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DRINA RIVER BASIN HYDROPOWER UTILIZATION IMPACT ON ENERGY SELF-SUFFICIENCY RISK INDICATOR

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A brief or preliminary announcement

Abstract: *Countries all over the world uncritically change the legislative framework are hastily integrating the requirements of the energy transition (switching to renewable energy sources - RES), which can have long-term adverse consequences for the country's energy self-sufficiency and stability generated by the neglecting the real possibilities and benefits. This study presents facts that emphasise unquestionable water power (hydropower) advantages in comparison with RES that occupy a significant part of public space and publications (wind and solar) despite their variability, the critical minerals requirement for TW/h production and Energy Returned on Investment- EROI. In addition, Energy self-sufficiency risk indicator (InES) highlights the percentage of countries with very high risk 46% and 23%, globally and Europe. Increase of hydropower utilization by 10% scenario for Drina River Basin countries is assessed with respect to energy self-sufficiency risk.*

Key words: *Renewable energy sources, Hydropower, Energy Self-sufficiency risk indicator, Drina River Basin*

(Introductory lecture of the forum - work by invitation)

1. INTRODUCTION

Impact of energy self-sufficiency on national security it has been a principle of strategic national security guidelines since 1953 in the United States of America (Spero, 1973). The joint study by OECD (the Organisation for Economic Co-operation and Development) and IEA (the International Energy Agency) indicates that in 20th century global population quadrupled while energy consumption increase is 30-fold (OECD/ IEA, 2011). Given that, it is the national interest of every country to manage energy sources and the energy sector in such a way as to strive for energy self-sufficiency. The control of energy routes by colonial powers, and politically and economically powerful states or alliances in the post-colonial era, generated many war conflicts, political and economic instability in states and regions rich in natural resources and energy sources (Sjekloca, 2018).The energy sector complexity is beyond connection with all society aspects due to different interests (other resource users, producer, consumer, price, electricity trader, environmental impact, ownership relations, lobbyists, and others). Shift to RES is increasing exponentially, and some issues and constrains not clarified properly in policies. Critical minerals (lithium, germanium, titanium and others) are of the great importance for the future of the economy of European countries (Stopic, 2013). Their quantity required for energy production differ significantly with respect to RES (hydropower:6.4 kg/TW/h, biomass: 8.9 kg/TW/h, solar:81.82 kg/TW/h and wind: 529.88 kg/TW/h) as indicated in study by Hesthammer (2020). Indisputable advantage of hydropower over all other renewable energy sources based on the index of strategic priority (ISP) is the highest for hydropower plants, while its low value <1 for all other OIR raises the question of their renewability due to very low efficiency with huge energy consumption for their construction they fail to return the energy spent for construction and maintenance, so hydropower plants must have absolute priority in energy development strategies and hydropower enables very rational use within large energy systems (Đorđevic, 2004). The Energy Returned on Investment – EROI parameter is the highest for hydropower >100, for wind power plants it is 18, and the value for some RES is even lower than the lower limit (about 7) that ensures the sustainable use of energy sources (Dasic et al., 2022). The installed power of the sun and wind has the greatest expansion, and their variability represents a serious challenge for the management and stability of the electrical energy system ((*ibid*). Creators of national energy strategies should respect the laws of mathematics and physics during the RES projects implementation to avoid experience the "green duck of the energy transition" like California (Siljakovic, 2023a).

2. ENERGY SELF-SUFFICIENCY

In professional and scientific literature, on the international organizations (IEA, OSCE, etc) websites different definitions of terms closely related to energy self-sufficiency (energy poverty, energy security, etc) and various indicators related to energy (available reserves, hydro potential, energy consumption per capita, energy production from renewable energy sources, carbon dioxide emissions), determining the annual energy balance sheet and more are provided. The complex nature of energy sovereignty and causal links with energy poverty and security, and the importance of energy sovereignty for the transition from energy poverty to energy security is indicated in study by Laldebaev et al. (2016). Although energy security, sustainability and sovereignty occupy an important place in energy studies they are subject to different conceptualizations du to the lack of universal definitions (Thaler & Hofmann, 2022). The authors defined energy sovereignty as the country's ability to independently decide on the "hardware" (structure and supply sources) and "software" (energy sector policies, energy market and operational rules) of energy management-management and highlighted that Switzerland which, despite the connection with the EU transmission grid, refuses to sign any agreement (*ibid*). Application of the same energy transition model in the USA and the European Union (EU) is impossible from the perspective of energy security due to EU energy poverty that is documented by a high degree of energy dependence and indisputable pitfalls for energy self-sufficiency for small countries in the energy community with the EU are evident due to lack of basic resources in EU that plans significant increase of the variable RES that require constant support from stable energy sources-basic capacities (Siljakovic, 2023b).

Table 1: Risk categories for InES assessment *(Source: Matic, 2023)*

ES	InES	Colour
0-0.25	Very High Risk	
0.26-0.50	High Risk	
0.51-0.75	Moderate Risk	
0.76-1.00	Low Risk	
> 1	No risk	

To assess risk to energy self-sufficiency Matic (2023) define energy self-sufficiency (ES) as a ratio between energy production and consumption (EP/EC) at the country level and developed energy self-sufficiency risk indicator (InES).

30 energy indicators for sustainable development were proposed by the International Atomic Energy Agency (IAEA, 2005) and presented instructions and methodology for their evaluation. Almost two decades later, the number of energy coefficients and indicators is increasing, even a rough estimate of their number is not possible (Matic, 2023). Energy self-sufficiency (ES) values presented in Table 1 are applied on data base developed based on publicly available data on energy production and consumptions (https://www.eia.gov/international/rankings/world?pa=12&u=0&f=A&v=none&y=01%2F01%2F2021.). The developed indicator (InES) allows the risk assessment of energy self-sufficiency (ES) and countries classifying within the risk categories. The summary results are presented in subsequent chapter.

3. RISK INDICATOR (InES) SUMMARY RESULTS AND SCENARIO DEVELOPMENT FOR DRINA RIVER BASIN COUNTRIES

At the Global level energy self-efficiency risk assessment for year 2018 is applied for 217 countries and territories. Only 46 (21%) are risk-free and 99 (46%) have an very high risk for energy self-sufficiency, even in states that are in the first 15 countries by gross domestic product (GDP 2024) (https://globalpeoservices.com/top-15-countries-by-gdp-in-2024/) and very high human development index (HDI>0.8) (https://hdr.undp.org/data-center/human-development-index#/indicies/HDI) of the UN development agency (Japan, South Korea, Italy). Figure 1 presents comparison of InES results for 2014 and 2018 year within the Europe (countries that span across two continents, namely Russia and Turkey are not included in analyses).

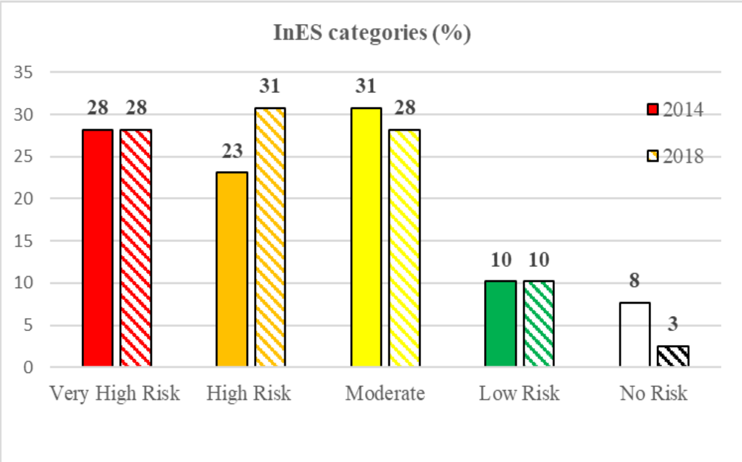

Figure 1: Energy self-sufficiency risk assessment for the Europe

Only Norway is not at risk for energy self-sufficiency with production almost 5 fold higher than consumption. The InES results indicate that 11 (28%) countries have very high risk for energy self-sufficiency (Italy, Spain, Moldova, Estonia, Latvia and others). Percentage of countries with high risk is 23% and 31, for 2014 and 2018 is 31%). Moderate risk countries percentage decreased while low risk remain the same (10%) in Romania, Denmark, Iceland and Albania. The reason for the difference in values and risk categories for 2014 and 2018 is the transition of the Netherlands and Slovenia from a moderate to a high risk category, Austria, which was without risk in 2014, has a high risk in 2018, and Serbia from the no risk category in 2014 is country with moderate risk in 2018.

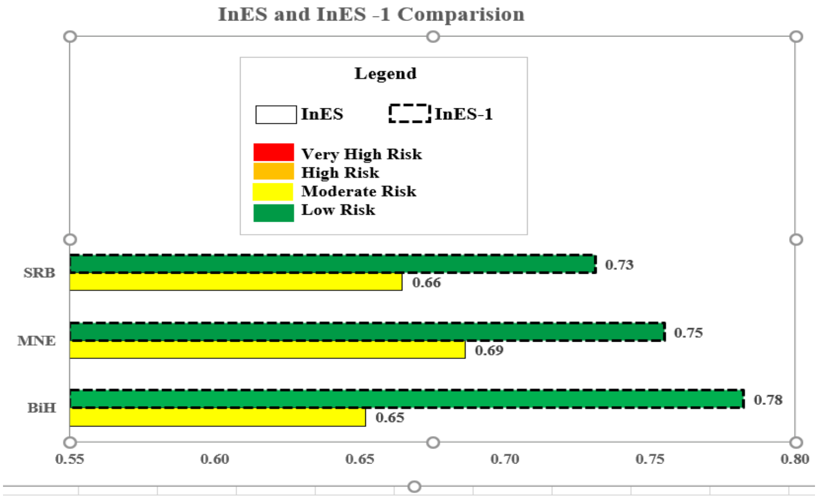

Figure 2: Comparison of InES for 2018 and InES -1 for increased hydropower utilization by 10%

The Drina River Basin (almost 20,000 square kilometres) is an international basin shared by Bosnia and Herzegovina (37%), Montenegro (31.5%), Serbia (30.5%), while Albania share is approximately 1%. Due to its natural characteristics (average rainfall of 1100 mm, a large number of canyons and gorges, a developed hydrographic network) has tremendous hydro potential (Matic and Simic, 2016). It is characteristic of all three countries with more than 30% share of river basin, that they have a large hydro potential, which for Montenegro is about 5000 GW/h per year (Milentijevic, Divac and Milovanovic, 2002), 5.6 and 6.1 TW/h (Sekulic, 2019), while for Serbia it is about 17,700 GW /h (Water management strategy on the territory of the Republic of Serbia (SUVRS) until 2034, "Official Gazette of RS", No. 3/2017). Based on the results of the Hydropower-europe project (www.hydropower-europe.eu) Montenegro and Bosnia and Herzegovina have over 50% of the total unused hydro potential, while for the Republic of Serbia it amounts to about 40%, the accuracy of the data should be taken with a grain of salt. According to Principles on Sustainable Hydropower Development in the Danube Basin the requirements for the production and use of RES represent an important step in strengthening energy security, and hydropower represents an important component of the development of the Danube and the implementation should be at the national level with the exchange of experiences in terms of technical provisions and administrative processes (ICPDR, 2013). Due to transition to RES, the possibilities of reducing the risk to energy self-sufficiency in Bosnia and Herzegovina, Montenegro and Serbia) by increased (10%) hydropower utilization is assessed, since it is the only real IOE that enables stable energy supply, with the lowest participation of critical minerals in electricity production and has a very high value of the EROI parameter compared to IOEs that are in linear expansion (sun and wind) given the current level of technical-technological development. The significant hydropotential of Bosnia and Herzegovina, Montenegro and Serbia, which cooperate by participating in the work of international basin management commissions (Danube, Sava) and have almost identical area within the Drina River Basin, qualified them for assessment of the selected scenario (increase in hydropower utilization by 10%) on energy self-sufficiency risk.

Positive impact on energy self-sufficiency in Bosnia and Herzegovina, Montenegro and Serbia due to an increase in hydro potential utilization by 10% are depicted in Figure 2. With respect to InES and InES -1 this scenario improved energy self -efficiency and all three countries are within low risk category (InES-1> 0.75).

4. CONCLUSIONS AND RECOMENDATIONS

Water and energy are intertwined with all other segments of society, due to their impact on the society stability, and it is necessary to manage them wisely based on appropriate social, economic and administrative framework blended with professional staff characterized by high personal and professional integrity. A good example is Switzerland, which, despite successful and intensive cooperation in the energy sector with EU members is not the signatory of any legally binding document that would threaten its energy sovereignty. Opposite examples of binding documents quick signature and acceptance of the other countries interests are the most visible throughout Africa, especially in states that are abundant with natural resources. The analysis of the InES results identified a significant number of countries (some of which are in) that have high energy self-sufficiency risk, and some of them are the developed countries with high HDI. If the principles of the energy transition are not changed, it is unlikely that countries with extremely high and high risk can reach energy self-sufficiency, regardless of the installed unstable RES capacities. The analysis InES with a 10% increase in water power utilization shows a positive impact on energy self-sufficiency for evaluated Drina River basin countries, while the risk remains high for Italy, France and Germany. In the case of Bosnia and Herzegovina, Montenegro and Serbia, additional advantage for increase in hydropower utilization within public energy companies is the decades-long tradition and highly skilled staff in water management and energy sector based on numerous successfully implemented projects not only at the regional level but also around the world. The next phase of research will introduce additional factors in InES to allow more detailed energy self-sufficiency risk assessment.

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