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GETTING ELECTRICITY FROM METRO TUNNELS VIA WIND TURBINES

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ABSTRACT

This article examines the technology of obtaining electricity from wind currents generated in metro tunnels. The energy potential of wind flux formed as a result of train movement is analyzed, and the possibility of creating renewable energy sources through the use of this flow is devised. The article on the installation of wind turbines in metro tunnels, their mechanism of operation and the process of converting energy into electric current is described in detail. It also covers the economic and environmental efficiency of this technology and prospects for its future development. This study can make an important contribution towards improving the energy efficiency of urban transportation infrastructure and ensuring environmental sustainability.

Keywords: Metro tunnels, wind flow, electricity, wind turbines, renewable energy, sustainable development, urban infrastructure, energy efficiency, environmental technology, innovative energy.

INTRODUCTION

In the modern world, the use of renewable energy sources is becoming increasingly important to solve global environmental challenges and meet energy demands. The complexity of the city's infrastructure and the growth of energy consumption necessitate new, innovative solutions. Metro tunnels are often one of the most energy-consuming systems, and finding ways to use them efficiently and obtain energy from them is one of the most pressing issues today. Wind currents generated by train traffic in metro tunnels have great energy potential. By using this flow, there is an opportunity to generate electricity using wind turbines. The technology not only saves energy, but also ensures environmental sustainability. This article analyzes the technical and economic aspects of energy generation by installing wind turbines in metro tunnels. The practical application of the technology, current challenges and future development areas will also be highlighted.

Analysis of literature and current technologies. Scientific research on the technology of obtaining electricity from wind flow in metro tunnels shows that it occupies a leading place among innovative ways to use renewable energy sources. Scientific articles and whitepapers in this field provide an in-depth study of the effectiveness, cost-benefits and environmental impact of the technology. Literature Review: An Experiment on Indian Metro Projects: An experiment was conducted on the use of wind currents generated by the movement of trains

in the metro system in Delhi, India. During this project, it was possible to generate enough electricity for station lighting by installing wind turbines of small size (M. Sharma, 2021). 'T-Wind' Technology of South Korea: In South Korea, an innovative technology called "T-Wind" is installed in subway tunnels. This system consists of low-noise wind turbines, maximizing the energy generation potential of the wind stream (K. Lee et al., 2022). EU Studies: A study on wind energy in the EU offers a roadmap for the development of energy savings in metro and rail infrastructure. In particular, the efficiency of receiving generators and the resilience of the turbine to wind have been studied (J. Müller, 2023). Current Technologies: Noiseless Wind Turbines: Modern wind turbines are highly efficient, specifically designed to work in enclosed environments such as subway tunnels. They use advanced materials and designs to minimize noise and vibration. Monitoring via IoT (Internet of Things): IoT technologies are used to monitor the performance of turbines in real-time. This system will allow to analyze the efficiency of turbines and determine the periodicity of maintenance. Energy Storage Systems: Modern battery systems are used to store and distribute the accumulated electricity. Optimization with Artificial Intelligence: Artificial intelligence algorithms are used to predict wind flow variability and control the turbine at maximum efficiency. Proposal: Integration of Wind and Pressure Energy Combination of Wind and Pressure Technology The movement of trains will not only change the wind flow, but also the air pressure in the tunnels. In combination with wind turbines, it is possible to double energy production by installing special units that collect pressurized energy. Special panels for energy harvesting Pressure sensitive panels can be installed on the walls and ceiling of metro tunnels. These panels serve to convert the pressure generated by passing the train into electricity. Getting Benefits of a Ventilation System Ventilation systems in a metro system create a constant flow of air. Power can be generated from this stream by means of small turbines. Converting a ventilation system into an energy source in combination with wind turbines increases efficiency. Control system based on artificial intelligence With the help of artificial intelligence, the process of wind and pressure energy harvesting can be controlled in real time. For example, by taking into account the train speed, airflow direction and pressure, optimal operation of turbines is ensured. Benefits More energy generation: The combination of wind and pressure technology increases power output. Multi-Purpose Use: The combination of different technologies allows to maximize the energy potential of the metro infrastructure. Energy backup system: The energy obtained is stored in special batteries and distributed according to need.

Muhokama. India and South Korea Experiences: Pilot projects have been implemented in India and South Korea aimed at generating energy in metro tunnels through wind turbines. These experiments have shown the interoperability and cost-effectiveness of the technology. But these projects used only wind energy and did not take into account other potential energy sources, such as pressure variations. A study in the European Union: An analysis of the use of wind turbines in metro infrastructure shows that there is a great deal of variability for the technology to extract energy from the wind stream alone to perform optimally. Energy generation depends on train speeds, passenger flow and tunnel design. Use of ventilation systems: Some projects have implemented the practice of converting the airflow from the ventilation system into electricity along with wind turbines. While this is an additional energy

source, the overall efficiency of the system remains low. Discussion of my proposal My proposal: To introduce an integrated system that combines wind energy and pressure energy. Advantages of the offer: Using two sources at once: Energy can be harvested from wind current through wind turbines, air pressure through pressure-sensitive panels. This significantly increases the amount of energy production. Synchronization with the train movement: The pressurized energy generated during the train passage will work in conjunction with the wind energy which improves the overall efficiency of the system. Sustainability in energy production: By combining different energy sources, the technology reduces the volatility in energy production. Challenges: Technical complexity: Installing pressure-sensitive panels and synchronizing them with wind turbines requires certain technological solutions. Initial Investment: The cost of an integrated system may be high, but it brings economic benefits in the long run. Maintenance: Maintaining and managing a system can be more complex because two different technologies are used. Relevance of the offer: The technologies currently available are largely based on a single source (wind current). By combining wind energy and pressure energy, the energy sources available in metro tunnels can be used to the fullest. This approach helps improve energy efficiency by expanding the possibilities of sustainable energy production. Prospects for practical implementation: Pilot a short segment of a metro tunnel as a pilot project at the first stage. Analyze production efficiency by monitoring the system in real time through IoT technologies. Cost-effectiveness assessment of energy harvesting and distribution.

CONCLUSION

The technology of obtaining electricity from the wind currents generated in metro tunnels plays an important role in sustainable development and solving environmental problems. This article explores the technical, economic, and environmental aspects of installing wind turbines in subway tunnels. Analysis shows that generating energy from wind turbines not only provides additional electricity, but also helps improve the energy efficiency of transportation infrastructure. The paper also put forward a new proposal to combine wind energy with pressure energy. Through this innovative approach, the energy potential of metro tunnels can be maximized. The combined use of wind turbines and pressure-sensitive panels not only increases energy production but also serves to ensure the stability of the system. It is important to carry out pilot projects, research and technical tests to implement these technologies in the future. The integration of wind and pressure energy will not only contribute to environmental sustainability, but will also be an important step towards ensuring the energy independence of the city's infrastructure.

REFERENCES

1. Sharma, M. (2021). Wind Energy Utilization in Metro Systems: A Case Study of Delhi Metro. International Journal of Renewable Energy, 29(3), 123-134.
2. Lee, K., Cho, H., & Kim, J. (2022). Application of Wind Turbines in Subway Tunnels for Energy Production. Journal of Sustainable Urban Energy, 45(2), 201-215.
3. Müller, J. (2023). Wind Energy Generation in Urban Infrastructures: Opportunities and Challenges. European Journal of Renewable Energy, 31(4), 354-365.

4. Smith, R., & Zhang, W. (2020). Energy Harvesting from Transportation Infrastructure: Current Practices and Future Trends. Renewable and Sustainable Energy Reviews, 57, 1183-1195.
5. Gupta, S. (2019). Innovations in Energy Recovery Systems in Urban Transport. Journal of Green Technology, 22(1), 45-58.
6. Wang, L., & Yang, S. (2021). Integrating Wind and Pressure Energy for Sustainable Transportation Systems. Renewable Energy Applications, 14(3), 87-99.
7. Green, P., & Foster, J. (2020). Harnessing Ambient Energy in Urban Metro Systems. Energy Science and Engineering, 8(7), 2546-2559.
8. Liu, T., & Han, J. (2022). The Role of IoT in Optimizing Wind Energy Systems in Transportation Infrastructure. Journal of Smart Energy Systems, 10(4), 105-118.
9. Zhang, Y., & Sun, Z. (2021). Impact of Pressure and Wind Energy on Energy Efficiency in Metro Tunnels. Advances in Energy Engineering, 33(2), 78-92.
10. Brown, A., & Collins, M. (2020). Technological Advances in Wind Turbine Systems for Urban Transport Networks. Journal of Renewable Energy Technologies, 12(5), 130-142.