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Energy purchase schemes of railway carriers in times of crisis on global energy and fuel markets

Abstract: The paper outlines energy purchase schemes for railway carriers, in a particularly difficult situation on the energy and fuel market. The National Power System was described and the dependence of forward prices of electricity on the prices of energy raw materials, i.e. natural gas, coal, CO2 emission allowances. An analysis of the impact of the geopolitical situation on the energy and fuel markets was also undertaken. It was also explained how electricity contracting schemes operate on the basis of the Energy Law.

Keywords: Energy prices; Railway

Introduction

Rail transport is a key element in the European strategy for sustainable and smart mobility. It also remains a sector of strategic importance to the economic bloodstream, as demonstrated powerfully by Russia's aggression against Ukraine. Although the conflict is military in nature, its effects are most strongly felt in the economic sphere. It was precisely Russia's military intervention in Ukraine that contributed to the global crisis and the rise in energy and fuel prices.

Electricity expenses account for nearly 15% of all costs incurred by railway operators and are usually the second largest item after salaries—often exceeding expenditures on access to railway infrastructure. For years, operators' representatives have been expressing objections regarding the level of these expenses. This publication analyzes the energy purchasing models of railway operators who, through no fault of their own, find themselves in a particularly difficult market situation. It is worth noting that the issue of energy prices does not affect all operators equally. Some currently have secured energy supplies under long-term contracts, thus paying pre-increase prices. Others, however, have had to contract energy purchases while factoring in price increases of several hundred percent. Discussing purchasing models may prove useful for operators who will soon be contracting energy for subsequent periods, as well as for those who have so far relied on a single model, thereby prompting a search for alternatives.

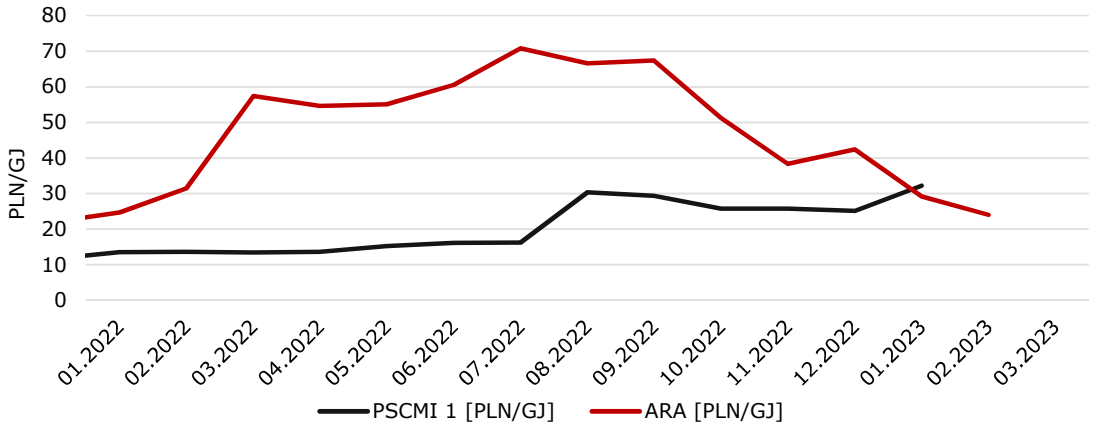
Characteristics of the National Power System

The generation sources connected to the National Power System (KSE) are primarily coal-fired thermal power plants (both hard coal and lignite), with a total installed capacity of about 31 GW. Renewable energy sources have an installed capacity of 19 GW. However, they produce on average only around 13% of the total generated energy, and their output depends on atmospheric conditions (wind, sun). Therefore, these sources do not serve as the primary means of meeting demand but rather supplement it. They do, however, positively influence electricity prices and emissions levels. Meanwhile, gas-fired power plants have an installed capacity of 3.3 GW, accounting for around 10% of total electricity production. The remaining portion of energy production comes from biomass and biogas plants, as well as other generating units, including pumped-storage power stations.

Forward electricity prices depend significantly on the prices of energy commodities such as natural gas, thermal coal, CO_2 emission allowances, and the geopolitical situation.

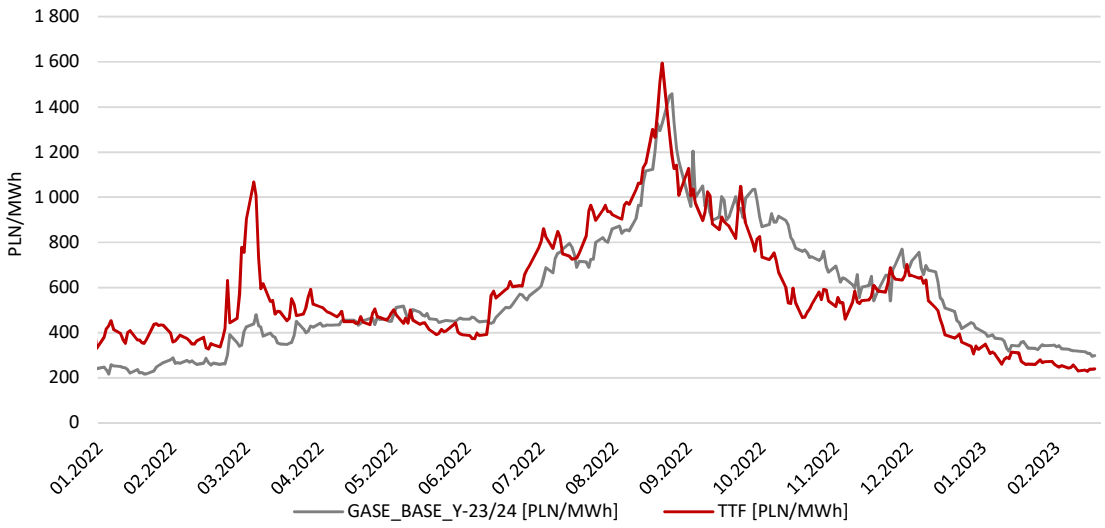
SPOT prices, on the other hand, are strongly dependent on the availability of generating sources on a given day, including renewables.

As for fuels, in the case of thermal coal, a significant amount is sourced domestically. This resulted in only slight price increases for this raw material after the outbreak of the war in Ukraine (unlike ARA coal). Figure **1** presents the relationship between these two indices.



1. Relationships between the Two PSCMI and ARA Indices

In the case of natural gas, there is a significant correlation between domestic quotations (TGE) and global indices (e.g., TTF). This is due to roughly 25% of domestic demand being met by domestic sources. The remaining portion is imported—until recently, mainly from the East. Figure **2** shows the correlation between the aforementioned indices (TTF and BASE_Y-23/24 TGE).



2. Correlation of TTF and BASE_Y-23/24 TGE Indices
Source: Audytel

In the merit-order model operating on the SPOT market, the energy price is determined by the most expensive source that fills the balance of the National Power System (KSE) at any given moment. The availability of generation from renewable energy sources (RES) also plays a role in shaping the SPOT price, as it allows for reduced production from conventional sources burdened with environmental fees. In view of the appearance of outsized margins at some

generation companies, a series of regulations were introduced—intended, under the adopted assumptions, to stabilize energy trading prices for consumers.

The Act of October 27, 2022, on extraordinary measures aimed at limiting the amount of electricity prices and supporting certain consumers in 2023 obliges energy companies to make contributions to the Price Difference Payment Fund (Fundusz Wypłaty Różnicy Ceny). The amount of this contribution is determined by the difference between the stock exchange price of electricity and the generation costs associated with purchasing fuel and CO_2 emission allowances, plus a 3% margin. According to its creators' intentions, the Fund covers losses incurred by electricity sellers resulting from the obligation to sell energy to consumers at administratively set prices.

The above-mentioned changes in how the energy market functions, along with global conditions, have a significant impact on the behavior of entities operating on the market. New assumptions in this regard have been introduced within the framework of how electricity is contracted. Faced with market changes and prevailing uncertainty, these assumptions are leading to increasingly sophisticated risk management techniques (e.g., allocating contract risks between the seller and the buyer). This also affects the specific market of railway operators, both for traction energy and non-traction energy. The following sections of this paper discuss the evolution of traction energy purchasing models that has taken place recently.

Evolution of electricity contracting models

Currently applicable Energy Law provides for two schemes of electricity contracting:

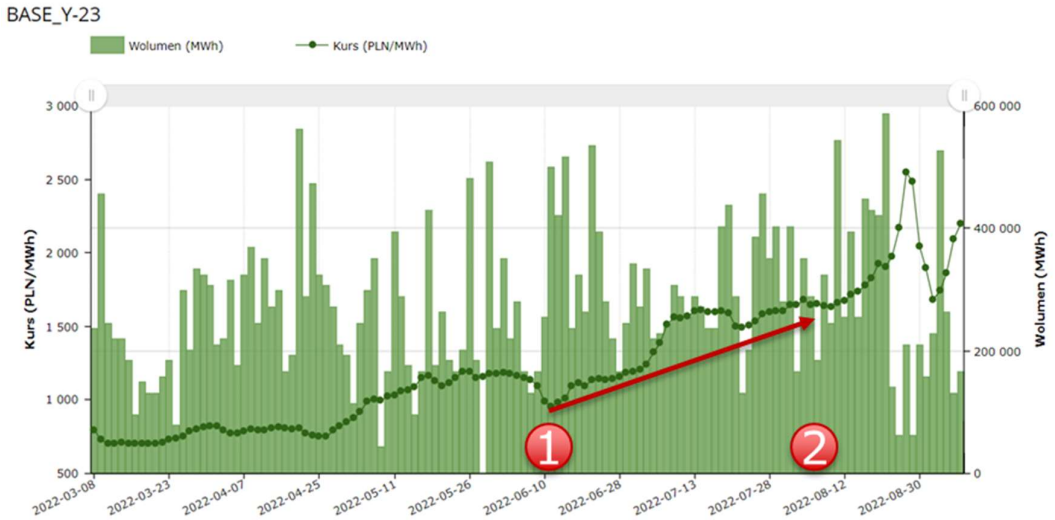
- a comprehensive agreement,
- separate energy sales and distribution service agreements.

The principle of TPA (Third Party Access) makes it possible to conclude two separate contracts with the distributor and the energy seller. Under this model, the energy seller invoices for the cost of energy purchases, and the Distribution System Operator (DSO) invoices for distribution services. Trading companies that sell electricity to consumers connected to the distribution network are required to conclude a General Distribution Agreement with the DSO.

It should be noted that switching to the TPA model may in the future entail adjusting the metering and settlement systems to the requirements specified in the Distribution Network Operation and Maintenance Manual (Instrukcja Ruchu i Eksploatacji Sieci Dystrybucyjnych, abbreviated as "Irysa").

Constant price model

In this model, the unit total cost of energy expressed in PLN/MWh is known at the time the seller's offer is accepted and remains unchanged throughout the term of the sales agreement. Since 2022, however, this model has practically ceased to function due to the inability to estimate a fixed price for the contract term amid high price volatility on the wholesale market (particularly when offers must be binding for a long period).



3. Relationship Between Price and Volume (Fixed-Price Model); 1 – End of the offer-collection period (day on which the fixed energy price is proposed), 2 – Settlement of the proceedings; *Source: Audytel*

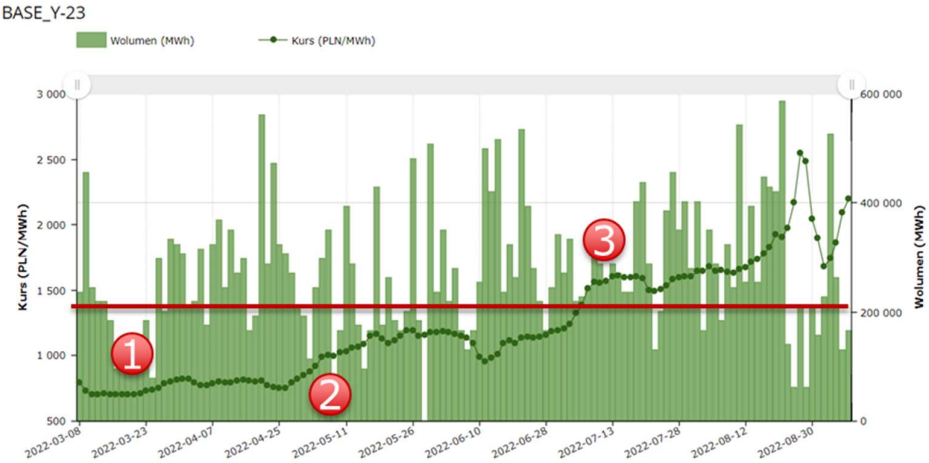
An alternative option is the direct purchase of green energy from the generator in the form of a Power Purchase Agreement (PPA), bypassing energy trading companies. An increasing number of renewable energy producers are opting for this solution, particularly those entities that cannot count on support from the auction system. Green PPAs typically have a long-term perspective (10 years or more), and the energy price is periodically indexed according to a formula agreed upon by both parties.

Concluding separate agreements for energy sales and distribution (the TPA model) may, in the future, entail the need to adapt the metering and billing systems installed in carriers' rolling stock to the requirements set forth in the Instruction for the Operation and Maintenance of the Distribution Network (*Instrukcja Ruchu i Eksploatacji Sieci Dystrybucyjnej*). This could lead to changes in the terms under which distribution services are provided, which, in the long run, may pose a barrier to developing TPA in the railway sector.

Tranche Model

In the tranche model, the energy buyer decides when to contract a specified amount of energy at prices indexed to the products listed on the Forward Electricity Market (RTPE). Buying energy under the tranche model involves indicating to the seller a portion of the volume and the price at which it will be contracted.

The energy sales agreement sets out how to calculate the price of energy for a given period based on forward instrument quotations. Because energy purchases are spread out over time, the resulting average price may be more advantageous than in a model with a fixed ("constant") price. However, this requires the buyer to continuously monitor the energy market and make business decisions based on that monitoring—decisions inherently subject to standard price risk. The sales agreement also defines other costs associated with purchasing energy, such as the cost of acquiring property rights, excise duty, and all other necessary expenditures. In particular, balancing costs and the energy seller's margin play a key role in this regard.



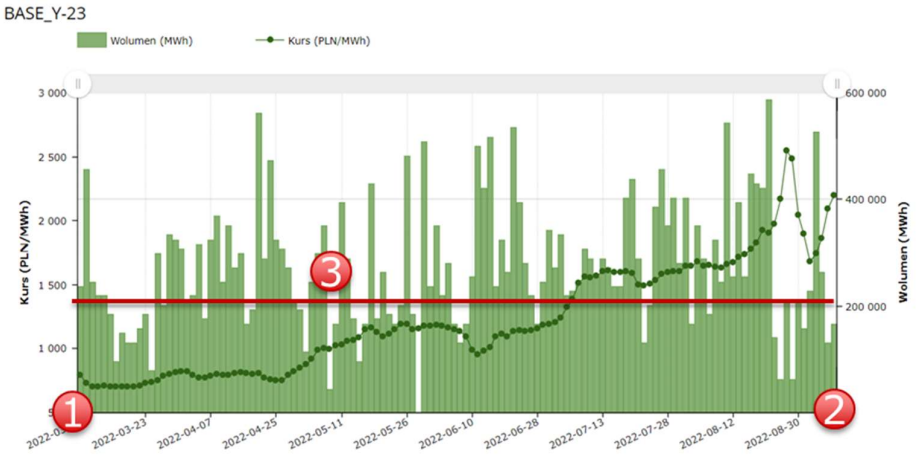
4. Relationship Between Price and Volume (Tranche Model)**;** 1 – Purchase of the first tranche, 2 – Purchase of the second tranche, 3 – Purchase of the third tranche, The energy price is determined as the volume-weighted average of the tranche prices. *Source: Audytel*

A drawback of the tranche model is that the energy traded on the forward market of the Polish Power Exchange (Towarowa Giełda Energii, TGE) practically comes solely from coal, which means its value is strongly dependent on the increasingly unpredictable prices of gas and CO_2 emission allowances.

Price-Protecting Product

In this model, the price is calculated automatically as the volume-weighted average price of all transactions concerning the BASE_Y product in the period from January until about mid-December. A variant of this model also exists in which prices are determined separately for each quarter.

As in the tranche model, the energy sales agreement defines the other components of the energy price, such as the cost of purchasing property rights, excise duty, and other expenses, including balancing costs and the seller's margin.

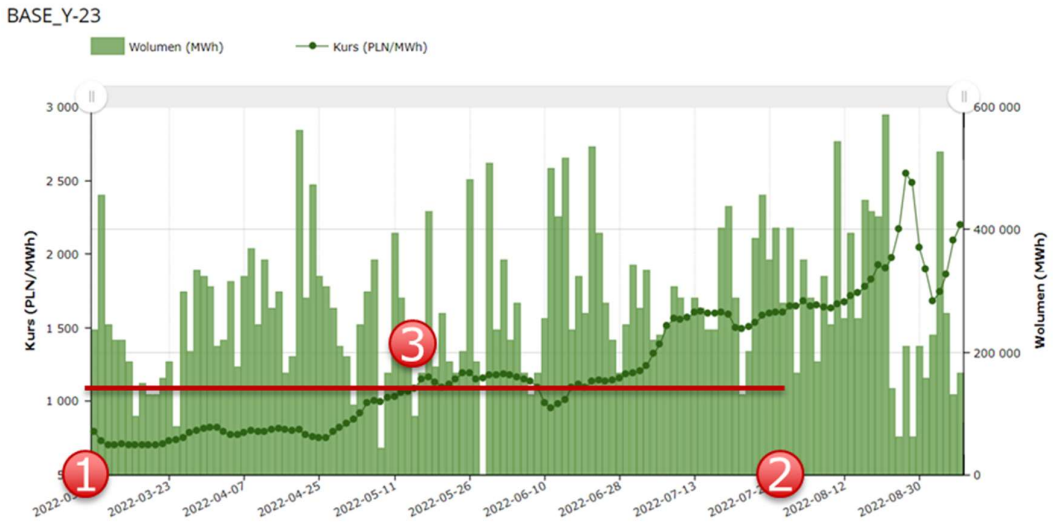


5. Relationship Between Price and Volume (Price-Protecting Product)**;** 1 – Start of the price determination period (~Jan 2), 2 – End of the price determination period (~Dec 15), 3 – The energy price is determined as the volume-weighted average of all transactions between points 1 and 2. *Source: Audytel*

Price-Protecting Product With a "Click"

In this model, the energy buyer can make one "click" on the first business day of month "M" in the period from January to December of the year preceding the start of deliveries. If the buyer decides not to "click," the energy price will be calculated as the volume-weighted average price of all transactions concerning the BASE_Y product for that year.

If a "click" is made, the price is calculated as the volume-weighted average price of all BASE_Y product transactions from January through the end of the month in which the "click" occurred (inclusive). As in the previous model, the sales agreement also specifies the other components of the energy price.

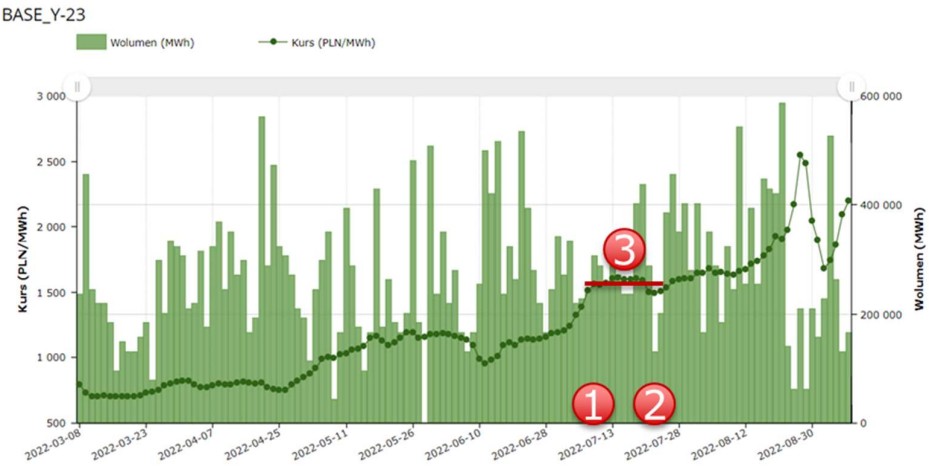


6. Relationship Between Price and Volume (Price-Protecting Product With a "Click"); 1 – Start of the price determination period (~Jan 2), 2 – End of the price determination period, determined at the buyer's discretion, 3 – The energy price is determined as the volume-weighted average of all transactions between points 1 and 2. *Source: Audytel*

Early Price Determination Variant

With a high degree of certainty, one can say that the model discussed in this section, which has been in use since roughly mid-2022, has effectively replaced the previously used model based on a fixed price.

The difference between the early price determination model and the price-protecting model lies in how the price is determined on the basis of several quotations (it also appears in a quarterly variant).



7. Relationship Between Price and Volume (Early Price Determination Variant); 1 – Start of the price determination period (offer acceptance), 2 – End of the price determination period (the fifth quotation after offer acceptance), 3 – The energy price is determined as the volume-weighted average of all transactions between points 1 and 2. *Source: Audytel*

Summary

The energy purchasing models for railway operators discussed here have gradually evolved due to recent global economic changes brought about, among other factors, by the SARS-CoV-2 pandemic and the war in Ukraine. The disruption of traditional supply chains and the raw-material "earthquake" caused by political shifts have created a lack of price stability not only for energy carriers but also for other goods and services essential to the production and transmission of energy and gas. It should be remembered that a significant increase in the price of energy carriers triggers an essential inflationary impulse; in times of multi-criteria inflation, this can pose a substantial threat to the economic stability of countries with little diversification in their energy mix, including Poland.

Therefore, it is necessary to implement solutions that fully—rather than temporarily—regulate the issues raised in this article. The problematic areas include the following:

- Difficulties in medium- and long-term financial planning. For operators running electric rolling stock, electricity is one of the main cost drivers. Its price affects not only current economic indicators but also the cost of transport services, thereby influencing the availability of environmentally friendly passenger transportation. This is particularly important for urban and suburban railway operators who, if they use electric vehicles, do not burden the local environment.
- The need for increased energy market monitoring. Most of the energy purchasing models presented in this publication require railway operators to monitor the energy and raw-materials market on an ongoing basis. Among other things, this necessitates creating an expert staffing base capable not only of conducting real-time analyses of numerous economic parameters (including risk analysis) but also of making swift decisions on costs involving significant volumes.
- Rising energy costs (not only in the commercial domain but recently also in the area of distribution charges and rates) necessitate implementing efficiency measures. Some operators have, for several years, been undertaking various cost-saving projects (including ecodriving). However, in the near future, the importance of energy consumption efficiency is expected to grow not only in terms of daily rolling-stock operation but also in long-term investment decisions. Such is the situation in the railway sector, which, although the public sometimes forgets, is a strategically significant part of the infrastructure that defines transportation links throughout the entire country.