Achieving 24/7 carbon free energy

The missing piece — unlocking the wave energy revolution for 24/7 carbon-free electricity.

Wave power.
To power the planet.

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Executive summary

Wave energy: the missing link for 24/7 renewable power

As the world moves toward a sustainable future, sectors such as hydrogen production, heavy industries, and data centres are emerging as critical economic growth and innovation drivers. These industries, however, share one key characteristic: an unrelenting need for constant 24/7 power to operate effectively. Whether fuelling electrolysis for green hydrogen, powering energy-intensive processes in steel manufacturing, or keeping servers running in data centres, an uninterrupted energy supply is indispensable for ensuring reliability, productivity, and competitiveness.

Despite significant advances in wind and solar power, achieving 24/7 carbon-free energy remains elusive due to their inherent intermittency. With its continuous generation capability, superior energy density, and complementary production profile, wave energy represents the critical missing piece in the renewable energy puzzle.

This paper outlines how wave energy can stabilise electricity grids, reduce costs, enhance energy security, and create economic opportunity while urging policymakers and investors to act now to avoid repeating the historical mistake of underestimating transformative clean energy technologies.

The unfinished transition

In the last decade, a significant shift occurred in energy production. For the first time in history, wind and solar energy had become cheaper than fossil fuels, spurring governments and investors worldwide to accelerate their investments in renewable energy dramatically.

Yet, one crucial issue remained unresolved.

Despite significant investments, utilities still face intermittent reliability challenges. The inherent variability of wind and solar energy can lead to price volatility and a reliance on fossil-fuel backups to maintain grid stability.

> "Since 2017, we've matched our annual electricity consumption with 100% renewable energy. Now we're going even further: By 2030, Google aims to run our business on carbon-free energy everywhere, at all times."

Sundar Pichai
CEO of Google and Alphabet

The reality of today's energy landscape

The surge is driven by the exponential growth of data-intensive applications and technological advancements in artificial intelligence (AI). Data centres demand constant power to ensure data integrity and service reliability.

Leading tech companies are committing to 24/7 carbon-free energy (CFE) programs to address these challenges. Google, for example, plans to run entirely on carbon-free electricity by 2030, aiming to match its energy demand with renewable sources hourly. As of 2021, it has already achieved 66% of its global energy from carbon-free sources.[6] Microsoft has pledged to use 100% renewable energy in its data centres by 2025 and become carbon-negative by 2030, including considerable investments in renewable energy projects. [5]

- Up to 61% of the world's electricity is still sourced from fossil fuels. [1]
- Data centres alone consume 1% of global electricity, which is expected to double by 2030. [2],[3]
- Even tech leaders such as Google, Microsoft, and Amazon struggle to achieve complete reliance on renewable energy due to intermittent availability. [4], [5], [6]

The core challenge: aligning supply and demand

- In many inland regions, wind energy production is higher during nighttime hours, when demand is typically lower. [4]
- Across broad geographic areas, solar energy peaks at midday, but the highest demand occurs during the evenings.
- Battery storage remains costly and unsustainable for periods over 4-6 hours.

These mismatches underscore a fundamental gap in the current renewable energy transition. To bridge this gap, we need a stable, demand-aligned energy source for grid reliability.

The missing piece is a continuous, predictable renewable source complementary to wind and solar. That missing piece is wave energy.

The great untapped source at our fingertips

One of the world's largest untapped renewable energy sources has been right in front of us all along—the vast, powerful ocean[7]

Why wave energy is different:

- Unlike wind and solar, waves rarely ever rest. [7]

- Waves generate power continuously, day and night offering a stable energy output. [7]
- Wave energy boasts an energy density of around 833 times that of wind, making it a highly efficient and powerful renewable resource with untapped potential. [7]
- With a power density of 30 kW/m, wave energy exhibits a significantly higher energy concentration, approximately ten times that of solar power and five times that of wind energy.[10]
- Wave power output is more predictable than other renewable energy sources.[7]
- Waves retain power-generating potential longer than the wind; even after winds subside, waves propagate, providing a more consistent energy source. [8],[9]
- Wave energy complements other renewables, generating power precisely when wind and solar production falter. [7],[8],[9]

> "Wave energy has a very consistent power profile. Adding wave energy to a mix of wind and solar brings us closer to a 24/7 supply."

Patrik Möller
CEO of CorPower Ocean

Complementarity is the overlooked principle in renewable energy investment, which integrates diverse energy sources to stabilise the grid.

Practical implications:

As the demand for reliable and continuous renewable energy grows, wave energy presents a promising solution for various regions. By integrating wave energy into existing power grids, industries and cities can lower their energy costs, enhance energy stability and reduce their reliance on fossil fuels.

Some-potential key applications include:

- An Irish data center could achieve uninterrupted operations by integrating a balanced mix of wind, solar, and wave energy, ensuring resilience against renewable intermittency.[11]
- Coastal cities in Spain have the potential to stabilise their renewable energy grids by incorporating wave energy, significantly reducing reliance on fossil fuels.[12],[13]
- Utilities in California could leverage wave energy to establish a stable, carbon-free baseload power system, minimising the need for costly long-duration storage or battery solutions.[14],[23]

This is not speculative — it is occurring today.

The investment opportunity of the decade

The market underestimates wave energy, a costly oversight reminiscent of past misjudgements regarding solar energy in 2005 and lithium-ion batteries in 2010.

Economics of wave energy:

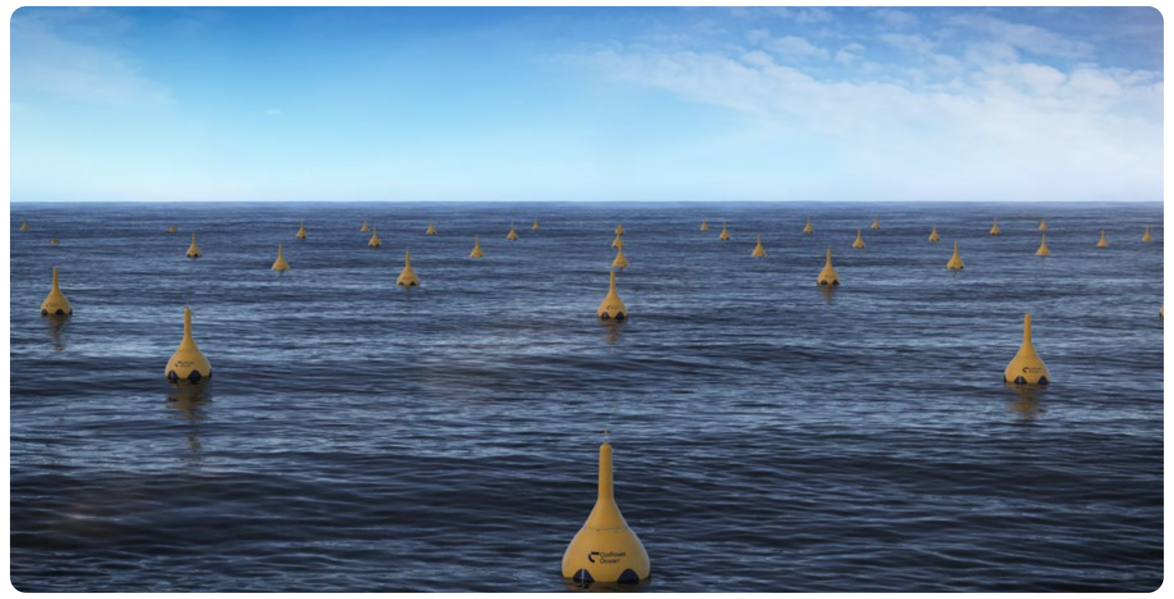
- The Levelized Cost of Electricity (LCOE) for wave energy could drop below $100/MWh, even with only 300 MW installed in the market, and reach €70/MWh after 600 MW, surpassing the economics of offshore wind.[14]
- Integration of wave energy can reduce renewable grid overgeneration by 39%, substantially lowering system costs, as demonstrated in the Spanish Atlantic coast case study.[12],[13],[14]
- Incorporating wave energy into 100MW data centre energy procurement could save up to €29 million annually in certain regions .[12],[13],[14] With even larger data centres, the savings could be significantly higher.

The integration of wave energy can reduce renewable grid overgeneration by 39%, substantially lowering system costs while providing stable power when other renewable sources are unavailable. This strengthens grid resilience, energy security, and sustainability.

Yet, wave and tidal energy currently receive less than 1% of global clean energy investments.[1] This is not due to technological shortcomings; instead, it results from awareness and policy gaps—gaps that policymakers and investors can address immediately.

Why this matters for policymakers

"The current trajectory of data center demand is incompatible with Ireland's climate goals. Data centres are growing far faster than the renewable energy required to meet their needs." [15]
— Professor Hannah Daly of UCC.



Governments worldwide commit to achieving 24/7 carbon-free energy, but existing policy frameworks still have critical gaps.

Key policy gaps:

Focused policies and financial incentives for innovative technologies to support 24/7 CFE:

- The EU's Renewable Energy Directive III mandates hourly renewable matching, a goal challenging to achieve without stable, complementary sources like wave energy.[16],[17]

Policy support for permitting and regulatory challenges:

- The U.S. is experiencing a 30% backlog in renewable energy grid connection requests. The integration of wave energy could help alleviate congestion and enhance grid reliability.[18]
- Asia-Pacific countries, including Japan, Indonesia, Australia, and India, urgently seek stable grid solutions to accommodate the increased renewable capacity. [19],[20],[21],[22] Wave energy provides a clear path forward.

Benefits that governments should recognize:

- Energy Security: Wave energy offers stable, locally generated power, reducing dependence on energy imports and enhancing regional energy independence. [7]
- Job Creation: The wave energy sector involves significant local manufacturing, engineering, and operational roles, driving employment and economic growth in coastal communities. [7]
- Streamlined Permitting & Regulatory Support: Accelerated consenting processes and regulatory recognition of wave energy's role in grid stability will facilitate faster investment and implementation. [7]

Recommended policy shifts:

- Provide incentives for wave energy investment comparable to those that have enabled wind and solar.
- Incorporate wave energy explicitly into national energy roadmaps targeting 24/7 carbon-free energy compliance.
- Establish market mechanisms that recognise and price predictable renewable sources, ensuring the integration of wave energy into the broader energy mix.

These policy changes are not about funding experimental technologies but scaling a proven solution to lower energy bills and strengthen and balance our renewable energy portfolio.

The next move belongs to you

A decade ago, solar power generation was dismissed as economically impractical. Today, it is the world's cheapest and most accessible source of electricity. Wave energy now stands at a similar tipping point, ready to transform the renewable energy landscape.

For policymakers, this represents an unprecedented opportunity to define the future of renewable energy strategies. For investors, wave energy is the most significant untapped opportunity in the renewable sector.[2]

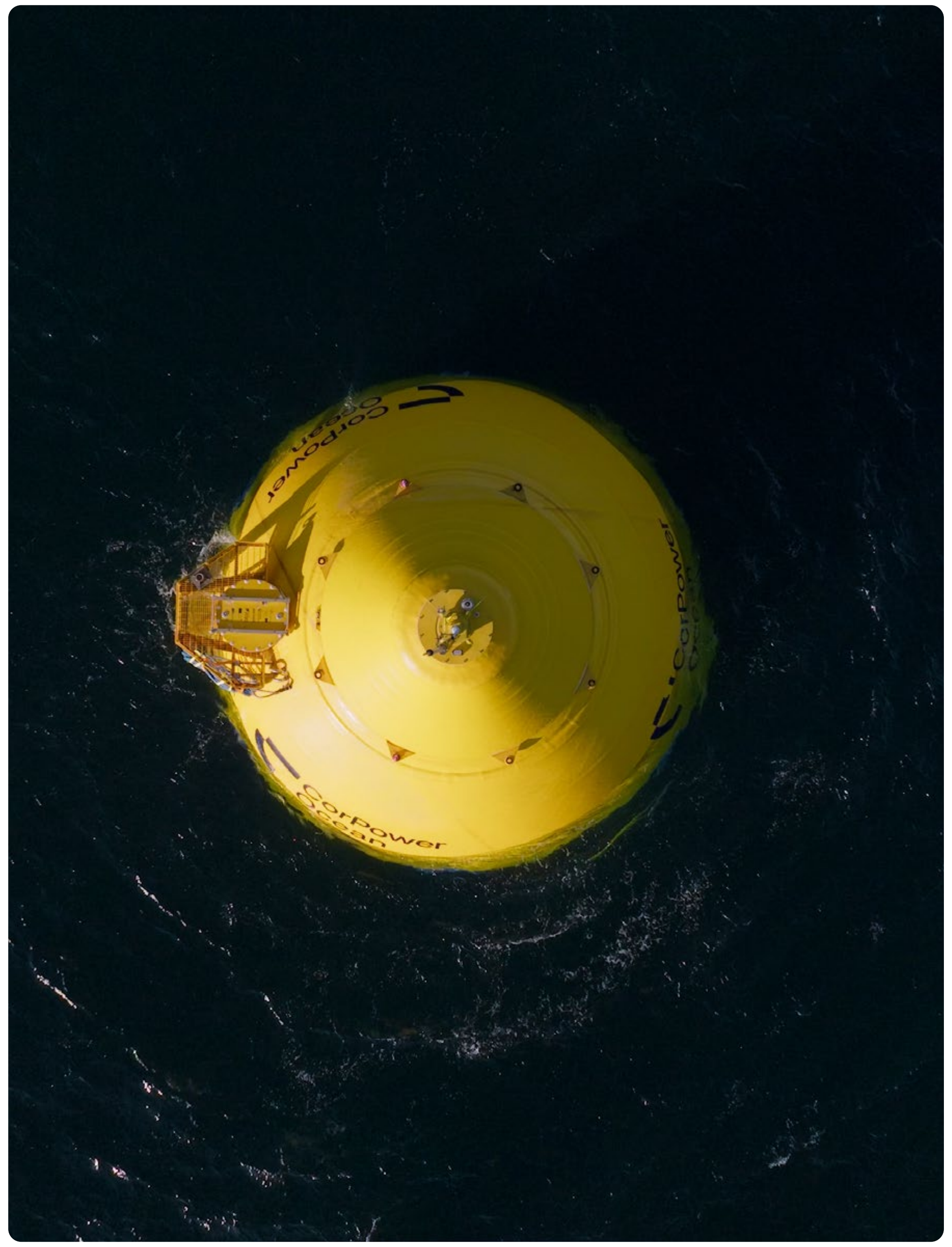
The question is no longer whether wave energy will contribute to 24/7 clean power. The real question is whether you will act now or watch as others seize this historic opportunity. The technology is proven. The opportunity is clear.

Will you complete the renewable energy puzzle?

Next steps

For investors:

1. **Explore strategic partnerships:** Connect with wave energy technology developers like CorPower Ocean to understand investment opportunities, potential returns, and market trends.
2. **Conduct site-specific feasibility studies:** Evaluate coastal properties and energy demands to determine the optimal potential for integrating wave energy.
3. **Create diversified renewable portfolios:** Incorporate wave energy alongside existing solar and wind investments to improve energy stability and financial returns.
4. **Engage with data centres and energy-intensive industries:** Incorporate wave energy alongside existing solar and wind investments to improve energy stability and financial returns.



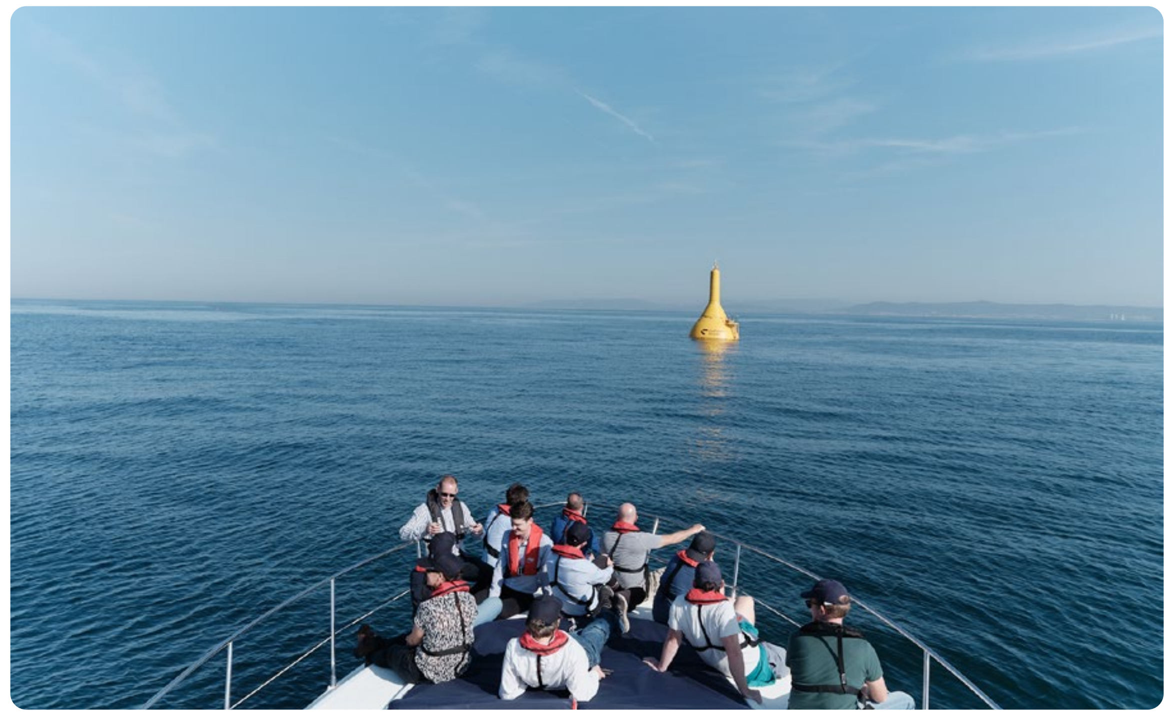
"When I talked with CorPower Ocean and learned they have 18 metres tall machines which have lasted through enormous storm waves in Portugal it was really exciting, because it was clear to us this is now ready!"

Jon Koplin
Senior Director of Cisco Investments

For policymakers:

1. **Set ambitious national targets for marine energy:** Define clear national deployment targets for wave and tidal energy within the broader renewable energy mix to signal long-term political commitment and stimulate private sector investment.
2. **Implement market-based support mechanisms:** Introduce targeted government-backed mechanisms (e.g., Contracts for Difference) to support early-stage wave energy projects, enabling cost reductions through scale and learning, with a pathway to future subsidy-free competitiveness.
3. **Boost funding for commercial-scale projects:** Prioritize national and EU funding for commercial wave energy deployments to de-risk capital investment, strengthen domestic supply chains, and secure a leadership position in Europe's marine energy sector.
4. **Streamline permitting processes:** Establish fast-track consenting pathways for wave energy projects, supported by clear and consistent environmental assessment guidelines to reduce delays and increase investor confidence.
5. **Incentivize innovation in offshore wind tenders:** Integrate non-price criteria—such as innovation, technology co-location, and environmental benefits—into offshore wind auctions to encourage project consortia to actively support the development and integration of wave energy.

As part of its commitment to advancing clean energy solutions, CISCO is an investor in CorPower Ocean, supporting its wave energy technology to drive sustainability and innovation in renewable energy.[2]



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