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IMPROVING COMPETITIVENESS AND ECONOMIC GROWTH IN THE REPUBLIC OF SERBIA THROUGH THE CONCEPT OF CIRCULAR ECONOMY

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***Abstract**: The circular economy is a closed circular system in which material and energy losses are converted into resources that may be used for alternative objectives. Inextricably connected with sustainable development, it is primarily concerned with reducing material and energy losses. The optimal course of action would be to eradicate these losses and repurpose materials. Therefore, biodegradable items are used and commodities are disposed, reused and recycled. The primary aim of this study is to examine the impact of energy generation and non-energy materials on the gross domestic product (GDP) of Serbia and other OECD member states. The objective is to ascertain which energy or material production sector is more significant in GDP to enhance competitiveness. The findings reveal the present state of economic growth and the areas that need improvement to foster more business competitiveness. The Adaptive Neural Fuzzy Inference System (ANFIS) as it is well-suited for statistical analysis of highly nonlinear data. The most significant determinant of GDP in Serbia is the proportion of domestic material consumption devoted to the consumption of non-metallic minerals. Among OECD members, however, metal consumption as a proportion of domestic total material consumption is the most significant predictor of GDP. Additionally, the findings indicate that the ideal combination for forecasting GDP using two parameters is the sum*

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of non-energy material output and total municipal trash generation. The findings may exemplify optimal strategies for incorporating the circular economy principle into operations to enhance corporate competitiveness, mitigate energy and material waste, and minimize adverse environmental effects.

Keywords: *circular economy, losses, energy, GDP, competitive, ANFIS*

JEL classification**:** *C45, C53, O47*

UNAPREĐENJE KONKURENTNOSTI I EKONOMSKOG RASTA U REPUBLICI SRBIJI PUTEM KONCEPTA CIRKULARNE EKONOMIJE

Sažetak: *Cirkularna ekonomija predstavlja zatvoreni, kružni sistem u kom se materijalni i energetski gubiti pretvaraju u resurse koji se mogu koristiti za realizaciju alternativnih ciljeva. Neraskidivo povezana sa održivim razvojem, cirkularna ekonomija se prvenstveno bavi smanjenjem materijalni i energetskih gubitaka. Optimalan pravac delovanja bi se odnosio na eliminisanje ovih gubitaka i prenamenu materijala. Radi toga, koriste se biorazgradivi materijali, dok se proizvodi odlažu, ponovo koriste i recikliraju. Osnovni cilj ovog rada je istraživanje uticaja proizvodnje energije i neenergetskih materijala na vrednost bruto društvenog proizvoda Republike Srbije i drugih članica OECD. Svrha rada se odnosi na identifikovanje sektora, proizvodnje energije ili priozvodnje materijala, koji ostvaruje značajniji uticaj na vrednost BDP u cilju unapređenja konkurentnosti. Rezultati istraživanja ukazuju na trenutno stanje ekonomskog rasta, kao i na oblasti koje je potrebno unaprediti kako bi se podstakao rast poslovne konkurentnosti. Adaptivni nero fazi sistem zaključivanja je veoma pogodan za primenu na visoko nelinearnim podacima. Najznačajnija determinananta bruto društvenog proizvoda u Republici Srbiji jeste proporcija domaće potrošnje materijala namenjene potrošnji nemetalnih minerala. Među OECD članicama, potrošnja metala kao proporcija ukupne domaće potrošnje materijala je veoma značajan predictor bruto društvenog proizvoda. Pored toga, rezultati istraživanja ukazuju na to da je za prognoziranje vrednosti bruto društvenog proizvoda najbolje primeniti dva parametra, ukupnu vrednost proizvodnje neenergetskih materijala i ukupnu vrednost proizvodnje komunalnog otpada. Rezultati takođe mogu poslušiti pri konstruisanju optimalne strategije inkorporacije principa cirkularne ekonomije u aktivnostima unapređenja korporativne konkurentnosti, ublažavanja efekata energetskog i materijalnog otpada i minimiziranja negativnih uticaja na životnu sredinu.i*

Ključne reči: *cirkularna ekonomija, gubici, energija, BDP, konkurentan, ANFIS*

1. INTRODUCTION

The circular economy is a sustainable development concept that aims to minimise material and energy losses. The circular economy is predicated on the principle of material circulation in order to mitigate environmental harm, curtail energy use, and foster economic progress. The linear economy model predominates in developing industries, resulting in environmental damage and the wasteful use of finite natural resources. The principles underpinning the circular economy include repairing, upgrading, replicating, and reusing goods and resources. Within the energy sector it implies the use of renewable energy sources, including but not limited to solar, wind, biomass, and energy obtained from trash. It also entails the use of biodegradable goods, which can be disposed of or returned to nature after they have served their purpose; hence, no losses occur.

In order to achieve balance, the circular economy might rearrange the flow of materials between the environment and the socioeconomic system (Yong, 2007). Dong, Liu and Bian (2021) discovered that the circular economy contributes positively to sustainable development. According to Christensen (2021) modified procedures have the potential to reroute the movement of materials and facilitate the transition to a circular economy; utility companies play a significant role in facilitating this shift. Because the circular economy is predicated on recycling, resource use, and decreasing reliance on resources, mining is an integral part of the transition to a low-carbon economy and the progression toward a circular economy (Upadhyay, Laing, Kumar, & Dora, 2021). Ozili (2021) also identifies advantages that financial organisations, including banks, may get from the circular economy. Green finance and banking organisations implementing the circular economy have a greater chance of survival than those operating under conventional economic principles. Notwithstanding advancements in sustainable development, resource recovery, and economic efficiency, apprehensions about the circular economy paradigm persist among the business community, given the inherent difficulties associated with reducing, reusing, and recycling materials (Sanguino, Barroso, Fernández-Rodríguez, & Sánchez-Hernández, 2020; Webster, 2021). There are propositions that "incubators" for the circular economy might assist companies in identifying and seizing possibilities associated with a circular economy while the state's involvement is restricted (Hull, Millette, & Williams, 2021; Pollard, Osmani, Cole, Grubnic, & Colwill, 2021; Salvador, Barros, Freire, Halog, Piekarski, & Antonio, 202). The circular economy has been proposed as a viable resolution to the environmental damage caused by the overconsumption of waste (Liu, Liang, Song, & Li, 2017). The circular economy idea can be most effectively implemented by adhering to the best-case scenarios. Aguilar-Hernandez, Rodrigues and Tukker (2021) examined over 300 circular economy scenarios from 2020 to 2050. The results indicated that deploying the circular economy model in 2030 might provide many benefits, including increased employment, GDP growth, and CO2 emission reduction. The findings presented in the study Robaina, Murillo, Rocha and Villar (2020) indicate that the primary outcomes after adopting the circular economy model are advancements in GDP and initiatives pertaining to repair and recycling.

Numerous initiatives aim to integrate circular economy best practices into a given system. These best practices include the reuse and recycling of resources in the production of new or similar goods. The primary aim of this study is to examine the impact of energy production and non-energy materials on Serbia's economic development and competitiveness. This study aims to ascertain whether the energy production or non-energy materials production sector has a more substantial influence on the Gross Domestic Product (GDP) or on enhancing company competitiveness. Energy production is a subset of energy consumption, while non-energy material manufacturing is an industry intricately linked to the circular economy (Luo, Li, & Peng, 2020; Marino, & Pariso, 2020). In pursuit of this objective, the Adaptive Neural Fuzzy Inference System (ANFIS) was implemented (Jang, 1993). This approach is well-suited for statistical analysis of very nonlinear data because of the potentiality of phase decision systems.

2. METHODOLOGY

2.1. THE CONCEPT OF CIRCULAR ECONOMY

The circular economy is an economic system whose primary objectives are the consistent use of resources and the reduction of material losses. In the circular economy, recycling, reusing, repairing, and remanufacturing are the primary activities that comprise a closed circular loop system. The primary objective of the circular economy is to reduce carbon dioxide emissions, losses, and pollution associated with utilising incoming resources. Ensuring the extended lifespan of goods, equipment, and infrastructure is the second objective of the circular economy. An example of a circular economy is shown in Figure 1. Energy and material losses need to be used as inputs for alternative processes. Consequently, a regeneration strategy is required to generate regenerative resources and eradicate energy and material losses.

2.2. PRODUCTION OF ENERGY AND ENERGY MATERIALS

This research used factors pertaining to energy production and non-energy material production to estimate and forecast GDP. The manufacturing characteristics of non-energy materials are determined by recycling and waste resources. The sector of energy consumption is represented by the criteria for energy generation. The OECD Green Development Database was used in this research to monitor progress towards green development, provide information to the public, and aid in policy formulation for that development. A vast array of domain data and indicators are synthesised in this database. Members of the OECD are included in this database.

The indicators are compiled in accordance with a conceptual framework and chosen based on a set of exact criteria. The primary objective is to cover the primary attributes of green development in terms of the total productivity of resources and natural materials. Indicating if economic development is becoming more environmentally friendly via the more efficient use of natural capital and including characteristics of production that are seldom measured in financial and economic models are necessary. There are two data sets produced. The first set comprises the parameters of energy production and non-energy materials, whereas the subsequent set comprises the parameters pertaining to non-energy material production (Table 1).

Table 1

Parameters for energy production and non-energy materials

1.	Energy production, GDP per unit of total primary energy delivered
2.	Energy intensity, Total delivered primary energy per capita
3.	Total primary energy delivered, index 2000=100
4.	Total primary energy delivered
5.	Supply of renewable energy sources, percentage of total energy supplied
6.	Electricity from renewable energy sources, percentage of total generated electricity
7.	Energy consumption in agriculture, percentage of total energy consumption
8.	Energy consumption in the service sector, percentage of total energy consumption
9.	Energy consumption in industry, percentage of total energy consumption
10.	Energy consumption in transport, percentage of total energy consumption
11.	Energy consumption in other sectors, percentage of total energy consumption
12.	Production of non-energy materials, GDP per unit of total domestic material consumption
13.	Biomass, the percentage of total domestic material consumption
14.	Non-metallic minerals, percentage of total domestic material consumption
15.	Metals, the percentage of total domestic material consumption

Note. https://stats.oecd.org/Index.aspx?DataSetCode=GREEN_GROWTH

Energy output is determined by dividing the total primary energy provided by the GDP per unit. Additionally, this parameter serves as an endeavour to enhance energy efficiency while mitigating the release of detrimental gasses, including carbon dioxide. Regarding energy intensity, these metrics concurrently account for climatic and structural influences. The aggregate primary energy supplied comprises production, imports, exports, international aviation and military bunkers, and a one-percentage-point variation in inventory. The energy intensity is determined by dividing the quantity of primary energy supplied per capita. The quantity of primary energy provided is denoted in millions of oil equivalent tons. As an index, the total amount of primary energy supplied is also denoted by figures above 2000, rounded to the nearest hundred. The renewable energy supply is determined by dividing the amount of primary energy provided by renewable sources, expressed as a percentage. In addition to hydro, geothermal, solar, wind, wave, tidal, and ocean energy, renewable energy sources include waste material and combustible renewable energy sources (solid biomass, liquid biomass, biogas) (renewable municipal waste). The power derived from renewable sources is computed as a proportion of the overall electricity generation derived from renewable sources. The energy use in the agricultural sector is denoted as a percentage of the overall energy consumption. Energy consumption in agriculture includes deliveries to users categorised as engaging in hunting and fishing activities, as per the worldwide industry standard. As a result, energy consumption associated with land tillage, as well as heating for agricultural and home uses, is included under this criterion. The energy use within the service sector is denoted as a proportion of the overall energy usage. This parameter encompasses public and proprietary services. The energy consumption of a transportation system is denoted as a proportion of the overall energy consumption. This criterion encompasses all modes of transportation (utilising mobile engines) irrespective of the economic sector to which they contribute or are affiliated. Industry energy consumption comprises the subsequent subsectors: non-metallic metals and non-petrochemicals, transport equipment, machinery, mining, the food and tobacco sectors, paper and printing, wood and wood products, construction, textiles, and leather, in addition to any manufacturing industry not specifically mentioned earlier. Energy consumption in unmarked branches and household usage are included in the energy consumption of other sectors.

The GDP created per unit of consumed materials determines the output of non-energy materials. Material consumption is reflected in the total domestic material consumption, which is computed as the addition of biomass used for food purposes, structural minerals, industrial minerals, metals, and wood. The biomass use is quantified as a proportion of the overall domestic material consumption. Biomass consists of wood and food-producing resources. Cereals, fruits, vegetables, sugar beets, sunflowers, and minute quantities of permanent biomass like rubber and fibrous materials are used as feed ingredients. Additionally, allied goods such as fertiliser derived from domestic cattle are also included. Wood consists of firewood and wood-based goods (paper, furniture, etc.). The proportion of domestic material consumption devoted to non-metallic mineral consumption is denoted. Included among non-metallic minerals are industrial and structural minerals. Primary (sand, gravel, stones, limestone, etc.) and processed (glass, cement, concrete) minerals are examples of structural minerals. The term "industrial minerals" refers to primary or refined non-metallic substances (salts, arsenic, sulfates, asbestos, etc.). The fraction of total domestic material consumption that is allocated to metal usage. Metals include metal products, metal ores, and metals themselves.

The gross domestic product has been used as an exit criterion for assessing economic expansion. In order to represent GDP as an index of 2000 = 100, any figures over 2000 are rounded to the nearest hundred. In addition to sub-production and sales, GDP measures other pertinent economic activity. Nevertheless, when expressed as a gross figure, it fails to account for the depreciation of manufactured items or the depletion of natural resources.

The energy production figures and real GDP as an output for the Republic of Serbia are shown in Table A11 of Annex A1. The data pertaining to the output of non-energy materials and real GDP in the Republic of Serbia is shown in Table A12 of Annex A1. As an exit for OECD members, energy output figures and real GDP are included in Table A21 of Annex A2. The statistics pertaining to the production of non-energy materials and real GDP as an outlet for OECD members are shown in Table A22 of Annex A2.

2.3. ANFIS METHODOLOGY

ANFIS, a technology using artificial intelligence, was used for this objective. ANFIS is a five-layer network. An ANFIS network is composed mostly of a phase decision system. Layer 1 transforms received signals in the value phase by applying affiliation functions. In the value phase, input signal conversion serves to standardise input amounts in preparation for more ANFIS network processing. A bell-shaped affiliation function is used in this study because of its optimal characteristics for data regression.

The function of belonging in the form of a bell is defined based on the following equation:

$$\mu(x) = bell(x; a_i, b_i, c_i) = \frac{1}{1+\left[\left(\frac{x-c_i}{a_i}\right)^2\right]^{b_i}} \quad (1)$$

where the parameters are the ANFIS network and the input signal. The input signal variability influences the ANFIS network's general architecture. AnFIS network configuration settings are optimised during network training using the information in Table A1 of Appendix A1. Establishing the most appropriate connections between input and output to minimise predicate error is the objective of network training.. $\{a_i, b_i, c_i\}x$.

The output of the second layer, which multiplies the phase signals of the first, represents the strength of the regulations. In the rule layer, which comprises the third layer, all signals from the preceding layer are normalised. The fourth layer determines the rules, and every signal is translated into actual combat. The last layer provides the output value after summing all signals.

The evaluation of the ANFIS network's performance is conducted by calculating the coefficient of determination (R2) and the least squares error (RMSE), which are determined by the following relationships:

1) RMSE

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(P_i - O_i)^2}{n}}, \quad (2)$$

2) Coefficient of determination (R^2)

$$R^2 = \frac{\left[\sum_{i=1}^{n}\left(O_i - \overline{O_i}\right)\cdot\left(P_i - \overline{P_i}\right)\right]^2}{\sum_{i=1}^{n}\left(O_i - \overline{O_i}\right)\cdot\sum_{i=1}^{n}\left(P_i - \overline{P_i}\right)} \quad (3)$$

3) Pearson correlation coefficient (r)

$$r = \frac{n\left(\sum_{i=1}^{n} O_i \cdot P_i\right) - \left(\sum_{i=1}^{n} O_i\right)\cdot\left(\sum_{i=1}^{n} P_i\right)}{\sqrt{\left(n\sum_{i=1}^{n} O_i^2 - \left(\sum_{i=1}^{n} O_i\right)^2\right)\cdot\left(n\sum_{i=1}^{n} P_i^2 - \left(\sum_{i=1}^{n} P_i\right)^2\right)}} \quad (4)$$

where Pi and Oi denote experimental and certain values, respectively, and n signifies the aggregate quantity of training data. Deviations from relative data and ANFIS forecasts were determined using the lowest squares error, computed by summing the least squares of deviations for each point on a chart. Descriptive of the strength of the regression link, the coefficient of determination R^2 indicates how well the regression line conforms to the data. Values of the Pearson coefficient and the coefficient of determination should be as near the unit as feasible for more precise regression or prediction. A forecast in which this coefficient is set to 1 would be considered optimum. A decrease in prediction accuracy results from the dispersion of predictive data on charts, which is represented by coefficients less than 1.

Superfluous factors may be eliminated during the selection process. Low-importance parameters have no bearing on the outcome. The data are partitioned into two groups, namely training (trn data) and testing (chk data), in accordance with Tables A1 and A2. The MATLAB function "exhsrch" does an exhaustive search of the input data provided.

3. RESEARCH RESULTS

3.1. ANFIS RESULTS

The ANFIS network is first trained using data from Tables A11 and A12, of which 15 inputs pertain to Serbia and the output is GDP. The primary aim is to compute the root mean square error (RMSE) for every individual input by using the ANFIS network to forecast GDP. The RMSE values for each parameter pertaining to energy production and production of non-energy materials in Serbia are shown in Figure 1. As can be seen, factor 14 has the most importance to GDP projection, as it has the smallest RMSE value. The proportion of non-metallic mineral use to the overall domestic material consumption is denoted by Factor 14. The proportion of domestic material consumption devoted to non-metallic mineral consumption is denoted. Included among non-metallic minerals are industrial and structural minerals. Primary (sand, gravel, stones, limestone, etc.) and processed (glass, cement, concrete) minerals are examples of structural minerals. The term "industrial minerals" refers to primary or refined non-metallic substances (salts, arsenic, sulfates, asbestos, etc.). In Serbia, component 10, which represents energy consumption in transportation, has the biggest root mean square error (RMSE), diminishing its significance in the context of GDP projection.

The numerical RMSE values for each element, as predicted by the GDP in Serbia and for OECD nations, are shown in Table 2. ANFIS models have two RMSE values for training (thorn) and testing (chk). Fifty per cent of the data was allocated for training purposes, with the remaining fifty per cent being used for ANFIS network testing. Individually, 15 ANFIS models comprise each submission. The objective of training each of these models for an epoch was to ascertain the significance of input elements in generating corresponding GDP projections. As shown by the similar error rates throughout training and testing, it is possible to conclude that the ANFIS model has not been overtrained. Upon comparing the statistics, it becomes evident that the consumption of metals by OECD member nations has the greatest impact on GDP. Additionally, it is worth noting that the contribution of non-metallic mining consumption to the GDP of OECD countries is not substantial.

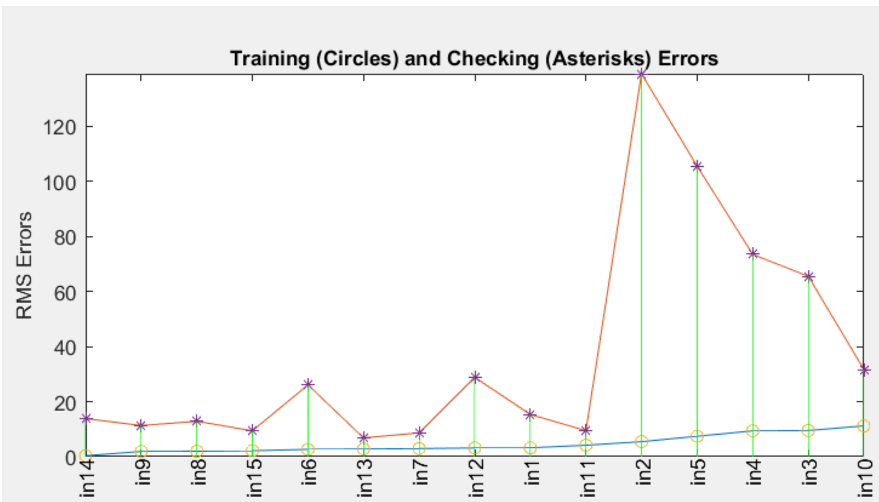

Figure 1. RMS errors for individual parameters based on impact on GDP in Serbia

Note. Author's calculation.

Table 2

RMS errors for individual parameters based on the impact on GDP for Serbia and OECD members

	Republic of Serbia	OECD members
1. Energy production	Thorn=3.2217, chk=15.3177	trn=15.2157, chk=11.6255
2. Energy intensity	trn=5.4499, chk=138.9365	trn=15.8697, chk=13.7280
3. Total primary energy delivered, index 2000=100	trn=9.5078, chk=65.4689	trn=11.8271, chk=9.8133
4. Total primary energy delivered	trn=9.3574, chk=73.4271	trn=14.3457, chk=14.1199
5. Supply of renewable energy sources	trn=7.4236, chk=105.4331	trn=17.1605, chk=16.7613
6. Electricity from renewable energy sources	trn=2.6567, chk=26.0622	trn=17.6626, chk=16.1841
7. Energy consumption in agriculture	trn=2.9346, chk=8.6655	trn=16.5015, chk=15.1602
8. Energy consumption in the service sector	trn=1.9724, chk=12.8528	trn=9.5518, chk=12.9565
9. Energy consumption in industry	trn=1.8883, chk=11.3072	trn=14.9634, chk=15.8505
10. Energy consumption in transport	trn=11.1766, chk=31.6381	trn=14.6794, chk=12.8508
11. Energy consumption in other sectors	trn=4.1597, chk=9.4468	trn=16.1052, chk=16.2567
12. Production of non-energy materials	trn=3.1699, chk=28.7849	trn=8.1152, chk=9.3744
13. Biomass	trn=2.7566, chk=6.8070	trn=15.0961, chk=11.4525
14. Non-metallic minerals	***trn=0.3572, chk=13.8164***	trn=14.6956, chk=14.9097
15. Metals	trn=2.1614, chk=9.4006	***trn=7.7005, chk=16.3203***

Note. Author's calculation.

4. CONCLUSION

The circular economy is an economic model that aims to foster future growth by prioritising preserving the external environment and nature. The circular economy is predicated on the concept of sustaining human existence. When energy supplies are few and present modes of production and consumption prevail, a circular economy may provide an answer. Based on a system of closed circular energy and material resources, the circular economy operates.

The primary aim of this study is to examine the impact of energy production and non-energy material production characteristics on the gross domestic product (GDP) of Serbia and other OECD member states. The objective of this study is to ascertain whether the energy production or non-energy materials production sector has a more substantial influence on GDP and, therefore, on the enhancement of competitiveness. The Adaptive Neural Fuzzy Inference System (ANFIS) is implemented to do this. The usage of non-metallic minerals has the greatest impact on Serbia's gross domestic product. Metal consumption has the most significant influence on the GDP of OECD member states. The contribution of non-metallic mining consumption to the GDP of OECD members is negligible.

It may be deduced from the findings that Serbia should augment its metal consumption to attain parity with the economic progress of OECD member states. The collected findings may serve as exemplary guidelines for the circular economy concept's application.

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ANNEX A1

Table A11

Parameters of energy production in Serbia

Energy production, GDP per unit of total primary energy delivered	Energy intensity, Total delivered primary energy per capita	Total primary energy delivered, index 2000=100	Total primary energy delivered	Supply of renewable energy sources, percentage of total energy supplied	Electricity from renewable energy sources, percentage of total generated electricity	Energy consumption in agriculture, percentage of total energy consumption	Energy consumption in the service sector, percentage of total energy consumption	Energy consumption in industry, percentage of total energy consumption	Energy consumption in transport, percentage of total energy consumption	Energy consumption in other sectors, percentage of total energy consumption	Real GDP, index 2000=100
5465.487	1.74204	118.2778	16.016	11.13886	31.82718	0.2465078	6.018899	34.42892	22.65818	36.6475	136.5585
6493.653	1.736353	115.2943	15.612	13.16295	31.77458	1.233657	9.521299	25.40067	22.95445	40.87938	158.1552
6390.515	1.805827	119.5407	16.187	11.03355	22.7935	1.178742	10.58836	27.64963	20.26217	40.31094	161.3757
7063.961	1.626824	107.4071	14.544	12.67189	25.68909	2.089104	9.602955	28.13943	20.36011	39.8084	160.2758
7092.733	1.67106	110.0657	14.904	12.94283	26.06113	2.072539	9.234312	27.346	22.16465	39.1825	164.912
7844.204	1.4904	97.93959	13.262	15.12592	32.98152	1.931832	9.474591	23.78491	24.52319	40.28547	162.2908
7175.233	1.662315	108.9727	14.756	13.0862	26.90251	1.800948	10.3436	24.02844	23.28199	40.53318	165.1736
7162.504	1.725329	112.8129	15.276	13.09898	28.13487	2.121279	9.828965	23.91159	22.31231	41.82586	170.6909
7153.35	1.767799	115.2721	15.609	12.06996	25.48907	2.073104	10.23459	24.48445	22.83688	40.37098	174.1889
7594.036	1.743661	113.352	15.349	13.16047	29.73658	1.86281	9.752356	25.98071	23.25225	39.14091	181.8397

Table A12

Parameters of production of non-energy materials in Serbia

Production of non-energy materials, GDP per unit of total domestic material consumption	Biomass, the percentage of total domestic material consumption	Non-metallic minerals, percentage of total domestic material consumption	Metals, the percentage of total domestic material consumption	Real GDP, index 2000=100
1.280545	54.93901	33.64956	11.41143	136.5585
1.528886	53.04695	28.75206	18.201	158.1552
1.62559	53.25163	25.55226	21.19612	161.3757
1.809157	42.94401	31.57574	25.48025	160.2758
1.661461	52.0261	22.22121	25.75269	164.912
1.542874	53.93705	20.11509	25.94785	162.2908
1.628583	45.03785	26.25692	28.70523	165.1736
1.467177	47.31183	25.87295	26.81523	170.6909
1.659562	39.66288	30.43023	29.9069	174.1889
1.569051	49.50348	26.08447	24.41205	181.8397

ANNEX A2

Table A21

Energy production parameters

Energy production, GDP per unit of total primary energy delivered	Energy intensity, Total delivered primary energy per capita	Total primary energy delivered, index 2000=100	Total primary energy delivered	Supply of renewable energy sources, percentage of total energy supplied	Electricity from renewable energy sources, percentage of total generated electricity	Energy consumption in agriculture, percentage of total energy consumption	Energy consumption in the service sector, percentage of total energy consumption	Energy consumption in industry, percentage of total energy consumption	Energy consumption in transport, percentage of total energy consumption	Energy consumption in other sectors, percentage of total energy consumption	Real GDP, index 2000=100
8826.367	3.254377	95.44046	1678.353	6.420461	18.5517	2.950462	10.23068	26.22146	24.68238	35.91433	85.83326
11707.61	3.179969	100.7703	1772.08	11.27353	24.70799	2.640972	12.62459	23.98399	26.97872	33.77164	120.2103
11731.95	3.158605	100.5814	1768.758	12.47474	27.91644	2.553398	13.01538	23.60345	26.28076	34.54701	120.2344
11932.29	3.120545	99.84254	1755.765	13.12106	30.1717	2.571397	13.16731	23.33632	26.25779	34.66735	121.3893
12655.89	2.98967	96.10636	1690.063	13.63062	31.46343	2.659827	12.78105	23.94561	27.71869	32.89499	123.9327
12795.84	3.022118	97.60636	1716.441	14.06999	33.04113	2.499092	13.14044	23.46823	27.79351	33.09873	127.2589
12954.69	3.032611	98.40902	1730.556	14.2445	33.33186	2.525502	13.15796	23.15053	27.98008	33.18602	129.8981
13121.2	3.07226	100.1639	1761.417	14.40108	33.45408	2.541875	13.04277	23.55828	27.99207	32.86501	133.914
5352.338	5.581285	83.84415	2288.226	6.961026	19.09514	1.364847	11.51985	23.34249	36.26098	27.51171	71.37879
5605.401	5.675304	90.83206	2478.936	7.118982	18.77071	1.367863	11.82618	21.50333	36.83042	28.4722	80.98391
6287.054	5.854374	100	2729.142	6.447741	16.0582	1.206874	11.83079	22.90521	36.79903	27.2582	100
6868.174	5.750032	103.6581	2828.978	6.443316	16.10363	1.677225	12.01204	19.51234	38.75154	28.04681	113.2394
7550.711	5.230707	99.57514	2717.547	7.346258	17.24032	1.76541	12.68244	19.37154	38.73235	27.44826	119.5891
7741.915	5.155612	99.12372	2705.227	7.864479	19.41638	1.785822	12.83744	19.53984	38.62576	27.21119	122.0615
8019.06	5.050881	98.03568	2675.533	8.200684	19.32087	1.74518	12.47072	19.91062	39.01956	26.85392	125.0433
8016.53	5.104189	99.98215	2728.655	8.619265	20.04105	1.694568	12.69241	19.46404	39.00652	27.14256	127.4858
8147.765	5.107526	100.9511	2755.1	8.63221	20.45455	1.636462	12.89735	19.21322	38.47406	27.77891	130.8286
8462.196	5.016077	100.032	2730.016	8.595517	20.66553	1.716439	12.72969	19.21101	39.69491	26.64827	134.6403
8666.114	4.941216	99.41963	2713.303	8.8508	22.08114	1.696488	12.72559	19.18978	40.03992	26.34816	137.0406
8882.95	4.889446	99.24834	2708.628	9.24793	24.1985	1.72511	12.68393	19.04909	40.12773	26.41415	140.2275
8194.264	3.339897	75.55217	642.031	3.976755	12.39039	2.340472	10.90509	35.23991	26.29814	25.21638	78.97456
7858.75	3.831093	89.53382	760.845	3.472061	10.14154	2.17794	13.10679	32.03857	27.34161	25.3347	89.75755
7839.162	4.171752	100	849.785	3.385445	9.018647	2.17077	13.70079	30.7091	26.7374	26.68176	100
8403.907	4.24036	103.7258	881.446	3.501632	8.268871	2.109931	14.69172	29.19155	26.30231	27.70432	111.1983
8629.543	4.336745	108.1701	919.213	3.868527	8.572367	1.956162	14.30385	28.65298	25.77892	29.30757	119.0763
9007.837	4.196933	105.0629	892.809	4.062795	9.214039	1.874756	14.22723	29.20513	25.48949	29.20357	120.7259
9250.417	4.149241	104.2317	885.745	3.945718	8.798679	1.893719	13.86529	28.82656	25.52133	29.89328	122.9961
9462.185	4.140055	104.3403	886.668	4.266535	9.726371	1.834807	14.17982	29.13196	25.36626	29.48715	125.9429
9710.062	4.078918	103.1002	876.13	4.711858	10.89627	1.772406	14.17716	29.09455	25.42591	29.5298	127.7061
9913.527	4.059661	102.871	874.182	4.957206	11.84383	1.870634	14.1357	28.23516	25.92617	29.83199	130.0922
10010.63	4.071079	103.373	878.448	4.952598	12.22848	1.922751	14.08912	27.81522	25.98659	30.18666	132.0075
10204.06	4.090365	104.0321	884.049	5.280137	13.31454	1.847376	13.94631	27.49142	25.78605	30.92867	135.4162

Table A22

Parameters of production of non-energy materials

Production of non-energy materials, GDP per unit of total domestic material consumption	Biomass, the percentage of total domestic material consumption	Non-metallic minerals, percentage of total domestic material consumption	Metals, the percentage of total domestic material consumption	Real GDP, index 2000=100
0	33.33333	33.33333	33.33333	85.83326
3.403811	31.01805	63.46789	5.514061	120.2103
3.765492	33.37396	60.98759	5.638452	120.2344
3.857792	34.02959	59.18972	6.780695	121.3893
3.812986	35.26351	58.32495	6.41154	123.9327
3.986153	33.89724	58.90404	7.198723	127.2589
4.043387	34.35774	58.74871	6.893549	129.8981
3.992864	34.29899	59.33814	6.362866	133.914
1.886461	23.30155	57.35181	19.34664	71.37879
1.982073	21.98267	57.24782	20.76951	80.98391
2.063529	22.77075	57.10828	20.12097	100
2.217392	22.85453	59.90219	17.24328	113.2394
2.874452	28.32773	50.72296	20.94931	119.5891
2.92041	28.3162	50.46878	21.21502	122.0615
3.228215	29.64258	45.52305	24.83437	125.0433
3.111924	30.84143	44.54292	24.61565	127.4858
3.242061	31.58285	43.15933	25.25782	130.8286
3.37943	32.44012	41.88441	25.67547	134.6403
3.48951	33.20387	40.65423	26.1419	137.0406
3.62182	33.97746	39.41026	26.61228	140.2275
2.375676	19.43443	62.07285	18.49272	78.97456
2.465624	20.05789	62.51141	17.43069	89.75755
2.662974	20.64682	59.0311	20.32209	100
3.100619	21.48204	57.75063	20.76732	111.1983
3.657303	22.1197	55.03258	22.84772	119.0763
3.688337	22.42532	54.31113	23.26355	120.7259
4.178116	25.52284	49.18826	25.28891	122.9961
4.28764	25.12926	48.57531	26.29542	125.9429
4.3635	25.54854	47.99104	26.46042	127.7061
4.528671	25.97681	47.02766	26.99553	130.0922
4.687572	26.46947	45.95464	27.5759	132.0075
4.855577	26.69905	45.41676	27.88419	135.4162