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Powering the Future: Capital Allocation, Risk Management, and Economic Imperatives in Critical Energy Infrastructure and LNG Expansion

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Abstract

Financing of critical energy infrastructure is changing as LNG expansion, AI-powered electricity demand and large-scale grid modernization all converge. This review looks at the mechanisms that allocate capital, the management of risk, governance issues and economic consequences of this new cycle of infrastructure investment. Comprising a range of financing models—such as utility balance sheet investment, regulated rate base financing, corporate and project finance debt, infrastructure equity, and blended concessional financing—these financing options are increasingly used together to meet different levels of project risk. The analysis also identifies that the LNG expansion is moving towards a more competitive market, where offtake is becoming more important, financial assumptions more conservative and where hyperscale technology companies are now entering the power generation and infrastructure ownership market due to continued electricity supply pressures. The ability to modernize the grid has become an essential cordon between these advancements is the transmission constraints that are driving up electricity demand and impacting project timelines and financing needs. Delays in construction, cost overruns, constraints on supply chains, regulatory uncertainty, and differential access to capital continue to be major challenges in delivering infrastructure. The review also takes into account the wider economic impacts of infrastructure investments such as employment creation and economic growth. Special emphasis is placed on financing in emerging markets, where financing needs are far greater than blended and concessional financing. The results show that besides raising the capital needed to develop the infrastructure, it is equally important to enhance project preparation and delivery supervision.

Keywords: Energy infrastructure financing, LNG expansion, Artificial intelligence, Grid modernization, Infrastructure investment

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Significance:

This review demonstrate how financing, risk management, and governance can accelerate reliable energy infrastructure investment amid rising LNG and AI demand.

Introduction

Improved infrastructure for liquefied natural gas, unprecedented growth in electricity demand from artificial intelligence and data centres and the absence of an investment programme in grids, transmission networks and generation assets are driving the financing of an energy build out on a scale unprecedented in decades [1]. The several developments are attracting investment from utilities, technology firms, sovereign wealth funds, commercial lenders, development banks and institutional investors for various aspects of a highly interdependent infrastructure system. While there are variations in financing models, from corporate capital expenditure to project financing, to direct ownership of the assets to a combination of concessional financing, the issue is a physical constraint—the slow speed of turbine, transformer, transmission equipment, and other key infrastructure production and installation [2]. There has also been a paradigm shift in energy infrastructure financing with LNG expansion coinciding with AI-fueled electricity consumption. Planning for energy security, which has been about diversification of energy supplies and mitigating geopolitical risks, should now include the increasing demand for electricity power caused by digital infrastructure. Meanwhile, the investment in LNG is in a new stage, with significant LNG investment in the global market, which may impact the supply situation and create market and price risk [3]. Data centers are also seeing significant amounts of capital expenditures to support the electricity generation, transmission, cooling and supporting infrastructure to power the data centres, which are another major source of capital expenditure in AI infrastructure. This growth begins to compete with one another for capital, equipment, natural gas and grid space. The financing climate is the expression of two related investment cycles. The first one is the LNG capacity cycle, with investment decisions taken over the last five years when global gas markets were tight after the invasion of Ukraine now coming to fruition as new capacity [4]. First one is the LNG capacity cycle, where investments taken during the period of tight global gas markets after the invasion of Ukraine are now reflecting in new capacity. The second is the technology cycle of AI infrastructure that has quickened as computational demand, large language models, and data centre needs have increased [5]. Infrastructure projects are both time consuming and expensive to construct and are essential to both cycles, with long construction timelines and complex contractual negotiations. But demand is shifting much faster than the traditional infrastructure planning and financing models can keep up. The complexity of risk management has thus increased. The combination of construction cost overruns, supply chain disruptions, geopolitical uncertainty, commodity price volatility, regulatory changes, permitting delays, and technological shifts all have to be taken into account when financing LNG terminals, power plants, transmission corridors and large scale data centres [6]. The long development time of infrastructure projects makes it especially vulnerable to changes during the process from financial commitment to commercial operation. These risks can impact project bankability, financing rates, contractual agreements, and project responsibilities between governments, developers, lenders, utilities, and technology companies.

Capital Markets Foundations for Energy Infrastructure Financing

The capital sources available for financing critical energy infrastructure are diverse, with various options available to address different facets of the risk-return continuum. Domestic grid and generation investment is still largely based on utilities' balance sheets and regulated rate base financing as utilities can recover capital costs over long depreciation schedules through customer rates and it is the lowest cost source of capital for grid connected assets [7]. Corporate and project finance debt, which is generally secured on the project's own cashflows, and not a sponsor's balance sheet, is still the primary financing structure for LNG terminals and large-scale generation assets, albeit that the volume of project finance transactions in the international market fell sixteen percent in 2025, even though international FDI grew by fourteen percent over the same period [8]. But precisely because it can move faster than debt structures that are geared to traditional utility regulatory timelines, equity capital, from infrastructure funds, sovereign wealth funds, and now, increasingly, technology companies that use the power directly, has grown as a share of the financing stack (Table 1) [9]. Markets for blended and concessional finance (a mix of public or philanthropic financing with private investment to mitigate early stage risk) are an important complement to commercial finance and are estimated to be worth a total of 4.2 trillion dollars per year across emerging and developing economies through 2030 – a figure that is a small fraction of the 18.7 billion dollars of annual financing commitments recorded in 2025 globally.

Table 1: Capital Allocation and Financing Mechanisms in Critical Energy Infrastructure

Application	Primary Financing Model	Key Capital Source & Characteristics	Reference
Domestic Grid & Generation	Regulated Rate Base & Balance Sheet	Utilities recover capital costs over long depreciation schedules through customer rates, representing the lowest cost source of capital.	[2], [3]
LNG Terminals & Large Generation	Corporate and Project Finance Debt	Secured on project cash flows rather than sponsor balance sheets; international market volume declined by 16% in 2025.	[5]
AI Infrastructure & Data Centers	Equity Capital & Direct Ownership	Infrastructure funds, sovereign wealth funds, and hyperscalers funding direct asset ownership to bypass multi-year interconnection queues.	[6]
Emerging Markets Development	Blended and Concessional Finance	Public/philanthropic capital mixed with private investment; estimated at $4.2 trillion annual need through 2030 against $18.7 billion commitments.	[7],[9]

Financing the AI Driven Power Demand Surge

That is the most structurally different financing trend of the last two years, as big techs transition from merely power consumers to being direct infrastructure providers and owners. The power purchase agreement (PPA), which enabled hyperscalers to finance new renewable power without the risk of construction or ownership, was the standard for the period from 2021 to 2024 [10]. It has effectively started to fall apart as queues of data centres waiting to be interconnected grew into years, and when it turned out that about two thirds of data centres were power constrained and not capital constrained, the model was shown to be flawed. Direct financing and ownership is the answer. At the end of 2025, Google went beyond just structuring a partnership, and it was a full buy-out of Intersect Power, as Google took ownership of the generation assets (Figure 1) [11]. In the end, Google structured a partnership with Intersect Power and TPG Rise Climate to catalyze $20 billion in co-located clean power generation, and then, at the end of 2025, it outright acquired Intersect Power. Long duration baseload commitments are being made with nuclear power as the tool: Constellation Energy has recently been awarded a Microsoft power purchase agreement for its restart of the former Three Mile Island Unit 1, which is estimated to be ten billion dollars or more over its lifetime, and Meta announced agreements in January 2026 for up to 6.6 gigawatts of nuclear baseload by 2035 [12]. The amount of capital that is involved is hard to overestimate. As of April 2026, more than 650 billion dollars will be invested in AI infrastructure by the four largest cloud operators in 2026 alone – and that's not because of a shortage of funds but because power simply couldn't be secured in time.



Figure 1. Creating a bankable and resilient water & energy portfolio [13]

Risk Management in Capital Intensive Energy Projects

As important to project financing decisions as commodity price or offtake risk is construction and delivery risk. The in-depth analysis of 662 energy infrastructure projects in 83 countries and covering almost 90 years of construction activity revealed that more than 60 percent of projects were built at a higher-than-expected construction cost and that the average project was built 40 percent over budget and almost 2 years late [14]. Risk is very different for different technologies. Nuclear power plants have the greatest exposure, with average exposure of 100 percent overrun, which is close to 1.56 billion dollars over initial estimates, and average delays of thirty five months, followed by hydroelectric at just under thirty seven percent overrun and geothermal at eleven percent. In contrast, solar photovoltaic and transmission infrastructure, on average, performed better than budget, with increasing numbers of lenders citing this fact as a comparison in their calculation of risk adjusted returns of firm baseload projects versus solar (Table 2) [15]. At the highest level, government-managed megaprojects exhibit the same trends, with the US National Nuclear Security Administration's portfolio of major projects increasing from a cumulative $2.1 billion in cost overruns in 2023 to $4.8 billion in 2025, and cumulative schedule delays for the projects reaching thirty years [16]. These reoccurring issues – the lack of comprehensive design from the outset of construction, the cost of financing while projects are on hold, and the lack of effective information management throughout geographically distributed teams – are well documented in literature, but are recurring in energy and defence infrastructure programmes, indicating that the mitigation of risk has not matched the scale and speed of the current build out [17].

Table 2: Technology-Specific Risk Profiles and Construction Performance

Energy Technology	Average Cost Overrun	Average Schedule Delay	Risk Implications for Underwriting	Reference
Nuclear Power	~100% (~$1.56 billion overrun)	35 Months	Highest risk profile; requires substantial financial contingencies, high interest during construction, and robust contractual protections.	[14]
Hydroelectric	~37%	Significant Delays	High capital exposure requiring specialized long-term project debt structuring and comprehensive design supervision.	[16]
Geothermal	~11%	Moderate Delays	Moderate upfront exploration and resource risk requiring targeted risk-mitigation instruments.	[17]
Solar PV & Transmission	Better than budget	Low / Minimal	Favorable performance metrics compared to baseload thermal assets, increasingly used by lenders as a benchmark for risk-adjusted returns.	[19]

Economic Impact and Growth Effects

The economic rationale behind this amount of capital investment is well documented and the resulting multiplier effect. In the U.S., 1.3 trillion dollars in projected private investment in oil and gas infrastructure is expected to create over one million jobs every year over the years, with the indirect and induced effects of jobs included, adding nearly two trillion dollars to GDP [18]. Even larger impacts are reported in broader infrastructure spending studies: McKinsey's infrastructure investment report estimated that the total number of jobs created would be 1.8 million, and that GDP would be increased by three hundred to four hundred billion dollars, stemming from the impact and job creation impact that happen well before projects are completed (Figure 2). A study of energy distribution network investments in Romania found an economic multiplier range between 6 and 10 times the amount invested, which means that the money invested would generate an increase in GDP of more than three per cent of the national output within 5 years [19]. These multiplier benefits are a key driver of the governments' continued strategy of investing in energy infrastructure, such as LNG export capacity and adjacent power generation using artificial intelligence, instead of a commercial decision, while they struggle to balance affordability and reliability with the cost of faster demand growth for existing rate payers.



Figure 2. Eleven techniques for directing capital to the initiatives that deliver the strategy [20]

Cross-Cutting Issues and Regulatory Considerations

The increasing pressures for the same turbines, transformers, skilled workers and project finance capital for the LNG terminals, data centre campuses and grid modernization projects [21]. Consequently, there are interdependencies that were smaller in the past 10 years, but are growing as delays or cost escalation in one sector can increasingly become a concern for another. The competition has complicated the capital allocation process as infrastructure developers have to consider project-specific requirements and constraints within the broader energy and technology context. Lenders are also fine-tuning underwriting criteria to reflect market conditions [22]. Those who had previously valued LNG and power project risks on the basis of the scarcity conditions of 2022, 2023, are now adjusting their valuations given the possibility of a looser LNG market and an electricity market that is suddenly plagued by a high level of uncertainty regarding the level of demand. The financing models are therefore increasingly based on pessimistic commodity prices, project revenues, construction costs, power availability, and debt service capacity [23]. Lenders continue to grapple with how to strike the right balance between long-term investment needs and market conditions, with underwriting practices across both LNG infrastructure and power infrastructure still in flux. Multilateral development banks and development finance institutions also continue to be significant players in emerging market energy financing. Instruments like concessional loans, guarantees and first loss tail can help reduce the risk of a project in early stages and bring in private capital to projects that may not otherwise meet traditional commercial lending criteria [24]. Concurrently, these institutions shape project governance in environmental, social and financial reporting, procurement and safeguards. They are not only providing capital, but also contributing to the overall design and supervision of infrastructure projects. These trends suggest that financing of infrastructure today relies ever more on the interplay of capital allocation, ownership models, regulatory environments, and project governance. Being able to raise the funds is just one aspect of the task. Effective cost allocation, credible risk sharing, disciplined project management, and clear regulatory accountability are all equally vital to the ability of the vast pipeline of LNG, grid, generation and AI related infrastructure to be delivered on schedule and within financially sustainable limits [25].

Challenges and Limitations

The financing pipeline can be a slow process to turn into operating infrastructure due to several structural issues. Physical delivery constraints, not capital availability, are now the primary constraint on both LNG and AI power projects, with some urgent projects for both suppliers and users of turbines and transformers, and about seven gigawatts of committed hyperscale capacity, delayed as of April 2026 despite significant funding [26]. Second, the financing gap in emerging and developing economies is still very large compared to need, with annual investment in blended finance under twenty billion dollars and an annual need of 4.2 trillion dollars, a significant number of which could be accessed through blended finance, but is not; the current wave of energy investment is overwhelmingly weighted toward wealthy economies developing AI infrastructure and gas exporting countries, while large parts of Africa and South Asia remain facing acute electricity access gaps [27]. Third, it is noted that a lack of capital alone does not address the broader emerging markets infrastructure gap of $7.5 trillion per year, but rather that this is caused by risk mispricing at the project level. For the highest-risk technologies, construction risk is still poorly priced for 4th. As nuclear power is increasingly at the heart of the baseload strategies of hyperscalers, how delivery risk is being financed on the technology that's attracting the most corporate power commitments for the largest baseload projects is also worth questioning [28]. Lastly, the costs of new grid investments being placed on the shoulders of large commercial customers versus ordinary rate payers are still being drafted, and even more, Government is not yet certain about the regulations, making it more difficult for lenders to underwrite multi-decade transmission and generation projects.

Discussion

Financing of the critical energy infrastructure sector is shifting structurally, with the financing of LNG expansions, AI-related electricity consumption, and modernization of the electricity grid becoming more intertwined in the same financing environment. Previously, there were distinct markets for energy supply, electricity infrastructure, and digital technology, but these are increasingly merging as they have common needs for generation capacity, transmission networks, natural gas, equipment, skilled workforce, and long-term financing [29]. The effects are not limited to individual projects as limitations in one segment of a project can be passed on to other parts of the system. The question now is really not just about the amount of money available, but whether the money can be turned into usable infrastructure, in the correct time, at the correct cost and in the right reliability. A diverse financing structure is supporting the current investment cycle. The utility balance sheet and financing with regulated cost recovery is especially significant for investments in the grid and generation, since they include relatively predictable revenue streams in the long-term due to a long depreciation period and regulated cost recovery [30]. Project finance and corporate debt continue to be the main focus for LNG terminals and large generation projects with significant reliance on contract revenues and project cash flows for repayment. The importance of equity from infrastructure funds, sovereign wealth funds, and technology companies has grown as equity can take on more development and construction risk than traditional debt. Another layer is that of blended and concessional finance, including in emerging markets where commercial financing might not be available at the required scale or cost [31]. These mechanisms illustrate that financing infrastructure does not require financing from one source of capital. Rather, more and more, projects are calling

for a blend of public, private, corporate, institutional and development financing. AI-powered electricity demand is a more fundamental shift in infrastructure markets, with financing needs differing significantly from what is currently on offer. In the past, large technology firms were not necessarily large electricity providers, but rather electricity buyers [32]. They were able to use power purchase agreements to guarantee long-term electricity supply with most of the construction and ownership costs borne by the energy developers. Long interconnection queues on the grid, however, and the lack of generation capacity have prompted large technology firms to take a more direct role in energy infrastructure as well. Whereas traditional ownership of the electricity asset would involve the electricity consumer only as a user, direct ownership or co ownership shifts this perception of risk because the electricity consumer becomes an investor, developer and long term user of the electricity asset [33]. While this model offers more flexibility in power supply and project timing, it also creates more risks for the technology companies in the construction, regulatory, operational and asset management areas. This is reflected by the rising demand for nuclear generation. The demand for long duration electricity for hyperscale data centres has contributed to the growth in interest around firm generation, which can deliver electricity without the need to only rely on VRCs [34]. These can be offered by nuclear projects, but also there are well documented examples of nuclear projects with high cost overruns and construction delays. This generates a significant financing conflict. From a long-term electricity supply point of view the technology may be appealing, but it could also have a high project delivery risk. Financing structures should, however, demonstrate the strategic importance of reliable generation and financial implications of delays, cost escalation, and the regulatory complexity [35]. LTPPAs are not a way to completely remove construction risk, but they give certainty of power sales. The physical foundation that has been connecting these financing trends is grid modernization.The physical foundation that has been connecting these financing trends is grid modernization. New LNG facilities have significant electricity and supporting infrastructure needs, and data centres have an important need for stable, high capacity connections to the electricity system [36]. Meanwhile, there is a mix of renewable generation, nuclear, gas fired generation and industrial loads contesting for transmission capacity. This creates a system where generation investments can be made without transmission investments but fall short of providing the expected economic benefit. Existing grid capacity has been found wanting in the face of the rapid growth of data centre demand and in artificially limited markets, wholesale electricity prices are a good indication of how inadequate infrastructure can drive up costs [37]. Risk management is also becoming as relevant since the amount that is being deployed on the project grows the financial risks of construction failures. Costs and schedule overruns have been observed on energy infrastructure projects, but vary significantly by technology. Projects involving nuclear power and hydroelectric power have often had cost and schedule issues, whereas projects involving solar photovoltaic and transmission projects have tended to have different profiles [38]. Projects with a high likelihood of delay will need higher financial contingencies, higher interest during construction, stronger contractual protection, and higher returns for investors to offset the extra risk. Overall, the evidence points to a coordination challenge more than capital as the main hurdle of the energy and AI infrastructure revolution. The LNG expansion, grid modernization, generation investment and development of data centres are increasingly interdependent.

Conclusion

The convergence of LNG expansion, AI driven electricity demand, and grid modernization is reshaping energy infrastructure financing and creating new relationships between governments, utilities, technology companies, lenders, and investors. Although substantial capital is available, physical constraints, construction risks, regulatory uncertainty, and uneven access to finance continue to limit project delivery. Effective financing therefore requires stronger risk allocation, reliable long term contracts, improved project governance, and greater coordination between generation and transmission investment. Expanding blended finance and private participation can also improve infrastructure development in emerging markets. Ultimately, successful capital deployment will depend on converting financial commitments into reliable, affordable, and economically productive infrastructure.

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