

ENERGY INDUSTRY GROUP

Power to Compete: A Framework for Clean Economic Development

The U.S. electricity system is at a defining crossroads. Load growth is accelerating, driven by the expansion of data centers, the reshoring of manufacturing, and the electrification of buildings and transportation as core pillars of decarbonization strategies. These forces are not only reshaping the nation's energy landscape but are also elevating the stakes for states that aspire to decarbonize while capturing transformative economic growth opportunities.

The competition for new projects is both real and fierce. States with ambitious climate goals face a stark reality: Without a competitive clean energy strategy, they risk losing economic opportunities to jurisdictions with less emphasis or no emphasis — on decarbonization. In an era where power reliability and cost are nonnegotiable for industries like big tech and advanced manufacturing, climate-leading states could find themselves sidelined in attracting high-value investments. Yet, this moment presents an unprecedented opportunity to position clean economic development as a driver of both sustainability and prosperity.

Industry and policymakers alike often view this opportunity through a predominantly technological lens, rekindling interest in advanced nuclear, betting on innovations like enhanced geothermal, or envisioning dedicated large-scale solar microgrids. For example, over the past several months Microsoft and Constellation Energy announced their plans to restart a shuttered nuclear reactor at Three Mile Island,¹ and Google and NV Energy are seeking regulatory approval to enable the search giant use geothermal energy for a new data center.² While technology will undoubtedly play a vital role, no single-power generation solution can meet the challenge of providing reliable, emissions-free power at scale, on an accelerated timeline, and at competitive prices across diverse geographies and grid configurations.

Without a competitive clean energy strategy, states with ambitious climate goals risk losing economic opportunities to those with lesser emphasis on decarbonization.

The path forward demands a broader, integrated approach one that aligns technology, finance and policy into a cohesive clean economic development strategy. This paper offers a framework for such an approach, highlighting actionable ideas that can emerge from deeper public-private collaboration. We also explore the strategic advantages clean economic development offers for investors, developers, industrial customers and communities. While there is no one-size-fits-all solution, the moment calls for visionary partnerships to build thriving, sustainable economies together. Whether you are a state energy leader seeking to align policy with growth, an investor evaluating opportunities in clean energy infrastructure, or a hyperscaler charting a course toward net-zero operations, this paper invites you to imagine what is possible and how it can be achieved.



¹ "Microsoft and Constellation Energy announced their plans to restart a shuttered nuclear reactor at Three Mile Island," World Nuclear News, September 20, 2024. <u>https://www.world-nuclear_news.org/articles/constellation-to-restart-three-mile-island-unit-powering-microsoft</u>

² "Google partners with Nevada utility for geothermal to power data centers," Reuters, June 13, 2024, <u>https://www.reuters.com/business/energy/google-partners-with-nevada-utility-geothermal-power-data-centers-2024-06-13/</u>



1. Background/Context

The U.S. electricity system faces unprecedented load growth (~3-5 percent CAGR),³ driven primarily by AI-powered data centers and reshored manufacturing.⁴ For states with decarbonization goals, this surge in demand poses a critical challenge: While many have made substantial progress toward their clean electricity targets, accelerating load growth means they are falling further behind their aspirational timelines. Even before this demand surge, most states were tracking slightly behind their interim goals - targets that were set assuming

Deeper collaboration between states and the private sector can lead to promising solutions.

relatively flat or gradual load growth. This widening gap reflects two key challenges: the inherent limitations of intermittent clean energy sources in providing reliable, on-demand power and the mounting difficulties in integrating and interconnecting new renewable installations into the grid. While stakeholders are actively pursuing clean energy solutions, neither current technologies (like solar and wind with storage) nor emerging options (such as advanced nuclear or enhanced geothermal) are scaling guickly enough to meet rising demand. This leaves natural gas as the default option - potentially compromising decarbonization goals. And while federal policy changes are important, the most promising solutions may lie in deeper collaboration between states and private sector partners.

EXHIBIT 1

Challenges Across the Clean Economic Development Ecosystem



Data center and manufacturing companies with net-zero or sustainability pledges are searching broadly for clean energy capacity to avoid compromising their goals.

State and local agencies

States and local governments aiming for decarbonization worry about losing economic development due to insufficient clean power or compromising sustainability to secure it.

Local communities Local communities want affordable electricity, equitable job opportunities and positive contributions to climate action.

Source: A&M interviews and research

Clean economic development ecosystem

Investors

Investors seek opportunities that fit traditional risk/return profiles, which are harder to find due to rising risks.

Developers

Renewable developers grapple with high costs, grid connection issues, permitting hurdles, land acquisition, supply chain challenges and community opposition.

Utilities

Utilities struggle to meet growing demand and integrate renewables due to grid constraints, intermittency, regulations and high capital needs.

³ Robert Walton, "US electricity load growth forecast jumps 81% led by data centers, industry: Grid Strategies" Utility Dive, December 13, 2023, https://www.utilitydive.com/news/electricity-loadgrowing-twice-as-fast-as-expected-Grid-Strategies-report/702366,

⁴ Robert Walton, "Five-year US load growth forecast surges 456%, to 128 GW: Grid Strategies", Utility Dive, December 6, 2024, https://www.utilitydive.com/news/shocking-forecast-uselectricity-load-could-grow-128-gw-over-next-5-years-Grid-Strategie



2. Market Hurdles Facing Clean Energy Developers

Developers of clean energy projects face a core set of challenges that are heightened by the promise and pressure of new economic development opportunities:

Complex and Protracted Permitting: Renewable energy projects often require more than three years to secure siting and interconnection permits, primarily due to opaque timelines and administrative bottlenecks. While grid operators are implementing reforms, such as PJM's transition from "first-come, first-served" to "first-ready, first-served" queues, permitting remains a critical constraint.

High Project Mortality: Developers struggle to accurately assess project viability due to limited grid data and unclear utility interactions. Combined with substantial nonrefundable upfront payments and potential community opposition, these uncertainties lead to frequent project cancellations.

Construction Cost and Labor Constraints: IRA prevailing wage requirements, coupled with a limited supply of qualified workers, have increased construction costs. This is particularly challenging in regions with complex geological conditions or limited construction seasons.

Market Design Limitations: Current market rules and structures can create challenges for clean energy projects, particularly around capacity value, energy pricing and ancillary services. Many wholesale markets were designed around traditional dispatchable generation, making it harder for variable renewable resources to compete effectively or capture their full value. For instance, capacity market rules often discount the reliability contribution of wind and solar resources, while insufficient price granularity in energy markets undervalues flexible resources during high-demand periods. Additionally, complex participation requirements can limit storage providers' ability to offer their full range of grid services, reducing their economic viability.

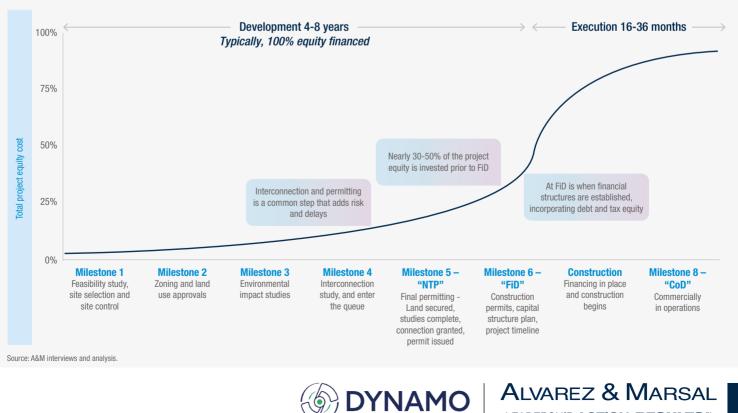
Data and Coordination Gaps: Developers face persistent challenges in coordinating with utilities, particularly around transmission interconnection. Even with new cluster-based approaches, developers must still navigate individual node applications without comprehensive system data.

These barriers extend project development timelines by years, during which developers bear mounting costs without a return on their invested capital. This dynamic creates two market wide effects: Successful projects require higher profit margins to offset development risks, driving up electricity costs, and developers increasingly focus on states with more streamlined processes, reducing market competition and innovation in challenging jurisdictions.

EXHIBIT 2

Developers Face Significant Time and Equity Commitments Prior to Final Permits.

Illustrative Project Lifecycle in Development





Through A&M's analysis of interviews with clean energy developers, we estimate that delays in development could cost developers 3 to 5 percent on project returns.

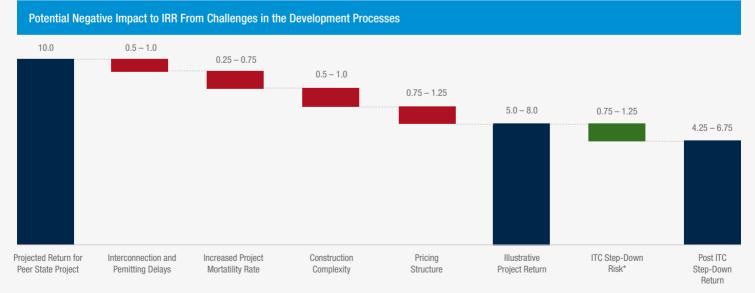
It is difficult to assess the level of financial impact created by these development challenges, and to allocate them to specific sub-elements of a project's projected return. Project developers are generally more focused on overcoming hurdles than in measuring their impact. However, through A&M's interviews with clean energy developers⁵ and our analysis we estimate that delays along the development lifecycle could end up costing developers 3 to 5 percent on project returns (see Exhibit 3). This extended timeline not only makes projects more expensive as developers need higher post-development returns to compensate, but this reduction in potential returns combined with increased project risk diminishes developers' enthusiasm to expand their involvement and investors' interest in navigating the complex nature of the capital stack, particularly for newer technologies (such as nuclear, enhanced geothermal, hydrogen) that are poised to play an important role in clean economic development. This creates a development environment with fewer projects, leading to a slower pace of transition and less competition among developers that results in higher prices for the system.

⁵A&M conducted open interviews with 15+ clean energy developers and economic development and state energy officials in 2024.

EXHIBIT 3

Impact to Developer Returns From "Nonfinancial" Factors

Illustrative



*ITC requires project to reach final stages, investment decisions are being made now for projects that will qualify for the full ITC, in a few years projects being developed will likely only qualify for the reduced ITC if development pprocess is delayed. Source: Expert interviews, A&M analysis

Note: Project IRR based on an illustrative solar PV Project of medium to large scale with storage, develped, constructed and held for a useful life of ~3- years.





2.1. Needs, Opportunities and Solutions Vary Significantly by Project Size, With Varying Appetite and Need for **Public Sector Financial Support**

While public-private engagement is beneficial for any clean energy project, its criticality varies depending on the size of the project. The larger the project, the more innovative public sector support and direct financial backing from the public sector is needed. Key financial considerations based on project size are summarized in the table below.

Project Size	Examples	Primary Challenges	Opportunities for State Support
Small (<5 MW)	On-site solar plus storage or geothermal for light manufacturing or a small data center	Developing viable business modelSecuring financing	 Nonfinancial (e.g. permitting reform, ensuring data accessibility)
Medium (5–20 MW)	On-site solar plus storage or geothermal for light manufacturing or a small data center	 Developing viable business model Ensuring adequate grid capacity Managing high financing costs (in the case of smaller counterparties) Land availability (depending on geography) 	 Nonfinancial (e.g. permitting reform, ensuring data accessibility)
Large (20–100 MW)	Large-scale renewables, CCUS, geothermal energy, SMRs and hydrogen for, e.g., a hyperscaler data center or a large manufacturing facility	 Developing viable business model Ensuring adequate grid capacity Securing financing Managing technology risks 	 Financial in the form of grants, tax credits or low-cost loans Nonfinancial (e.g. permitting reform, ensuring data accessibility)
Mega (100+ MW)	Large-scale renewables, CCUS, geothermal energy, SMRs and hydrogen for large heavy industry plants	 Developing viable business model Ensuring adequate grid capacity Securing financing Managing technology risks Build-out of dedicated transmission structures 	 Financial in the form of grants, tax credits, loan guarantees or non-dilutive equity Streamlined permitting process to enable transmission build-out



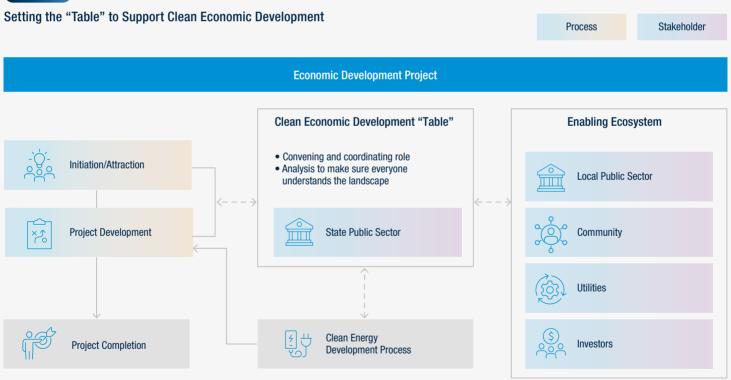


3. What Can the State and Private Sector Ecosystem Do to Address This?

There are several principal areas of activity to meet the clean energy opportunity; namely, reducing complexity through stakeholder coordination, eliminating nonfinancial barriers by supporting grid infrastructure programs and improving permitting and data transparency, and supporting the financing and development of projects through innovative structures.

Leading Coordination to Reduce Complexity can be accomplished by facilitating coordination among different stakeholders, including renewable developers, utilities, end use customers and the community. A clear process defined by the state supports multiple solution archetypes (e.g., traditional renewables development, virtual power plants, other innovative approaches detailed later in this section), resulting in an acceleration in clean economic development.

EXHIBIT 4







Overcoming Nonfinancial Barriers to clean energy deployment can be achieved by supporting grid infrastructure investment approaches to meet demand, as well as by addressing nonfinancial challenges such as permitting and data transparency. The most important nonfinancial contributions for the energy component of economic development projects are permitting, interconnection, community engagement/buy-in, well-understood processes and transparent data - contributions that effective coordination and leadership from the clean economic development table can help address.

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Even reducing delays in development by two years (i.e., from ~five to three years) would be equivalent to public sector grants fully covering 3 to 5 percent of construction costs for a 150-MW project. For example, the overnight construction cost of 150-MW Solar PV plant is around \$217 million;⁶ a two-year reduction in the development timeline would be worth ~\$6 to \$11 million to a developer.

Supporting the Financing and Development of Projects Through Innovative Structures can support the development of both on-site renewable projects and advanced technologies for larger loads.

What could these innovative structures look like?

⁶ U.S. Energy Information Administration, "Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2023," March 2023, https://www.eia.gov/outlooks/ aeo/assumptions/pdf/elec cost perf.pd

EXHIBIT 5

How Innovative Structures Could Cover the Range of Needs







- Bring Your Own Power: This approach enables commercial and industrial customers to develop dedicated clean energy resources, with or without future grid-connection plans. It is relatively common for states (California, New York, Texas, Massachusetts) and utilities to offer customer-sited, selfgeneration programs, and recent years have seen significant growth in behind-the-meter solar installations. However, these programs typically involve very low levels of power generation, typically less than 1 MW. However, even modest opportunities driving load growth (a small data center, a manufacturing line extension, a charging depot for a small fleet of medium-duty vehicles) are likely to exceed this. Programs targeting larger-scale self-generation (1MW+) typically require substantially different approaches than these existing programs for several reasons:
 - Grid impact studies and interconnection processes become much more individualized and technically rigorous.
 - Financial structures often need to move beyond simple retail rate compensation to more sophisticated mechanisms that account for time-of-use, capacity value and grid services.
 - Technical requirements typically require custom engineering review rather than standardized processes.
 - Programs need flexibility to handle diverse technologies (CHP, large-scale solar, fuel cells, etc.) rather than being designed mainly around rooftop solar.
 - Resource planning and grid integration components need to be more robust, often requiring integration with utility planning processes.

Community-scale virtual power plants integrate multiple distributed generation, storage and demand-response technologies across participating community assets.

Community-Scale Virtual Power Plants: Community-scale virtual power plants (VPPs) represent an emerging approach to addressing load growth and grid resilience through aggregated distributed energy resources (DERs) across municipal infrastructure and private sector assets. Unlike traditional utility-scale generation or individual behind-themeter solutions, these comprehensive systems integrate multiple distributed generation, storage and demandresponse technologies across participating community assets. The allure of this approach is driven by its scalability - typically achieving 10-50 MW of flexible capacity - and its alignment with grid modernization trends.

However, this approach differs significantly from existing distributed energy strategies for several critical reasons:

- Aggregation technologies enable orchestration of diverse energy assets with sub-minute response times, including building-level solar, commercial and industrial battery storage, electric vehicle charging networks, flexible industrial loads and grid-interactive smart devices.
- Economic models move beyond traditional utility compensation frameworks to create multi-stakeholder value streams spanning wholesale markets, retail services and capacity products, including direct grid services, capacity firming, ancillary support and local resilience planning.



- Technical integration requires advanced software platforms for managing heterogeneous energy resources, incorporating forecasting and automated dispatch capabilities while meeting utility cybersecurity and communications protocols.
- Regulatory frameworks must evolve to create market mechanisms that properly value the multi-dimensional grid benefits provided by coordinated distributed energy systems.
- Infrastructure planning becomes increasingly dynamic, with energy systems conceived as flexible, adaptive networks rather than static, centralized generation and distribution models
- Bring Your Own Capacity: Bring Your Own Capacity (BYOC) represents an innovative approach to accelerating clean energy deployment by enabling commercial, industrial and institutional customers to directly contribute to grid modernization and clean energy expansion. Unlike traditional self-generation models, this approach creates a collaborative framework where energy users become active partners in grid transformation, addressing critical infrastructure challenges while securing dedicated clean energy resources. The core principles of Bring Your Own Capacity include:
 - Financial Contribution Model: Customers provide direct financial support for grid upgrades that enhance interconnection capabilities, particularly focusing on critical infrastructure like substations and transmission infrastructure. This might include funding storage systems, grid-enhancing technologies or specific interconnection improvements that facilitate broader clean energy integration.

- Public Sector Enablement: Government agencies provide comprehensive support through:
 - Detailed grid constraint and opportunity mapping
 - Technical assistance and project development quidance
 - Streamlined permitting processes
 - Interconnection priority for projects demonstrating significant grid benefits
 - Support in identifying and accessing multiple incentive streams
- Innovative Financing Mechanisms: Two primary implementation strategies emerge:
 - Clean Transition Tariff: A premium pricing mechanism that allows customers willing to pay for clean, firm and rapidly deployed power to fund the incremental cost difference between advanced clean energy projects and traditional grid power. This approach creates a direct market signal for accelerated clean energy development while providing price certainty for both developers and energy users.
 - Industrial-Scale Solar Development: A statesupported model where public entities provide development finance, with a particular focus on electrical infrastructure investments. These infrastructure costs could be strategically recouped through customer rates, spreading the financial burden while creating a pathway for large-scale clean energy deployment.



The BYOC approach fundamentally reimagines the relationship between energy users, utilities and clean energy developers. By creating flexible, collaborative pathways for grid modernization, it offers a pragmatic strategy for accelerating the transition to a more responsive, resilient and clean energy system.

Responsible GigaPower: Industrial-scale power needs – potentially 30–300 GW of new capacity – are required to support data centers, semiconductor fabrication plants and other large manufacturing facilities. All approaches to meeting loads of this scale involve complex technical, regulatory and financial arrangements that require careful consideration and sustained coordination among multiple stakeholders.

The landscape includes various approaches under development or consideration. Some large technology companies are pursuing bilateral agreements with utilities to repower nuclear facilities, while others are exploring off-grid solar microgrids as a potential path to energy independence. Small modular nuclear reactors represent another possible future solution, though none have been constructed to date. Each of these options faces significant development timelines: While data center power needs may arise within two to four years, most clean energy infrastructure projects require five to ten years for development and construction (and longer for nuclear). Given these timing constraints, natural gas is best positioned to meet near-term demand due to its shorter development cycle and established deployment pathways.

For states committed to decarbonization, two potential strategies could help balance immediate power needs with environmental goals:

- A Clean Bridge Power Purchase Agreement would enable states to capture the near-term benefits of natural gas while ensuring a transition to cleaner technologies. This notional contract structure would guarantee plant owners long-term returns while preserving state authority to mandate future conversion to cleaner technologies or replacement with new generation options. States would commit to funding these transitions, aiming to provide investor certainty while ensuring environmental compliance.
- 2. Publicly-Financed Carbon Capture and Storage could offer another pathway. Under this conceptual approach, states would fund mandatory CCS on new gas plants while retaining ownership of captured CO2, creating potential future value in circular economy applications.

One implementation model being explored is **Clean Industrial Area Development**, where utilities would proactively expand electrical infrastructure capacity at existing industrial sites, subject to regulatory approval. This semi-speculative expansion would enable greater power delivery to support new industrial loads. The cost of these infrastructure upgrades could be recovered either through site-specific electric rates (if the upgrades are included in the utility's rate base) or through state loans to pay for the expansion, which end users would repay through their electric bills.

These approaches require careful coordination between utilities, regulators and private sector partners, along with strong environmental safeguards and community engagement. Given the complexity of these projects and their critical role in economic development, success demands sophisticated technical analysis, innovative financial structures and sustained stakeholder alignment.





4. The Strategic Potential of Clean Economic Development

Clean economic development represents not just the future of climate leadership in states, but a strategic hedge against market uncertainties. While global oil and gas resources remain abundant and producers have demonstrated ability to scale production when needed, accessing these resources requires significant new investment and face increasing cost pressures. Even with robust upstream development, the rapid expansion of LNG exports continues to integrate domestic gas into a global market characterized by greater price volatility. States that rely heavily on gas-fired generation to meet new load growth may find themselves exposed to financial and operational risks, particularly during periods when global demand growth outpaces investment in new supply.

The technology landscape presents another compelling reason to prioritize flexible, clean energy solutions. The artificial intelligence sector driving much of today's load growth is itself undergoing rapid evolution. Next-generation data center architectures and energy-efficient chips could fundamentally reshape both the magnitude and timing of power demand. These innovations may ultimately devalue investments in inflexible natural gas generation assets that could be stranded well before the end of their useful lives. In contrast, clean economic development approaches, particularly those emphasizing demand-side flexibility and distributed resources, offer the adaptability needed to accommodate AI's evolving power requirements while building lasting grid capacity.

The rapid proliferation of large industrial and technology loads is exposing critical constraints in transmission and distribution infrastructure. Utilities and grid operators increasingly face multi-year interconnection gueues and billion-dollar upgrade requirements to accommodate new data centers and industrial facilities - with each major new load potentially affecting voltage stability, power flow and system operations across interconnected portions of the grid. Clean economic development strategies, particularly those emphasizing distributed generation, storage and advanced load management, can help reduce these bottlenecks while supporting faster grid integration. Even when full grid independence isn't the goal, these flexible solutions can accelerate project timelines by meeting a portion of immediate power needs while simultaneously helping address grid capacity constraints and stability requirements. This distributed approach not only enables faster facility deployment but also contributes to system resilience, allowing regions to attract and retain major employers with less dependence on lengthy grid expansion projects.

Clean economic development strategies can provide flexibility and a hedge against market and technology risks inherent in a gas-only strategy.



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5. Conclusion

The convergence of accelerating power demands and decarbonization imperatives presents both an unprecedented challenge and a transformative opportunity for U.S. states. While the scale of needed infrastructure development is daunting, potentially requiring hundreds of gigawatts of new capacity, the solutions emerging from innovative publicprivate collaboration offer promising pathways forward. From community-scale virtual power plants that maximize existing grid capacity to responsible gigapower approaches that ensure clean development of major industrial sites, states and their private sector partners are pioneering frameworks that can deliver both economic growth and environmental progress. These approaches recognize that the path to clean economic development isn't simply about building more generation. It's about reimagining how we develop, deploy and pay for energy infrastructure in ways that align public policy goals with private sector capabilities and market realities.

The stakes could not be higher. States that successfully implement these frameworks will not only capture immediate economic opportunities but also position themselves for longterm competitive advantage in an increasingly carbon-conscious global economy. They will build energy systems resilient to market volatility, adaptable to technological change and capable of supporting next-generation industries. The templates for success presented in this paper, from Clean Bridge PPAs to Clean Industrial Area Development, demonstrate that with creative thinking and sustained collaboration, states can transform the apparent tension between rapid development and decarbonization into a catalyst for innovation and growth. The future of clean economic development belongs to those willing to embrace this challenge and engage in the hard work of reimagining how we power our economy.



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