

CLEAN ENERGY FROM SMALL HYDROPOWER PLANTS

Vinnytsia, Vinnytsia Oblast, Ukraine

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1. What future urban problem needs to be addressed?

Vinnytsia City Territorial Community faces the problem of insufficient use of small rivers' potential for electricity generation. There are numerous small rivers within the community that have significant hydrological potential. However, this potential remains understudied and is practically unused for the placement of small hydroelectric power plants (mini-HPPs, micro-HPPs, small HPPs).

Currently, the main sources of energy for the city are centralised networks, which are vulnerable to crisis situations (e.g., shelling of energy facilities). In addition, existing energy supply methods do not always take into account environmental aspects and climate change.

The problem also extends to neighbouring areas and settlements that are part of Vinnytsia City Territorial Community, where a similar situation is observed: low energy efficiency, lack of local energy generation and old energy systems.

The above problem falls under the category of 'Climate-Resilient City.' It also has elements of a 'Safe City,' as ensuring autonomous energy supply increases the city's energy security and emergency preparedness.

For Vinnytsia, solving this problem is a key priority, as small hydropower plants can significantly increase the city's energy security by providing autonomous power supply to individual areas in the event of a main grid outage, which is especially important in conditions of martial law and attacks on energy facilities. In addition, the use of small hydropower plants will contribute to the creation of a reliable backup power source for critical infrastructure, increasing the overall resilience of the power system. The transition to renewable energy sources will also help reduce CO₂ emissions, adapt to climate change, and create a sustainable foundation for the city's digital transformation by attracting investment in the green economy.

Although each city has its own specific characteristics, this problem is typical for many medium-sized cities in Ukraine and Europe, especially those with small rivers and a need to transition to sustainable energy supply.

Therefore, this challenge is pan-European, and the solution planned for implementation in Vinnytsia has the potential to be scaled up in other countries.

2. Innovations

Until now, the problem of utilising the potential of small hydropower plants in Vinnytsia City Territorial Community has only been partially resolved. There have been individual projects to study the hydrological characteristics of rivers, but their results have been fragmentary and have not covered the full potential for the placement of small hydropower plants.

In addition, there is one private Sabarivska HPP in Vinnytsia, which was built between 1948 and 1952 on the Pivdennyi Buh River and has an installed capacity of 1.05 MW.

In addition, an active local resident in Vinnytsia successfully built and installed his own micro-HPP with a generator capacity of up to 5 kW on the Vinnychka River to provide energy to an apartment building.

The city has also actively explored the possibilities of implementing solar and wind stations, but the potential of small HPPs has remained insufficiently studied.

Current approaches to solving this problem have a number of limitations. Data on the hydrological characteristics of rivers, such as water flow and head levels, are incomplete and need to be systematised. There is no overall strategy for integrating small hydropower plants into the local power system, which complicates their large-scale implementation. Technological constraints also play a significant role, as access to modern methods of assessing potential and implementing projects is limited. In addition, legal obstacles, such as the complexity of obtaining permits due to the lack of clear regulations, as well as the need for coordination between different authorities, slow down the process.

The future solution should take into account a comprehensive approach to studying the potential of small hydropower plants.

It should include a detailed analysis of the hydrological characteristics of rivers, such as water flow, seasonal fluctuations and technical parameters, and use modern modelling and forecasting methods.

Environmental sustainability must become a key consideration, so it is important to take into account standards for minimising environmental impact and to develop mechanisms for restoring small river ecosystems.

The introduction of innovative technologies, such as digital tools for monitoring the condition of rivers and the efficiency of hydropower plants, will help ensure high productivity with minimal impact on the environment.

Integrating small hydropower plants into the local power grid through microgrids will ensure autonomous power supply and optimise energy distribution between different sources.

Finally, developing universal recommendations will allow this experience to be adapted for other cities in Ukraine and countries in the region, making the solution scalable and effective.

3. Expected impact of your pilot solution.

If the study of the potential of small hydropower plants and their implementation is successful, Vinnytsia will see a significant positive impact on the environment. The transition to renewable energy sources will reduce the burning of fossil fuels, which will reduce CO₂ emissions and the overall environmental impact on the region. The introduction of modern technologies for small hydropower plants will help minimise the negative impact on river ecosystems and create conditions for the restoration of natural water bodies and the preservation of biodiversity. The integration of small hydropower plants into the local energy system will be a step towards creating a sustainable environment, making Vinnytsia a model for other regions in the field of sustainable development.

The implementation of the project will also have a positive impact on the lives of citizens. Uninterrupted power supply to critical infrastructure such as hospitals, schools and water supply stations will improve the quality of life of the population, and autonomous systems will ensure the operation of life support facilities during crisis situations.

In addition, the project will contribute to raising environmental awareness among residents and create new jobs in the fields of energy, construction and system maintenance.

The project will also have a significant impact on city management. The implementation of smart systems will automate the monitoring and optimisation of energy consumption, enabling quick and informed decisions based on real-time data analysis. Efficient use of resources will reduce administrative costs by reducing the need for frequent repairs and maintenance of outdated infrastructure.

Transparency in the functioning of the energy system will increase citizens' trust in the authorities, and involving the population in energy efficiency initiatives will create a platform for cooperation.

In view of the above, the development of digital tools and decentralised energy management mechanisms will help the city respond effectively to new challenges and create a model for sustainable management.

4. Piloting

Vinnytsia city community is deeply interested in the status of a pilot partner, as the issue of sustainable energy supply and the use of small river potential is extremely relevant. The city is actively seeking effective solutions to ensure energy security, and the significant but understudied potential of small rivers creates unique opportunities for research and implementation of innovative projects. The existing infrastructure, such as small rivers and reservoirs, together with the available data on their hydrological characteristics, creates a solid foundation for the rapid launch of the initiative.

The city has significant experience in managing infrastructure and innovation projects, which will ensure effective coordination of work. In addition, political and civic support for the idea of transitioning to a 'smart city' and sustainable development makes this project particularly relevant. The community is ready to cooperate with other regions to scale up the results, which reinforces the strategic importance of Vinnytsia's participation.

The city's financial capabilities are also an important factor. Through existing programmes and financing mechanisms, it is planned to attract investment for research and construction of small hydropower plants. The possibility of obtaining grants from international organisations that support sustainable initiatives is also being considered.

Participation in the project will allow Vinnytsia not only to become a leading example for other cities in Ukraine and the region, but also to develop universal recommendations that can be adapted for other territories with similar small river potential.

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