From megawatts to ecosystems:

Delivering resilient power value chains in the Middle East

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01 Executive summary

The Middle East is entering a new era of surging electricity demand; one marked not just by rapid growth, but by rising complexity. Fuelled by population expansion, industrial diversification and the rise of digital infrastructure, the region's power systems must evolve faster to meet ambitious development goals.

Meeting the region's power needs will require integrated value chains that synchronise generation, grid buildout and end-use across assets, timelines and funding structures. This means rethinking capital allocation, procurement models, regulatory frameworks and commercial partnerships.

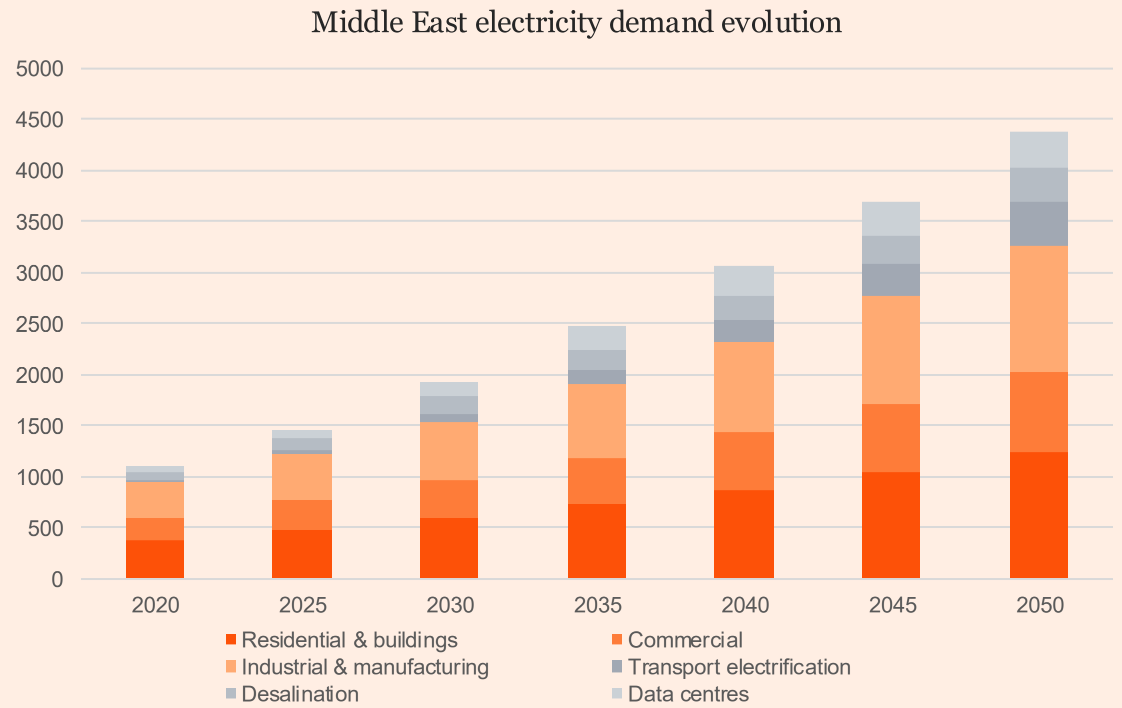
Insights from PwC Middle East's June 2025 Executive Roundtable on 'Tariffs, Capital and the Future of Energy' show that the region has key advantages, including cost competitive electricity, strategic geography and the ability to absorb financial risk paired with the capacity to invest across the value chain. To realise this potential, governments and developers must align infrastructure, finance and policy.

From capital stack design to multi-offtaker models and system wide planning, this paper outlines how the region can unlock secure, scalable and commercially viable power ecosystems. This will be central to achieve energy security and the success of regional ambitions in AI, industry and the net-zero transition.

02 The demand surge - a shift in load profiles

Middle East electricity demand growth

The population of the Middle East is projected to reach 700m by 2050, with over 60% under the age of 30. Cities are expanding, mobility is increasing and cooling needs are intensifying, all of which are placing a growing strain on national grids.



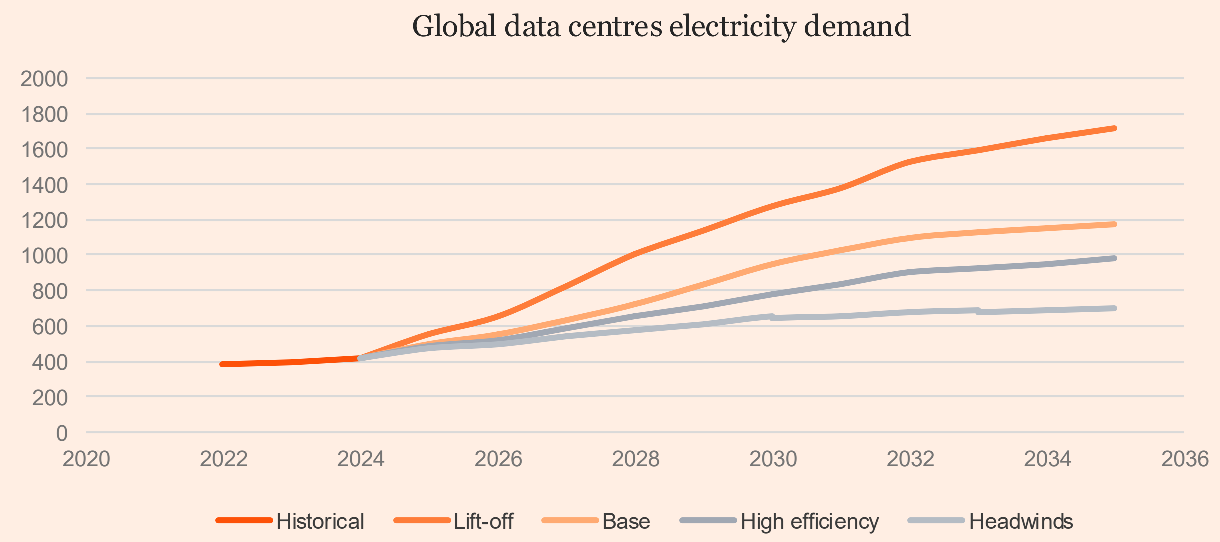
Source: IEA electricity reports and data sets

At the same time, the region is emerging as a hub for hyperscale data centres, AI infrastructure and cloud services. Capacity is expected to more than triple by 2030, with major investments from companies such as AWS, Microsoft and G42. In parallel, the region is rapidly becoming an industrial powerhouse. Together, these trends are driving a substantial increase in demand for 24/7 power, transmission and grid stability, significantly heightening the need for scalable and reliable electricity systems.

Industrial diversification is also fuelling demand. National agendas such as Saudi Arabia's Vision 2030 and the UAE's Operation 300bn are accelerating development in energy intensive sectors and assets like manufacturing, data centres, hydrogen, desalination and metals. These industries operate around the clock and require firm baseload power with limited demand flexibility, reshaping how and where electricity is consumed, from dynamic urban loads to industrial clusters with high reliability requirements.

As these forces redefine the region's load profile, traditional models built around seasonal residential demand are no longer sufficient. Power systems must adapt to serve continuous, high-capacity users across increasingly complex and interconnected geographies.

Despite strong forecasts pointing to rising demand, uncertainty remains around the ultimate scale, the pace at which demand will materialise and whether it will peak and decline or plateau at a sustained high level. This makes it difficult for developers to accurately time and size their investments.



Source: IEA report "Energy and AI" 2025

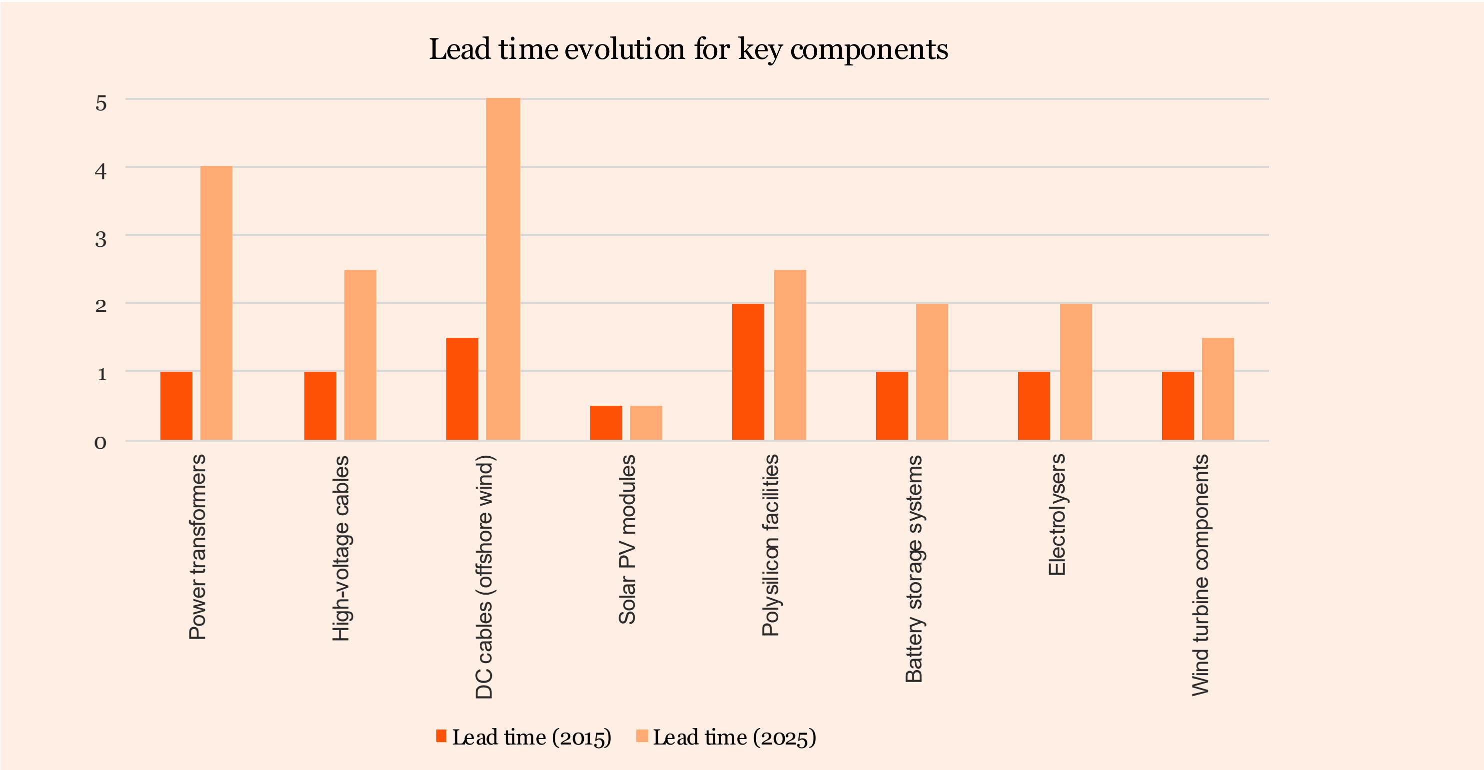
03 Global supply pressures and fragmented delivery

3.1 Equipment bottlenecks and grid delivery delays

The single greatest threat to energy system delivery is equipment availability. From transformers to cables to turbines, global demand is outpacing production capacity. According to BloombergNEF, achieving net-zero will require an 80 million km expansion of global transmission lines by 2040, more than double the existing network.[1] Yet critical components are scarce.

Transformer lead times often exceed 24 months and can reach five years for large units. Hitachi Energy's backlog has tripled to US$43bn,[2] while Siemens Energy notes that only 20% of US transformer demand is met domestically.[3] Similar bottlenecks affect cables, both terrestrial and subsea, as well as turbines, where supply is limited and highly concentrated.

The Middle East is acutely experiencing these constraints. Early procurement is not always enough. Developers that secure turbines may still face delays in transmission buildout or substation commissioning, holding back integrated delivery. Competition is global and synchronised. The US, Europe, China and India are all scaling generation and grid capacity simultaneously, straining the limited pool of equipment, engineering talent and capital. This concurrency is no longer cyclical, it is structural.



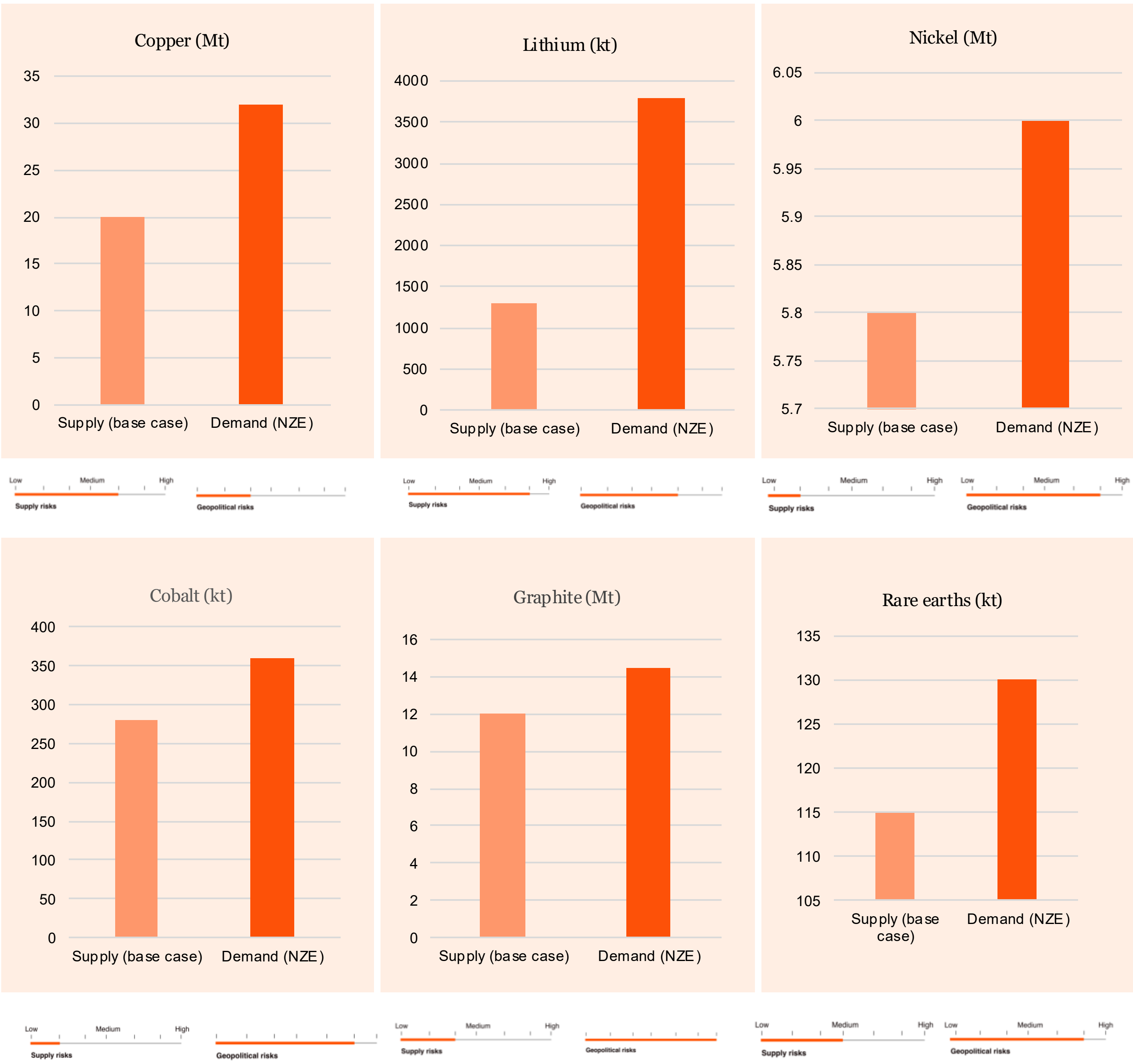
Source: IEA: Average observed lead time for permitting, construction and grid connection for selected energy projects.

1. https://about.bnef.com/insights/finance/global-net-zero-will-require-21-trillion-investment-in-power-grids/
2. https://www.hitachi.com/New/cnews/month/2025/03/250311a.html
3. https://www.siemens-energy.com/global/en/home/press-releases/siemens_energy_addresses_shortage_US_powertransformers_invests_new_factory.html

3.2 Strategic materials – from global risk to local response

Beyond equipment, access to raw materials is emerging as a critical constraint on energy delivery. Copper, rare earth elements, lithium and polysilicon are foundational to solar PV, wind turbines, batteries and EVs. Demand is surging, but production is not keeping pace.

The chart below shows projected shortfalls across key minerals. As the Middle East scales solar, grid and battery projects, securing these materials is a strategic imperative. Supply is geographically concentrated, with risks of export restrictions, political instability and price volatility.



Source: IEA - Global Critical Minerals Outlook 2024

3.3 Developer strategies – delivering under constraints

In a globally constrained environment, delivery risk isn't just technical, it is systemic. Developers are adapting by rethinking procurement and contracting models:

- Joint ventures with OEMs to expand regional manufacturing capacity
- Front loaded payments to secure scarce production slots
- Bulk purchases of components (transformers, cables) to free issue to EPCs
- Early stage offtake and procurement guarantees backed by sovereign entities

These are no longer "nice to have" strategies. They are becoming preconditions for bankability.

> Survey insights from the PwC Middle East Executive Roundtable confirm that developers cite access to essential equipment as the largest delivery barrier.

To stay ahead of global bottlenecks, developers must adopt proactive sourcing strategies, including early stage offtake agreements, joint ventures and sovereign backed procurement guarantees to ensure project delivery and financing certainty.

04 Interface risk - delivering the whole, not just the parts

As systems grow more interdependent, spanning generation, transmission, storage and offtake, success depends not only on the performance of each individual asset, but on the seamless coordination between them.

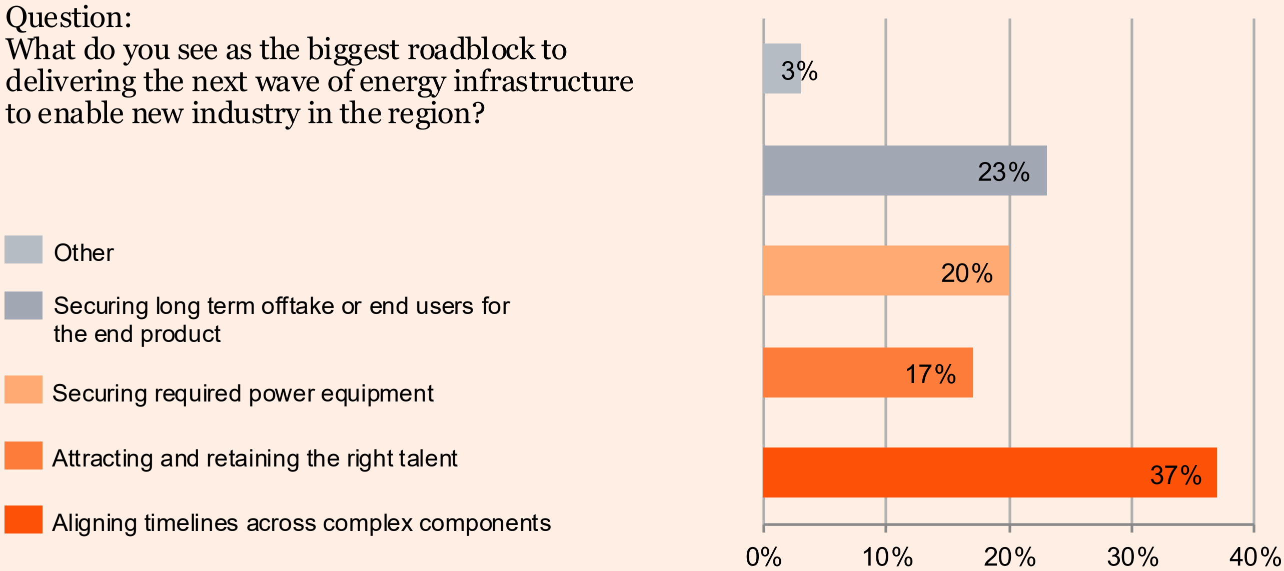
In traditional infrastructure delivery, delays or cost overruns could be contained within a single project. In today's chain based models, a delay in one part of, even as minor as a transformer not arriving on time, can stall progress across the entire chain. This magnifies financial risk and increases the exposure of developers, equity investors, debt financiers and offtakers.

4.1 Synchronised development risk

Modern energy infrastructure depends on tightly linked assets that must come online in a coordinated manner. If a data centre is completed but its corresponding power supply or transmission line is delayed, the entire investment is left idle, resulting in underperformance and potential system wide strain. Similarly, if generation assets are ready but grid integration is not, curtailment or stranded capacity can occur, undermining overall project value.

Without synchronisation, even the most advanced assets can become stranded liabilities. According to the insights from PwC's Executive Roundtable, misaligned construction schedules were identified as the single greatest bottleneck to energy infrastructure delivery. The challenge is no longer abstract, interface risk or risk arising from poor coordination between linked project components is now delaying project timelines and distorting cost forecasts across the system.

Question:
What do you see as the biggest roadblock to delivering the next wave of energy infrastructure to enable new industry in the region?



Source: Insights from PwC Middle East's June 2025 Executive Roundtable

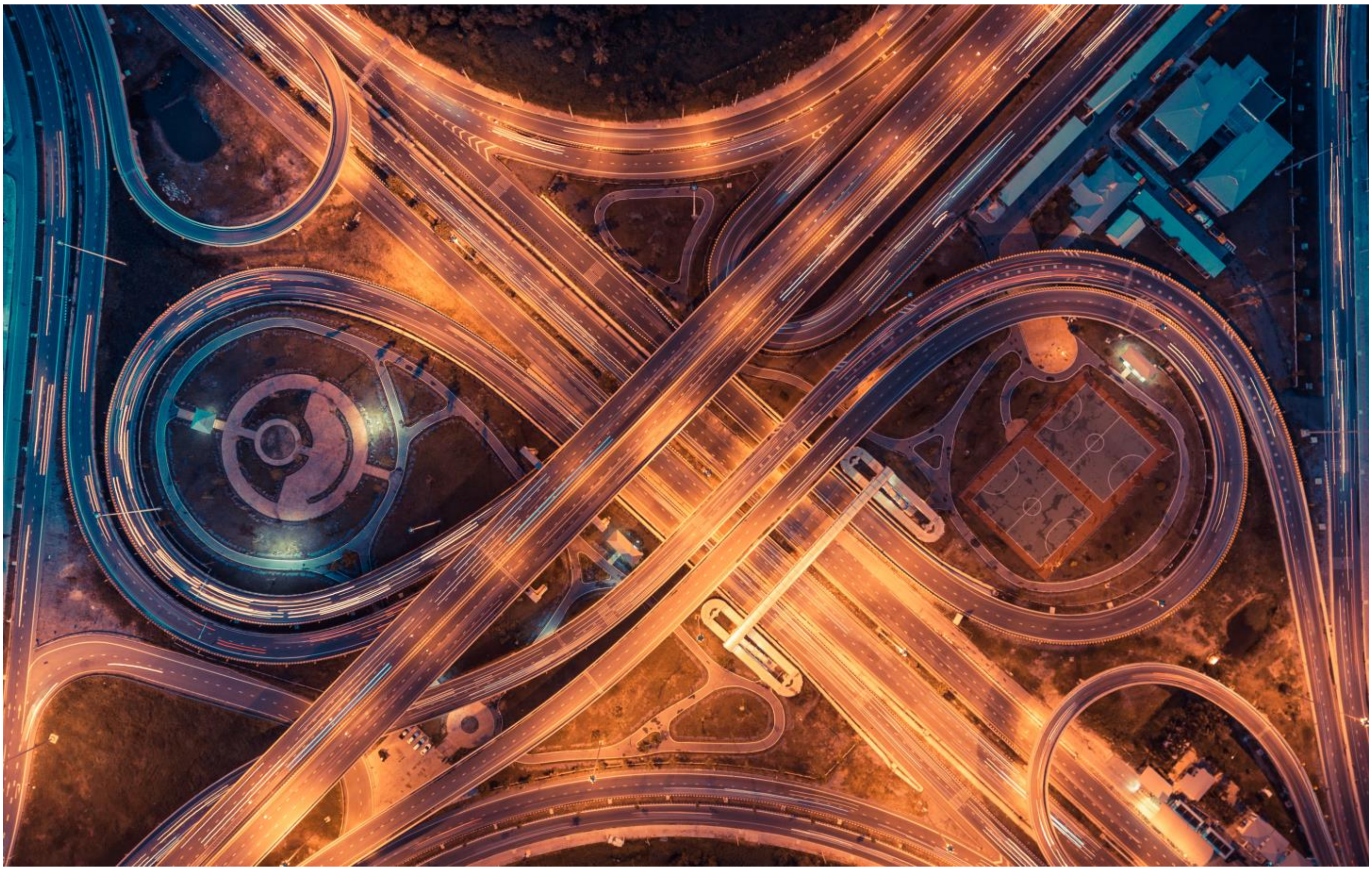
4.2 Interface risk within and between assets

Each infrastructure asset, whether a substation, power plant or interconnector, progresses through feasibility, design, procurement, construction, commissioning and operational handover phases. These stages are typically delivered under separate work packages or contracts, often involving different contractors and delivery models. While each party may fulfil its own scope, risk emerges at the interfaces where technical alignment, contractual coordination and schedule integration are required.

This risk becomes more pronounced where assets are operationally interdependent, for example, a solar farm providing power to a water treatment facility. If one is delayed or underperforms, the functionality of the other is directly impacted. These challenges are not only technical, they also carry contractual, financial and operational implications that must be actively identified and managed.

Poor interface coordination can trigger cascading delays, especially where contract boundaries are poorly defined or accountability for integration is unclear. To address this, developers are increasingly adopting interface management plans, shared commissioning schedules and integrated delivery strategies that ensure alignment across work packages. Appointing a lead party to manage coordination between contractors is becoming standard practice.

In large, multi-asset developments, a new role is emerging, the “systems integrator.” This party is responsible for managing interdependencies between assets and ensuring overall system performance. The function is becoming essential in complex programmes involving integrated delivery i.e. power, hydrogen and digital infrastructure components within a unified operational system.



4.3 Non-linear and multi-role asset flows

Integrated value chains are not straightforward. Some assets serve multiple roles. A battery can ensure grid stability, facilitate arbitrage and provide backup power. A data centre might be both an energy offtaker and a heat producer. This complexity creates interdependencies that demand more advanced control, planning and risk management.

Traditional models of "one asset, one purpose" are becoming obsolete. This shift toward multi-role infrastructure introduces new risks:

Operational

a failure in one function may compromise the asset's ability to perform other functions

Financial

monetising stacked services requires integrated metering, pricing and regulatory approvals

Contractual

performance guarantees must reflect the layered nature of asset roles

For example, in a green hydrogen facility, an electrolyser may rely on a solar PV farm, which itself could depend on battery storage for dispatchability. If the battery storage facility underperforms, it could impact hydrogen production targets, trigger offtake liquidated damages and undermine the financial and commercial structure.

Managing these risks requires sophisticated digital infrastructure, from predictive analytics to integrated supervisory control and data acquisition (SCADA) systems, as well as coordinated oversight bodies that span multiple infrastructure layers.

As ecosystems become the new unit of delivery, the ability to manage interface risk will determine whether projects succeed or stall. Stakeholders must move beyond asset centric planning to ecosystem level orchestration, with clear ownership of schedule, performance, completion and integration across every interface.

The shift from single offtakers (e.g. utilities) to multiple offtakers with diverse and often competing requirements is also critical.

These may include industrial clusters, logistics hubs, desalination plants, green hydrogen projects and hyperscale data centres. Each have distinct load profiles, reliability expectations and price sensitivities. This introduces complexity in planning and operations, particularly in managing curtailment risks where supply outpaces demand and reliability challenges where intermittent supply cannot meet continuous demand.

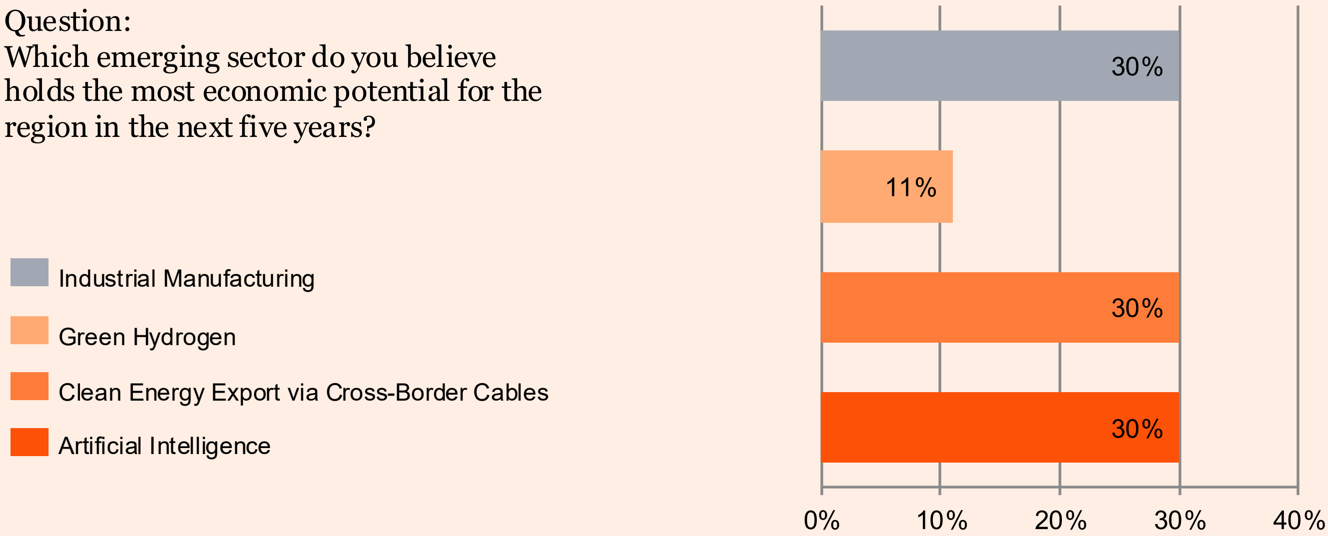
For example, integrating solar generation with AI data centres introduces a critical mismatch. Solar output fluctuates by time of day and season, while AI workloads demand high uptime and stable loads. Addressing this mismatch will require coordinated investment in energy storage, flexible offtake arrangements and advanced grid management systems.

4.4 Multi-offtaker and tiered models

Traditional power projects were built around a single, long term offtaker. Today's demand is more fragmented. Projects may supply power to a mix of industrial users, hyperscalers, municipalities and even national grid operators.

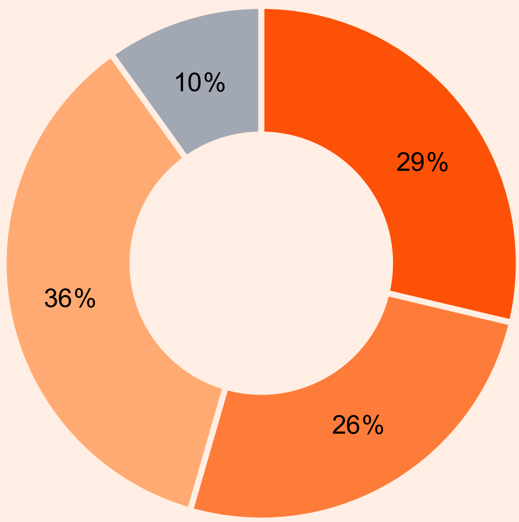
These customers have different reliability, pricing and demand profiles. Structuring bankable, flexible agreements that align incentives while preserving revenue certainty is a growing discipline in its own right.

Question:
Which emerging sector do you believe holds the most economic potential for the region in the next five years?



Question:
What do you see as the biggest opportunities to drive regional growth?

AI and data centers
Climate tech, decarbonisation and electrification
Reshoring and local manufacturing initiatives
Tourism

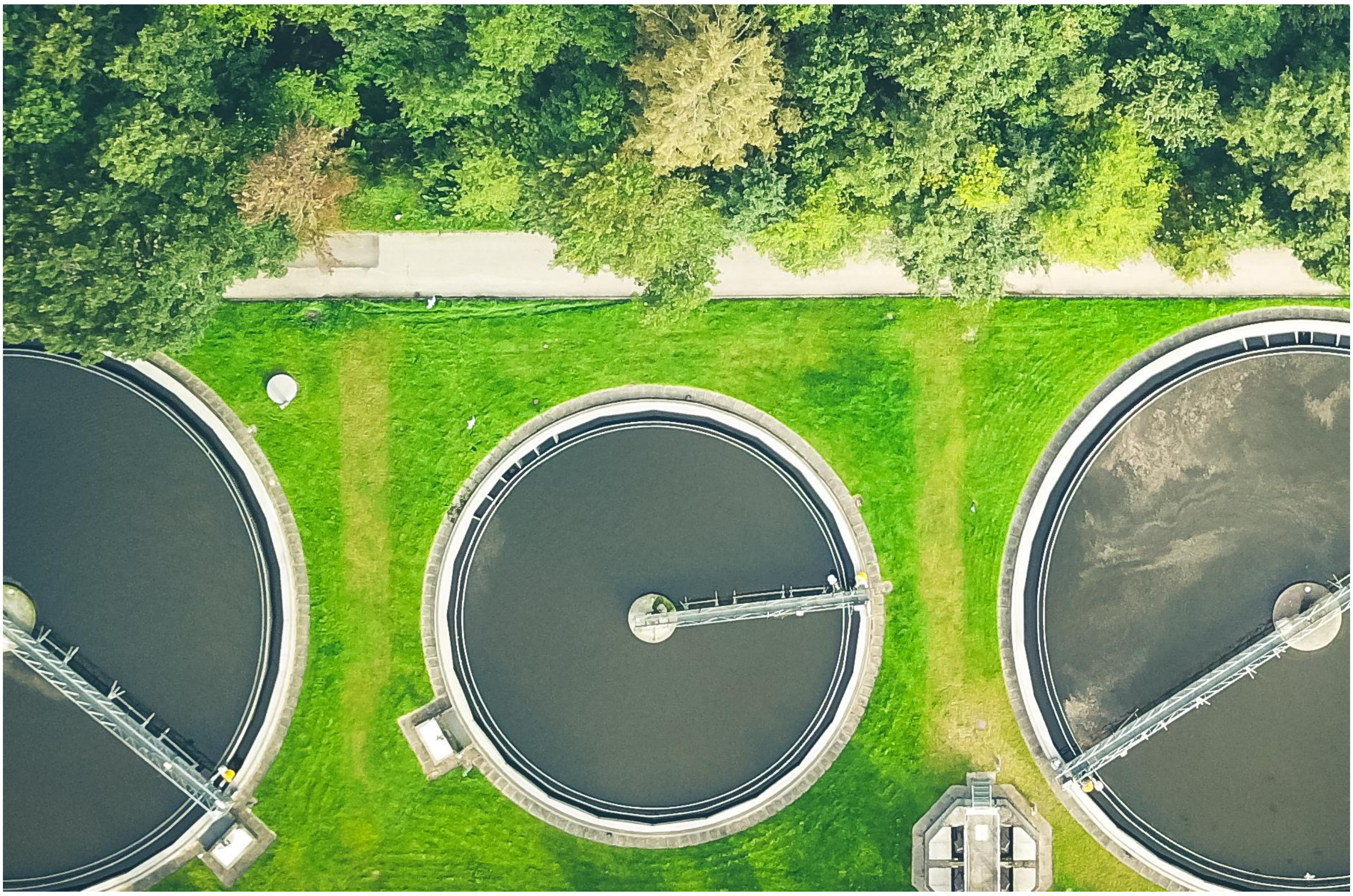


Source: Insights from PwC Middle East's June 2025 Executive Roundtable survey

At the heart of this transformation, lies the opportunity to unlock multiple revenue streams from a single integrated energy platform. Beyond the primary sale of electricity, infrastructure owners and operators can monetise:

- Grid services, including frequency regulation, voltage support and reserve capacity
- By-products, such as waste heat for district heating, desalination, or industrial processes
- Energy exports, including cross border electricity trade and green fuels such as hydrogen or ammonia
- Platform based services for power-intensive sectors like AI, cloud and industrial computing
- Localised manufacturing, leveraging low cost, clean energy to enable green industrial zones
- Environmental markets, such as carbon credits, green certificate or clean hydrogen premiums

The shift toward multi-revenue models increases financial complexity, making projects harder to underwrite as they rely on multiple offtakes, contractors, technologies and market exposures.



05 Financing complexity - capital stack alignment across the chain

5.1 Multi-asset financial close

In integrated energy systems, capital must still flow to individual assets, each requiring its own debt syndicate and equity arrangement. A solar farm, transmission corridor and data centre may all form part of a unified solution, but debt financiers will evaluate and finance them separately. The challenge arises when these assets are interdependent, yet their financing processes must proceed in parallel. In a solution driven approach, the capital stack for the full value chain cannot be underwritten by a single syndicate. Instead, multiple syndicates must reach financial close concurrently, each with distinct risk appetites, due diligence requirements and timelines. If one segment fails to secure financing, for example, a transmission link delays closing, it can create a cascading effect, stalling the ecosystem. This turns financing coordination into a form of interface risk, where misalignment across capital flows can compromise delivery even before construction begins.

This interdependency is especially challenging given the scale and scope of upcoming energy projects in the Middle East. For example, Saudi Arabia's planned 130GW of renewable energy capacity by 2030 (up from ~3GW in 2023)[4] will require concurrent investment in transmission infrastructure, energy storage and new industrial offtakers. Each of these elements typically involve different investors, risk profiles and regulatory approvals. However, they must move in sync for the ecosystem to succeed.

A more sophisticated financial structuring approach is required, including:

- Staggered risk layering, where sovereign or concessional capital absorbs early stage risk, enabling debt financiers to step in at later phases
- Contingent capital facilities that provide liquidity buffers in case one component experiences delays
- Cross asset credit enhancements, such as revenue pooling, escrow accounts or cross guarantees across project special purpose vehicles (SPVs)
- Portfolio financing frameworks that allow syndicates to assess system level viability, rather than asset-by-asset risk

4. https://www.climatescorecard.org/2025/02/saudi-arabias-vision-2030s-renewable-energy-project-initiatives/

These tools are becoming essential to prevent fragmentation and unlock funding at the pace and scale required. International Finance Corporation (IFC) and European Bank for Reconstruction and Development (EBRD) have used similar blended structures for integrated infrastructure corridors in Central Asia. Middle East sovereign wealth funds such as the Abu Dhabi Developmental Holding Company (ADQ) and the Saudi Public Investment Fund (PIF) are exploring multi-asset structures to support industrial zones platforms.

5.2 Capital market perception of interface risk

Debt financiers and equity investors are pricing risk differently. Where interface risk is high, capital costs increase. Where visibility across the value chain is limited, underwriters demand more guarantees, tighter covenants and larger reserves.

Some projects, especially those with novel technologies or multiple offtakers, face difficulties reaching financial close without sovereign guarantees or secured offtake agreements.

Ambition without regulatory clarity creates friction. Outdated permitting processes and fragmented regulatory environments slow down critical infrastructure. Governments across the region must streamline permitting, harmonise standards and introduce market frameworks that reward flexibility, ensure long term price signals and derisk capital deployment for clean power assets.

These dynamics are already emerging in the Middle East, where capital deployment into complex industrial zones is being paced by the slowest link in the ecosystem.

The capital market response is clear:

- Require system wide risk visibility before committing
- Favour projects with clear governance and coordination mechanisms across SPVs
- Prioritise readiness of anchor loads such as hydrogen users and desalination plants

06 Strategic enablers - orchestrating the full chain

"In today's energy transition, value lies not just in the power delivered but in the ecosystems built around them. Success now depends on the synchronised orchestration of infrastructure, finance, policy and offtake, ensuring that every part of the value chain moves in step to deliver scalable, resilient and commercially viable industries.

Danny Touma
Partner, Energy Transition

Delivering integrated energy systems at scale will require more than technical solutions, it demands orchestration. Traditional, linear models of infrastructure development often fail to align stakeholders and timelines, causing countries to miss out on emerging value chains. In contrast, the Middle East has a unique opportunity to leapfrog these challenges. With the catalytic role of sovereign wealth funds and state led coordination, the region can mobilise capital, infrastructure, and policy in parallel, accelerating delivery and securing a first mover advantage in critical sectors such as clean energy, hydrogen and industrial decarbonisation. Strategic enablers that operate across value chain siloes will be essential to unlock this system wide acceleration.

6.1 Sovereign wealth funds as system integrators

SWFs are uniquely positioned to close the orchestration gap in large scale, integrated energy systems. Their ability to invest across the value chain, from generation and grid infrastructure to industrial offtakes, enables them to align timelines, absorb early stage risk and bring long term strategic coherence to complex developments. Unlike other equity investors, SWFs are not limited by asset class or investment horizon, allowing them to convene multi-asset partnerships and act as anchor equity investors across otherwise siloed components.

As global infrastructure bottlenecks intensify, SWFs are uniquely positioned to stabilise delivery pipelines and unlock constrained supply. Their financial scale and sovereign status allow them to secure priority access to equipment from OEMs, underwrite long lead items and co-invest in domestic manufacturing and assembly. In doing so, SWFs are derisking individual projects. They also proactively address systemic constraints, such as limited transformer and cable availability, delayed grid infrastructure and global competition for strategic materials that increasingly threaten project timelines and energy transition targets.

In recent regional examples, entities such as PIF in Saudi Arabia and ADQ in the UAE, have taken cross-chain equity positions in green hydrogen clusters, transmission projects and anchor offtakers like AI data centres. This not only ensures that capital is synchronised but also enhances supplier confidence and accelerates procurement.

Their involvement signals execution certainty to suppliers and financiers alike, making SWFs indispensable as system integrators in a world where interface risk, capital complexity and delivery friction are rising simultaneously. Acting as both investor and orchestrator, SWFs can help ensure that energy ecosystems are not just funded, but feasible.

6.2 ECAs and supplier diplomacy

Export Credit Agencies (ECAs) do more than reduce capital cost. They unlock supplier commitment. In an environment where OEMs are oversubscribed, early involvement of ECAs can facilitate slot allocation, ensure priority treatment and reduce the risk of cascading delays.

This is especially valuable in projects that rely on non-domestic suppliers of turbines, cables or storage technologies.

Today, ECAs are evolving into strategic enablers, not just financing tools. Their guarantees increasingly extend beyond individual equipment packages to cover entire integrated portfolios. For example, Euler Hermes (Germany) and Bpifrance Assurance Export (France) now offer flexible export credits for multi-asset projects that include linked power, transmission and storage components.

Developers that engage ECAs early in the procurement process can secure priority access to scarce manufacturing slots. This is a critical advantage given 24-month+ lead times for key equipment. ECAs can also catalyse bank participation by lowering the cost of capital through risk sharing mechanisms, especially for complex, cross border developments.

Moreover, in integrated projects where components originate from multiple jurisdictions (e.g. turbines from Europe, switchgear from Korea, cables from China), coordinating multiple ECAs under a lead arranger framework is becoming a standard strategy for risk mitigation and delivery assurance.

In the Middle East, where many projects depend on global supply chains, ECAs are not just financiers but facilitators. By aligning public and private sector priorities and securing supplier commitment, they help derisk delivery and accelerate capital deployment.

6.3 Cluster planning and proactive transmission development

The traditional model, building generation, then waiting for grid access and hoping offtakers follow, is no longer viable. Governments can reduce risk and accelerate development by building grid infrastructure upfront in key zones (for example, AI corridors, hydrogen valleys, industrial cities).

This “transmission first” model lowers entry barriers for developers, derisks offtakers and reduces system wide curtailment. It also reduces the fiscal burden on governments by partly monetising the transmission asset by charging power generation assets that build and connect to it.

07 From megawatts to ecosystems

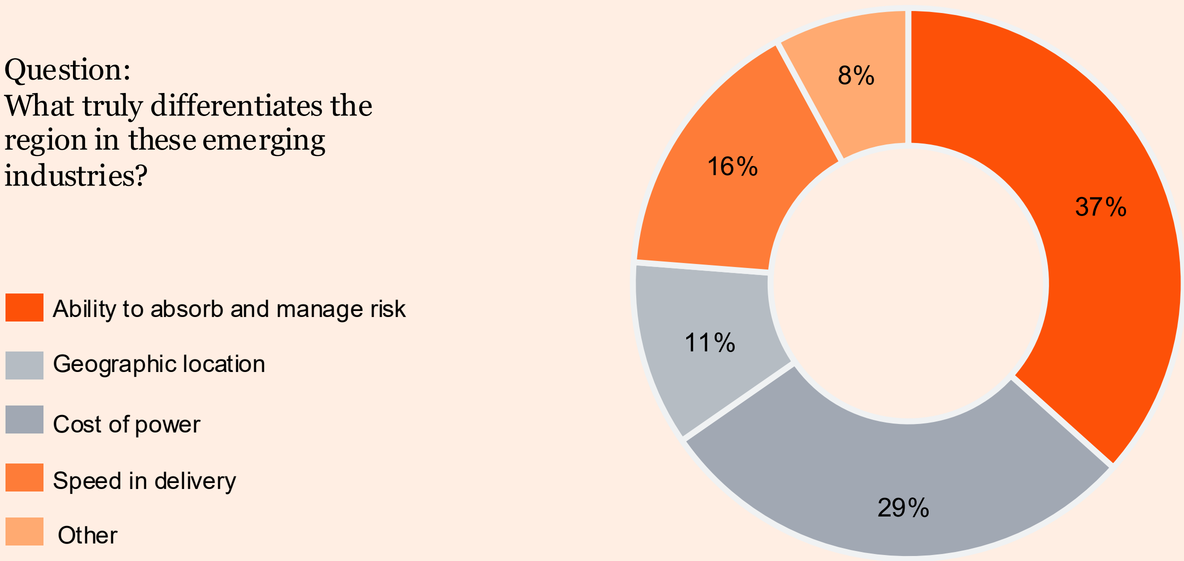
Predicting future energy demand in the Middle East is complex. Population expansion, industrial diversification and a surge in digital infrastructure will continue to drive electricity consumption across the region.

However, the region enjoys a strategic advantage. Governments are investing heavily in next generation cities, green industries and digital infrastructure. To meet rising demand reliably and competitively, the focus must shift from isolated power assets to integrated ecosystems, aligning generation, transmission and end-use from the outset.

This requires a new mindset. Risk must be managed across entire value chain. Our survey findings from PwC's Executive Roundtable, show that the region's ability to absorb and coordinate risk is a key enabler. Capital must be structured not around single projects, but around system wide outcomes. Success will depend not just on engineering, but on synchronised delivery and strategic alignment across sectors.

The governments, developers and investors that lead this shift will shape the future of energy in the Middle East, securing long-term competitiveness in power, industry and digital infrastructure.

Question:
What truly differentiates the region in these emerging industries?



Source: Insights from PwC Middle East's June 2025 Executive Roundtable

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Energy security in the Middle East isn't just about adding megawatts anymore. It's about connecting the whole system. The real challenge is delivering under pressure, where timing, capital and supply chains need to line up. If we don't manage those links, projects stall. But the region has a key strength, the ability to coordinate at scale. With the right structures in place, it can move from isolated builds to fully integrated solutions and lead the way globally.

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