

Material flow efficiency of Central and East European countries of the European Union

MSc. Toivo Tanning

Tallinn School of Economics,
Tallinn, Estonia, EU
toivo.tanning@gmail.com

Dr. Lembo Tanning

TTK University of Applied Sciences,
Tallinn, Estonia, EU
lembo.tanning@gmail.com

Abstract--The effectiveness of the use of material resources is dependent industry, construction and other sectors of work, but also in non-production and household activities. Resources underpin the functioning of global economy and our quality of life. The purpose of this article is to analyse the material flow efficiency or resource productivity of new European Union (EU) states, with emphasis on Baltic countries, and to compare them on the EU level. All economic systems utilize a variety of resources. The scarcity of resources forces countries, companies and people make a variety of choices. How far is the use of these lands resource, including the 2009th economic crisis? The analysis showed that the greater use of resources does not always lead to economic growth. Effective use of resources is different from country to country. When sustainably new EU member states, but also the total Europe use of resources? What are the lessons from the resource productivity? That's what we look at on the basis of the Baltic countries. The small Baltic States are part of the former Soviet bloc countries. With regard to acute political and economic situation in Eastern Europe is very topical, what is the position of small states in a resource productivity, or material flow efficiency.

Keywords: *material flow efficiency, resource productivity or efficient of Europe, resource saving, Central and East European countries.*

I. Introduction

Why is resource efficiency important? Natural resources underpin the functioning of the European and global economy and our quality of life. Our present use of resources in the future is not possible. Increasing resource efficiency will ensure economic and employment growth in Europe. It will bring major economic opportunities, improve productivity, reduce costs and increase competitiveness. Resource-efficient Europe will provide a long-term framework for actions in many policy areas, supporting political agendas for climate change, energy, transport, industry, raw materials, agriculture and regional development. Resource efficiency strategy Europe will support the transition to low-carbon economy to achieve sustainable growth. These resources include raw materials such as fuels, minerals and metals, but also food, soil, water, air, biomass and ecosystems. The pressure

on the resources increases. Intensive use of the world's resources puts pressure on our planet and threatens the security of supply. Continuing our current patterns of resource use is not an option. In response to these changes, increasing resource efficiency will be key numbers to securing growth and jobs for Europe. It will bring major economic opportunities, improve productivity, drive down costs and boost competitiveness. [1]

Based on projections the world population grew over 40 years while by 2,510 million, an increase of 9,376 million people in 2050. [2] Growth occurs mainly in developing and emerging economies countries, where people aspire to wealth and consumption growth. Intensive use of world resources exerts pressure on our planet and threatens the security of supply.

A resource-efficient Europe is one of the main objectives of the Europe 2020 Strategy [3], which aims at guiding the effective use of resources to achieve sustainable economic growth. [1, 3]

In absolute terms (thousand tones) allows you to view an analysis of indicators corresponding changes in the country, the development of stability. [4 - 5] In relative terms (here tonnes per capita) analysis allows you to compare countries with each other, however, the respective indices.

Material flow efficiency in new EU states, in eleventh Central and East European countries (Bulgaria, Croatia, the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia and Slovakia) has been analysed. It is CEE-8 and Baltic States. Former post-communist countries were selected for observation; new EU member states, Malta and Cyprus, have been excluded.

The history and economic background of his countries is more detail in previous earlier publications of authors. [4-15].

The theoretical foundations are given in more detail the works of other authors [16 - 21], in previous earlier publications of authors [22 - 25] and of Eurostat [3].

II. Methodology

Resource productivity and *resource intensity* are key concepts used in sustainability metering as they attempt to decouple the direct connection between resource use and environmental deterioration. The leading indicator assigned to this policy initiative is termed *resource productivity*.

Resource productivity is GDP divided by domestic material consumption (DMC). DMC measures the total amount of materials directly used by an economy. It is defined as the annual quantity of raw materials extracted from the domestic territory of the focal economy, plus all physical imports minus all physical exports. It is important to note that the term "consumption" as used in DMC denotes apparent consumption and not final consumption. DMC does not include upstream flows related to imports and exports of raw materials and products originating outside of the focal economy. The trend in the development of resource productivity over time is presented as an index, with 2000 as the base year. [26]

Resource productivity is the ratio of the volume of GDP in market prices over DMC. [3]

Resource productivity is a measure of the output per unit of resource input. [21]

Resource intensity is a measure of the resources (e.g. materials, energy and water) required for the provision of a unit of a good or service. It is usually expressed as a ratio of materials used to value (expressed, for example, in money, mass, volume). Resource intensity is determined by two factors: changes in the mix of materials used to produce individual goods and services, and the product composition of output. [21]

Resource productivity and resource intensity are essential concepts for measuring the progress of dematerialisation and other efficiency-led strategies. [21]

The indicator DMC is defined as the total amount of material directly used in an economy. DMC equals *Direct Material Input* (DMI) minus *exports*. DMI measures the direct input of materials for the use in the economy. DMI equals *Domestic Extraction* (DE) plus *imports*. [27]

Domestic material consumption by material of Eurostat is in environmental accounts [28].

Material flow accounts data description: material flow accounts and resource productivity. [29]

Economy-wide material flow accounts (EW-MFA) compile material flow inputs into national economies. EW-MFA cover all solid, gaseous, and liquid material inputs, except for water and air,

measured in mass units per year. Like the system of national accounts, EW-MFA constitute a multi-purpose information system. The detailed material flows provide a rich empirical database for numerous analytical purposes. Further, EW-MFA are used to derive various *material flow indicators* such as:

Domestic extraction (DEU): total amount of material extracted for further processing in the economy, by resident units from the natural environment;

Imports (IMP): imports of products in their simple mass weight;

Direct material input (DMI): measures the direct input of material into the economy; it includes all materials which are of economic value and which are available for use in production and consumption activities (=DEU+IMP);

Exports (EXP): exports of products in their simple mass weight;

Domestic material consumption (DMC): measures the total amount of material actually consumed domestically by resident units (=DEU+IMP-EXP). Note: IMP and EXP are distinguished into extra-EU-trade and total trade.

Resource productivity (GDP/DMC) is defined as the ratio of GDP over DMC and commonly expressed in Euro per kilogram material. The data set *env_ac_rp* employs different types of GDP for calculating this ratio - depending on the analytical perspective:

GDP in current prices over DMC (unit = 'Euro per Kilogram'): to be used to analyse a single country at one point in time (for one particular year);

GDP in chain linked volumes over DMC (unit = 'Euro per kilogram, chain linked volumes (2005)'): eliminates price inflation over time; to be used when comparing over time (various years) one single country;

GDP in purchasing power standard (unit = 'Purchasing Power Standard per Kilogram'): eliminates differences in price levels across countries; to be used when comparing across countries at one point in time (for one particular year).

In order to compare the performance over time and across various countries the second resource productivity ratio employing GDP in chain-linked volumes has been *indexed to the year 2000* (unit = 'Index, 2000=100'). This index allows a comparison of countries' resource productivity performance. [29]

This can be expressed in monetary terms, as monetary return per unit of resource. Here in tonnes per capita.

Material resources are divided: biomass (MF1), metal ores (gross ores) (MF2), non-metallic minerals (MF3), fossil energy materials/carriers (MF4), other products (MF5) and waste for final treatment and disposal (MF6). Here we look also subgroups of MF4: liquid and gaseous energy materials/carriers (MF42); crude oil, condensate and natural gas liquids [NGL] (MF421) and natural gas (MF422). [30 - 31]

In summary, the main indicators are: Domestic Extraction Used (DEU). Domestic Material Consumption (DMC). Exports (EXP). Imports (IMP). Direct Material Inputs (DMI).

$$DEU = DMC + (EXP - IMP) \quad (1)$$

$$DMI = DEU + IMP = DMC + EXP \quad (2)$$

National accounts (including GDP) was from Eurostat methodology. [32]

All figures are the authors' illustration.

III. ANALYSIS OF RESOURCE PRODUCTIVITY

Next we analyzed resource productivity, or material flow efficiency of new European Union (EU) states, with emphasis on Baltic countries; and to compare them on the EU level.

A. Material flow analyses by DMC per capita

TABLE 1. RESOURCE PRODUCTIVITY, GDP AND DMC 2012 [30]

	GDP PPS per capita	DMC per capita (tonnes per capita)	Resource productivity (GDP PPS / DMC)	
	PPS per capita	tonnes per capita	PPS per kilogram	Index (EU-27=100)
Estonia	18 200	28.7	0.64	33.5
Latvia	16 400	18.4	0.89	46.6
Lithuania	18 300	12.8	1.43	74.9
EU - 27	25 600	13.5	1.91	100.0

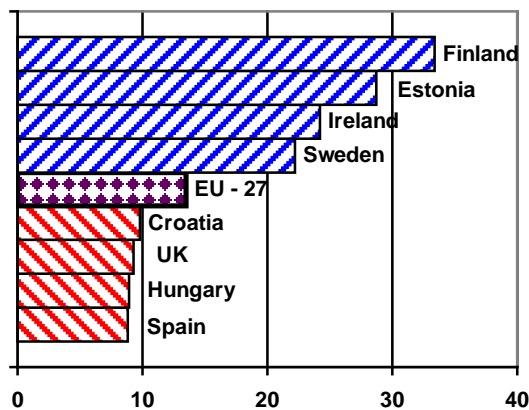


Figure 1. DMC per capita of EU countries [30]

The highest DMC per capita (tonnes per capita) in the Baltic countries had Estonia. Lithuania levels were almost the same as the EU-27 average. Latvia level was between them.

EU countries in 2012 had the highest per capita DMC Finland (33.4), Estonia (28.7) in front. This was followed by Ireland (24.2) and Sweden (22.2). Fewer DMC per capita was Spain (8.8), Hungary (8.9), UK (9.3) and Croatia (9.8). [30]

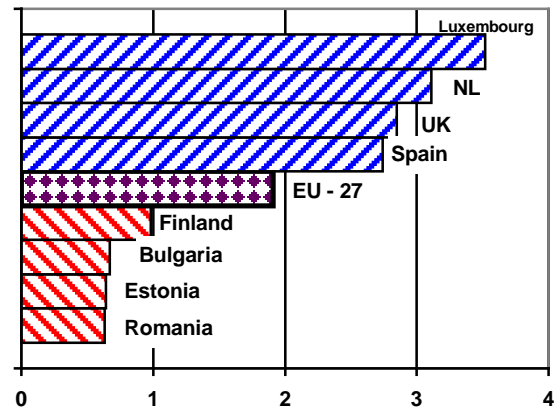


Figure 2. Resource productivity of EU countries [30]

The smallest resource productivity (GDP PPS / DMC, PPS per kilogram), in the Baltic countries was Estonia, which was three times less than the EU-27 average. Even here the level of Lithuania was almost the same as of EU-27 average and level of Latvia was between them.

EU countries in 2012 had the largest resource productivity Luxembourg (3.52). Followed the Netherlands (3.11), United Kingdom (2.85), Spain (2.74) etc. Smaller resource productivity was Romania (0.63), Estonia (0.64), Bulgaria (0.67) and Finland (0.98). [30]

B. Material flow analyses by thousand tones

TABLE 2. RESOURCE PRODUCTIVITY. 2000=100 [26]

	2001	2008	2009	2010	2012	2013
EU-27	101.52	109.36	118.14	123.81	129.24	131.49
Estonia	108.94	88.77	81.73	82.89	83.06	80.60
Latvia	111.36	147.18	156.61	133.88	146.67	136.18
Lithuania	118.84	99.86	126.14	116.3	128.44	130.73

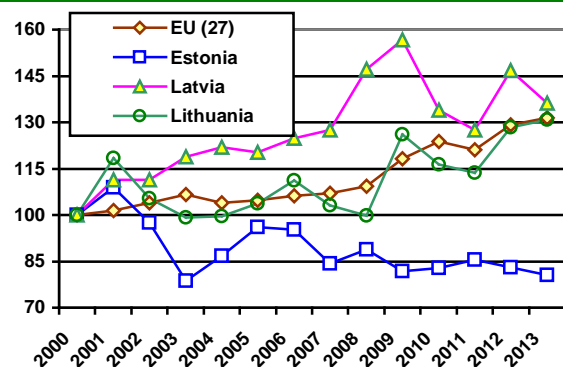


Figure 3. Resource productivity. Index, 2000=100 [26]

Resource productivity in EU-27 grew 31.5% in 13 years. In a few years, however, was a step backwards.

Nearly the same large was the increase in Lithuania. Latvia resource productivity grew strongly, then fell for two years and rose sharply again in 2012th. In total it increased to 1.5 times. Estonia it declined steadily.

TABLE 3. RESOURCE PRODUCTIVITY. EURO PER KILOGRAM, CHAIN LINKED VOLUMES [26]

	2000	2007	2008	2009	2010	2011	2012	2013
EU (27)	1.34	1.44	1.47	1.59	1.66	1.62	1.73	1.76
Estonia	0.40	0.34	0.36	0.33	0.33	0.34	0.34	0.33
Latvia	0.25	0.32	0.37	0.39	0.34	0.32	0.37	0.34
Lithuania	0.49	0.51	0.49	0.62	0.57	0.56	0.63	0.65

Trend of resource productivity by euro per kilogram has slowly grown in the EU-27 and the Latvia and Lithuania. Estonia trend was reversed. This indicator was the EU-27 from 3 to 5 times higher than in the Baltic States.

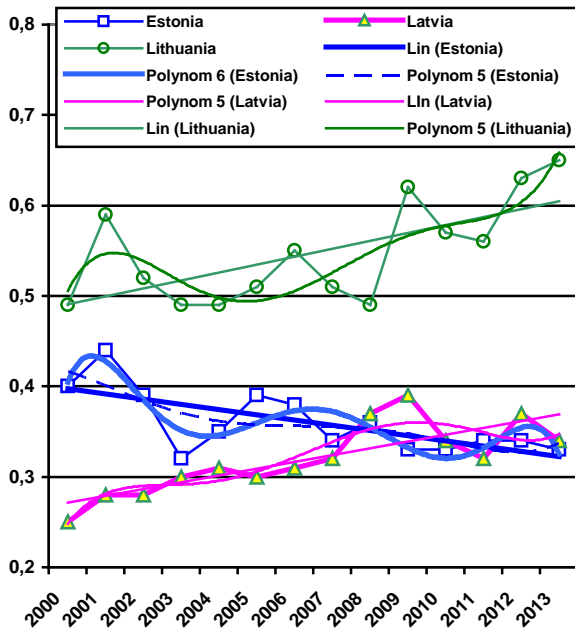


Figure 4. Resource productivity. Euro per kilogram [26]

Resource productivity trend lines:

$$\text{Estonia } y = -0,006x + 0,4046; R^2 = 0,4483 \quad (3)$$

$$y = 2E-05x^5 - 0,0008x^4 + 0,0092x^3 - 0,0459x^2 + 0,0793x + 0,3714; R^2 = 0,5797 \quad (4)$$

$$y = -2E-05x^6 + 0,0007x^5 - 0,0111x^4 + 0,0906x^3 - 0,3633x^2 + 0,6362x + 0,0491; R^2 = 0,8182 \quad (5)$$

$$\text{Latvia } y = 0,0086x + 0,2581; R^2 = 0,6992 \quad (6)$$

$$y = 3E-05x^5 - 0,0011x^4 + 0,0137x^3 - 0,0777x^2 + 0,1948x + 0,1151; R^2 = 0,828 \quad (7)$$

$$\text{Lithuania } y = 0,007x + 0,4908; R^2 = 0,2942 \quad (8)$$

$$y = 4E-05x^5 - 0,0016x^4 + 0,0211x^3 - 0,1237x^2 + 0,2978x + 0,308; R^2 = 0,5971 \quad (9)$$

Estonia and Latvia R^2 was very high, Lithuania smaller. The correlations of theoretical relationship is characterized by complex, as a rule, a 5-grade polynomials. In general there was a strong relationship between correlations.

C. Material flow analyses per capita

In absolute terms (thousand tonnes here) allows you to view an analysis of indicators corresponding changes in the country, the development of stability. In relative terms (here tonnes per capita) analysis allows you to compare countries with each other, however, the respective indices.

1) Resource analyses per capita

Here we look total dynamics *domestic extraction used* (DEU), *domestic material consumption* (DMC), *direct material inputs* (DMI), exports (EXP) and imports (IMP) of resource.

$$\text{Once more: } DEU = DMC + (EXP - IMP);$$

$$DMI = DEU + IMP = DMC + EXP$$

TABLE 4. DOMESTIC MATERIAL CONSUMPTION, TONNES PER CAPITA. [31]

	2000	2007	2008	2009	2010	2012	2013
EU-27	15.578	16.63	16.285	14.353	13.940	13.492	13.236
Germany	17.541	16.198	16.111	15.381	15.401	16.179	16.269
Estonia	14.042	29.027	26.487	24.758	25.097	28.710	30.434
Latvia	14.642	22.384	19.046	14.976	17.653	18.410	20.865
Lithuania	8.336	15.082	16.19	11.036	12.418	12.813	13.141

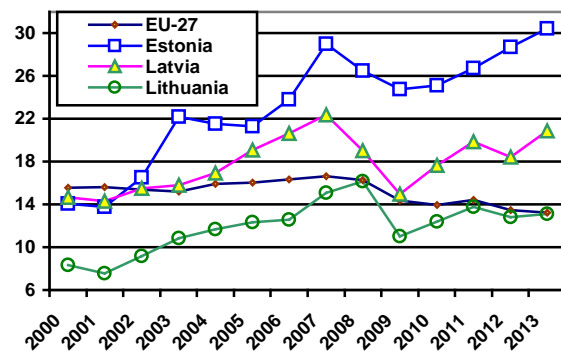


Figure 5. DMC tonnes per capita [31]

DMC per capita growth was in Estonia double, in Latvia 26% and in Lithuania 54%. In 2013 was the DMC more than double in Estonia and more than 1.5 times in Latvia higher than the EU average.

TABLE 5. TOTAL EXPORTS RESOURCE, TONNES PER CAPITA [31]

	2000	2008	2009	2010	2012	2013
Estonia	6.507	8.776	7.606	9.297	9.775	9.494
Latvia	3.909	6.477	6.336	8.333	9.640	8.982
Lithuania	2.734	6.684	6.086	6.824	8.386	8.998

Resource export shows that the EU and the Baltic countries are not very poor in terms of material or natural resources.

Total exports resource per capita grew in all Baltic countries in 2003 - 2012: in Estonia - growth of 1.4 times, in Latvia and in Lithuania – growth of two times.

TABLE 6. TOTAL IMPORTS RESOURCE, TONNES PER CAPITA [31]

	2000	2008	2009	2010	2011	2012	2013
Estonia	4.002	7.357	6.728	7.172	8.111	6.886	6.869
Latvia	2.438	5.744	4.071	4.623	5.41	6.322	6.297
Lithuania	3.648	8.153	6.679	7.886	8.687	8.865	9.499

Total imports resource per capita grew in all Baltic countries. Resource exports of Estonia and Latvia have higher their imports. Lithuania has slightly exceeded imports for export.

TABLE 7. TOTAL EXTRA EU27 IMPORTS RESOURCE, TONNES PER CAPITA [31]

	2000	2008	2009	2010	2011	2012	2013
Estonia	2.513	2.453	2.343	2.548	2.763	2.429	2.261
Latvia	1.441	2.259	1.774	2.084	2.235	2.409	2.406
Lithuania	2.993	5.791	4.932	5.615	6.007	5.914	6.416

In 2012 was extra EU27 imports the percentage of total imports resource in Estonia 35%, in Latvia 38% and in Lithuania 67%. Thus, Estonia and Latvia, dependent two times less of extra EU27 imports when Lithuania.

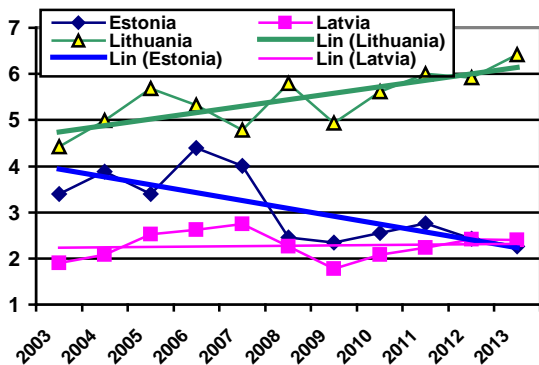


Figure 6. Total extra EU27 imports resource, tonnes per capita [31]

Before the crisis grew in all extra EU-27 imports resource per capita. However, already before the crisis began Latvia and Estonia this decrease. Estonia, it decreased in period 2006 – 2008 1.8 times and in 2009th continued to decrease. Latvia decreased from 2007 - 2009 1.55 times, but it is still follows trend. At the same time in 2012 Lithuania was more than two times higher than Latvia and Estonia.

Lithuania trend was a intermittent growing:

$$y = 0,1214x + 4,6783; R^2 = 0,4656 \quad (10)$$

Estonia trend was a decrease:

$$y = -0,1729x + 4,1125; R^2 = 0,4826 \quad (11)$$

Latvia trend was stable:

$$y = 0,0024x + 2,2509; R^2 = 0,0005 \quad (12)$$

In summary, total extra EU27 imports resource per capita trend: Lithuania intermittent growing, Estonia decrease and Latvia was stable.

This shows that Latvia and Estonia should be much better than to live in an economic blockade when Lithuania. The final assessment should be analyzed in more detail product groups and countries.

TABLE 8. TOTAL DIRECT MATERIAL INPUTS RESOURCE, TONNES PER CAPITA [31]

	2001	2008	2009	2010	2012	2013
Estonia	20.179	35.263	32.363	34.394	38.486	39.928
Latvia	18.229	25.523	21.312	25.986	28.050	29.847
Lithuania	10.981	22.873	17.122	19.242	21.199	22.140

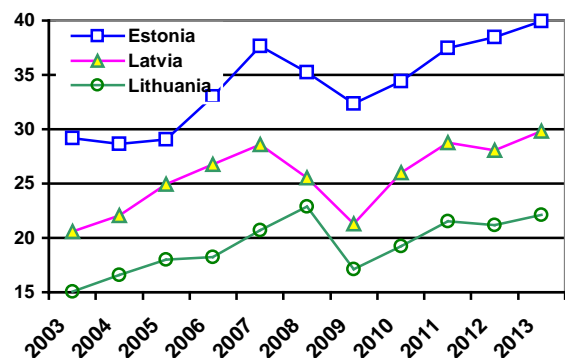


Figure 7. DMI tonnes per capita [31]

Total direct material inputs (DMI) resource per capita grew in all Baltic countries, in Estonia and Latvia to 2007, in Lithuania to 2008. During the economic crisis it decreased, but later, together with improvements in the economy growth continued.

TABLE 9. TOTAL DOMESTIC EXTRACTION USED RESOURCE, TONNES PER CAPITA [30]

	2000	2008	2009	2010	2011	2012	2013
Estonia	16.547	27.906	25.635	27.222	29.386	31.599	33.058
Latvia	16.113	19.779	17.241	21.363	23.347	21.728	23.55
Lithuania	7.423	14.720	10.443	11.355	12.865	12.334	12.64

Total domestic extraction used (DEU) resource per capita grew also in all Baltic countries, in Estonia and Latvia to 2007, in Lithuania to 2008. During the economic crisis it also decreased, but later, together with improvements in the economy growth continued. Than Estonian DEU record levels in 2012, when Latvia and Lithuania it was the pre-crisis years.

TABLE 10. TOTAL RESOURCE OF ESTONIA, TONNES PER CAPITA [30]

Est	2000	2008	2009	2010	2012	2013
DMC	14.042	26.487	24.758	25.097	28.710	30.434
Exp	6.507	8.776	7.606	9.297	9.775	9.494
Imp	4.002	7.357	6.728	7.172	6.886	6.869
DEU	16.547	27.906	25.635	27.222	31.599	33.058
DMI	20.549	35.263	32.363	34.394	38.486	39.928

Here is a consolidated table of the development and distribution of resources in Estonian. All of these indicators have grown.

2) Resource productivity of fossil energy materials/carriers tonnes per capita

This section is focused on the third (non-EU Member States) countries on imported fossil fuels, especially crude oil imports, and in particular for the purchase of natural gas from Russia.

TABLE 11. DOMESTIC MATERIAL CONSUMPTION OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF CEE-8 COUNTRIES [31]

	2004	2008	2009	2010	2012	2013
Bulgaria	4.809	5.524	4.908	5.204	5.691	4.781
Czech Rep.	7.163	6.86	6.447	6.356	6.258	5.743
Croatia	1.906	2.003	1.773	1.754	1.665	1.678
Hungary	3.360	3.249	2.531	2.61	2.361	2.115
Poland	4.425	4.378	4.151	4.098	4.322	4.109
Romania	2.748	2.976	2.647	2.582	2.723	2.532
Slovenia	4.566	4.868	4.346	4.316	4.207	3.820
Slovakia	3.359	3.006	2.757	2.749	2.701	2.501

Domestic material consumption and extraction used of fossil energy materials/carriers per capita of CEE-8 countries was greatest in Czech Rep. and Bulgaria, even though their economic level is different a great deal.

TABLE 12. DOMESTIC MATERIAL CONSUMPTION OF FOSSIL ENERGY MATERIALS/CARRIERS TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2004	2009	2010	2012	2013
EU-27	3.889	3.404	3.333	3.259	3.066
Germany	5.466	5.26	5.287	5.262	5.204
Estonia	10.3	10.704	12.285	12.448	14.529
Latvia	1.128	1.206	1.104	1.184	1.108
Lithuania	1.403	1.487	1.721	1.828	1.751

Domestic material consumption and extraction used of fossil energy materials/carriers per capita were in Estonia is very high, thanks to its oil shale. Latvia has it the lowest.

TABLE 13. DOMESTIC EXTRACTION USED OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF CEE-8 COUNTRIES [31]

	2000	2008	2009	2010	2012	2013
Bulgaria	3.242	3.865	3.657	3.986	4.615	3.987
Czech Rep.	6.666	5.82	5.42	5.295	5.216	4.549
Croatia	0.591	0.707	0.692	0.663	0.617	0.566
Hungary	1.887	1.349	1.327	1.325	1.211	0.984
Poland	4.344	3.773	3.519	3.455	3.691	3.683
Romania	1.981	2.34	2.255	2.158	2.256	2.224
Slovenia	2.256	2.238	2.173	2.165	2.081	1.830
Slovakia	0.693	0.426	0.466	0.43	0.411	0.328

TABLE 14. DOMESTIC EXTRACTION USED OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2000	2008	2009	2010	2011	2012	2013
EU (27)	2.154	1.765	1.664	1.636	1.617	1.585	1.491
Germany	2.684	2.546	2.431	2.398	2.47	2.595	2.395
Estonia	7.681	10.776	10.076	12.041	12.627	12.775	14.126
Latvia	0.169	0.398	0.399	0.336	0.46	0.363	0.367
Lithuania	0.165	0.18	0.15	0.123	0.148	0.15	0.165

Of the European were the largest DEU fossil energy materials/carriers than in Norway: 2004th it was 61.845 and of the EU in Estonia: 2013th it was 14.126 tonnes per capita. Of the EU was smaller DEU in Belgium and Sweden - near zero.

TABLE 15. DIRECT MATERIAL INPUTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF CEE-8 COUNTRIES [31]

	2000	2008	2009	2010	2012	2013
EU (27)	4.07	4.074	3.813	3.754	3.704	3.526
Bulgaria	4.761	6.15	5.446	5.771	6.369	5.50
Czech Rep.	8.777	8.176	7.678	7.802	7.514	6.925
Croatia	:	2.551	2.406	2.357	2.106	2.168
Hungary	3.308	3.918	3.17	3.176	2.975	2.818
Poland	5.176	4.948	4.668	4.764	4.85	4.88
Romania	2.50	3.28	2.912	2.824	2.944	2.782
Slovenia	4.418	5.372	4.866	4.966	4.96	4.734
Slovakia	4.003	3.995	3.793	3.873	3.836	3.724

TABLE 16. DIRECT MATERIAL INPUTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2000	2008	2009	2010	2011	2012	2013
EU-27	4.07	4.074	3.813	3.754	3.732	3.704	3.526
Germany	5.97	6.458	6.104	6.19	6.343	6.36	6.352
Estonia	9.22	13.769	13.371	15.003	15.972	15.155	16.39
Latvia	1.14	1.976	1.873	1.913	2.244	2.215	2.219
Lithuania	2.237	4.505	3.965	4.491	4.814	4.83	5.061

Of the EU was the largest DMI of fossil energy materials/carriers in Estonia: 2013th it was 16.39 and of CEE-8 countries in Czech Republic 6.925 tonnes per capita.

TABLE 17. TOTAL IMPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF CEE-8 COUNTRIES [31]

	2000	2008	2009	2010	2012	2013
Bulgaria	1.519	2.285	1.789	1.785	1.754	1.513
Czech Rep.	2.111	2.355	2.259	2.507	2.298	2.376
Croatia	:	1.845	1.714	1.694	1.489	1.602
Hungary	1.421	2.569	1.843	1.851	1.765	1.834
Poland	0.832	1.175	1.149	1.308	1.159	1.197
Romania	0.519	0.94	0.657	0.666	0.689	0.558
Slovenia	2.162	3.134	2.693	2.8	2.879	2.904
Slovakia	3.311	3.569	3.327	3.443	3.425	3.396

Of CEE-8 countries was the largest fossil energy materials import in Slovakia and smallest in Romania.

TABLE 18. TOTAL IMPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2000	2008	2009	2010	2012	2013
EU-27	2.919	3.451	3.178	3.263	3.256	3.227
Germany	3.286	3.912	3.673	3.792	3.765	3.957
Estonia	1.539	2.993	3.294	2.962	2.38	2.264
Latvia	0.972	1.578	1.473	1.577	1.852	1.852
Lithuania	2.072	4.324	3.815	4.368	4.68	4.896

Of Baltic countries was the largest fossil energy materials total import and extra EU-27 import in Lithuania. Latvia and Estonia import was lower than in EU-27 and Germany.

TABLE 19. EXTRA EU-27 IMPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF CEE-8 COUNTRIES [31]

	2000	2008	2009	2010	2012	2013
Bulgaria	1.335	2.04	1.57	1.531	1.518	1.284
Czech Rep.	1.531	1.555	1.454	1.626	1.342	1.362
Hungary	1.080	2.051	1.391	1.31	1.178	1.281
Poland	0.185	0.329	0.305	0.345	0.229	0.219
Romania	0.466	0.794	0.527	0.481	0.487	0.383
Slovenia	1.306	1.467	1.196	1.288	1.142	1.324
Slovakia	2.416	2.467	2.256	2.213	2.226	2.290

In CEE-8 countries were the largest fossil energy materials extra EU-27 import in Slovakia and smallest in Poland. It was in Hungary, Poland and Slovenia slightly increased, the other was a loss.

TABLE 20. EXTRA EU-27 IMPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2000	2008	2009	2010	2011	2012	2013
EU-27	1.91	2.30	2.14	2.11	2.11	2.11	2.03
Germany	1.91	2.20	2.13	2.05	2.08	2.05	2.02
Estonia	1.31	1.59	1.59	1.44	1.62	1.29	1.10
Latvia	0.78	0.96	0.92	0.96	0.98	0.93	0.89
Lithuania	1.92	4.00	3.51	3.95	4.15	4.06	4.30

Extra EU-27 imports of fossil energy materials/carriers per capita was in the EU-27, Germany, and Latvia slightly increased, in Estonia markedly decreased and in Lithuania increased by 2.2 times over the analysis period.

TABLE 21. TOTAL EXPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF CEE-8 COUNTRIES [31]

	2000	2008	2009	2010	2011	2012	2013
Bulgaria	0.334	0.626	0.538	0.567	0.6	0.678	0.719
Czech Rep.	1.252	1.316	1.232	1.445	1.335	1.256	1.182
Croatia	0.549	0.633	0.603	0.468	0.441	0.490	0.490
Hungary	0.30	0.669	0.639	0.567	0.598	0.614	0.703
Poland	0.813	0.57	0.517	0.666	0.61	0.528	0.771
Romania	0.154	0.304	0.265	0.242	0.245	0.222	0.250
Slovenia	0.244	0.504	0.519	0.649	0.676	0.753	0.914
Slovakia	0.745	0.99	1.035	1.124	1.268	1.135	1.223

TABLE 22. TOTAL EXPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2000	2008	2009	2010	2011	2012	2013
EU-27	1.222	1.373	1.288	1.384	1.397	1.432	1.488
Germany	0.784	0.961	0.844	0.903	0.982	1.098	1.149
Estonia	0.744	2.247	2.667	2.718	3.277	2.707	1.861
Latvia	0.212	0.611	0.666	0.809	0.976	1.031	1.111
Lithuania	1.017	2.549	2.477	2.77	2.989	3.002	3.310

All EU countries total and extra EU-27 exporting fossil energy materials, including the Baltic States and CEE-8 countries increased.

TABLE 23. EXTRA EU-27 EXPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF CEE-8 COUNTRIES [31]

	2000	2008	2009	2010	2011	2012	2013
Bulgaria	0.233	0.488	0.378	0.447	0.468	0.539	0.576
Czech Rep.	0.020	0.042	0.067	0.067	0.067	0.066	0.056
Hungary	0.048	0.173	0.13	0.138	0.135	0.141	0.193
Poland	0.082	0.077	0.08	0.082	0.091	0.102	0.134
Romania	0.087	0.187	0.149	0.126	0.15	0.146	0.153
Slovenia	0.098	0.188	0.183	0.233	0.233	0.207	0.226
Slovakia	0.016	0.06	0.042	0.047	0.051	0.037	0.043

TABLE 24. EXTRA EU-27 EXPORTS OF FOSSIL ENERGY MATERIALS TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2000	2008	2009	2010	2011	2012	2013
EU-27	0.311	0.396	0.409	0.42	0.405	0.445	0.460
Germany	0.186	0.226	0.204	0.205	0.203	0.266	0.228
Estonia	0.059	0.93	1.292	1.26	1.556	1.171	0.586
Latvia	0.034	0.12	0.086	0.135	0.235	0.229	0.201
Lithuania	0.196	0.703	0.651	0.803	0.693	0.515	0.945

TABLE 25. DOMESTIC MATERIAL CONSUMPTION OF CRUDE OIL, CONDENSATE AND NATURAL GAS LIQUIDS (NGL) TONNES PER CAPITA OF EU-27 AND BALTIC COUNTRIES [31]

	2000	2007	2008	2009	2010	2011	2012
Germany	1.555	1.289	1.403	1.393	1.406	1.357	1.336
Estonia	0.413	0.803	0.569	0.574	0.303	0.228	-0.257
Latvia	0.417	0.665	0.641	0.546	0.494	0.483	0.528
Lithuania	0.622	0.828	0.998	0.734	0.853	0.751	0.807

TABLE 26. TOTAL IMPORTS OF CRUDE OIL, CONDENSATE AND NATURAL GAS LIQUIDS (NGL) TONNES PER CAPITA OF EU-27, GERMANY AND BALTIC COUNTRIES [31]

	2000	2007	2008	2009	2010	2011	2012
EU-27	1.723	1.889	1.901	1.816	1.847	1.829	1.827
Germany	1.771	1.644	1.733	1.658	1.628	1.583	1.631
Estonia	0.538	2.375	1.928	2.53	2.185	2.507	1.589
Latvia	0.464	0.788	0.741	0.683	0.636	0.8	0.877
Lithuania	1.421	1.961	3.115	2.81	3.138	3.256	3.302

TABLE 27. EXTRA EU-27 IMPORTS OF CRUDE OIL, CONDENSATE AND NATURAL GAS LIQUIDS (NGL) (MF421) TONNES PER CAPITA OF EU-27, GERMANY AND BALTIC COUNTRIES [31]

	2003	2007	2009	2010	2012
EU-27	1.284	1.386	1.347	1.348	1.296
Germany	1.159	1.106	1.11	1.021	1.037
Estonia	0.397	1.32	1.145	0.959	0.767
Latvia	0.325	0.39	0.308	0.233	0.237
Lithuania	2.104	1.893	2.757	3.053	3.063

Trend: EU-27 – stable or small growth, Germany and Latvia - small decrease, Lithuania – growth of 1.5 times, Estonia - growth of 2 times.

TABLE 28. EXTRA EU-27 IMPORTS OF CRUDE OIL, CONDENSATE AND NATURAL GAS LIQUIDS (NGL) (MF421) TONNES PER CAPITA OF EU-27, GERMANY AND BALTIC COUNTRIES [31]

	2000	2008	2009	2010	2011	2012
EU-27	0.282	0.363	0.297	0.273	0.318	0.352
Germany	0.12	0.177	0.177	0.157	0.201	0.179
Estonia	0.87	0.113	0.039	0.058	0.035	0.059
Latvia	0.033	0.079	0.059	0.085	0.09	0.075
Lithuania	0.036	0.139	0.089	0.13	0.163	0.133

Domestic material consumption and total imports of fuels bunkered of fossil energy in Estonia and Latvia were between 2000 and 2012 is very small. These imports (Imports: by resident units abroad) were from 0.104 to 0.029 tonnes per capita. [31]

3) Natural gas analyses per capita

Next we look gas trade movements by world energy review in 2013th. [33]

Trade movements in 2013th by pipeline total world imports- exports of natural gas was 710.6 billion cubic metres and Russian Fed. total exports 211.3 billion cubic metres (30%).

To Europe was import from Netherlands 53.2, Norway 102.4, Russian Fed. 162.4 and total import 397.1 billion cubic metres. To Germany was import from Netherlands 22.4, Norway 33.5, Russian Fed. 39.8 and total import 95.8 billion cubic metres. In 2012th was import by pipeline imports of natural gas to Germany 83.5 billion cubic metres.

Trade movements in 2013th as liquefied natural gas (LNG). Total world imports- exports 325.3 billion cubic metres. To Japan was imports from Qatar 21.8, Russian Fed. 11.6, total 119.0 billion cubic metres.

To South Korea was import from Qatar 18.3, total 54.2 billion cubic metres. [33]

TABLE 29. DOMESTIC MATERIAL CONSUMPTION, TOTAL IMPORTS AND EXTRA EU-27 IMPORTS OF NATURAL GAS TONNES PER CAPITA, TOP-6, 2012 [31]

Domestic Material Consumption	Total imports	Extra EU-27 Imports
Netherlands 2.155	Luxembourg 1.855	Belgium 1.022
Luxembourg 1.853	Netherlands 1.341	Netherlands 0.877
Austria 1.070	Belgium 1.155	Austria 0.821
Belgium 1.042	Germany 1.188	Germany 0.799
Germany 0.997	Austria 1.140	Slovakia 0.785
Italy 0.863	Slovakia 1.043	Lithuania 0.778

TABLE 30. TOTAL IMPORTS AND EXTRA EU-27 IMPORTS OF NATURAL GAS TONNES PER CAPITA OF EU-27 [31]

EU-27	2000	2008	2009	2010	2011	2012
Total Imports	0.476	0.638	0.594	0.616	0.619	0.595
Extra EU-27 Imports	0.333	0.454	0.411	0.399	0.375	0.381

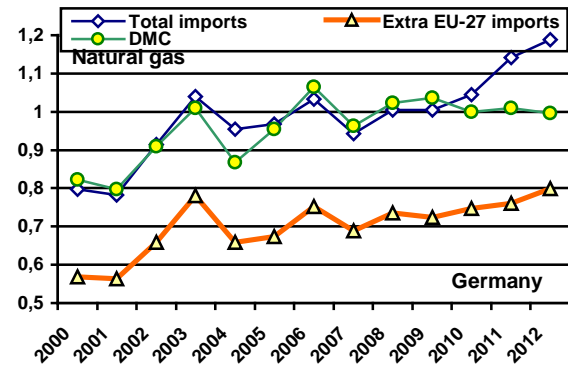
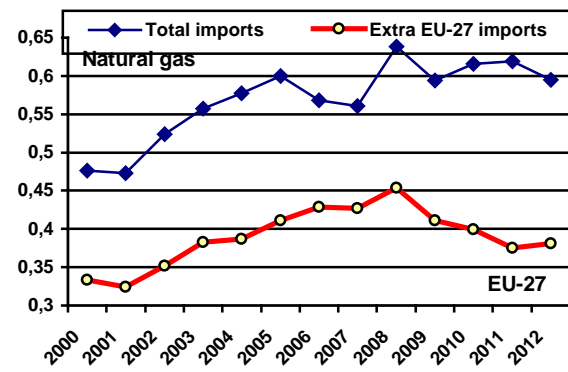


Figure 8. DMC, total and extra EU-27 imports of natural gas tonnes per capita of EU-27 and Germany [31]

TABLE 31. DMC, TOTAL IMPORTS AND EXTRA EU-27 IMPORTS OF NATURAL GAS TONNES PER CAPITA OF GERMANY [31]

Germany	2000	2008	2009	2010	2011	2012
DMC	0,822	1,023	1,037	0,999	1,009	0,997
Total Imports	0,797	1,004	1,005	1,044	1,142	1,188
Extra EU27 Imports	0,569	0,736	0,724	0,747	0,76	0,799

TABLE 32. DMC, TOTAL IMPORTS AND EXTRA EU-27 IMPORTS OF NATURAL GAS TONNES PER CAPITA OF BALTIC COUNTRIES [31]

Estonia	2000	2008	2009	2010	2011	2012
DMC	0.006	0.551	0.368	0.38	0.378	0.352
Total Imports	0.006	0.551	0.368	0.382	0.381	0.362
Extra EU-27 Imports	0.006	0.511	0.315	0.353	0.32	0.346

Latvia	2000	2008	2009	2010	2011	2012
DMC	0.385	0.546	0.511	0.575	0.559	0.542
Total Imports	0.385	0.565	0.539	0.613	0.602	0.584
Extra EU-27 Imports	0.380	0.555	0.532	0.61	0.597	0.576

Lithuania	2000	2008	2009	2010	2011	2012
DMC	0.513	0.651	0.535	0.64	0.771	0.747
Total Imports	0.55	0.727	0.584	0.697	0.825	0.795
Extra EU-27 Imports	0.55	0.718	0.57	0.68	0.807	0.778

TABLE 33. TOTAL EXTRA EU-27 IMPORTS LIQUID AND GASEOUS ENERGY MATERIALS (MF42) TONNES PER CAPITA. EU-27, GERMANY AND BALTIC COUNTRIES [31]

	2003	2007	2009	2010	2012
EU-27	1.677	1.841	1.786	1.772	1.688
Germany	1.999	1.883	1.926	1.858	1.837
Estonia	0.437	1.892	1.46	1.312	1.114
Latvia	0.91	0.956	0.84	0.843	0.813
Lithuania	2.72	2.664	3.327	3.733	3.841

Extra EU-27 imports liquid and gaseous energy materials/carriers: EU (27) – stable or small decrease, Germany and Latvia - small decrease, Lithuania – growth, Estonia - growth of 2.5 times.

TABLE 34. EXTRA EU-27 IMPORTS NATURAL GAS (MF422) TONNES PER CAPITA. BALTIC COUNTRIES [31]

	2003	2008	2009	2010	2011	2012
Estonia	0.04	0.511	0.315	0.353	0.32	0.346
Latvia	0.585	0.555	0.532	0.61	0.597	0.576
Lithuania	0.617	0.718	0.57	0.68	0.807	0.778

In the EU-27 in 2012 was extra EU-27 imports natural gas 0,381 tonnes per capita. From EU countries were the largest importers Belgium (1.022), Netherlands (0.877), Austria (0.821), Germany (0.799), Slovakia (0.785) and Lithuania (0.778). At the same time, some countries, it was close to zero. In Estonia (0.346) was it a bit smaller and Latvia (0.576) higher than the EU average. For 10 years extra EU-27 imports has been very stable in most countries. In 2003 - 2012 only in Estonia and United Kingdom was strong growth and in France in Hungary a big loss.

Estonia extra EU-27 imports natural gas grew strongly until 2007. Next, it decreased and stabilized in the next four years. Latvia and Lithuania are much bigger than Estonia, Lithuania in 2012, even 2.2 times. When Latvia extra EU-27 imports natural gas per capita was stable, then the Lithuanian imports small rose. Extra EU-27 imports natural gas per capita in Latvia and Lithuania is much greater than in Estonia.

Therefore, we should analyze the *resource productivity* in depth below. This, however, is strongly correlated with labour productivity analysis [4 - 15].

Taking into account this publication and the previous work of the authors [4 – 15, 22 - 25] and other authors' works [16 - 21] have made the following conclusions and suggestions.

5. CONCLUSIONS

- ❖ In relative terms (here tonnes per capita) analysis allows you to compare countries with each other, however, the respective indices.
- ❖ The development of Baltic and CEE-8 economies (GDP) has been cyclical, characterized by a well theoretically complicated polynomial.
- ❖ Development of the Baltic economies was before and after the economic crisis, the EU's largest.
- ❖ DMC per capita growth was in Estonia double, in Latvia 26% and in Lithuania 54%. In 2013, was the DMC more than double in Estonia and

more than 1.5 times in Latvia higher than the EU average.

- ❖ Trend of resource productivity by euro per kilogram has slowly grown in the EU-27 and the Latvia and Lithuania. Estonia trend was reversed. This indicator was the EU-27 from 3 to 5 times higher than in the Baltic countries. Resource productivity in EU-27 grew 31.5% in 13 years. In a few years, however, was a step backwards. Almost as large was the increase in Lithuania. Latvia resource productivity grew strongly, then fell for two years and rose sharply again in 2012. In total, it increased by 1.5 times. Estonia decreased steadily.
- ❖ Of the European was the largest DEU fossil energy materials/carriers than in Norway: 2004th it was 61.845 and of the EU in Estonia: 2013th it was 14.126 tonnes per capita. Of the EU was smaller it in Belgium and Sweden - near zero.
- ❖ Extra EU-27 imports liquid and gaseous energy materials/carriers and crude oil, condensate and natural gas liquids per capita: EU-27– stable or small decrease, Latvia - small decrease, Lithuania – growth, Estonia - growth over 2 times.
- ❖ The EU has a poor energy region, it is unexpected decrease in mineral fuels (sanctions) is very sensitive.
- ❖ The great problems in the energy sector of EU countries are growing import of natural gas dependence on Russia and high import price level.
- ❖ So far the mineral fuels imports from third countries progressed steadily.
- ❖ Total imports resource per capita grew in all Baltic countries.
- ❖ Resource export shows that the EU and the Baltic countries are not very poor in terms of material or natural resources. Total exports resource per capita grew in all Baltic countries in 2003 - 2012: in Estonia - of 1.4 times, in Latvia and in Lithuania –of two times.
- ❖ Total exports; direct material inputs and domestic extraction used resource per capita grew in all Baltic countries in 2003 – 2012.
- ❖ Total imports resource per capita grew in all Baltic countries.
- ❖ Before the crisis grew in all extra EU-27 imports resource per capita. However, already before the crisis began Latvia and Estonia this decrease.
- ❖ In summary, total extra EU27 imports resource per capita trend: Lithuania intermittent growing, Estonia decrease and Latvia was stable.
- ❖ Total extra EU27 imports resource per capita trend: Lithuania intermittent growing, Estonia decrease and Latvia were stable. Extra EU27 imports per capita of Estonia and Latvia was two times less when in Lithuania. This shows

that Latvia and Estonia should be much better over live an economic blockade when Lithuania. In summary, total DMC and DEU of Estonia growth. Lithuania and Latvia were large abrupt changes, peak was before the crisis, and the biggest drop one year after the crisis.

- ❖ In the EU-27 in 2012 was extra EU-27 imports natural gas 0,381 tonnes per capita. From EU countries were the largest importers Belgium (1.022), Netherlands (0.877), Austria (0.821), Germany (0.799), Slovakia (0.785) and Lithuania (0.778). At the same time, some countries, it was close to zero. In Estonia (0.346) was it a bit smaller and Latvia (0.576) higher than the EU average. For 10 years extra EU-27 imports has been very stable in most countries. In 2003 - 2012 only in Estonia and United Kingdom was strong growth and in France in Hungary a big loss.
- ❖ Extra EU27 imports natural gas per capita in Latvia and Lithuania was much greater than in Estonia.
- ❖ Of the Baltic countries are more dependent of the imported resources Lithuania.
- ❖ Of the Baltic countries are more advanced DMC in Estonia.
- ❖ The use of environmentally friendly materials has risen, and the use of sustainable materials is reduced.
- ❖ Material flow is generally decreased less so EU whole, but also in the Baltic States.
- ❖ Resource productivity is generally has increased in the EU the whole, as well as in the Baltic countries.

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