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SERBIAN ENERGY EFFICIENCY PROBLEMS

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Topics to be considered:

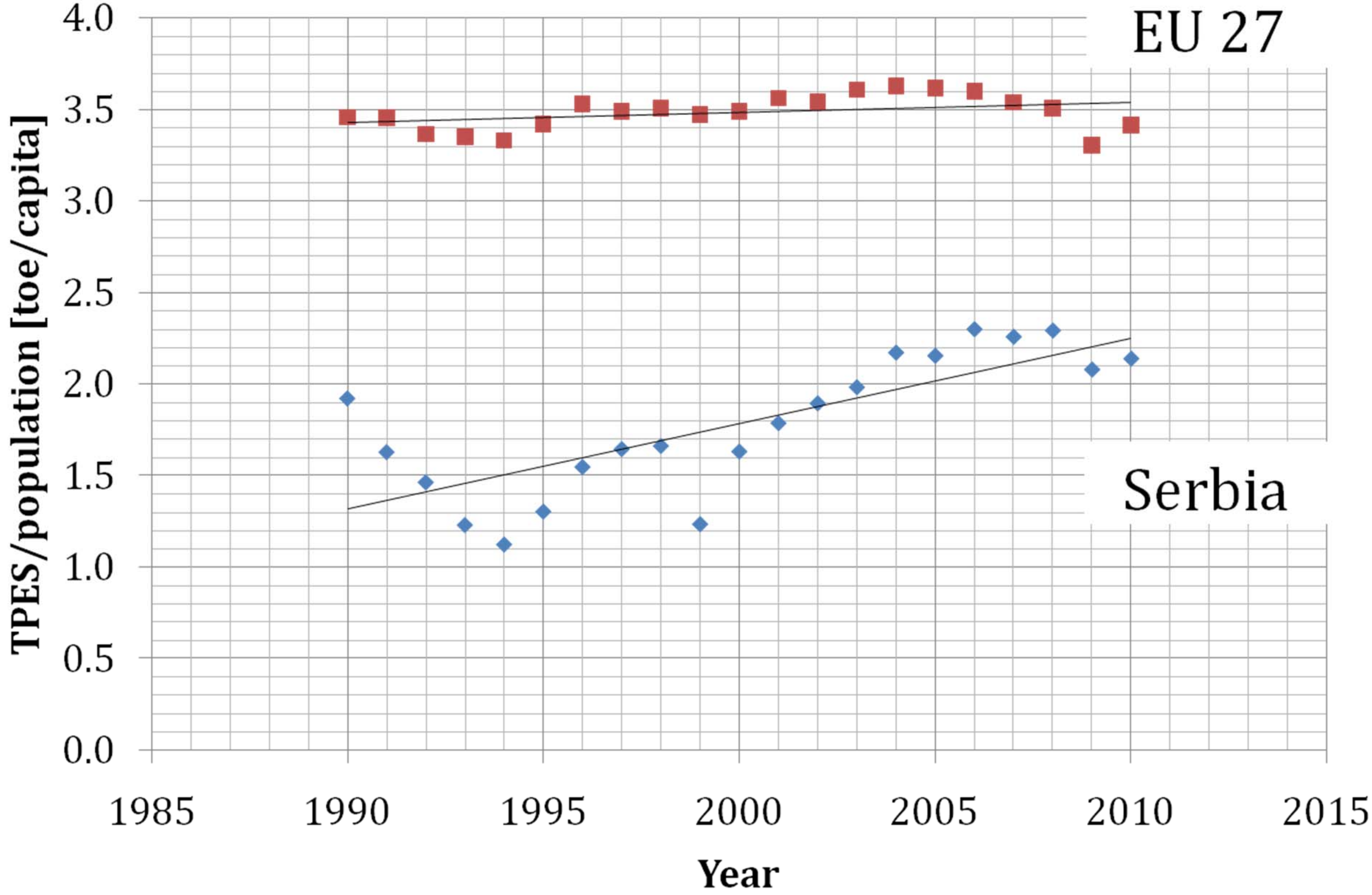
1. Global position of Serbia
2. Serbian Energy System
3. Energy Efficiency Indicators
4. Presentation and Evaluation of Energy Efficiency Indicators
5. The Key for Making an Effective Energy Efficiency Policy
6. Energy Efficiency Multi-Criteria Decision Analysis for Serbia
7. Conclusions

1. Global Position of Serbia

At the beginning, indicators showing energy, environmental and economic position of Serbia with reference to EU 27 will be shown.

Indicators are as follows:

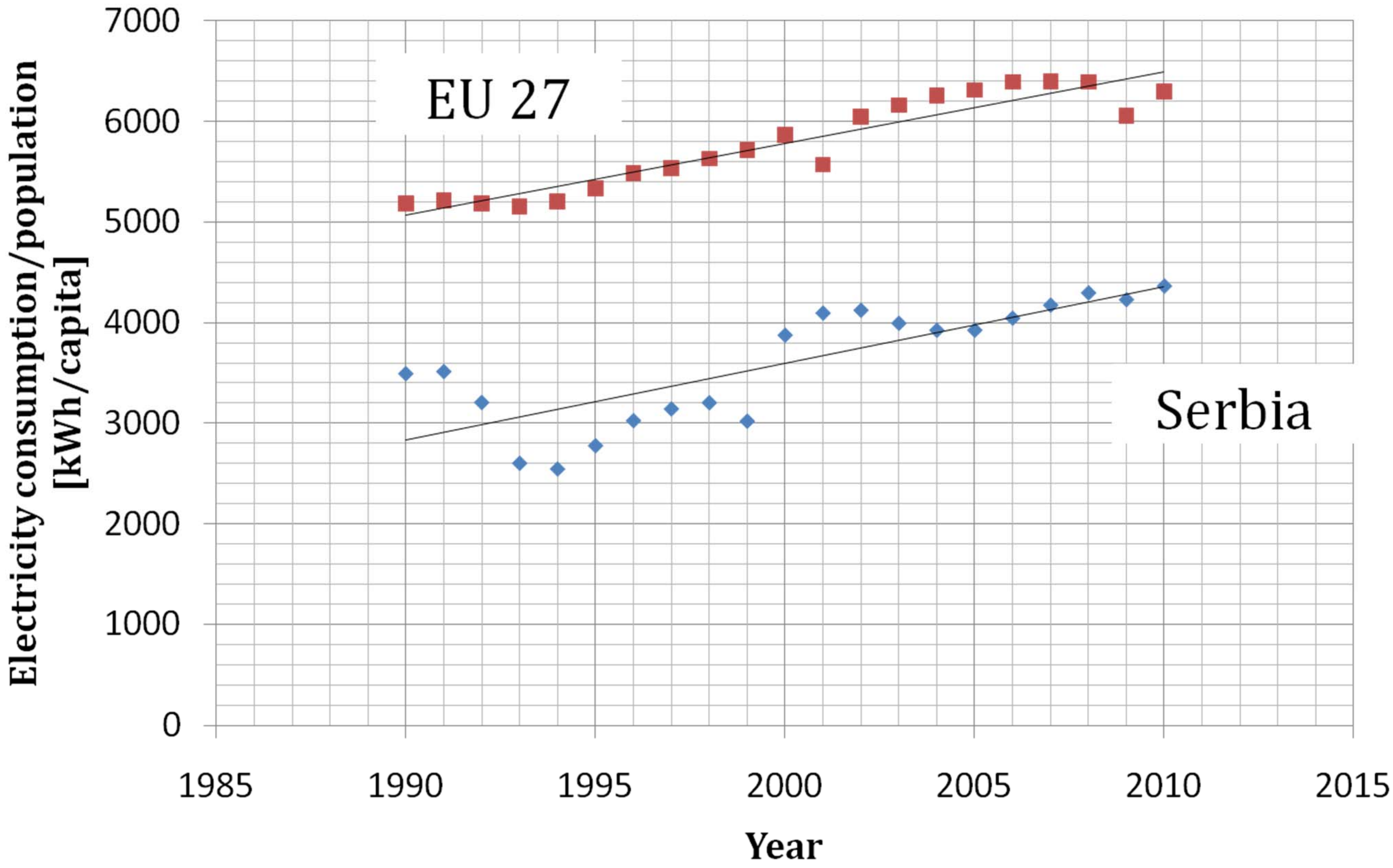
1. Total primary energy supply per population [toe/capita]
2. Electricty consumption per population [kWh/capita]
3. CO_2 emission per population [tCO_2/capita]
4. GDP(ppp) per population [2005 US$/capita]


EU 27
Serbia
TPES/population [toe/capita]
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1985
1990
1995
2000
2005
2010
2015
Year

1. In the period from 1990 to 2010 , TPES per population in Serbia was growing while in EU 27 it was in stagnation

2. TPES per population in Serbia is much lower than in EU 27

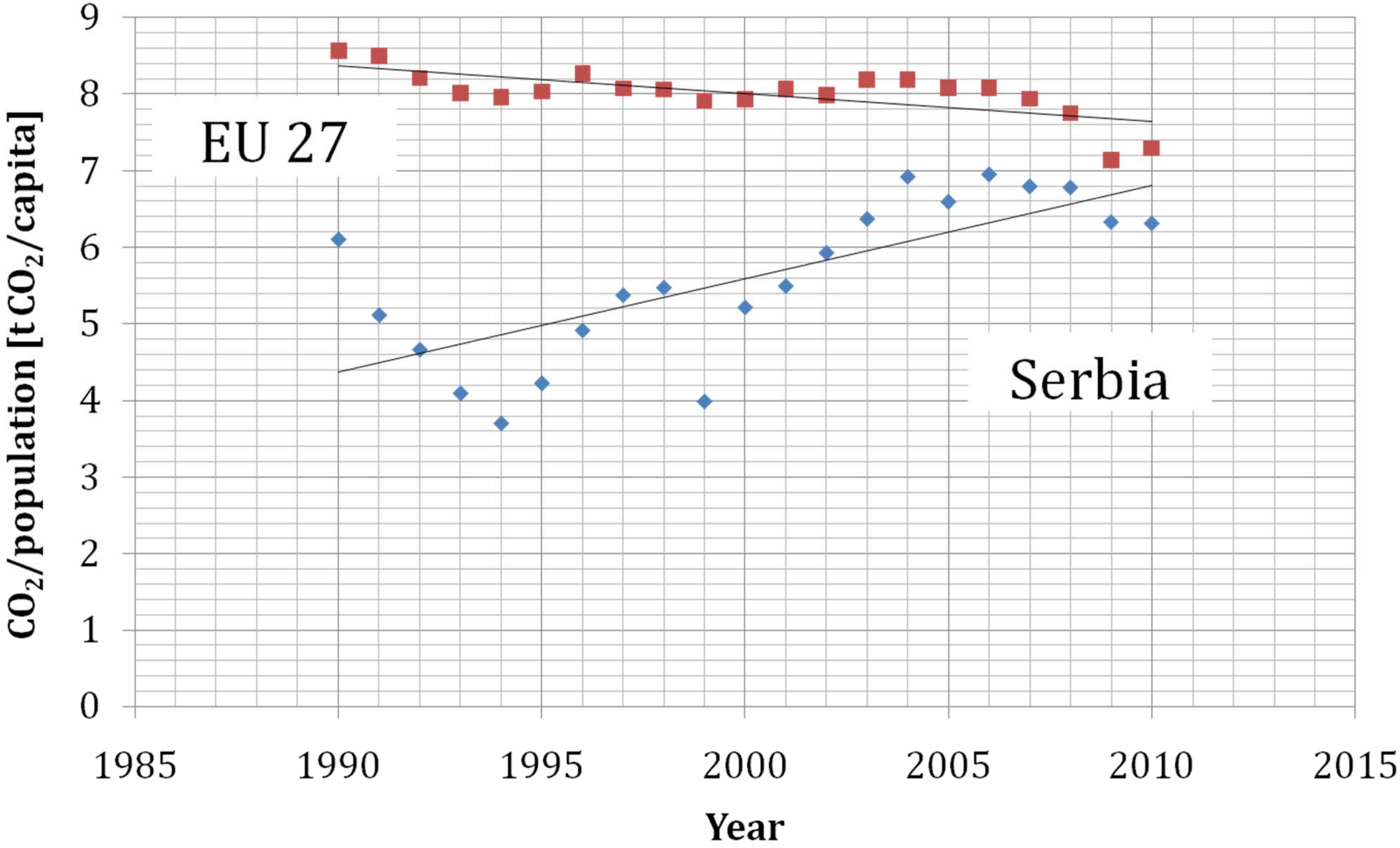
3. The growth of TPES/population in Serbia causes concern in particular when it is well know that the economic activities are very slow.



EU 27
Serbia
Electricity consumption/population [kWh/capita]
Year
7000
6000
5000
4000
3000
2000
1000
0
1985
1990
1995
2000
2005
2010
2015

1. In the period from 1990 to 2010, the growing trend of electricity consumption is approximately the same as in EU 27

2. However, electricity consumption in EU 27 is much higher than in Serbia

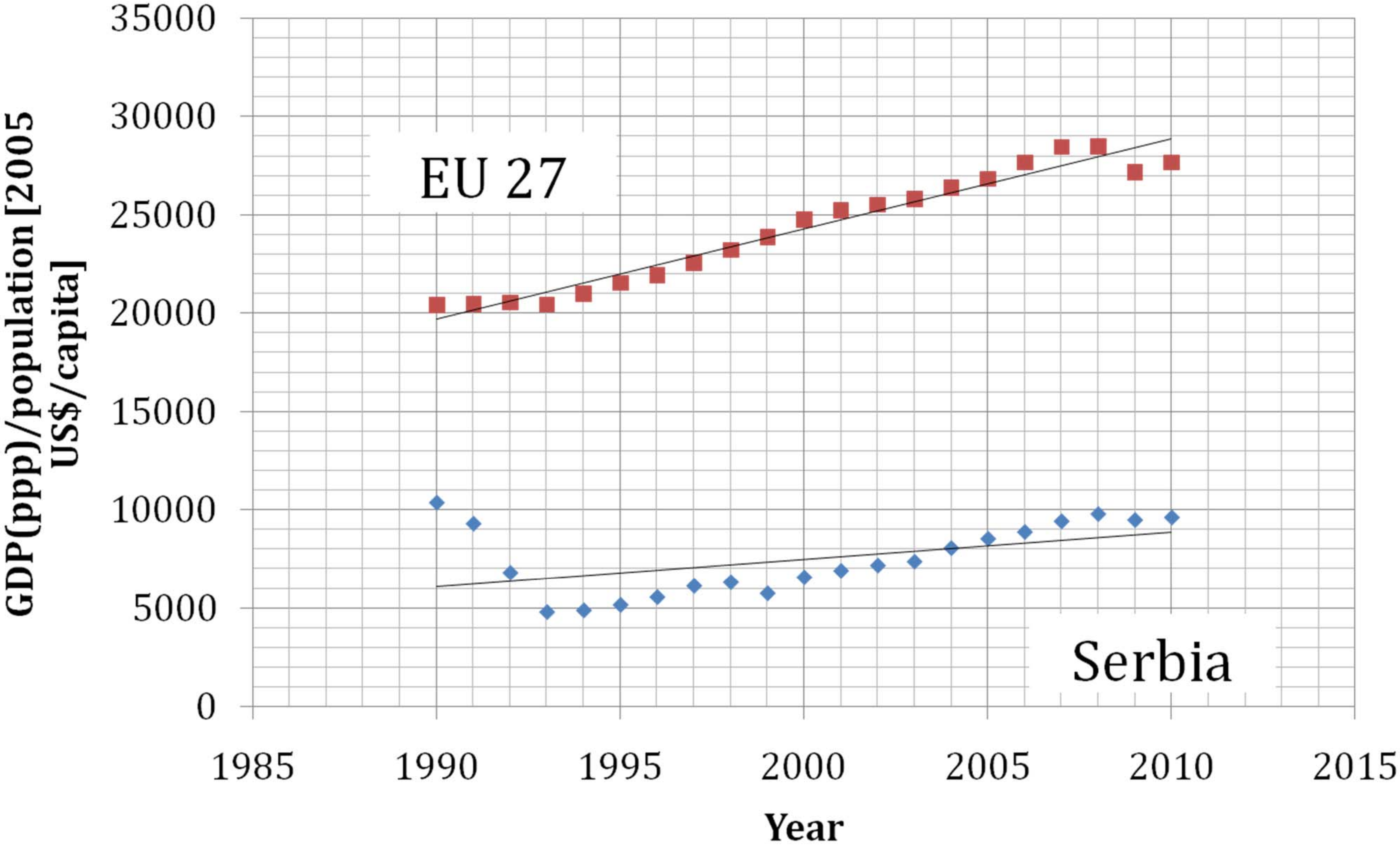


9
8
7
6
5
4
3
2
1
0
1985
1990
1995
2000
2005
2010
2015
Year
CO2/population [t CO2/capita]
EU 27
Serbia

1. The growth of CO_2 emissions in Serbia is very obvious while in EU 27, it is falling.

2. Although CO_2 emission per capita is lower in Serbia than in EU 27, the growth of CO_2 emissions is not the consequence of economic growth but of further decline of energy efficiency and failure to utilize renewable energy sources.

3. The pronounced growth of CO_2 emissions indicates the absence of the utilization of renewable energy sources and the absence of effects of measures aimed at increasing energy efficiency.


35000
30000
25000
20000
15000
10000
5000
0
GDP(ppp)/population [2005 US$/capita]
EU 27
Serbia
1985
1990
1995
2000
2005
2010
2015
Year

1. Everything becomes clear when GDP(ppp)/capita is compared
2. This indicator refers to economic activities which are at a very low level in Serbia compared to EU 27.
3. This means that increased consumption of TPES and electricity and consequential growth of CO_2 emissions can be the result of unfavorable overflow of energy consumption from productive to non-productive activities (public and residential sectors)
4. With all this, there is a decline in the number of population.

Basic social and economic characteristics for Serbia and EU 27

SERBIA	EU 27
Slight decline of population	Very slight growth of population
Slowdown of economic growth	Stable economic development
Considerable growth in primary energy consumption per capita	Stagnation in the consumption of primary energy per capita
Growth in electrical energy consumption per capita	Growth in electrical energy consumption per capita
Considerable growth in carbon dioxide emissions per capita	Considerable fall in carbon dioxide emissions per capita
GDP (PPP)/per capita = 9,608 US$ (2005) in 2010	GDP (PPP)/per capita = 30,386 US$ (2005) in 2010

2. Serbian Energy System

Energy Balance

Participation of Energy Types in TPES in Serbia (2009)
(In thousand tones of oil equivalent (Mtoe) on a net calorific value basis)

Energy	Mtoe	%
Coal and Peat	8.02	55.5%
Crude Oil	2.99	20.7%
Oil Products	0.96	6.6%
Gas	1.40	9.7%
Nuclear	0.00	0.0%
Hydro	0.88	6.1%
Geothermal, Solar, etc.	0.05	0.3%
Combustible Renewables and Wastes	0.29	2.0%
Electricity	-0.12	-0.9%
Heat	0.00	0.0%
Total	14.45	100.%

3. Energy Efficiency Indicators

Energy efficiency concerns everything related to the prevention of energy losses within a system. It is reduced to a very simple and understandable equation:

$$\mathbf{E_{useful} = E_{primary} - E_{losses}}$$

Losses occur in:
-energy transformation,
-transmission
-distribution,
-end users.

Decrease of losses in the first three categories mainly depends on available technologies.

Decrease of losses with end users needs to be resolved by both technical and non-technical measures.

It is quite often possible to avoid unnecessary use of energy by better organization, better energy management and changes in consumers behavior, and even more in their lifestyle – which is also the most difficult.

Energy efficiency should be understood as a set of organized activities which are implemented within the boundaries of a defined energy system with the aim of reducing the consumption of input energy, harmful gas emissions and energy costs with no change to the level of services performed or with the creation of new value in a production process within the defined system.

The definition itself indicates the complexity of the problem arising from the need to connect ***people, procedures*** and ***technologies*** in order to achieve consistent and permanent improvements in energy efficiency.

To improve energy efficiency, it is necessary to:

- ***reduce*** excessive and unnecessary use of energy by introducing legislation and energy policy which encourages changes of behavior;
- ***reduce*** energy losses by implementing energy efficiency improvement measures and by introducing new technologies;
- ***monitor*** energy consumption in order to get the full picture of energy consumption and consequences thereof;
- ***manage*** energy consumption by improving operational and maintenance practice.

Today, energy efficiency is unfortunately a matter of ***technology*** and not of ***knowledge***.

New technologies are often uncritically and very aggressively imposed on users without substantial evidence of their efficiency in relation to the technology used hitherto.

Actually, only unconvincing marketing-style explanations are offered, which do not provide enough knowledge to users intending to apply new technologies.

Because of its complexity, there are no doubts that energy efficiency is difficult to measure.

There are six groups of indicators which are most frequently used and also employed in various situations:

1. ***Energy intensity*** is the relation between energy consumption (measured in energy units: toe, Joule) and activity indicator measured by monetary units (gross domestic product, added value). Energy intensity is the only indicator which can be used for the assessment of energy efficiency at the high aggregation level at which it is not possible to characterize an activity by means of technical or physical indicators, i.e., at the level of the whole national economy or the sector .

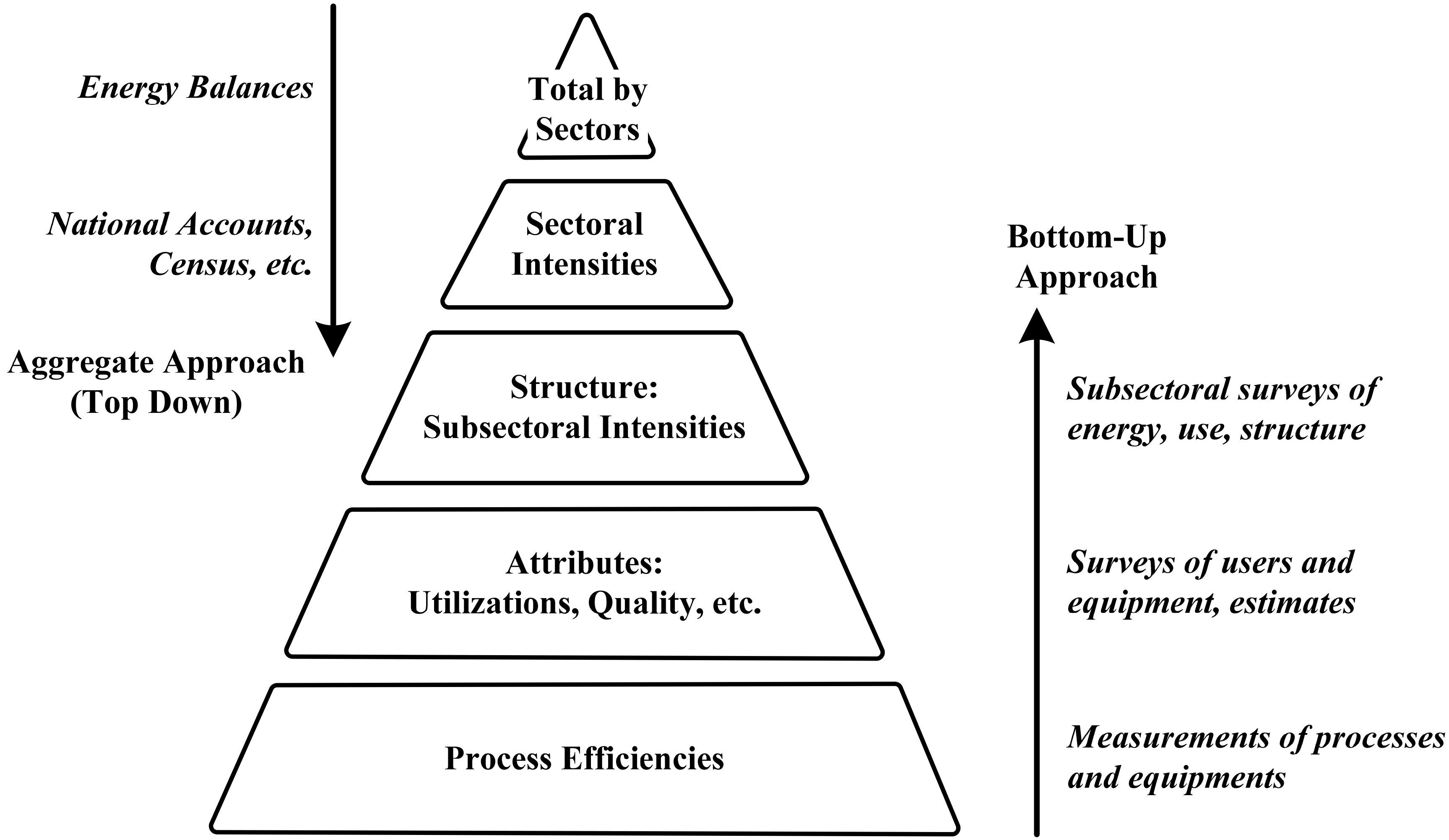
2. ***Specific consumption*** connects energy consumption with activity indicator which is measured by physical units (tons of steel, number of vehicles, etc.) or with an energy consumption unit (vehicle, dwelling unit, etc.). As a matter of fact, it is more used in industrial plants, in buildings or in transport when the efficiency of certain machines or objects or devices is measured.
3. ***Energy efficiency index*** provides overall assessment of trends in the energy efficiency sector. It is calculated by means of weighted average of sub-sector indicators (towards end users, manner of transportation, etc.). The reduction implies the improvement of energy efficiency. Such an index is more relevant for understanding the reality of changes in energy efficiency than the energy intensity indicator. Some years in the analyzed period are taken as base years (100%).

4. ***Diffusion indicators*** have been introduced in order to supplement existing energy efficiency indicators because they can easily be tracked. Their aim is to improve interpretation of trends which have been noticed relevant to energy efficiency indicators. There are three types of these indicators: 1) market penetration of renewable energy sources (number of sold biomass boilers, percentage of fuel wood boilers for heating, etc.); 2) market penetration of efficient technologies (number of sold energy saving electric bulbs, percentage of electrical appliances with the **A** grade**,** etc.); 3) diffusion of energy efficient practice (number of passengers using public transport, non-motor transport, percentage of goods transported by railway, combined passenger–railway transport, percentage of efficient processes in industry, etc.).

5. ***Adjusted energy efficiency indicators*** – refer to differences which exist among countries relevant to climate, economic structures or technologies. The comparison of energy efficiency performance in different countries is important only when it is based on such indicators. External factors which can affect the consumption of energy include: a) weather conditions; b) degree of load; c) operating hours of public buildings; d) degree of utilization of installed equipment; e) level of production; f) added value, including GDP changes; g) planned utilization of installations and vehicles; h) relationship with other departments, etc. Some of these factors are important for the correction of aggregate indicators whereas the others will be used only for individual plants in which energy efficiency measures have been made.

6. ***Target indicators*** – are aimed at providing referent values which will show possible improvements of desired energy efficiency or possibilities for energy efficiency in a certain country. In a way, they show similar resulting values but they are determined at macro levels assuming careful interpretation of differences. Their aim is to define the distance to the average of three best countries; this indicates the benefits that can be generated.

The Energy Efficiency Indicator Pyramid



4. Presentation and Evaluation of Energy Efficiency Indicators

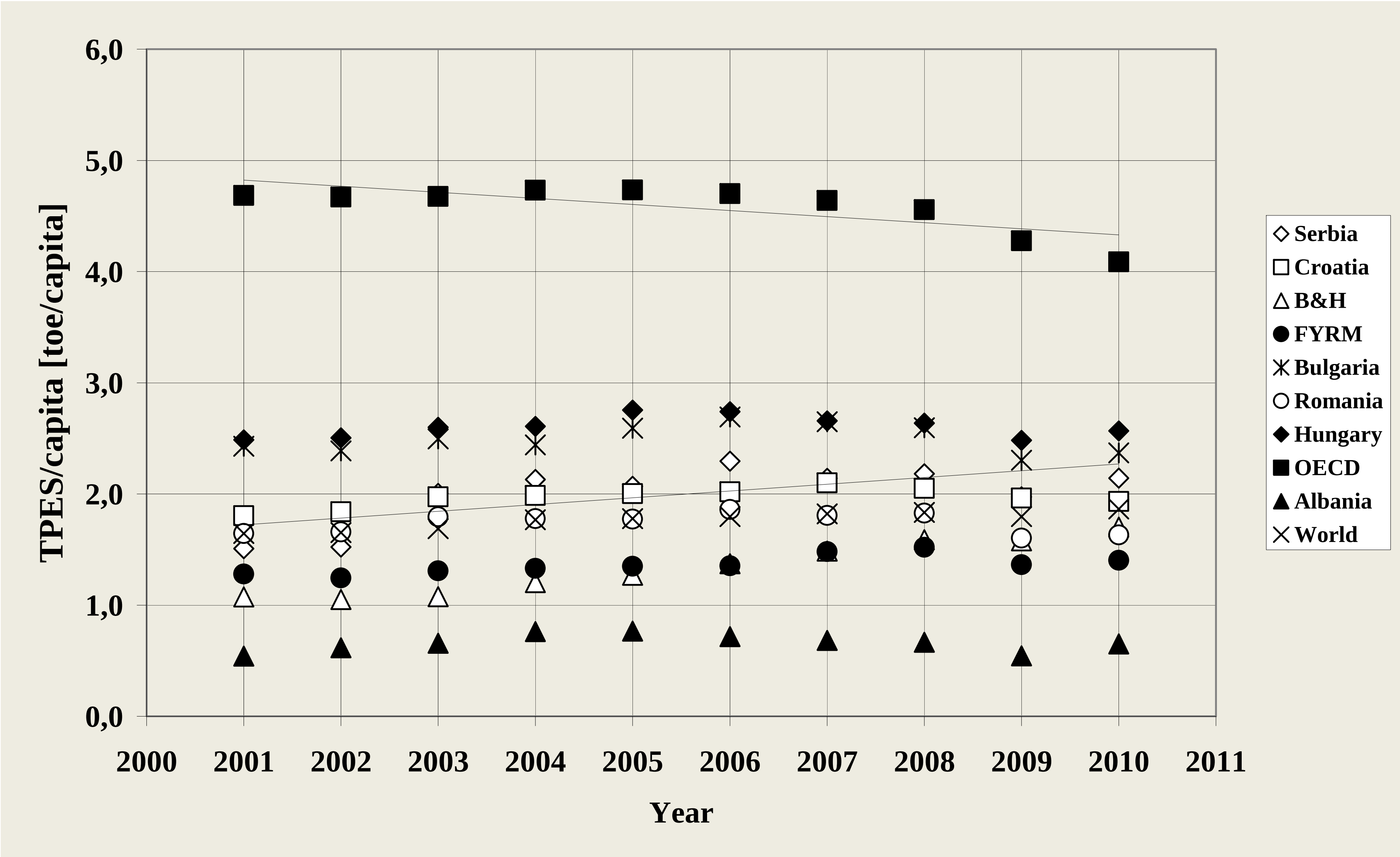
Key Indicators for Serbia, Neighboring Countries, OECD and the World (2009)

Country [i] or Region	Land Area	Population	GDP (ppp)[ii]	TPES	Electricity Consumption	CO_2 Emissions
	km^2	million	US$ 2000	Mtoe	TWh	Mt of CO_2
Serbia (112)	88,361[iii]	7.32	57.83[vi]	14.45	30.96	46.26
Croatia (126)	56,594	4.43	63.14	8.7	16.44	19.77
Bosnia and Herzegovina (127)	51,197	3.77	33.13	5.95	10.8	19.09
Albania (143)	28,748	3.16	18.16	1.72	5.58	2.7
Macedonia, FYRM (148)	25,713	2.04	14.95	2.78	7.08	8.34
Montenegro (160)	13,812	0.67				
Hungary (110)	93,028	10.02	147.51	24.86	37.82	48.16
Romania (82)	238,391	21.48	199.91	34.41	48.69	78.36
Bulgaria (105)	110,879	7.59	74.84	17.48	33.38	42.21
OECD	32,355,838	1,225	32,114	5,238	9,813	12,045
World	148,940,000	6,761	64,244	12,150	18,456	28,999

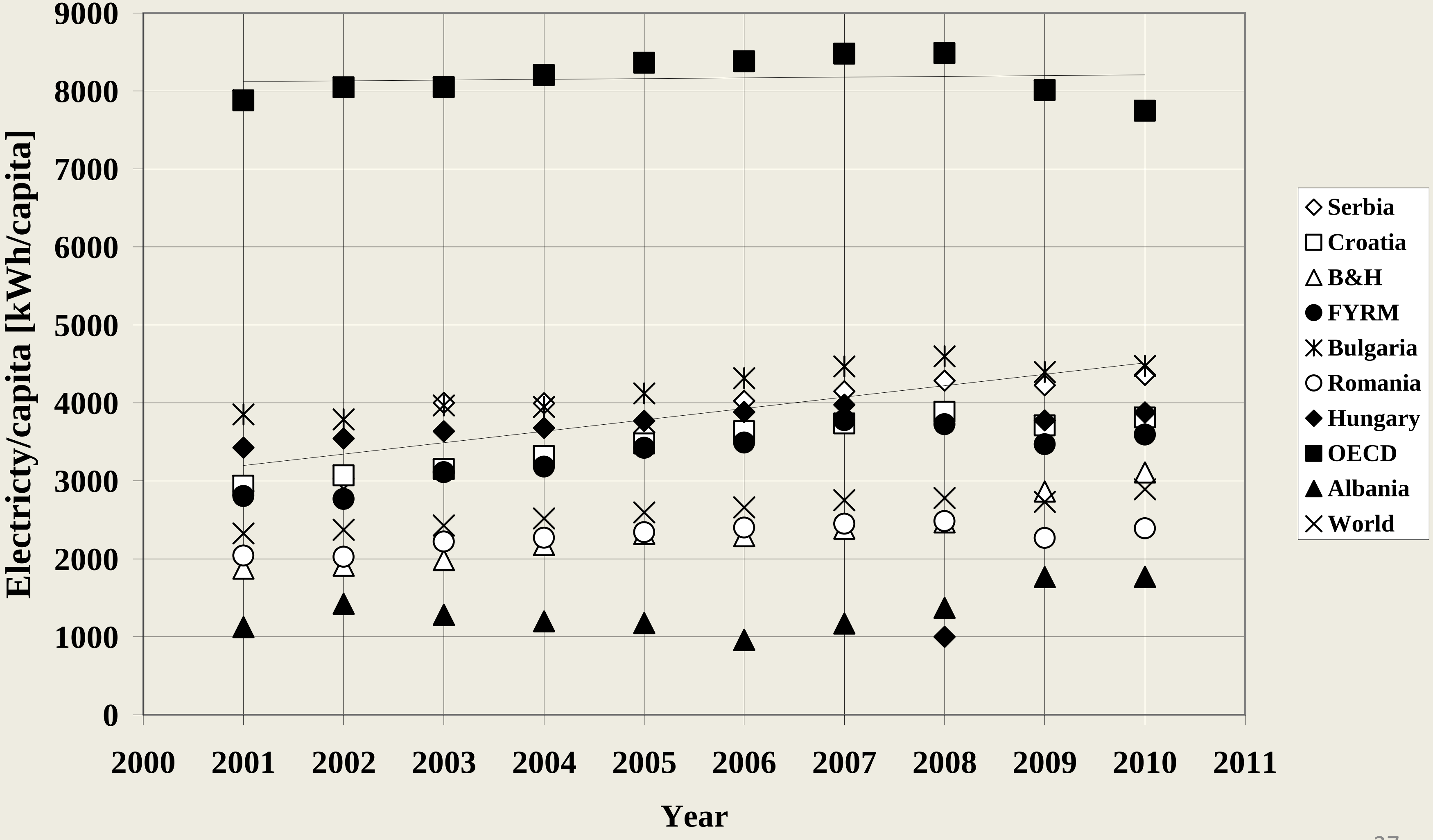
Compound Indicators for Serbia, Neighboring Countries, OECD and the World

Country or Region		TPES/Pop	TPES/GDP (ppp)	Electricity Cons/Pop	CO_2/TPES	CO_2/pop	GDP(ppp)/ Population
	Population/ km^2	toe/capita	toe/000 2000US$)	kWh/cap	t CO_2/toe	t CO_2/cap	US$ 2000 (ppp)/cap
Serbia (112)	83	1.97	0.25	4,230	3.20	6.32	7,900
Croatia (126)	78	1.96	0.14	3,711	2.27	4.46	14,253
Bosnia and Herzegovina (127)	74	1.58	0.18	2,865	3.21	5.06	8,788
Albania (143)	110	0.54	0.09	1,766	1.57	0.85	5,747
Macedonia, FYRM (148)	79	1.36	0.19	3,471	3.00	4.09	7,328
Hungary (110)	108	2.48	0.17	3,774	1.94	4.81	14,722
Romania (82)	90	1.60	0.17	2,267	2.28	3.65	9,307
Bulgaria (105)	68	2.30	0.23	4,398	2.41	5.56	9,860
OECD	35	4.28	0.16	8,011	2.30	9.83	26,216
World	45	1.80	0.19	2,729	2.39	4.29	9,503

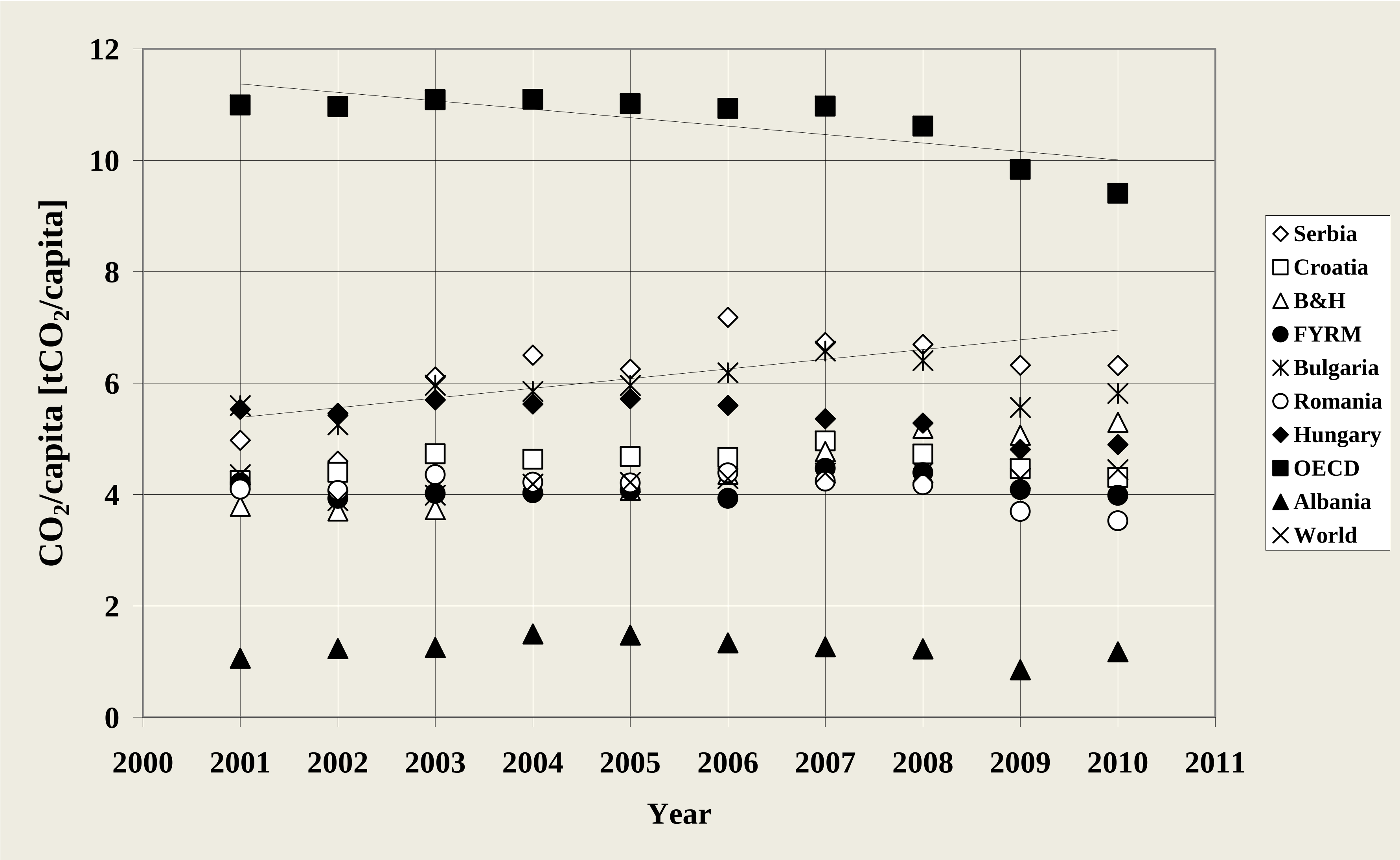
TPES/capita from 2001 to 2010



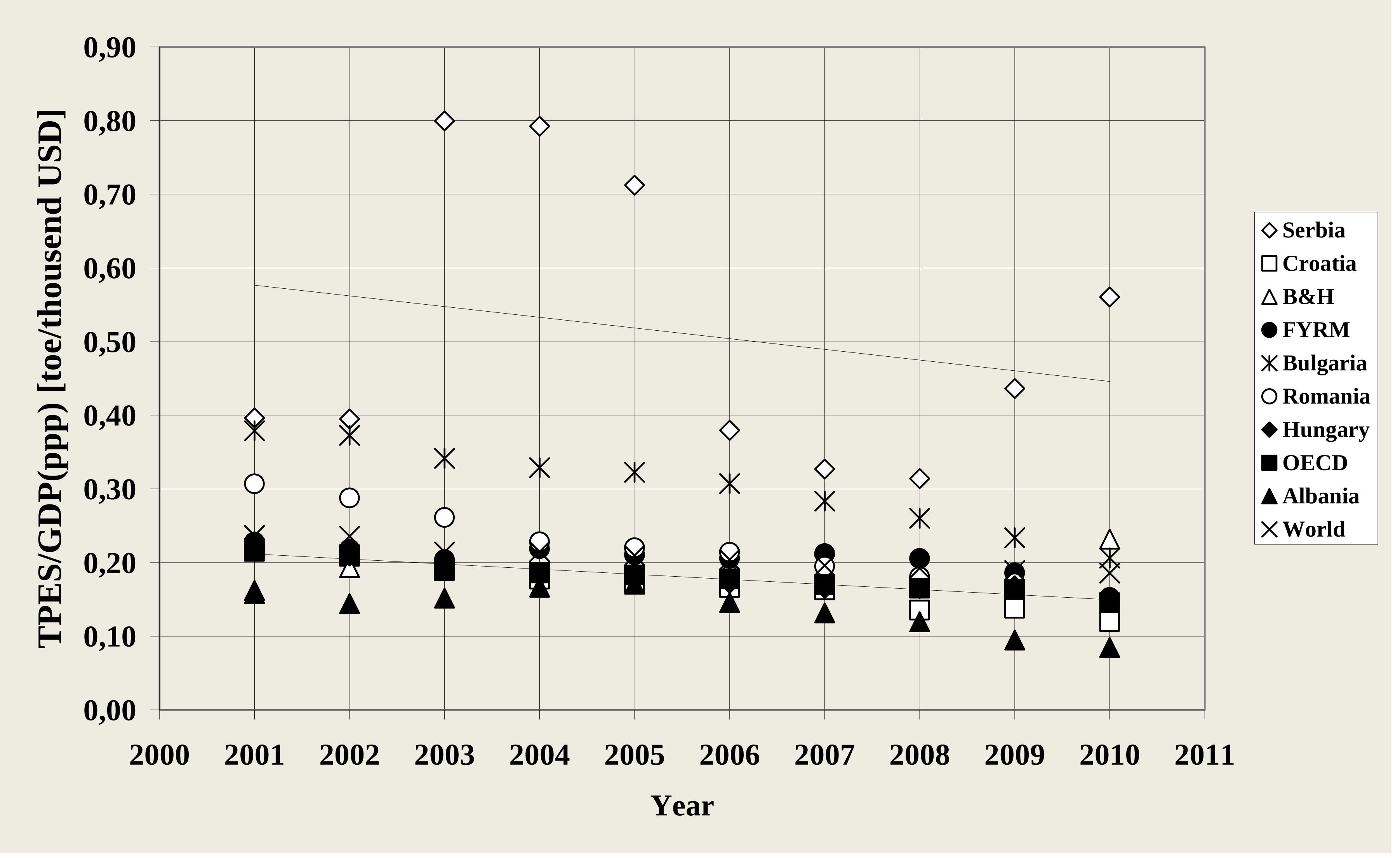
Electricity/capita from 2001 to 2010



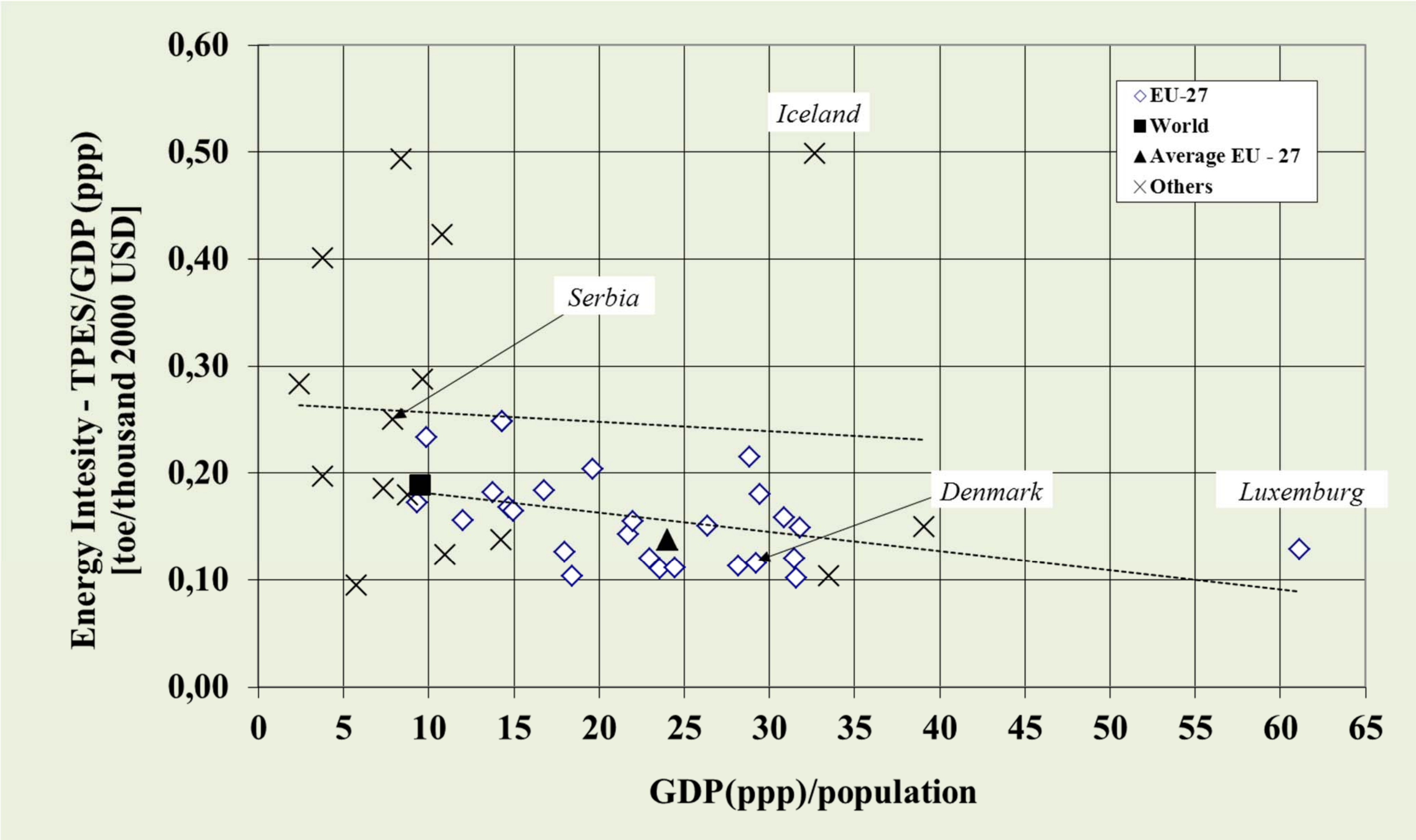
CO_2/capita from 2001 to 2010



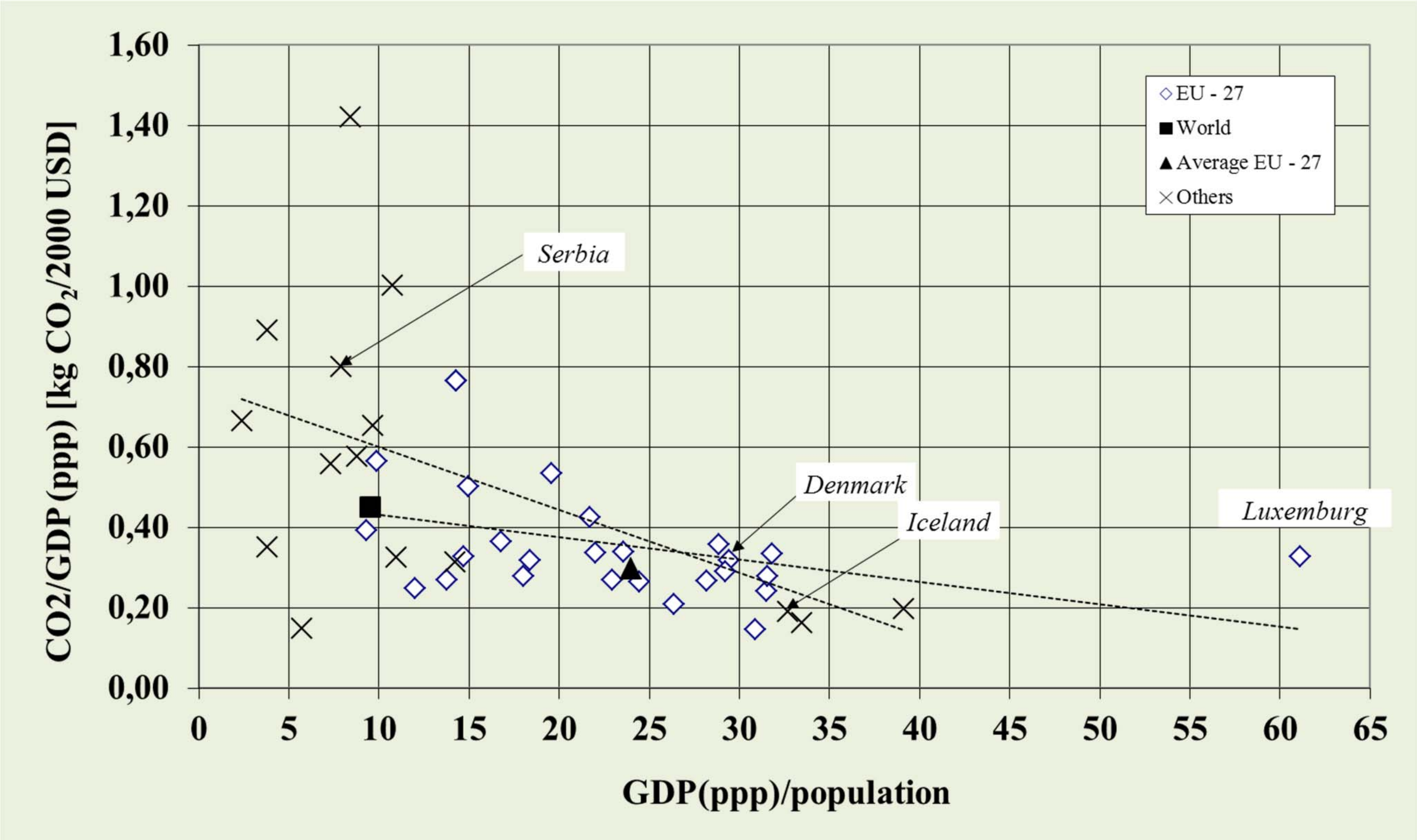
TPES/GDP(ppp) from 2001 to 2010



Energy Intensity versus GDP(ppp)



CO_2/GDP(ppp) versus GDP(ppp)



Iceland and Serbia:

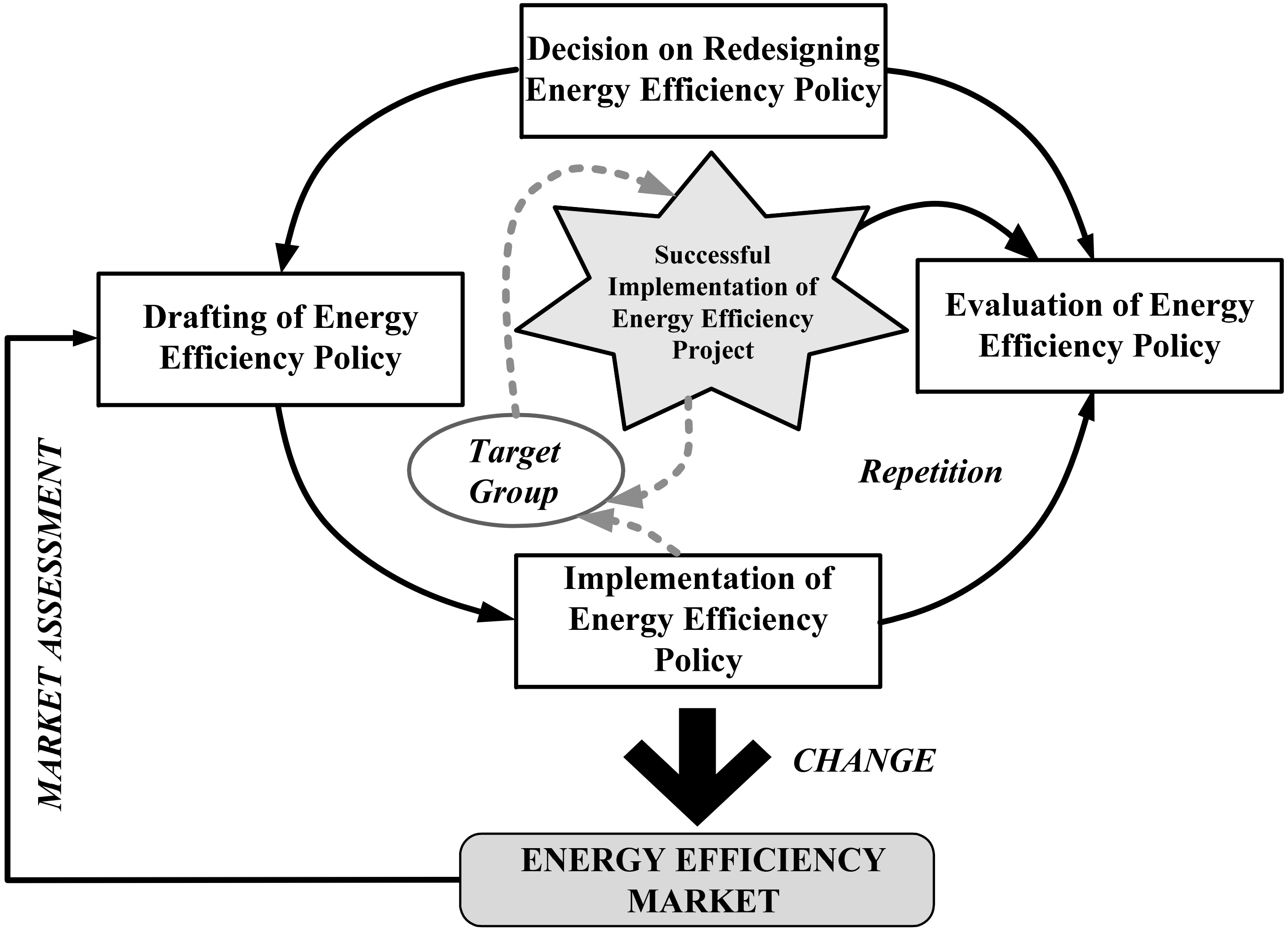
- Enormous primary energy consumption comes from the consumption of electricity in the aluminum industry (74% of total electricity consumption).
- Since this consumption is connected with industry, it is obvious that the GDP in Iceland is high in comparison to Serbia.
- At the same time, the emission of CO_2 in Iceland is much lower than in Serbia. The reason is in the fact that in Iceland hydro- and geothermal potential are used for the production of 95% of its electricity, and in Serbia the majority of electricity is produced using coal.

5. The Key for Making an Effective Energy Efficiency Policy

Most appropriate description for the policy making consists of the following stages:

1. **Policy design**:
   - **Policy definition -** objectives, tasks, approaches for different target groups, legal and regulatory frameworks;
   - **Policy instruments development -** incentives, penalties, standards, technical and financial support;
2. **Policy implementation -** institutional framework, stakeholders, human resources, capacities and capability development, supporting infrastructure;
3. **Policy evaluation**: monitoring of achieved results through energy statistics and energy efficiency indicators, qualitative and quantitative value of impacts of the policy instruments.

The Key for Making an Effective Energy Efficiency Policy



Changeability of Energy Efficiency Policy

Results of Energy Efficiency Multi-Criteria Decision Analysis for Serbia

The practical implementation of energy efficiency policy is a very complex activity as it requires the fulfillment of a large number of criteria which differ by nature.

The consideration and evaluation of the effects of these activities represent, then, a multi-dimensional problem.

Multi-criteria analysis enables the consideration and evaluation of all aspects of energy efficiency policy in relation to defined criteria in an organized and systematic way and takes into account and assesses each individual criterion.

The following criteria are involved:

K1. Government goals and the achievement of objectives: long-term development of the energy sector; energy transition; lower import dependency; geographical dispersion of sources; compatibility of energy systems.
K2. Goals of the economy and the accomplishment of interests: cheap and accessible energy for the economy; opportunities for the ESCO (Energy Service Company) concept.
K3. Goals of public companies and plants and the achievement of defined tasks : efficiency of energy production and distribution; introduction of renewables; acceptable quality, price and diversity of energy; technical viability; cost effectiveness.
K4. Meeting social interests: reducing risks of energy system breakdown, lack of energy and pollution; advancement of health, safety and the environment.

Results of analysis (1/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Building construction	Upgrading building construction		0.4	0.2	0.4	0.2	0.33
	Implementation of energy services in buildings		0.8	0.4	0.6	0.6	0.58
	Implementation of administrative buildings project		0.6	0.2	0.4	0.4	0.38
	Promotion of highly efficient technologies		0.8	0.4	0.4	0.4	0.46
	Education and training		0.8	0.2	0.2	0.8	0.35
	Improvement of performances in existing private buildings		0.6	0	0.2	0.6	0.25
	Financial schemes		0.6	0.8	0.8	0.6	0.75
	Assessment of needs for human resources development		0.4	0.2	0.4	0.2	0.33

Results of analysis (2/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Industry	Energy management		0.4	0.2	0	0.6	0.18
	Upgrading services in the area of RES and energy efficiency		1	0.6	0.2	0.8	0.50
	Production of electricity from RES		1	0.4	0.2	1	0.46
	Establishment of minimum standards for energy efficiency		0.8	0.4	0	0.6	0.30
	Acquiring new technologies and assessment of service life		0	0.6	0	0.2	0.19
	Intensified market transformation		0.8	0.8	0.2	0.2	0.46
	Monitoring market transformation and new incentives		0.6	0.4	0.2	0	0.30
	Assessment of needs for human resources development		0.4	0.2	0	0.2	0.14

Results of analysis (3/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Electric power plants, thermal power plants and utilities	Development of incentive schemes in RES and energy efficiency		1	0.6	0.8	0.4	0.74
	Distributed heat and power production		0.8	0.4	0.6	0.8	0.60
	Connection to the public distribution grid		0.4	0.4	0.6	0.6	0.51
	"Green" certificate		0.4	0	0.2	0.6	0.21
	"White" certificate		0.4	0	0.2	0.4	0.20
	Carbon trading and certification issues		0.2	0.4	0.4	0.2	0.35
	Legislation, standards and norms for fuels		0.8	0.6	0.8	0.4	0.71
	Assessment of needs for human resources development		0.4	0.2	0.4	0.2	0.33

Results of analysis (4/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Transport	Restructuring the whole national transport system		1	0.4	0.6	0.6	0.61
	Legislation, fiscal regime, fuel standards		0.6	0.4	0.2	0.6	0.36
	Supply chains for fuels and bio-fuels, and other fuels markets		0.6	0.4	0.4	0.8	0.47
	Reduction of demand for transportation		0.2	0	0.2	0.4	0.16
	Economic instruments and incentives		0.6	0.2	0.6	0.4	0.47
	Information, stimulation and education		0.6	0.4	0.4	0.6	0.45
	Alternative vehicle fuel market		0.6	0.2	0.4	0.8	0.41
	Assessment of needs for human resources development		0.4	0.2	0.4	0.4	0.34

Results of analysis (5/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Energy policy, legislation and market transformation	Relevance chain for energy policy		0.8	0.4	0.4	0.2	0.44
	Energy laws and regulations with respect to sustainability		1	0.6	0.6	0.4	0.64
	Energy planning in urban and rural areas.		0.8	0.2	0.6	0.6	0.52
	Promotion of successfully implemented projects		0.6	0.2	0.2	0.4	0.28
	Training and establishment of a network for policy creators		0.8	0.2	0.4	0.2	0.39

Results of analysis (6/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Sustainable energy development	Promotion of sustainable development and mobilization		0.8	0.2	0.4	0.6	0.43
	Planning utilization of RES and efficiency measures at the local level		1	0.4	0.6	0.6	0.61
	Establishment of conditions for development of local market		0.8	0.6	0.2	0.4	0.43
	Support for establishing local and regional agencies		0.8	0.4	0.6	0.6	0.58
	Training and establishment of a network for policy creators		0.8	0.4	0.6	0.8	0.60

Results of analysis (7/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Financial mechanism and incentives	Investment schemes for supporting programs and projects		0.8	0.6	0.8	0.4	0.71
	Conditions for fair competition		0.4	0.6	0.4	0.2	0.44
	Micro-finance schemes		0.6	0.6	0.6	0.4	0.58
	Financial mechanism for stimulating innovative projects		0.6	0.4	0.6	0.6	0.54
	Training and establishment of a network for policy creators		0.8	0.4	0.4	0.2	0.44

Results of analysis (8/9)

Tech and Non-Tech	**TASK (Energy policy options)**	**Criteria:**	**K1**	**K2**	**K3**	**K4**	**SUM**
		Weight of each criteria:	**0.16**	**0.28**	**0.47**	**0.09**	
Monitoring and assessment	Monitoring and assessment of programs and measures		0.4	0.2	0.4	0.6	0.36
	Methods, indicators and modeling of future development		0.6	0.2	0.4	0.6	0.40
	Elaboration of mechanism for the exchange of experience		0.6	0.2	0.6	0.4	0.47
	Energy management based on advanced monitoring process		0.6	0.4	0.6	0.6	0.54
	Training and establishment of a network for policy creators		0.6	0.4	0.4	0.4	0.43

Results of analysis (9/9)

Tech and Non-Tech	TASK (Energy policy options)	Criteria:	K1	K2	K3	K4	SUM
		Weight of each criteria:	0.16	0.28	0.47	0.09	
Advertising and promoting	Dissemination of results, development and demonstration		0.4	0.2	0.2	0.4	0.25
	Exchange of knowledge regarding best projects		0.4	0.4	0.6	0.6	0.51
	Dissemination of programs and their results		0.4	0.2	0.4	0.6	0.36
	Campaigns promoting an energy sustainable society		0.4	0.2	0.6	0.6	0.46
	Training and establishment of a network for policy creators		0.6	0.4	0.6	0.6	0.54

7. Conclusions

The national energy policy should be relied on the following:

1. **Ultimate and continuous promotion of energy efficiency in all energy sectors,**
2. **Full use of renewable energy sources and reduced consumption of imported fossil fuels,**
3. **Development of service providers sector in order to achieve previous objectives (production of insulation materials, boilers for the use of biomass, small plants for the production of biogas, solar collectors, etc.),**
4. **Modification of economic and financial mechanisms aimed at the implementation of previous objectives.**

Thank You