sciendo

B&H Electrical Engineering, Volume 19, Issue 1, 2025:13-19
ISSN:2566-3143, eISSN:2566-3151, DOI: 10.2478/bhee-2025-0003

Professional paper

Submitted: November 13, 2024

Accepted: April 6, 2025

REPLACEMENT MARKET PRICE AS THE BASIS FOR THE PURCHASE OF ELECTRICITY FROM RES IN THE PROCESS OF CONDUCTING FIP AUCTIONS

Eldar Hukić[1,3], Almir Tuhčić[2]

Abstract: In the past year, a set of energy laws was adopted in the Federation of Bosnia and Herzegovina (FB&H), namely the Law on Energy and Regulation of Energy Activities in the FB&H, the Law on Electricity in the FB&H and the Law on the Use of Renewable Energy Sources and Efficient Cogeneration. The new set of energy laws also defines a new method of incitement, which is provided for large plants for the production of electricity from RES and efficient cogeneration through the auction system. In this sense, in addition to the establishment of the auction system, the correct calculation of the replacement market price is also very important. During the writing of this paper, an analysis of the surrounding organized electricity markets was performed, and a methodology was proposed that would, in the best sense, give a correct calculation of the replacement market price. In this regard, the replacement market price would at the same time mirror the actual electricity trade in the Federation of Bosnia and Herzegovina for a period of one month, and would also take into account the price movement on the surrounding organized electricity markets.

Keywords: Auctions for RES&EC, organized electricity market, replacement market price

INTRODUCTION

Current status

At this moment, Bosnia and Herzegovina (B&H) has decided to gradually abandon the existing energy sources, which are dominantly based on fossil fuels, and invest significantly in renewable energy sources (RES). RES in Bosnia and Herzegovina are increasingly represented in the total production of both electricity and thermal energy. By signing the Treaty on the Establishment of the EC, Bosnia and Herzegovina undertook to carry out reform processes that will adopt the EU regulatory framework for the energy sector. In the past period, by implementing a series of reform laws, B&H has successfully applied the basic principles of security of supply, competitiveness and sustainability. In the following period, the introduction of a wholesale market for electricity is foreseen, along with the amendment of the legislation. Bearing in mind the above, B&H, i.e. the Federation of Bosnia and Herzegovina (FB&H), has adopted legal and by-laws which define the implementation of a market-based system of incentives for renewable energy sources and efficient cogeneration (RES&EC) in accordance with EU regulations, with the aim of market integration RES.

In the past period in FB&H, the incentive system was based on "feed-in tariff" ("feed-in tariff" - FIT) schemes. FIT incentive schemes provided privileged producers with priority and guaranteed purchase at technologically specific tariffs (so-called "guaranteed prices") for the entire production over a period of 12 years. The amounts of electricity were limited by annual quotas for a certain type of technology.

Development of incentive system, reasons and goals

The previous system of incentives for RES was simply too expensive, and it was not sustainable considering the relatively low electricity prices in B&H and the surrounding area. On the other hand, Bosnia and Herzegovina is committed to continuing with incentives for RES with the aim of reaching a point in the near future when incentives will no longer be needed. This means that future RES incentive systems will be cost-effective and competitive to guarantee that reductions in technical costs will also lead to reductions in incentive costs.

An additional incentive for the introduction of a new legal framework is the announcement of the introduction of the EU ETS, or a similar and appropriate system of taxation of carbon dioxide emissions. In addition to the above, in accordance with the temporary agreement, along with the preparation for the introduction of the EU ETS or a similar carbon dioxide emission taxation system, B&H expects the introduction of the CBAM (Carbon Border Adjustment Mechanism) [3]. The introduction of CBAM will additionally

[1] Regulatory Commission for Energy in FB&H, Bosnia and Herzegovina
[2] PE Elektroprivreda B&H JSC Sarajevo, Bosnia and Herzegovina
[3] Correspondence email: e.hukic@ferk.ba

encourage the production and use of energy, and above all electricity, from renewable sources, with the aim of maintaining the competitiveness of products from Bosnia and Herzegovina on the EU market. The increased demand for electricity from renewable sources will only be able to be met by the construction of larger production facilities, which, on the other hand, will only be possible to build if certain preconditions are created. One of the prerequisites is conducting auctions for the production of electricity from renewable energy sources and efficient cogeneration (RES&EC).

The reform of the legal framework aims to reduce incentive costs and facilitate the development of projects in the liberalized environment of the electricity sector. EU regulations classify all plants for the production of electricity from a renewable source, with an installed capacity of more than 500 kW, as large. In this regard, the reform of the incentives system foresees different ways of incentives for large and small plants.

For small plants, the "feed-in tariff" (FIT) was retained as an incentive system. Accordingly, it is planned to hold FIT auctions. FIT auctions represent a bidding process in which the winner(s) are awarded the right to sell the produced electricity (MWh) at guaranteed purchase prices. In this sense, electricity (MWh) is a product that is the subject of an offer. Guaranteed purchase prices are determined regularly at intervals (most often once a year). Quotas are determined in a transparent manner for each renewable electricity generation technology.

For large plants, a "feed-in premium" ("feed-in premium" - FIP) was introduced as an incentive system. Feed-in premiums (FIP), instead of ensuring a fixed price for electricity produced from a renewable source, provide incentives in the form of a fixed premium per MWh of electricity produced. Regardless of the demand or production in the system, the investor-owners of the generation facilities should sell the produced electricity on the wholesale market, which would then be given an incentive in the form of a fixed premium. It should be emphasized that the introduction of upper and lower limits on the total income is also foreseen, as an element of insurance for both investors and the auction organizer. Of course, the important thing is that before the introduction of the wholesale electricity market, that is, the organized day-ahead electricity market, the use of a substitute market price that will imitate efficient pricing on the market is foreseen.

1. FIP AUCTIONS

1.1. FIP auction in the Federation of Bosnia and Herzegovina

Therefore, the new incentive system in FBiH is based on competitive tenders where the project owner (project of a plant for the production of electricity from renewable sources) must prove its competitive advantage over other projects in order to win financial support in the form of a fixed premium. The envisaged auction system is regulated by the following legal and by-laws:

- Law on the use of renewable energy sources and efficient cogeneration,
- Rulebook on auctions (draft).

It is necessary to emphasize several key definitions that are listed in the Law on the Use of Renewable Energy Sources and Efficient Cogeneration:

- The auction is a non-discriminatory competitive bidding process, which foresees the participation of a sufficient number of bidders, for the subject of the auction.
- Auction for large plants - FIP Auction is a bidding process, by which the winner/winners are awarded an incentive in the form of a fixed premium per delivered MWh of electricity from RES and EC from large plants.
- The fixed premium is the amount of money awarded to the winner/winners of FIP auctions per MWh of electricity produced, which is added to the price realized on the organized day-ahead electricity market.
- The volume of the auction means the maximum amount of electricity from renewable energy sources expressed in GWh, which will be incentivized through fixed premiums through the implementation of auctions.
- The upper limit of income represents the maximum income of the plant above which no fixed premium is paid.
- The lower income limit represents the minimum income that allows covering the costs of the plant without making a profit.
- Replacement market price means the price at which a privileged producer of electricity from OIE&EC who has exercised the right from Article 29, paragraph (1) point b), sells electricity to the Operator for OIE&EC until the establishment of an organized day-ahead electricity market.

The aforementioned definitions clearly determine the auction process in such a way that auction participants (project holders of electricity production facilities from renewable sources) offer fixed premiums that will be added to the price realized on the organized electricity market for a day in advance. The winner(s) of the auction are those auction participants who, in addition to meeting all the necessary conditions specified in the public invitation, offer the lowest amount of the fixed premium. Additional insurance, which is intended primarily as insurance for investors, but also for the auction organizer, is the introduction of the terms lower- and upper-income limits. By defining the lower limit of income, the investor is ensured that in the contract period, regardless of the

B&H Electrical Engineering, Volume 19, Issue 1, 2025:13-19
ISSN:2566-3143, eISSN:2566-3151, DOI: 10.2478/bhee-2025-0003

movement of electricity prices on the market, he has at least a minimum income that allows covering the costs of construction, management and maintenance of the plant without making a profit. By defining the upper income limit, the auction organizer ensures that, regardless of the movement of electricity prices on the market, the cost of the auction process does not exceed the previously planned and defined threshold [2].

1.2. Application of replacement market price

As described in the previous part, the replacement market price will be applied until the establishment of a wholesale electricity market, that is, an organized day-ahead electricity market. It is important to emphasize that it is intended that the replacement market price is determined on a monthly basis [1].

Bearing in mind the above, and considering the data available to the Regulatory Commission for Energy in FB&H - FERK, it was decided that the replacement market price of electricity is defined as the average realized price of electricity trade in the Federation of Bosnia and Herzegovina in the period of the previous month. The basis for determining the replacement market price will be the data that license holders are required to submit to FERK in accordance with the Reporting Rulebook.

Figure 1. shows the movement of the realized average price of electricity trade in the Federation of Bosnia and Herzegovina, on a monthly basis, for the period from the 5th month of 2023 to the 4th month of 2024 [4].

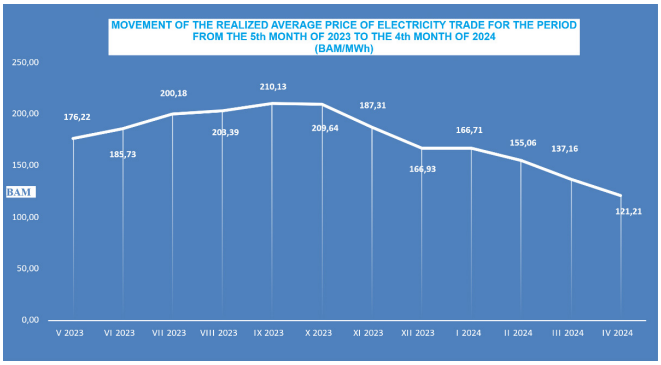

Figure 1: Movement of the realized average price of electricity trade

It is clear from the above that the replacement market price will have a constant value for all hours of every day in the month in question. The foreseen method of determining the replacement market price can hardly really imitate the actual movement of electricity prices on the market.

2. ELECTRICITY MARKET

2.1. Electricity market in Bosnia and Herzegovina and neighboring countries

Despite all its specificities, electricity is still a commodity like many others. In general, and simplified, it can be said that the electricity market is the place where the supply and demand for electricity takes place. However, in order for the electricity market to be functional, it is necessary to ensure several essential elements:

- Sufficient number of bidders and buyers;
- Timely response of supply and demand to the price;
- Liquidity;
- Efficiency.

The electricity market is efficient if the cheapest producers produce electricity that is consumed by those who are most willing to pay for it, and if a sufficient amount of electricity is produced at the same time. Markets in the electric power system can be classified into two dominant forms of electricity trading:

- Bilateral trading or OTC market ("Over the Counter");
- Organized day-ahead and intraday trading (stock market).

Bilateral electricity trading or OTC market is represented in Bosnia and Herzegovina. For a long time, they have been working on the establishment of a wholesale electricity market, that is, an organized day-ahead electricity market. The lack of it represents a significant deficiency and an obstacle for the development of renewable energy sources and the energy transition in general.

The Croatian Electricity Exchange Ltd. operates in the Republic of Croatia. (CROPEX). CROPEX is organized as a central electricity trading point where electricity is offered and purchased in a transparent, liberalized and competitive manner for the benefit of all market participants. CROPEX was founded in May 2014 by the co-owners of Croatian transmission system operator d.o.o. (HOPS) and the Croatian energy market operator Ltd. (HROTE). CROPEX enables its members to buy or sell electricity in a clear, anonymous and maximally safe way, considering that CROPEX assumes the trading risk as the central contractual party between the seller and the buyer of electricity.

In the Republic of Serbia SEEPEX JSC Belgrade (SEEPEX) is a licensed operator of the electricity market and was formed as a joint stock company in the form of a strategic partnership between the Electric Grid of Serbia (EMS) and EPEX SPOT, the European electricity exchange. SEEPEX is the first stock exchange outside the European Union in the region of Southeast Europe. SEEPEX manages the organized electricity market in Serbia with standardized electricity products and day-ahead delivery.

In Hungary, the national TSO, MAVIR, founded Hungarian Power Exchange Ltd. in 2010. (HUPX Ltd. – "HUPX d.o.o."). HUPX Ltd. is the operator of the organized Hungarian electricity spot market with a leading position in Central and Eastern Europe. Organized electricity market operated by HUPX Ltd. they are often used by companies that trade in electricity in Bosnia and Herzegovina. As such, it is most often a source of trade reference prices as well as a platform for trading exchanges. On this exchange there is a HUPX DAM market (day-ahead market) where standard hourly and block electricity products can be traded on a day-ahead basis. An intra-day market (HUPX IDM) was also established, which resulted in a significant increase in daily electricity trading volumes.

2.2. Market characteristics and electricity price movements on neighboring exchanges

Liberalization, restructuring and privatization of energy systems are processes that bring to the fore changes in the organization of economic relations, and above all in the area of electricity trade, which takes on the characteristics of a commodity. Trading and new market relations and price movements in individual electricity markets depend on many factors. First of all, electricity prices depend on supply and demand. However, equally important factors are the strong increase in the capacity of renewable energy sources, especially solar power plants and wind power plants, favorable hydrological conditions, then price movements and the state of the nuclear energy market, price movements as well as security of supply on the natural gas market are equally important, and in ultimately, the volume and character of electricity consumption.

Each of the countries in our neighborhood, for which we have provided basic data on electricity exchanges, is specific to itself.

In the Republic of Croatia, the development of renewable energy sources, especially wind power plants, prevails in the last decade. A good part of the electricity comes from NPP Krško, there are several gas-fired thermal power plants that produce electricity as needed, but large amounts of energy are also imported from neighboring countries.

Hungary gets most of its electricity from nuclear power plants. Gas thermal power plants are in second place, while solar power plants are the third largest source of energy in the country.

In the Republic of Serbia, a large part of electricity is produced from coal in thermal power plants. In addition to thermal power plants, hydropower is the second leading source of electricity production. In the last few years, the Republic of Serbia has recorded a strong increase in the production of electricity from wind farms.

2.2.1 Republic of Croatia

In the Republic of Croatia, at CROPEX in the month of May 2024, the maximum hourly values of electricity trade were recorded, for each day individually, as shown in the Figure 2. [5].

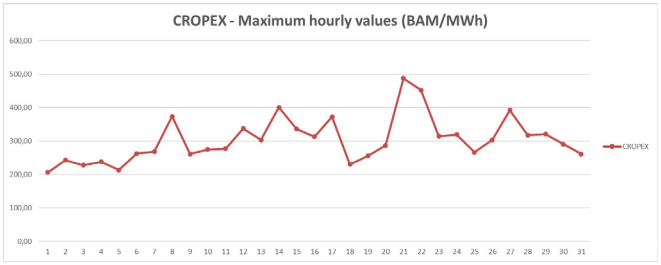

Figure 2: Maximum hourly values, for each day individually, for the month of May 2024

Likewise, Figure 3. shows the realized hourly values of electricity for the first day of the 5th month.

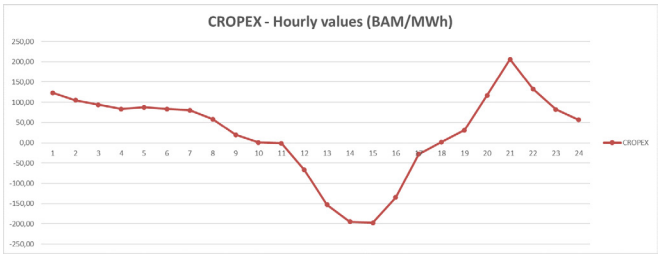

Figure 3: Realized hourly electricity values for the first day of May 2024

2.2.2 Republic of Serbia

In the Republic of Serbia, at SEEPEX in the month of May 2024, the maximum hourly values of electricity trade were recorded, for each day individually, as shown in the figure below [6].

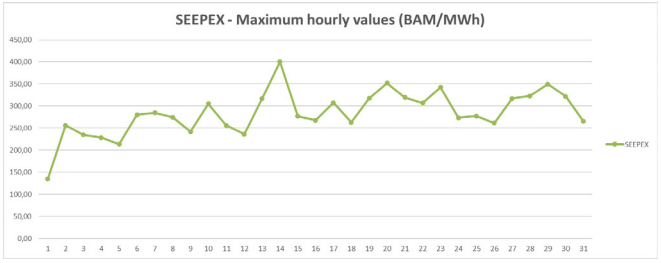

Figure 4: Maximum hourly values, for each day individually, for the month of May 2024

Likewise, Figure 5. shows the realized hourly values of electricity for the first day of the 5th month.

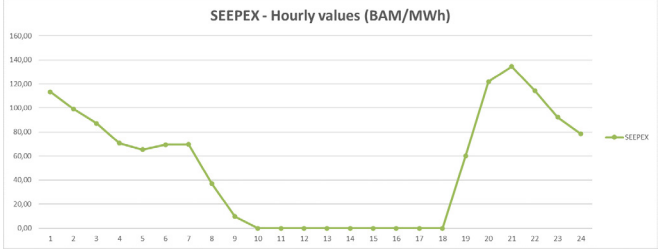

Figure 5: Realized hourly electricity values for the first day of May 2024

B&H Electrical Engineering, Volume 19, Issue 1, 2025:13-19
ISSN:2566-3143, eISSN:2566-3151, DOI: 10.2478/bhee-2025-0003

What is characteristic of the diagrams shown is that there was no electricity trade in the period from 10 am to 6 pm, i.e. SEEPEX does not have negative prices and the price value from the SEEPEX report is „0“. In the same period, the surrounding stock exchanges recorded negative values for electricity. It can be said that this is an indicator that it is an electricity market that is developing and that needs a better connection with other markets in the neighborhood.

2.2.3 Hungary

In Hungary, the maximum hourly electricity trade values were recorded on HUPX in the month of May 2024, for each day individually, as shown in the Figure 6. [7].

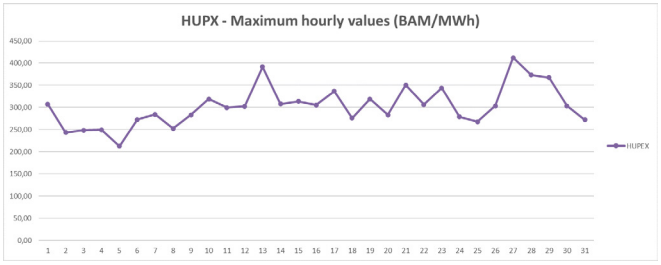

Figure 6: Maximum hourly values, for each day individually, for the May 2024

Likewise, Figure 7. shows the realized hourly values of electricity for the first day of the May.

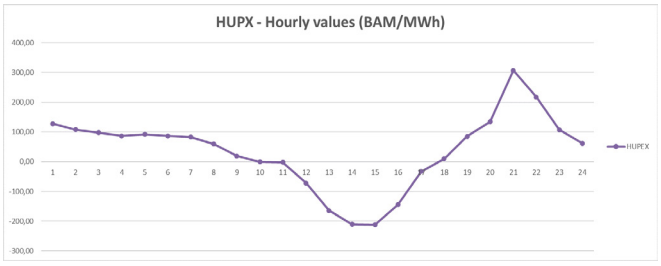

Figure 7: Realized hourly electricity values for the first day of May 2024

What is characteristic of the diagrams shown is that in the period from 11 a.m. to 6 p.m., a negative value of electricity was achieved, as was also the case at CROPEX. It can also be concluded here that this is a good indicator that it is a developed and well-connected electricity market.

3. PROPOSAL FOR THE CALCULATION OF THE REPLACEMENT MARKET PRICE

Analyzing the movement of electricity prices on neighboring markets, it can be concluded that they are very well connected and that the prices on the markets are more or less similar, and that they have the same or similar trends of growth and/or decline. The Figure 8. shows a comparison of the maximum hourly values of electricity trade, for each day individually, for three neighboring exchanges.

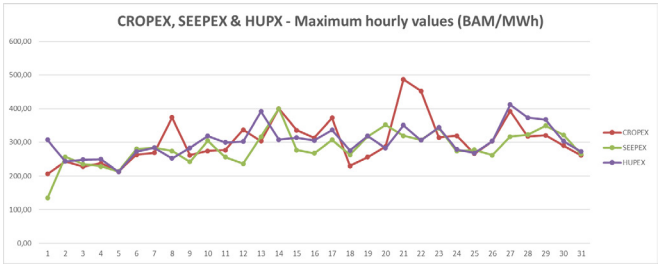

Figure 8: Comparative display of maximum hourly values, for each day individually, for the May 2024

Likewise, Figure 9. shows a comparative view of the realized hourly values of electricity for the first day of the month of May.

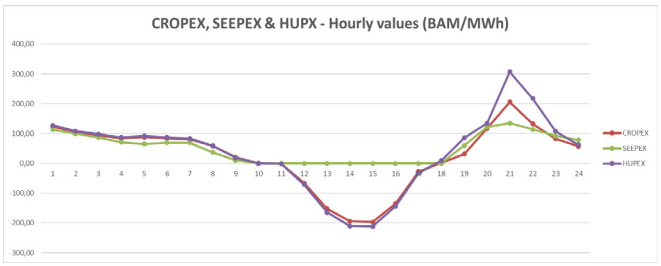

Figure 9: Comparative overview of the achieved hourly value of electricity for the first day of May 2024

It is obvious that there is a connection between price movements in neighboring electricity markets. The analysis shows that there are the same or similar price growth and/or price reduction trends. It is also known that electricity prices on the bilateral market in B&H also follow the trends on the neighboring stock exchanges. Bearing the above in mind, it is possible to claim with great accuracy that even during the establishment of the stock exchange in B&H, the price of electricity, on an hourly basis, would follow the trends of the neighboring stock exchanges. Based on this, it can be concluded that it is possible to simulate the movement of the replacement market price on an hourly basis for a given month, based on trends in the growth and/or reduction of electricity prices on neighboring exchanges, and using the realized and calculated reference trading price on a monthly basis.

3.1. Description of the methodology

If the trends of growth and/or reduction of electricity prices on neighboring exchanges are taken into consideration, then the dependence of the movement of the replacement market price for each hour on the basis of one month can be defined. It should be emphasized that the basis for calculating the hourly values of the replacement market price is actually the reference price of electricity for the month in question, which represents the average realized trade price for the month in question. The amount of the reference price of electricity is multiplied by the average trend of growth or decrease in the price of electricity on the three considered exchanges, which in fact represents the ratio of the sum of the electricity prices for the considered hour and day of the month for the three

considered exchanges and the sum of the average hourly electricity prices on monthly level for the three considered stock exchanges. For each of the neighboring stock exchanges, the weight coefficient "k" is determined, which represents the degree of influence of prices from individual stock exchanges on electricity prices in B&H, that is, FB&H. The degree of influence depends on several factors, first of all, on the amount of electricity that electricity traders from B&H, i.e. FB&H, trade on a particular stock exchange, as well as on the realized trade price. The formula for calculating the hourly value is:

$$C_{ij} = C_{ref} \frac{k_H C_{Hij} + k_S C_{Sij} + k_M C_{M\,ij}}{k_H C_{Hpros} + k_S C_{Spros} + k_M C_{Mpros}} \quad (1)$$

Where:

C_{ij} – The price of electricity on the i-th day, j-th hour;
C_{ref} – Reference price of electricity for the month in question;
k_H – Weight coefficient for CROPEX;
C_{Hij} – Price of electricity on the i-th day, j-th hour for CROPEX;
k_S – Weight coefficient for SEEPEX;
C_{Sij} – The price of electricity on the i-th day, j-th hour for SEEPEX;
k_M – Weight coefficient for HUPX;
C_{Mij} – Price of electricity on the i-th day, j-th hour for HUPX;
C_{Hpros} – Average hourly price of electricity for the considered month for CROPEX;
C_{Spros} – Average hourly price of electricity for the considered month for SEEPEX;
C_{Mpros} – Average hourly price of electricity for the considered month for HUPX;

3.2. Graphic representation

For a better understanding of the model itself, it is actually necessary to compare the movement of the calculated hourly price with the values of hourly prices realized on neighboring exchanges. During the calculation, the value of 1 was adopted for the coefficient "k". Figure 10. shows a comparative representation of the maximum hourly values of the substitute market price and the prices on the neighboring stock exchanges, for each day individually, for the month of May 2024.

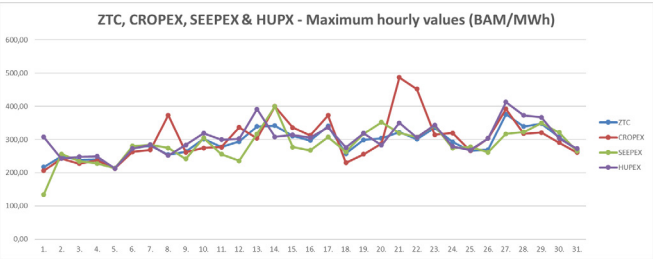

Figure 10: Comparative display of maximum hourly values, for each day, for the May 2024

Likewise, Figure 11. shows a comparison of the achieved hourly values of the substitute market price and the prices on the neighboring electricity exchanges for the first day of May.

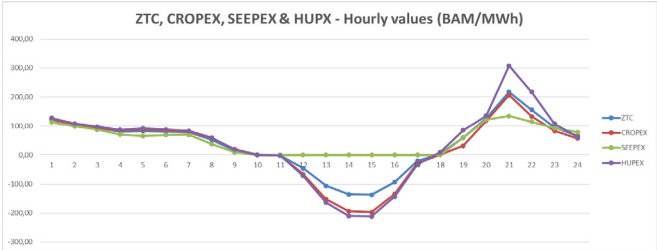

Figure 11: Comparative presentation of the realized hourly value of electricity for the first day of the May 2024

3.3. Weight coefficient "k"

As mentioned earlier the weight coefficient "k" represents the degree of influence of prices from individual neighboring stock exchanges. The degree of influence depends mainly on the amount of traded electricity as well as on the realized trading price. For the calculation of the weight coefficient "k" it is necessary that the electricity traders have the obligation to submit summary data on the completed transactions on the neighboring stock exchanges. This obligation does not currently exist, and this requires a change in the legal and by-law regulations.

4. CONCLUSION

The new legal framework and the new incentive system, for the purpose of implementing the auction system, require a correct calculation of the replacement market price. The proposed methodology in a simple and fast way offers a solution to overcome the problem of not establishing a wholesale electricity market, that is, an organized day-ahead electricity market. The legally provided solution has several significant drawbacks, of which it should be noted that the reference price has a constant value during one month and practically cannot have a negative value. It is precisely for this reason that a model was created that can alleviate the shortcomings to a certain extent. The model predicts the calculation of the replacement market price based on the reference monthly price and the trend of the electricity trade price on three neighboring exchanges (CROPEX, SEEPEX, HUPX). In this way, greater cost efficiency can be ensured, that is, maximum production of electricity from renewable sources with minimal costs. Of course, for the implementation of such a model, it is necessary to ensure legal and sub-legal assumptions.

REFERENCES

[1] Law on the use of renewable energy sources and efficient cogeneration ("Official Gazette of the Federation of Bosnia and Herzegovina", number 82/23).
[2] Rulebook on auctions (draft).

B&H Electrical Engineering, Volume 19, Issue 1, 2025:13-19
ISSN:2566-3143, eISSN:2566-3151, DOI: 10.2478/bhee-2025-0003

[3] REGULATION (EU) 2023/956 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 10 May 2023, Establishing a carbon border adjustment mechanism.
[4] Report on the weighted average price of electricity, FERK, https://ferk.ba/
[5] Croatian electricity exchange Ltd. (CROPEX), https://www.cropex.hr
[6] SEEPEX JSC Belgrade (SEEPEX), https://seepex-spot.rs/
[7] Hungarian Power Exchange Ltd. (HUPX), https://hupx.hu/

BIOGRAPHY

Eldar Hukić, received his B.Sc. and M.Sc. degrees in Electrical Engineering from the Faculty of Electrical Engineering, University of Tuzla in 2004 and 2010, respectively. He is currently pursuing a Ph.D. degree in Electrical Engineering at the Faculty of Electrical Engineering, University of Ljubljana. His research interests include RES integration, flexibility services and smart grids.

Almir Tuhčić, received his received his B.Sc. degree in Electrical Engineering from the Faculty of Electrical Engineering, University of Tuzla. He is currently pursuing a M.Sc. degree in Electrical Engineering at the Faculty of Electrical Engineering, University of Sarajevo. His research interests are: power system analysis, RES integration and power quality.