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ENERGY RESOURCES COST-REDUCING ACTIVITIES IN TIMBER INDUSTRY ENTERPRISES IN LATVIA

***Ivanda Adata, Inguna Jurgelane-Kaldava**
Riga Technical University, Latvia
*Corresponding author's e-mail: ivandadata@gmail.com

Abstract
The energy-intensive timber industry enterprises have a significant role in Latvia's manufacturing sector, contributing to the country's sustainable economic development. They maintain the economic well-being of residents of Latvia's rural regions and represent a substantial proportion of output value and export volume in the manufacturing sector and the state economy. Due to surging energy prices that negatively impact production costs, it is more difficult for enterprises to compete in foreign markets. The study aims to analyse energy consumption trends in timber industry enterprises in Latvia to propose activities for reducing energy costs, thus promoting the international competitiveness of timber industry enterprises. The analysis is based on data from Europe's power market Nord Pool and databases of the Official Statistics Portal of Latvia. Methods used: statistical data analysis using time series analysis and expert interviews. The research results show that a significant threat to the competitiveness of enterprises is the increasing price of electricity, which is the second most consumed energy resource, accounting for nearly 15% of the total annual energy consumption of timber industry enterprises. To address high electricity costs, enterprises have the opportunity to install solar panels. Calculations show that, at an electricity price of 0.198 EUR per kWh, investments could lead to a five-year payback period with an ROI of 7.52%. At a lower electricity price of 0.13 EUR per kWh, the payback period would extend to ten years but still provide a reasonable ROI of 5.2%.
Key words: timber industry, energy consumption, cost-reducing activities, solar panels.

Introduction

Latvia is a country rich in forests, as they cover around 3.4 million hectares or 53% of Latvia's total territory. Among European countries, only Finland (74%), Sweden (69%), Slovenia (62%), and Estonia (57%) have a larger forest area (The World Bank, 2020). The timber industry in Latvia mainly relies on the forestry and logging sector that provides high-quality resources such as pines, birches, and other tree species from local forests. Local resource usage saves on logistics costs incurred by importing from abroad and supports local forestry enterprises. Resources can be used to manufacture a wide range of sustainable products, including pallet boards, furniture, and renewable energy sources such as wood chips, briquettes, and pellets.

The global economic situation has changed rapidly, not only because of the COVID-19 pandemic, which has affected exports of various goods and services to Asia, the United States, and Europe but also due to the Russo-Ukrainian war, which has resulted in very volatile prices of energy resources and other raw materials. Surging energy prices have increased manufacturing costs, making it more difficult for enterprises to compete in foreign markets. As innovative technologies continue to emerge, enterprises must shift to sustainable energy practices, reducing reliance on fossil fuels.

The research examines energy consumption trends and investigates the impact of the price hike on the performance of timber industry enterprises in Latvia. It includes an interview with two industry experts, summary of seven energy cost-reducing activities, approximate costs for implementing each activity, and a calculation of the investments required for installing solar panels with an economic evaluation at different electricity prices. The research had three main tasks: 1) to analyse energy consumption trends in timber industry enterprises in Latvia; 2) to investigate whether the performance of timber industry enterprises in Latvia has been affected by the increase in energy resource prices; 3) to summarise different energy resources cost-reducing activities, compare their advantages and disadvantages.

Materials and Methods

It was specified that timber industry enterprises are enterprises whose type of activity corresponds to NACE 16 (manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials) and NACE 31 (manufacture of furniture) according to the statistical classification of economic activities in the European Community, Revision 2. Quantitative and qualitative research methods were used to achieve the goal and perform the tasks. To investigate the energy price hike impact on timber industry enterprises, interviews with industry experts were conducted. To identify energy resource cost-reducing activities that would promote the international competitiveness of timber industry enterprises, seven energy resources cost-reducing activities were summarized, and a calculation of the investments required for installing the solar panels with an economic evaluation at different electricity prices was done.

Results and Discussion

Timber industry enterprises in Latvia export at least 70% of their production annually. In 2020 and 2021, they contributed approximately 3.5% to the country's gross domestic product. In 2020, the export volume amounted to 1.8 billion EUR or 13.3% of the country's total exports, while in 2021, it increased to 2.5 billion EUR or 14.9% of total exports (Official Statistics Portal, 2022). One of the reasons for the rise in export volume in monetary terms is the significant increase in energy prices. Higher energy costs have prompted enterprises to increase manufacturing expenses, resulting in higher prices for final products and leading to lower demand, which negatively impacts the industry's actual export volume. Therefore, monitoring consumption trends and energy prices is essential for assessing their impact on the industry's operations.

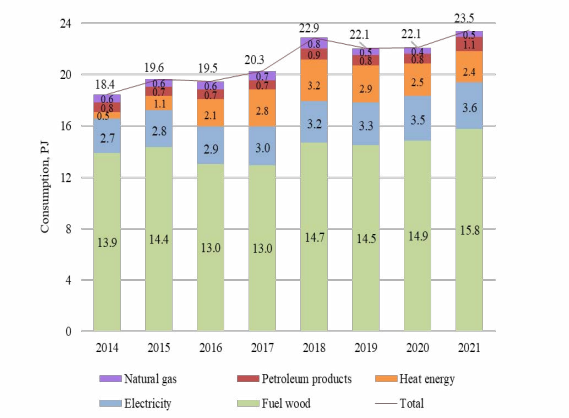

Figure 1. Energy resource consumption in timber industry enterprises in Latvia 2014.–2021., PJ.

From 2014 to 2021, the average annual growth rate of energy consumption in timber industry enterprises in Latvia was 3.5%. In 2021, the total consumption reached 23.5 petajoules (PJ) (Figure 1). The consumption of petroleum products, especially diesel fuel, was relatively insignificant, averaging only 0.8 PJ or 3.9% per year. Natural gas was consumed at an average of 0.6 PJ per year, but dynamic fluctuations in heat energy consumption were observed. In 2014, it accounted for approximately 0.5 PJ or 2.6% of the total energy consumption, but in 2018 increased to 3.2 PJ or 14.1%. Meanwhile, in 2021, the heat energy consumption decreased to 2.4 PJ, leading to a reduced share of the total energy resource consumption of 10.4%. While renewable energy resources, mainly fuel wood, accounted for the largest share of energy consumption, with an average of 14.27 PJ or 68% per year, the second most consumed energy resource was electricity, with an average consumption of 3.14 PJ or 14.9% of the total consumption (Official Statistics Portal, 2022). Despite the dominance of renewable energy resources, electricity still accounts for a significant portion of energy consumption. The cost of this resource has become a concern in recent years. If the average electricity price on the Nord Pool exchange moderately fluctuated with seasonal ups and downs between 2014 and 2020, then in 2021, it experienced a sharp increase, reaching almost 468 EUR per megawatt-hour (MWh) by August 2022. (Nord Pool, 2022). The increasing electricity prices have had a significant impact on various industries, including the timber industry.

Timber industry generated 4.2 billion EUR in total turnover in 2021 (Official Statistics Portal, 2022). Yet over 55% of revenue was produced by only twenty-six enterprises, representing less than 1% of the industry (Lursoft, 2022). That indicates a small number of competitive enterprises, emphasizing the need for prompt solutions. To investigate the effects of the price hike on the performance of timber industry enterprises and to find out how they are tackling it, a quality specialist of pallets and pallet collars manufacturing enterprise LLC 'KRONUS' and a member of the board of furniture production enterprise LLC 'RAUKO' were interviewed.

When asked about the impact of rising energy costs on the enterprise's financial standing and exports, 'RAUKO' explained that projects are planned at least 6–12 months before the sale, with minimal scope for modifying the contracts. As a result, the increase in energy costs, particularly electricity, directly and indirectly affects manufacturing costs. Moreover, raw material suppliers and business partners include the energy price increase in their product and service costs, which 'RAUKO' currently covers from its anticipated profits. For heating, firewood is purchased, and the cheapest available transport is used for exporting goods. In contrast, 'KRONUS' reported that the main impact on its operations is not primarily due to higher energy prices but rather the shortage of timber on the market resulting from the Russo-Ukrainian war. The enterprise has taken measures to secure itself against potential cost increases. It invested in a boiler house that utilizes timber residues from manufacturing and allows to generate heat energy. In addition, an electricity contract signed in 2020 with favourable tariffs remains valid until the end of 2023, reducing concerns about rising electricity prices. 'KRONUS' has not faced any rise in fuel costs, as it relies on an outsourcing service that provides a fixed price for exporting goods.

During a discussion regarding measures aimed at saving electricity and improving energy efficiency, both implemented and planned, 'RAUKO' stated that they are shifting to LED lighting in production and office buildings. Additionally, the enterprise

is gradually replacing outdated manufacturing equipment with energy-efficient alternatives. 'RAUKO' highlighted its efforts to reorganize manufacturing areas, to prevent unnecessary electricity consumption. That includes prohibiting individual employees from working in these areas, illuminating the entire building, and using the centralized ventilation system – the largest electricity consumer. In future, 'RAUKO' intends to undertake two projects – installing solar panels and securing a stable electricity supply for production building. At the same time, 'KRONUS' has installed light sensors in areas with infrequent employee presence to save electricity and implemented an international standard for Energy Management systems ISO50001 to increase energy efficiency. That includes installing thermostats in manufacturing areas to regulate heat and attaching energy meters to each manufacturing equipment to identify the equipment that consumes the most energy and optimize its operating time. 'KRONUS' has also reviewed its manufacturing process and rearranged equipment according to the production cycle, reducing the movement of loading equipment, saving time and resources. In the future, 'KRONUS' is considering the installation of solar panels to increase the proportion of green energy and is developing a project to replace diesel forklifts with electric ones. Also, as 'KRONUS' recycles the residual wood material from manufacturing into briquettes, it plans to expand production and invest in equipment to manufacture pellets from the residuals.

Analyzing the responses, it is evident that 'KRONUS' is more committed to sustainable manufacturing practices and has timely implemented several activities to reduce energy costs. However, for 'RAUKO', the rising electricity prices have emerged as a significant threat that will reduce turnover, profit margins and the ability to compete in the global market. To reduce the impact of external factors, an enterprise must plan how to efficiently use its available resources. The following section summarizes seven cost-reducing activities for energy resources, comparing their advantages and disadvantages.

1) Employee training can play a significant role in promoting energy literacy and reducing energy consumption. By reminding employees to use artificial lighting only when necessary, turning off electrical devices when not in use, and rearranging premises for better airflow, the enterprise can reduce daily energy consumption and save money without significant financial investments. There are at least three ways to provide practical knowledge to employees on how to change their behaviour concerning energy consumption.

The first is interactive e-learning in energy efficiency prepared by JSC 'Latvenergo' trade brand Elektrum (Elektrum, 2022). The necessary resources for learning are any device with an Internet connection (smartphone/tablet/computer) and up to half an hour of the employee's time. The cost of implementing the activity is zero euros. However, considering employees working in production buildings may not have access to a device with an Internet connection during working hours; another alternative is to organize joint employee training events at least twice a year with an energy specialist providing practical recommendations for reducing energy costs. Per price list of Riga Energy Agency, an in-person consultation on energy efficiency costs 30 EUR per hour, excluding value-added tax (VAT). Price includes the specialist's preparation time for the training and the time required for providing the training (Riga City Council, 2021). Assuming the specialist requires two full working days (16 hours) to prepare for the training, and one part-time working day (6 hours) to provide the training, the total cost of the service, including VAT, would amount to 798.60 EUR per consultation, with twice-yearly consultations costing 1,597.20 EUR. Although the expenses are not high, there remains uncertainty about whether employees will implement the specialist's recommendations in their daily practices. In such a scenario, an alternative worth considering is hiring an energy manager or a quality assurance specialist.

Business managers often undertake numerous responsibilities, including energy resource management, which may not always yield successful results. Therefore, it is worth considering creating a new position by hiring an employee with relevant knowledge in energy management. The employee's duties would include regular monitoring and analysis of energy consumption data, organising measures to improve energy efficiency, controlling the performance of heating, ventilation, and air conditioning systems, developing preventive measures to reduce risks and ongoing employee training in energy management practices. According to Baltic online recruitment company cv.lv, the average gross salary of an energy manager in the private sector is 1,900 EUR, and of a quality assurance specialist – 1,700 EUR for full-time working hours. Adding social tax (employer's share of 23.59%) and business risk state fee of 0.36 EUR, the total cost of an energy manager position would be 2,348.57 EUR per month or 28,182.84 EUR per year, but the employment of a quality assurance specialist would cost 2,101.39 EUR per month or EUR 25,216.68 per year. This alternative could be the most beneficial for the enterprise, offering advantages with costs offset by expected energy savings. Although to ensure the success of an energy manager or quality assurance specialist, the enterprise must install data monitoring devices for energy consumption monitoring and provide a management system, such as a mobile app

or an online platform, for processing and analysing the obtained data.

2) Data monitoring enables management to understand where they can reduce energy consumption by optimizing the operating time of production equipment and where they need to implement more complex solutions. Typically, those responsible for paying energy bills have the most detailed knowledge of the enterprise's energy consumption. However, to identify areas for improvement and encourage employee engagement in reducing consumption, enterprises should monitor energy consumption and present the data in a simple, understandable way to all employees.

Prudently made investments in the building's engineering system can pay off in the short term. Several companies offer complex data monitoring solutions for energy management, including monitoring devices, data analysis platforms, and other services. The more expensive the subscription, the more technology and services are included. If the enterprise does not have an energy manager or quality assurance specialist, the service provider can handle data collection and analysis, reducing the enterprise's need for involvement. Yet, while subscriptions for complex data monitoring solutions are available, individual data monitoring devices can also be a cost-effective alternative. Data monitoring devices can track building temperature, air humidity, and CO2 levels. They come in stationary or portable versions, and the costs based on the online store of Scientific Technical Company 'LĀSMA' range from 160 EUR to 1,100 EUR without VAT for a stationary data logger and from 20 EUR to 1,500 EUR without VAT for a portable one. The price mainly depends on the device application possibilities. Software for recording and analysing data can be obtained free of charge or purchased, but paid software will be much more advanced, and its license costs around 350 EUR without VAT. Like the previous activity, the expenses in this case can also be covered by potential energy cost savings.

3) An energy audit provides a comprehensive evaluation of an enterprise's premises and equipment and offers an independent analysis of its energy consumption. Referring to Article 10 of the Energy Efficiency Law (Saeima, 2016), an energy audit is mandatory for all large enterprises. According to the State Construction Control Office, an energy audit for production enterprises cost from EUR 2,000 to EUR 8,500 once every four years, excluding VAT, i.e., 500 – 2,125 EUR per year (Jansone, 2022). While the costs relative to the benefits of an energy audit are not high, considering the market's dynamic demand and fluctuating production volumes influenced by ever-changing factors in the enterprise's external and internal environment, conducting an energy audit once every four years may not be enough. It raises awareness of the current situation for enterprises but offers only general recommendations to promote energy efficiency without focusing on an immediate reduction in energy resource consumption.

4) Switching to energy-efficient light bulbs is a long-term investment in a safe work environment. While it's feasible to fulfil the occupational safety requirements with fluorescent or halogen light bulbs, their shorter lifespan can make them less efficient and more expensive to maintain than LED luminaires. One fluorescent daylight tube costs approximately 30 – 60 EUR without VAT and can operate from 7,000 to 15,000 hours. The cost of a LED tube ranges from 15 EUR to 400 EUR without VAT, and its average lifespan ranges from 25,000 to 50,000 hours. The price of luminaires depends on their intended use – those required for the factory will differ from those installed in the office building. Even though the initial investment in LED luminaires may be higher, their longer lifespan and adaptability to lighting requirements make them a more sustainable and efficient choice. They can also provide better quality lighting than traditional bulbs, which leads to improved visibility, productivity, and overall comfort in a workspace. Integrating sensors or relays to adjust lighting brightness and duration can further enhance energy efficiency resulting in lower energy bills and a more sustainable environment.

5) Solar panels are not a novelty in Latvia, but they have faced limited demand due to the lack of targeted financial support. However, the significant surge in energy resource costs during the first half of 2021 has increased interest in solar panel installations among households and entrepreneurs.

Various companies in Latvia offer solar panel installation services to legal entities. To assess the installation expenses from project development to full implementation and the cost differences between roof and ground installations, six companies were contacted via email, but only one responded. A representative of LLC 'Enefit' indicated that it is necessary to consider the type of roof when installing solar panels on a building - the cost per kilowatt (kW) of solar panel power can vary significantly between a sloping roof and a flat roof ranging from 50 EUR to 250 EUR. During ground installations, additional costs for panel mounting brackets, ranging from 100 EUR to 120 EUR per kW, must be considered. The installation expenses may also fluctuate based on the number of panels used. Suppose for the annual electricity usage of 240 MWh, a 240 kW solar panel system would be necessary to achieve maximum capacity, costing around 1,100 EUR to 1,300 EUR per kW for roof installation and 900 EUR to 1,000

EUR per kW for ground installation. For an annual electricity usage of 840 MWh, an 840 kW solar panel system must be set up, which would incur an initial expense of EUR 900 to EUR 1,200 per kW for roof installation and EUR 800 to EUR 950 per kW for ground installation, meaning that the larger the solar panel system installed, the lower the cost per kW.

To determine the economic viability of solar panels, a sample of random numerical values representing the electricity consumption of a small timber enterprise was generated and the annual electricity consumption was calculated to be 271.61 MWh, assuming a change in consumption from 21 to 24 thousand kilowatt hours (kWh) within a year. The manufacturing costs of products sold by the enterprise in the previous financial year were estimated to be 1.5 million EUR. If the enterprise has a fixed yearly contract for electricity priced at 0.198 EUR per kWh, the electricity consumption would cost 53,779.18 EUR, equivalent to 3.59% of the manufacturing costs of the products sold in the last financial year.

To generate enough power to meet the total consumption, a solar panel system with a capacity of 270 kW would be required, but there are several limitations. 1) Some enterprises may face space limitations when installing solar panels. Generating 271 MWh of electricity would require at least 720 panels, each with a nominal power of 375W, occupying approximately 1,500–1,700 m^2 with proper spacing. 2) Solar panels have lower output from October to March compared to April to September. If panels were installed to meet full annual electricity consumption, there would be excess electricity production for half of the year and only partial for the other half, which would not be sufficient to meet the total consumption. 3) Solar panels generate electricity solely during daylight hours and may experience a decrease in output due to higher air temperatures.

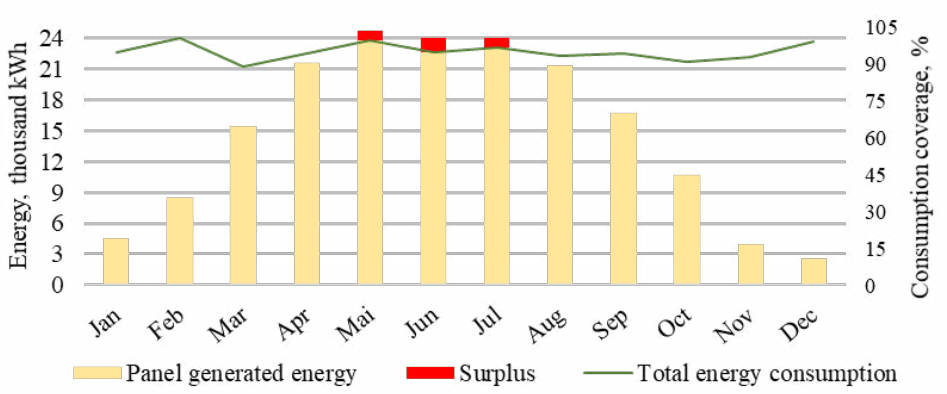

Figure 2. Monthly energy consumption and coverage by a 162kW solar panel system, kWh.

To determine the optimal panel capacity for the enterprise's peak consumption from April to September, the European Commission's Photovoltaic Geographical Information System tool was used (European Comission, 2022). By specifying the approximate location of the enterprise in the central part of Latvia, several situations were modelled with various solar panel capacities until a suitable result of a 162 kW solar panel system was obtained to cover the previously generated electricity consumption. When installed on the ground, the system would generate 178 MWh of electricity per year, covering an average of 34% of the total consumption from October to March, 74% in September, around 96% in April and August, and fully meeting the consumption from May to July, resulting in excess electricity production. If solar energy is fully consumed according to demand, the system will produce a surplus of 3,428 kWh of electricity (Figure 2). With estimated installation costs of 950 EUR per kW, the installation of a 162 kW solar panel system on the ground would amount to 153,900 EUR. Considering an electricity price of 0.198 EUR per kWh and not factoring in any surplus electricity transmitted to the grid, the investment, utilizing a discount rate of 10.04% as indicated on the State Treasury's website for forecasting future cash flow, would be fully repaid in five years with an expected return on investment (ROI) of 7.52%. Upon evaluating the variations in the payback period of a solar panel system at different electricity prices, the conclusion was that even if the electricity price were to decrease to 0.13 EUR per kWh, the investment of 153,900 EUR for a 162 kWh solar panel system would take ten years to repay under constant conditions. However, the ROI in this case would be lower – only 5.2% (Table 1). In the long term, investment in a solar panel system would reduce the proportion of electricity costs in manufacturing costs by 2.8 times.

Table 1

Payback period and return on investment (ROI) at different electricity prices

Electricity price, EUR per kWh	Payback period, years	ROI, %
0.198	5.46	7.52
0.188	5.84	2.09
0.178	6.29	8.03
0.168	6.82	1.96
0.158	7.45	5.06
0.148	8.2	6.22
0.138	9.14	5.66
0.13	10.08	5.2

One of the positions that make up at least 10% of the solar panel system total costs (based on the costs provided by 'Enefit') is the cost of metal mounting brackets. Although serving as a durable means of support, the metal structures tend to heat up and, as a result, heat the solar panels too. Thus, it leads to reduced panel efficiency and a consequent decrease in electricity production. To avoid that, wooden constructions can be used as an alternative to metal. Timber enterprises can manufacture the necessary constructions for solar panels by themselves, utilizing their available resources, manufacturing equipment, and employee knowledge. Although wood may initially appear less fire-resistant and more susceptible to environmental conditions, advancements in modern technology have significantly improved wood durability and safety. Impregnating wood can increase its resistance to fire, water, and decay, making it a durable and reliable option for various construction needs. After reviewing several wood preservatives, it was found that using a wood antiseptic can protect the wood against mould, fungi, and insects for up to 15 years when used outdoors. By performing regular protection control every two years, it is possible to extend the lifespan of wood up to 30 years. Achieving successful results, timber industry enterprises will have an opportunity to diversify their product range and start producing and selling wood constructions for solar panel systems, thus increasing their market share. Industry experts 'KRONUS' and 'RAUKO' were introduced to this alternative. Both recognized it as practical and technically feasible.

6) Wind energy is another renewable source of energy. However, wind stations are less prevalent in Latvia than solar panel systems. According to the annual wind energy report by the European Wind Energy Association 'WindEurope', Latvia had the third-lowest installed wind energy capacity in European Union in 2021, with only 66 megawatts (MW) (WindEurope, 2022). Estonia and Lithuania have much higher wind energy capacity, with 320 MW and 668 MW installed, respectively. A variety of factors contribute to Latvia's relatively low wind energy capacity. High costs for wind technologies, lack of financial support, public objections to noise and vibrations caused by wind turbines, and environmental concerns are among the most significant. As wind generators have not gained as much popularity in Latvia as solar panels, the exact costs for wind power plant construction remain uncertain. However, the approximate cost of constructing a wind power plant in Latvia is around 1.2 million EUR per megawatt of capacity, according to online information about wind parks built in Latvia and Lithuania.

While wind stations offer significant benefits in providing green energy and supporting climate neutrality goals, they have particular installation requirements. First, an environmental impact assessment must be conducted before constructing the wind station, and all potential risks associated with it must be analysed, such as noise pollution and vibrations that could affect nearby buildings and the local fauna. Additionally, wind generators require more space than solar panels, and regulations state that wind power plants with a capacity of 20 kW to 2 MW cannot be installed within 500 meters of residential and public buildings. For capacities exceeding 2 MW, the distance increases to 800 meters (Republic of Latvia Cabinet of Ministers, 2013). Despite generating sufficient renewable electricity, it remains critical to assess the overall impact of the production process on the environment and the local community. Additionally, it is important to note that turbines are inactive during calm weather, and measures must be taken to prevent overloading during strong winds, which can result in additional expenses.

7) Electrification of loading equipment has both advantages and disadvantages. In timber industry, vehicles are used not only for employees to move from one facility to another but also to move raw materials and manufactured products within the premises. The internal combustion engine forklift remains the most common vehicle in factories and warehouses. Given the European Parliament's decision to gradually prohibit internal combustion engines in cars and vans (European Parliament, 2022), transitioning loading vehicles to electric power would be beneficial as well. Replacing an internal combustion engine forklift with an electric one promotes energy efficiency, fuel cost savings, improved employee health and the overall climate by reducing emissions and noise pollution. However, the initial cost of purchasing electric forklifts

is higher than those with internal combustion engines. Summarising the loading equipment costs available online, a 2022 forklift with a gas or petrol engine costs around 18,000 EUR, a comparable model with a diesel engine is approximately 19,000 EUR, the same forklift with an electric motor has a starting price of 22,000 EUR. Besides, an enterprise must plan for the necessary charging infrastructure, which can add approximately 2,500 EUR to the electrification cost, depending on the type of charging station chosen. While charging times may require adjustments if employees work in multiple shifts, investing in the electrification of loading equipment can pay off in short time, especially when paired with solar energy. Eventually, the operating costs of an electric forklift will be lower than a forklift with an internal combustion engine.

In conclusion, timber industry enterprises can increase the proportion of renewable energy resources in their overall consumption in the future. Achieving this goal involves utilizing wood residues produced during the manufacturing process to generate heat energy and installing renewable energy technologies that enhance energy autonomy, making the manufacturing process more eco-friendly. While the primary advantage of cost-reducing activities is moving towards environmentally sustainable business practices and improving the value of the enterprise, a drawback is the high initial costs involved, which may discourage some entrepreneurs from pursuing such activities. However, businesses prioritizing renewable energy sources to reduce their dependence on fluctuating energy markets and implement cost-reducing activities into their management strategies to lower energy consumption and manufacturing costs will gain increased attractiveness to customers and partners, resulting in enhanced competitiveness.

Conclusions

1. Electricity is the second most consumed energy resource, accounting for nearly 15% of the total energy consumption of timber industry enterprises annually. Its increasing price has emerged as a significant threat that may reduce turnover, profit margins and the ability of enterprises to compete in global market.
2. The results of the expert interviews show that the energy price hike has had less impact on an enterprise whose management strategy focuses on sustainability, forecasting possible scenarios in the future, timely identification of potential risks, and implementation of risk preventive measures.
3. To address high electricity costs, enterprises have the opportunity to install solar panels. Calculations show that, at an electricity price of 0.198 EUR per kWh, investments may lead to a five-year payback period with an ROI of 7.52%. At a lower electricity price of 0.13 EUR per kWh, the payback period extends to ten years but still provides a reasonable ROI of 5.2%. In the long term, investment in a solar panel system may reduce the proportion of electricity costs in production costs by 2.8 times.
4. To reduce the costs of the solar panel system, ensure full-fledged electricity production from panels and promote the competitiveness of timber industry enterprises, it is possible to replace the steel constructions of the solar panel system with self-made constructions from wood. Achieving successful results, timber industry enterprises will have an opportunity to diversify their product range and start producing and selling wood constructions for solar panel systems, thus increasing their market share.

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