ECE/ENERGY/GE.6/2014/INF.1

Discussion Paper No. 1

Economic Commission for Europe

Committee on Sustainable Energy

Group of Experts on Energy Efficiency

First Session
Geneva, 17-18 November 2014
Item 5 of the provisional agenda
Draft Work Plan of the Group of Experts on Energy Efficiency for 2014–2015

Initial review of energy efficiency in the ECE region[1]

Contents

[1] The designations employed and the presentations of the material in this paper do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This paper has been issued without formal editing. Mention of firm names and commercial products does not imply the endorsement of the United Nations.

Executive summary

The Group of Experts on Energy Efficiency is mandated to carry out concrete, result-oriented activities that, in line with the Sustainable Energy for All (SE4All) initiative of the United Nations Secretary-General, help significantly improve energy efficiency in the region, thus contributing to economic growth, improved social wellbeing, better energy security and climate change mitigation effort.

This paper provides a general outlook of energy efficiency status based on available data from IEA, GTF and WEC. It takes a look at aggregate indicators of energy intensity and energy productivity and gives a brief overview of industry, transport, residential and services sectors based on available data.

The energy intensity among United Nations Economic Commission for Europe (ECE) members has been improving. Countries are moving towards using less energy to produce a unit of value-added activity. Meanwhile in the ECE region the rate of improvement in energy intensity, which is considered as a proxy indicator for energy efficiency evolution by GTF[1], has been slowing down and doesn't meet the objectives of the SE4All initiative (-2.3% of compound annual growth rate (CAGR) for 1990-2010 period versus the SE4All objective of -2.6% for 2010-2030 period). Nevertheless, improvements in intensity in the region provided cumulative reductions in energy consumption of 800 EJ in the twenty years from 1991 to 2010. This amount is higher than the primary energy consumption of all ECE member states for the three year period from 2008 to 2010.

Aggregate energy intensity can give an overall picture of the situation, but it offers little useful information for policy making unless it is supplemented with underlying sector details. This detailed information on sectorial and sub-sectorial activity is what is often missing for many countries of the region. Without this data it is difficult to monitor the state of development of energy efficiency, the drivers for energy demand, or potential policy responses. Neither the amount of energy savings nor the scale of required investments in energy efficiency can be properly estimated without appropriate indicators.

Hence, energy efficiency data collection and analysis is an area that might be developed. There is no one unique approach to statistics treatment since the needs depend on the situation of the given country. However the Group of Experts jointly with the international organizations might work on data collection standards and their implementation in ECE countries. The states should seek to prioritize policy information needs because the cost of collecting energy and activity data at a detailed level might be high. Data collection requires not only financing, but also time and development of human resources and a clear strategy.

The Group of Experts on Energy Efficiency might identify information priorities by conducting a survey on disaggregated energy intensity indicators, or undertaking a project to identify information needs and data priorities to ensure only necessary data is collected and minimize costs. The project could be carried out in cooperation with such international organizations as IEA, IPEEC, WEC, Energy Council, etc. The results of the survey would be the first steps towards identifying information gaps and thus indicating in what sectors and in which way data collection could be strengthened.

[1] IEA and the World Bank, 2014, Sustainable Energy for All 2013-2014: Global Tracking Framework Report, Washington, DC: World Bank

Introduction

Energy efficiency is a key component for sustainable development. Doubling the global rate of energy efficiency improvements is one of the three major objectives of the Sustainable Energy For All initiative launched in 2011 by United Nations General Secretary Ban Ki-moon. Enhancing energy efficiency increases global resource productivity, reduces production costs, improves productivity, and thus supports economic growth.

Recognized generally as the "first fuel"[1], energy efficiency satisfies more energy service demand than any other fuel in IEA member countries. It is often the cheapest and most available approach to powering economies. Moreover, investments in energy efficiency create jobs, stimulate economic growth and improve energy security.

Energy efficiency improvement has a clear impact on consumers: reducing energy costs, boosting business performance and delivering more services for household consumers. It provides better cooling and heating systems, more efficient appliances, as well as advanced vehicles that cover larger distances using less fuel. Investing in energy efficiency is crucial to meeting future energy demand growth and mitigating climate change. It improves productivity and leads to reductions of local pollutants and greenhouse gas emissions[2].

The reality is that improvements in energy intensity are happening, but not fast enough. The average compound annual growth rate (CAGR) of energy intensity in the ECE region amounted to -2.3% for the period 1990-2010, while the SE4All objective is to attain a -2.6% rate for the period 2010-2030. Although the ECE region has collectively reduced energy intensity in industrial, transport and service sectors, the rate of improvement has regressed since 1990 and it is uneven as some countries make slower progress than others. Therefore, in support of accelerating global energy efficiency improvements in line with the SE4All initiative, ECE members should discuss how they might develop concrete, results-oriented activities that enhance understanding of the multidimensional facets that can advance energy efficiency improvements. This might include developing a strategy with intergovernmental dialogue and facilitated collaboration with key stakeholders to develop cross-cutting energy efficiency solutions.

This report examines the state of development of energy efficiency in the ECE region as required by the member states to facilitate the discussion about the underlying issues. It presents an overview of available energy efficiency indicators as well as their relevance, timeliness and quality of data. The first section considers general trends in energy intensity. The following section looks at sectorial indicators. The final part presents a survey project concerning energy efficiency statistics. The data used in this report comes from the World Bank's SE4All Database, the International Energy Agency and the World Energy Council.

[1] IEA, 2014, Energy efficiency market report, International Energy Agency, OECD Publishing, Paris http://www.iea.org/W/bookshop/463-Energy_Efficiency_Market_Report_2014

[2] SE4All website http://www.se4all.org/our-vision/our-objectives/energy-efficiency/

Chapter 1: Energy intensity, productivity and per-capita consumption

Indicators

Energy intensity is a basic measure of how a system converts energy into production. It is usually expressed as the ratio of energy consumption per unit of economic output. Countries with a high level of energy intensity use more energy to create a unit of GDP than countries with lower levels of energy intensity. Energy efficiency, by contrast, is the ratio of energy input per unit of output, but may be measured in activity terms, (kilowatt/per unit value added) or physical terms, such as kilowatt hours per ton of steel produced or liters of fuel per 100 passenger kilometers.

Energy intensity is the ratio of the total primary energy supply (TPES) divided by the gross domestic product (GDP) of an economy, sector homogeneous business or process. It is often used as an energy efficiency indicator simply because TPES and GDP are readily available.

However, a given country with high energy intensity does not have by definition low efficiency. For instance, a small country with a high share of the services sector and a mild climate would have much lower aggregate energy intensity than a large industry-oriented country situated in an area with very cold temperatures, even if energy is consumed more efficiently in the latter[1].

Though energy efficiency influences the country's energy intensity, other important contributing factors should be taken into account. Here are some of them: the size of the country (affects demand for fuel in transport sector); the structure of the economy (share of industries consuming large amounts of energy); the climate (determines demand for heating or cooling).

Trends in energy intensity

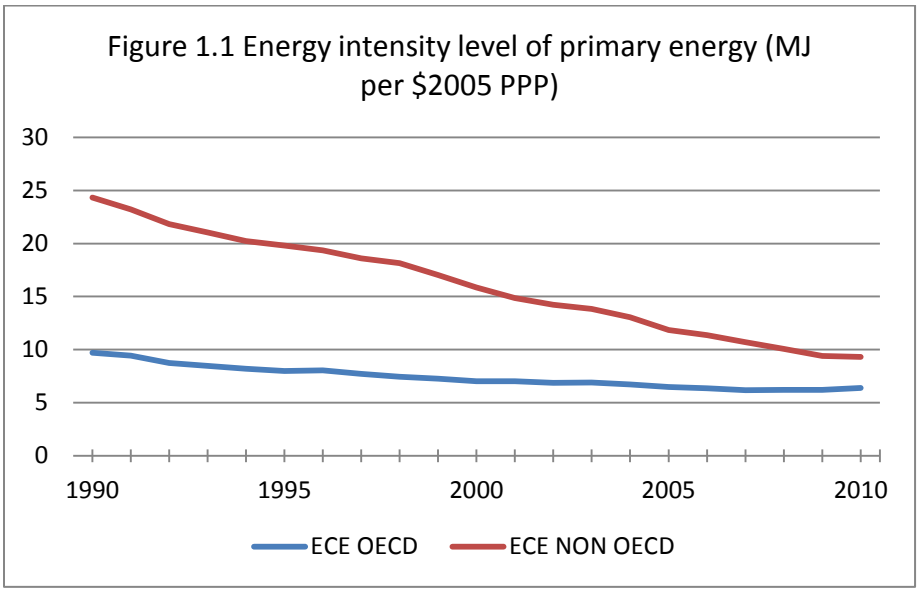
The rate of change in energy intensity does not accurately reflect the progress made in underlying energy efficiency. Energy intensity may also be affected by other factors, such as shifts in the structure of the economy, demographic changes, weather variation, fuel-use shifts and the overall level of activity in the economy[2]. On the other hand, at a high level, it can provide useful information about how closely countries' energy needs and economic performance are linked and how their relationship changes over time.

Energy intensity in the ECE region has dramatically decreased between 1990 and 2010. Aggregate energy intensity across ECE fell by 34% for OECD members and by 61% for non-OECD states (Figure 1.1). However from 2007 the improvement stagnated for OECD countries.

Trends for a group of countries have to be analyzed in relation to the country-specific starting points in 1990. Some countries had low levels of aggregate energy intensity in 1990 and thus less room for its enhancement. It is also partly due to the fact that those states have had energy efficiency policies running even before the starting point. Other countries had high levels of intensity and consequently more potential for improvement.

[1]IEA, 2014, Energy Efficiency Indicators: fundamentals on statistics, International Energy Agency, OECD Publishing, Paris.

[2]IEA and the World Bank, 2014, Sustainable Energy for All 2013-2014: Global Tracking Framework Report, Washington, DC: World Bank



Source: World Bank Sustainable Energy for All database (due to data gaps, countries not included in calculation: Andorra, Liechtenstein, Monaco, San Marino)

Decomposition

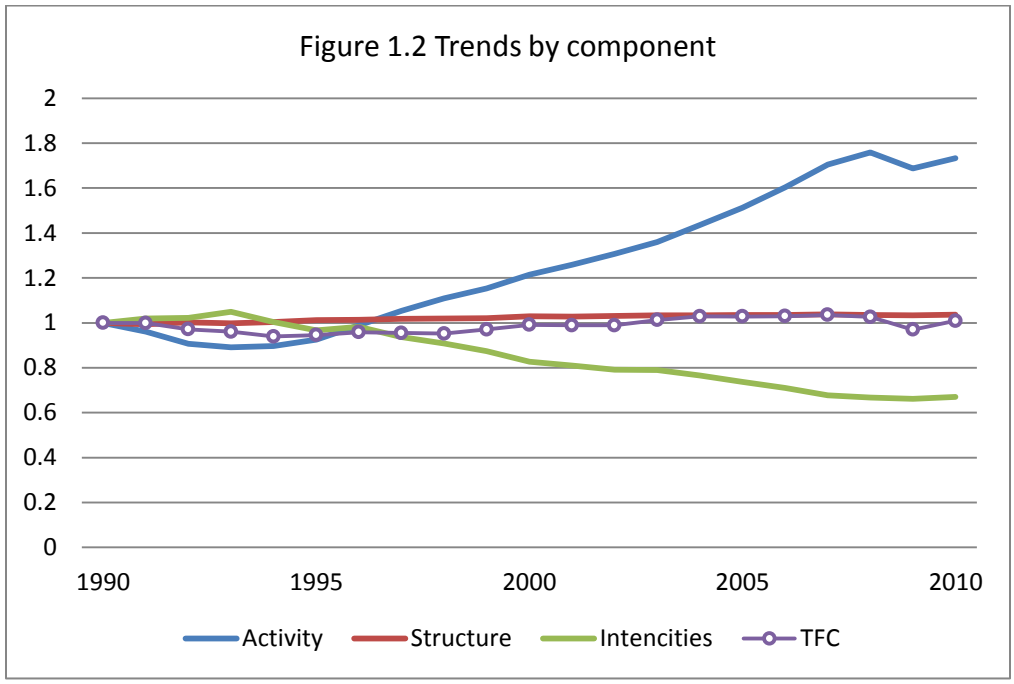
According to US Department of Energy "Declines in energy intensity are a proxy for efficiency improvements, provided energy intensity is represented at an appropriate level of disaggregation to provide meaningful interpretation, and other explanatory and behavioral factors are isolated and accounted for"[1].

Decomposition analysis is a analytical process used to isolate the influence of various factors on energy demand. Understanding how different driving forces impact on energy consumption is critical to determine which of them are changing energy demand. It also helps to determine the most viable sectors for development of energy efficiency policies. Decomposition of energy end-use trends usually factors out three main components affecting energy consumption: aggregate activity change, sectorial structure and energy intensities, commonly ascribed to energy efficiency improvement[2].

Figure 1.2 illustrates the variations in key components of energy demand for 20 years since 1990. The decomposition analysis shows that energy consumption growth caused by climbing economic activity was constrained by the increasing energy efficiency. The impact of structural changes was insignificant during the stated period.

[1] US Department of energy http://www1.eere.energy.gov/analysis/eii_efficiency_intensity.html

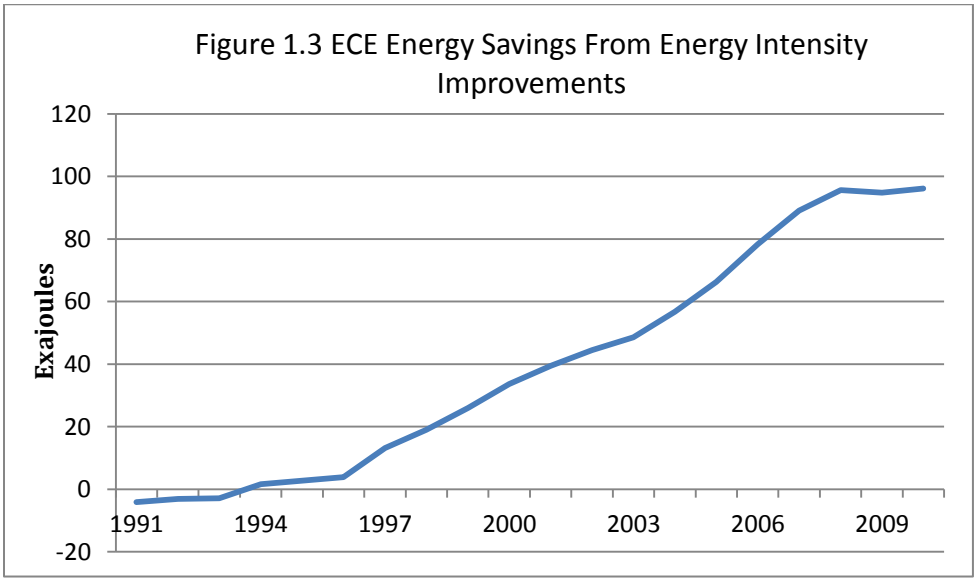
[2] IEA, 2013, Energy efficiency market report, International Energy Agency, OECD Publishing, Paris



Source: World Bank Sustainable Energy for All database (due to data gaps, countries not included in calculation: Andorra, Greece, Israel, Kyrgyz Republic, Liechtenstein, Malta, Monaco, Montenegro, San Marino)

Reducing Energy Demand

Reducing the level of energy intensity can leads to significant reductions in energy consumption.. Since 1991, the ECE region has avoided cumulative energy demand of nearly 800 EJ of energy from energy intensity improvements, while those made in 2010 alone amounted to 96 EJ (Figure 1.3).



Source: World Bank Sustainable Energy for All database (due to data gaps, countries not included in calculation: Andorra, Liechtenstein, Monaco, Montenegro, San Marino)

Energy productivity and per-capita consumption

Energy productivity is the ratio between the GDP of a country and its total energy consumption, measured at purchasing power parity. It estimates the amount of GDP that can be produced with one unit of energy. Energy productivity is not a perfect energy efficiency indicator because it doesn't reflect such differences between the countries as their structure of economy, size, or climate. Nevertheless, this index can provide useful information when plotted against energy availability measured as TPES per capita. Adjusting energy consumption by dividing it by the number of citizens makes it possible to compare countries that have remarkable discrepancies in population. Per-capita energy consumption reflects the energy 'wealth' or energy 'availability' of a country, the share of heavy industry in its economy and the efficiency of energy use. However, countries that are structurally similar can differ in terms of energy use per capita because of differences in their size or climate.

In order to advance the economic and social performance and improve energy sustainability of ECE member countries it is important to understand the driving forces of both energy availability and productivity.

Plotting shifts in energy productivity and per capita availability over a period of time on the same graph helps to show trends of energy consumption over time, which are mainly based on economic structure and weather conditions. Comparing countries that have similar trajectories of productivity and per-capita consumption over time can help show how they might progress to greater productivity and efficiency[1].

For the following figures the starting point of an arrow corresponds to what the energy productivity and per capita consumption of a country was in 2001. The ending point represents those same measures in 2012. Productivity is measured as thousand USD (PPP)/toe, while per capita availability is measured as toe/capita.

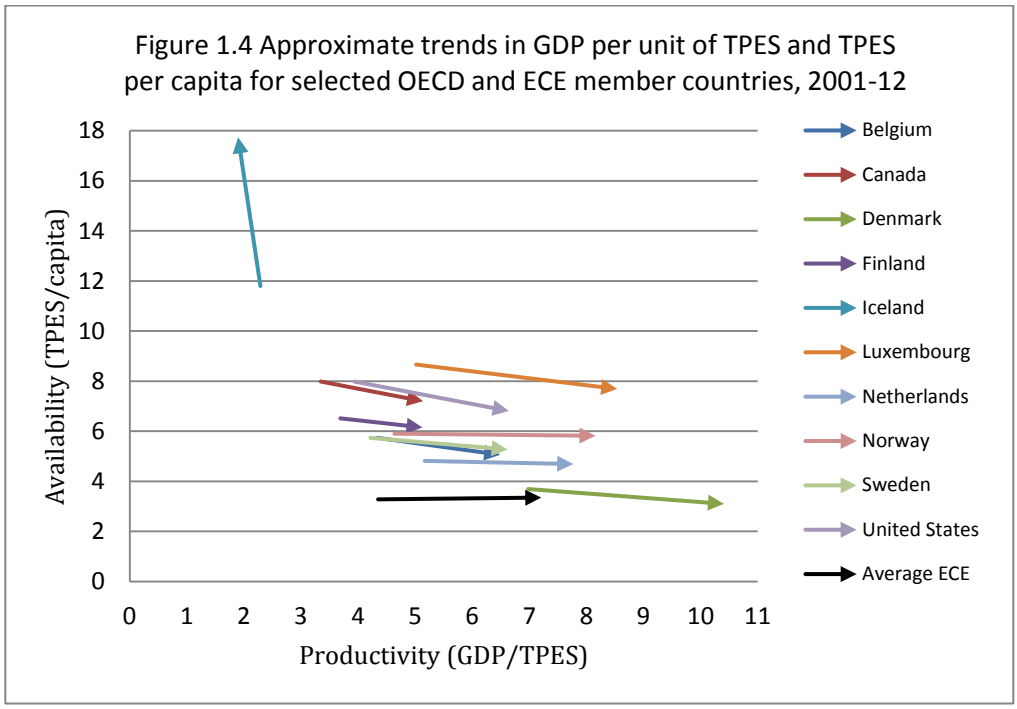
During the period from 2001 to 2012 most of ECE members improved their energy productivity. Only Bosnia and Herzegovina, Iceland and Kyrgyzstan have seen their productivity drop compared to 2001 levels (Figures 1.4-1.7).

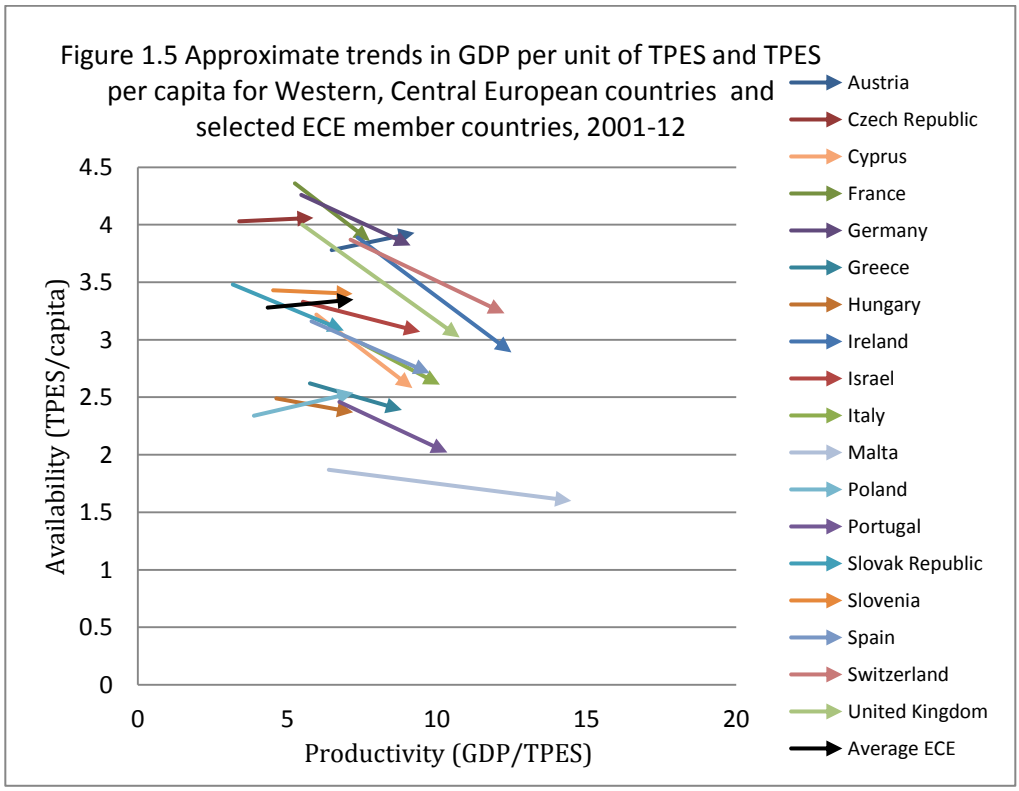
As to trends in per capita use, they vary from country to country. Economies that have a high level of per-capita consumption are more prone to decrease it while improving their energy productivity than economies with already lower energy intensities. Many European countries follow the same tendency, but their decline in per-capita consumption as well as productivity progress is more intense over the analyzed period.

Most of Balkan countries and some of the Eastern European states are still developing their energy availability.

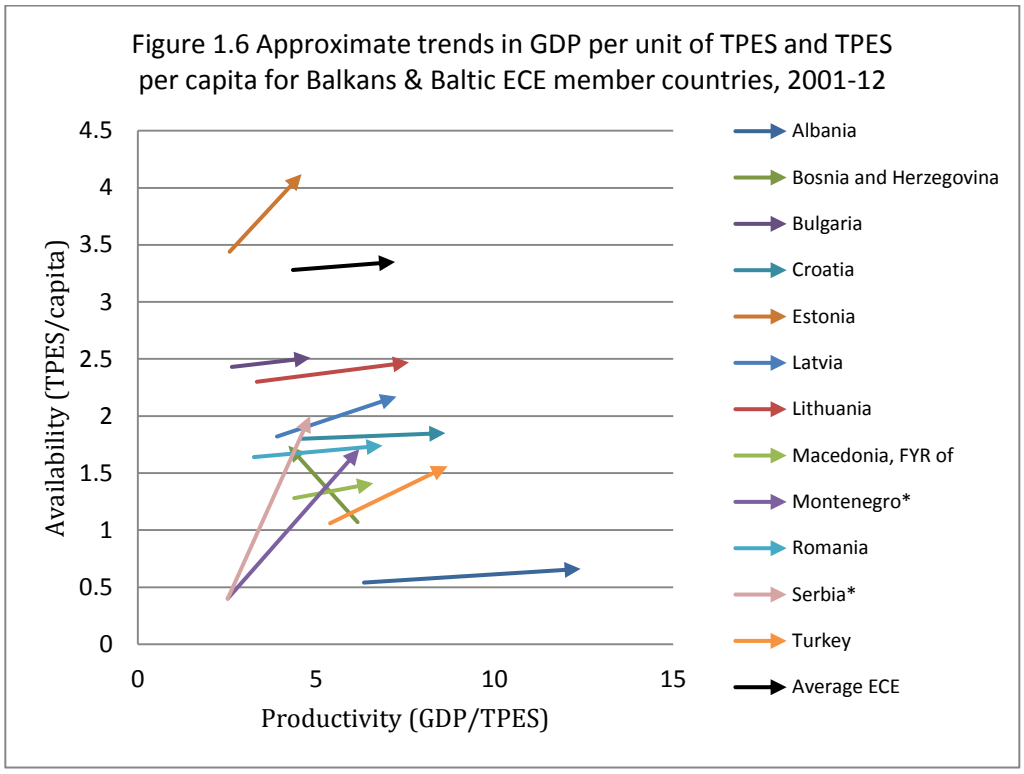
Some countries like Azerbaijan or Tajikistan have made major shifts in productivity, but still have low levels of availability. In contrast, other countries like Kazakhstan or Turkmenistan have massively increased per-capita consumption but achieved moderate improvement in productivity.

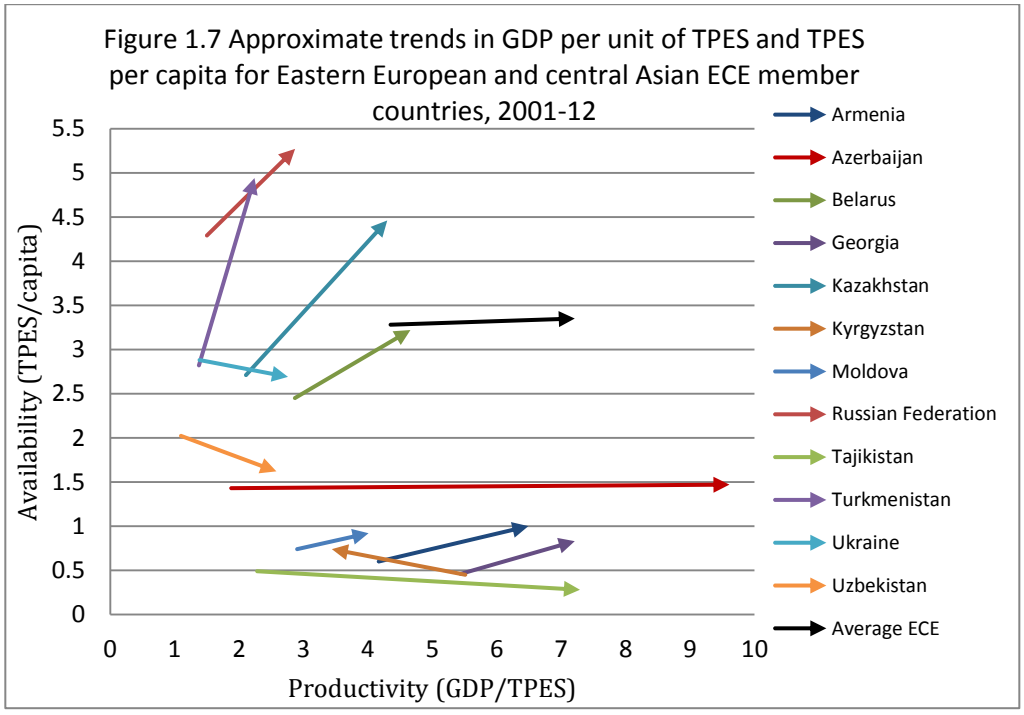
[1] IEA, 2013, Energy efficiency market report, International Energy Agency, OECD Publishing, Paris





Source: IEA Key world energy statistics, 2003 and 2014 (due to IEA data gaps, countries not included in calculation: Andorra, Liechtenstein, Monaco, San Marino)





*Source: IEA Key world energy statistics, 2003 and 2014 (due to data gaps, countries not included in calculation: Andorra, Liechtenstein, Monaco, San Marino)*data for 2001 is given for Serbia and Montenegro as one country*

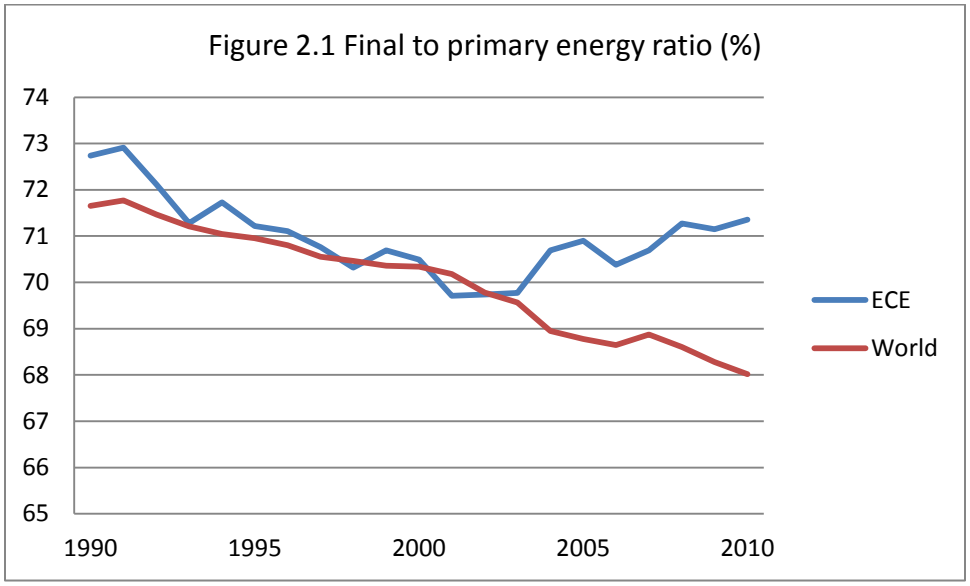
Chapter 2: Energy intensity trends per sector

The analysis of sectorial energy intensity trends can provide further insights. A simple intensity measure can be calculated (as Energy/GDP), but this number has little information content without the underlying sector detail. This review considers the following sectors: industry, households, transport, services and power generation. Due to the lack of data for a large part of ECE member countries the study is not able to separate out the influence of energy efficiency measures from activity and structural factors that operate at a sectorial level. This means that the shifts in energy intensity described below cannot be considered as an accurate presentation of the impact of energy efficiency measures. In order to make precise estimations countries will have to engage in more elaborate data collection.

Power sector

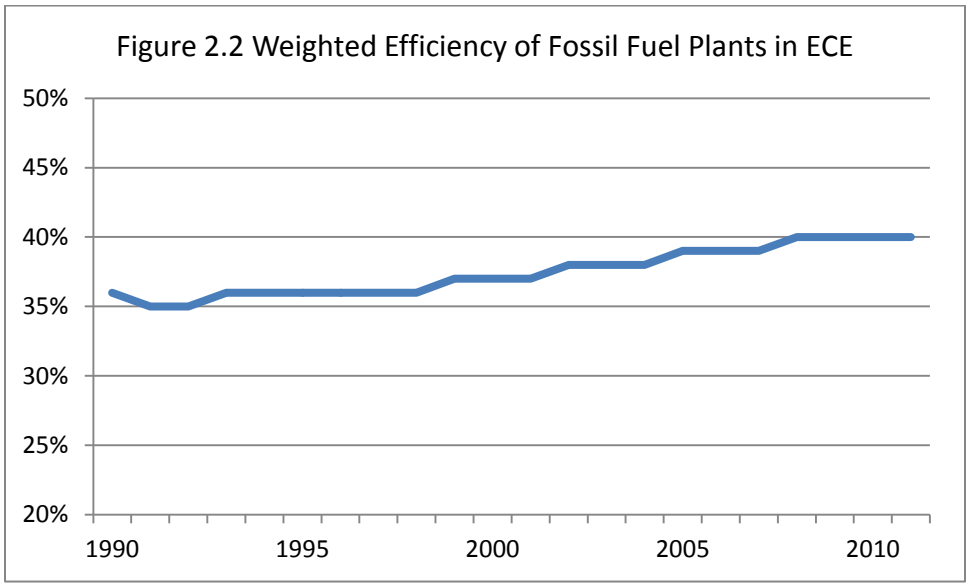
It is important to consider the efficiency of conversion and transformation from primary to final energy. Final to primary energy ratio reflects overall energy efficiency in the supply sector obtained by dividing end-use final energy over primary energy. A higher ratio indicates better power sector efficiency.

Figure 2.1 highlights a gradual reduction in global primary to final energy transformation efficiency. This ratio fell from 72% in 1990 to 68% in 2010. Meanwhile in the ECE region the indicator dipped by around 1,4% during the same time period, but it stayed higher than the world's average (71,3% against 68%) in 2010.



Source: World Bank Sustainable Energy for All database (due to data gaps, countries not included in calculation: Andorra, Liechtenstein, Monaco, San Marino)

Figure 2.2 illustrates the slow progress in the efficiency of thermal power plants. The efficiency ratio covers electricity generation from conversion of fossil fuels (coal, gas and oil). In the ECE region average power plant efficiency grew from 36% to around 40% over the 1990 to 2010 period.

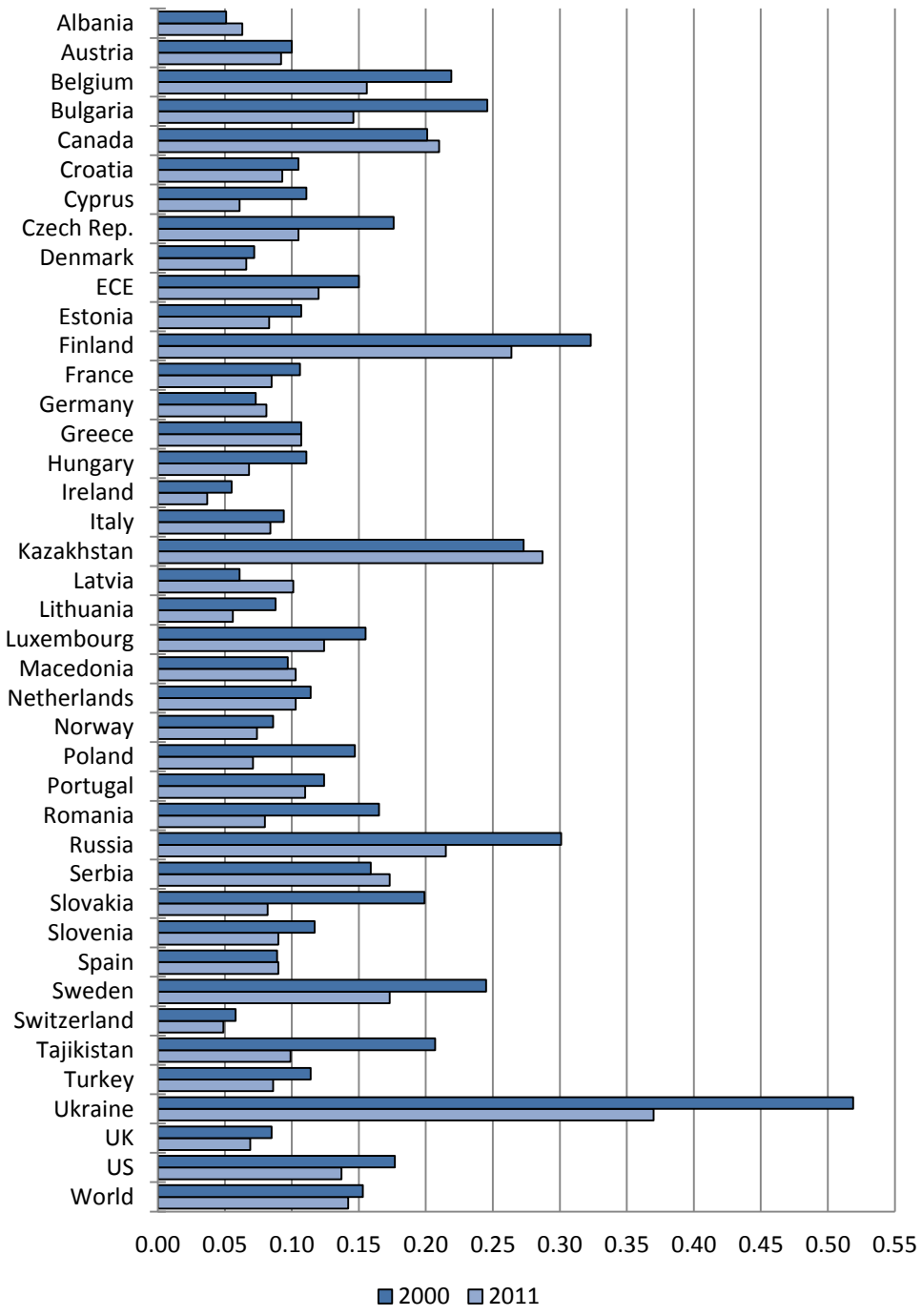


Source: SED calculations based on information from the IEA Data Services website (due to data gaps, countries not included in calculation: Andorra, Liechtenstein)

Industry

The only energy efficiency indicator for the industrial sector available for the majority of ECE members is aggregate energy intensity (total industrial energy consumption per unit of GDP). For most of 39 ECE member countries analyzed, energy intensity of industry has decreased between 2000 and 2011 (Figure 2.1). Slovak Republic, Poland and Romania are the countries that made the highest proportional improvements. Energy intensity of industry in Ukraine and Kazakhstan is more than twice as high as the average in the region.

Figure 2.1 Energy intensity of industry (koe per $2005bn PPP)

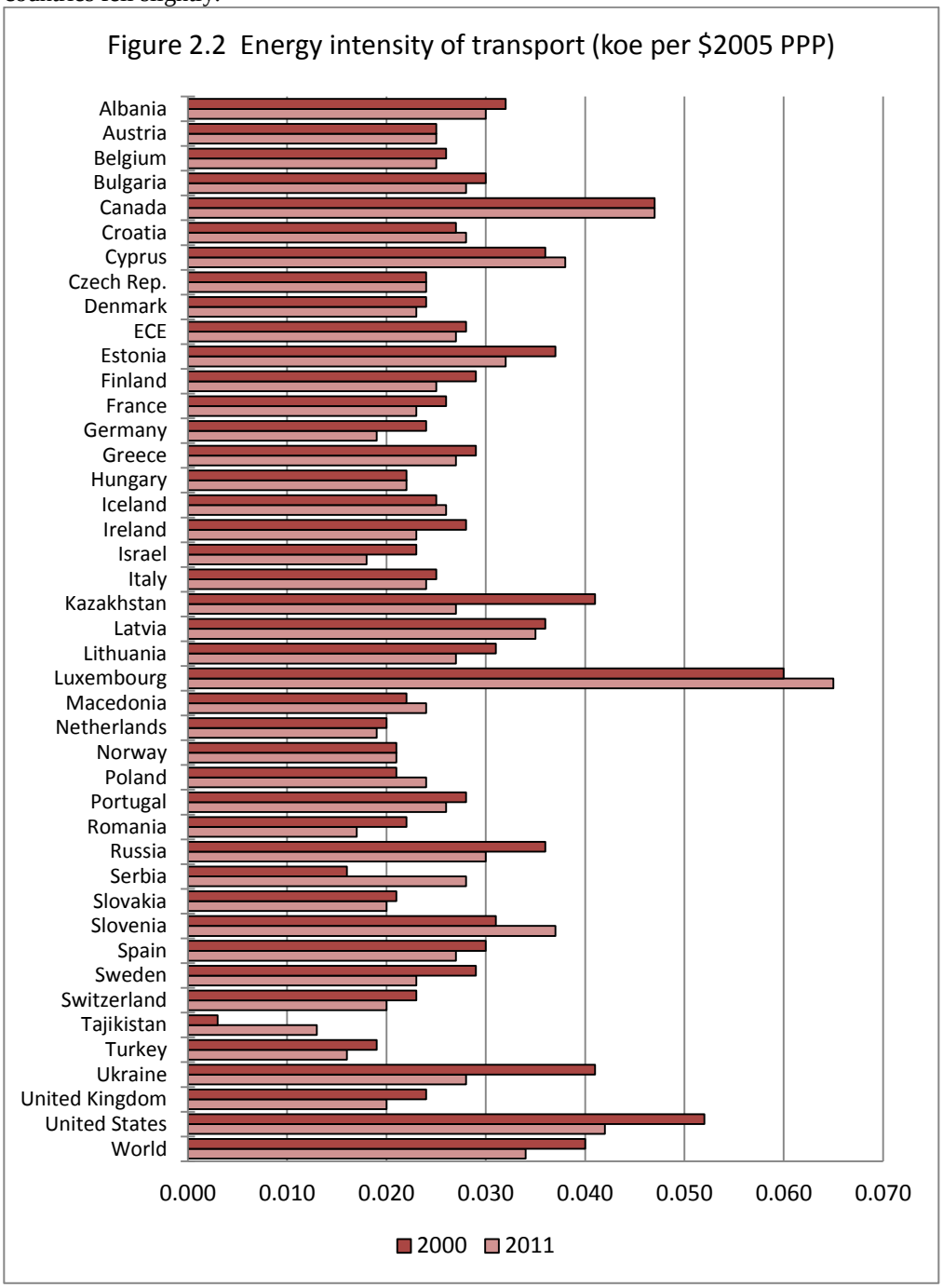


Source: WEC energy efficiency indicators http://www.worldenergy.org/data/efficiency-indicators/

Transport

The differentiation between passenger and freight transport was not made due to lack of data for a sufficient number of ECE members. From 2000 to 2011 changes in energy intensity of transport sector were not significant (Figure 2.2). However, the average of 41 presented countries fell slightly.

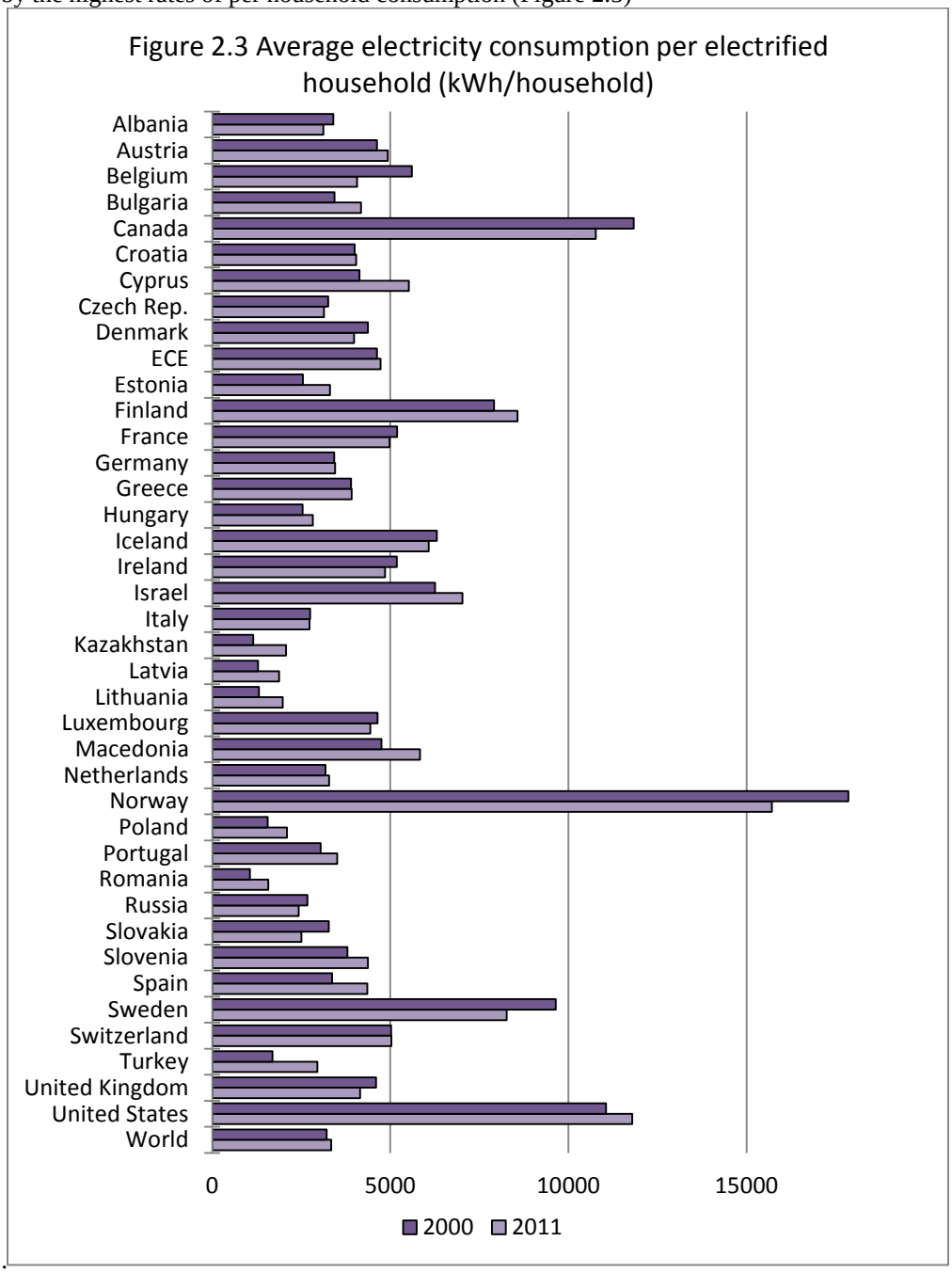
Figure 2.2 Energy intensity of transport (koe per $2005 PPP)



Source: WEC energy efficiency indicators http://www.worldenergy.org/data/efficiency-indicators/

Households

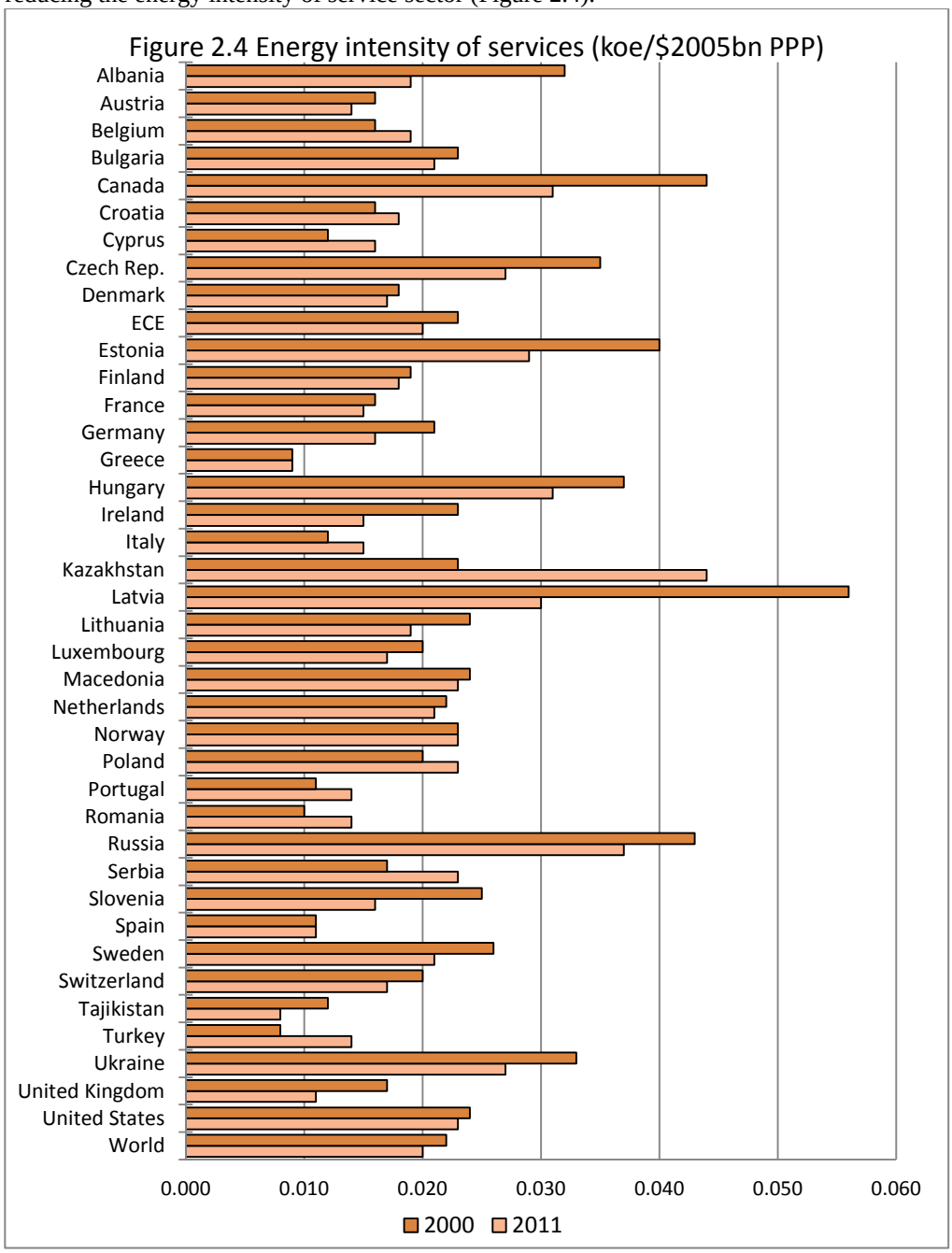
Average electricity consumption per electrified household in the ECE region was marked by a small growth. Such countries as Norway, Canada, USA, Sweden and Finland are characterized by the highest rates of per household consumption (Figure 2.3)



Source: WEC energy efficiency indicators http://www.worldenergy.org/data/efficiency-indicators/

Services

The evolution of average energy intensity of service sector in the ECE region follows closely the worldwide trend. Though the overall rate of improvement is quite low, some countries, namely Latvia, Albania, Slovenia, United Kingdom and Ireland, achieved significant results in reducing the energy intensity of service sector (Figure 2.4).



Source: WEC energy efficiency indicators http://www.worldenergy.org/data/efficiency-indicators/

Chapter 3: Future project

Estimating progress in energy efficiency and its underlying causes requires detailed data and standardized statistical metrics that allow adequate comparisons. Aggregated indicators only partly reveal the actual state of development of energy efficiency in the region. Efficiency impacts can be biased by changes in economic structure, market activity, consumer behavior and climate. This is what distinguishes energy efficiency statistics from other datasets on energy that use straightforward information on capacity, supply and demand.

Energy efficiency indicators help tracking shifts in energy use by ECE member countries. They also measure the outcomes of the market for energy efficiency. Understanding the extent to which changes are related to energy efficiency improvements compared to other macroeconomic, structural and behavioral factors is a core issue from an energy policy perspective.

Tracking changes in energy use over time allows long-term trends to be revealed. Examining the detail behind aggregate energy statistics helps to evaluate the impact of policies on energy consumption and efficiency. A closer look at end-use indicators consists in splitting different factors that may cause changes in energy consumption.

That is why collecting sectorial activity and energy data from most of ECE countries would be an important step forward. This would make possible a decomposition analysis that would break out structural and energy efficiency changes over time in different sectors of the economy.

The project consists in conducting a survey of ECE countries on their national situation, plans and framework conditions. An effort aiming data collection would not only provide the up to date information but also help to identify data gaps that can be fulfilled. Further consultations on data treatment between the Sustainable energy division and ECE members could lead to gradual improvements in statistics and thus grant better energy efficiency market assessments.

It should be mentioned that this will require countries to cooperate with the ECE to develop their data systems. The support of international organizations that deal with energy efficiency statistics would be as well a crucial element in realizing the project.

Collecting data and developing indicators should not be considered as a final goal but more as a first step to their further use.

Conclusion

Energy intensity in ECE states continues to fall though the pace of improvement is slowing down. This means that the average decline in energy intensity across the region doesn't meet the SE4All energy efficiency objective. Therefore attaining this goal might require substantial additional effort in the future.

Based on a decomposition analysis of energy demand in 47 ECE member countries, energy efficiency has been a considerable factor in improving energy intensity and in reducing total final energy consumption between 1990 and 2010. Savings from energy intensity improvements in the ECE region made in 2010 alone account for 96 EJ. This is more than the total amount of energy consumed in the United States during the same year.

While the absolute majority of ECE members improved their energy productivity during the 2001 to 2012 period, tendencies in per-capita use of energy vary from country to country. North American and Western European countries tend to decrease their per-capita consumption while the trend is opposite in Southeastern and Eastern European countries.

Moderate improvements in energy intensities in industry, transport and services sectors were achieved, the best results being attained in the field of industry. However, the electricity consumption per household grew slightly across ECE countries, showing that demand for electricity in residential sector keeps increasing despite energy efficiency measures.

Better data collection and analysis will help to improve the tracking of energy efficiency developments, which will in turn back adequate decision making. On this count the Group of Experts on Energy Efficiency offers to conduct a survey of ECE member states on detailed energy intensity indicators.

ECE can assist in improving energy efficiency data treatment by collaborating with countries and existing international organizations dedicated to energy efficiency data collection, such as IEA, IPEEC, WEC, Energy Charter, etc. Working jointly on a synthesized approach to an effective energy efficiency measuring would be an important step towards reaching SE4All objectives.

Acronyms and abbreviations

ECE – United Nations Economic Commission for Europe
EE – Energy efficiency
EJ – Exajoule
GDP – Gross domestic product
GTF – Global Tracking Framework
IEA – International Energy Agency
IPEEC – International Partnership for Energy Efficiency Cooperation
koe – Kilograms of oil equivalents
kWh – Kilowatt hour
SE4All – Sustainable Energy for All
TFC – Total final consumption
toe – tons of oil equivalent
TPES – Total primary energy supply
USD (PPP) – US dollar considering purchasing power parity exchange rates
WB – World Bank
WEC – World Energy Council