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Analysis of the Material Flow of New Members of the European Union

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Abstract With regard to acute political and economic situation in Eastern Europe, with the European Union (EU) and Russia on mutual economic partial blockade, has become very topical, what is the position of material in the former Soviet bloc countries. The purpose of this article is to analyse the material or resource flow of new EU states, the main emphasis the Baltic countries and to compare them on the EU level. Energy security is always one of the most important problems in the EU. The EU and including the Baltic countries are poor of material and energy region. The analysis showed that the greater use of resources does not always lead to economic growth. Effective use of resources is different in Europe from country to country. How far is the use of these lands resource, including the 2009. economic crisis? What are the prospects for a partial boycott of resources? What are the lessons from the resource flow?

Keywords: *material flow, domestic material consumption, fossil energy materials, imports, exports, regression analysis, Baltic countries*

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1. Introduction

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

We analyze the material flow problems of new European Union (EU) Member States from Baltic and Central and Eastern Europe (CEE-8) or former Soviet-bloc countries, with the exception of Malta and Cyprus. The Baltic States are part of the former Soviet Union a half century. After the collapse of the Soviet-bloc in 1989–90, Baltic and CEE-8 countries became fully independent again. This will help them to better understand the economic backwardness of place Western Europe, the countries of the Western civilization.

The history and economic background of his country's is more detail in previous earlier publications of authors. [2-12].

Natural resources underpin the functioning of the European economy and our quality of life. These resources include raw materials such as fuels, minerals and metals but also food, soil, water, air, biomass and ecosystems. The pressures on resources are increasing. 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 to securing growth and jobs for Europe. It will bring major economic opportunities, improve productivity, drive down costs and boost competitiveness. [1]

All economic systems utilize a variety of resources. The scarcity of resources forces countries, companies and people make a variety of choices. That's what we look at on the basis of the new EU Member States or former Soviet-bloc countries countries.

The theoretical foundations are given in more detail the works of other authors [13,14,15,16,17] and Eurostat [1].

2. Methodology

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* [18,19].

Domestic material consumption by material of Eurostat is in environmental accounts.

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. 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 availble 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.

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*. This index allows a comparison of countries' resource productivity performance [20].

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

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 (MF421) and natural gas (MF422).[19]

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

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

$$DMI = DEU + IMP$$
$$= DMC + EXP - IMP + IMP = DMC + EXP \quad [5] \quad (2)$$

Econometrics is the application of mathematics, statistical methods, and, more recently, computer science, to economic data and is described as the branch of economics that aims to give empirical content to economic relations. [21] The basic tool for econometrics is the linear regression model, but we use the complicated nonlinear model, which can perform more specific conclusions.

The processing of data is used to *regression analysis*. Regression analyzis are statistical analysis procedures that have the goal of relationships between a dependent and one or more independent variables to model. They are particularly used when relationships to describe quantitatively or values of the dependent variables are to predict [22,23].

Mathematically, the relationship between the independent variable x and the dependent variable y are represented as:

$$y = f(x) + \varepsilon, \text{ in the one} - \text{dimensional case,} \quad (3)$$

$$y = f(x_1, x_2, ..., x_n), \text{in the n} - \text{dimensional case} \quad (4)$$

In general, we can model the expected value of y as an nth degree polynomial, yielding the general polynomial regression model:

$$y = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + \ldots + a_n x^n + \varepsilon \quad (5)$$

Most authors using simple linear regression. It's convenient to use, but as a rule it is not well-characterized complex processes. We use *polynomial regression*, which gives a much more precise picture. Numerical values of the parameters used to find the indirectly *least squares method* or *ordinary least squares*. We are a non-linear correlation [22,23].

For this purpose we use the computer program. Microsoft Excel provides a set of data analysis tools—called the Analysis ToolPak— that you can use to save steps when you develop complex statistical or engineering analyses.

All *figures* are the authors' illustration.

3. Analysis of Material Flow

3.1. Material Flow Analyses by Total Domestic Material Consumption

Next we analized material flow in EU – 27, CEE-8 and Baltic countries of tonnes.

Table 1. Total Domestic Material Consumption (DMC). Thousands tonnes [18]

	2000	2002	2004	2006	2007	2008	2009	2010	2011	2012	2013
Bulgaria	101,025	110,416	125,339	137,818	142,480	153,661	122,850	121,077	134,084	131,611	121,455
Czech Rep	182,902	173,506	189,424	193,819	196,657	193,577	176,695	167,813	177,066	157,389	153,112
Estonia	19,616	22,779	29,363	32,050	38,915	35,415	33,040	33,416	35,509	37,975	40,112
Croatia	:	48,018	59,139	60,669	60,728	70,171	54,175	44,018	45,378	41,644	39,731
Latvia	34,666	35,789	38,301	45,747	49,252	41,469	32,074	37,029	40,932	37,452	41,994
Lithuania	29,173	31,553	39,520	41,184	48,735	51,779	34,905	38,462	41,721	38,283	38,868
Hungary	122,983	134,989	165,718	153,872	122,011	136,786	109,290	99,999	99,227	88,441	104,146
Poland	539,230	494,777	543,131	563,045	628,635	643,542	617,953	644,877	797,705	698,069	685,790
Romania	172,796	263,064	306,020	360,737	428,678	550,989	432,598	400,003	445,627	430,425	456,874
Slovenia	34,152	34,864	38,083	43,054	47,691	41,958	34,653	32,739	29,459	25,535	25,391
Slovakia	54,273	60,461	70,533	74,298	72,005	82,948	73,090	71,871	74,319	64,414	62,002

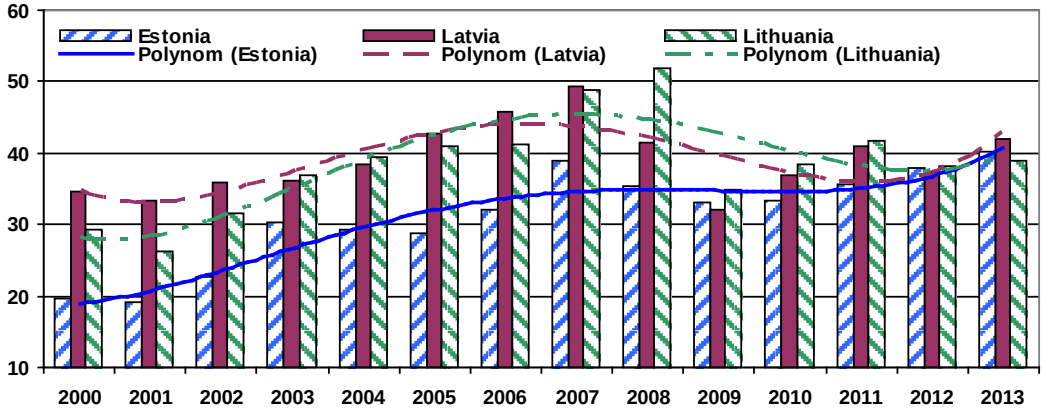

Figure 1. Total Domestic Material Consumption of Baltic States. Million tonnes [18]

Before the economic crisis, GDP growth rose by analogy with DMC. The peak was reached in 2007 - 2008. 2009. followed by a decline, especially large in Lithuania. In the following years the economy grew, and with it DMC or vice versa the better DMC used to cause growth. For more of the answer gives the material flow components detailed analysis.

DMC trend lines of Baltic States and next of CEE-8 countries:

$$Estonia\ y = 0,0063x^4 - 0,1721x^3 + 1,3601x^2 - 1,142x + 18,86; R^2 = 0,906 \quad (6)$$

$$Latvia\ y = 0,0141x^4 - 0,4028x^3 + 3,5708x^2 - 9,7221x + 41,333; R^2 = 0,5883 \quad (7)$$

$$Lithuania\ y = 0,0117x^4 - 0,3474x^3 + 3,1022x^2 - 6,9536x + 32,467;\ R^2 = 0,7274 \quad (8)$$

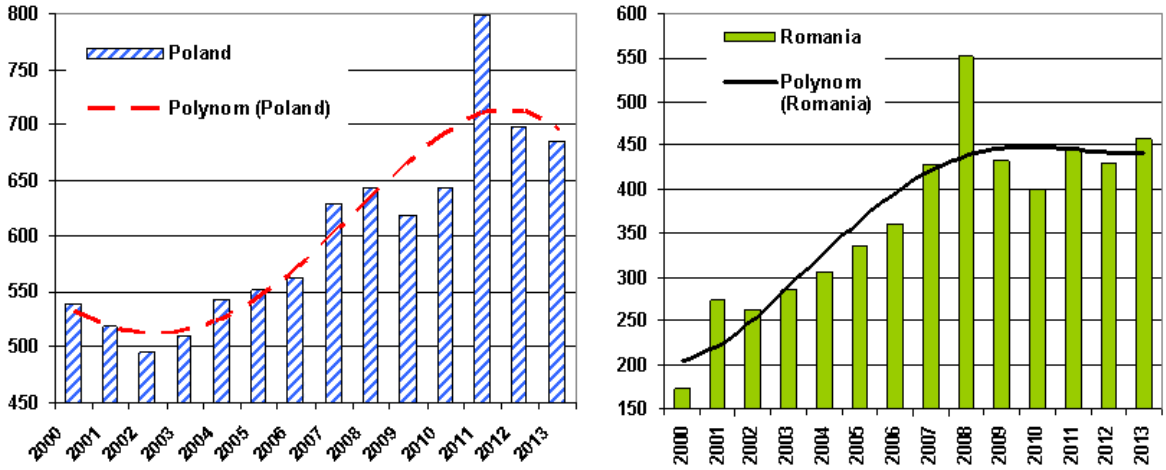

Figure 2. DMC of Poland and Romania. Million tonnes [18]

$$Poland\ y = -0,0276x^4 + 0,396x^3 + 2,2219x^2 - 22,934x + 553,13;\ R^2 = 0,8546 \quad (9)$$

$$Romania\ y = 0,0453x^4 - 1,5114x^3 + 14,781x^2 - 18,361x + 210,97;\ R^2 = 0,8275 \quad (10)$$

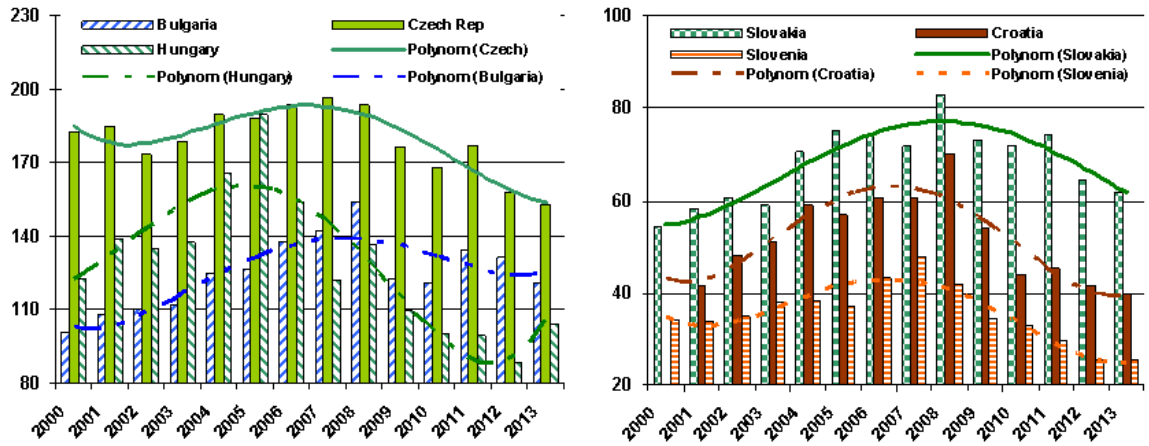

Figure 3. DMC of CEE-6 countries. Million tonnes [18]

$$Czech\ y = 0,0215x^4 - 0,695x^3 + 6,9306x^2 - 23,094x + 201,9;\ R^2 = 0,8486 \quad (11)$$

$$Hungary\ y = 0,0385x^4 - 0,9425x^3 + 5,7106x^2 - 1,8908x + 119,86;\ R^2 = 0,8101 \quad (12)$$

$$Bulgaria\ y = 0,0188x^4 - 0,5821x^3 + 5,3784x^2 - 11,825x + 110,2;\ R^2 = 0,7374 \quad (13)$$

$$Slovakia\ y = 0,0054x^4 - 0,1916x^3 + 1,8411x^2 - 2,6166x + 55,77;\ R^2 = 0,8544 \quad (14)$$

$$Croatia\ y = 0,0171x^4 - 0,5132x^3 + 4,5461x^2 - 10,657x + 49,768;\ R^2 = 0,834 \quad (15)$$

$$Slovenia\ y = 0,0121x^4 - 0,3726x^3 + 3,4952x^2 - 10,229x + 42,104;\ R^2 = 0,8754 \quad (16)$$

These theoretical trend lines (4-degree polynomial) is characterized by changes in the Baltic States and CEE-8 DMC. Also, they are like the cyclical nature of the changes in GDP. However, these R^2 of Baltic States are smaller than the GDP R^2, thus a little weaker link.

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 2. Components of DMC. Total imports resource, thousands tonnes [18]

	2000	2002	2004	2006	2007	2008	2009	2010	2011	2012	2013
Bulgaria	18,120	18,682	23,228	28,309	29,858	29,051	22,224	22,390	23,414	23,072	21,834
Czech Rep	47,575	47,804	61,639	63,590	63,891	67,137	58,524	67,444	70,526	66,575	67,643
Estonia	5,591	6,060	9,733	11,991	12,140	9,837	8,979	9,550	10,767	9,108	9,054
Croatia	:	14,582	19,465	22,127	23,044	22,793	16,765	16,062	16,070	15,001	15,763
Latvia	5,771	6,564	8,794	12,225	13,541	12,508	8,719	9,697	11,142	12,861	12,673
Lithuania	12,766	16,233	21,009	24,095	23,352	26,076	21,125	24,427	26,305	26,486	28,096
Hungary	34,195	38,244	47,652	49,537	51,334	52,213	38,675	39,670	41,682	38,526	41,177
Poland	70,503	76,984	90,720	97,672	113,831	120,494	102,814	120,795	133,252	119,274	119,323
Romania	25,328	31,189	40,559	44,620	50,295	49,264	33,119	37,092	38,178	38,066	35,400
Slovenia	11,788	13,550	16,000	17,626	21,685	20,565	16,546	17,095	17,430	16,802	17,874
Slovakia	29,999	32,182	40,067	41,354	44,160	43,641	38,147	41,810	45,408	42,664	43,875

Resources imports are all increased, more than others in Latvia, and in Lithuania.

Table 3. Components of DMC. Total exports resource, thousands tonnes [18]

	2000	2002	2004	2006	2007	2008	2009	2010	2011	2012	2013
Bulgaria	12,029	12,799	14,944	17,614	16,996	18,233	16,136	20,013	22,534	22,936	26,574
Czech Rep	40,812	41,915	53,530	54,744	57,111	61,821	54,788	62,664	65,516	66,339	62,320
Estonia	9,091	9,036	9,672	12,386	11,573	11,734	10,150	12,379	14,267	12,930	12,513
Croatia	:	12,710	14,695	17,041	18,260	17,204	16,191	15,014	14,113	12,391	14,685
Latvia	9,255	9,965	11,610	13,585	13,595	14,103	13,569	17,478	18,298	19,610	18,077
Lithuania	9,569	12,840	16,532	18,425	18,198	21,376	19,251	21,135	23,540	25,055	26,614
Hungary	19,785	22,799	23,826	34,739	38,497	38,038	34,796	33,533	35,953	34,894	35,694
Poland	64,088	66,431	73,802	78,236	76,949	74,612	68,374	80,070	81,417	79,448	97,429
Portugal	17,989	19,480	24,538	30,159	32,086	32,714	28,608	32,087	33,390	34,657	37,82
Romania	19,153	21,592	24,631	26,373	24,624	27,156	26,542	31,108	33,521	31,034	37,615
Slovenia	7,609	7,943	8,783	11,235	12,318	13,017	12,007	12,392	13,161	13,341	13,519
Slovakia	20,215	21,424	23,220	27,585	31,618	29,602	26,193	27,488	30,586	30,411	32,977

Total exports resource are also of Baltic and CEE-8 countries growth, in Lithuania and in Latvia over two times, but in Estonia 42%.

Table 4. Material flow accounts, thousands of tonnes, 2012 [24]

	IMP	IMP_XEU27	EXP	EXP_XEU27
European Union (27)	3 243 159	1 581 231	2 220 731	638 003
Germany	602 849	231 998	376 202	91 182
Netherlands	391 326	189 342	354 513	78 738
France	341 935	141 709	195 697	53 924
Italy	309 536	211 924	146 027	61 753
United Kingdom	286 829	182 743	156 973	46 524
Lithuania	26 486	17 671	25 055	7 046
Latvia	12 861	4 901	19 610	4 038
Estonia	9 108	3 213	12 930	3 772

Here are the EU, the major countries and Baltic States import and export of materials.

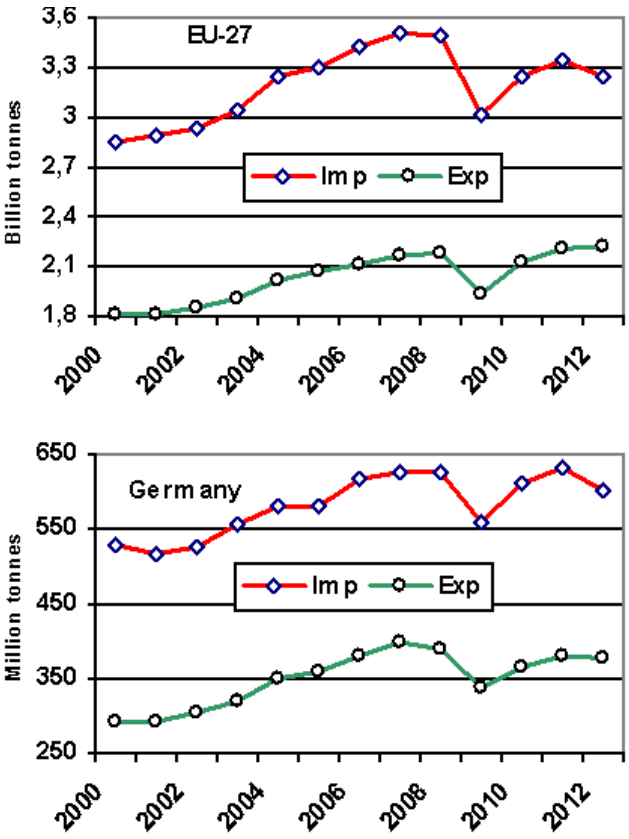

Figure 4. Total import and export of the EU-27 and Germany [18]

Trend lines of import and export of the EU-27 and Germany run practical parallel. EU-27 difference was accordingly one billion ja 430 million tonnes. EU-27 import was in 2000 1.6 and in 2012 1.5 times larger than exports. Germany difference was accordingly 1.8 and 1.6 times.

In 2012 was import 3243 million and export 2220 million tonnes of the EU-27; import of Germany was accordingly 602 million and export 376 million tonnes.

The EU-27 total imports of material in 2012 was 3,243 million tonnes and export 2,220 million tonnes. IMP_XEU27 was 1 581 and EXP_XEU27 638 million tonnes.

EU-28 exports of primary goods (food & drink; raw materials; energy) was in Jan-Jun 2014 147,5 billion and imports 295,9 billion EUR [25].

In contrast to the monetary value of trade EU's physical trade balance is asymmetric. The EU imports three times more goods by weight from the rest of the world than it exports. The amounts of physical imports into the EU are dominated by fossil fuels and other raw products which typically have significantly lower values per kilogram [13].

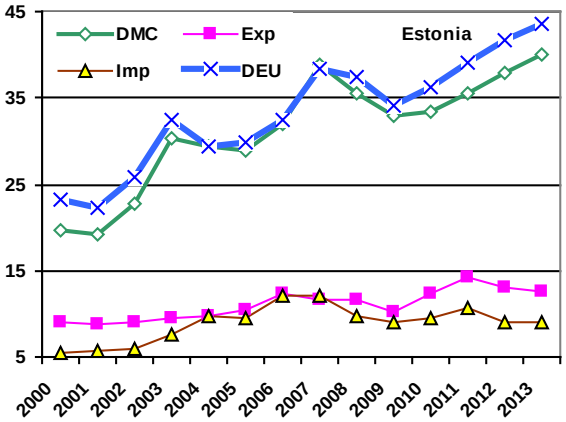

Figure 5. Total resource of Estonia, thousands tonnes [18]

Table 5. Domestic Extraction Used, thousands tonnes [18]

	2000	2002	2004	2006	2007	2008	2009	2010	2011	2012	2013
Bulgaria	94,933	104,533	117,055	127,123	129,619	142,843	116,762	118,701	133,204	131,475	126,194
Czech Rep.	176,139	167,617	181,315	184,973	189,877	188,260	172,959	163,033	172,056	157,153	147,789
Estonia	23,116	25,755	29,302	32,445	38,349	37,313	34,211	36,245	39,009	41,796	43,571
Croatia	34,472	46,146	54,368	55,583	55,944	64,582	53,602	42,970	43,421	39,034	38,653
Latvia	38,149	39,190	41,117	47,108	49,306	43,065	36,924	44,810	48,087	44,201	47,398
Lithuania	25,976	28,159	35,043	35,515	43,580	47,079	33,031	35,171	38,956	36,851	37,386
Hungary	108,573	119,544	141,892	139,074	109,174	122,611	105,411	93,862	93,498	84,809	98,663
Poland	532,815	484,223	526,213	543,609	591,753	597,660	583,512	604,152	745,870	658,243	663,896
Romania	166,620	253,467	290,092	342,491	403,007	528,881	426,021	394,019	440,970	423,393	459,089
Slovenia	29,973	29,258	30,867	36,664	38,325	34,410	30,115	28,036	25,190	22,074	21,036
Slovakia	44,488	49,703	53,686	60,529	59,463	68,909	61,137	57,548	59,497	52,160	51,104

Domestic Extraction Used (DEU) of Baltic countries in tones growth, in Estonia 1.8, in Latvia and in Lithuania 1,4 times.

DMC of Estonia increased with the high growth GDP until 2007 80%, or 15,799 thousand tones and subsequent decreased a little. The 2012 level was nearly the same as in 2007. The increase occurred mainly at the expense of imports, 3517 thousand tones. From 2000 to 2012, imports increased by 63% and 81% DEU.

Table 6. Total resource of Estonia, thousands tonnes [18]

Est	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
DMC	19,616	22,779	30,416	29,363	28,850	32,050	38,915	35,415	33,040	33,416	35,509	37,975	40,112
Exp	9,091	9,036	9,604	9,672	10,481	12,386	11,573	11,734	10,150	12,379	14,267	12,930	12,513
Imp	5,591	6,060	7,549	9,733	9,416	11,991	12,140	9,837	8,979	9,550	10,767	9,108	9,054
DEU	23,116	25,755	32,471	29,302	29,915	32,445	38,349	37,313	34,211	36,245	39,009	41,796	43,571

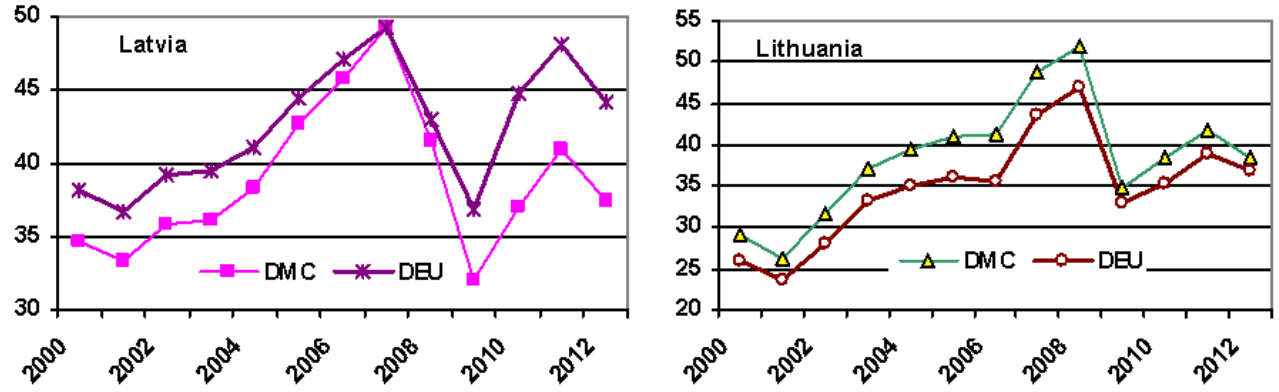

Figure 6. Total resource of Latvia and Lithuania, thousands tonnes [18]

Table 7. Total resource of Latvia, thousands tonnes [18]

Lat	2000	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
DMC	34,666	35,789	38,301	42,742	45,747	49,252	41,469	32,074	37,029	40,932	37,452	41,994
Exp	9,255	9,965	11,610	13,112	13,585	13,595	14,103	13,569	17,478	18,298	19,610	18,077
Imp	5,771	6,564	8,794	11,406	12,225	13,541	12,508	8,719	9,697	11,142	12,861	12,673
DEU	38,149	39,190	41,117	44,448	47,108	49,306	43,065	36,924	44,810	48,087	44,201	47,398

Economic (GDP) growth until 2007 of Latvia was the EU's biggest. Her DMC grew in the same period 42% or 14,586 thousand tonnes and declined in subsequent years to levels of 2004. The increase occurred mainly at the expense of imports, 7,770 thousand tonnes. From 2000 to 2012 exports grew steadily, a total of 111% and imports of 123%. What was the whole, the growth of 29% until 2007. Total growth of DEU was until 2007 by 29%.

Table 8. Total resource of Lithuania, thousands tonnes [18]

Lit	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
DMC	29,173	31,553	36,990	39,520	40,899	41,184	48,735	51,779	34,905	38,462	41,721	38,283	38,868
Exp	9,569	12,840	14,514	16,532	18,943	18,425	18,198	21,376	19,251	21,135	23,540	25,055	26,614
Imp	12,766	16,233	18,273	21,009	23,719	24,095	23,352	26,076	21,125	24,427	26,305	26,486	28,096
DEU	25,976	28,159	33,231	35,043	36,123	35,515	43,580	47,079	33,031	35,171	38,956	36,851	37,386

Also economic (GDP) growth of Lithuania was very high until 2008. Her DMC grew in the same period 77% or 22,606 thousand tonnes and declined in subsequent years to levels of 2004. Growth occurred both imports and exports at the expense of continuously, in period 2000 to 2012 by 104% and 123%.

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.

Next we look material flow accounts in raw material equivalents (RME) of EU 27.

Table 9. Material flow accounts of EU-27, thousand tonnes [24]

	2000	2008	2009	2010	2011	2012
Domestic Extraction Used	6 508 005	6 877 813	6 162 608	5 957 662	6 224 943	5 812 166
Total Imports in RME	3 133 336	3 832 190	3 339 357	3 527 146	3 613 616	3 617 956
Total Exports in RME	1 728 340	2 160 365	1 804 819	2 038 078	2 182 022	2 315 427
Raw Material Consumption	7 913 001	8 549 637	7 697 146	7 446 731	7 656 537	7 114 695
Raw Material Input	9 641 340	10 710 002	9 501 965	9 484 809	9 838 559	9 430 122

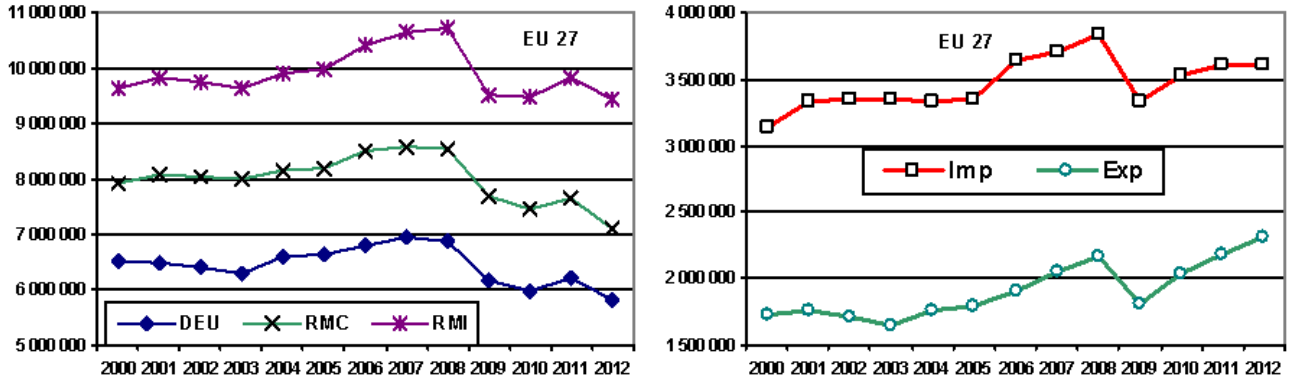

Figure 7. Material flow accounts of EU 27, thousand tonnes [24]

3.2. Material Flow Analyses by Key Components of DMC

Next we analyze the development of the key components of DMC during 2000 to 2012.

Table 10. Domestic material consumption by material - 1 000 tonnes. Biomass (MF1) [19]

	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Estonia	2,869	2,854	3,291	4,396	3,986	4,045	5,768	4,973	5,035	5,167	5,160	5,743
Latvia	26,540	24,858	22,372	22,667	23,986	23,461	23,326	16,360	18,905	20,027	21,319	18,332
Lithuania	14,772	14,940	16,953	16,941	15,697	13,991	16,833	15,824	16,196	14,820	16,085	17,313

Biomass (MF1) divided: Crops (excluding fodder crops) (MF11); Crop residues (used), fodder crops and grazed biomass (MF12); Wood (MF13); Wild fish catch, aquatic plants/animals, hunting and gathering (MF14); Live animals, and animal products (MF15) and Products mainly from biomass (MF16).

Biomass of the EU 27 and Latvia declined slightly over the analyzed period. Biomass of the EU 27 in 2012 was 1.693 million tonnes, over the 12 years it decreased by 3.7%. Lithuania had a small and Estonia double biomass consumption growth. However, Estonia consumed of biomass three times less than Latvia and Lithuania.

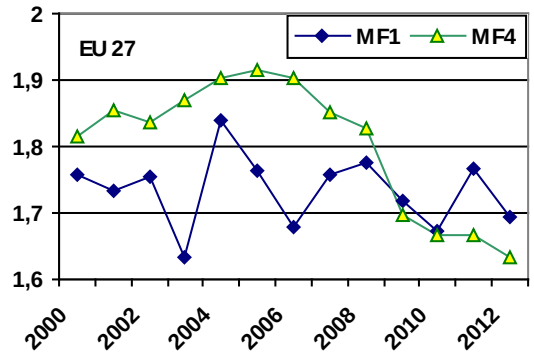

Figure 9. DMC by MF1 and MF4 - bn tonnes [19]

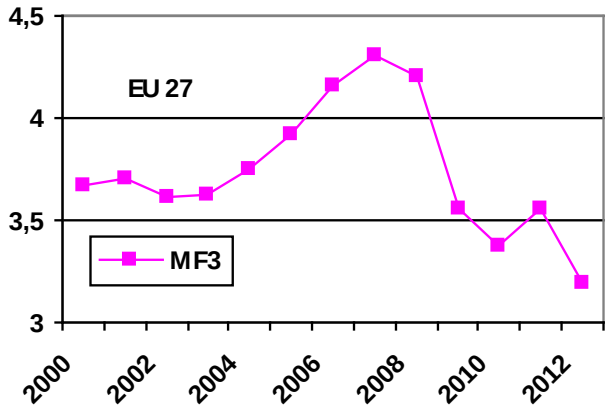

Figure 8. DMC by MF3 - bn tonnes [5]

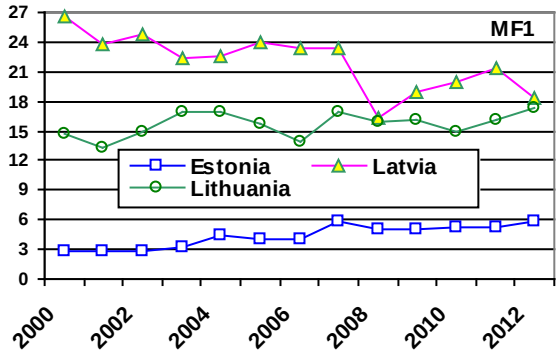

Figure 10. DMC by biomass 1 000 tonnes [19]

Table 11. Domestic material consumption by material,1 000 tonnes. Metal ores (gross ores) [19]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Estonia	111	39	191	449	756	39	-39	152	-199	-283	-341	-203	-120
Latvia	-33	47	145	270	181	-32	145	351	87	-318	-123	-47	12
Lithuania	-48	-71	99	148	384	328	560	535	268	-197	-239	-92	-86

Metal ores (gross ores) (MF2) divided: iron (MF21); non-ferrous metal (MF22): copper (MF221), nickel (MF222), lead (MF223), zinc (MF224), tin (MF225) and other; products mainly from metals (MF23).

EU-27 metal ores consumption in 2012 was 237 million tonnes, over the 12 years it decreased by 15.7%. Consumption of metal ores in the Baltic countries was very small and with large fluctuations.

Table 12. Domestic non-metallic minerals consumption - Million tonnes. [19]

	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Estonia	4,902	7,158	12,040	10,261	11,027	14,053	16,671	15,398	14,069	12,325	13,864	16,033
Latvia	5,868	8,008	10,700	12,864	15,892	18,903	22,886	22,200	11,089	15,099	17,493	16,864
Lithuania	9,949	11,626	14,788	17,158	18,476	20,996	25,707	29,583	14,309	18,787	20,684	16,264

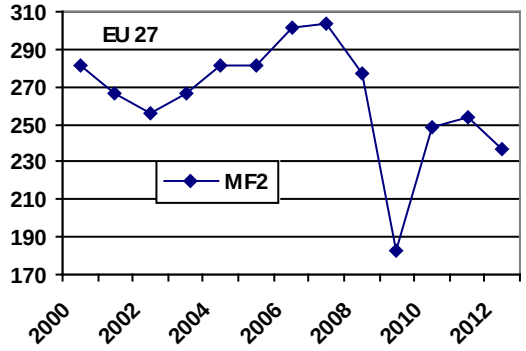

Figure 11. DMC by Metal ores (gross ores) of EU-27, million tonnes. [19]

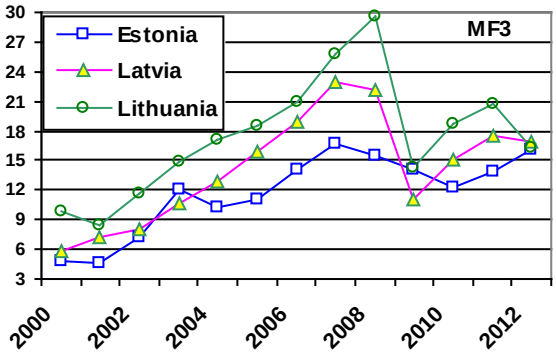

Figure 12. DMC by non-metallic minerals 1 000 tonnes. MF3 [19]

Non-metallic minerals (MF3) divided: marble, granite, sandstone, porphyry, basalt, other ornamental or building stone (MF31); chalk and dolomite (MF32); slate (MF33); chemical and fertiliser minerals (MF34); salt (MF35); limestone and gypsum (MF36) and other.

EU-27 non-metallic minerals consumption in 2012 was 3,189 million tonnes, over the 12 years it decreased by 13.0%. Estonia, Latvia and Lithuania it decreased 3.3, 2.9 and 1.6 times.

Fossil energy materials/carriers (MF4) divided: coal and other solid energy materials/carriers (MF41); Liquid and gaseous energy materials/carriers (MF42): Crude oil, condensate and natural gas liquids (MF421), Natural gas (MF422), Fuels bunkered (MF423); Products mainly from fossil energy products (MF43).

Table 13. Domestic fossil energy materials consumption - million tonnes. [19]

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
EU-27	1816	1853	1835	1870	1903	1914	1903	1851	1828	1696	1665	1667	1632	1540
Germany	426	435	444	453	451	450	453	446	451	430	432	438	423	419

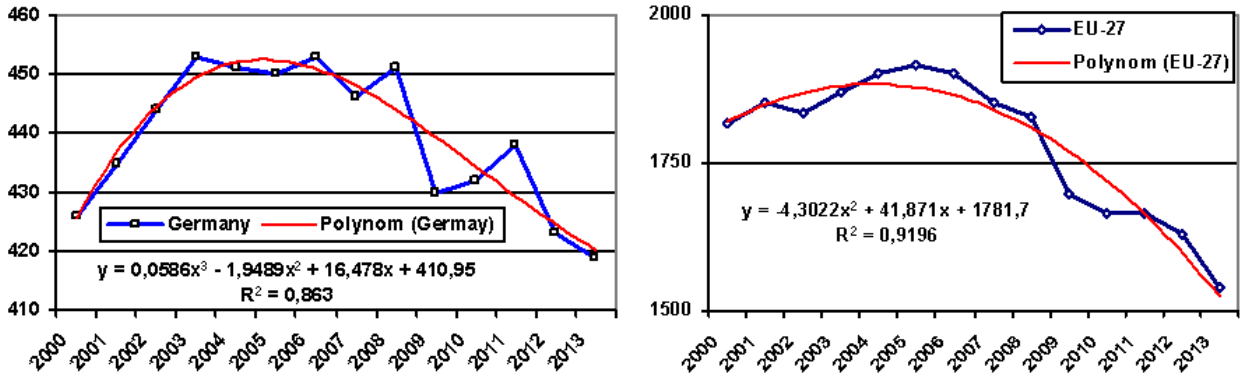

Figure 13. DMC by fossil energy materials in Germany and EU-27 1 000 tonnes. MF4 [19]

EU-27 fossil energy materials consumption grew until 2005, the peak was 1914 million tonnes. Next it is decreased, which is characterized by a parabola. From 2005 to 2013, consumption dropped by 19.5%.

Germany's fossil energy materials consumption share is a quarter of total EU-27 consumption. There has been a very small fluctuations. The changes characterized from 3-degree polynomial. From 2006 to 2013, consumption dropped by 7.5%.

Table 14. Domestic fossil energy materials consumption - 1 000 tonnes. [19]

	2000	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Estonia	11,841	12,625	14,035	13,960	14,130	16,297	15,406	14,285	16,357	16,852	16,465	19,150
Latvia	2,197	2,706	2,552	2,946	3,312	2,709	2,972	2,584	2,316	2,612	2,409	2,230
Lithuania	4,269	4,662	4,737	6,190	5,477	5,879	6,256	4,705	5,330	5,528	5,462	5,178

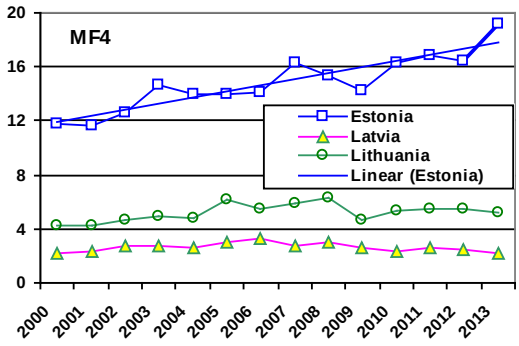

Figure 14. DMC by fossil energy materials/carriers 1 000 tonnes. MF4 [19]

$$Estonia \quad y = 0,4498x + 11,471; \; R^2 = 0,8218 \qquad (17)$$

From 2000 to 2013 Estonia, Latvia and Lithuania growth it according to 61.7%, 1.5% and 21.3%. In 2013 was annual growth of Estonia 16.3%.

EU-27 *other products* consumption in 2012 was 4,659 thousand tonnes, over the 12 years it decreased by 15.5%. Consumption of *other products* in the Baltic countries was very small and with large fluctuations.

EU-27 *waste for final treatment and disposal* consumption in 2012 was 218 thousand tonnes, over the 12 years it growth by 45.3%. In the Baltic countries was it also very small and with large fluctuations.

Table 15. Total DMC by key components, thousand tonnes [19]

	EU-27		Estonia		Latvia		Lithuania	
	2000	2012	2000	2012	2000	2012	2000	2012
Total DMC	7,526,545	6,757,464	19,616	37,975	34,666	37,452	29,173	38,283
Biomass	1,758,066	1,693,745	2,869	5,743	26,540	18,332	14,772	17,313
Metal ores (gross ores)	281,219	236,960	111	-120	-33	12	-48	-86
Non-metallic minerals	3,666,645	3,189,593	4,902	16,033	5,868	16,864	9,949	16,264
Fossil energy aterials/carriers	1,816,430	1,632,289	11,841	16,465	2,197	2,409	4,269	4,269
Other products	4,035	4,659	-107	-136	94	15	232	-665
Waste for final treatment and disposal	150	218	:	-11	:	-181	:	-6

When EU-27 *metal ores (ores gross)* the percentage in total DMC was 3.5%, then Baltic countries practically 0. *Other products* and *waste for final treatment and disposal* as well as the percentage was practically to 0.

Therefore, it is useful to analyze components of the DMC only for *biomass*, *non-metallic minerals* and *fossil energy materials/carriers*. In 2012, the total DMC of Estonia, Latvia and Lithuania almost equal.

Biomass consumed in Estonia was three times less than Latvia and Lithuania. Estonian biomass percentage was 15.1%, Latvia 48.9%, Lithuania 45.2% and EU-27 for comparison 25.1%.

Fossil energy materials/carriers trends were reversed: Estonia percentage was 43.4%, Latvia 6.4%, Lithuania 11.1% and for comparison EU-27 24.2%.

Non-metallic minerals trends were the same: Estonia percentage was 42.2%, Latvia 45.0%, Lithuania 42.5% and for comparison EU-27 47.2%.

Components of DMC and DEU of Estonia growth.

Table 16. DMC by main material category, thousand tonnes [19]

	Total		Biomass		Crop residues (used), fodder crops and grazed biomass	
	2000	**2012**	**2000**	**2012**	**2000**	**2012**
EU-27	7 526 545	6 757 464	1 758 066	1 693 745	740 863	757 637
Estonia	19 616	37 975	2 869	5 743	2 016	1 770
Latvia	34 666	37 452	26 540	18 332	1 979	2 425
Lithuania	29 173	38 283	14 772	17 313	6 360	8 867

	Metal ores (gross ores)		Non-metallic minerals		Sand and gravel		Fossil energy materials/carriers	
	2000	**2012**	**2000**	**2012**	**2000**	**2012**	**2000**	**2012**
EU-27	281 219	236 960	3 666 645	3 189 593	2 474 446	:	1 816 430	1 632 289
Estonia	111	-120	4 902	16 033	2 554	11 288	11 841	16 465
Latvia	-33	12	5 868	16 864	2 735	12 036	2 197	2 409
Lithuania	-48	-86	9 949	16 264	7 315	12 390	4 269	5 462

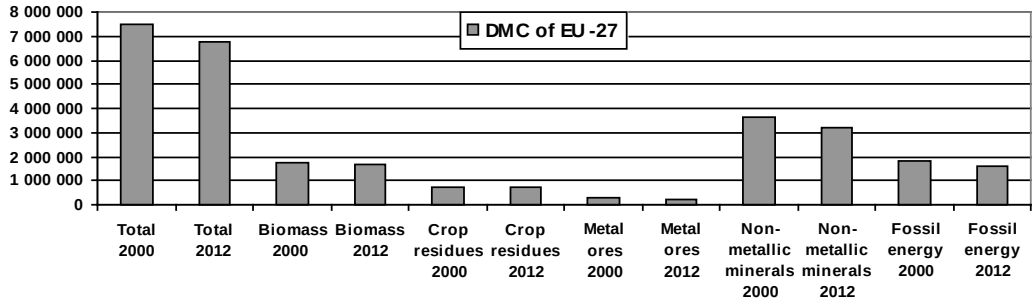

Figure 15. DMC of EU-27 by main material category, thousand tonnes [19]

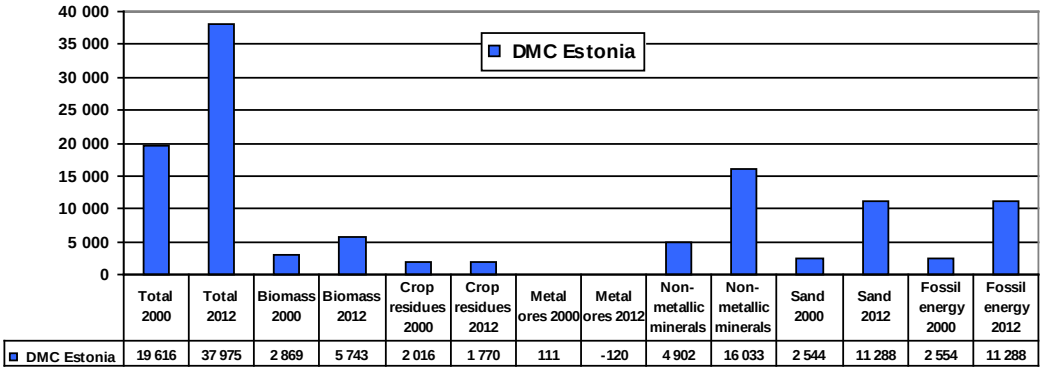

Figure 16. DMC of Estonia by main material category, thousand tonnes [19]

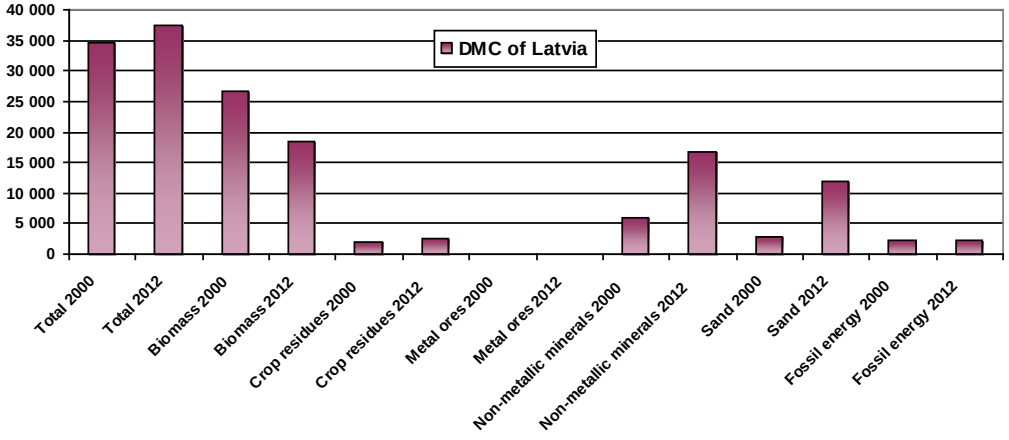

Figure 17. DMC of Latvia by main material category, thousand tonnes [19]

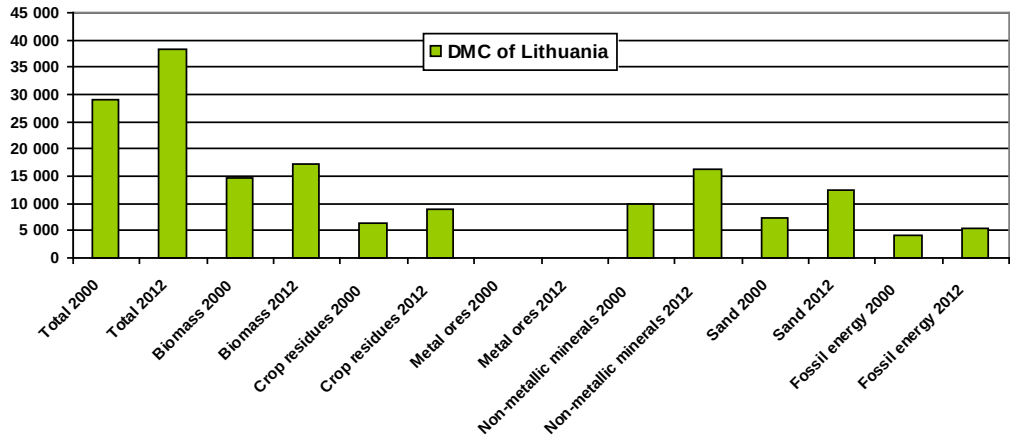

Figure 18. DMC of Lithuania by main material category, thousand tonnes [19]

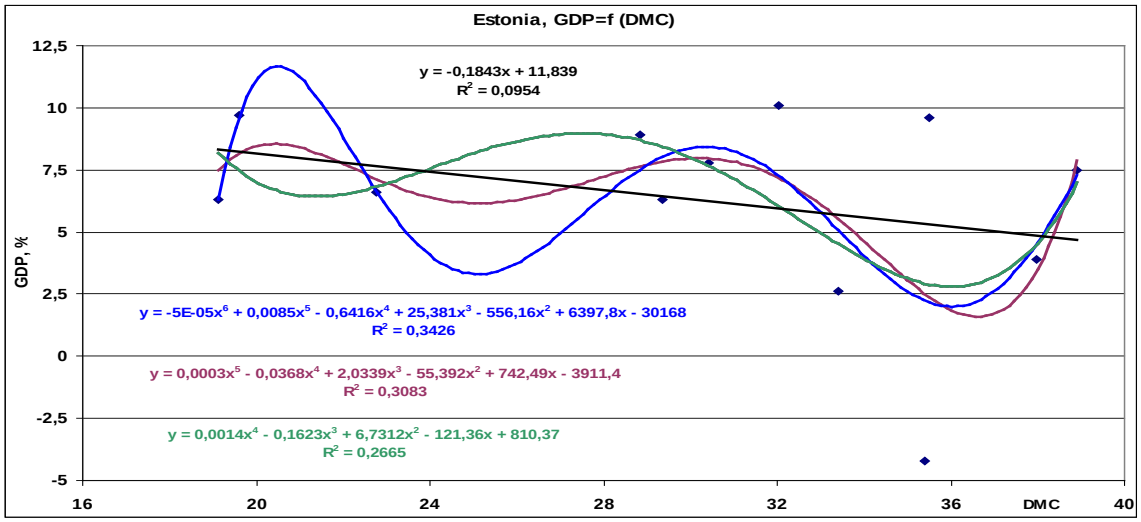

Figure 19. GDP = f(DMC) of Estonia, 2000 – 2012 (Note: outliers (2009. year) excluded)

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

The processing of data is used to *regression analysis*. For this purpose we use the computer program.

Figure and regression analysis shows the example of Estonia relatively weak relationship between GDP and DMC, as R^2 is small. The figure shows that the DMC can increase GDP even decreased. It shows that the optimum borders over the DMC large expenditures to exceed the income therefrom. Also, as higher fossil-on fuel consumption is harmful to the environment.

Therefore, we should analyze the *resource productivity* in depth below. This, however, is strongly correlated with labor productivity analysis [26-35].

Taking into account this publication and the previous work of the authors [2-12,26-35] and other authors' works [13,14,15,16,17] have made the following conclusions and suggestions.

4. Conclusions

- 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.
- Resource productivity was not so large fluctuations when in the whole national economy (GDP).
- Before the economic crisis, GDP growth rose by analogy with DMC. The peak was reached in 2007 - 2008. 2009. followed by a decline, especially large in Lithuania. In the following years the economy grew, and with it DMC or vice versa the better DMC used to cause growth. For more of the answer gives the material flow components detailed analysis.
- Volume growth of material resources does not always result in economic growth. This leads inevitably to increased costs, which could exceed the income.
- Total exports resource of Baltic countries in tones growth, in Lithuania and in Latvia over two times, but in Estonia 42%.
- Domestic Extraction Used (DEU) of Baltic countries in tonnes growth, in Estonia 1.8, in Latvia and in Lithuania 1.4 times.
- Total DMC and DEU of Estonia growth. Lithuania and Latvia were great abrupt changes, in peak was before the crisis, and the largest decline year after the crisis.
- Biomass decreased in the period analyzed EU-27 and Latvia scarce. Lithuania had a small and Estonia double biomass consumption grew. However, Estonia biomass consumed was three times less than in Latvia and Lithuania.

- EU-27 metal ores consumption in 2012 was 237 million tonnes, of 12 years it fell 15.7%. Consumption metal ores in the Baltic countries was very small and with large fluctuations.
- EU-27 non-metallic minerals consumption of 12 years fell 13.0%; Estonia, Latvia and Lithuania aga 3.3, 2.9 and 1.6 times.
- EU-27 fossil energy materials/carriers consumption of 12 years fell 10.1%; Estonia, Latvia and Lithuania however, grew 39.0%, 9.6% and 27.9%.
- EU-27 other products consumption grew in 12 years was 15.5%. *Other products* consumption of the Baltic countries was very small and with large fluctuations.
- EU-27 waste for final treatment and disposal consumption in 12 years was 45.3%. In the Baltic countries was it very small and with large fluctuations.
- The EU has a poor energy region, it is unexpected decrease in mineral fuels (sanctions) is very sensitive.
- Total imports resource per capita grew in all Baltic countries.
- So far the mineral fuels imports from third countries progressed steadily.
- Of the Baltic countries are more dependent of the imported resources 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.
- 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.

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