead on high technology investment. Public procurement is an important means of addressing demand side weaknesses of innovation. Incorporating a green growth agenda into government procurement and green criteria in all tender processes is particularly important in emerging economies where the state has a greater role in boosting demand in order to make up for weaknesses in the private sector.

- ***Monitoring, evaluation and reporting***
  Environmental monitoring and reporting systems should be established to identify violations and to assess whether policies have been effective over the long term. Indicators should form part of all monitoring and enforcement regimes, as a tool to simplify, quantify and communicate environmental data. Effective compliance regimes should include a combination of promotion, monitoring, and enforcement tools, which are mutually supportive. Methods to promote compliance, such as education, training and outreach, are an important feature of enforcement and compliance regimes.

- ***Diversify the energy mix and increase the share of renewables***
  Due to energy security concerns several countries, particularly those that rely on Russian gas, have prioritized a diversified supply of energy. The next step is to concentrate efforts on shifting energy diversification towards renewable energy supplies, the potential for which in most of the region is substantial.

Countries that have succeeded in improving their energy and environmental performances have done so through creating an enabling institutional framework for environmental management. They have established a dedicated government body, such as an energy agency at the national level and similar dedicated bodies at regional and local government levels, to coordinate engagement of concerned stakeholders in designing and implementing energy policies through partnerships.

Partnerships between government, industry and academia are also essential to accelerate technology diffusion and absorption.

National institutions: At the *national level*, the central responsibility for the public management of energy and environmental strategy and policy is often assigned to a *dedicated government body*, such as a national energy or environmental agency. This government body requires strong technical skills and dedication to implement national energy policies.

At the *sub-national* level, many countries have also set up local or regional government bodies to provide more targeted measures and to collaborate closely with local industry players, academia, and local intermediary institutions (such as energy and information centres), when implementing IEE programmes and projects.

An array of *intermediary organizations and institutions* can also help firms implement green projects and meet nationally established targets. Support institutions—such as industry associations, and cleaner production centres, energy research and development laboratories, energy technology and information centres, and cluster development institutions, as well as metrology, standards, testing, and quality control centres—together can create a business environment rich with information and energy efficient relevant knowledge.

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Annex

Agenda of the Round Table

9:30 am	***Welcome and opening remarks:*** ***Olga Memedovic***, Chief Europe and NIS Programme, UNIDO
9:40 am	***Introductory remarks by moderator:*** ***Scott Foster,*** Director, Sustainable Energy Division, UNECE, Geneva
9:45 am	***Keynote speech:*** ***Friedrich Hinterberger,*** Scientific Head, Manager, Sustainable Europe Research Institute (SERI), Vienna
9:55 am	***Panel discussion***
10:35 am	***Open floor discussion***
10:55 am	***Concluding remarks:*** UNIDO
11:00 am	***Cocktail reception***
	UNIDO Director-General participated in the discussion

List of Panelists with Biographies

Keynote speaker

Friedrich Hinterberger

Scientific Head, Manager, Sustainable Europe Research Institute (SERI), Austria

Mr. Hinterberger is the founding President of the Sustainable Europe Research Institute (SERI), and a board member of the Austrian Chapter of the Club of Rome. He served as a scientific member at the Justus-Liebig University, Giessen (1985-1991). He was a leader of the working group Ecological Economics and Ecological Economical Policy at the Wuppertal Institute for Climate, Environment and Energy (1993-2000). Since 1985, he has taught at universities in Austria and abroad.

Mr. Hinterberger holds a PhD in Economics and Public Finance from Justus-Liebig-University, Giessen, Germany.

His work focus is ecological economics, scenarios for sustainable economies and societies, and quality of life research.

Panelists

Murat Sungur Bursa

Chief Executive Officer, Zorlu Energy Group, Turkey

Mr. Bursa has over 30 years' work experience, including 25 years in Turkish government institutions, occupying mostly high-ranking positions, such as under-secretary, general manager and director. He has extensive experience of international affairs, environmental and development issues, as well as the implementation of multi-billion dollar earthquake rehabilitation projects.

Mr. Bursa is a graduate of Mechanical Engineering and holds a Masters Degree in Business Administration.

Irene Gamsjäger

Chief Financial Officer, Siemens, Austria

Ms. Gamsjäger's professional experience in the Siemens corporation includes research and development management, product management, mergers and acquisition, and corporate strategic projects. After several international assignments, Ms. Gamsjäger is now responsible for commercial and shared functions of the SIMEA R&D, and Production Facility for Electronics, with six plants in Austria and Romania.

Ms. Gamsjäger holds a degree in Economics from the University of Economics, Vienna.

Panelists (continued)

Timur Ivanov

Director General of the "Russian Energy Agency" Ministry of Energy of the Russian Federation

Mr. Ivanov has held executive positions in commercial organizations (1997-1999), worked as an advisor to the Department of Construction of Nuclear Objects within the Russian Nuclear Ministry (1999-2002), as an advisor to the First Deputy Director of 'RosEnergoAtom' (2002-2006), and as both advisor to the President (2004-2006) and the First Vice-President at the firm 'AtomStrojExport' (2006-2008).

Mr. Ivanov has also been deputy chairman of the company 'Inter RAO EES' (2008-2009). Since 2008, he has been First Vice-President of 'AtomStrojExport' and an advisor to the Energy Minister.

Mr. Ivanov holds a degree in Applied Mathematics from Lomonosov Moscow State University, a degree in Finance and Economics from the International Academy of Marketing and Management and a degree in Economics from Ivanovo State University.

Marek Kulczycki

Member of the Supervisory Board of Deutsche Bank, Poland

Mr. Kulczycki has been a staff member at UNIDO (1980-1986), Department Director in the Ministry of Foreign Trade in Warsaw, in charge of business cooperation between Poland and OECD countries (1987-1991), and was appointed Deputy Minister in the Ministry of Trade and Industry in 1991. In addition, he has worked for the Polish-American Enterprise Fund as head of the loan programme for the small business sector, and as President and CEO of the First Polish-American Bank in Krakow (later-Fortis Bank Polska). He held the position of CEO and President of the Management Board of Deutsche Bank between 2002 and 2009.

Mr. Kulczycki is the author of several publications, manuals and books on economics and finance. He holds a PhD from the Foreign Trade Faculty, Warsaw School of Economics, where he also lectured between 1971 and 1980.

Alexey Makushkin

Director General of Analytical Center for the Government of the Russian Federation

Mr. Makushkin has been Director General of the Analytical Center for the Government of the Russian Federation since 2009. He has worked as Director for economic programmes in Russia as Chief Economist for Russia, Director of the East-West Institute (Moscow office), and Head of the Center for Situation Analysis at the Accounting Chamber of the Russian Federation (2007-2008).

He graduated in 1983 from Plekhanov Institute of the National Economy (Moscow) with a degree in National Economy Planning. He holds a PhD in Economics (Institute of Economics of the USSR Academy of Sciences).

Panelists (continued)

Michael Zgurovsky

Rector, National Technical University of Ukraine “Kyiv Polytechnic Institute” and Director, Institute for Applied System Analysis of National Academy of Sciences of Ukraine and Ministry of Education and Science of Ukraine

In addition to other positions, Mr. Zgurovsky is Head of the Association of Rectors of Technical Universities of Ukraine and Co-Head of the Ukrainian Union of Scientists and Engineers.

Mr. Zgurovsky is the author of more than 350 scientific publications, including 35 books published abroad, and is the recipient of awards from Ukraine, Italy, Poland, Estonia and Vietnam. He is three-time recipient of the State Prize of Ukraine in the field of science and engineering (1990, 1999 and 2005), and was awarded the Glushkov Prize of the National Academy of Sciences of Ukraine in 1996 and the title of Honorary Scientist of Ukraine in 2000.

Mr. Zgurovsky holds a PhD in Technical Sciences, and is academician of the National Academy of Sciences of Ukraine, and a member of the Russian Academy of Science.

Moderator

Scott Foster

Director, Sustainable Energy Division, United Nations Economic Commission for Europe (UNECE), Geneva

Mr. Foster has more than 30 years' experience in the energy field. He has worked extensively with governments and international organizations on energy policy, market design and regulation, climate change, investment promotion, and renewables technology and policy. He has led major studies of the long-term outlook for European energy markets from pricing and supply security perspectives, and has advised governments, regulators, and industry on the strategic implications of those outlooks. Before founding Nomad Energy Consulting in 2004, Mr. Foster was Vice President of Global Regulatory Affairs within AES Corporation, Senior Director for Global Power with Cambridge Energy Research Associates (CERA), and Senior Expert in the Energy Diversification Division of the International Energy Agency.

Mr. Foster holds MS in Civil Engineering from Stanford University, and an MBA from UC Berkeley.

List of UNIDO Staff Members with Biographies

Mr. **Kandeh K. Yumkella** is Director-General of the United Nations Industrial Development Organization (UNIDO). Before assuming his current post, Mr. Yumkella worked in various high-level policy positions in UNIDO, and was Special Advisor to two previous Director-Generals. He also served as Director of the Africa and LDCs Regional Bureau and a Representative and Director of the first UNIDO Regional Office in Nigeria. Prior to joining UNIDO he served as Minister of Trade, Industry and State Enterprises of the Republic of Sierra Leone. Mr. Yumkella holds a Ph.D. in Agricultural Economics from the University of Illinois.

Mr. **Dmitry Piskunov** is Managing Director of the Programme Development and Technical Cooperation Division. Prior to joining UNIDO, Mr. Piskounov held various senior executive positions in the Academy of Science and in the governments of the Soviet Union and the Russian Federation, including Deputy Chief Executive Secretary of the Presidium of the USSR Academy of Science and Advisor to the President of the USSR Academy of Sciences. Mr. Piskounov holds a Ph.D. in solid-state physics and semiconductors from the Moscow Institute of Electronic Technology.

Mr. **Heinz Leuenberger** has been Director of the Environmental Management Branch (EMB) of UNIDO since March 2006. The Branch is responsible for activities related to resource efficient and cleaner production, waste, chemicals and water management and the reduction of mercury use in artisanal gold mining. Mr. Leuenberger is currently involved in the design, formulation and implementation of the 'Green Industry Initiative' of UNIDO. Prior to joining UNIDO, he served as Chief Technical Advisor (CTA) for the Vietnam Cleaner Production Centre, the Cleaner Production Programme of Lao PDR, and the Kingdom of Cambodia. Mr. Leuenberger holds a Ph.D. in Chemistry from the Federal Institute of Technology (ETH) in Zurich, Switzerland.

Mr. **Pradeep Monga** is an energy expert with over 30 years working experience in the field of energy policy, strategic planning and clean technologies. Mr. Monga is presently working as Director of Energy and Climate Change at the United Nations Industrial Development Organization (UNIDO). His primary responsibility is to provide strategic policy advice to member states on sustainable energy issues. Prior to joining UNIDO in 2001, Dr. Monga worked with UNDP for over five years, overseeing their energy and environment portfolio in India. He has held senior positions in the Government of India, and undertaken several international assignments with the World Bank, FAO and other multi/bi-lateral organizations. Mr. Monga holds a Ph.D. in Rural Energy Policies and Alternatives.

Ms. **Amita Misra** is Director, Bureau for Regional Programmes and Deputy to the Managing Director, Programme Development and Technical Cooperation Division, UNIDO. Previously, she served as Senior Advisor to the Director-General and as Director of the Financial Services Branch, where she successfully led the Organization to meet the UN system goal of becoming IPSAS compliant. Prior to joining UNIDO in 2004, she served in diverse capacities in major Indian public enterprises, and in federal, state and municipal governments. She was a consultant with the IMF on financial restructuring and, as a UN auditor, she has worked on oversight of UN agencies.

Ms. **Olga Memedović** is Chief of the Europe and NIS Regional Programme of UNIDO. Ms. Memedović has 30 years work experience, including as Senior Industrial Development Officer in the Strategic Research and Economics Branch and the Private Sector Development Branch of UNIDO. Prior to joining UNIDO, Ms. Memedović worked as project leader at the Netherlands Economic Institute, and as Research Fellow at the Tinbergen Institute of Erasmus University Rotterdam, Free University Amsterdam and University of Amsterdam. She has been a consultant and project leader for research projects for the World Bank, European Parliament, European Commission, and Dutch Ministry of Foreign Affairs. Further she was an economist at Energoprojekt (a multinational engineering, construction and consulting company in Belgrade). Ms. Memedović holds Ph.D. in Economics from Erasmus University.

Mr. **Edward Clarence-Smith**, has worked at UNIDO for 12 years and is Head of UNIDO's Regional Office for China, the Democratic People's Republic of Korea, Mongolia, and the Republic of Korea. Prior to this, Mr. Clarence-Smith worked in UNIDO's Cleaner Production programme and was the Senior Coordinator for all UNIDO programmes funded by the Global Environmental Facilities (GEF). Before joining UNIDO, Mr. Clarence-Smith worked for the Natural Resources Defense Council in New York, the Environment Directorate of the OECD in Paris, the Joint Research Center of the European Commission, an international environmental consultancy company in Italy, and the US Environmental Protection Agency (USEPA) in Washington, D.C. Mr. Clarence-Smith holds a degree in Environmental Engineering.

Памятная записка

I. Введение

В ходе четырнадцатой сессии Генеральной конференции ЮНИДО, которая будет проходить 28 ноября – 2 декабря 2011 года в Вене, в рамках программы ЮНИДО для Европы и новых независимых государств (Европа и ННГ) будет организован региональный круглый стол по теме "Содействие развитию инновационных отраслей и технологий для обеспечения устойчивого будущего в Европе и регионе ННГ". Тема круглого стола указывает на то, что интеллектуальные стратегии и политические меры, нацеленные на развитие комплекса новых инновационных отраслей и технологий и предназначенные для конкретной страны и региона, имеют важнейшее значение для согласования трех основных элементов устойчивого развития: экологического, экономического и социального.

II. Справочная информация

Для реализации национальных целей развития странам с переходной экономикой в Европе и регионе ННГ требуется промышленная модернизация. С учетом существующих экологических, социальных и экономических проблем основное внимание в ходе этого круглого стола будет уделено необходимости перехода региона к новой модели промышленного развития, которая обеспечивает ресурсо- и энергоэффективность, сокращение выбросов углерода, малоотходность, низкий уровень загрязнения и безопасность при одновременном повышении производительности труда, создании рабочих мест и повышении благосостояния общества. Доминирующие модели производства и потребления не только не совместимы с этими целями устойчивого развития, но и не дают возможность пользоваться преимуществами быстрорастущих рынков товаров и услуг, имеющих более устойчивый характер.

Общественное благо, формирующееся благодаря многим новым экологически безопасным технологиям и услугам, нередко свидетельствует о том, что современные рыночные силы не в состоянии обеспечить тот уровень инноваций и развития, который необходим для решения глобальных проблем. Для преодоления многочисленных рыночных сбоев и барьеров, препятствующих внедрению этих технологий и товаров, требуются новые инновационные промышленные стратегии и политические меры, которые предполагают мобилизацию научных, технологических и финансовых ресурсов для построения в будущем новой модели развития.

В странах с переходной экономикой препятствия на пути внедрения новых экологически безопасных технологий и продуктов могут быть еще более заметными вследствие того, что наряду с рыночными сбоями и барьерами в них имеются институциональные, управленческие и функциональные проблемы. Необходима более эффективная политическая основа, отвечающая конкретным условиям соответствующих стран региона, включая их потенциал в плане улучшения обслуживания региональных и глобальных рынков и функционирования в качестве составной части региональных и глобальных производственно-сбытовых цепей. Для того чтобы расширить масштабы технологических изменений и вывести регион на путь устойчивого развития, требуются также согласованные коллективные действия на национальном и региональном уровнях.

III. Цели круглого стола

Главная цель круглого стола – помочь лучше разобраться в том, какие отрасли, технологии и политические инициативы могут способствовать переходу к устойчивому будущему в Европе и регионе ННГ. Перед участниками круглого стола стоят также следующие цели:

- Определить новую парадигму развития региона и разработать новую модель развития, которая исключала бы зависимость экономического роста от потребления ресурсов (материальных и энергетических) и отходоемкого и неэкологичного производства и потребления, но предусматривала обеспечение возможностей для создания новых рабочих мест и совместного использования материальных благ обществом.

- Изучить ситуацию в регионе и его субрегионах с точки зрения использования и продуктивности ресурсов, энергоемкости производства, выбросов парниковых газов, применения патентных и лицензионных соглашений, касающихся экологически безопасных технологий, а также прогресса, достигнутого в деле содействия повышению энерго- и ресурсоэффективности промышленного производства, и выявить проблемные зоны, связанные с высокой ресурсо- и энергоемкостью в качестве приоритетных направлений для принятия мер стратегического характера.

- Обсудить перспективы и возможности новых инновационных отраслей и технологий в энергетике (включая такие возобновляемые источники энергии, как ветровая, солнечная и геотермальная энергия; новое поколение угольных и энергетических сетей, таких как интеллектуальные микроэнергосистемы) и в обрабатывающей промышленности (например, удаление и утилизация отходов, рациональное водопользование, биотехнология, более чистое производство, промышленная энергоэффективность, энергосбережение и экология).

- Обсудить руководящие и политические рамки, обеспечивающие системный и согласованный подход к достижению энергетических, экологических и социальных целей и целей экономического роста, включая рассмотрение вопросов о том, насколько эффективным будет углеродный налог с точки зрения стимулирования более широкого использования неуглеродных источников энергии? Какой комплекс законодательных мер, рыночных инструментов, мер по расширению знаний осведомленности общественности, добровольных соглашений и программ управления с учетом фактора спроса необходим для развития рынков для инновационных отраслей и технологий?

- Обсудить роль таких новых политических инициатив, как "умные города", инновационные сети и региональные инновационные системы, "умный транспорт" и "умное материально-техническое снабжение", которые могут способствовать применению и внедрению на рынке инновационных продуктов и процессов, уменьшающих загрязнение окружающей среды и содействующих эффективному использованию природных ресурсов. Какие механизмы и показатели можно использовать для измерения и мониторинга прогресса?

- Обсудить вопрос о том, каким образом управление региональными и глобальными производственно-сбытовыми цепями может способствовать внедрению экологически безопасных технологий и продуктов.

IV. Вопросы, подлежащие обсуждению

В ходе данного мероприятия будут рассмотрены некоторые возможные решения и ответы на вышеизложенные вопросы и будет заложена основа для разработки новой устойчивой промышленной модели для региона. Интерактивные обсуждения будут развернуты вокруг следующих четырех основных вопросов: каким является нынешнее положение региона, каким оно может быть в 2050 году, какие отрасли и меры потребуются для претворения в жизнь этой концепции и какие меры могут облегчить переход. В рамках этих тем в ходе обсуждений будут освещены, в частности, следующие проблемы и вопросы:

- Что представляют собой глобальные и региональные рынки для устойчивых экоинновационных продуктов и услуг и как они формируются?

- В каком положении находится регион с точки зрения энерго-/ресурсоэффективности и экоинноваций (обзор показателей для мониторинга устойчивого промышленного развития и информирования директивных органов). Какое отношение это имеет к региональным и глобальным производственно-сбытовым цепям?

- Каковы потенциальные возможности региона с точки зрения перехода к новой модели промышленного роста? Обладает ли регион потенциалом, который позволит стать направляющей силой в процессе продвижения к третьей промышленной революции? Какой должна быть роль региона в 2050 году?

- Какие существуют барьеры, препятствующие внедрению в регионе новых инновационных отраслей и технологий?

- Какие руководящие и политические рамки требуются для содействия инвестициям в новые инновационные отрасли и технологии в регионе? Что представляют собой другие политические меры/ варианты, такие как нормативная политика (законодательные меры, например, законодательство в энергетической сфере, целевые показатели исполнения, аудит, кодексы, маркировка и стандарты); рыночные инструменты (например, налогообложение, адекватное ценообразование на ресурсы, субсидирование потребителей и торговые схемы); финансовые инструменты (системы стимулирования, содействующие получению малыми и средними предприятиями доступа к финансированию), меры в области инноваций, информационные меры; добровольные соглашения и механизмы (например, корпоративная социальная ответственность, глобальная инициатива в области отчетности); программы и инструменты управления спросом; кодексы поведения поставщиков и частные соглашения.

- Каким образом новые отрасли и технологии могут создавать новые рабочие места и способствовать повышению конкурентоспособности и обеспечению устойчивого будущего? Какие примеры этого существуют в регионе? В чем заключаются инициативы в области инновационной политики?

- Какова оптимальная роль общественных и частных структур и ведущих организаций в стимулировании и координации участия заинтересованных сторон в разработке и осуществлении устойчивых стратегий и мер на основе партнерских отношений промышленности, научных кругов и правительства?

V. Организация работы и повестка дня круглого стола

В ходе круглого стола будут проведены интерактивные обсуждения с участием отдельных докладчиков/ участников дискуссий под руководством эксперта в данной области, который будет вести обсуждения. В ходе круглого стола будут представлены несколько справочных документов и аналитических материалов по соответствующим вопросам. Докладчики и участники дискуссий будут представлять правительства, научные учреждения, государственный и частный секторы и профессиональные органы, проявляющие интерес к вопросам, связанным с новыми технологиями и устойчивым развитием. Приглашения к участию в работе круглого стола направляются высокопоставленным представителям правительств, международных учреждений по вопросам развития, банков, научных учреждений и гражданского общества.

Сначала будут представлены доклады, посвященные сценариям, опыту, политике и новым инициативам в отдельных странах, а затем будут заслушаны замечания группы экспертов.

VI. Повестка дня круглого стола

09:30	Официальное приветствие ЮНИДО и вступительные замечания: • ***Кандэ К. Юмкелла,*** Генеральный директор ЮНИДО; • ***Дмитрий Пискунов,*** Управляющий директор ЮНИДО.
09:40	**Модератор** представит цели и структуру круглого стола и предлагаемый подход к его проведению, подчеркнув, что основное внимание будет уделено поиску ответов на главный вопрос: "Какие новые отрасли, технологии и политические инициативы будут способствовать переходу к устойчивому будущему в регионе?". Затем Модератор представит основного докладчика/участников дискуссии.
09:45	**Основной докладчик** представит главную тему круглого стола, выделив основные вопросы для обсуждения. В своем докладе он в общих чертах изложит основные тенденции, стимулы, риски и возможности в области обеспечения устойчивости.
10:00	**Обмен мнениями участников дискуссии:** Модератор кратко затронет важнейшие положения основного доклада и, опираясь на них, будет стремиться содействовать интерактивному обсуждению ключевых тем/ вопросов участниками дискуссии. Модератор будет вовлекать участников дискуссии в беседу, с тем чтобы они высказали свои мнения и предложения относительно конкретных мер.
10:40	**Вопросы и ответы:** Модератор предложит присутствующим, представившись, задать участникам дискуссии вопросы.
10:55	**Модератор** посвятит заключительные пять минут круглого стола подведению итогов и обобщению ответов на главный вопрос и закроет круглый стол не позднее 11 час. 00 мин.
11:00	**Коктейль**

VII. Вспомогательная документация

Для облегчения определения рамок обсуждений заблаговременно будут представлены и распространены несколько справочных документов и аналитических материалов по соответствующим вопросам. Дополнительные справочные материалы будут включать перечень докладчиков/ участников дискуссии и их биографические данные, а также соответствующие материалы ЮНИДО.

VIII. Языки

Рабочий стол будет проводиться на английском языке с синхронным переводом на русский язык.

IX. Список лиц для контактов

Ms. Olga Memedovic	**Ms. Solomiya Omelyan**
Chief, Europe and NIS Programme United Nations Industrial Development Organization (UNIDO) E-mail: O.Memedovic@unido.org Tel: (+43 1) 26026 4676 Fax: (+43 1) 26026 6822	Programme Officer, Europe and NIS Programme United Nations Industrial Development Organization (UNIDO) E-mail: S.Omelyan@unido.org Tel: (+43 1) 26026 3818 Fax: (+43 1) 26026 6822
Ms. Shabnam Marboot	**Ms. Aloma Macho**
Assistant, Europe and NIS Programme United Nations Industrial Development Organization (UNIDO) E-mail: S.Marboot-Sadegh@unido.org Tel: (+43 1) 26026 3439 Fax: (+43 1) 26026 6822	Senior Secretary United Nations Industrial Development Organization (UNIDO) E-mail: A.Macho@unido.org Tel: (+43 1)26026 3399 Fax: (+43 1) 26026 6822

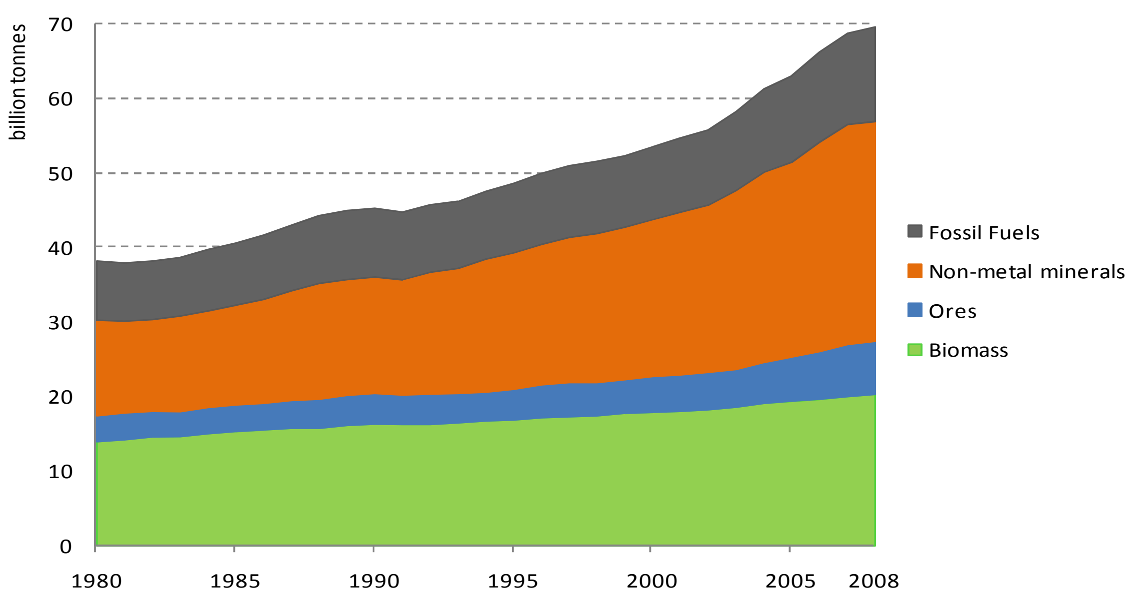
Keynote Speech and Summary of the Round Table Discussion

Keynote speech: Resource efficiency and eco-innovation: Opportunities and challenges for the Europe and NIS region

Friedrich Hinterberger, SERI

Global resource use continues to rise in all categories of materials, including biomass, fossil fuels, metals and minerals (see Figure 1). Increased resource use must be curtailed to forestall a global crisis. Environmental problems, including climate change, water scarcity, air pollution and loss of biodiversity, which have a massive negative impact upon quality of life, are caused in one way or another by the excessive use of all categories of resources, and not just energy use at the global level.

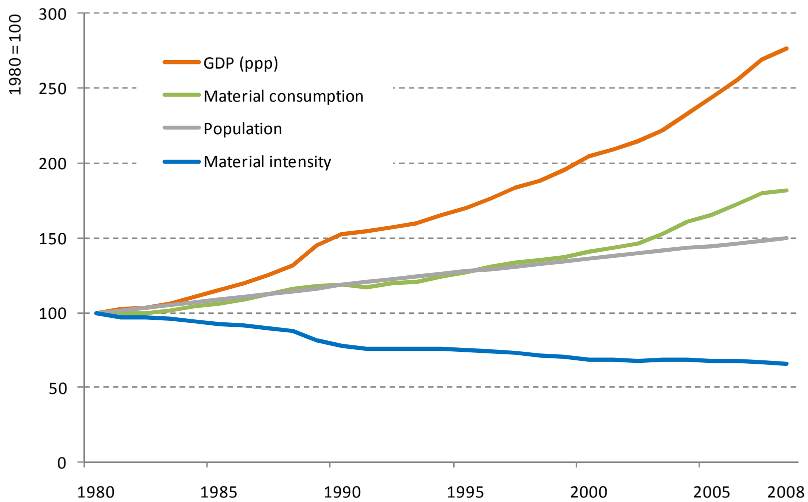
Figure 1 Global material use



Source: SERI (2011).

Despite this increase in material use, some decoupling at the global level has occurred (see Figure 2). Material intensity has been cut by 30-40 per cent over the last thirty years but material use is still increasing. This rise has been in line with population growth. However, in recent years, the rate of growth in material use has been outstripping population growth, mainly because of large investments in infrastructure in emerging economies. It is hoped that this growth will flatten once this infrastructure-building period is complete.

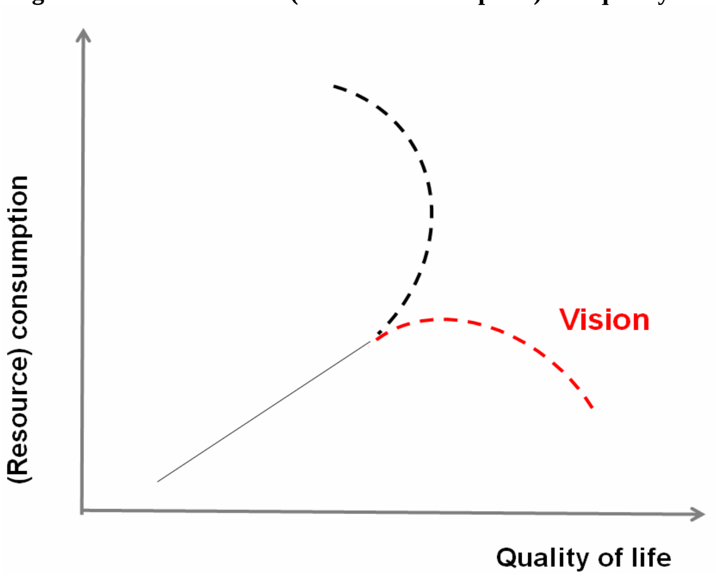
Figure 2 Global 'relative de-coupling' but absolute growth in consumption



Source: SERI (2011).

The danger is that after a sustained period during which quality of life has improved globally, resource use at current rates of growth will lead to a deterioration in the quality of life due to its negative environmental consequences. The vision now is to reduce global resource consumption in absolute terms (see Figure 3). The challenge is how to achieve this in order to mitigate environmental problems, while at the same time exploiting economic opportunities. Energy and material savings, expansion of new markets and eco-product design hold the promise of economic and environmental benefits.

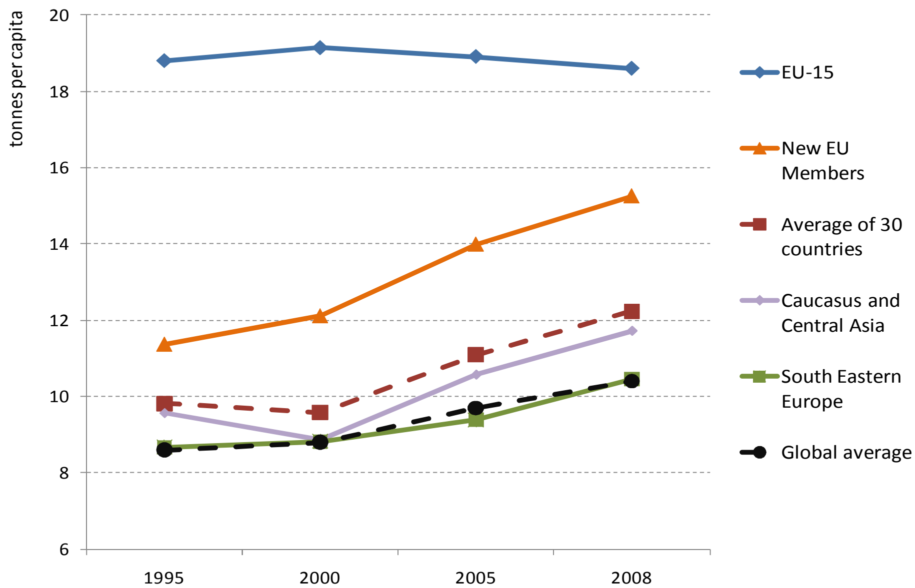
Figure 3 Future of (resource consumption) and quality of life



Source: SERI (2011).

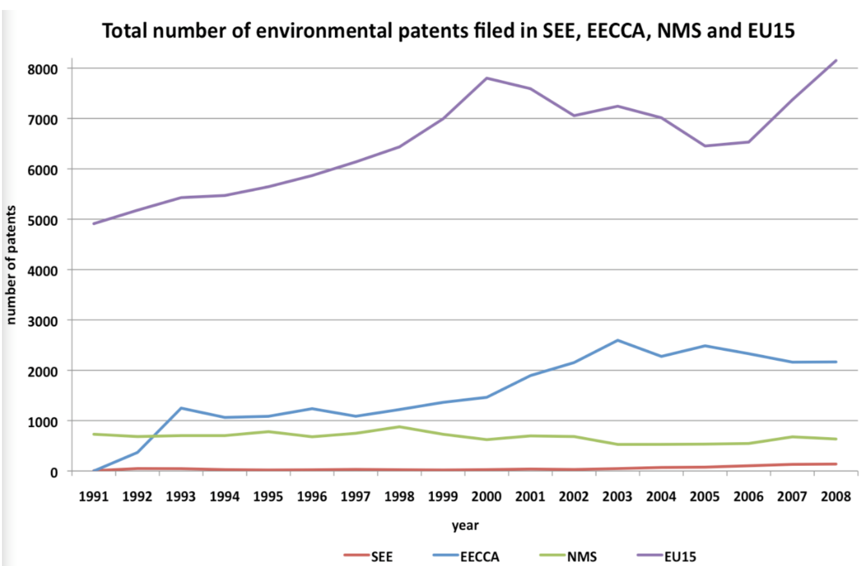
Compared to the European Union, particularly the EU-15, where material consumption has remained broadly stable, in the Europe and NIS region it has been increasing. The new EU Member States have increased material consumption the most and are approaching levels found in the EU-15, but there are also substantial increases in other sub-regions, although these remain well below EU-15 levels (Figure 4). This divergence in Europe and NIS region is also reflected in environmental patents; the EU-15 and new member states have the most, whereas the other sub-regions have only a fifth or a tenth as many (Figure 4).

Figure 4 Material consumption by region, 1995-2008



Source: SERI (2011).
Note: Average of 30 countries represents 30 countries across Central and Eastern Europe and the Newly Independent States.

Figure 5 Environmental patents filed by region, 1991-2008



Source: Technopolis (2011).

Figures 4 and 5 underline the diversity in the Europe and NIS region in terms of economic and social structures, innovation and technology profiles. Overall, the region has seen improvements in material and energy efficiency over the past fifteen years, but the trends are not sufficient to close the gap with the EU-15. This is why the current development path must change.

Countries need policies and strong commitment to bring about an absolute reduction in resource use. A policy framework that addresses the whole life cycle of products, from resource extraction and manufacturing to consumption and recycling, is needed. The whole value chain should be examined to assess the material and environmental consequences of production and consumption. Often, only part of the value chain is created in a single country or region, while resources come from various countries of the world. This means that coherent and integrated policy mixes are needed at the local, national, regional and global levels, covering material and energy (or carbon) taxes, the diffusion of technology and standards, and all sectors: transport, housing, infrastructure, industry, manufacturing and services.

Round Table Discussion

Moderator: Mr. Scott Foster, *UNECE*

Panelists:
Mr. Murat Sungur Bursa, *Zorlu Energy Group*
Ms. Irene Gamsjäger, *Siemens*
Mr. Timur Ivanov, *Russian Energy Agency*
Mr. Marek Kulczycki, *Deutsche Bank*
Mr. Alexey Makushkin, *Analytical Centre, Government of Russian Federation*
Mr. Michael Zgurovsky, *National Technical University of Ukraine 'Kyiv Polytechnic Institute'*

Special guests:
Mr. Dmitry Politov, *Skolkovo Foundation*
Ms. Marianne Moscoso-Osterkorn, *Renewable Energy and Energy Efficiency Partnership (REEEP)*

Olga Memedovic (Chief, EUR and NIS Programme, UNIDO) opened the Round Table and welcomed the panel members and participants. The purpose of the Round Table and the main issues to be covered are energy efficiency, eco-technology and renewable energy, which are central to the question of sustainable industrial growth in the Europe and NIS region. After the introductory remarks, Olga Memedovic introduced Scott Foster, the Round Table Moderator.

Scott Foster (Moderator) reminded the panelists and audience about the recent announcement of the birth of the seven billionth human being, a milestone that underlines the challenges facing the planet, and drew attention to the data showing a convergence of resource use among richer countries. These data indicate that a key challenge is how to move beyond country convergence at the higher levels of resource use. There has been a lot of talk about the role governments should play in influencing markets and ensuring that they work effectively, for example, to achieve energy efficiency. Scott Foster invited Timur Ivanov to comment on this issue.

Timur Ivanov (Director General of the "Russian Energy Agency" Ministry of Energy of the Russian Federation) pointed out that in Russia the task ahead is to improve efficiency in the economy, where energy intensity is up to 2.5 times higher than in most European and North American countries. The question is how to ensure that Russian firms are competitive, given that energy intensity is so high. Industrial firms expect government support to close the gap between the technical potential for energy efficiency and the financial tools at their disposal.

Substantial improvements are achievable though the concerted commitment of society. A decree signed by President Medvedev in 2008 commits Russia to cut energy intensity by 40 per cent by 2020. Russia has also adopted a special task force charged with cutting energy intensity by 13.5 per cent by 2020. The remaining 26.5 per cent will come about from structural changes in the economy. Russia has also recently established a customs zone with Kazakhstan and Belarus, and it expects imminent membership of the World Trade Organization (WTO). The government should further explore ways to incentivize business investment in energy efficiency and modernization.

State-owned enterprises, for instance, are legally obliged to reduce energy consumption by 3 per cent annually. Other measures include compulsory energy audits. However, a coherent state approach towards energy efficiency in the economy has yet to emerge. Although ecological issues and CO_2 emissions are discussed in the Russian Duma, the business sector is impatient for new laws to be passed. The government's role is to establish the overall policy framework for businesses to operate and business should use this to make investments and to modernize. Legal provisions would motivate business to improve efficiency and would also justify investments in energy efficiency. At the same time, the government should not concentrate solely on penalizing businesses for failing to meet targets.

Renewable energy sources currently represent less than 1 per cent of energy supply, and the target is to increase this share to 4.4 per cent by 2020. This target translates to more than 10 gigawatts of capacity. A problem is that investment in renewables in Russia has few precedents. There is potential for Russia to specialize in waste energy. Annually, 600 billion tonnes of different types of waste are generated and new technologies could lead to synergies: heat provision; solving ecological problems; and the creation of valuable derivatives such as biomass, biofuel and biogas.

Timur Ivanov concluded by calling on the Russian government and the Russian Energy Agency to identify existing barriers to energy efficiency and to work together to move things forward. At the moment the special task force is helping and the government is also providing regional subsidies to the tune of 200 million roubles. Within a framework established by the government, these subsidies should be used to catalyze business activity.

Following on from the comments made by Timur Ivanov on subsidies, Scott Foster asked **Irene Gamsjäger**, from Siemens, to remark on the most efficient way of bringing new solutions to the marketplace, including new technologies. Should it be through government R&D, subsidies or through some other solution? Irene Gamsjäger underlined that Siemens is committed to contributing to the discussion on sustainability. Siemens is involved in sustainability in two ways: it is a green company and it also seeks to promote green industry, through its green portfolio focusing on energy efficiency and sustainable energy, which currently represents around one third of company sales.

Siemens has 25-26 production enterprises in Central and Eastern Europe. The company's environmental work is not only motivated by a desire to be a socially responsible — the 'good guy' — but also by good business sense as the company can profit from this sector. Siemens realizes that if it wants to be a green company it must ensure that all stages of the value and supply chains are clean. This is Siemens' philosophy and all the company's factories around the world have the same approach to energy efficiency.

What motivates a company like Siemens to expand into the Europe and NIS region? Irene Gamsjäger explained that Siemens follows market opportunities. Siemens is interested in local resources, whether it is raw materials or human resources. Siemens' typical approach, which is similar to that of other multinational companies, is to source materials locally.

To forward the green economy the countries of the Europe and NIS region need to develop their own domestic technologies and this requires investment in education and R&D. They also need to stem brain drain since the brightest and best are easily lured abroad by better pay and conditions.

Irene Gamsjäger concluded by reiterating the importance of localization. The demand for high-technology products is not the same in industrialized and in transition countries, so this difference represents an opportunity for local set-ups in the region. Siemens always provides subsidiaries in other countries with a package of methods and processes to become greener, but for industry as a whole to become greener, there must be substantial investment.

Referring to Irene Gamsjäger's remarks on the importance of considering the complete value chain when thinking about sustainability, Scott Foster asked **Alexey Makushkin** (Analytical Centre, Government of the Russian Federation) for his thoughts on the quality of available data and statistics: Are the numbers that we have consistent across countries and industries? And how can we be sure that we are gathering the right information?

Alexey Makushkin remarked that official statistics in the NIS had been badly hit in the past 20 years by institutional collapse, which has made it difficult to use official statistics to inform industrial policy. Unlike some Southern and Eastern European countries, Russia has not borrowed statistical experience and techniques from Western Europe. Although the process of reform will take some time in Russia, there is a reliable, robust and versatile system of statistical monitoring. The important thing is to understand what data are being collected for. In this case it is eco-economics and the greening of industry. Due to their expertise and international experience, academia and think tanks have an important role to play in data collection and analysis.

Often regular statistics are not incorporated into policy making. In Russia this is an issue since public institutions lack the expertise to use statistical data in a meaningful way in the policy making process. This boils down to a basic lack of understanding of what outcomes-based monitoring is. There is a conservative mentality that focuses on financial or technical issues, which is not sufficient to deal with the issues at hand. This is where organizations such as the UNIDO have a role to play, namely to put in place a system that provides educational opportunities for building capacity of public administration and to facilitate multi-level governance.

To approach the issue from the perspective of the private sector, **Scott Foster** asked **Murat Sungur Bursa** (Zorlu Energy Group) to address the question: What should governments be doing to spur private sector involvement in eco-issues? Murat Sungur Bursa stated that existing patterns of consumption and production, as well as patterns of development, are unsustainable. This is a big issue and there is no easy solution. There needs to be cooperation and coordination between all relevant actors, including the public and private sectors.

Governments tend to make short-term decisions and seek to avoid being blamed for any environmental costs. From the private sector perspective, sustainability represents a niche and an opportunity that varies from country to country according to the size of the market and government regulations. It is important to highlight two separate processes. The first is that companies are becoming more eco-friendly whilst at the same time seeing their profits rise. However, this does not mean that the economy or society is on the right track. Observers should not assume that, although a company is regarded as a green energy company, the sector is green or even that it is becoming greener. This leads to the second point; to confront the challenge of green industry, we need the private sector, government and multinationals to work together to ensure that the potential of the private sector is fully realized.

Governments should focus on education to change behaviour so that future generations are raised with values based on sustainability. Governments should also put in place environmentally-friendly legislation and ensure compliance with this legislation. Greater compliance will help to increase the size of the market. Third, public procurement is a major driver for the private sector, and governments should adjust procurement decisions to bring them in line with environmental legislation.

In terms of subsidies, it is wrong to think that the private sector wants more and more subsidies.

Subsidies can have a negative effect, by encouraging companies to make the wrong investment decisions. The private sector wants to avoid subsidies that push the market in the wrong direction. Governments should incorporate environmental costs into the total costs for materials, services and production. The private sector has to accept this.

The private sector also needs long term policies and a long-term commitment from governments to increase market stability and predictability. This will help to ensure that the full potential of private sector capacity is realized.

Turning to **Michael Zgurovsky** (National Technical University of Ukraine, Kyiv Polytechnic Institute), Scott Foster asked whether we have the right information needed to measure progress towards sustainability. It is one thing to have data, and another to use this to inform policy. A critical question is whether we have the right indicators of progress in the Europe and NIS region. Michael Zgurovsky noted that many international organizations are conducting analysis and synthesizing indices and data. A problem is that simple arithmetic and aggregation of raw data often lead to errors. To ensure validity and reliability, it is important to use intellectual data-processing technologies.

A further problem when speaking about the estimation of data validity or reliability is the variance of opinions surrounding similar data, which in turn influences interpretation. Therefore it is very important that international organizations and institutions are careful about the tools they use to synthesize new data and indicators.

Scott Foster then asked the last panelist, **Marek Kulczycki** (Deutsche Bank, Poland), member of the supervisory board of Deutsche Bank in Poland, to comment on the barriers that exist to financing investment in sustainable development, and on the connection between long term challenges and the short term financial crisis.

Marek Kulczycki began by summarizing the focus of the Round Table as being on three issues – employment, energy and economic effectiveness. Employment, which is not a new issue, was also mentioned by UNIDO Director-General Kandeh Yumkella in his opening speech at the 2011 UNIDO General Conference. It is still a problem with huge social and economic consequences. Without employment life has no meaning. Similarly, without energy, there cannot be employment and production. Effective financing is also crucial to employment. Innovative technologies and industries cannot exist without financing.

Marek Kulczycki argued that every reasonable project which is feasible from a technical, financial and economic perspective will succeed in finding financing. There is no shortage of financial resources. Generally, at a national and global level, liquidity is not a barrier to investment. Rather, the problem is miscommunication between relevant actors.

The financial sector today lacks any connection to the real economy, and has instead turned to the virtual economy, investing in financial instruments, such as derivatives, rather than in products. Using the example of Poland, Marek Kulczycki described how savers' money is not being used to fund tangible projects, for example in the energy sector. Instead, the rate of return on their savings is dependent on indices of foreign stock exchanges, something about which Polish people have very little understanding.

The private sector wants stability. Whilst profitability is an important factor, the private sector also needs government to work with it to reduce risk and uncertainty. Marek Kulczycki described the vicious circle that acts as a barrier to investment in sustainable energy projects and technologies. As financial institutions, banks want to see that environmental projects are supported by governments so that, for instance, renewable energy sources are included in the national electricity generation system. On the other hand, the government wants confirmation that a project has financial backing before it will commit to making it a priority. Somebody has to break this circle. The private sector, government, and institutions such as UNIDO cannot do it by themselves. Governments and UNIDO are not good entrepreneurs so therefore these three actors must work together to find a solution.

Marek Kulczycki said that UNIDO had a very important role to play. There is a lack of communication between government and the private sector and UNIDO can mediate. UNIDO should take advantage of its global reputation and facilitate dialogue.

Having heard from all the panelists, Scott Foster introduced the two guests at the Round Table – **Marianne Moscoso-Osterkorn**, former Director-General at the Renewable Energy and Energy Efficiency Partnership (REEEP), and **Dmitry Politov** from the Skolkovo Foundation, Moscow. Marianne Moscoso-Osterkorn's discussion focused on education, awareness raising, subsidies and the role of governments. Energy crises are critical for driving national energy efficiency programmes. Japan during the 1970s is the first example where an international energy crisis motivated a country to focus on energy efficiency. Japan initiated a nationwide energy efficiency programme in response to rising global energy prices. Education and awareness of energy efficiency are important. We should direct attention at subsidies that distort energy prices. The IAEA estimates that global annual subsidies on fossil fuels amounts to US$ 200 billion. It is not, however, a simple matter of removing the old subsidies and applying new ones. Fossil fuels are still needed and must be supported. The further issue is data. Targets are set, but governments do not fully understand what the targets are for, or the baseline is unclear. This is an area where UNIDO has a very important role to play.

Moscoso-Osterkorn made a final point about the role of government as an investor, referring to Murat Sungur Bursa's comments on the procurement rules of governments, which are critical indicators and drivers for pushing the private sector in the right direction. Governments can be champions of environmentally-friendly investment and, if they behave in a certain way, the private sector will follow.

Dmitry Politov (Skolkovo Foundation, Russia) began by summarizing the topic of the discussion as sustainable development that encompasses energy issues and energy efficiency. Because the root of the issue is consumption and production patterns, we need to look at sustainable development, to produce new technologies that will make every aspect of life more efficient. Dmitry Politov echoed the comments of Marianne Moscoso-Osterkorn in underlining the importance of education for innovation, which requires government funding and support. Governments should support companies that are trying to increase energy efficiency and those that are developing new efficient technologies.

Dmitry Politov also followed on from Marianne Moscoso-Osterkorn's comments about funding, arguing that banks typically only proceed with investments if they are sure of government support. In Russia, they are attempting to create a special enterprise zone at Skolkovo, which will house a university and will be the first energy efficient city in the world. In three years the Skolkovo Innovation Centre will open and it will serve as a valuable example for UNIDO.

Joining the panel, UNIDO Director-General, **Kandeh Yumkella** stated that UNIDO could not have chosen a better topic than sustainable development for the region. With concerted effort, it is possible that the third industrial revolution could be, if not led, then co-led by the region. Mr. Yumkella mentioned UNIDO's hosting of the Nevski Forum in Russia where similar topics were discussed and many countries from the region were represented. Widespread use of terms such as eco-technology show that the foundations are in place and that the political machinery is already engaged in discussion.

Kandeh Yumkella mentioned the first water optimization conference held a couple of years ago in Hungary, supported by Slovenia and Slovakia, as well as the host nation. After the conference, Coca-Cola announced that it was going to look at water optimization in the supply chain, which Kandeh Yumkella believed was evidence that UNIDO was working in the right direction. Hungary has been leading on this issue in particular. There was a large attendance at the Hungarian Embassy when they hosted a discussion during the World Economic Forum.

Kandeh Yumkella also used the examples of Azerbaijan and Kazakhstan. At last year's World Energy Forum conference on energy efficiency, the Kazakhstan delegation were keen to discuss innovative new industries. In Azerbaijan too, Kandeh Yumkella spoke of a conversation with the President about the vision for new industries and in particular solar power. Finally, he referred to his visit to Montenegro and the government intention to declare the country the world's first eco-state.

He used these examples to highlight the appropriateness of the focus on innovation. The Europe and NIS region has a strong scientific base, unlike many other regions. It is also next to the EU, where ambitious targets are already in place, such as the 20-20-20 goals. Such targets provide industry with the long term stability it needs to make investment decisions. Common goals spread as policy becomes more stable, first by country and then by region. The private sector needs clear goals and stable public policy if it is going to respond. The market for cleaner technologies in the region will boost economic growth. The region also has the potential to lead in these technologies because it can start from scratch and develop new types of infrastructure, compared to other countries where the infrastructure is more mature. Kandeh Yumkella's final comment addressed the need for collective action. Countries need to work together because it is in the collective interest to do so.

Scott Foster reiterated the enormity of the challenge, as shown by the comments made so far by the speakers, and opened the floor to questions from the audience.

Grzegorz Donocik (former UNIDO staff member) referred to Murat Sungur Bursa's discussion on the role of government in promoting education, legislation and compliance enforcement. At present, the region is very marginal in promoting new innovative technologies and is dependent on technology imports. This is because countries in the region allocate too little to R&D in comparison to countries such as Finland and Israel. If the region wants to contribute to new technologies then it is the governments' responsibility to provide more money for science, technology and development.

Scott Foster asked the panelists to speak about governments' role in supporting R&D. **Timur Ivanov** mentioned Skolkovo, which is the biggest R&D project in Russia. The Russian president has also issued decrees that oblige state-owned companies to re-invest 3 per cent of total turnover in R&D. It is important to understand what exactly is required and what results are wanted. This requires collaboration with UNIDO and other partners to build a vision of where the market should go and what should be done. Timur Ivanov also mentioned that the Russian government was spending money on education, at the regional and federal level, including awareness campaigns directed at children.

Irene Gamsjäger said that she also saw an important role for R&D but stressed the importance of finding local solutions to local problems. It is arrogant to assume that German mindsets and technologies can be automatically applied to other countries, and thus it is important to understand local markets and their requirements. Public funding helps to speed up this process when the private sector is not mature enough.

Murat Sungur Bursa welcomed the focus on R&D. Using an example from his experience as an engineer, the point was made that existing technology does not allow us to reach full sustainability, which is why we need R&D.

Volker Krey (International Institute for Applied Systems Analysis, Austria) referred to Friedrich Hinterberger's presentation, specifically his comments on the inclusion of energy in holistic policy frameworks. Volker Krey said that it was difficult to implement such policies in reality because they involve the cooperation of multiple institutions. Volker Krey asked what the panel thought was the biggest challenge in the region as well as in general for implementing such holistic policies.

Andreas Klingen (Erste Bank Group, Austria) picked up on the remarks made by Murat Sungur Bursa and Timur Ivanov concerning stability and reliability, which he described as the key issues. Investors looking to make long term investments will only do so if they are confident of stability. Other factors are already in place, such as R&D, skilled people and support from international organizations; what is necessary is stability in the region and Andreas Klingen asked what was being done for this.

The next remark came from **Ummuhan Yokus**, (Ministry of Science, Industry and Technology, Turkey) who emphasized his agreement with the comments made by Murat Sungur Bursa and Timur Ivanov on energy efficiency and energy consumption. Ummuhan Yokus went on to discuss the importance of the knowledge-based economy and its connection to technology. Using the example of Turkey, Ummuhan Yokus commented that it was difficult for countries where most firms are small and medium enterprises to invest in new technologies and R&D. Competitiveness and innovation programmes that include energy efficiency and material consumption are needed. Collaboration and an environment that is conducive to knowledge dissemination are also important.

A question from **Kamila Mukhamedkhanova** (Centre for Economic Research, Uzbekistan) referred to the role of government control of energy infrastructure services and the applicability of public-private-partnerships for the regulation and control of service infrastructure. Kamila Mukhamedkhanova also asked about the panel's opinion on creating demand for energy efficiency, and the possibilities of changing people's behaviour.

A final comment was made in Russian by a representative from the Kazakhstan delegation. After thanking Kandeh Yumkella for mentioning the efforts being pursued in Kazakhstan on energy efficiency, the delegate described some of the projects that the government was pursuing. Mention was also made of the government's plan to develop an integrated energy efficiency plan and the problems faced by major enterprises in Kazakhstan in obtaining financial support for R&D.

Scott Foster noted that time was running out and asked the audience to send any questions they might have to the secretariat. Scott Foster then called upon the rapporteur, **Edward Clarence-Smith** (UNIDO staff member), to give a brief summary of the Round Table

Edward Clarence-Smith made some concluding remarks on the need for a new approach to industrial development that could lift millions of people out of poverty without harming the environment. Unless we develop new green growth plans, the eco-systems that support our economies will collapse. Industrialization is the only way to reduce poverty and maintain quality of life. UNIDO follows two strategies. The first involves the greening of industry while the second is the generation of new green industries.

Current developments are unstructured and governments need to engage. The panelists had given us some guidance on what needs to be done. Edward Clarence-Smith then cited a process used in quality assurance: Plan-Do-Check-Act, and mentioned the problem of data.

Both government and industry need to be clear about their respective roles. One side cannot take all the responsibility. Edward Clarence-Smith referred to Marek Kulcyzycki's remark that there must be a role for international organizations such as UNIDO, but we have to work out exactly what that role should be. Once roles are clarified then we must act since the topics raised at the Round Table are not academic. For this, we also need good policies and we heard during the Round Table from the panelists and the audience some ideas about what these should be. Finally, we also need a reliable set of indicators to monitor the results of our actions.

Scott Foster and **Olga Memedovic** thanked everyone and closed the Round Table.

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