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From Towers to Tethers: Lessons Learned, Lessons Ahead

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Over the past two decades, research and innovation in wind energy have been extraordinarily intense, transforming wind power from a niche renewable option into one of the most economically competitive sources of electricity. Continuous advances in aerodynamics, materials, structural design, control systems, and large-scale manufacturing have dramatically reduced the cost of energy (CoE), particularly for onshore wind. Today, onshore turbines compete directly with fossil-based generation in many markets, a result achieved through systematic optimization, upscaling, improved reliability, and an increasingly mature supply chain. Offshore wind, while still facing significant economic and logistical challenges, is following a similar path. Although cost reduction and industrial consolidation are ongoing, the technological roadmap is relatively well defined.

Airborne wind energy (AWE), on the other hand, is at a much earlier stage of development. The prospect is appealing: access to stronger, more consistent winds at higher altitudes, potentially lower material consumption, and new deployment scenarios. However, the industry is still exploring its fundamental architectures, operational concepts, and scaling strategies. Many of the questions that were central to wind turbines decades ago—structural durability, load mitigation, control robustness, certification, maintainability, and bankability—are re-emerging in a new and more complex dynamic context.

The experience gained with conventional wind energy offers both guidance and reasons for caution. The systematic approach that has enabled turbine costs to be re-

duced (rigorous modeling, validation campaigns, incremental scalability, industrial standardization) provides a methodological roadmap. At the same time, the challenges of the past remind us of the risks of premature scalability, underestimating operational complexity, or neglecting reliability in the pursuit of performance.

The key question, therefore, is whether the AWE community can learn from this adjacent technological history: can it replicate the virtuous circle of innovation and cost reduction while avoiding the mistakes made in the past? The journey from towers to tethers is not a simple transfer of technology, but it can benefit greatly from the lessons learned in over twenty years of wind energy evolution.



A personal research path [Graphic design by Elisa Croce]