Firming Cost of Renewables in the U.S. and Comparison with Europe

Based on Lazard LCOE v18.0 | Prepared by Nenuphar Advisors

NENUPHAR ADVISORS

Presented By
Raul Assuncao
www.nenupharadvisors.com
+971 54 486 1971
+34 602 453 375
+351 961 953 547

LCOE – Jul 2025 – v2_BESS

Disclaimer

NENUPHAR ADVISORS

This presentation is provided for informational purposes only and does not constitute an offer, invitation, or solicitation for the sale or purchase of securities, assets, or financing of the business described herein.

It is not intended to form the basis of, or act as an inducement to enter into, any contract or investment activity. **Nenuphar Advisors** and its affiliates, including **Nenuphar Advisors – FZCO**, **Nenuphar Frontier, Lda.** and **Nenuphar Advisors SL**, and **Nenuphar Advisors – FZCO** ("**Nenuphar Advisors**"), make no representation or warranty, express or implied, as to the accuracy, completeness, or reliability of the information provided.

The information contained herein, sourced from publicly available materials or provided to **Nenuphar Advisors**, has not been independently verified and should not be relied upon. **Nenuphar Advisors**, its directors, officers, employees, and advisers accept no liability for any errors, omissions, or misstatements, or for any direct, indirect, or consequential loss arising from reliance on this presentation.

Prospective investors or financiers are advised to perform their own independent investigation and analysis.

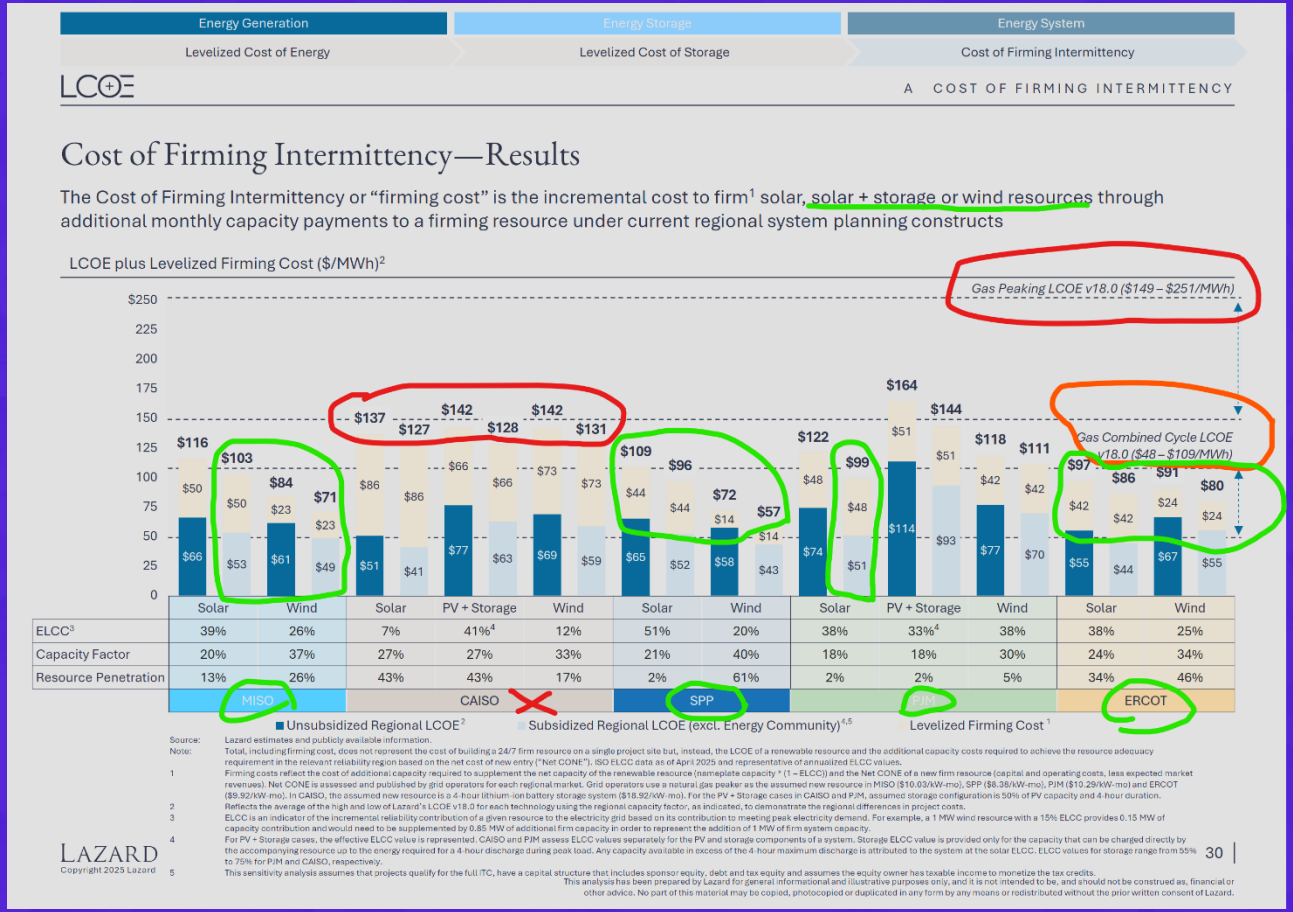
Nenuphar Advisors reserves the right to amend or terminate negotiations or procedures related to any transaction without prior notice or liability.

No obligation is undertaken to update this presentation or provide additional information.

Costs or expenses incurred by recipients in connection with the evaluation of this presentation are their sole responsibility.

Firming Cost of Renewables in the U.S. and Comparison with Europe

NENUPHAR ADVISORS



Firming Cost of Renewables in the U.S. and Comparison with Europe

NENUPHAR ADVISORS

🎯 Objective of the Chart

To show the average cost of providing firm (dispatchable) power using renewables (solar, wind, solar+storage, wind+storage) with capacity backup, compared to Gas Peaking Plants and Natural Gas Combined Cycle (CCGT) plants.

🟩 Main Conclusion (Highlighted in Green):

✅ In ERCOT, MISO, SPP, and PJM: Wind + Storage and Solar + Storage:

– Always show an LCOE + Firming Cost that is lower or competitive with Gas Peaking Plants ($149–251/MWh), and often even with Natural Gas Combined Cycle (CCGT) plants ($48–109/MWh).

💡 **Don’t forget that Natural Gas in the U.S. is 3 times cheaper than in Europe, which clearly and definitively removes Natural Gas from the equation of best backup energy sources in Europe.**

Firming Cost of Renewables in the U.S. and Comparison with Europe

NENUPHAR ADVISORS

🔍 TECHNOLOGY ANALYSIS:

1. Solar + Storage:

LCOE + Firming in MISO: ~$86/MWh
SPP: ~$66
PJM: ~$66
ERCOT: ~$73
CAISO: ~$164
📌 **Conclusion: Except in CAISO, Solar + Storage is clearly competitive with CCGT and much cheaper than Gas Peaking.**

2. Wind + Storage:

LCOE + Firming in MISO: ~$71
SPP: ~$66
PJM: ~$73
ERCOT: ~$72
CAISO: ~$144
📌 **Conclusion: Wind + Storage consistently beats the cost of Gas Peaking and CCGT in all markets, except CAISO. MISO and SPP are the most competitive.**

3. Standalone Solar or Wind (without "Firming")

Even cheaper (e.g., Wind in MISO ≈ $61/MWh total), but without full dispatchability.The cost for “Firming” adds only a small premium (≈ $20–$30/MWh).

Firming Cost of Renewables in the U.S. and Comparison with Europe

NENUPHAR ADVISORS

🔥 COMPARISON WITH GAS:

🟥 Gas Peaking (Red Circle):

LCOE: $149–$251/MWh → Renewables with storage are always cheaper, even with firming.

🟧 Natural Gas Combined Cycle (CCGT) (Orange Circle):

LCOE: $48–$109/MWh

Only in CAISO and PJM do renewables with firming occasionally exceed this range (due to higher firming costs).

⚙️ OTHER IMPORTANT DATA:

Metric	Notes
ELCC (Effective Load-Carrying Capacity)	Higher for hybrid systems (e.g. Solar+Storage has 33–38%)
Capacity Factor	Higher for Wind (30–37%) than Solar (20–27%)
Resource Penetration	MISO: 43%, SPP: 44%, ERCOT: 61% (more renewables = more credible firming modeling)

💡 Strategic Implications

✅ MISO, SPP, ERCOT are now ready for baseload renewables with storage — cost-competitive AND clean.

⚠️ CAISO has firming challenges due to over-penetration and saturation, raising costs..

🔄 Firming cost ≠ dealbreaker anymore — in most U.S. regions, firmed renewables beat peakers and are within CCGT range.

NENUPHAR ADVISORS

📌 Final Takeaways

Firmed renewables are now viable baseload in MISO, SPP, ERCOT.

Peakers are obsolete from a cost point of view in most areas.

Gas CCGTs are still competitive in PJM and CAISO, but barely.

Storage is the game-changer — especially where renewables already dominate.

NENUPHAR ADVISORS

THANK YOU
FOR YOUR ATTENTION

Contact Us

www.nenupharadvisors.com
info@nenupharadvisors.com

Madrid, Spain
+34 602 453 375

Lisboa, Portugal
+351 961 953 547

Dubai, UAE
+971 54 486 1971

Nairobi, Kenya
+254 791 865 589