In Defense of the Energy Sector

Private Investment as the Engine of the Renewable Energy Transition

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Abstract

The energy sector stands accused of impeding the renewable transition. This brief argues the opposite: that the sector's sustained capital deployment into clean energy technologies is precisely what has transformed renewables from an expensive niche into a globally competitive force. Renewables have not yet reached the scale, storage integration, and profitability required for full fossil-fuel substitution without private capital. The defense presents evidence that energy companies — including Panthalassa, Tesla Energy, Bloom Energy, NuScale Power, TerraPower, TotalEnergies, Shell, and BP — are actively funding the innovations that will make a full renewable transition economically viable. Public funds alone cannot close the multi-trillion-dollar gap; the energy sector's private investment is not the problem — it is the solution.

1 Introduction

The central question before this court is whether the energy sector has acted as a barrier to the renewable energy transition or as one of its primary enablers. The prosecution's narrative — that fossil fuel interests have held back clean energy — is incomplete. It ignores the capital flows, technology investments, and infrastructure build-outs that energy companies have undertaken precisely because they understand that the future is renewable.

This brief advances two core arguments. First, renewable energy sources are not yet fully profitable at a global deployment scale without private capital underwriting cost reductions, grid integration, and storage development. Second, the energy sector — broadly defined to include utilities, oil majors, and clean-technology firms — is providing that capital in increasing measure, accelerating the timeline to profitability and universal deployment. To punish the sector for the economics of an energy transition it is actively funding would be both unjust and counterproductive.

2 The Economics of Renewable Energy: Competitive But Not Yet Complete

2.1 The Cost Revolution in Renewable Generation

The cost of producing electricity from renewable sources has undergone a dramatic transformation over the past fifteen years. According to the International Renewable Energy Agency (IRENA), the levelized cost of energy (LCOE) — the lifetime average cost of generating one megawatt-hour of electricity — for utility-scale solar photovoltaics fell from approximately $359/MWh in 2009 to $61/MWh by 2024: an 83% reduction in roughly one decade [1]. Onshore wind experienced a similarly steep decline, falling to levels roughly 67% below the weighted average cost of new fossil fuel generation by 2023.

These numbers represent a genuine triumph of market-driven investment. The LCOE of renewables now sits below that of new coal and gas plants across most major markets on an unsubsidized basis [2]. As Wood Mackenzie projects, onshore wind LCOE is expected to decline a further 42% by 2060, and offshore wind by up to 67%, as manufacturing scales and technology matures [3].

2.2 Why Profitability at Global Scale Remains Elusive

Cost competitiveness in electricity generation is a necessary but not sufficient condition for global deployment. Several structural barriers prevent renewables from replacing fossil fuels at scale today, even where their LCOE is lower.

The first and most significant barrier is the distortion created by incumbent fuel subsidies. In 2023, global government subsidies to fossil fuels amounted to approximately $1.5 trillion [4]. These subsidies — covering consumer price supports, producer incentives, and general services — artificially reduce the delivered cost of fossil-fuel energy and impose an unlevel playing field on any competitor, regardless of its generation cost.

The second barrier is capital access and the cost of financing. A solar project in an emerging economy faces cost-of-capital premiums that can double its effective LCOE relative to an identical project in Germany or the United States [5]. The International Energy Agency estimates that annual clean energy investment in emerging and developing economies must triple from roughly $770 billion per year in 2022 to between $2.2 and $2.8 trillion per year by the early 2030s to meet Paris Agreement targets [6]. This magnitude of capital — tens of trillions of dollars over a decade — lies far beyond the capacity of public funding alone.

The third barrier is grid infrastructure and system integration. Renewable generation is intermittent by nature; solar panels do not produce power at night, and wind turbines are idle in calm weather. Until battery storage, long-duration storage, and grid interconnection are sufficiently developed and deployed, fossil-fuel "dispatchable" generation remains essential for reliability. The energy sector is investing heavily in precisely these bridging technologies, as the evidence below demonstrates.

3 The Energy Sector's Investment in the Renewable Transition

3.1 Global Clean Energy Investment: A Record-Setting Trend

The claim that the energy sector is obstructing the renewable transition is contradicted by the investment data. According to the IEA's World Energy Investment 2024 report, global clean energy investment surpassed $2 trillion for the first time in 2024 — exceeding total investment in oil, gas, and coal combined for the first time in history [7]. Solar PV alone attracted more than $500 billion, more than any other single electricity generation source. Battery storage exceeded $50 billion, and nuclear power investment reached $80 billion — nearly double the 2018 level.

BloombergNEF corroborates this picture. Global energy transition investment grew from $1.8 trillion in 2023 to $2.1 trillion in 2024 and reached $2.3 trillion in 2025 [8]. Electrified transport, renewable power, and grid infrastructure account for the three largest categories. Private capital — flowing from energy companies, institutional investors, and technology firms — is the dominant driver.

3.2 Panthalassa: Harnessing the Untapped Ocean

Among the most innovative entrants in the clean energy space is Panthalassa, a Portland, Oregon-based company founded in 2016. Panthalassa is developing autonomous floating nodes capable of converting open-ocean wave motion into continuous electricity, which is then used to produce green hydrogen and clean fuels directly at sea [9], [10]. The company's mission is to generate what it describes as the world's lowest-cost renewable electrons from an energy source that is both geographically vast and temporally consistent relative to solar or wind.

Panthalassa has raised $78.1 million in funding, backed by investors including Lowercarbon Capital, and assembled a technical team drawing on expertise from NASA, SpaceX, and the U.S. Air Force. Wave energy is one of the least-developed but highest-potential renewable resource classes; the energy sector's willingness to back early-stage ventures like Panthalassa reflects a genuine commitment to expanding the renewable portfolio beyond the already-mature solar and wind markets.

3.3 Tesla Energy: Solving the Intermittency Problem

Tesla Energy represents the clearest example of how private capital is solving the most critical barrier to full renewable deployment: storage. Tesla's Megapack — a utility-scale battery system — and its residential Powerwall product are converting intermittent solar and wind generation into dispatchable electricity, addressing the very problem that critics use to argue renewables cannot replace fossil fuels.

In 2024, Tesla Energy deployed 31.4 GWh of energy storage, representing 114% year-over-year growth [11]. The division generated $10.1 billion in revenue, a 67% increase from $6 billion in 2023, with a gross profit of $2.6 billion [12]. Tesla operates two Megapack manufacturing facilities — in Lathrop, California and Shanghai, China — each with 40 GWh of annual production capacity. In 2025, Tesla projected a further 50% growth in storage deployments.

This trajectory matters enormously for the renewable transition argument. Battery storage at the scale Tesla is deploying turns solar and wind from "weather-dependent" sources into reliable, grid-scale power. The economics of this storage are still maturing — Tesla received $756 million in U.S. manufacturing tax credits in 2024 to support its domestic production [11] — which is precisely the defense's point: private investment, supported by targeted policy incentives, is making the economics work.

3.4 Bloom Energy: Bridging to a Hydrogen Future

Bloom Energy takes a different but complementary approach. The company manufactures solid oxide fuel cells (SOFCs) — highly efficient distributed power generators that currently run on natural gas but are explicitly designed as hydrogen-ready transition technology. With 1.3 GW of SOFC technology deployed globally, Bloom Energy represents the energy sector's investment in the reliable, modular power generation that can serve as a bridge between today's gas-dependent grid and tomorrow's green hydrogen economy.

In August 2024, Bloom Energy demonstrated a hydrogen SOFC achieving 60% electrical efficiency — and 90% total efficiency when combined heat and power is fully utilized — running on 100% hydrogen fuel at its Fremont, California research facility [13]. This milestone is significant: it demonstrates that the same physical hardware currently burning natural gas can transition seamlessly to green hydrogen as supply scales.

Bloom Energy is also scaling rapidly. In November 2024, the company announced the world's largest single-site fuel cell installation: an 80 MW project in South Korea in partnership with SK Eternix [14]. A $5 billion partnership with Brookfield Asset Management was announced to deploy fuel cell technology across AI data centers globally [15], reflecting broader recognition that clean, reliable distributed power is essential infrastructure for the digital economy. Bloom received $75 million in federal Inflation Reduction Act tax credits in 2024 to expand its Fremont manufacturing plant.

3.5 Nuclear Power: The Baseload Foundation of a Renewable Grid

Renewable energy skeptics correctly note that solar and wind cannot provide the stable, 24/7 baseload power that modern economies require. This is where advanced nuclear power — particularly small modular reactors (SMRs) — plays a critical role, and where the energy sector is making multi-billion-dollar commitments.

3.5.1 TerraPower: Advanced Sodium-Cooled Reactors

TerraPower, founded by Bill Gates, is developing the Natrium reactor: an advanced sodium-cooled fast reactor combined with molten salt thermal storage that allows it to dynamically adjust its power output in response to grid demand — making it uniquely compatible with renewable-heavy electricity systems. TerraPower has raised a total of $1.4 billion in equity as of June 2025, including a $650 million funding round that attracted NVIDIA's venture arm (NVentures) and HD Hyundai [16]. The U.S. Department of Energy has contributed approximately $2 billion in co-funding toward the project.

In April 2025, TerraPower received its final safety evaluation from the Nuclear Regulatory Commission — the critical regulatory approval required before construction — for its first commercial reactor in Kemmerer, Wyoming, which is targeted for commercial operation by 2030 [17]. The Natrium project is a direct product of private capital deploying into advanced nuclear technology precisely because the sector recognizes that a decarbonized grid will require firm, dispatchable, zero-carbon power.

3.5.2 NuScale Power: Small Modular Reactors at Commercial Scale

NuScale Power is the furthest-advanced SMR developer in the United States by regulatory standing. The company's light-water SMR design has received NRC design certification, and it has attracted more than $1.8 billion in total investment — including $578.3 million from the U.S. Department of Energy [18]. In 2025, NuScale entered a landmark partnership with the Tennessee Valley Authority and ENTRA1 Energy to deploy up to 6 gigawatts of SMR capacity across the United States [19]. At the end of 2025, the company held $1.3 billion in cash and investments, reflecting strong ongoing investor confidence.

SMRs represent the energy sector's bet that nuclear can be made economically competitive through modularization and factory manufacturing — the same learning-curve logic that brought down solar costs. Private investment is funding the demonstration projects necessary to prove out that economics.

3.6 The Oil Majors: Scale, Infrastructure, and the Long Transition

It would be incomplete to discuss energy sector investment without acknowledging the oil majors, who control the largest pools of energy capital. The picture here is mixed, and the defense does not contend it is otherwise — but the direction of travel is clear.

3.6.1 TotalEnergies: 26 GW and Growing

TotalEnergies has made the most systematic renewable commitment among the oil majors. The company invested approximately $5 billion in low-carbon energy in 2024 and reached 26 GW of gross installed renewable electricity capacity, with targets of 35 GW by 2025 and 100 GW by 2030 [20]. Its Seville Solar Cluster in Spain — 263 MW of installed solar capacity generating 515 GWh of annual electricity — was the largest solar installation in Europe upon commissioning [21]. In France, the company is investing €4.5 billion in the Centre Manche 2 offshore wind farm, its largest domestic investment in three decades.

3.6.2 Shell: Hydrogen and Grid-Scale Commitments

Shell committed $10–15 billion to low-carbon investments across 2023–2025, and has staked a significant position in renewable hydrogen. Its Holland Hydrogen 1 project at the Rotterdam Energy and Chemicals Park is one of the largest renewable hydrogen production facilities in Europe. Shell's 2024 Energy Transition Strategy, published in March 2024, outlines a pathway to net-zero emissions by 2050 across all operations and energy products [22]. Critics note — and the defense concedes — that Shell's 2024 renewable spending of approximately £2 billion remains substantially below its oil and gas capital expenditure [23]. However, this disparity reflects rational economic decision-making: Shell generates the returns on fossil fuel assets that fund renewable investments. Curtailing fossil fuel revenues faster than renewable revenues can replace them would destroy the capital available for the transition.

3.6.3 BP: The Investment Reality

BP's recent decision to moderate its transition investment from a previously announced $4 billion per year to $1.5–2 billion per year reflects exactly the argument this defense advances: renewables are not yet sufficiently profitable to attract unlimited private capital without continued development [24]. BP's 60.6 GW renewables pipeline (as of end-2024) and its Lightsource BP solar acquisition represent genuine long-term commitments, but rational capital allocation requires matching investment pace to economic returns. The energy sector cannot be expected to accelerate the renewable transition by destroying shareholder value — the capital that funds both today's operations and tomorrow's clean energy projects.

4 The Investment Gap: Why Private Capital Is Not Optional

The IEA has estimated that annual clean energy investment in emerging and developing economies alone must triple to $2.2–2.8 trillion per year by the early 2030s to stay on a Paris-aligned trajectory [6]. The totality of OECD government budgets could not sustain this level of spending. Private capital — from energy companies, institutional investors, sovereign wealth funds, and project finance lenders — is not a supplementary source; it is the primary mechanism through which the transition can occur at the required pace and scale.

Research confirms that competitive electricity markets, long-term power purchase agreements, and reliable regulatory frameworks are the most important enablers of private renewable investment [25]. These are conditions that energy sector participants have advocated for and, in many cases, created through their own project development. The sector's investment returns in unlisted renewable infrastructure have outperformed broader infrastructure markets by 22%, and by 33.5% in emerging markets [6] — evidence that renewable energy investment is becoming self-sustaining precisely because the sector has taken the early risk.

5 The Profitability Bridge: From Demonstration to Deployment

The defense's central contention is that we are in a transitional period — one where renewables are cost-competitive in generation but not yet complete as a system. The gap between "cheapest electrons" and "fully deployable zero-carbon grid" is filled by storage, grid infrastructure, advanced nuclear, green hydrogen, and the digital management systems that coordinate them. Each of these requires significant additional private investment before it is economically self-sustaining without policy support.

This is not a counsel of delay. It is a description of economic reality. The levelized cost of offshore wind, for example, is still declining from \$100–150/MWh in 2018 to projected levels below \$60/MWh by the end of this decade — but the capital to fund the next generation of turbine farms must be raised now, from investors who will not commit unless returns are credible [2], [3]. The same logic applies to green hydrogen (currently \$3–10/kg, with cost targets of \$1/kg for competitiveness with gray hydrogen), to long-duration storage, and to SMRs.

The energy sector is funding the journey down these cost curves. To penalize it for the current position on those curves — rather than credit it for the trajectory — is to misunderstand how capital-intensive industries achieve scale.

6 Conclusion

The evidence presented in this brief establishes the following: renewable energy has achieved genuine cost competitiveness in electricity generation, driven in large part by private capital deployed by the energy sector. Full profitability at global scale — encompassing storage, grid integration, firm clean power, and green fuels — is a work in progress, with billions of dollars flowing toward precisely the technologies that will complete the transition.

Companies like Panthalassa are expanding the renewable resource base to the open ocean. Tesla Energy is solving the storage problem at gigawatt-hour scale. Bloom Energy is building the hydrogen bridge. TerraPower and NuScale Power are making nuclear power small, modular, and compatible with renewable grids. TotalEnergies, Shell, and BP are deploying tens of gigawatts of capacity while funding the next generation of clean technologies.

The energy sector's argument is not that renewables should wait. It is that the transition requires the private capital, project expertise, and infrastructure reach that the sector uniquely provides — and that displacing this investment with punitive measures would slow, not accelerate, the arrival of a fully renewable global energy system. The defense rests on the evidence that the energy sector is part of the solution.

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