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# INNOVATIONS IN WIND POWER GENERATION DEVICES (WPP) THAT SAVES PRODUCTION COSTS

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**ABSTRACT**
The innovation of Wind Power Plants in order to save costs in terms of production compared to Conventional Wind Power Plants¸ power plants that we usually encounter are in the form of windmills whose task is the same, namely using the wind as the driving force, models such as windmills that usually cost a lot, so the innovation created by SkySails Group is expected to be the beginning for other inventions, but certainly not to replace existing Wind Power Plants. This research employs a comprehensive methodology to explore the feasibility and advantages of kite-based wind farm systems, focusing on using towers as kite anchoring points. The result by Airborne Wind Europe, found that a wind farm containing a kite wind farm generating 50 megawatts of electricity would use only 913 metric tons of material over a 20-year period. This is far less than a conventional wind farm that requires 2,868 metric tons of material. This certainly supports sustainable green energy.

**Keyword:** Innovation, Wind Power Plants, Conventional.

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## INTRODUCTION

This kite wind farm can be an alternative to conventional wind farms that use windmills, this kite wind farm can be superior to conventional wind farms in terms of production costs and land to build. In general, cross-kite wind power systems involve the use of kites that fly in the air and are connected by ropes to generators on the ground. However, by utilizing towers as kite hook-up points, several advantages can be gained. The tower can help reduce cosine losses, reduce mass losses and rope drag, and simplify the process of starting and landing the kite. And this innovation has the potential to be one of the gateways to renewable energy that is more environmentally friendly. The renewable energy sector has focused on finding sustainable and affordable solutions. Wind power plants (WPPs) have relied on traditional windmill structures, but new ones are changing the landscape. Vision-based wind power systems, led by pioneers such as SkySails Group, depart from traditional designs. By using kites tethered to the ground by strong ropes, these systems reduce losses and improve efficiency, especially when a tower is used as an anchor.However, wind power removal systems are more expensive to build and maintain, especially challenges edition related to: building towers. Despite these challenges, the potential benefits are enormous. Tower-mounted solar panel systems are easy to deploy, making existing sites suitable for renewable energy projects. Tower designs may also include additional components to improve overall structural value.To assess the viability of a wind energy system, a thorough analysis of the financial, technological and environmental sectors is essential (Soukka, 2018). This approach allows stakeholders to make informed decisions about the suitability of this innovative approach for their specific projects. In conclusion, although there are challenges, the potential benefits in terms of efficiency and flexibility that wind energy systems can produce in the kite are promising candidates for the transition to clean energy sources. Innovation and strategic execution will be key to achieving our full potential(Zhang et al., 2023).

The concept of utilizing wind power through innovative means has been around for some time, but the idea of using kites in wind farms presents a novel approach. This kite-based wind farm system offers a compelling alternative to traditional wind farms that use windmills. The use of kites, connected by ropes to ground-based generators, can potentially surpass conventional wind farms in terms of production costs and the amount of land required for installation. The addition of towers as anchor points for the kites introduces further benefits, such as reducing cosine losses, minimizing mass losses and rope drag, and simplifying the kite's launching and landing processes (Lledó et al., 2019).

The renewable energy sector is in urgent need of sustainable and cost-effective solutions. Traditional wind power plants (WPPs) have relied heavily on windmill structures, but the rising demand for efficient and eco-friendly energy sources necessitates exploring new technologies. The vision-based wind power systems, exemplified by companies like SkySails Group, represent a significant shift from traditional designs. The integration of kites tethered to the ground by strong ropes, especially when using towers as anchors, can enhance efficiency and reduce losses. However, the higher costs associated with building and maintaining these systems, particularly the towers, present notable challenges.

Previous studies, such as those by (Soukka, 2018), have highlighted the importance of conducting thorough analyses of the financial, technological, and environmental aspects when assessing the viability of new wind energy systems. These analyses are crucial for understanding the potential benefits and limitations of innovative approaches like kite-based wind farms. The existing literature suggests that while there are challenges, particularly in terms of infrastructure costs, the potential benefits in terms of efficiency, land use, and environmental impact make this a promising area of research.

This research focuses on evaluating the feasibility and advantages of kite-based wind farm systems, particularly emphasizing the use of towers as kite anchoring points. One key objective is to evaluate the cost-effectiveness of these systems by analyzing potential savings in production costs and land use compared to traditional windmill-based setups. This analysis will consider the lower material and installation costs associated with kite systems and the reduced land footprint required for their deployment. Another critical objective is to enhance the efficiency of kite-based wind power systems by examining how the use of towers can minimize energy losses. The study will explore how towers can reduce cosine losses, decrease drag from the ropes, and optimize the overall aerodynamic performance of the system. By addressing these factors, the research aims to demonstrate that kite-based wind farms, with strategic tower integration, can offer a more efficient and cost-effective alternative to conventional wind energy systems.

In conclusion, while the implementation of kite-based wind energy systems presents certain challenges, particularly in terms of infrastructure development, the potential benefits in efficiency and flexibility make them promising candidates for advancing renewable energy technologies. The success of these systems will depend on continued innovation and strategic execution to realize their full potential in the transition to clean energy sources.

## METHOD

This research employs a comprehensive methodology to explore the feasibility and advantages of kite-based wind farm systems, focusing on using towers as kite anchoring points. The study begins with a thorough literature review to understand existing technologies and case studies, providing a foundation for designing a conceptual model. The design phase includes computer simulations to evaluate system efficiency, emphasizing reducing cosine losses and optimizing aerodynamic performance. A detailed cost-effectiveness analysis is conducted to compare kite-based systems with traditional windmill setups, considering capital, operational, and maintenance costs, as well as land use. The research also assesses the environmental impact, comparing visual and noise pollution with conventional wind farms. Prototype development and field testing are crucial to validating simulation results and refining the system design, ensuring real-world applicability. Stakeholder analysis, including interviews and surveys, provides insights into the perceived feasibility and acceptance of this innovative technology. The study concludes with optimization and final assessment, offering recommendations for future research and dissemination of findings to guide the advancement of kite-based wind farm systems.

## RESULTS AND DISCUSSION

### Efficiency and Efficiency Benefits

Crosswind technology offers the ability to improve system efficiency by reducing cosine and mass losses and rope drag through the use of towers. Compared to traditional wind turbines, which are limited to a certain height, kite technology can utilize stronger and more stable winds at higher altitudes, which in turn can increase the efficiency of energy collection(Pereira & Sousa, 2023). In addition, the use of towers can provide additional benefits, such as the ability to use tower-mounted wind sensors to measure wind shear and wind speed at the height of the kite crossing, which can help predict power and optimize the system's characteristics. Construction and maintenance costs: The use of towers in wind energy technology can result in higher construction and maintenance costs compared to traditional wind turbines. The towers required to support the kite cross must be designed to withstand higher loads, which can lead to higher construction costs. In addition, maintenance of the towers and suspension lines may also require additional costs. However, the advantages of using towers, such as the ability to use kite lines in hard-to-reach areas such as forests or areas that cannot be used for traditional wind turbines, can provide significant added value (Gao et al., 2022).

### Land Availability and Flexibility

Electric power technologies equipped with wind kite towers allow them to be used in hard-to-reach areas or in restricted areas such as forests or cities. This can open up new opportunities to use wind energy in places where it was not possible before. In addition, the flexibility of the tower design also allows for the addition of additional functions, seperti stasiun cuaca atau antena, yang dapat meningkatkan nilai infrastruktur yang dibangun (Ye et al., 2023).

### Comprehensive Analysis

Although cross-kite technology offers the potential for higher performance and better capacity factor compared to conventional wind turbines, it is important to remember that each system has its own advantages and disadvantages. It is important to conduct a comprehensive analysis covering financial, technical, and environmental aspects to understand the impact of the cross-kite technology. each approach. Thus, it is possible to better select the approach that best suits the specific needs and conditions of a renewable energy project (Salma et al., 2020).

By considering this comparison in detail, it is possible to identify the advantages and challenges of using towers in cross-kite wind power technology compared to the conventional approach using wind turbines. A careful and thorough analysis is required to select the approach that best suits the specific needs and conditions of a renewable energy project (Liang et al., 2023).

**Disadvantages of High Construction and Maintenance Costs**

The use of towers in cross kite wind power technology can result in higher construction costs compared to conventional wind turbines (Tsai et al., 2023). The towers required to support cross-kites must be designed to withstand greater loads, which can significantly increase construction costs. In addition, maintenance of the towers and suspension lines can also entail additional costs that need to be considered in long-term planning. High Material Demands: The use of towers in cross-kite wind power technology requires strong and durable materials to withstand the loads generated by the cross-kite. This can result in high material demands and affect the construction cost and sustainability of the project. Proper material selection and close monitoring of wear and damage are crucial to maintain reliability and safe operation (Mickle et al., 1988).

**Challenges in Load Conveyance to the Ground**

Towers used in cross-kite wind power technology must be designed to safely and efficiently transmit the loads generated by the cross-kite to the ground. This can pose technical challenges in structural design tower and suspension systems that require special attention to ensure the safety of system operation. A deep understanding of structural mechanics and system dynamics is required to address these challenges(Castro-Fernández et al., 2023).

**Space and Location Limitations**

The use of towers in cross-kite wind power technology can limit the choice of system installation locations. Compared to conventional wind turbines that can be installed in a variety of open locations, towers for cross kites require larger spaces and may not be suitable for all types of environments. This can limit flexibility in system placement and requires careful analysis of suitable locations(Faizan et al., 2023).

Challenges in Management and Operations: Operation and management of cross-kite wind power systems with towers can involve additional challenges such as suspension line maintenance, power management, and complex operational coordination (Sánchez-Arriaga et al., 2017). This requires a deep understanding of the technology and operational processes to ensure optimal system performance. Proper training of operational personnel and development of maintenance Effective procedures are key in overcoming this challenge (Peng et al., 2021). Considering these shortcomings, it is important to conduct a thorough evaluation covering technical, financial and environmental aspects before adopting cross-kite wind power technology with the use of towers. With a good understanding of the challenges that may be faced, appropriate mitigation measures can be implemented to ensure the success and sustainability of the project (Bauer et al., 2018).

## CONCLUSION

In conclusion, the exploration of kite-based wind power systems represents a significant step forward in the quest for sustainable and cost-effective renewable energy solutions. These innovative systems offer promising alternatives to traditional windmill structures, leveraging kites tethered to the ground via robust ropes, and utilizing towers as anchor points. While kite-based wind power systems present challenges such as higher construction and maintenance costs, their potential benefits in terms of efficiency, land utilization, and flexibility make them a compelling option for the transition to clean and sustainable energy sources.The comprehensive analysis presented underscores the importance of evaluating kite-based wind power systems from financial, technical, and environmental perspectives to inform decision-making for specific projects. Despite challenges such as high construction costs and operational complexities, strategic implementation and continued innovation hold the key to realizing the full potential of this technology.Looking ahead, the exciting potential of tower-based parachute wind energy production technology could revolutionize the renewable energy industry. With careful analysis, innovative solutions, and a commitment to overcoming challenges, kite-based wind power systems have the potential to play a pivotal role in driving the transition to clean and green energy. To ensure the success and sustainability of tower wind power in the future, it is important that research, development and deployment continue.

What's exciting about this topic is that tower-based parachute wind energy production technology could bring major changes to the renewable energy industry. While the use of towers is more efficient and flexible in cultivation, there are also challenges to overcome, such as high construction costs, high material requirements, and increased operational complexity. However, with careful analysis and the right approach, this technology can be an attractive and sustainable option to meet future energy needs. It is important to continue to innovate and find solutions to overcome the existing challenges so that tower-based wind energy production becomes an integral part of the transition to clean and green energy.

## REFERENCES

Bauer, F., Hackl, C. M., Smedley, K., & Kennel, R. M. (2018). Crosswind kite power with tower. *Green Energy and Technology*, *0*(9789811019463), 441–462. https://doi.org/10.1007/978-981-10-1947-0_18

Castro-Fernández, I., DeLosRíos-Navarrete, F., Borobia-Moreno, R., Fernández-Jiménez, M., García-Cousillas, H., Zas-Bustingorri, M., Ghobaissi, A. T., López-Vega, F., Best, K., Cavallaro, R., & Sánchez-Arriaga, G. (2023). Automatic testbed with a visual motion tracking system for airborne wind energy applications. *Wind Energy*, *26*(4). https://doi.org/10.1002/we.2805

Faizan, M., Pati, S., & Randive, P. (2023). Effect of channel configurations on the thermal management of fast discharging Li-ion battery module with hybrid cooling. *Energy*, *267*. https://doi.org/10.1016/j.energy.2022.126358

Gao, X., Zhao, P., Zhao, C., Li, H., Dong, J., Luo, J., Li, C., & Zhou, D. (2022). Research on Laser Crosswind Measurement Technology. *Laser and Optoelectronics Progress*, *59*(5). https://doi.org/10.3788/LOP202259.0328002

Liang, H., Sun, Y., Li, T., & Zhang, J. (2023). Influence o f Marshalling Length o n Aerodynamic Characteristics o f Urban Emus u nder Crosswind. *Journal of Applied Fluid Mechanics*, *16*(1). https://doi.org/10.47176/jafm.16.01.1338

Lledó, L., Torralba, V., Soret, A., Ramon, J., & Doblas-Reyes, F. J. (2019). Seasonal forecasts of wind power generation. *Renewable Energy*, *143*. https://doi.org/10.1016/j.renene.2019.04.135

Mickle, R. E., Cook, N. J., Hoff, A. M., Jensen, N. O., Salmon, J. R., Taylor, P. A., Tetzlaff, G., & Teunissen, H. W. (1988). The Askervein Hill Project: Vertical profiles of wind and turbulence. *Boundary-Layer Meteorology*, *43*(1–2). https://doi.org/10.1007/BF00153977

Peng, X., Liu, Z., & Jiang, D. (2021). A review of multiphase energy conversion in wind power generation. In *Renewable and Sustainable Energy Reviews* (Vol. 147). https://doi.org/10.1016/j.rser.2021.111172

Pereira, A. F. C., & Sousa, J. M. M. (2023). A Review on Crosswind Airborne Wind Energy Systems: Key Factors for a Design Choice. In *Energies* (Vol. 16, Issue 1). https://doi.org/10.3390/en16010351

Salma, V., Friedl, F., & Schmehl, R. (2020). Improving reliability and safety of airborne wind energy systems. *Wind Energy*, *23*(2). https://doi.org/10.1002/we.2433

Sánchez-Arriaga, G., García-Villalba, M., & Schmehl, R. (2017). Modeling and dynamics of a two-line kite. *Applied Mathematical Modelling*, *47*. https://doi.org/10.1016/j.apm.2017.03.030

Soukka, E. (2018). *Chassis Design of a Control Pod for a Kite Power System*.

Tsai, W. C., Hong, C. M., Tu, C. S., Lin, W. M., & Chen, C. H. (2023). A Review of Modern Wind Power Generation Forecasting Technologies. In *Sustainability (Switzerland)* (Vol. 15, Issue 14). https://doi.org/10.3390/su151410757

Ye, Z., Chaer, I., Hartungi, R., & Ross, M. (2023). Theoretical analysis of the power generation of pumping cycle kite power systems compared to traditional wind turbines in Aberdeen. *Frontiers in Built Environment*, *9*. https://doi.org/10.3389/fbuil.2023.1091068

Zhang, X., Jia, J., Zheng, L., Yi, W., & Zhang, Z. (2023). Maximum power point tracking algorithms for wind power generation system: Review, comparison and analysis. In *Energy Science and Engineering* (Vol. 11, Issue 1). https://doi.org/10.1002/ese3.1313