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# Multicriteria selection of the optimal energy mix during the world energy crisis

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***Abstract:*** *Sustainable development is feasible through energy transition. The key elements of such transition are: the implementation of energy efficiency measures, the use of renewable resources, tackling climate change and environmental protection. It is known that the EU has established a legally binding framework for achieving the goals of the Paris Agreement from 2015, as well as ambitious goals through the 2030 Agenda. Since Serbia signed Sofia Declaration from 2020, it will create new Energy Strategy and technical study based upon existing energy sources, to get to the aim of optimal energy mix. This will take into account the electricity system and energy security, as well as the economic and financial analysis of the proposed technical solutions of the optimal mix. In this paper, a multi-criteria analysis has been developed for the purpose of evaluating the results and selecting the scenarios on the basis of which the draft of the Integrated National Energy and Climate Plan will be prepared. The basis for this analysis should be the selection of the optimal energy mix that will be continuously monitored with special reference to the period of energy crises, when there are major disruptions in prices and availability on the world energy market.*

***Keywords***: *multicriteria analysis, optimal energy mix, Green Agenda, energy transition, world energy crisis*

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# Višekriterijumski izbor optimalnog energetskog miksa u funkciji energetske tranzicije u vreme svetske energetske krize

***Apstrakt:*** *Održivi razvoj je izvodljiv kroz energetsku tranziciju. Ključni elementi takve tranzicije su: sprovođenje mera energetske efikasnosti, korišćenje obnovljivih izvora, suočavanje sa klimatskim promenama i zaštita životne sredine. Poznato je da je EU uspostavila pravno obavezujući okvir za postizanje ciljeva Pariskog sporazuma iz 2015. godine, kao i ambicioznih ciljeva kroz Agendu 2030. godine. Pošto je Srbija potpisala Sofijsku deklaraciju od 2020. godine, napraviće novu energetsku strategiju i tehničku studiju zasnovanu na postojećim izvorima energije, kako bi se došlo do cilja optimalnog energetskog miksa. U obzir će se uzeti elektroenergetski sistem i energetska sigurnost, kao i ekonomska i finansijska analiza predloženih tehničkih rešenja optimalnog miksa. U ovom radu razvijena je višekriterijumska analiza u cilju evaluacije rezultata i odabira scenarija na osnovu kojih će biti pripremljen nacrt Integrisanog nacionalnog energetskog i klimatskog plana. Osnova za ovu analizu bi trebalo da bude izbor optimalnog energetskog miksa koji će se kontinuirano pratiti sa posebnim osvrtom na period energetskih kriza, kada dolazi do velikih poremećaja cena i smanjenja dostupnosti na svetskom energetskom tržištu.*

***Ključne reči****: višekriterijumska analiza, optimalni energetski miks, Zelena agenda, energetska tranzicija, svetska energetska kriza*

## 1. Introduction

The Energy Development Strategy unto 2025, with special reference to 2030., defines the basic goals of energy development of the Republic of Serbia (Statistical Office of the Republic of Serbia, 2021). Those goals are: energy security, establishment of energy markets and functioning of the sector in accordance with the principles of sustainable development, as well as the legal and institutional framework. Potential directions of their development in the light of the activities of the Energy Community and the process of joining the European Union, should enable the achievement of these goals. The strategy represents a framework for the development of the energy system of the Republic of Serbia with all possible (positive and negative) implications to the quality of the environment (State Audit Institution, (2019). That document was

adopted in 2015. and was overcome in accordance with the new circumstances that affected the world.

If we are talking today about the strategic priorities of the energy development of the Republic of Serbia until 2030, then they can be defined as: ensuring energy security, dependence/independence on the energy import, efficiency issues due to delays in construction of new power facilities. Thus, in addition to the savings, it is necessary to secure adequate reserves of oil and natural gas and access to the construction of new electricity generation capacities, as well as the development of the energy market. Back in 2005, the Republic of Serbia accepted, signed and ratified the Agreement on the Establishment of the Energy Community (EnZ, (2021). It has integrated into the European Union's energy market. This should secure more significant investments and contribute to the economic development and stability of the state.

Energy transition is the path for the transition to the sustainable energy. The key elements of such a transition are: the implementation of energy efficiency measures, the use of renewable energy sources and environmental protection, as well as reducing the impact on climate change. The development of the energy sectors includes the electricity system, the district heating system, renewable energy sources, coal, oil, natural gas and energy efficiency.

It is known that the EU has established a clear legally binding framework for achieving the goals of the Paris Agreement from 2015, as well as ambitious goals through the 2030 Agenda, all in terms of renewable energy sources, energy efficiency and greenhouse gas emissions. Like the EU member states, the contracting parties of the Energy Community, which includes the Republic of Serbia, are obliged to monitor and report on these areas.

Serbia is also a signatory to the Sofia Declaration on the Green Agenda for the Western Balkans from November 10, 2020, which also obliges it to draft an Integrated Energy and Climate Plan. In April 2021, a set of laws in the field of energy and mining was passed, which we call the "green package", including the Law on the Use of Renewable Energy Sources and the Law on Energy Efficiency and Rational Use of Energy and the Law on Amendments to the Law on Mining and geological research and the Law on Energy (Government Republic of Serbia, Serbian Chamber of Commerce, Belgrade, 2021.), which obliges us to develop an Integrated Energy and Climate Plan, as well as to monitor and report on its implementation.

The challenges on the path of energy transition are the cause of the need to define new goals in the field of energy efficiency, renewable energy sources

and reduction of greenhouse gas emissions for 2030, all with a vision for 2050 (Tomić, 2021). It is necessary to define the optimal energy mix of energy efficiency, renewable energy sources, security of supply and energy poverty, which will define the speed of the process of decarbonization or energy transition.
The current structure of the energy sector of the Republic of Serbia requires serious changes, arrangements and investments, in order to be harmonized with the European policy in this area. In that sense, the key task in the process of drafting the Integrated National Energy and Climate Plan is to define scenarios from which new goals will be determined in the field of energy efficiency, renewable energy sources and reduction of greenhouse gas emissions.

After the world health pandemic crisis, 2020, which was the year of stopping the economy, comes 2021, which is the year of recovery and accelerated economic growth, both in the world and in Serbia (Tomić & Milošević, 2020, pp 28). The energy crisis, which occurs in the fall of 2021., with a radical jump in the prices of electricity and gas, is a consequence of the change in economic relations in the world, the regrouping of capital and investments in energy. China is buying up all the world's coal reserves, Europe is putting thermal power plants out of use, nuclear energy together with gas is becoming an important pillar of environmental protection and the embodiment of "clean" energy sources.

Electricity prices on the wholesale market have become completely deregulated, causing a new blow to the economy. Additional support measures will be needed to develop market competitiveness. Currently, energy prices are a matter of supply and demand and the availability of gas and electricity. In Serbia, the supply of small customers and households is at the level it was before the energy crisis. Consequently, the economy is under the impact of

changes in the free market, although the state is trying in different ways to mitigate these shocks through different models of supporting the economy.

Based on all the changes, the state must give the following guidelines with the new strategy (Nikolić & Vasović, 2015, pp 201), as follows:

- To define the optimal energy mix in Serbia based on existing energy sources.
- To develop a technical study of the optimal energy mix, considering the electricity system and energy security.
- To create an economic and financial analysis of the proposed technical solutions of the optimal mix, in order to enable sustainability in the application of sustainable energy sources.
- To consider the impact of additional costs for large fluctuations in the energy price market, as well as for transmission and distribution system operators by investing in sustainable energy sources.
- To consider and estimate the final price of the electricity for consumers.

## 1.1. Overview of electricity consumption by sources in Serbia

In accordance with the Energy Development Strategy until 2025, and with projections until 2030, in the Republic of Serbia, AERS in its Report expects an annual increase in electricity consumption of less than 1% on average. This expectation is based on projections of GDP and consumption growth in the industrial sector, as well as on the implementation of measures to increase energy efficiency in all sectors of consumption 8.

The report also states that the total production of electricity in the Republic of Serbia, under average hydrological conditions, is of such a nature that about 2/3 of electricity is produced in coal-fired power plants, and 1/3 from hydro potential. Since the end of 2018, significant capacities of wind power plants have been connected to the transmission system, so that their share in the total electricity production is becoming increasingly important, so in 2020 it

amounted to about 2.5% 8. Table 1 represents electricity taken from eligible producers from 2016-2020.

*Table 1: Electricity taken from eligible producers from 2016-2020.*

| Sust. energy sources /fuel for cogeneration | 2016. | 2017. | 2018. | 2019. | 2020. |
|---|---|---|---|---|---|
| Watercourses | 192453 | 183233 | 265917 | 230298 | 221283 |
| Fossil fuels (coal, fuel oil and natural gas) - combined production | 78188 | 112446 | 105814 | 91501 | 100062 |
| Biogas | 34048 | 71255 | 95494 | 136070 | 179897 |
| Solar power | 11100 | 11100 | 10521 | 10941 | 9043 |
| Wind | 26237 | 48457 | 150419 | 892994 | 835168 |
| In total | 342026 | 426491 | 628165 | 1361804 | 1345454 |

Source: EnZ, (2021), Report of the Energy Community on the progress of Serbia for 2020.,53 (3), 64-75

Within the obligations from the Agreement on Energy Community, a goal has been set for all signatories to that Agreement, which are binding percentages for increasing the share of renewable energy in gross final energy consumption by 2020. In that way, Serbia undertook the obligation to provide 27% of gross final energy consumption from renewable sources in 2020. With the further implementation of projects in the field of renewable energy sources in the period from 2021 to 2030, we want to further increase the contribution of renewable energy sources, which affects the reduction of greenhouse gas emissions, all in order to increase the final participation renewable energy sources in gross final consumption, while on the other hand it would reduce greenhouse gas emissions (Energy Agency, 2021).

As energy and oil crises arise suddenly, each country makes decisions to adequately respond to the economic shocks that these crises cause. By reviewing electricity consumption during two months during the heating season (when consumption is highest during the energy crisis), it is necessary to choose the optimal energy mix to ensure energy stability of the system to consider all relevant factors (Miletić, 2016.). These are factors that could influence the scenarios in the future implementation of the Integrated Energy

and Climate Plan. We can, by reviewing electricity consumption according to sources from 13.12.2021. to 12.2.2022, and all with the help of multi-criteria analysis, to select the optimal energy mix during the energy crisis. Aplication Energy Fluks represent all overview of all energy sources and changes every day. Table 2 shows overview of electricity consumption by sources from 13.12.2021.-31.12.2021. Table 3 is shown for the period from 01.01.2022.-31.01.2022. for the same consumption.

*Table 2: Overview of electricity consumption by sources from 13.12.2021. to 31.12.2021.*

| Period 13.12. | Thermo MW | Hidro MW | Wind MW | Gas MW | Pump MW | Solar MW | Imp. MW | Export MW |
|---|---|---|---|---|---|---|---|---|
| 14.12. | 1744 | 1285 | 10 | 98 | 0 | 0 | 0 | 1842 |
| 15.12. | 2255 | 1248 | 39 | 97 | 0 | 0 | 0 | 1290 |
| 16.12 | 2057 | 1530 | 68 | 75 | 0 | 0 | 0 | 1233 |
| 17.12 | 2254 | 1627 | 161 | 83 | 0 | 0 | 0 | 843 |
| 18.12. | 2758 | 1110 | 53 | 75 | -25 | 0 | 0 | 797 |
| 19.12. | 2741 | 1043 | 353 | 73 | -603 | 0 | 0 | 985 |
| 20.12. | 2902 | 1008 | 355 | 74 | 0 | 0 | 0 | 670 |
| 21.12. | 2869 | 1694 | 4 | 71 | 0 | 0 | 0 | 523 |
| 22.12. | 2892 | 1594 | 1 | 70 | 0 | 0 | 0 | 625 |
| 23.12. | 3008 | 1266 | 293 | 75 | 0 | 0 | 0 | 460 |
| 24.12. | 3171 | 1230 | 208 | 75 | -602 | 0 | 0 | 717 |
| 25.12. | 2415 | 907 | 203 | 95 | -25 | 0 | 0 | 930 |
| 26.12. | 2250 | 1187 | 0 | 92 | 0 | 0 | 0 | 1018 |
| 27.12. | 1992 | 1665 | 0 | 102 | 0 | 0 | 0 | 1005 |
| 28.12. | 2359 | 1041 | 346 | 103 | -292 | 0 | 0 | 1289 |
| 29.12. | 2075 | 1908 | 1 | 100 | 0 | 0 | 0 | 669 |
| 30.12. | 1968 | 1281 | 21 | 97 | -25 | 0 | 0 | 1436 |
| 31.12. | 2058 | 841 | 29 | 99 | 0 | 0 | 0 | 977 |
| Total: % | **67,99** | **27,78** | **0,96** | **3,27** | **0** | **0** | **0** | |
| Total import | | | | | | | | : **17318** |

Source: www.ems.rs application Energy Flux (date 2/12/22 time 9 p.m.)

*Table 3: Overview of electricity consumption by sources from 1.1.2022. to 31.1.2022.*

| Period from 01.01. | Thermo MW | Hidro MW | Wind MW | Gas MW | Pump MW | Solar MW | Imp MW | Export MW |
|---|---|---|---|---|---|---|---|---|
| 2.1. | 1958 | 1594 | 105 | 97 | -594 | 0 | 0 | 951 |
| 3.1. | 2104 | 1556 | 12 | 93 | -314 | 0 | 0 | 880 |
| 4.1. | 2106 | 1390 | 140 | 97 | -590 | 0 | 0 | 1185 |
| 5.1. | 2034 | 1617 | 198 | 91 | -311 | 0 | 0 | 804 |
| 6.1. | 2612 | 1379 | 188 | 99 | -563 | 0 | 0 | 668 |
| 7.1. | 2244 | 1377 | 78 | 100 | -310 | 0 | 0 | 757 |
| 8.1. | 2121 | 1818 | 11 | 99 | -310 | 0 | 0 | 797 |
| 9.1. | 2007 | 1794 | 91 | 98 | 0 | 0 | 0 | 646 |
| 10.1. | 2509 | 1818 | 6 | 98 | 0 | 0 | 0 | 639 |
| 11.1. | 2738 | 1415 | 0 | 95 | 0 | 0 | 0 | 895 |
| 12.1. | 2556 | 1823 | 20 | 90 | 0 | 0 | 0 | 795 |
| 13.1. | 2761 | 1450 | 16 | 92 | 0 | 0 | 0 | 933 |
| 14.1. | 2675 | 1036 | 343 | 97 | 0 | 0 | 0 | 777 |
| 15.1. | 2485 | 1650 | 6 | 94 | -25 | 0 | 0 | 714 |
| 16.1 | 2505 | 1283 | 0 | 97 | -25 | 0 | 0 | 1031 |
| 17.1 | 2660 | 1340 | 315 | 98 | -312 | 0 | 0 | 946 |
| 18.1. | 2419 | 1729 | 65 | 71 | 0 | 0 | 0 | 806 |
| 19.1. | 2367 | 1345 | 147 | 1 | -25 | 0 | 0 | 1249 |
| 20.1. | 2387 | 1427 | 79 | 83 | 0 | 0 | 0 | 967 |
| 21.1. | 2329 | 1286 | 55 | 0 | 0 | 0 | 0 | 1055 |
| 22.1. | 2551 | 1223 | 145 | 91 | -25 | 0 | 0 | 1086 |
| 23.1. | 3103 | 800 | 332 | 91 | -313 | 0 | 0 | 1105 |
| 24.1. | 2785 | 1636 | 31 | 77 | 9 | 0 | 0 | 937 |
| 25.1. | 2840 | 1343 | 25 | 1 | 0 | 0 | 0 | 1093 |
| 26.1. | 2591 | 866 | 76 | 78 | 0 | 0 | 0 | 1506 |
| 27.1. | 2269 | 1415 | 99 | 76 | 0 | 0 | 0 | 1220 |
| 28.1. | 2406 | 938 | 352 | 80 | 0 | 0 | 0 | 1277 |
| 29.1. | 2347 | 1061 | 92 | 82 | -25 | 0 | 0 | 1322 |
| 30.1. | 2487 | 659 | 364 | 78 | -25 | 0 | 0 | 1232 |
| 31.1. | 2400 | 1220 | 145 | 68 | 0 | 0 | 0 | 1104 |
| **Total: %** | **62,61** | **31,83** | **3,78** | **1,77** | **0** | **0** | **0** | |
| **Total import** | | | | | | | | **: 29377** |

Source: www.ems.rs aplikacija Energy Flux (date 2/12/22 time 9 p.m.)
Table 4 represents overview of electricity consumption by sources from 1.2.2022. to 12.2.2022.

*Table 4: Overview of electricity consumption by sources from 1.2.2022. to 12.2.2022.*

| Period from 1.2. | Therm o MW | Hidro MW | Wind MW | Gas MW | Pump MW | Solar MW | Imp. MW | Export MW |
|---|---|---|---|---|---|---|---|---|
| 2.2. | 2434 | 997 | 353 | 80 | 0 | 0 | 0 | 1089 |
| 3.2. | 2634 | 836 | 17 | 70 | 0 | 0 | 0 | 1404 |
| 4.2. | 2599 | 767 | 136 | 81 | 0 | 0 | 0 | 1267 |
| 5.2. | 2553 | 619 | 92 | 82 | -25 | 0 | 0 | 1257 |
| 6.2. | 2558 | 559 | 150 | 74 | -25 | 0 | 0 | 1210 |
| 7.2. | 3010 | 1068 | 314 | 110 | -578 | 0 | 0 | 912 |
| 8.2. | 2399 | 1291 | 104 | 90 | 0 | 0 | 0 | 967 |
| 9.2. | 2542 | 985 | 28 | 98 | 0 | 0 | 0 | 1018 |
| 10.2. | 2447 | 1223 | 36 | 92 | 0 | 0 | 0 | 870 |
| 11.2. | 2444 | 757 | 340 | 96 | 0 | 0 | 0 | 959 |
| 12.2. | 2224 | 1393 | 206 | 87 | 0 | 0 | 0 | 772 |
| **Total: %** | **56,88** | **35,63** | **5,27** | **2,23** | **0** | **0** | **0** | |
| **Total importt** | | | | | | | | **11725** |

Source: www.ems.rs aplikacija Energy Flux (date 2/12/22 time 9 p.m.)

## 2. Literature review

Article “Multi-Period Multi-Criteria DecisionMaking under Uncertainty: A Renewable Energy Transition Case from Germany” shows the effects of implementation of MCDM in uncertain periods of time. Methods used was PROMETHEE with different scenarios planning. It was carried out into German energy sector in town Jühnde regarding energy transition. The correlation between future perspective and external factors during multi-periods connected to decision making was highlighted. Enhanced problem structuring was marked as important factor for decision makers to have a better understanding. Good and bad solutions were given so that the option chosen would be the most suitable for sustainable system. This paper also states that this type of research can transfuse to health care sector regarding deep and uncertain times. The ultimate implementation of this system would be aggregation of data from different periods and carrying it out in the multi-atribute decision making

algorithm so the important strategic decisions are done with certinty in unertain times (Witt & Klumpp, 2021).

“Fuzzy Ensemble of Multi-Criteria Decision Making Methods for Heating Energy Transition in Danish Households” shows the heating alternatives in Danish households through comparison with multicriteria decision making. Thirteen heating alternatives with nineteen quantitative criteria were shown within thorough analysis. Also, the combination of 6 weighting methods and 4 normalization methods with a fuzzy circularization were created for obtaining the optimal solution. VIKOR (multicriteria compromise ranking) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) were the methods used to stabilize and make the analysis firmer. Technical, environmental and financial data were used as dimensions for defining the criteria. After the implementation of VIKOR and TOPSIS, results showed that air-to-water heat pump, solar heating and direct district heating are the top three rankings in the final result under Danish national average data. Contributions of these paper are: comparative analysis of 13 individual heating alternatives in Denmark obtained from proposed framework and Danish Energy Agency; proposals of best soultions for decision makers; different perceptions regarding the usage of heating alternatives within specific needs and social status; etc.(Wen, Yan, Qu and Liu, 2021).

In paper “Sustainable energy transition readiness: A multicriteria assessment index”, a multicriteria analysis reviewed transition of countries to sustainable energy regarding social, political, economic and technological aspects with set of eight evaluation criteria. The analysis was done with PROMETHEE II and AHP (Analytic Hierarchy Process) method. Fourteen countries were assessed for the transition of their energy sector. They all have different characteristics and are of various economic and social growth. Fields of improvement were marked and suggestions for policy makers were given. Austria, Canada, Chile, China, Greece, India, Indonesia, Kenya, Netherlands, Poland, Spain, Sweden, Switzerland, and United Kingdom (UK) were the countries involved. Through eight criteria which are: public awareness and acceptance, human capital, political will & compliance with EU energy policy, regulatory indicator for Sustainable Energy, financial market sector soundness, ease of doing business, carbon lock-in and infrastructure & innovation the research with two multicriteria methods was conducted. The results of research showed Sweden as the most imminent for sustainable transition, second and third place showed Western Europe and Canada as favourites. This paper showed strengths and shortcomings of each country and implies the improvements needed. It also helps to show the adaptations and customization of each energy system of

these countries and help policy makers in their decisions (Neofytou, Nikas and Doukas, 2020).

Article “China's energy transition strategy at the city level: The role of renewable energy” showed the application of AHP method in energy transition at the city level. The cities from China: Guiyang, Tongren, Zhangjiakou, and Nanning were observed. Renewable energy was connected to various priority values for each city. Research showed that resources are not the only crucial factor for energy transition and decision making. Since China has and index system for renewable cities that was prevails to the overall share of renewable energy consumtion, this paper indicated other factors such as: city planning, social benefits, ecological benefits, return on investment, etc. Also, different types of renewable energy sources were observed and put in four categories for their deployment in prioritization in energy transition. Results indicated that for the cities observed, gas supply, heat supply, electricity, and fuel are of highest priority. This will also contribute to overall urban planning of the cities. Every city would be looked as an individual and the adjustmests would be appropriate for each one. Good correlation between prioritization of renewables utilization and available renewables was discovered in Zhangjiakou and Nanning. Since the policies have important role, the imperative of rational consumption of energy, improvements of energy efficiency were given as suggestions. Also, the pilot projects for renewable resources are proposed, and the implementation of renewables within the national power grid (Xiao-Chen, Yan-Yun, Bing, Qiao-Hong and Qing, 2018.).

## 3. Research methodology - multicriteria approach to the choice of optimal alternatives

The way to choose the optimal type of solution for a given problem is the decision-making process. This is a way of achieving the goals that have been formulated. A quality decision must be based on accurate, relevant and timely information. In addition to this information, a prerequisite for good decision-making is that the decision-maker has adequate competencies, experience and

assessments. In order to better implement the decision-making process (Roy, 1991.), it is divided into several phases, which it goes through. Those are:

1. Zero situation analysis.
2. Description of the problem or opportunity.
3. Defining goals.
4. Identification of alternatives.
5. Information gathering.
6. Assessing alternatives.
7. Choosing one alternative.
8. Application of the decision.
9. Analysis of the results of the applied decision/solution.

The methods to be used for multicriteria analysis are as follows:

1. AHP (Analytical Hierarchy Process).
2. ELECTRE (Elimination Et Choice Translating Reality).
3. COPRAS (Complex Proportional Assessment).

The AHP method is used to evaluate the evaluation criteria, while the ELECTRE and COPRAS methods are used to rank the alternatives (Stojanović, 2016.).
In this consideration, the ELECTRE method was applied, which is a method of multi-criteria decision-making based on comparing alternatives in pairs. ELECTRE starts from the decision matrix and the weight of the criteria, and in nine steps the problem is solved, that is, the best alternative is chosen.

When choosing ELECTRE alternatives, it is best to use the following criteria[2]:

S1 Technological level of electricity production.
S2 Share of sustainable energy sources in total consumption.
S3 Price.
S4 Environmental requirements.
S5 Imports of electricity.

By defining alternatives A1, A2 and A3 for the stated consumption periods, namely December 2021, January and February 2022 and criteria S1, S2, S3, S4 and S5, an evaluation matrix is formed. In this case, the criteria have a qualitative structure, which cannot be precisely determined or changed, and it

is necessary to form a qualitative scale with five levels. Table 5 and 6 show scales and matrix used in analysis.

*Table 5. Qualitative scale*

| Qualitative values | very weak | weak | medium | | high |
|---|---|---|---|---|---|
| numerical values | 1 | 2 | 3 | 4 | 5 |

*Source: author's calculation*

The initial table of criteria for the application of the ANR method is as follows:

*Table 6. Quantification decision matrix*

| Norm | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| Type of exp. | max | max | max | max | max |
| A1 | 3 | 3 | 2 | 3 | 1 |
| A2 | 4 | 3 | 3 | 3 | 2 |
| A3 | 4 | 5 | 5 | 4 | 5 |

*Source: author's calculation*

Calculated and presented analysis results. They indicate the following:

- A3 dominates A1, A2;
- A2 dominates A1;
- A3 dominates over A2;
- A1 does not dominate any action.

## 4. Results and discussion

The results show that the best alternative is A3 (electricity consumption by sources for February 2022), followed by A2 (electricity consumption by sources for January 2022) and lastly alternative A1 (electricity consumption by sources for December 2021).

The starting element for the analysis of the obtained results is the consumption of electricity according to sources for February 2022 (with 67.99% TE, 27.78% Hydro, 0.96% wind and 3.27% gas) - Alternative A1. It is characterized by the highest consumption of coal reserves and the realization of the highest production capacity. The advantages are that by coal exploitation we reduce imports, we respond to prices, but we have a very small share of sustainable

energy sources due to climatic conditions and endangered environmental standards.

This is followed by electricity consumption by sources for January 2022 (with 62.61% TPP, 31.83% Hydro, 3.78% wind and 1.77% gas) - Alternative A2, which stabilized consumption, increased the share of sustainable sources energy, coal reserves are higher, but there are certain limitations in terms of the application of environmental standards.

Electricity consumption by sources for February 2022 (with 56.88% TPP, 35.63% Hydro, 5.27% wind and 2.23% gas) - Alternative A3 is characterized by relatively lower coal exploitation, significantly higher share of sustainable energy sources, lower prices and lower imports, as well as favorable natural and climatic conditions, which together enable high environmental standards.

## 5. Conclusion

The main goals of energy development of the Republic of Serbia by 2030 are energy security, establishment of energy markets and functioning of the sector in accordance with the principles of sustainable development. On the other hand, legal and institutional framework, as well as potential directions of their development in light of activities should enable the achievement of these goals. The strategy will be a framework for the development of the energy system of the Republic of Serbia with all possible (positive and negative) implications for the environment.

The state will define the optimal energy mix in Serbia with the new Strategy, which will be based on existing energy sources, and a technical study of the optimal energy mix will also be done. All this will take into account the electricity system and energy security, as well as the economic and financial analysis of the proposed technical solutions of the optimal mix. Aim of these measures would be to enable sustainability and stability while using sustainable energy sources. The impact of additional costs for large fluctuations in the energy price market, as well as for transmission and distribution system operators by investing in sustainable energy sources and the final price of electricity prices for consumers will be considered.

The selection of the optimal energy mix in the function of the green transition during the energy crisis is the starting point for drafting strategic documents. The methodology has shown that when observing electricity consumption (according to sources) and at the time of peak consumption (December,

January and February), we must calculate comprehensively from the technological process, through the participation of sustainable energy sources, all the way to price and quantities of imports with special emphasis on environmental standards. A multi-criteria analysis has been developed for the purpose of evaluating the results and selecting the scenarios on the basis of which the draft of the Integrated National Energy and Climate Plan will be prepared. The basis for this analysis should be the selection of the optimal energy mix that will be continuously monitored with special reference to the period of energy crises, and these are the periods when there are major disruptions in prices and availability on the world energy market.

With this, the Republic of Serbia wants to send the message that it is committed to a healthy environment. Serbia is committed to following global trends in the field of green transformation. For Serbia, the Green Agenda is the path to climate-neutral Serbia, economic development and growth, the path to new and healthy jobs. The energy transition is not a race, but above all a marathon that should create new jobs, start innovations and digitalization in this area.

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