FORESIGHT FOR RESILIENCE

THE OMAN CLEAN ENERGY STRATEGIC OUTLOOK

SUPPORTED BY

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QUALITY ASSURANCE & STANDARDS OF EXCELLENCE

This report has undergone a rigorous process of professional fact-checking and copy-editing to ensure the highest standards of accuracy, relevance, and clarity.

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Contents

Executive summary

- **This study applies strategic foresight and scenario analysis to assess how Oman's clean energy transition can remain resilient under divergent global futures.**
- **Oman's clean-economy future depends on navigating global uncertainty through foresight, agile policymaking, and coordinated national action.**
- **Sector choices must balance financial, employment, and strategic objectives—there is no universal "best" sector, only context-dependent portfolios.**
- **The most robust opportunities lie in building energy efficiency, solar PV, and minerals and metals, embedded within integrated industrial ecosystems.**
- **Long-term economic and financial stability requires dynamic industrial policy, an employment-centred approach, and strategic public investment—short-term financial optimisation alone does not secure long-term resilience.**
- **Regional coordination within the GCC toward distributed and complementary value chains is essential to avoid duplication but requires proactive steps toward new regional mechanisms.**

Context and Mandate. The report forms part of the Oman Labour Market Intelligence Analysis, a national initiative examining opportunities and pathways in the clean energy economy and related sectors, with a particular focus on sectoral planning, education systems, and labour-market policy.

Purpose and Audience. Its purpose is to clarify how Oman's emerging clean energy economy may evolve, which sectors are preferable under different conditions, and how strategic trade-offs can be managed. The analysis is intended for high-level policymakers, investment planners, and international experts.

Analytical Approach. The study combines two components: (a) a foresight analysis assessing external drivers shaping Oman's future energy economy; and (b) a structured sectoral profiling exercise identifying strengths, weaknesses, trends, and clusters across multiple sectors.

Trends and Uncertainties. Trend analysis shows that rising Asian energy demand, economic growth, and intensifying climate impacts are high-certainty developments, while fossil-fuel markets, global security dynamics, and the evolution of GCC collaboration represent major uncertainties that must inform strategic planning.

Scenario Insights. Four contrasting scenarios illustrate how different global and regional contexts may shape Oman's clean-economy prospects. Across all of them, anticipatory governance, agile diplomacy, deeper GCC collaboration, diversified external partnerships, and adaptive industrial planning are key levers for turning uncertainty into strategic opportunity.

Planning Implications. Clean-economy planning must recognise that financial, labour-market, and strategic considerations operate on different logics but are ultimately interconnected and equally relevant for the country's economic future. Environmental policy and climate action should be sequenced along the carbon-abatement curve, prioritising negative-cost, win–win measures before higher-cost interventions.

Strategic Economic Principles. Long-term prosperity depends on strengthening economic development alongside immediate financial performance. Institutions involved in national investment and sector development should incorporate broader economic and strategic objectives—such as employment creation and economic resilience—into their decision-making. Employment, in particular, is both a channel for sharing national wealth and a requirement for long-term economic and fiscal stability. Placing insufficient weight on long-term development can make short-term financial outcomes more fragile.

Sector Prioritisation Logic. Priority setting requires a holistic perspective and explicit weighting of objectives and criteria. The best option depends on policy preferences but even more so on local and global conditions that are still emerging. Choices must also distinguish between domestic and export-market viability and be grounded in Oman's competitive niche relative to regional peers.

Most Promising Sectors. The study identifies building energy efficiency, solar PV development, and the extraction and processing of minerals and metals as the most promising sectors overall, while noting that other sectors may perform strongly in specific niches or under particular scenario conditions.

Integrated Ecosystems and Value Chains. The analysis emphasises that future sector development must focus on integrated industrial ecosystems and value chains rather than isolated production stages. Such ecosystems enable scale, competitiveness, learning effects, and capability building, whereas fragmented approaches struggle to generate employment, attract investment, or build strategic resilience.

System-Level Enablers. Translating plans into jobs and value requires strong system foundations: medium-term fiscal clarity, aligned investment mandates, indicative resource envelopes for land, water, energy, and skills, streamlined permitting and delivery processes, and the development of high-value service ecosystems across engineering, digital services, logistics, and certification—including for fast-moving consumer and "soft industrial" exports to regional markets.

Regional Coordination and GCC Industrial Complementarity. Greater economic coordination within the GCC is vital to avoid sectoral cannibalisation and enable new industries to reach scale and coherence. While Oman should identify niches where it holds clear comparative advantages, the more effective pathway is proactive regional engagement toward distributed and complementary supply chains. This can include co-ownership and shared interests, and Oman can lay the groundwork for mechanisms that foster regional alignment—such as a GCC future industries fund.

Dynamic Policymaking and International Positioning. Industrial and sectoral policy must remain dynamic and responsive to shifts in markets, technology, and geopolitics. At the same time, a holistic institutional approach—including diplomatic missions, trade representatives, regulators, and economic agencies—can proactively shape external market conditions, build strategic partnerships, and expand opportunities for Omani industries.

Foresight and External Engagement. Permanent foresight capacity and coordinated external engagement are essential for navigating uncertainty and converting emerging signals into strategic advantage. Embedded foresight units, indicator frameworks, and early-warning systems support adaptive decision-making and ensure alignment between scenario dynamics and industrial or investment choices, including decisions on when to accelerate, pause, or recalibrate individual sectors within the wider portfolio.

Foreword & Introduction

Innovation stands at the heart of Oman's future. Successfully navigating this future requires leveraging existing strengths—firmly anchored in the present—while simultaneously building new capabilities. Technologies shaping tomorrow's economies, from advanced digital solutions to new industrial applications of clean energy, offer powerful avenues for growth and development. The Sultanate of Oman, endowed with abundant natural resources and a strong industrial foundation, has harnessed these assets over the past century to generate prosperity and stability. Yet sustaining and expanding this success in a changing world demands strategic innovation—especially in and around the energy sector, which will remain the backbone of the Omani economy for years to come.

Economic diversification has long stood at the centre of Oman's development agenda and remains a defining objective across the Gulf region. While progress has been made over past decades, the need for diversification has grown even more urgent. The global economy is evolving at an unprecedented pace: technologies are advancing rapidly, geopolitical alliances are shifting, and demographic dynamics are transforming labour markets. In this environment, Oman and its Gulf peers must act with greater agility and foresight to secure their place in the future economy.

Recent years have also witnessed a shift in how diversification is approached. Policymakers and investors increasingly focus not on isolated projects, but on developing entire value chains and industrial ecosystems. Among the sectors where this systemic approach holds exceptional promise is the clean energy industry. Clean energy builds on Oman's existing strengths: a mature energy sector, extensive institutional capacity, and a skilled workforce with transferable expertise across extraction, processing, and downstream industries. These endowments—combined with world-class solar and wind resources—create strong comparative advantages for participation in the emerging energy economy. Moreover, global climate policies and evolving market regulations are reshaping competitiveness across industries, making clean energy not only a technological or environmental choice but also a strategic and economic one.

Yet identifying the most promising avenues within this broad landscape is far from straightforward. The clean economy comprises diverse sub-sectors, each with distinct technological, financial, and employment characteristics. Decisions about where to expand must balance multiple national objectives: fiscal sustainability, macroeconomic stability, job creation, skills development, and long-term resilience. As a relatively small but well-equipped economy, Oman's prospects will also depend on external dynamics—from international climate commitments and global demand trajectories to evolving trade regimes and diplomatic partnerships.

These interdependencies underscore the need for rigorous, evidence-based analysis. Understanding how global trends intersect with national priorities is crucial for guiding industrial policy, workforce planning, and investment in the clean economy.

The Labour Market Intelligence Analysis (LMIA) report series responds to this need through a set of interconnected assessments on the viability of different sectors within the clean energy sphere. It offers a structured look into the future, as well as clear insights into labour market trends, education and training requirements, the job potential of emerging sectors, and the policies necessary to realise this potential.

This particular report, the Clean Energy Industry Outlook, focuses on the first set of these questions. It asks: How might the future clean energy economy unfold, and what does this mean for Oman? What benefits do different clean energy sectors offer—across multiple national objectives? Which sectors could be prioritised, and which goals should be emphasised? How can trade-offs between objectives be managed? And which policy measures are needed to enable progress?

To explore these questions, the report draws on a structured foresight process—specifically, a scenario and trend-mapping exercise—examining how Oman's energy economy, and the global context surrounding it, could develop by 2040. It presents four distinct, novel, and interdisciplinary scenarios that connect developments in technology, geopolitics, economics, and other domains, with a focus on external drivers of change. These scenarios are introduced alongside a foreword that reflects on the role of foresight in strategic decision-making, and collectively aim to provide a credible foundation for assessing long-term sectoral strategies.

The second component of the report presents the results of a systematic screening of 30 clean energy–related sectors, each of which may hold potential for industrial and economic development. The analysis evaluates each sector's strengths and weaknesses from an interdisciplinary perspective—considering market viability domestically and internationally, integration into existing frameworks, socioeconomic potential, bankability and ease of financing, and alignment with strategic co-benefits. Crucially, the assessment also evaluates the robustness of each sector across divergent future developments, based on the foresight scenarios. The report identifies not only priority sectors for decision-makers, but also thematic clusters of sectors, helping to visualise which options may be suited to different national strategies or external environments.

Finally, a recommendations section reflects on the implications of these findings for the broader question of how Oman can strategically structure its future energy economy.

The Clean Energy Industry Outlook is intended to support a range of stakeholders. First, policymakers in Oman and the wider region will find guidance for investment planning and long-term economic strategy. Second, academics and experts in energy, development, and international affairs may draw value from the scenarios and sectoral framework, which operate at the intersection of technology, geopolitics, and economics. Third, industry leaders and investors can gain unique insight into the direction of future government support and sectoral growth potential. And finally, the general public, as well as stakeholders from related institutions, may benefit from a clearer understanding of how clean energy intersects with employment, skills, and long-term national development.

The decisions made today will shape not only the structure of Oman's future energy economy, but also its position in global value chains, its employment landscape, and its resilience to external shocks. With this in mind, the following chapters explore both the forces that will define this future and the strategic options available to guide it—starting with a forward-looking analysis of global and regional developments through the lens of scenario-based foresight.

Foresight analysis

The role of foresight

Strategic foresight helps Oman anticipate and prepare for various futures and trends—something crucial, given the longevity of energy investments and the large possible effect of external factors on (energy) economic outcomes.

By nature, our ability to anticipate the future is extremely limited. While we may hold reasonable expectations about what might occur tomorrow or the day after, barring any unforeseen events, projecting what will happen in a decade or two remains almost impossible. Ironically, modern technology and globalisation have only added to this complexity rather than simplifying it.

For a producer economy such as Oman, thinking about the future and various drivers and trends is a crucial task. For instance, investments in the energy sector—from power grid infrastructure to new manufacturing processes to oil field developments—are long-term commitments that must consider key variables like energy prices and security over multiple decades. Oman's strategic location at the crossroads of key maritime trade routes between Europe, the Indo-Pacific, and East Africa has bolstered its role as a stable energy provider. However, this position also brings challenges, as these routes traverse choke points and areas of security tension, necessitating strategic decisions that anticipate potential disruptions to international trade. The range of crucial external uncertainties expands even further, notably with climate policies shaping global and regional demand for fossil fuels, renewables, and clean technologies, affecting both the timing and nature of these demands. International policies and regulations can either bolster or restrict industries, creating additional layers of complexity. Strategic decisions therefore need to anticipate any relevant events and trends.

Forecasting or predicting specific future outcomes is rarely effective, especially for long-term decision-making. While such methods work for short-term contexts like financial trades or military operations, they rely on extrapolating current trends to make probabilistic statements, which quickly lose accuracy as time progresses. The further into the future we look, the greater the uncertainty becomes, making forecasts for 20 years ahead nearly certain to be inaccurate. In these situations, strategic foresight becomes the preferred approach. Unlike forecasting, strategic foresight does not aim to predict a single future but instead explores different elements and scenarios, preparing decision-makers for a range of possibilities. It serves as a reframing tool, revealing patterns and trends that might otherwise go unnoticed, enabling a proactive response to diverse potential futures.

Trend and factor analysis

Analysis of key trends (high-impact, low-uncertainty factors that are predictable and stable—decision-makers should plan for them) and uncertainties (high-impact, high-uncertainty factors—decision-makers should prepare for their possibility) for Oman's future energy economy

- **Key Trends: Include climate change impacts, growth in Asian economies, and education levels for new sectors.**
- **Key Uncertainties: Include fossil fuel market dynamics, global security situations, and collaboration in the GCC.**

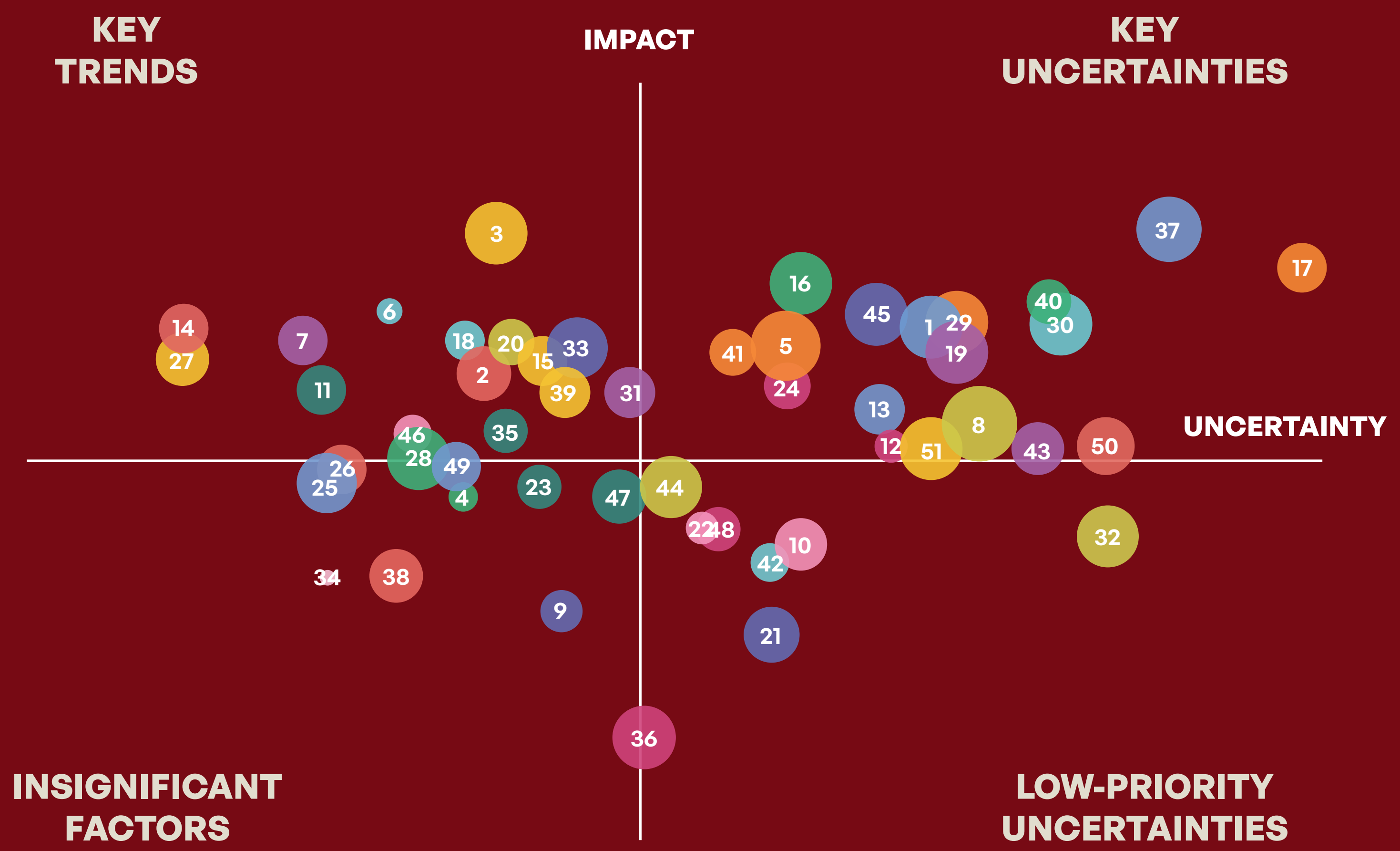
The factor analysis is a critical component of the foresight process, aimed at identifying and understanding the factors that will shape Oman's future. Figure 1 shows a comprehensive map of an assessment of 51 factors vis-à-vis their respective uncertainty and impact (see Appendix A). This analysis informs strategic decisions about what to look out for through identifying key trends and uncertainties.

(Key) trends are predictable, high-impact factors. They are predictable and have a significant impact on Oman's future, meaning that decision-makers must plan for these developments. In contrast, (key) uncertainties are also high-impact but unpredictable. These factors could significantly shape Oman's future, but their uncertain nature demands flexible, adaptive strategies. Decision-makers must prepare for a spectrum of possible outcomes, embracing a proactive approach to navigate these uncertainties effectively.

Patterns show that high-impact, high-uncertainty factors often stem from global geopolitics and macroeconomics, like fossil fuel market volatility and security issues, making them critical for scenario planning. In contrast, high-impact, low-uncertainty factors, such as climate change effects and stable economic growth in Asia, are predictable and should guide strategic planning. Low-impact, high-uncertainty factors, like demographic shifts in Oman, may not significantly alter strategic outcomes but are worth tracking. Low-impact, low-uncertainty factors, such as domestic stability and minor tech advances, offer a stable backdrop but hold less strategic importance.

Key trends include the growth of the economy and energy demand in Asia, particularly in countries like India, China, Pakistan, and Indochina. The increasing energy demand in these rapidly growing Asian economies is a significant trend that will influence global energy markets and affect Oman. Another critical trend is the impacts of climate change and environmental change. These predictable changes will affect economies, societies, and systems and will cause policy responses. Additionally, the level of relevant education and skills for new sectors within the Omani workforce and the availability of that workforce is a vital trend. The Omani workforce is highly educated and can easily be equipped with the necessary skills for emerging industries.

On the other hand, key uncertainties include the dynamics in oil, coal, and gas markets, encompassing price, supply, and demand fluctuations. Numerous factors, including the trajectories of popular conflicts, climate policy, and economic developments affect fossil fuel demand and supply and thus create the possibility for diverging futures that impact Oman as a producer economy significantly. Another major uncertainty is the global conflict and security situation—which could (energy) consumer behaviour, trade patterns, and the diffusion of industries, amongst various factors. Furthermore, the collaboration within the GCC is an uncertainty that can influence regional stability and economic opportunities alike. The extent and effectiveness of cooperation among GCC countries can impact various sectors, including energy, trade, and technology transfer.



Legend (Refer to Appendix for detailed labels)

1. GCC integration
2. Lifestyle choices
3. Global innovation
4. Omani demographics
5. Global climate policy
6. AI & innovative IT
7. Global population & urbanisation
8. Global order shifts
9. Social inclusion & welfare in Oman
10. Psychological aspects
11. Skilled workforce in Oman
12. Regional CO2 regulation
13. Legal system & regulatory alignment
14. Climate impacts
15. Social adaptability
16. Bankability
17. Fossil fuel dynamics
18. Raw materials demand
19. GCC rivalries
20. FDI attractiveness of Oman
21. Iran sanctions
22. Climate policy acceptance
23. Changing labour system in Oman
24. Local climate policy
25. Electric grid investments
26. Domestic stability
27. Asian growth
28. East Africa growth
29. Geopolitical change
30. Regional security
31. SME growth in Oman
32. Palestine conflict
33. New sectors' job potential
34. Desalination technology
35. China dominance
36. Spread of Islam
37. Global security
38. Energy nationalisation
39. Progress in known technologies
40. Economic diversification
41. Oman's credit rating
42. Migration to Oman
43. Technology transfer
44. Oman's diplomacy
45. Supply-chain concentration
46. Raw material progress
47. Infrastructure progress
48. Public/private leadership
49. Cyber warfare/terrorism
50. Intl_ organisations' climate action
51. Intl_ perception of GCC climate action

Figure 1: Impact-uncertainty diagram

Four scenarios: An Overview

Scenarios are hypothetical, plausible narratives that create a "memory of the future," enabling decision-makers to prepare for a wide range of outcomes, not just the most likely ones. Enhancing strategic readiness requires these scenarios to encompass even unlikely futures.

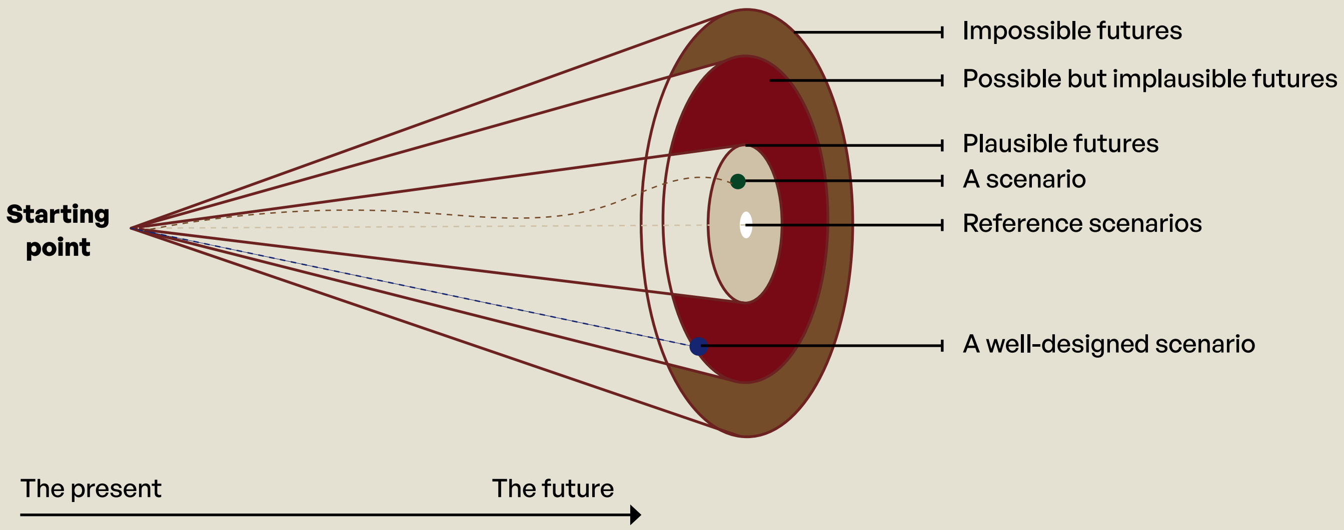


Figure 2: Illustration of the scenario corner

Scenarios are essential tools in strategic planning, providing hypothetical, often extreme yet plausible events that illustrate how the future might unfold. Unlike traditional forecasts, which aim to predict the most likely outcomes, scenarios broaden perspectives by highlighting relevant high-impact developments. The goal is to prepare decision-makers for a wide range of contrasting and unprecedented outcomes, ensuring they are equipped to thrive in various future conditions.

Scenarios are not just analytical exercises; they are narrative instruments designed to engage and immerse decision-makers in potential futures. They create a "memory of the future," enabling stakeholders to visualise these scenarios as if they were already happening. This approach helps decision-makers anticipate risks and opportunities, allowing them to prepare their organisations for diverse potential developments. Metaphorically speaking, scenarios are not maps showing where to sail; instead, they are maps of the waters that surround and must be navigated.

The Cone of Uncertainty (Figure 2) illustrates the range of potential futures, divided into areas representing plausible futures (inner, beige), possible but implausible futures (red), and impossible futures (brown). Scenarios are designed to push the boundaries of what seems possible, highlighting unexpected developments at the edge of plausibility. Exploring the full spectrum within the cone is crucial for comprehensive preparation. By considering extreme scenarios, decision-makers can effectively cover the entire range of possibilities, equipping themselves for anything that might fall between these extremes. The more diverse the scenarios, the broader the array of potential futures that can be anticipated and planned for.

While scenarios are often supported by data and quantitative methods, their true strength lies in their ability to evoke vivid images of what might happen, engaging stakeholders on an emotional level. They do not dictate specific actions but instead set the stage for strategic thinking, helping leaders understand what they might face and what adaptive strategies could be required.

Constant Current, Raging Storm, Rising Tide, and Shifting Winds are four global scenarios that showcase the effect of global, regional, and local drivers on Oman's energy economy and help anticipate for a range of possible futures.

To understand the potential pathways and challenges for Oman's energy sector, we developed four distinct scenarios: Constant Current, Raging Storm, Rising Tide, Shifting Winds, and (see Figure 3). Each scenario offers a detailed narrative that helps stakeholders anticipate diverse futures, enhancing strategic planning and preparedness.

"Constant Current" represents steady progress with moderate changes in the energy landscape. "Raging Storm" depicts severe instability and constrained growth, highlighting the importance of robust preparation for adverse conditions. "Rising Tide" envisions substantial yet achievable advancements in clean energy and technology, while "Shifting Winds" portrays a fragmented but stable global environment with mixed challenges and opportunities. Appendix A contains details on the method.

These scenarios are crafted to support stakeholders in Oman's energy sector by offering a structured approach to anticipate diverse challenges and opportunities. By visualising different possible futures, stakeholders can better identify risks and capitalise on opportunities, enhancing strategic planning and decision-making. Additionally, these scenarios promote collaboration among policymakers, industry leaders, and other stakeholders, facilitating a comprehensive understanding of the complexities inherent in economic and energy planning.

CONSTANT CURRENT

Oman advances towards Vision 2040, while global tensions and uncertainty moderate the pace of progress.

Adaptation	●●○	MEDIUM
Innovation	●●●○	MEDIUM
Energy economy	Balanced mix of oil, gas, and clean energy	
Strong clean sectors		
Role of Oman	Reliable safe option	
Main economic logic	Stability and risk management	

RAGING STORM

As momentum in the global green economy weakens, growing pressures shape a more demanding context.

Adaptation	●○○	LOW
Innovation	●○○○	LOW
Energy economy	Less oil and gas, moderate clean energy	
Strong clean sectors		
Role of Oman	Self-reliant actor	
Main economic logic	Domestic resilience and self-sufficiency	

RISING TIDE

In a fragmenting world with bold climate action, Oman and the GCC step up.

Adaptation	●●●	HIGH
Innovation	●●●●	STRONG
Energy economy	Strength in conventional and renewable energy	
Strong clean sectors		
Role of Oman	Connector and hub between regions	
Main economic logic	Shared growth through cooperation	

SHIFTING WINDS

Oman adjusts as rapid change tests the resilience of its traditional growth model.

Adaptation	●●○	MEDIUM
Innovation	●●○○	LIMITED
Energy economy	Mostly oil & gas, limited clean energy	
Strong clean sectors		
Role of Oman	Flexible middleman	
Main economic logic	Making use of cheap energy and adaptability	

Figure 3: Scenarios overview

Rising Tide

This scenario traces how a window of geopolitical stability, climate-driven urgency, and regionally anchored statecraft enables the Gulf to transcend fragmentation through pragmatic integration. At the centre of this transformation stands the GCC Future Industries Fund: a co-owned vehicle to translate trust into tangible investment, and rivalry into structured interdependence. Backed by sovereign wealth and designed to build industrial clusters across borders, the Fund underwrites a quiet revolution—anchoring growth in specialisation, distributing value chains, and disincentivising conflict through shared stakes. Oman capitalises on this shift by bridging diverging energy trajectories: exporting clean hydrogen to the West while scaling oil, gas, and carbon management for Eastern partners. Coupled with its growing CO_2 storage capacity and revival of Indian Ocean trade corridors, Oman repositions itself as a geostrategic hinge between regions, systems, and markets.

2025–2028: GLOBAL FRACTURES, LOCAL ORDER

By the end of 2025, unresolved global conflicts remain alongside tensions over trade routes such as the Red Sea. While not escalating further, they maintain enough instability to prevent oil and gas prices from dropping. The resulting stable inflow of profits allows Oman's government to foster spending into critical areas of economic development—with a particular focus on the clean energy industry.

This proves timely: throughout 2026, global climate disasters exacerbate the urgency of addressing climate change. Massive wildfires in Australia, record heatwaves in Southern Europe, and intensifying storms across the Americas keep climate action firmly on the global agenda. Despite sluggish economic growth, EU climate change mitigation efforts intensify and manifest in a renewed push for hydrogen, following both announcements of a mandated gas-to-hydrogen switch and financial incentives. Binding investment decisions for large projects in Oman follow, and Omani actors follow suit with large-scale investments in shared-use hydrogen infrastructure.

Simultaneously, key geopolitical issues remain for now and foster the divide between Western and Eastern powers. An increasingly common "us or them"-stance vis-à-vis key conflicts does not affect trade relations but creates a new wave of "inwardness". In preparation for future economic confrontation with China—the "rivalry of the century"—the US is hinting at a gradual reduction of its engagement in Middle East affairs. Europe increasingly sees "green nationalism" emerging as a popular compromise: the polarised reality of an entrenched far-right alongside ultra-greenism has reached a pragmatic deal, which fosters environmental reform with nationalist policies towards eco-friendly inwardness. While this fosters self-reliance and a stable (albeit stagnating) economy, it also depresses the willingness to engage in international affairs.

Against this backdrop, the GCC charts its own course. In 2027, a GCC initiative led by Oman and Saudi Arabia launches a structured dialogue with Iran: the "Gulf Neighbourhood Initiative." Initially focused on maritime safety, infrastructure resilience, and low-risk trade integration, it rapidly gains momentum and proves transformative. By 2028, the GCC and Iran agree to harmonise standards in select trade zones and coordinate on regional transit corridors, with the first GCC investments in southern Iran's logistics and food systems.

As both the dialogue and mutual trust deepen, later that year, security arrangements follow suit, including plans for airspace coordination protocols and a mutual maritime warning system. Simultaneously, things are moving vis-à-vis Yemen: first careful investments from GCC countries in the rather stable parts of the country come alongside a pragmatic rapprochement with previously disliked actors elsewhere in the country. Although Europe and the US are concerned about these developments, they lack the political will—and, following their inwardness, partially also the capacity—to intervene meaningfully.

2028–2031: THE FUND THAT CHANGED THE GULF

This shifting landscape has brought about a new realisation among GCC governments: just as earlier peace agreements with Iran were driven by the understanding that economic prosperity is incompatible with prolonged conflict, there is now a growing consensus that intense economic rivalry within the Arabian Peninsula serves no one's interest. Instead, pragmatic collaboration seems the way forward—and co-ownership is seen as a tempting tool.

Building on the (positive) experience of GCC-level common investments in Iran, in late 2028, the countries sign the proposal for a GCC Future Industries Fund. The plan foresees a groundbreaking joint investment initiative, financed and owned by each member state's sovereign wealth fund, that undertakes targeted investments in advanced technologies and industrial development, ranging from AI to renewable energy solutions.

In 2029, the fund receives its first seed funding from the member states and progresses with its first investments. Instead of focusing on singular use cases, it seeks to onshore entire value and supply chains and distribute them across the GCC while sharing profits. Building on existing industry hubs in the region, the fund invests in, accelerates, and scales new industries in clusters of excellence, where one cluster produces the intermediate goods for another. This co-owned entanglement fosters specialisation (and, thus, economies of scale and competitiveness) on the one hand, while creating shared interests that disincentivise regional competition and foster regional stability.

In 2030, Oman reaches another milestone: the first hydrogen exports are en route to Europe, positioning Oman as a key player in the global clean energy transition. This success has broader implications for the GCC, as the entire region benefits from the growing demand for clean energy. The hydrogen market is seen as a cornerstone for future growth, and Oman's role as a reliable hydrogen supplier is solidified.

In 2031, celebrating three years of coordinated investment and security coordination, the GCC and Iran sign a semi-formal Regional Stability Charter—a political framework combining mutual non-aggression, economic non-coercion, and shared crisis coordination protocols, particularly in maritime and airspace security.

By then, and exhilarated from the early success of collaboration on the fund, Qatar and Oman (re-) enter OPEC—and pitch a new proposal: production recommendations now include not only oil but also LNG and hydrogen. This strategic move has its opponents but is ultimately seen as a necessary—and feasible—way to guarantee that prices do not deteriorate, and that sufficient revenues can fill public budgets and, ultimately, also sustain the Industry Fund.

Into the early 2030s, favourable economic conditions encourage an uptake in industrial relocation from Europe to the Gulf. European tech industries, facing high energy costs and increasingly complex regulation at home, seek out the Gulf as an attractive destination for their operations. Oman, in particular, sees an influx of foreign direct investment from Europe, the U.S., and East Asia.

2033–2040: INTEGRATION, INNOVATION, INFLUENCE – THE GULF BECOMES THE FUTURE

In 2033, the completion of core GCC integration projects, including the Gulf Railway, marks a new chapter in regional connectivity. This infrastructure project, initially feared to cause industry relocation, has been coordinated with the Industry Fund and instead fosters specialisation. It acts as a catalyst for the growing industrial clusters, deepening regional economic integration. At the same time, the GCC complements this integration with a joint workforce and skills initiative, aligning education systems, vocational training, and migration policies to build a shared labour market for the region's specialised industries and shifting demographics.

At this point, the Industry Fund also expands its scope. It adds cross-border technology-sharing agreements, allowing states to adopt and implement cutting-edge technologies across the region.

The result is an increasingly integrated yet geographically distributed Gulf economy centred on innovation and interlinkage. Similar to Dhahran or Ruwais in the oil sector, co-owned clusters of excellence attract jobs, scale technologies, and encourage specialisation, but shared ownership disincentivises competition and fosters regional stability.

The fund also begins cautiously investing in Yemen. Three aims drive this: Yemen offers low-cost labour and local resources for certain industries; strategic investment can improve stability and reduce security risks for the wider region; and its large population represents a future consumer market. Oman takes the lead by expanding cross-border infrastructure and unveiling plans for a rail link from Salalah to Yemen.

Globally, climate disasters remain frequent, but policy only shifts in 2034, when the UNFCCC secures a flexible compromise. Countries must now establish either a national carbon trading scheme or join an international one. This enables diverse decarbonisation paths while creating pressure to coordinate through carbon border adjustment mechanisms.

The GCC responds with a long-prepared move: the launch of a unified regional carbon market. Member states trade emissions credits, with proceeds flowing into the Industry Fund. At the same time, the "tougher-but-flexible" agreement cements an already growing divide between West and East: the EU focuses on hydrogen and renewables, while the East—including the GCC—prioritises decarbonising oil and gas through CCS, energy efficiency, and process innovation. Oman benefits from both trajectories: hydrogen exports to the West and fossil exports to the East.

While CCS had remained unprofitable for Oman until then, the tide turns in 2035, when a pilot shipment of captured CO_2 from Japan arrives. A mutual recognition of carbon credits has been established, allowing Oman to monetise storage services. Although cross-border CO_2 trade remains niche, it paves the way for Oman's first direct air capture plant in 2037. That year, the EU, GCC, and several smaller carbon systems merge, expanding carbon trading and reinforcing Oman's innovation ecosystem. Oman's mineralisation capacity makes it a key player in climate diplomacy, and its ability to balance clean and fossil energy exports strengthens its bridging role between diverging energy systems.

In parallel, Oman spearheads the Oman Indian Ocean Union by 2037, forging trade and technology ties with Indian Ocean countries based on historical Omani influence. This opens markets for clean tech exports and boosts Oman's geopolitical standing. Meanwhile, the GCC and Iran finalise a comprehensive Economic and Security Partnership Pact, combining shared maritime and airspace security with enhanced economic corridor integration.

By now, the Industry Fund—now the world's largest sovereign wealth tech fund—expands into Egypt, acquiring assets previously owned by individual GCC countries. Each investment is guided by the triple logic of economic development, regional stability, and global influence. The idea of a common GCC currency is revived, this time with a concrete plan for implementation by 2040.

As the 2040s begin, the Gulf region is no longer merely reacting to global trends—it is setting them. Oman, positioned at the intersection of East and West, energy and innovation, remains a pivotal actor in this new order. Entering the 2040s, the Gulf no longer follows the pace of others—it defines one of its own, with Oman anchoring the balance between continuity and change.

Shifting Winds

This scenario traces how a globally intensified climate agenda—paired with disappointing technological progress and a post-boom fossil fuel glut—reshapes both the global and Gulf regional energy landscape. It envisions a world of climate commitment without innovation, economic stagnation without collapse, and regional cooperation without integration. Within this landscape, Oman emerges as a strategically detached yet economically relevant actor, benefitting not from unity or leadership, but from adaptability, infrastructural readiness, and bilateral positioning.

2025–2028: WHEN ABUNDANCE BECAME A BURDEN

In the winter of 2025-2026, the global landscape is marked by significant shifts. News emerges about economic growth in China, once a powerhouse, beginning to slow down due to changing demographics and increased competition, both from India and elsewhere. The Chinese economy cooling off reduces demand for oil and gas. Simultaneously, numerous global conflicts cool down. While not resolved, the situation in Ukraine, Palestine, Libya, and Venezuela lessens in intensity. Especially for the latter two, oil and gas production increases and heightened exports are incipient.

The combination of reduced demand from China and elevated supply from former conflict regions contributes to an oversaturated oil and gas market. By mid-2026, oil prices plummet to around $35 a barrel. For Oman and other GCC countries, this drastic decrease in oil prices poses significant economic challenges. Whereas oil and gas production remain profitable, government revenues drop, putting many projects and planned recruitment on hold.

Despite the oversaturation, the global emphasis on climate change remains strong, particularly in Europe and the United States – for whom despite geopolitical stabilisation geoeconomic competition remains intense, and clean tech is increasingly considered a core area of rivalry with China. In 2026, Europe experiences severe droughts, and politicians vow to intensify climate action; national emission reduction commitments are reaffirmed in all member states and the Carbon Border Adjustment Mechanism is enforced by early 2027, putting further downward pressure on oil prices.

Public sentiment across the Gulf begins to turn. As tighter fiscal conditions translate into reduced public recruitment, climate initiatives—once presented as future-oriented and strategic—are increasingly perceived as externally imposed and economically misaligned. By 2027, a growing share of the population views global climate action as a Western agenda designed to undermine development in the Global South. While no country formally abandons its net-zero commitments at this stage, the political tone shifts noticeably. Officials across the region begin to speak of the need for a "climate policy that serves the people, not the other way around," signalling that further changes may be forthcoming.

2028–2035: A DECADE OF DRIFTING TRACKS

By 2028, the indicated shift in tone begins to translate into policy. While some Gulf countries remain committed to their climate pathways, others start to recalibrate more visibly. Oman takes a cautious middle course. With public finances under strain and investor appetite shifting, several clean energy projects are cancelled or quietly delayed. Energy efficiency also begins to lose momentum: as oil prices remain low, abundance—rather than scarcity—shapes the public calculus, and efficiency gains lose their relevance. While the narrative of "transition" is not yet fully abandoned, most of the GCC sees a return to fossil fuel-based industrialisation, as these sectors remain major employers and central to economic stability.

Despite a globally strong push for climate action—and considerable investment in research and development—progress on core technologies remains underwhelming. By 2030, the production cost of hydrogen from electrolysis still exceeds USD 6 per kilogram, while ammonia and pipelines remain the only (albeit costly and impractical) transport options. Costs for solar and wind energy continue to decline, though at a much slower pace than anticipated, and no significant breakthrough is achieved in any other major technology. This combination of strong political commitment and disappointing technical progress implies that mitigation efforts must increasingly rely on changes in global demand. For climate-ambitious countries, energy efficiency becomes the central pillar of climate strategy, with a shift away from technological frontierism toward reducing waste. In parallel, careful degrowth emerges as a limited but tangible approach to reducing emissions, particularly in parts of Europe. The global economy, while not in crisis, becomes measurably poorer—strained by the high costs of implementing climate solutions in a world of weak innovation.

At the same time, the erosion of regional coordination becomes harder to ignore. What once looked like temporary differences in climate and industrial strategy now starts to affect shared initiatives. Some Gulf countries push for alignment with global markets and emissions frameworks; others prioritise fossil-based industries with little interest in compliance. As coordination is attempted—on joint ventures, investment zones, or technology standards—basic incompatibilities begin to surface. Meetings still take place, but statements grow vaguer, and follow-up less frequent. Oman stays diplomatically present but increasingly sidesteps regional debates, choosing cooperation where useful, silence where not. There is no rupture—but the sense of common purpose has faded, replaced by parallel tracks and separate calendars.

Toward 2032, the effects of strategic divergence begin to materialise in trade and investment flows. As European carbon regimes tighten, access to key markets narrows—especially for carbon-intensive exports such as aluminium, steel, and petrochemicals. For some Gulf producers, alignment with EU standards becomes a strategic priority; others quietly redirect to markets with looser requirements. Intra-GCC trade sees modest gains, but without a shared vision, coordination remains elusive. Oman, meanwhile, becomes an increasingly attractive location for dual-purpose production: clean where necessary, carbon-intensive where possible. Logistics infrastructure is expanded, and new agreements with East African and South Asian partners gain ground. The result is not a bold repositioning, but a slow reconfiguration—Oman carving out utility and relevance in a region that no longer moves in sync.

By then, early scepticism toward climate agendas has hardened into conviction. With fiscal pressures mounting and public sector hiring stalled, a wave of influential op-eds and viral online commentary begins questioning the relevance of net-zero commitments. Senior national figures echo these concerns. In early 2033, five GCC states officially announce the cancellation of their net-zero plans, declaring that they will instead “forge our path guided by the blessings placed in our lands” — a phrase that quickly becomes emblematic of the region’s new orientation.

2035–2040: OMAN’S QUIET REALIGNMENT

By 2035, while most advanced economies double down on decarbonisation targets, Oman positions itself at the opposite end of the spectrum: as a haven for industries displaced by tightening carbon regulations elsewhere. Its competitive advantage—low-cost natural gas, minimal carbon pricing, and a permissive regulatory environment—draws investment in carbon-intensive sectors such as fertilisers, cement, aluminium, and, later, heavy machinery. Elements of the earlier clean economy agenda survive but are reframed entirely in commercial terms. Projects in green steel and ammonia persist not as national commitments, but as carbon-compliant exports to Europe and Japan. Their existence depends solely on foreign demand. Meanwhile, trade with East African partners increases by over 50% compared to the previous decade, signalling a shift in economic geography.

In parallel, global R&D coherence continues to erode. Breakthroughs remain elusive as economic headwinds constrain innovation budgets; major global players prioritise energy efficiency over frontier technologies. The result is not just stagnation, but fragmentation. Simultaneously, Gulf applied research gains relative prominence. While formal regional initiatives—such as the unified GCC visa—quietly fall away, informal cooperation intensifies. Researchers and companies collaborate pragmatically across borders, sustained by shared infrastructure, technical familiarity, and urgent common challenges. Joint efforts in key technologies become more frequent and effective. Oman remains selectively engaged—contributing where institutional stability and technical relevance align with broader regional needs. Though climate technologies hold little domestic traction, niche export opportunities still emerge.

By 2040, Kuwait and Oman jointly unveil a new oil-fired power plant, presented as a flagship of sovereign resource utilisation. The project symbolises a definitive break from the climate commitments of the 2020s, celebrated not as a step backward but as a return to national fundamentals. Oman’s development trajectory now stands in marked contrast to earlier aspirations. The country is less integrated in global climate diplomacy and plays a quieter role in regional coordination. At the same time, while there is not a unified Gulf knowledge economy, a quiet, decentralised network—more functionally integrated than many formal structures ever achieve—emerges. In the end, Oman’s path reflects not so much a plan as a convergence of gravities—economic, technological, and political—that steer the country toward selective disengagement and quiet resilience. Yet, it remains a functioning economy. It is not the future once imagined—but it works.

Constant Current

This scenario charts a world shaped by cautious industrial policy, strategic hedging, and persistent logistical risk. Following the Strait of Hormuz disruption, global systems stabilise without regaining coherence; climate ambition remains bounded, and innovation advances unevenly under concentrated control. Within the Gulf, investment resumes under stricter terms, while deeper cooperation gives way to guarded competition. Oman adapts by consolidating roles in low-exposure logistics, modular clean industry, and third-party carbon storage. Its relevance stems less from scale than from reliability—anchoring movement in a fragmented world.

2025–2028: FRAGMENTING ORDER, GRADUAL TIGHTENING

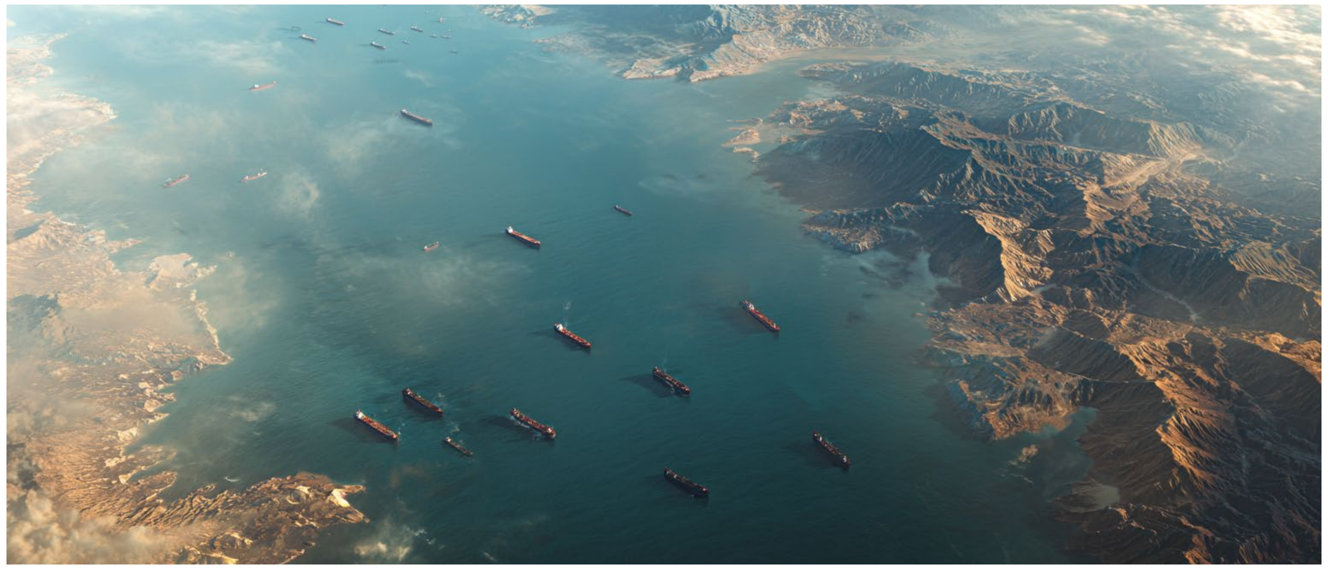
The winter of 2025–2026 arrives at a moment when global politics feels stretched but not yet unstable. The brief regional military escalation of 2025—already absorbed into the region's long record of confrontation—shapes expectations without dominating them. Regional frictions surrounding maritime security and overlapping influence networks persist without the decisive shift that would either settle or escalate them.

Simultaneously, governments reaffirm climate objectives, yet increasingly couple them to security, industrial resilience, and competitiveness. This posture is reflected in 2026 at COP31, where long-term ambitions are repeated but few new mechanisms emerge capable of materially accelerating implementation. A mild decoupling opens between stated goals and operational delivery. Hydrogen follows this broader trajectory. Once framed as a central lever in Europe's and Asia's industrial transition, it progresses more cautiously, shaped primarily by specific sectoral use cases rather than overarching visions. Early FIDs in the Gulf, including in Oman, move forward, but supply-chain constraints, capital intensity, and the concentration of critical technologies stretch timelines. The early sense of a "hydrogen wave" settles into a measured, procedural rollout.

Technological dependencies reinforce this realism. Advanced solar components, high-performance storage systems, smart-grid electronics, and electrolyser stacks remain concentrated among a small number of producing economies. Scale advantages, intellectual-property protections, and export frameworks strengthen this pattern. For countries pursuing localisation, the barriers become clearer: longer lead times, higher costs, and deeper reliance on external expertise. By 2027, it is increasingly evident that Oman's 2030 hydrogen export horizon will be more modest than early-decade expectations suggested. Strategy shifts toward selective industrial integration and domestic applications rather than rapid export growth.

Across the Gulf, cooperation and competition continue in parallel. High-level unity holds, and flagship projects—most visibly the Gulf Railway, still in phased development—retain political salience. Yet with construction progressing gradually and commissioning expected only near the decade's turn, its economic implications remain speculative. Conversations increasingly revolve around potential futures: some anticipate that the railway could eventually reshape regional logistics; others quietly worry it may, once operational, reinforce rather than rebalance existing industrial geographies. These anticipations subtly sharpen underlying rivalries, particularly in petrochemicals, logistics, and energy-adjacent industries, even as public messaging emphasises cohesion.

Oman maintains its steady institutional posture, benefiting from predictability and neutrality while operating within the constraints of a region integrated in form but becoming more differentiated in practice. By 2028, the overall atmosphere is one of muted forward motion: moderate fossil-fuel demand, cautious technological investment, measured climate ambition, and a Gulf order in which cooperation continues, even as strategic competition quietly thickens beneath the surface.



2029–2033: ECONOMY REROUTED

Throughout 2029, unresolved tensions in the region become more visible. After international sanctions against Iran had already thickened, a general narrowing of diplomatic and security space becomes increasingly apparent. A sequence of ambiguous incidents—targeted cyber disruptions, heightened surveillance activity, and sporadic encounters in contested waters—signals that the equilibrium is holding, but only just. Shipping companies react immediately: insurers raise war-risk premiums, narrow coverage windows, and update exposure assumptions.

Against this backdrop, mid-2029 brings the shift many had increasingly anticipated but hoped to avoid. After a series of escalatory exchanges and a renewed set of strikes on Iranian strategic assets, Iran responds in a manner that differs from earlier episodes. Rather than relying solely on indirect means or targeted action abroad, Tehran introduces temporary, selectively applied navigation restrictions in the Strait of Hormuz. At first, the measures consist of uneven inspection procedures, intermittent delays, and differentiated treatment of vessels based on destination and declared cargo.

A U.S. ship in late 2029 attempting to bypass the restrictions leads Iran to announce the full closure of the chokepoint. For the first time in years, the region confronts a structural disruption rather than an incremental one. Spot market fuel prices spike sharply in the immediate aftermath. Major carriers, particularly those moving long-haul flows to East Asia, reroute proactively, preferring predictability over the lower costs of the traditional passage. As each operator adjusts, the behaviour of others accelerates the shift. What had for years been discussed as a contingency becomes a de facto operating principle: Gulf waters can be transited, but always with alternatives available.

For Oman, the implications are immediate and structural. As carriers diversify routes, Suhar and Duqm experience a surge in demand that exceeds earlier planning horizons. Berthing requests rise sharply; bunkering operations increase throughput; warehousing and auxiliary services expand to meet new pressures. The shift is not treated as a temporary diversion. Instead, operators formalise arrangements for long-term routing diversification, embedding Oman's ports into broader resilience strategies—and into incremental industrial expansion as well. Companies move selected activities of regional relevance into the cluster, strengthening Oman's clean-energy economy.

The closure does not expand into all-out regional war, but it triggers a rapid response. Within a month, an alliance of selected Western and GCC states initiates coordinated naval operations aimed at restoring navigational continuity. The mandate remains deliberately narrow: rather than forcing a political resolution, the coalition focuses on establishing a permanently guarded maritime corridor through the central axis of the Strait. Over roughly two months, escorted convoys, layered surveillance systems, and predefined commercial lanes are put in place. By 2030, shipping resumes under a monitored, structured framework.

The reopening stabilises physical flows but does not restore confidence. Insurers reduce premiums from their 2029 peak but maintain a lasting risk surcharge, based on the judgement that any managed equilibrium in the region could prove temporary. Shipping companies adopt more conservative routing assumptions, embedding redundancy into their logistics networks. The corridor is safe in practice, but safety is no longer treated as a given; it becomes a priced condition. As soon as the corridor proves functional, fuel prices cool back toward pre-crisis levels, reinforcing the perception that the disruption was sharp but contained. While the global economy again considers investments inside the Gulf and interest in Sohar and Duqm moderates slightly, several GCC states begin deploying targeted incentives to draw back segments of logistics, manufacturing, and clean-tech production, reviving the region's underlying pattern of competitive overlap. Oman, nonetheless, continues to benefit from levels of investment and industrial allocation far above pre-2029 standards.

Around these ports, associated economic activity gradually intensifies. Early e-fuel production for marine applications finds a more stable niche; specialised logistics manufacturing expands; and port-adjacent service providers scale operations to meet the sustained increase in demand. Demand for these cleaner products comes largely from European buyers—where climate considerations remain moderately influential—and from GCC industrial users seeking to maintain their own emerging climate-aligned standards. The Gulf Railway becomes operational in 2031 and allows goods produced in Oman's new industries to move into the UAE and Saudi Arabia. Hydrogen continues on its more modest trajectory. By 2033, it remains relevant for specific industrial applications—cleaner steel pathways, port-related fuels, and selected domestic uses—but it no longer figures as a central export strategy. Instead, incremental progress in petrochemicals, logistics, and carbon-conscious industrial activity shapes the more immediate opportunities.

2034–2040: AFTER THE TURBULENCE

By the mid-2030s, the region is no longer in crisis—but nor has it returned to ease. What was once considered turbulence is now treated as baseline complexity. In 2034–2035, as confidence cautiously rebuilds in the Strait of Hormuz, several GCC states launch targeted campaigns to revive pre-crisis investment patterns. They offer incentives to lure back manufacturing, petrochemicals, and downstream clean-tech operations. Oman absorbs the rebalancing, consolidating its position in low-exposure logistics and modular clean industry, even as heavier segments pivot back toward larger economies.

But this is not a return to the past. The infrastructure of Gulf commerce has changed—not just physically, but conceptually. The corridor resumes operations, yet route diversification becomes a permanent behavioural norm. Insurers, industrial planners, and port authorities embed redundancy into their frameworks. Oman's ports, once peripheral, are now indispensable buffers: not the cheapest nor the fastest, but critical for optionality and continuity.

In 2036–2037, geopolitical hedging becomes a structural mode of engagement. Cooperative language persists in summits and joint announcements, but trust is replaced by termsheets. Dual-track strategies multiply: industrial corridors gain layered security; strategic reserves of energy, water, and rare materials are folded into business models. Free zones diverge from national regulatory regimes, while intergovernmental pacts include ever broader "force majeure" clauses.

Climate events continue to mount—heatwaves, short-duration urban floods, sea-level stress—but action remains bounded by fiscal caution and geopolitical fragmentation. Industrial players expand low-carbon output to protect access to Europe and East Asia, not out of transformative ambition. Carbon capture and storage becomes a modest but permanent pillar; Oman's legal frameworks and geology support third-party storage services. Adaptation measures—heat-resilient cooling, flood defences, decentralised logistics—proliferate, but are bolted onto existing models rather than reshaping them. This is procedural resilience, not reinvention.

Technological progress is real but gated. Between 2037 and 2039, concentrated IP regimes and uneven diffusion limit access to advanced clean technologies. Select zones—Duqm, NEOM, Ras Al-Khair, and Jebel Ali—emerge as semi-autonomous innovation enclaves. Elsewhere, selective adoption prevails. Oman positions itself in pragmatic innovation: low-cost applications in logistics, climate control, and materials handling that serve both domestic and regional needs.

By 2040, Oman stands at a crossroads. The country has made tangible gains in port logistics, petrochemicals, and carbon capture—its geological formations and legal environment positioning it as a quiet but capable service provider in the decarbonisation economy. Yet the broader economic transformation envisioned earlier in the decade remains incomplete. Despite a modest boom in large-scale solar and wind projects across the 2030s—and early hydrogen integration in hubs such as Sohar to support industrial continuity—Oman still relies heavily on its traditional energy base. The energy transition is underway, but far from resolved. Efficiency improvements and energy savings strategies become central, not just for competitiveness, but for system stability.

Diplomatically, Oman's hedging becomes more exposed. Growing alignment with Eastern partners—driven more by necessity than conviction—creates new trade and investment flows but complicates relations with Europe and the US. The country avoids unlocking Yemen as a growth market, aware that deep economic integration there would compromise its carefully managed neutrality.

By the close of the decade, the global picture remains recognisably Constant Current. Industrial policy is cautious. Governance is fragmented. Climate ambition is real, but bounded. The Strait's corridor is functional—but never again feels permanent. And so, Oman's advantage lies not in dominance, but in anchoring optionality. It becomes the necessary hinge in a world that no longer trusts its centre of gravity.

As larger powers in the region seek to reclaim influence through scale and spectacle, Oman quietly becomes the one place where movement—forward, sideways, or away—remains possible. In a Gulf where stability is performed, not presumed, quiet resilience outlasts ambition.

Raging Storms

This scenario charts a trajectory defined by early disruption, strategic misalignment, and eventual retreat into resilience. A major climate shock prompts national mobilisation, positioning Oman as a climate-forward outlier. But the external environment drifts: global decarbonisation slows, regional integration erodes, and clean industrial momentum stalls under fiscal constraint. Oman's climate agenda persists—less as a growth engine than as an institutional anchor. Market access narrows, external support fades, and logistical asymmetries deepen. Yet fragmentation breeds autonomy. As regional platforms collapse, Oman retools for inward resilience: clean technology production turns domestic, infrastructure adapts modularly, and the country charts a path of self-reliant strength.

2025–2029: FLOOD ALERT

In early 2026, a stalled cyclone system delivers several days of sustained rainfall across Oman's northern coastline. Ruwi and Al-Ghubra remain partially submerged for over 72 hours, with flooding disrupting mobility, logistics access, and municipal operations. Power supply is temporarily interrupted, and desalination output is reduced as key coastal infrastructure enters emergency mode. While normal operations resume within days, the incident marks a turning point in public sentiment. Across social media, local outlets, and professional circles, climate change rises to the forefront of national discourse. Omanis widely praise the country's climate vision and call for its greater prominence and accelerated implementation.

National policymakers begin to take up the issue. Within weeks, climate- and environment-related departments gain increased prominence across interministerial coordination. Agencies already tasked with implementation see their mandates expanded, and climate-related planning is pulled more visibly into infrastructure, investment, and industrial policy domains. The Net Zero Strategy—already a relevant national reference—gains renewed traction as a cross-cutting coordination framework. Its download rate surges across the public administration network, and it begins to serve as a broader strategic anchor for forward-looking decision-making. Climate resilience shifts from a sectoral concern to a core organising logic, permeating policy discussions across multiple levels of government.

By 2027, this policy orientation begins to materialise in infrastructure terms. A phased programme for solar PV deployment is launched, prioritising public facilities and grid balancing in vulnerable zones. Pilot corridors for green hydrogen and ammonia production enter technical planning stages in Duqm and Sohar. Regulatory fast-tracks are introduced for low-carbon manufacturing in energy- and water-intensive sectors. The strategic focus consolidates around emissions mitigation, resource security, and insulation from future disruption. Momentum builds slowly but consistently; underpinned more by long-term institutional logic than immediate returns.

Ironically, this consolidation of intent coincides with a visible weakening of external alignment, as global decarbonisation momentum begins to stall. Key conflicts around the world are escalating, and the international community is drifting further apart into regional blocks. 2027's COP 32 hosts only 52 nations, since the United Nations have factually broken apart after many large blocks ceded collaboration with it and paused any financial contributions indefinitely. In this world, there is neither much space for climate action—other national objectives often trump climate concerns—nor are there global institutions left that are able to coordinate climate policy. As a result, carbon border regimes lose traction, and climate finance slows across non-core geographies. Access to advanced technologies becomes more conditional, and multilateral frameworks fragment into regionally bounded clubs. Oman's clean-industrial trajectory, while internally coherent, increasingly diverges from global commercial patterns.

At the regional level, structural drift accelerates—but not solely along energy lines. Existing frictions between states begin to surface more openly across emerging sectors, including digital infrastructure, advanced logistics, and AI-linked investment zones. Competitive positioning creates overlapping claims and misaligned incentives, particularly around regulatory models and capital attraction. A number of joint ventures are quietly unwound. Coordination platforms—especially those designed to harmonise industrial standards and shared infrastructure—fall inactive by mid-2027. While formal rhetoric remains unchanged, cross-border confidence declines. A planned GCC platform for hydrogen certification is indefinitely delayed, and no replacement process is proposed. Oman's orientation—methodical, climate-aligned, and institutionally distinct—is increasingly treated as non-conforming to the region's evolving tempo.

Throughout 2028 and 2029, regional economic coordination continues to recede. Trade routing preferences, diverging regulatory models, and differences in industrial classification increasingly shape cross-border flows. Oman's planned clean industrial output—green steel samples, hydrogen-linked carriers—faces limited regional uptake, and shared certification efforts remain dormant. Access to key logistics corridors narrows incrementally as infrastructure decisions are shaped more by competition than coordination. Parallel to these developments, cybersecurity and information resilience rise in institutional importance. A series of non-attributed disruptions affecting digital platforms reinforce the need to reduce external dependencies and strengthen internal infrastructure oversight. While operational continuity remains intact, regulatory agencies take steps to improve system robustness and minimise exposure to unmanaged digital risk. The broader climate-industrial agenda remains in place, but by the end of 2029, the context has shifted: Oman is pursuing a forward-leaning development trajectory in a region and global system that are becoming increasingly fragmented, cautious, and structurally misaligned.

2029–2033: HIGH WATERS ARE LONELY

By 2029, Oman has enacted a voluntary, gradual phase-out of selected upstream and midstream oil and gas operations, justified publicly through climate considerations and long-term strategic diversification aims. The move is met with cautious optimism by the broader population, which—since the climate shock of 2026—has shifted perceptibly in favour of environmental policy. Many expect the green economy to compensate for any losses in conventional employment, particularly given the heightened visibility of sustainability debates in education and media. At this stage, climate discourse continues to enjoy legitimacy across institutional levels.

In 2030, this shift aligns uneasily with a global commodity rebound. Crude oil and LNG prices begin to recover, driven by renewed demand in Asia and delayed infrastructure investment in competing jurisdictions. However, Oman does not benefit from this upswing. Due to the earlier phase-out and plateauing domestic production, the country becomes a net importer of selected hydrocarbons—particularly natural gas for industrial use and power generation. Part of this is supplied through the Dolphin pipeline, for which Oman now incurs steady import costs. As a result, rather than generating windfall revenues, the rising energy prices translate into higher expenditure and limited fiscal space.

By 2031, these budgetary pressures quietly cascade into institutional planning and infrastructure scheduling. Clean energy manufacturing, while still prioritised in national strategy, is selectively delayed, and some previously announced capacity targets are quietly revised downwards. Training programmes and upskilling efforts continue, albeit with greater focus on employability and immediate fiscal returns.

Meanwhile, the broader regional context deteriorates further. By 2032, economic cooperation within the GCC has lost considerable momentum—not through outright conflict, but via diverging regulatory paths, inconsistent subsidy regimes, and competing national industrial policies. New sectors such as AI, green logistics, and digital trade become more openly theatres of competition. Occasionally, unconfirmed disruptions in digital infrastructure or supply chains are noted, without official attribution or commentary. While discreet, such incidents further encourage commercial actors to favour bilateral agreements over regional platforms.

Throughout 2032 and into 2033, Oman responds by doubling down on its pragmatic positioning. Investment in strategic logistics corridors continues, with selective progress in cross-border electricity interconnection and port upgrades. Even under fiscal constraint, the country remains attractive for dual-market production aimed at both Asia and Europe, especially where reliability and institutional predictability outweigh pure cost competition.

2033–2040: ASHES AND AFTERLIFE

By 2033, Oman remains committed to its climate and industrial goals, but mounting fiscal constraints limit the pace and scale of green sector expansion. Clean manufacturing initiatives proceed selectively, while grid upgrades and hydrogen infrastructure develop in modular formats. As export incentives weaken, project pipelines are increasingly tailored to domestic demand and funding availability.

From 2034, Oman begins to experience a progressive loss of access to key regional markets. Trade with Saudi Arabia and the UAE becomes significantly more restricted as escalating regional rifts cause selected border closures, restrictions on trade, and significant tariffs. This shift reduces Oman's integration into value chains, and even some essential goods such as certain spare parts are not available anymore.

By 2036, Oman is no longer in a position to rely on indirect oil and gas benefits from regional trade. It pays market-based prices for natural gas—including imports via the Dolphin pipeline—and cannot take advantage of the hydrocarbon windfall experienced by some neighbouring countries. Combined with continued global fragmentation, this limits external sources of climate finance and weakens the strategic return on decarbonisation exports.

Nonetheless, climate leadership remains a core pillar of national discourse. By 2037, extreme weather events intensify as a result of accelerating global emissions—

Oman is among the few countries maintaining a climate-aligned trajectory. As infrastructure adaptation becomes more complex and costly, fiscal space remains constrained. Multilateral frameworks provide limited support, and by 2038, there is growing consensus that regional and international cooperation on climate issues has entered a phase of long-term uncertainty.

Nevertheless, Oman gradually adapts. As access to regional supply chains diminishes, the economy pivots toward greater self-reliance. Public agencies prioritise contracts with Omani firms, while import substitution programmes offer incentives for foundational industries—particularly in clean energy, water systems, and agri-tech. By 2038, a nationwide localisation directive is issued, mandating that a growing share of infrastructure and utility procurement be sourced domestically wherever feasible. This creates a stable demand floor for local manufacturing and engineering services, prompting firms to retool existing assets and invest in capacity upgrades. Basic solar components, irrigation equipment, and modular infrastructure elements are increasingly produced or assembled within Oman, supported by revised standards and long-term government contracts. In parallel, shortages of imported agricultural inputs and heightened food insecurity lead to selective investment in greenhouse farming, seed resilience, and water-saving technologies. While this localisation remains uneven and efficiency gaps persist, the transition gradually builds productive capabilities, strengthens local industry, and embeds a new layer of institutional and economic resilience.

By 2040, Oman operates in a more autonomous yet functionally robust configuration. The external climate remains complex—economically, geopolitically, and environmentally—but domestic systems have gained in maturity and adaptability. Local industry plays a central role in meeting national needs, and clean energy deployment is increasingly underpinned by domestic value creation. Oman's trajectory underscores the potential of internal resilience as a stabilising force under conditions of regional and global uncertainty.

Strategic Considerations and Resilience Testing

Foresight—particularly through the use of scenarios—aims to foster anticipation by evoking what is often referred to as a "memory of the future." Scenarios are not predictions; rather, they present multiple plausible futures to help decision-makers grasp the range of ways in which the world could evolve, and to understand how today's trends and dynamics might contribute to these alternative outcomes.

However, scenarios go beyond simply offering a window into the future. When used strategically, they become tools for shaping policy and planning. The step from foresight to strategic foresight involves applying additional methods and analyses to ask how different visions of the future should inform decision-making today. In this way, scenarios are not endpoints—but entry points for deliberation, resilience-building, and structured action.

The four scenarios developed in this report generate a diverse set of insights and implications for policymakers. Each presents a distinct configuration of external drivers, thereby illuminating both risks and opportunities across multiple domains—from trade and technology to energy markets, labour needs, and global positioning.

THE CASE OF RISING TIDE

The Rising Tide scenario offers a window into a generally favourable future—both for Oman and for its regional neighbours. It illustrates key elements that could enable the emergence of a prosperous energy economy. On the one hand, the scenario suggests it may be possible for Oman to benefit from both clean energy industries and conventional oil and gas and their derivatives. This opportunity is particularly viable if Oman manages to leverage potential divergences in technological trajectories across the globe.

These divergences are already visible in emerging trends—such as Europe's pronounced focus on renewable energy, compared to the growing interest in CCS in parts of Asia. By carefully hedging risks and capitalising on the variety of available opportunities, Oman may be able to benefit from multiple pathways. However, doing so requires agility and flexibility—not only in industrial investment, but also in diplomacy. Seizing these opportunities will depend on the ability to proactively navigate and help shape global technological and geopolitical dynamics.

As the geopolitical dimension of the scenario underscores, this will require active engagement. A coordinated approach that unites traditional diplomacy, international climate policy, and industrial policy will be essential. Bridging these domains will not happen automatically. Policymakers should therefore either work to enhance coordination across the relevant authorities, or better yet, design institutions—domestically or internationally—that carry an integrated triple mandate across these areas.

At the same time, the Rising Tide scenario points to the critical role of enhanced collaboration within the Gulf. Greater coordination among GCC countries may be a necessary condition for strategic success—though the scenario also suggests it could be a feasible one. Currently, economic convergence in the Gulf is limited, and competition often dominates cooperation—particularly in high-value sectors and emerging technologies.

Yet such competition may not serve the region's long-term interests. While market competition can, in theory, lead to efficiency, in the context of the GCC, fragmented efforts and strategic rivalries may ultimately be counterproductive. The Gulf countries share a rare combination of high structural similarity and selective differentiation. This combination provides a unique foundation for integration, specialisation, and collective advantage.

One major implication of the scenario is the importance of shifting from isolated national projects to integrated regional supply chains. It is no longer sufficient to pursue single high-margin value chain segments. Instead, building distributed value and supply chains across the region—an integrated web of production and services—would allow each country to benefit from economies of scale while building a more stable and interconnected economic zone.

This form of distributed specialisation represents a potential win-win, provided the equilibrium is not destabilised by destructive competition. Otherwise, industries that are currently being nurtured may collapse—or require costly subsidies to remain viable. A persistent question, therefore, is how to make such frameworks stable, enforceable, and attractive for all involved parties.

One mechanism proposed within the Rising Tide scenario is the creation of a common fund among GCC countries. Such a fund—based on joint ownership and co-financing—could serve as a stabilising instrument by creating shared interests and aligning incentives around regional specialisation. Oman, like all other Gulf countries, has a strategic interest in enhancing regional collaboration. This could be pursued through bilateral initiatives, new multilateral frameworks, or through reforming and revitalising existing GCC mechanisms. Crucially, any such effort should go beyond increasing connectivity; it must create tangible incentives for economic cooperation.

A alternative would be to revert to open market competition and focus on identifying individual market segments or technological niches in which it holds a competitive advantage and can outpace regional rivals. As the subsequent sectoral analysis will demonstrate, there are indeed a number of clean energy sectors in which Oman could produce "national winners," especially when supported by targeted industrial policy.

However, such niche specialisation—while potentially successful—would likely offer less durable economic and regional stability than a strategy based on deep Gulf cooperation. Moreover, succeeding in a competition-based approach would require a clear-eyed mapping of the exact policy instruments, sequencing, and institutional conditions needed to build resilient, export-capable industries that can withstand external and regional pressures.

THE CASE OF SHIFTING WINDS

The Shifting Winds scenario offers a glimpse into a future shaped by global divergence—where non-convergence with dominant international trends leads to greater isolation for Oman, even as new opportunities emerge elsewhere. In this future, fossil fuels shift from being scarce to abundant, and Oman—together with selected GCC neighbours—remains among the few countries worldwide not adhering to strict climate policies or participating in global degrowth strategies. This marginalisation from the mainstream clean economy agenda limits the scope for diplomacy and domestic clean industries. However, the revival of conventional industries opens alternative pathways for economic development.

The scenario highlights a number of opportunities that policymakers may still be able to seize. One of the more striking developments lies in the interaction between a decentralised global innovation landscape and the fragmented but ambitious technological aspirations of the Gulf. As innovation becomes less concentrated and more diffuse across geographies, GCC countries—including Oman—could begin to play roles in innovation systems that had previously been out of reach.

Notably, the scenario shows that this may occur even in the face of regional political disintegration—as long as informal innovation networks persist and remain free to operate. While the global weakening of formalised research and innovation frameworks may lie outside the control of domestic policy, the ability to capitalise on this trend does not. In this context, countries such as Turkey and Saudi Arabia—both of which have successfully carved out niches in high-quality applied research—can serve as relevant benchmarks for Oman.

The scenario also underlines the strategic importance of enabling informal, cross-border research networks. In many cases, giving researchers the freedom to collaborate without bureaucratic constraints may prove more impactful than centrally engineered research partnerships—particularly when structural or political barriers are high. The implications for domestic policy are clear: fostering flexible, low-friction environments for collaboration may be as important as setting up formal institutions.

Another strategic insight from this scenario—and echoed in others—is the importance of public engagement in climate policy. At present, most GCC countries remain focused on the more accessible segments of the CO_2 abatement curve—targeting interventions that are both economically beneficial and environmentally positive. However, deeper decarbonisation, particularly in industry, is likely to entail trade-offs and possible economic costs. In such cases, ensuring societal support becomes critical.

This scenario highlights how tightly the oil and gas sector—an emissions-intensive pillar of the economy—is intertwined with social and political identity in many GCC states. As a result, public resistance to global climate narratives may increase if decarbonisation is perceived as undermining national prosperity. It is therefore essential to foreground the economic co-benefits of clean energy and the green economy, both in communications and in policy. Oman's industrial and sectoral strategies should continue to prioritise climate actions that generate tangible economic returns.

Finally, the Shifting Winds scenario suggests that even in a world where Oman pursues less ambitious climate action, economic opportunities may still exist, especially in conventional sectors. Oman's resource endowment, infrastructure, and geographic advantages remain assets. A mixed strategy that balances clean and conventional industries is not only feasible—it may be desirable under some global configurations.

However, the scenario also makes clear that in a world moving toward more uniform decarbonisation, non-alignment may incur growing political and economic costs. Policymakers should therefore avoid framing the challenge as a binary between abandoning traditional industries or embracing new ones. Instead, strategic monitoring of the evolving geopolitical implications of climate action—or inaction—will be critical. Conventional industries may still play an important role, but their viability must be continuously reassessed as climate diplomacy, regulation, and global supply chains shift.

THE CASE OF CONSTANT CURRENT

The Constant Current scenario presents a world in which shifting global connectivity meets evolving industrial strategies, without fully breaking from existing trajectories. For Oman, this future offers a complex mix of opportunity and risk. Recent regional trends continue: geopolitical instability remains a persistent factor, while formal cooperation within the GCC increases—yet economic competition on the ground remains the norm.

A central insight from this scenario is that regional disruptions may produce non-linear effects. Geopolitical realignments, and even security incidents, can generate both losses and unexpected gains. For example, the scenario outlines how a temporary closure of the Strait of Hormuz could redirect international attention to Omani ports—particularly Sohar, Duqm, and Salalah. This shift could, in the medium term, increase trade volumes and trigger industry relocation to Oman's free zones. As a general principle, such international incidents should be assessed not only for risk mitigation, but also for emergent opportunities they may create.

The same incident also illustrates how increased connectivity can cut both ways. The scenario references the GCC railway as an example: enhanced transport infrastructure can lower transaction costs, improve access to regional markets, and attract industries seeking regional distribution capacity. In such cases, Oman may benefit from industries relocating away from neighbouring countries. However, for other sectors, the reverse dynamic may apply. Without mechanisms to replace harmful competition with coordinated collaboration, expanded infrastructure and integration may lead to losses in domestic competitiveness.

For policymakers, the lesson is clear: increased connectivity is not inherently beneficial. Strategic planning must include a sector-by-sector evaluation of how infrastructure developments affect Oman's net economic position, and whether complementary policy support is needed to retain vulnerable industries. This is especially true in the context of regional transport and trade integration.

Another important insight from Constant Current is Oman's external dependency in the clean economy. While hydrogen exports and other clean sectors may remain viable, their scale could fall short of initial expectations—particularly if global climate policy commitments falter, or if geopolitical instability undermines long-term contracts. The scenario thus points to the need for highly adaptive industrial strategies. Policymakers should closely monitor global signals—especially around security and climate policy—and retain the institutional flexibility to recalibrate national strategies accordingly. In some cases, a "muddling through" approach may be economically acceptable, provided it is paired with close oversight and strategic pragmatism.

Finally, this scenario—like Rising Tide and Shifting Winds—emphasises the potential of non-traditional markets in Oman's future economy. While the EU and East Asia will likely remain key trading partners, broader engagement is essential. This includes proactive outreach to markets in East Africa, South Asia, and the immediate region—particularly Yemen. Although Constant Current depicts a regional climate in which Oman cannot fully capitalise on ties with Yemen, the strategic value remains clear. Oman's geographic proximity, diplomatic leverage, and infrastructure linkages position it well to explore both supply chain integration and market development vis-à-vis Yemen. Even under constraints, early planning in this direction may create advantages in the medium term.

THE CASE OF RAGING STORMS

Raging Storms represents the most adverse trajectory among the four scenarios. It envisions a future in which both global and regional structures disintegrate—and where a damaging divergence emerges between Oman's domestic climate and economic policy on one hand, and the direction of global development on the other. While the scenario primarily serves to illuminate the risks that policymakers should seek to avoid, it also underscores the strategic value of building resilience and autonomy in an uncertain world.

At the centre of this scenario is the idea that Oman continues to pursue ambitious climate action, even as much of the international community retreats from such commitments. In this context, Oman's clean economy faces two compounding challenges. First, its clean exports—such as green hydrogen or low-carbon goods—struggle to find viable international markets. Second, if fossil fuel revenues diminish significantly, the country faces mounting fiscal pressures in the absence of alternative income streams. The scenario thus highlights two critical risks for policymakers to monitor: a large portion of Oman's clean economy vision is dependent on external demand, and this demand may not materialise if global decarbonisation weakens or fragments.

Even if domestic demand exists, a substantial share of prospective returns for clean sectors remains tied to foreign markets. As such, while early, bold investment in clean technologies and industries may be warranted, Oman's strategy must be continuously assessed against global signals. Policymakers should ensure that ambitions remain aligned with the evolving pace and direction of international climate demand—and be prepared to adjust course if required.

This logic extends to climate policy more broadly. If timed and leveraged strategically, Oman's leadership in climate action—particularly its engagement in international climate diplomacy—could enhance both geopolitical influence and soft power. However, this must be carefully calibrated. In this scenario, the collapse of the global order leads to the breakdown of international climate institutions, and climate action becomes a marginal objective in a turbulent geopolitical environment. The lesson here is not to abandon climate ambition, but to remain synchronised with the shifting international landscape and maintain flexibility in the sequencing of domestic policies.

At the same time, the scenario shows the possible importance of onshoring industries. In this future, Oman is compelled to localise production to maintain economic continuity. While such a (reactive) development would be undesired, it points to a strategic imperative. Policymakers should consider building economic resilience pre-emptively, rather than waiting for external shocks to dictate internal restructuring.

This does not mean turning away from global trade or integration. Rather, it implies carefully balancing openness with the development of strategic national capacities. Designing the right mix of protective industrial policy and selective trade liberalisation will be complex—but if pursued with foresight and precision, it may offer a sustainable and resilient economic foundation in a fragmenting world.

WIND TUNNELLING AND SECTORAL ROBUSTNESS

A central technique in strategic foresight is wind tunnelling. Since scenarios are designed to explore the full cone of uncertainty—a broad spectrum of plausible futures—they can also be used as a testing ground for strategic decisions. Wind tunnelling applies these scenarios to evaluate how specific policies or investments perform under each future.

A policy that proves beneficial—or at least not harmful—across all scenarios is considered a robust strategy. Such strategies are particularly valuable in uncertain environments, as they support a wide variety of future outcomes. In contrast, a policy that performs well in only one scenario but poorly in another signals a vulnerability to uncertainty. In such cases, policymaking must proceed more cautiously and be equipped with adaptive mechanisms.

Within the Clean Energy Industry Outlook, wind tunnelling is used not just to test policies in the abstract, but to examine the future viability of specific clean energy sectors. As discussed in the scenario narratives, each of the four futures creates distinct external conditions—shaped by varying degrees of global integration, regional cooperation, climate ambition, and technological convergence. These conditions affect which sectors of the clean economy may thrive, struggle, or require conditional support.

For example, a sector that depends on globally harmonised climate policy or integrated trade regimes may perform well under Rising Tide or Constant Current, but face serious obstacles under Raging Storms. Conversely, a sector rooted in domestic resilience or regional self-sufficiency may gain prominence in Raging Storms, even if marginal in other scenarios. Some sectors may demonstrate viability across multiple scenarios—indicating structural resilience or market flexibility. Others may only be viable under specific conditions, requiring more agile and conditional policymaking.

This lays the conceptual foundation for sectoral robustness. Policymakers must ask: Which sub-sectors of the clean energy economy are consistently viable across different plausible futures? These sectors may be considered "safe bets" for long-term strategy. In contrast, sectors that succeed in only one or two scenarios may still be worth pursuing—but require continuous monitoring, flexible support instruments, and alignment with early-warning indicators.

Table 1 provides an overview of selected clean energy sectors and maps their relative performance across the four scenarios. For each sector, it highlights whether the enabling conditions are fully present, partially present, or absent in a given future.

When used in combination with early warning systems—tracking global climate policy, geopolitical realignments, or technology diffusion—this approach provides a strategic toolkit. It supports policymakers in identifying:

- **Which sectors are most robust, and therefore suitable for long-term investment; and**
- **Which sectors are more sensitive to external uncertainty, and therefore require more adaptive and dynamic policy frameworks.**

Across the four scenarios, several distinct patterns emerge in the robustness of cleanenergy sectors. Here, *robustness* refers to a sector's ability to remain viable or strategic under a wide range of future conditions, including divergent policy environments, market trends, and geopolitical trajectories.

1. **A subset of sectors demonstrates strong cross-scenario robustness.**
   Sectors such as building energy efficiency, solar PV development, minerals and metals extraction, and water filtering membranes manufacturing exhibit viability across all four scenarios. Their presence in every scenario suggests that they are structurally resilient—meaning they are less dependent on favourable policy signals or stable markets. They are followed closely by clean steel and aluminium, data centres, and hydrogen production and infrastructure, each of which perform in three or more scenarios. These sectors benefit from persistent structural trends—such as climate resilience, energy access, and digitalisation—that hold even under divergent global conditions. They can be considered reliable anchors for long-term policy and investment planning.

2. **A second group of sectors performs well, but only under favourable international or regional conditions.**
   Technologies such as solar panel fabrication, fuel cell manufacturing, clean cement, wind turbine manufacturing, bioenergy, and hydrogen-based fuels feature in two scenarios, generally aligned with Rising Tide and Shifting Winds. Their performance depends on sustained demand, technological diffusion, and regulatory alignment. These sectors are potentially attractive but more vulnerable to disruption; their *reliability* is conditional and thus requires adaptive policy frameworks and coordination with global trade or climate regimes.

3. **Several sectors show scenario sensitivity, with performance restricted to niche or volatile contexts.**
   Examples include electric vehicle infrastructure, mechanical storage production, AI & Web3, and variable speed drives manufacturing, all of which only appear viable in Raging Storms or Rising Tide. These sectors are sensitive to international fragmentation, infrastructure readiness, and sector coupling. Their inclusion in fewer scenarios highlights a lower robustness, implying that their success is contingent on specific political or technological circumstances. They may still play strategic roles but demand closer monitoring, dynamic support schemes, and diversified industrial strategies.

4. **A small number of sectors demonstrate low robustness across all scenarios.**
   Sectors such as ocean energy, geothermal energy, and concentrated solar power show minimal viability. Their exclusion across scenarios signals significant structural or cost-related barriers, making them candidates for targeted experimentation rather than broad national strategies. Investment here should be conditional, based on specific technological breakthroughs or export opportunities. Their low robustness means they are currently too uncertain to form a core part of planning assumptions.

Table 1: Wind tunnelling for sectoral robustness

Sector	Rising Tide	Shifting Winds	Constant Current	Raging Storms
AI & Web 3	✔			✔
Battery manufacturing	✔			✔
Bioenergy development (land & sea)	✔	✔		
Cabon capture tech innovation & manufacturing	✔	✔		
Clean cement & concrete	✔	✔		
Clean steel & aluminium	✔	✔	✔	
Concentrated solar power development	✔			
Data Centers & Server Farms	✔	✔	✔	
Development of small-scale nuclear energy	✔			
Electric vehicle infrastructure				✔
Electrolyser manufacuring	✔	✔		
Building energy efficiency	✔	✔	✔	✔
Fuel cell manufaturing	✔			
Geothermal energy development				
Heat pump manufacturing	✔			✔
Hydrogen production & infrastructure	✔	✔	✔	
Hydrogen-based fuels	✔	✔		
Inverters manufacturing		✔		
Mechanical storrage production			✔	
Minerals & metals extraction	✔	✔	✔	✔
Minerals & metals processing	✔			✔
Non-conventional construction materials	✔		✔	
Ocean energy				
Production of concentrated solar power tech	✔			
Water filtering membranes manufacturing	✔	✔	✔	✔
Solar panel fabrication	✔	✔		
Solar PV development	✔	✔	✔	✔
Variable speed drives manufacturing	✔			✔
Wind power development	✔			✔
Wind turbine manufacturing	✔			✔

Note: Wind tunnelling results as estimated by an expert panel review of the four foresight scenarios.

Sectoral screening

Evaluating and prioritising 30 energy-related sectors, the report guides Oman's strategic decisions by focusing on market viability, socio-economic impact, and investment trade-offs.

Oman is exploring emerging industrial opportunities within and adjacent to its energy sector. This effort is not only about enabling innovation but also about positioning the country to benefit from new sectors at both domestic and international levels. Some of these industries have already matured globally, while others are at the frontier of technological development, offering both challenges and new possibilities for Oman.

The diversity of potential sectors introduces significant variation in economic prospects and developmental requirements. While some industries offer strong alignment with national strategic objectives and promise substantial economic value, others may provide only limited contributions. This variation calls for a systematic and robust framework to assess and prioritise sectors in a way that supports strategic, targeted, and effective development. The objectives associated with establishing new industries are often interlinked—and at times competing. For instance, sectors that generate strong domestic value may not necessarily be competitive internationally, while sectors with low establishment costs may not generate sufficient employment opportunities.

This section outlines a holistic and analytical approach for evaluating and prioritising new sectors within Oman's wider energy economy. The aim is to equip decision-makers with a structured overview of sectoral strengths, constraints, and potential pathways for development. The assessment provides insights to guide prioritisation—both under general conditions and in specific strategic contexts.

The screening encompasses 30 sectors evaluated against seven major criteria and 25 sub-indicators. This enables a nuanced assessment of each sector's potential, covering factors including domestic and export market prospects, socio-economic and innovation potential, ease of financing, and integration into the national economic system. Detailed definitions, methods, and indicator descriptions can be found in the Appendix.

The outcomes of the screening serve several functions:

» **Quick overview:** A concise yet comprehensive profile of each sector to support rapid decision-making.

» **Prioritisation guidance:** Identification of sectors that merit immediate or conditional prioritisation based on feasibility and expected impact.

» **Investment trade-offs:** Insights into economic, strategic, and socio-political trade-offs associated with sectoral development.

» **Sector cataloguing:** A structured catalogue outlining the scope, maturity, and opportunity space of each sector.

The analysis extends beyond conventional financial evaluation—such as net present value calculations—to incorporate broader economic considerations. These include sectoral robustness in the face of global and geo-strategic uncertainty. By integrating strategic foresight, the screening assesses the resilience and viability of sectors under diverse future scenarios, helping ensure that Oman's investment choices remain sound and future-proof.

Development of an energy sector refers to all activities beyond the manufacturing of equipment up to the point of electricity production and generation. This includes companies involved in planning, engineering, and maintenance. The assessment therefore focuses on the viability of firms operating in these parts of the value chain rather than on electricity generation itself. While generation viability is not directly evaluated, it remains indirectly relevant: if a particular technology is unlikely to succeed in Oman, firms built around it may face limited business prospects. The central focus, however, remains on the viability of the companies themselves.

SECTORAL SCREENING

Oman's top sectors, particularly in energy and technology, display robust export potential, though they exhibit significant variability in domestic market viability and investment accessibility.

This chapter presents the results of the technology screening conducted on key sectors identified for Oman's future energy economy. It provides a comparative assessment based on a set of performance indicators and highlights the ten highest-ranking sectors, together with their strategic implications for investment.

The aggregated comparison is shown in Table 2, which reports scores for each indicator alongside an overall average, illustrating relative strengths and weaknesses. Boundaries between manufacturing and final products, as well as between conventional and clean production, are not always clear-cut; some degree of definitional overlap is therefore to be expected.

A lower score does not imply that a sector should be disregarded. National priorities, strategic considerations, or targeted policy objectives may justify investments in sectors that rank modestly in this assessment. Electric vehicle infrastructure, for instance, appears lower in the ranking but may still play a critical role in long-term system development.

The top sectors (Figure 4) include building energy efficiency, solar PV development, the extraction and processing of minerals and metals, carbon capture technologies, data centres, solar filtering, membrane manufacturing, hydrogen-based fuels, and hydrogen production. These sectors generally perform between medium and very high across indicators such as domestic market viability, export potential, robustness, predictability, and macroeconomic co-benefits. At the same time, there is substantial variation in socioeconomic and innovation potential, as well as in the accessibility of capital and investment, indicating that the costs, burdens, and job-creation effects associated with each sector differ markedly.

While the top ten sectors represent strong candidates for strategic investment, their relevance ultimately depends on Oman's specific priorities, including energy security, export positioning, and the availability of capital. Domestic market viability is consistently lower across almost all sectors, reinforcing Oman's comparative advantage as an export-oriented hub. Average scores vary considerably—from 37 to 80—reflecting differences not only in overall performance but also in the distribution of strengths and weaknesses across individual indicators.

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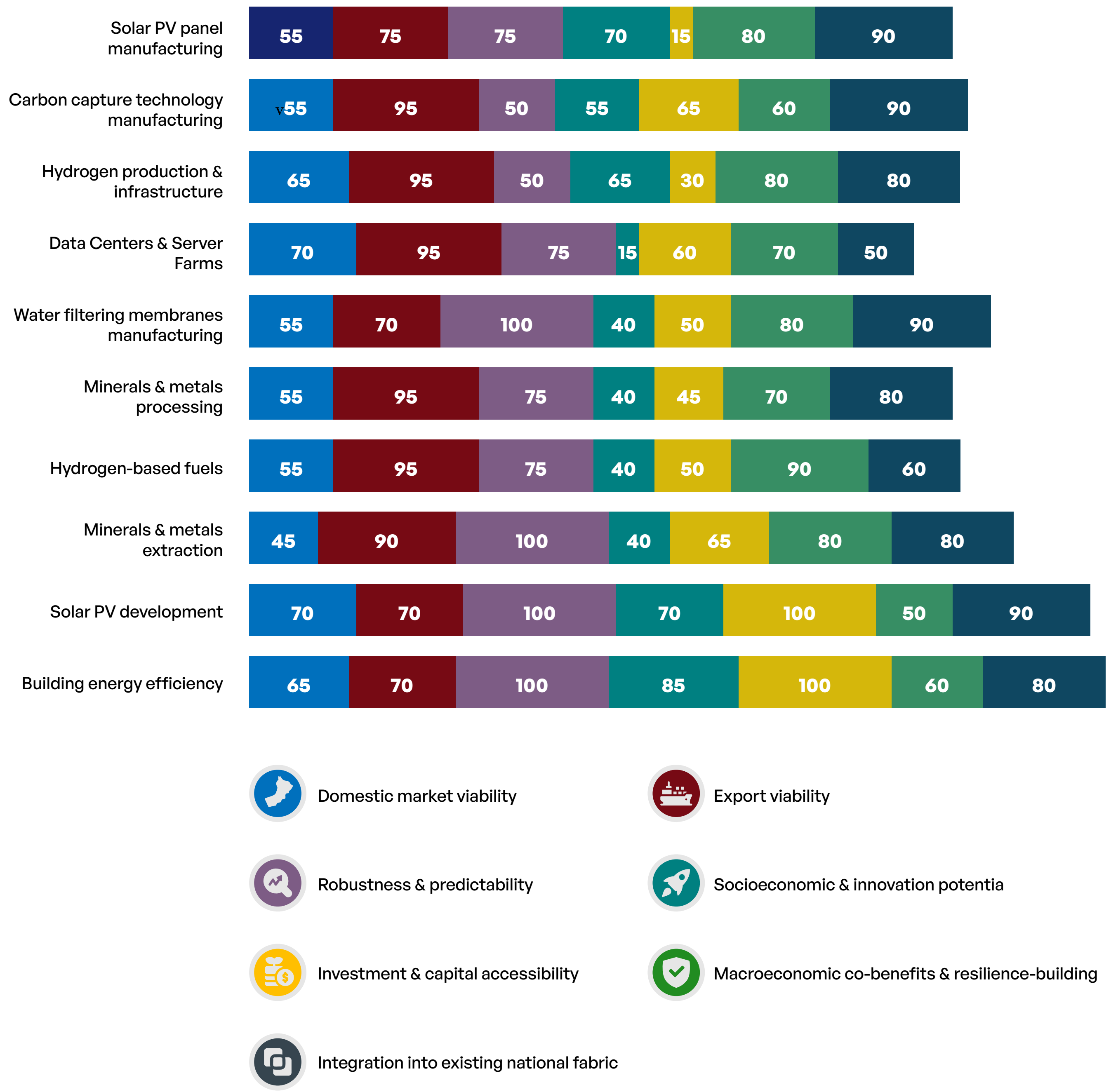
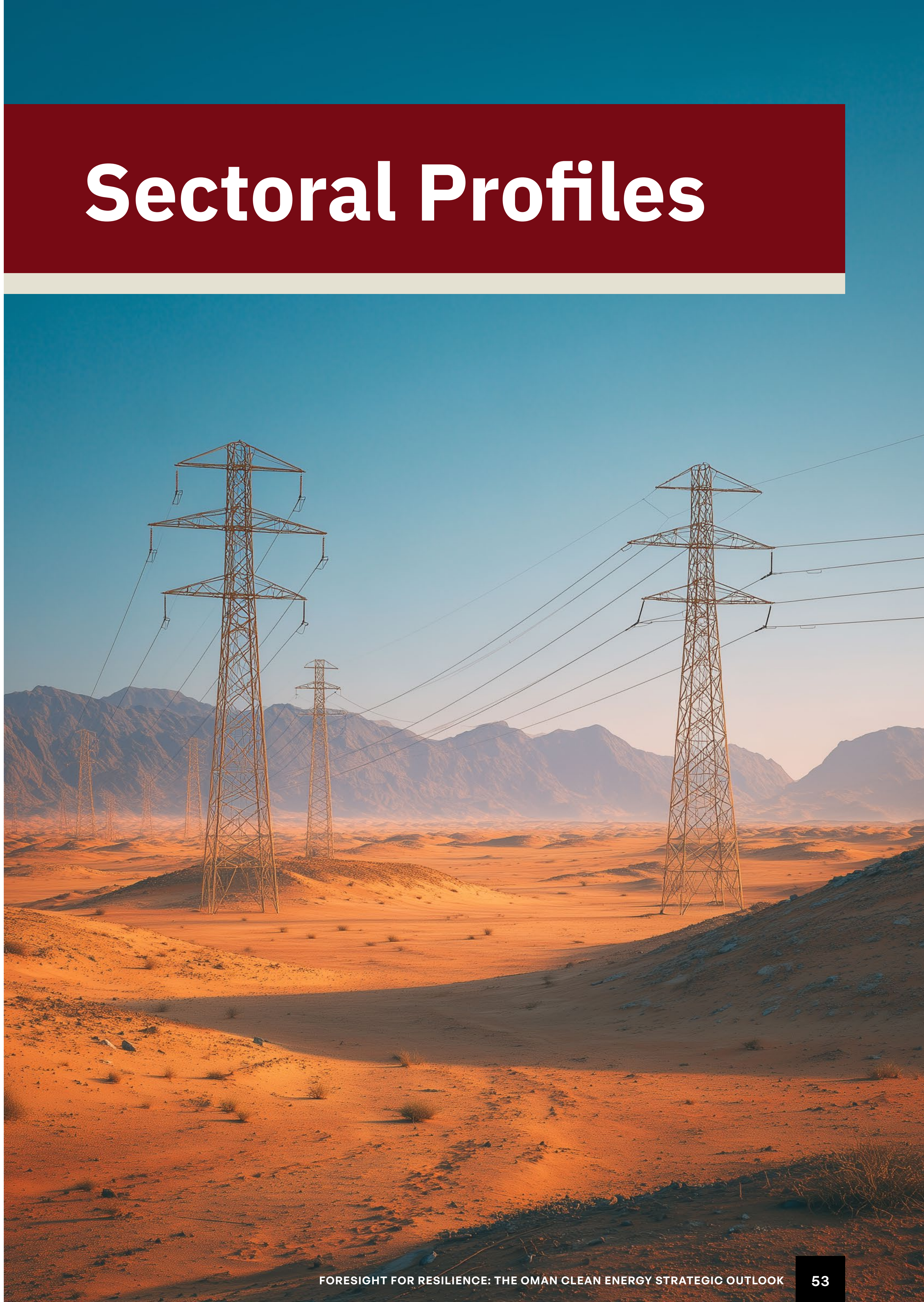
Table 2: Sectoral screening summary

Sector	Domestic Market Viability	Export Viability	Robustness & Predictability	Socioeconomic & Innovation Potential	Investment & Capital Accessibility	Macroeconomic Co-benefits & Resilience-Building	Integration into the Existing National Fabric	Average Score
Category 1 – Energy Development and Services								
Advanced Bioenergy Solutions	60	75	50	90	65	70	50	64.5
AI & Web 3.0	55	50	50	60	80	70	80	60
Concentrated solar power development	30	55	25	55	30	50	50	40.5
Data Centers & Server Farms	70	95	75	15	60	70	50	67.5
Electric vehicle infrastructure	30	30	25	50	50	40	80	39
Building energy efficiency	65	70	100	85	100	60	80	79.5
Geothermal energy development	5	25	50	55	15	60	50	34
Hydrogen production & infrastructure	65	95	50	65	30	80	80	67.5
Minerals & metals extraction	45	90	100	40	65	80	80	73.5
Ocean energy	25	35	50	30	50	60	30	39
Small-scale nuclear energy development	25	50	25	65	15	80	0	36
Solar PV development	70	70	100	70	100	50	90	79
Wind power development	60	75	75	45	65	50	70	65
Category 2 – Manufacturing								
Battery manufacturing	35	75	75	80	65	60	70	64.5
Carbon capture technology manufacturing	55	95	50	55	65	60	90	67
Concentrated solar technology manufacturing	50	50	50	45	35	70	90	54
Electrolyzed manufacturing	55	95	50	45	50	60	90	64.5
Heat pump manufacturing	30	75	75	35	50	60	90	59.5
Fuel cell manufacturing	30	30	50	60	15	50	90	43.5
Inverters manufacturing	40	50	50	40	50	70	90	55
Minerals & metals processing	55	95	75	40	45	70	80	68.5
Mechanical storage manufacturing	25	25	50	45	70	70	70	45.5
Solar PV panel manufacturing	55	75	75	70	15	80	90	66.5
Variable speed drives manufacturing	40	70	75	40	50	50	90	58
Water filtering membranes manufacturing	55	70	100	40	50	80	90	68
Wind turbine manufacturing	50	70	75	35	15	80	90	61
Category 3 – Final Products								
Clean cement & concrete	55	95	50	70	30	60	80	62
Clean steel & Aluminum	55	95	50	75	50	70	80	62.5
Hydrogen-based fuels	55	95	75	40	50	90	60	66
Non-conventional construction materials	30	65	50	90	65	70	70	58.5

Figure 4: Top 10 scoring sectors



Sectoral Profiles



Artificial Intelligence & Web 3.0

Artificial Intelligence (AI) and Web 3.0, a blockchain-based technology, are reshaping the global energy landscape by enabling data-driven forecasting, predictive maintenance, and decentralised energy trading through Smart Energy Systems. Their integration enhances efficiency, operational reliability, and innovation across the energy value chain. However, both technologies are energy intensive, requiring careful management to ensure that digital growth does not undermine sustainability goals.

For Oman, AI and Web 3.0 offer opportunities for both domestic integration and export-oriented development. The country's robust digital infrastructure, high connectivity, and strong alignment with Vision 2040 create favourable conditions for scaling data-driven and blockchain-enabled energy solutions. Cost reductions and technological convergence across both markets enhance bankability and scalability, supporting gradual sectoral expansion.

Deploying these technologies could strengthen operational resilience, allowing energy systems and infrastructure to respond more flexibly to demand fluctuations or disruptions. At the same time, expanding digital capabilities would enhance Oman's economic diversification, embedding the country more firmly within emerging digital economies and strengthening its geostrategic role in the global energy market.

Nonetheless, several challenges must be addressed. Capital requirements remain substantial during early development phases, and Oman's regulatory frameworks for AI, blockchain, and data governance are still evolving. The country also faces a shortage of specialised digital skills, requiring significant investment in education, reskilling, and research infrastructure. Additionally, while AI and Web 3.0 can create new jobs, they may also displace routine roles, necessitating proactive labour-market strategies to manage this transition.

Regionally, Oman faces strong competition from neighbours such as the UAE and Saudi Arabia, both of which have made major investments in AI and blockchain innovation. The UAE, for example, has positioned itself as a regional leader, with its AI market already valued at over USD 3 billion and expected to expand rapidly toward 2030. These developments raise the bar for new entrants and underscore the need for accelerated digital development and targeted policy support if Oman is to remain competitive.

In summary, AI and Web 3.0 technologies hold substantial promise for Oman's energy and industrial transformation. They can improve efficiency, enhance digital resilience, and support diversification, yet their contribution to energy security remains indirect. Realising their full potential will require regulatory modernisation, long-term digital investment, and strategic partnerships—ensuring that technological growth reinforces rather than competes with Oman's broader sustainability and energy-transition objectives.

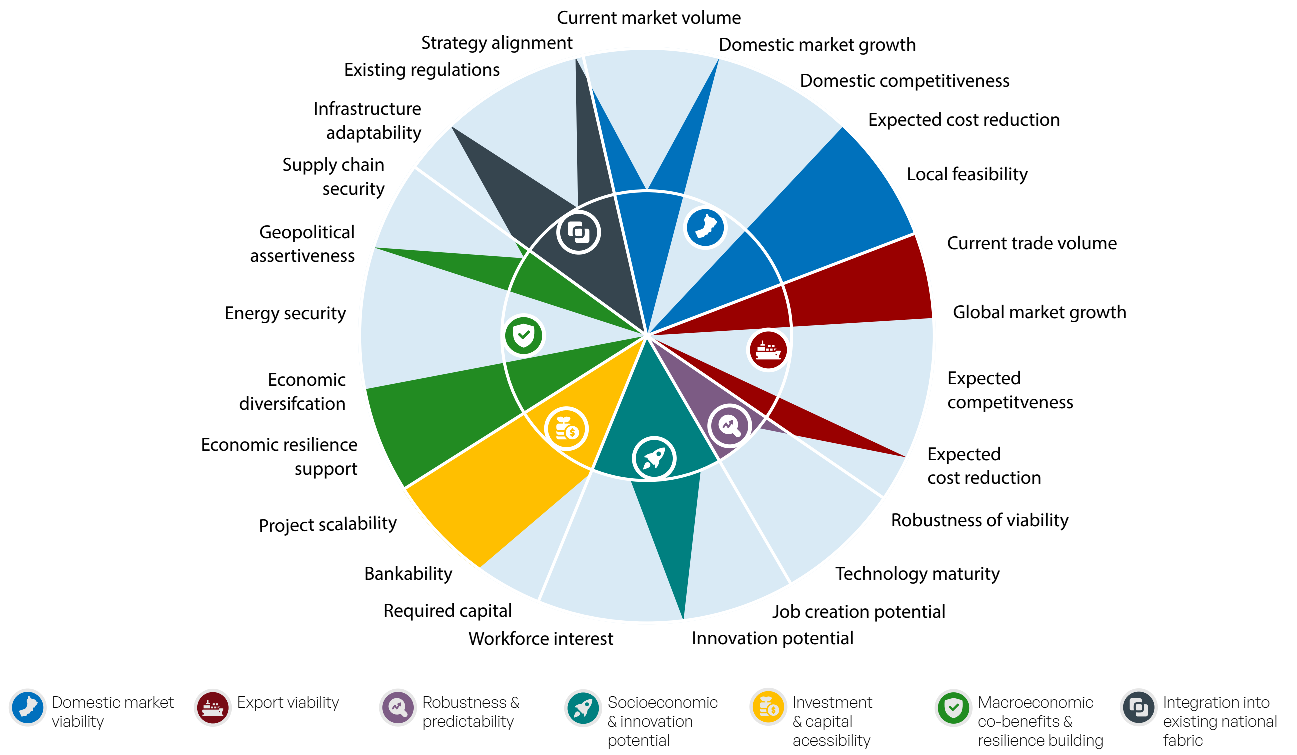


Figure 5: Sector profiling, AI & Web 3.0.

Advanced Bioenergy Solutions

Bioenergy in Oman remains at an early but emerging stage, increasingly viewed as both a waste-management solution and a tool for energy diversification. The country generates more than 1.3 million tonnes of organic waste annually, providing a significant domestic feedstock base. Recognising this potential, the national waste-management company Be'ah has announced plans for ten biogas plants totalling around 20 MW, alongside a 130–140 MW waste-to-energy facility scheduled for completion by 2030.

Private investment is also advancing. Wakud, an Omani clean-fuel start-up, is investing about USD 630 million to establish two bio-refineries in Sohar and Salalah that will produce roughly 600 million litres of sustainable aviation fuel (SAF) annually by 2027. These projects would place Oman within the emerging green-aviation-fuel market. Complementary research initiatives—focusing on dates, seaweed, and sewage-sludge feedstocks—seek to convert local waste streams into energy resources, supporting the national goal to divert 80 percent of municipal waste from landfills by 2030.

Despite clear momentum, the sector faces structural challenges. Bioenergy projects remain cost-intensive and have achieved only gradual cost reductions over the past decade. In 2021, the levelised cost of electricity (LCOE) for bioenergy stood at USD 0.067 per kWh, down 14 percent from 2010 but still higher than power from fossil fuels or renewables such as solar and wind, which are already competitive in Oman. Technical barriers—including feedstock variability, lower energy density, and limited infrastructure readiness—further constrain commercial scalability

Institutional and regulatory frameworks also lag behind technological ambition. Oman lacks a dedicated legal definition or incentive regime for bioenergy, and without supportive measures such as feed-in tariffs, tax incentives, or emission-penalty structures, large-scale deployment will remain difficult. While bioenergy could in principle enhance energy security and supply-chain resilience, these contributions are currently limited by weak policy integration and regulatory gaps.

In summary, bioenergy in Oman is technically feasible but not yet ready for large-scale deployment. The near-term focus should be on pilot projects, targeted R&D, and the development of a regulatory foundation that reflects local feedstock realities. If cost trajectories continue to improve and institutional frameworks mature, bioenergy could evolve from a niche concept into a meaningful contributor to Oman's long-term energy strategy—linking waste reduction, industrial innovation, and low-carbon growth in a single integrated pathway.

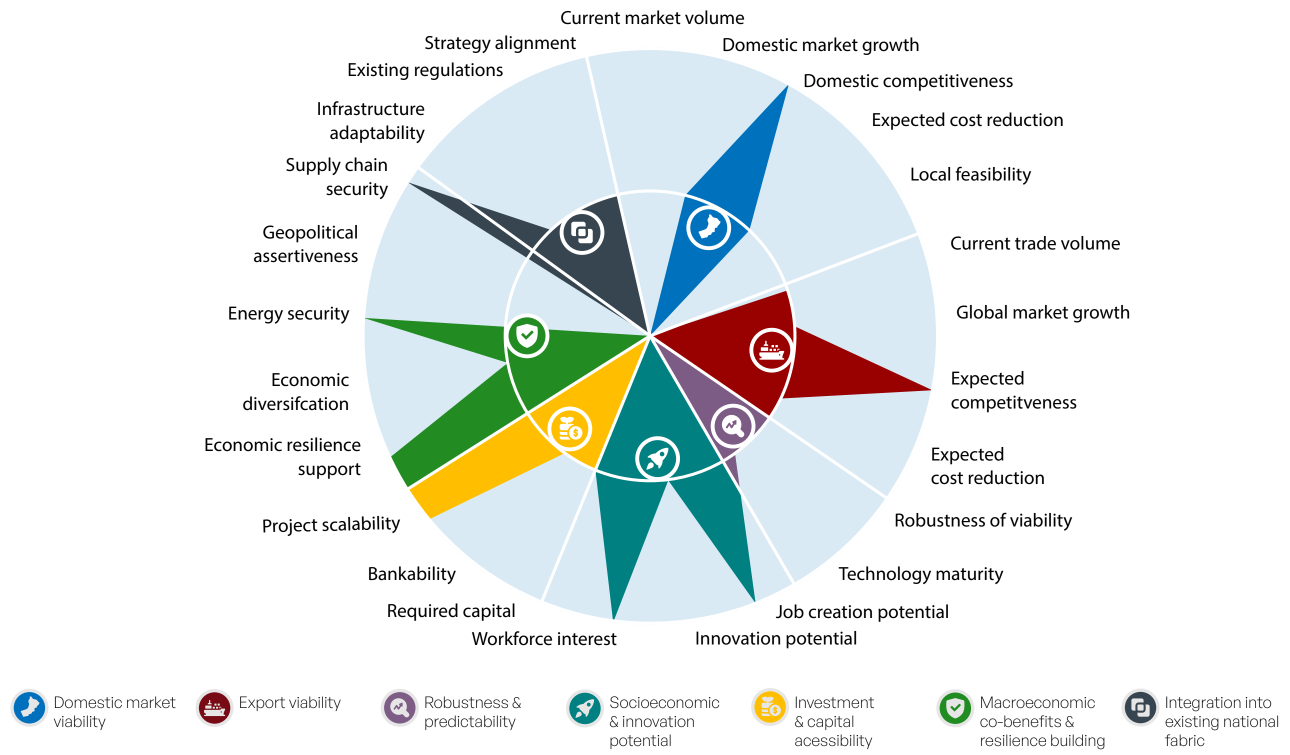


Figure 6: Sector profiling, advanced bioenergy solutions.

Building Energy Efficiency

Building energy efficiency represents one of the most practical and immediately applicable options for Oman's energy transition. Unlike energy-generation technologies, efficiency measures lower demand at the source, delivering savings across households, commercial facilities, and industry. The sector encompasses a wide spectrum of interventions, from improved building design and insulation to efficient lighting, HVAC optimisation, and digital energy-management systems. These measures do not produce energy for trade or export, but they directly reduce operating costs and limit the growth of domestic electricity demand—an increasingly important priority as consumption continues to rise alongside population and economic growth. In Oman, the building-efficiency market remains underdeveloped, but with growing regulatory attention and infrastructure modernisation, it is expected to expand steadily over the coming years.

Globally, interest in energy-efficiency solutions is accelerating. The market for energy-management systems, which form part of the broader efficiency landscape, continues to grow rapidly, reflecting technological progress and widespread adoption. Countries such as the United States, Germany, Japan, and China have already mainstreamed efficiency standards in buildings, demonstrating how regulation and market incentives can deliver measurable reductions in energy use. Oman, with its relatively modern building stock and infrastructure, is well positioned to adopt similar measures across both new and existing developments.

The economic case for building efficiency is strong. Many efficiency upgrades require modest investment yet deliver immediate savings on energy bills. For example, optimising HVAC systems, upgrading insulation, or retrofitting lighting can reduce building-level demand at a fraction of the cost of new supply capacity. Larger-scale measures, such as integrating power-recovery systems in industrial facilities, require higher upfront investment but can yield substantial long-term returns. By moderating demand growth, these measures also reduce the burden on Oman's power-generation and distribution networks, freeing up resources for other national priorities.

Employment creation is another important dimension. Building-efficiency initiatives generate jobs across design, construction, retrofitting, technology services, and operations. Since the sector requires skills in engineering, architecture, and facility management, it can also support the upskilling of the domestic workforce. Over time, energy-services companies specialising in audits, retrofits, and performance monitoring could emerge as a growing segment within Oman's private sector.

At the same time, building efficiency should be viewed primarily as a domestic measure with limited external impact. Unlike renewable generation or hydrogen, it does not create exportable energy, nor does it substantially alter Oman's regional position. The benefits are internal—reduced energy bills, improved comfort, and greater economic resilience against oil-price fluctuations. The absence of major industrial spillovers means it should be seen as a complementary strategy rather than a core driver of diversification.

In conclusion, building energy efficiency is easily implementable, cost-effective, and highly scalable within Oman's context. It supports cost savings, creates jobs, and strengthens economic resilience, but remains a domestic policy lever rather than an export-oriented growth engine. Policymakers should prioritise stronger building codes, mandatory efficiency standards for new developments, and targeted incentives to encourage retrofits in existing buildings. Coupling these with training programmes for engineers and contractors would build local capacity. Taken together, such measures would allow building efficiency to play a pivotal role in Oman's energy transition by reducing consumption growth at its source.

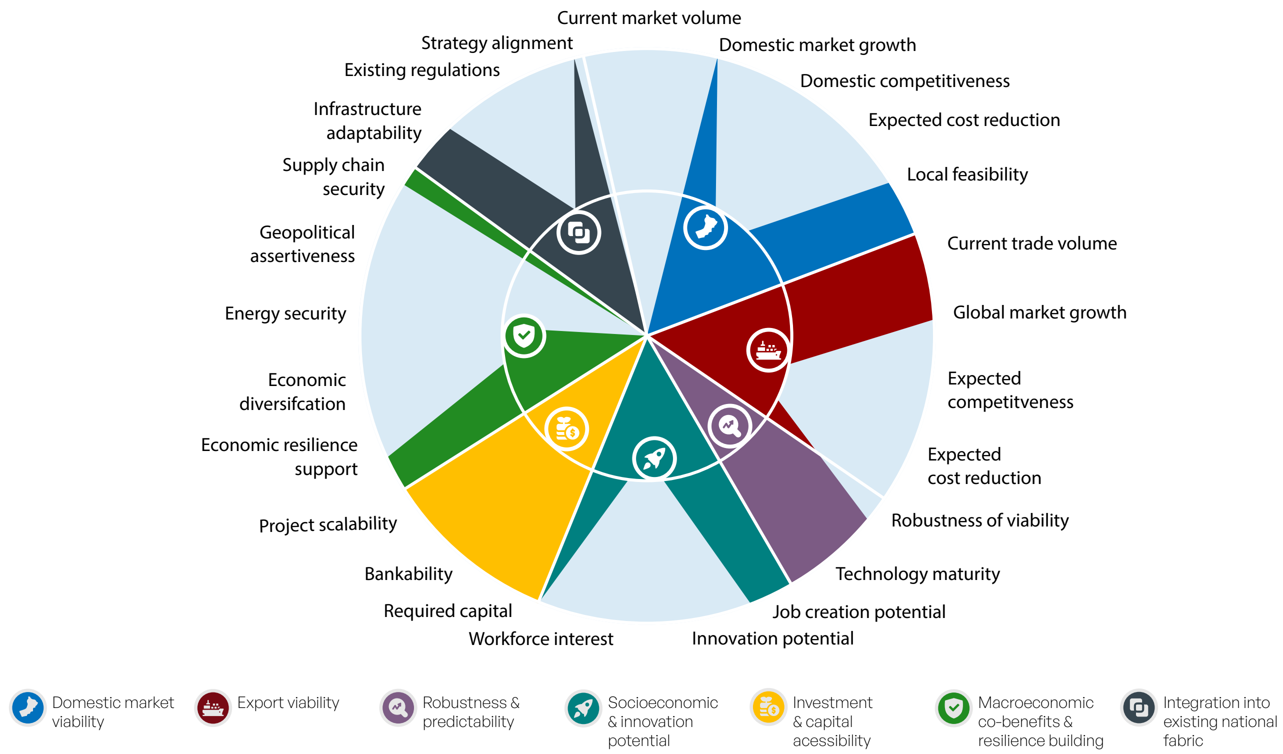


Figure 7: Sector profiling, building energy efficiency.

Concentrated Solar Power Development

Concentrated Solar Power (CSP) is a thermal-based solar technology that stores heat to generate electricity when required, distinguishing it from solar PV, which produces electricity only during daylight hours. CSP offers advantages in dispatchability and can serve industrial applications such as enhanced oil recovery, process heat, and desalination. Internationally, it is recognised as a mature technology, though its deployment has expanded more slowly than that of solar PV due to higher costs and the need for large-scale installations.

In Oman, CSP is not currently included within the national energy strategy. No commercial plants are in operation, and no near-term projects are under development. The Miraah project, once the world's largest CSP facility for enhanced oil recovery, demonstrated the technical feasibility of the technology but also highlighted its cost and scale challenges. CSP projects generally require substantial capital investment and extensive land area to be economically viable, which limits their suitability in Oman's current energy context. With lower-cost and more flexible alternatives such as solar PV and natural gas readily available, the economic case for CSP remains weak.

The technology's cost structure continues to present barriers to investment. The required infrastructure—mirrors, receivers, storage systems, and associated thermal networks—demands large-scale deployment to achieve competitive pricing. This reduces investor appetite, as CSP remains less cost-effective and less adaptable than other renewable options. In addition, because the electricity generated is tied to local grids, CSP does not provide the same export potential as fuels or hydrogen, further limiting its strategic value.

From a policy perspective, CSP aligns conceptually with Oman's objectives for diversification and resilience but is unlikely to deliver a major contribution in practice. While it offers the advantage of dispatchable renewable power, the high costs, technical complexity, and limited scalability under local market conditions make it a low priority. Unless significant cost reductions or new industrial applications emerge, its role will remain confined to small-scale or research-oriented initiatives.

In summary, CSP remains a technically sound but economically constrained option within Oman's renewable-energy landscape. It is unlikely to play a central role in the near term but could retain relevance for specific industrial uses where heat storage or continuous power supply offers a clear advantage.

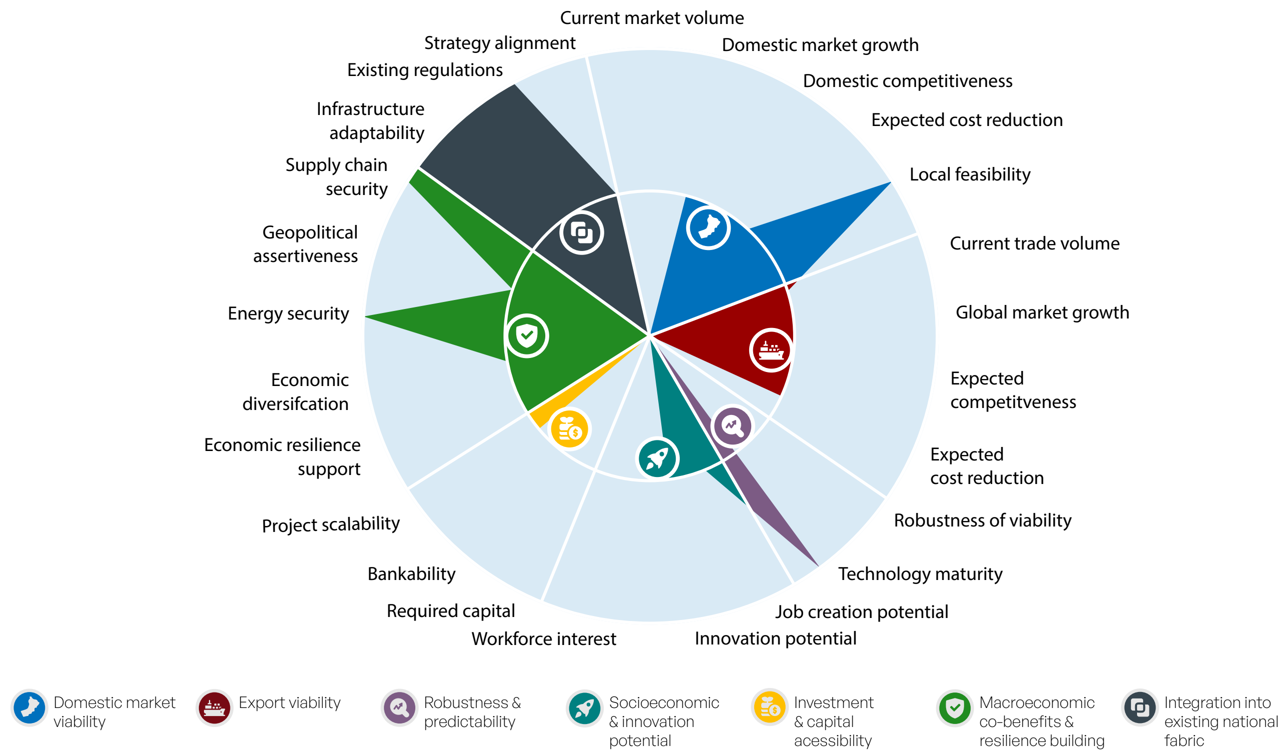


Figure 8: Sector profiling, concentrated solar power development.

Data Centers and Server Farms

Data centres are critical components of the modern digital economy, supporting cloud computing, data storage, streaming, and online services. Their global energy footprint continues to expand, reflecting the growing demand for digital infrastructure. This growth underscores the sector's scale and its influence on national and international energy systems.

In Oman, six data centres are currently in operation, with additional facilities under development as part of broader efforts to strengthen the country's digital infrastructure. These investments aim to position Oman as a regional hub for data hosting and processing. The country's advantages include its extensive network of submarine-cable connections, stable power supply, and competitive renewable-electricity potential. However, regional competition is intensifying, particularly from the United Arab Emirates and Saudi Arabia, both of which are rapidly expanding their own data-centre capacity.

Financially, the sector is considered stable and attractive to investors. Data centres typically offer predictable cash flows and steady demand growth, supported by the increasing digitalisation of economies. Although initial capital costs are high, facilities can be scaled incrementally to match future demand, limiting exposure to overcapacity.

Despite these strengths, several challenges constrain the sector's broader economic impact. Employment generation remains limited, as most operations are highly automated and dependent on imported hardware and software. The domestic value chain is narrow, with limited local innovation or technology development. Oman therefore risks functioning primarily as a host for international platforms rather than a creator of new digital solutions.

Cooling requirements also pose significant operational and environmental challenges. A substantial share of data-centre electricity use is dedicated to cooling, and Oman's hot climate amplifies both energy consumption and efficiency concerns. Unless new projects rely heavily on renewable power, expansion could conflict with national sustainability goals.

In conclusion, data centres represent a high-value but specialised segment of Oman's economy. They will not generate large-scale employment or innovation spillovers, yet they can play a strategic role in diversifying the national economy and enhancing technological readiness. Success will depend on securing a reliable supply of low-carbon electricity, establishing clear regulatory frameworks, and strengthening Oman's competitive position within the regional digital landscape.

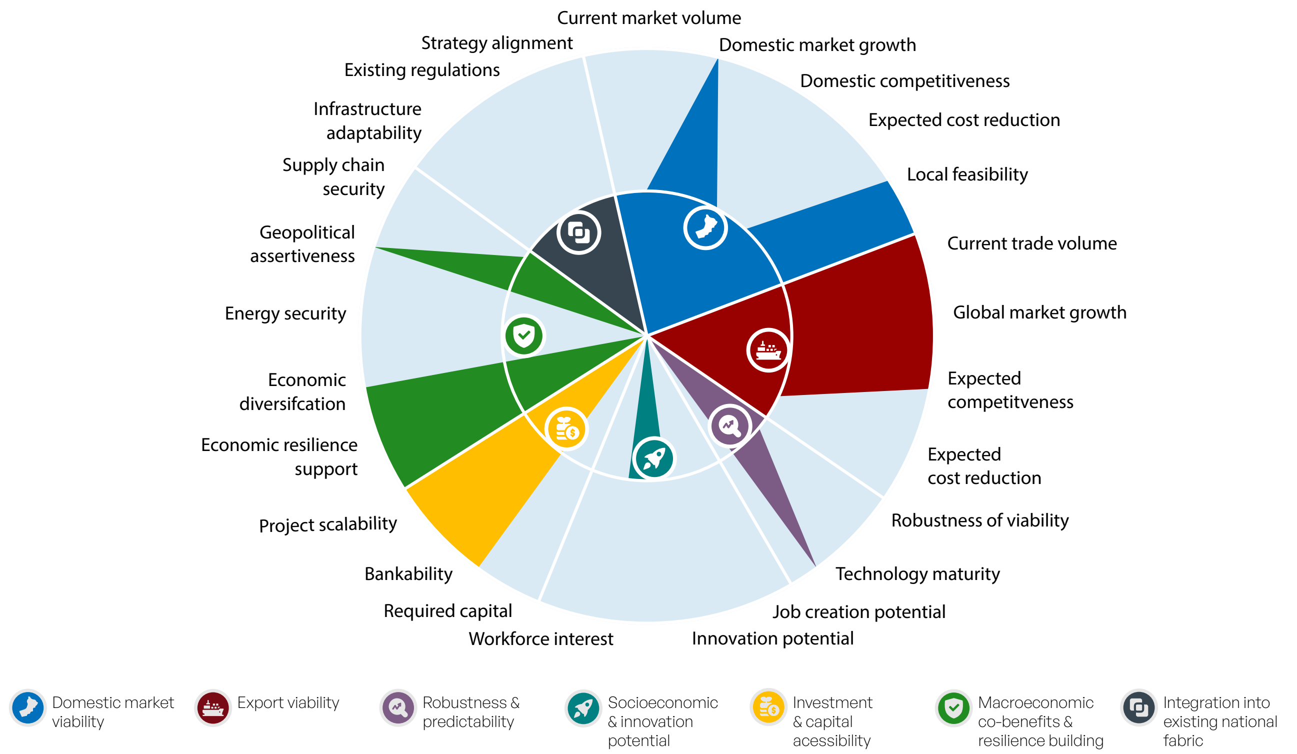


Figure 9: Sector profiling, data centres and server farms.

Electric Vehicle Infrastructure

Electric vehicle (EV) infrastructure refers to the systems and facilities that support EV use, including charging networks, grid upgrades, and associated services. Globally, the sector is expanding rapidly but remains highly competitive and dominated by a small number of well-established players. Manufacturing capacity and large-scale deployment are concentrated in a few leading markets, creating significant barriers for late entrants.

In Oman, EV infrastructure is still at an early stage of development. Progress has been limited, and prospects for large-scale domestic or export-oriented growth remain modest. Several structural factors constrain the sector's feasibility. High upfront capital costs and the advantages enjoyed by early movers make it difficult for new markets to gain traction. Regional competition is also strong, with neighbouring countries already advancing national networks and incentives for electric mobility.

Climatic conditions further complicate the case for large-scale deployment. High ambient temperatures reduce battery efficiency and longevity, while also increasing operational demands on charging systems. The cooling technologies required to maintain performance would add both capital and maintenance costs, reducing overall competitiveness.

While EV infrastructure aligns conceptually with Oman's renewable-energy and sustainability objectives, its broader contribution to diversification remains limited. Domestic demand for EVs is still low, and scalability is constrained by uncertain uptake. Most technologies—chargers, batteries, and vehicles—would likely continue to be imported, limiting opportunities for local manufacturing or technological innovation. Employment effects would therefore be minimal, primarily focused on installation, maintenance, and basic operations rather than research or advanced production.

From a resilience standpoint, expanding EV infrastructure could offer modest benefits by supporting future energy-transition goals and improving transport efficiency. However, integration into the wider economy would remain limited, and the macroeconomic impact relatively small. Public awareness, consumer acceptance, and competing investment priorities further restrict near-term momentum.

In summary, EV infrastructure in Oman remains a niche and early-stage opportunity. Although it supports the country's long-term sustainability agenda, its development faces structural and climatic constraints as well as strong regional competition. A gradual, targeted approach—focused on pilot projects and limited-scale deployment—would allow Oman to build experience and readiness for broader adoption in the future, while avoiding premature large-scale investment in a still-evolving sector.

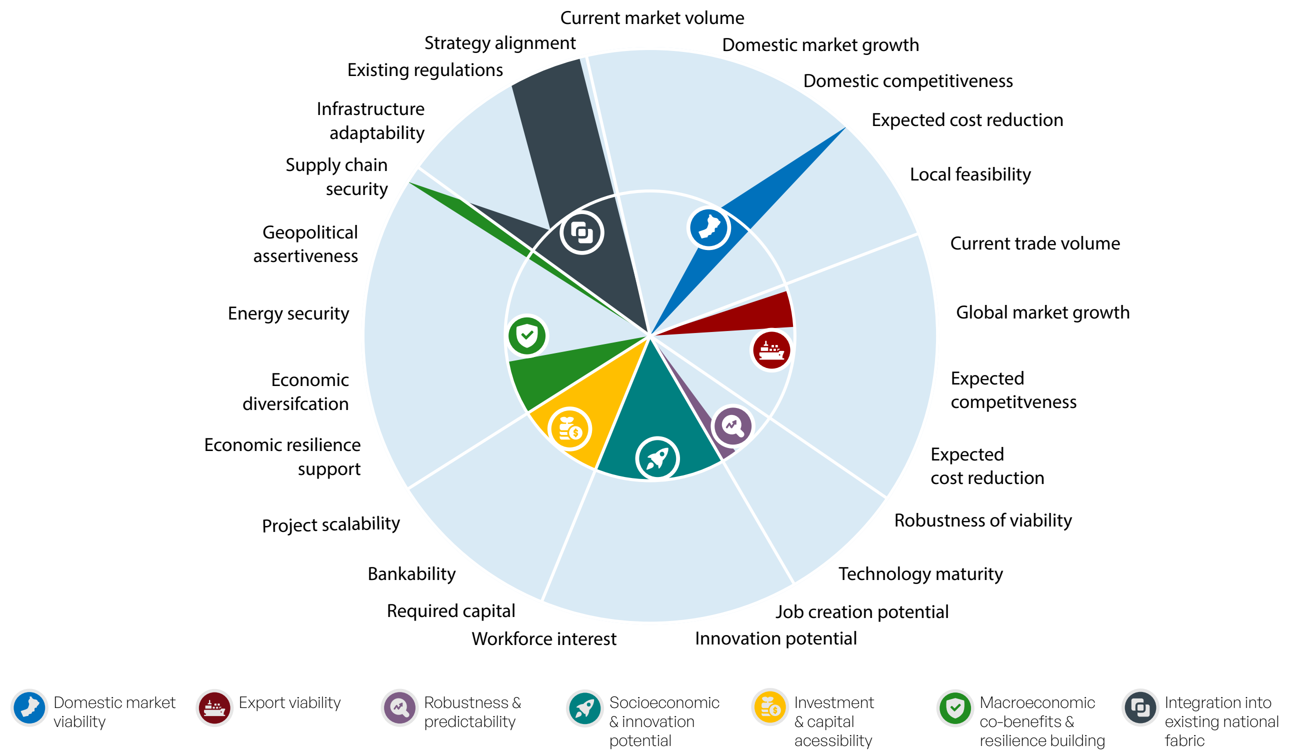


Figure 10: Sector profiling, electric vehicle infrastructure.

Geothermal Energy Development

Geothermal energy harnesses heat stored beneath the Earth's surface, typically through wells that bring hot water or steam to the surface for electricity generation or direct heating. It is a sustainable and mature technology, offering a stable energy supply that is less variable than solar or wind. For Oman, however, the development of geothermal resources faces several fundamental obstacles that make large-scale adoption unlikely in the foreseeable future.

The domestic market for geothermal energy is effectively absent. Unlike solar or wind, geothermal potential depends on specific geological conditions, which restrict where projects can be developed. Exploration and drilling require high upfront investment, and economic returns are only achievable at very large scales. Within Oman's current energy context, these factors make geothermal development difficult to justify. Even with high technological maturity, project bankability remains low due to limited awareness, the absence of a regulatory framework, and a lack of investor confidence.

Globally, geothermal power contributes only a modest share of renewable generation. Its expansion has been slower than that of solar or wind, reflecting geographic constraints and persistent cost challenges. Exploration and drilling remain capital intensive, and opportunities for significant cost reductions are limited. Because geothermal power is inherently tied to local geology, it offers little potential for export, making it less attractive for countries seeking to enhance their global competitiveness through energy trade.

From a domestic perspective, geothermal energy could, in principle, support diversification of Oman's energy mix and improve long-term supply security. It would also align with national sustainability goals by helping reduce reliance on fossil fuels. The workforce dimension is another point of alignment: geothermal projects require drilling, geological surveying, and reservoir management expertise, all of which are already present within Oman's oil and gas sector. This overlap could, in theory, facilitate a smoother transition for parts of the existing workforce.

Despite these potential synergies, structural limitations outweigh the benefits. The lack of a viable domestic market, high costs, and the scale required for economic feasibility make geothermal energy an unattractive option for Oman at present. While it could contribute marginally to energy resilience in the future, its role is likely to remain limited. Resources may be more effectively directed toward technologies that offer greater economic returns and clearer alignment with Oman's broader energy and industrial strategies.

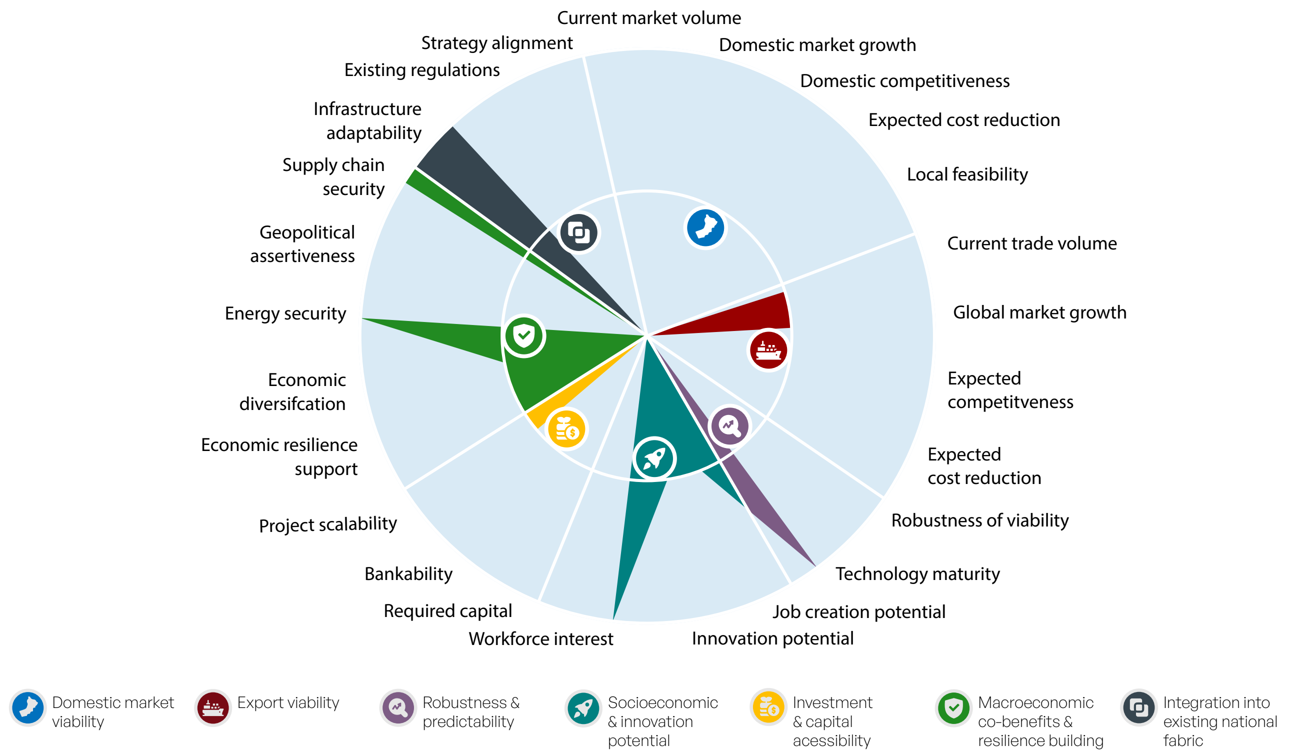


Figure 11: Sector profiling, geothermal energy development.

Hydrogen Production/ Infrastructure

Hydrogen production and infrastructure encompass the generation of hydrogen from low-carbon sources—primarily through electrolysis and reforming with carbon capture—as well as the associated systems for transport, storage, and export that enable its delivery to end users. Each stage of this value chain carries distinct technical and financial requirements that determine feasibility, cost, and scalability.

Globally, hydrogen is emerging as a critical component of the clean-energy transition. Its applications span industry, transport, and power generation, with policy frameworks in many regions now focused on accelerating its deployment. The growing emphasis on low-emission hydrogen reflects the declining cost of renewable electricity, technological advances in electrolysers, and the wider global commitment to decarbonisation.

For Oman, hydrogen represents one of the most strategic opportunities within its energy transition. National plans target the production of up to one million tonnes of green hydrogen annually by 2030, supported by large-scale initiatives such as the Oman Hydrogen Project in Duqm and international partnerships with firms including Intercontinental Energy. These efforts build on Oman's exceptional solar and wind potential, its extensive coastal zones, and the established port infrastructure at Duqm and Salalah. Integration with the country's oil and gas capabilities—particularly in engineering, logistics, and terminal operations—further enhances readiness and lowers development risks.

Oman's advantage lies in its clear export orientation. Domestic demand for hydrogen is expected to remain limited over the next decade, focused mainly on early pilot projects in refining, heavy industry, and power generation. The majority of production will be directed toward conversion into ammonia or synthetic fuels for export to key markets in Europe and Asia. This creates both opportunities and challenges: Oman benefits from competitive renewable resources and available land but must secure long-term offtake agreements and maintain alignment with evolving global certification standards. Regional competition is also intensifying, with Saudi Arabia and the United Arab Emirates advancing comparable hydrogen projects.

Hydrogen development is capital intensive, requiring multi-billion-dollar investments in generation, desalination, storage, and export facilities. Despite its technological maturity, scalability depends on large integrated projects that carry exposure to market and policy uncertainty. Access to affordable capital and credit guarantees will therefore be crucial to improving project bankability and attracting private investment.

Employment impacts are positive but moderate. The construction phase is expected to generate thousands of temporary jobs, while long-term operations will rely on smaller, highly skilled teams. The sector offers a practical transition pathway for Oman's existing oil and gas workforce, given the overlap in technical and project-management expertise. Broader innovation and local value creation will depend on expanding domestic capacity in engineering, procurement, and maintenance services.

In summary, hydrogen production and infrastructure provide Oman with a transformative yet externally dependent opportunity. The sector aligns closely with national diversification and export ambitions and has the potential to become a defining pillar of Oman's post-hydrocarbon economy. Its success will depend on the stability of international demand, the availability of competitive financing, and effective coordination across regulatory and institutional frameworks. If these conditions are achieved, hydrogen could establish Oman as one of the region's leading suppliers of low-carbon energy.

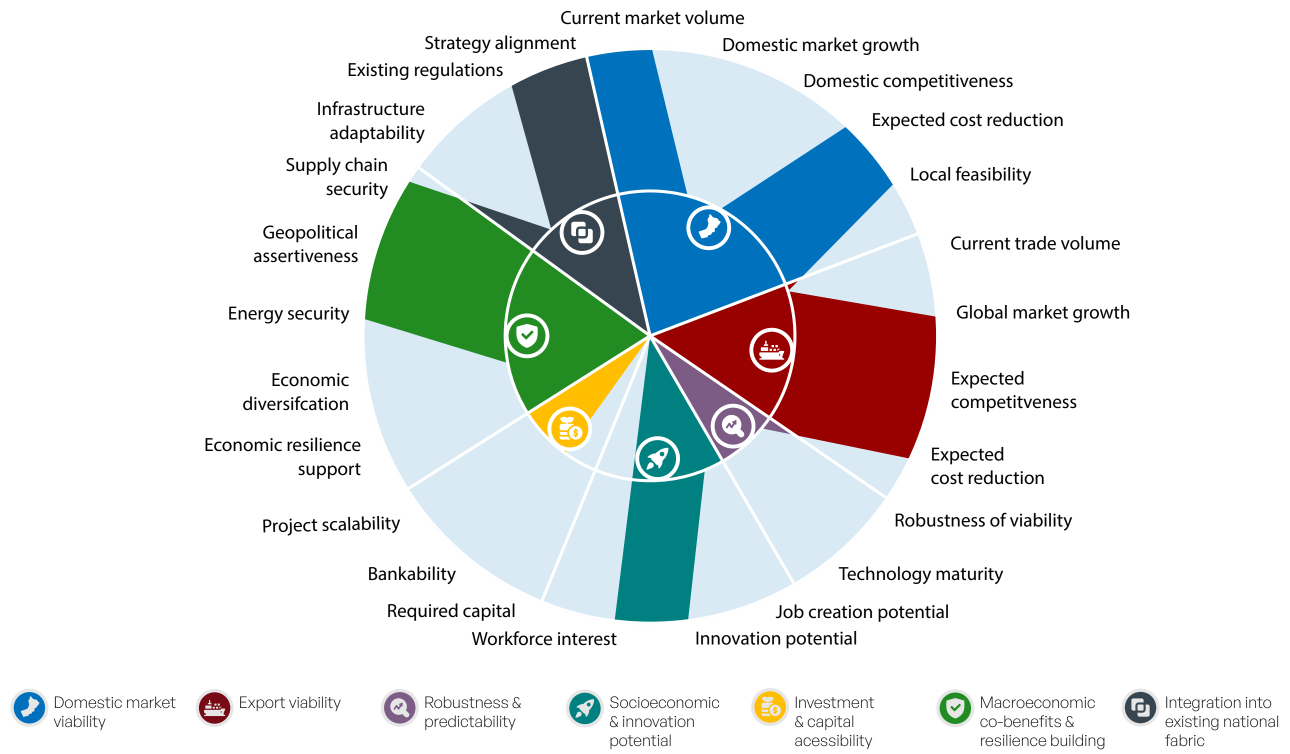


Figure 12: Sector profiling, hydrogen production and infrastructure.

Minerals/ Metals Extraction

The extraction of critical minerals and metals plays a central role in supporting industries that drive the global energy transition, including renewable energy, electronics, and electric mobility. As clean-energy systems and digital infrastructure expand, global demand for minerals such as lithium, copper, nickel, manganese, graphite, and silver continues to rise, reflecting their essential role in modern technologies.

However, extraction remains heavily concentrated in a few countries—principally China, Australia, and parts of South America—leaving supply chains exposed to price volatility and geopolitical disruption. Ensuring a sustainable and reliable supply of these materials has therefore become a strategic priority for many economies seeking to secure access to the raw inputs of the clean-energy era.

Oman possesses reserves of copper, nickel, manganese, and silver, offering a natural entry point into this growing global market. Although the country's extraction base is relatively modest, its export potential is significant. Oman already exports around USD 1.3 billion worth of minerals each year, primarily to Asian markets. Further development of this sector would strengthen national supply-chain security, reduce import dependency, and support downstream activities such as manufacturing and energy-technology production. The mining and minerals sector also aligns with Oman's industrial-diversification goals and benefits from a regulatory framework that encourages the expansion of resource-based industries

Investment prospects appear positive. The sector demonstrates a high degree of technological maturity and project bankability, creating favourable conditions for attracting foreign capital. Oman's political stability, coupled with its expanding infrastructure network and port access, positions the country as a reliable regional supplier. New mines and processing facilities could also generate wider economic benefits by stimulating growth in related sectors, including transport, logistics, and equipment services.

Nevertheless, several structural challenges remain. Domestic reserves of certain high-value minerals are limited, restricting Oman's competitiveness in fast-growing segments such as lithium and cobalt. Developing new mining infrastructure is a lengthy process, often taking many years before production begins, which can delay returns on investment. Moreover, the sector's potential for innovation and job creation is moderate: modern extraction is highly automated and capital intensive, limiting the number of direct employment opportunities. Workforce interest is also constrained by the technical and environmental challenges associated with mining operations.

In summary, minerals and metals extraction offers Oman a practical pathway to strengthen export revenues, enhance supply-chain resilience, and deepen industrial integration. While not transformative in terms of innovation or large-scale employment, the sector can play a valuable complementary role within Oman's wider diversification strategy. Its long-term success will depend on attracting sustained foreign investment, expanding geological exploration, and embedding environmental and sustainability standards that ensure competitiveness in the evolving global critical-minerals market.

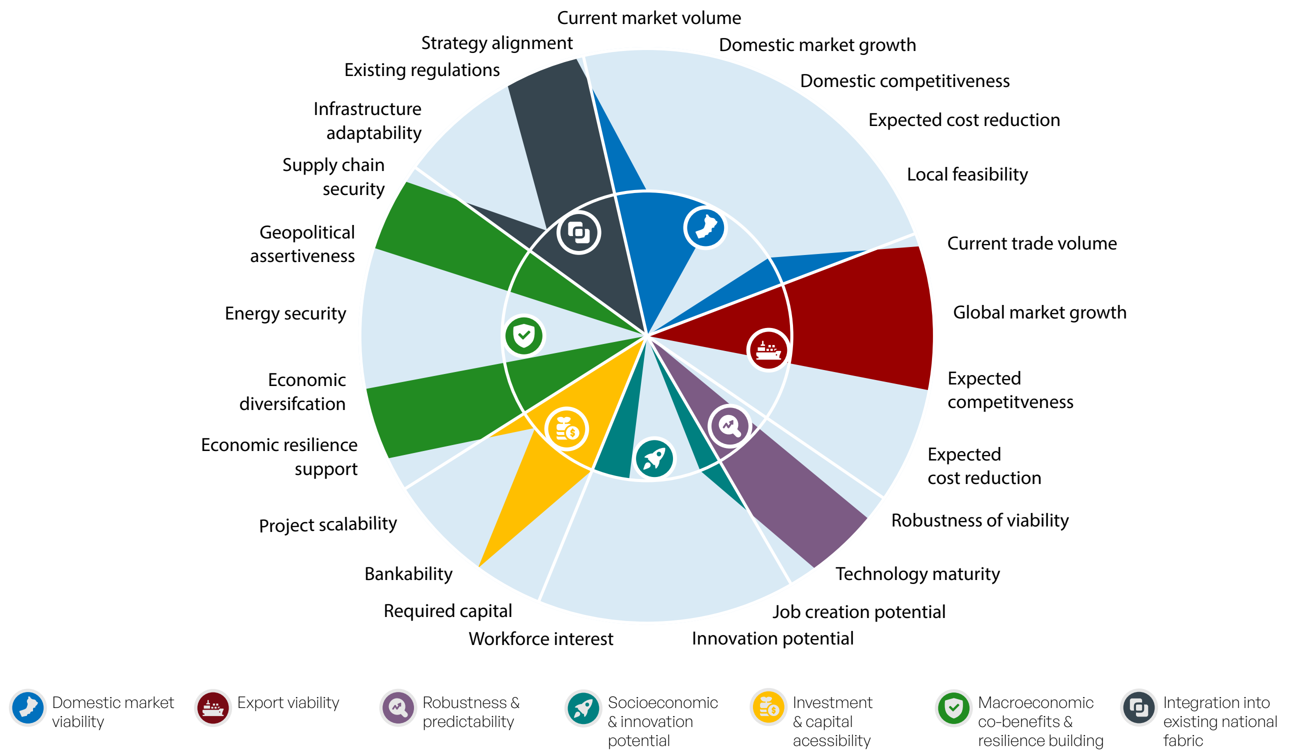


Figure 13: Sector profiling, minerals and metals extraction.

Ocean Energy

Ocean energy captures the power of waves and tides to generate electricity. Wave systems convert the motion of wind-driven surface waves through mechanisms such as oscillating water columns, while tidal systems harness the predictable rise and fall of sea levels driven by lunar and solar forces. Internationally, countries including Portugal, the United Kingdom, and Australia have advanced pilot and demonstration projects, establishing ocean energy as an emerging but still niche component of renewable-power generation.

In Oman, the potential for ocean energy remains limited but not entirely absent. The Waves Energy Centre's pilot project in Duqm represents the country's first step toward exploring this technology, focusing on feasibility studies, integration with coastal infrastructure, and environmental assessments. Oman's coastline provides some exposure to wave activity along the Arabian Sea, but its relatively low tidal range restricts opportunities for large-scale tidal generation. As a result, local feasibility and domestic-market prospects remain constrained, and deployment is likely to remain experimental in the medium term.

From a technological standpoint, ocean energy demonstrates strong innovation potential but remains in the early stages of commercialisation. Globally, most projects are still progressing from prototype to demonstration scale, and costs vary significantly across technologies. While reductions are expected as systems mature, limited market stability and uncertain financing conditions continue to challenge project bankability. Capital requirements are moderate, and theoretical scalability is high, but investors remain cautious given the technology's immaturity and unpredictable returns.

Socio-economic impacts are expected to be modest. Ocean-energy projects depend heavily on imported expertise and advanced engineering, offering limited scope for widespread local employment. Oman's domestic workforce would require specialised training in marine engineering, offshore maintenance, and environmental monitoring before the sector could generate meaningful local participation.

Despite these constraints, ocean energy could hold long-term potential as part of Oman's broader renewable-energy portfolio. Continued research and pilot projects—particularly along the southern coastline—could help assess its viability under local conditions. While the sector currently presents high risks and limited economic return, it offers an opportunity for technological learning and innovation. For the time being, ocean energy should be viewed as a research and development priority rather than a near-term commercial solution, with value primarily in building technical capacity and diversifying future energy options.

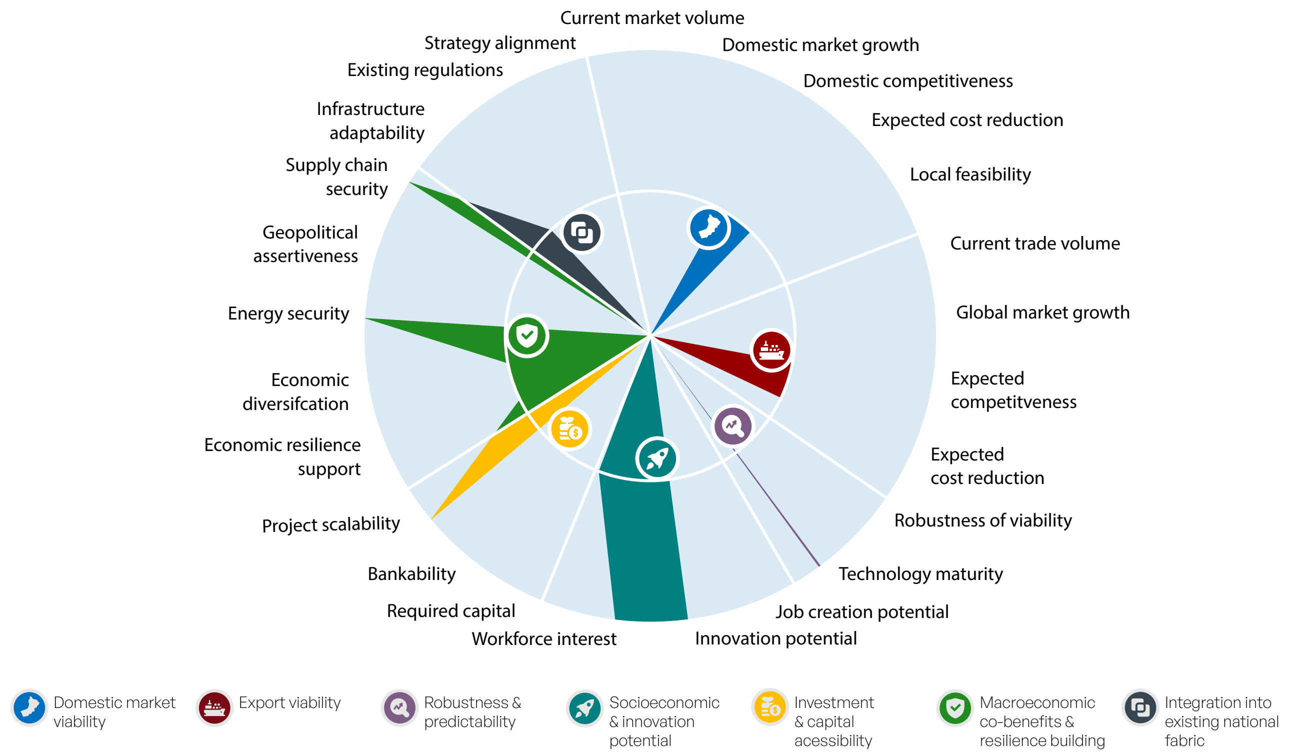


Figure 14: Sector profiling, ocean energy.

Small-scale Nuclear Energy Development

Small-scale nuclear energy, based on Small Modular Reactors (SMRs), represents a new generation of nuclear technologies designed to produce up to 300 megawatts of electricity per unit. SMRs are characterised by compact design, modular construction, and high energy density, allowing for more efficient fuel use, potentially reduced waste generation, and shorter deployment times compared with conventional nuclear power plants. Internationally, SMRs are increasingly discussed as potential low-carbon options for supporting baseload electricity generation and enhancing grid stability.

Despite these advantages, nuclear power remains a complex and politically sensitive domain. Safety concerns, waste-management challenges, and long-term environmental liabilities continue to shape public and institutional perceptions. The potential for severe accidents—though statistically low—demands rigorous regulatory oversight and sustained public confidence. In addition, the concentration of uranium production in a limited number of countries exposes the sector to geopolitical and supply-chain risks that can further undermine investor certainty.

In Oman, the economic and institutional foundations required for the deployment of SMRs are not yet established. Domestic energy demand can be met more cost-effectively through natural gas and renewable sources, both of which are already integrated into the national strategy. The country currently lacks a nuclear regulatory framework, technical expertise, and operational infrastructure to support such projects. Consequently, the feasibility of introducing SMRs under current conditions remains low.

Technological maturity is also a constraint. While SMR concepts have advanced globally, most designs are still undergoing demonstration, testing, or regulatory licensing. Although the modular approach offers lower total capital requirements than traditional nuclear plants, cost reductions are expected to be gradual. Bankability remains limited, with private investors cautious in the absence of established safety regimes and long-term policy commitments.

Job creation within the sector would be modest, though the introduction of high-technology activities could foster specialised training and knowledge transfer in engineering, safety, and systems management. However, building the required legal, technical, and institutional capacity would take considerable time and resources, requiring close collaboration with international regulatory bodies and experienced nuclear operators.

Export or partnership potential may be somewhat stronger in the long term. As SMR technologies mature, Oman could consider involvement through research collaboration or technology-transfer initiatives, particularly if regional demand for low-carbon baseload power grows. Yet integration into the national energy framework is not currently envisioned.

If successfully regulated and implemented, small-scale nuclear energy could theoretically contribute to Oman's long-term energy diversification and security. In practice, however, the absence of a regulatory framework, limited technical capacity, and high financial and safety barriers make this prospect remote. Under present circumstances, SMRs remain an impractical and high-cost option with minimal relevance to Oman's near- and medium-term energy priorities.

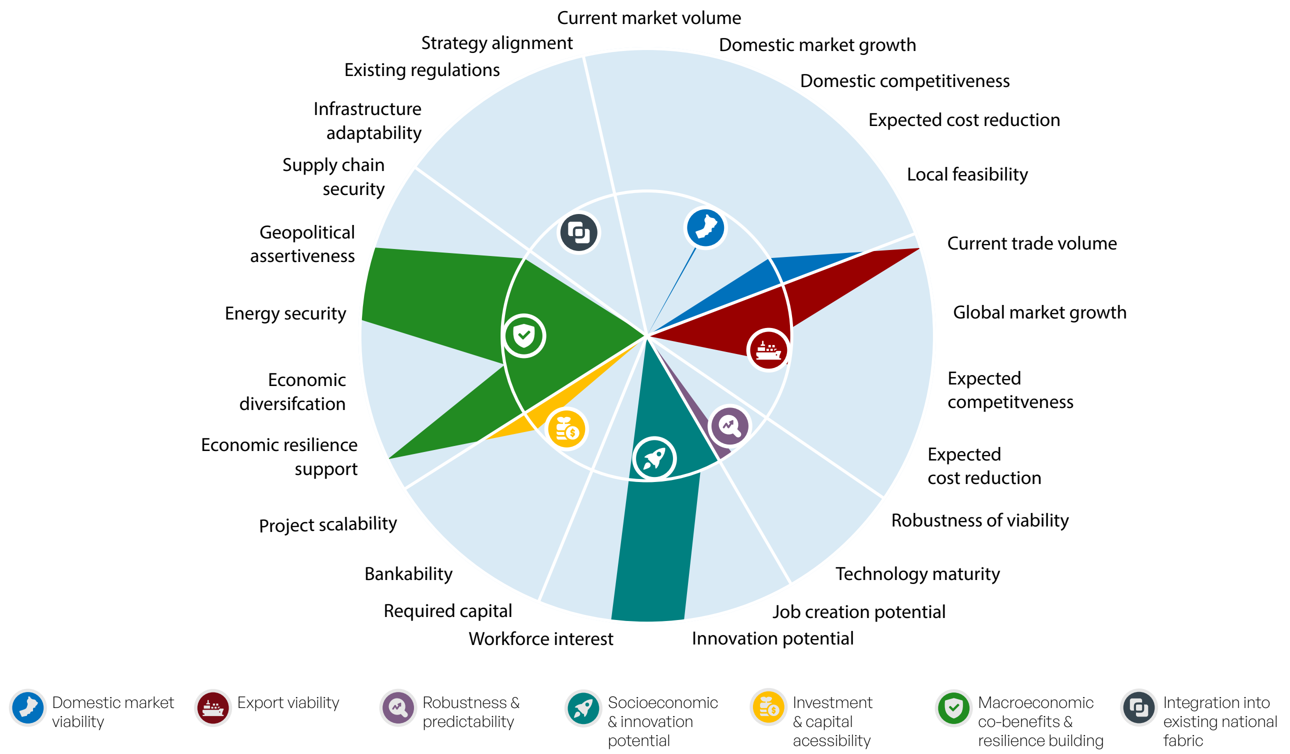


Figure 15: Sector profiling, small-scale nuclear energy development.

Solar PV Development

Solar photovoltaic (PV) development refers to the planning, construction, and operation of systems that convert sunlight directly into electricity using photovoltaic cells. It encompasses site assessment, design, installation, and long-term maintenance. Globally, solar PV has become the leading renewable-energy technology in terms of new capacity additions, reflecting its continued cost reductions, scalability, and central role in global decarbonisation efforts.

For Oman, solar PV represents one of the most mature and viable renewable technologies to advance both energy security and economic diversification. The sector aligns directly with the National Energy Strategy 2040, which targets 30 percent renewable electricity generation by 2030, primarily from solar resources. Oman's solar potential is among the highest in the region, with average irradiation exceeding 2 000 kWh/m^2 per year. Flagship projects such as the 500 MW Ibri II Solar Power Plant demonstrate the feasibility of large-scale PV deployment. The project alone supplies electricity to roughly 33 000 homes and offsets an estimated 340 000 tonnes of CO_2 each year, setting a benchmark for future initiatives.

Domestic market potential remains strong, supported by increasing energy demand, clear policy direction, and abundant solar resources. Oman also holds potential to develop a regional role in renewable-electricity generation and green-hydrogen production. However, competitiveness remains constrained by limited domestic innovation capacity and continued reliance on imported technology and expertise. Strengthening local capabilities in engineering, installation, and maintenance will be essential to maximise the sector's long-term contribution.

From a labour perspective, the solar PV industry offers significant employment opportunities, particularly during construction and operation phases. However, workforce participation is limited by a shortage of specialised training programmes and a continued preference for employment in established sectors such as oil and gas. Expanding vocational and higher-education pathways focused on renewable energy would help address this gap and support broader human-capital development.

Financially, solar PV projects require substantial upfront investment but benefit from scalability and proven reliability. The maturity of the technology, predictable performance, and well-developed supply chains reduce operational risk, making it one of the most bankable and cost-effective renewable options. As financing for low-carbon energy expands globally, Oman's stable regulatory environment positions it well to attract both domestic and international investment.

In summary, solar PV development provides Oman with one of its strongest opportunities to achieve long-term energy-transition and diversification goals. The sector is technologically mature, economically scalable, and strategically aligned with national policy objectives. While current challenges in innovation and skills development persist, solar PV remains a cornerstone of Oman's renewable-energy future and a key driver of sustainable economic growth.

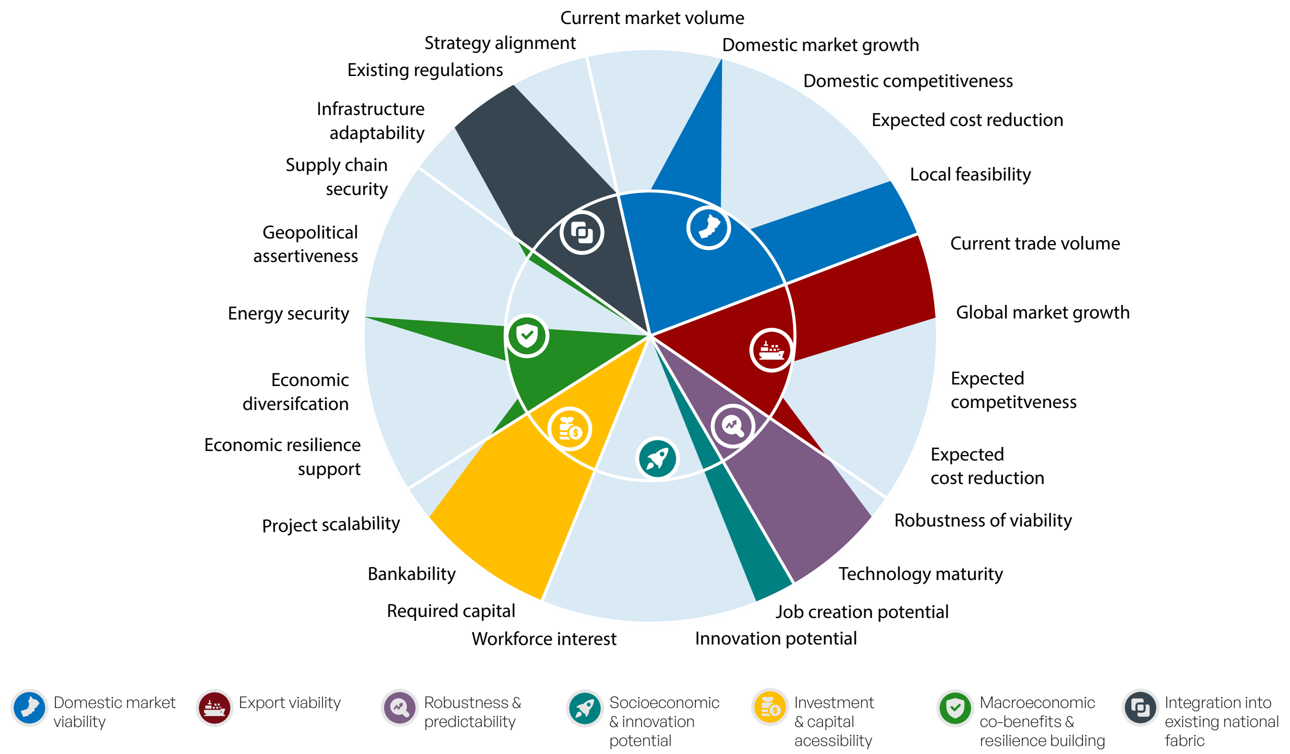


Figure 16: Sector profiling, solar PV development.

Wind Power Development

Wind energy continues to expand as one of the leading renewable power sources globally, driven by improving technology, declining generation costs, and growing emphasis on energy security. Despite steady progress, the sector still faces challenges related to supply chains, material costs, and grid integration, highlighting the importance of sustained policy and regulatory support to maintain competitiveness and ensure reliable system operation.

In Oman, wind energy remains in its early stages of development but is showing clear momentum. In 2024, renewable generation reached approximately 2.4 TWh, with wind contributing around 0.1 TWh. The 50 MW Dhofar Wind Farm, developed through a partnership between Masdar and the Rural Areas Electricity Company (Tanweer), currently stands as the country's only operational large-scale project. Building on this foundation, Oman plans to add around 1 GW of new capacity by 2027 through projects in Mahout, Duqm, Dhofar, Jaalan Bani Bu Ali, and Sadah. These initiatives align with Oman Vision 2040, which targets 30 percent renewable electricity generation by 2030 and a further increase to 39 percent by 2040.

Oman's southern regions, particularly Dhofar and Duqm, offer favourable wind conditions characterised by strong and consistent speeds. These factors, combined with advances in turbine technology and falling global costs, make wind power technically feasible and economically competitive within the national energy mix. Moderate capital requirements and scalability enhance its attractiveness to investors, while future integration with hydrogen production could create new export opportunities.

Nonetheless, several structural challenges constrain broader development. Oman's wind resources are geographically concentrated in the south, requiring costly transmission infrastructure to connect generation sites with major demand centres in the north. Seasonal variability—marked by strong winds in summer but weaker patterns in winter—adds complexity to grid management and reliability. While technological maturity ensures dependable performance, it limits local innovation, as most components and systems are imported.

Employment creation within the wind sector is moderate and primarily associated with construction, installation, and maintenance phases. Opportunities for local research, manufacturing, and high-skill employment remain limited. Expanding technical training and strengthening engineering capacity will be essential to increase local participation and enhance the sector's long-term competitiveness.

In summary, wind energy in Oman represents a high-feasibility but moderate-growth opportunity. Its scalability, proven technology, and potential linkages to green-hydrogen exports position it as a valuable complement to solar PV within the renewable-energy portfolio. However, regional concentration, limited innovation potential, and modest socio-economic spillovers reduce its broader transformative impact. With sustained investment and policy alignment, wind power can nonetheless play a stable and reliable role in supporting Oman's energy transition and diversification goals.

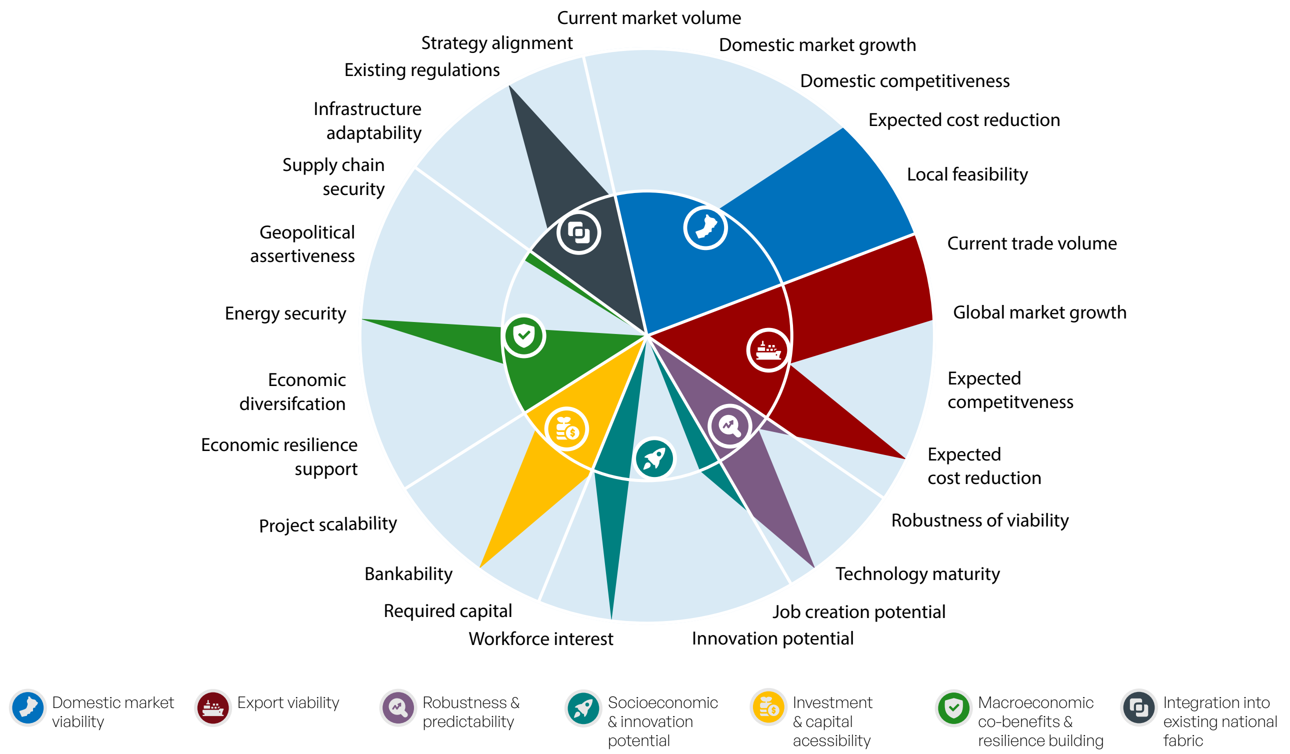


Figure 17: Sector profiling, wind power development.

Battery Manufacturing

Battery manufacturing is a cornerstone of the global clean-energy transition, underpinning the shift toward electrified transport and renewable-energy storage. It involves several complex stages, from mineral extraction and refining to the production of cathodes, anodes, electrolytes, and separators. These components are then assembled into cells and packs for use in electric vehicles, stationary-storage systems, and industrial applications. The sector's sophistication and reliance on global supply chains make it strategically important yet difficult to localise.

Over the past decade, the cost of lithium-ion batteries has fallen significantly driven by advances in chemistry, improved manufacturing processes, and economies of scale. Global demand has expanded rapidly, with electric mobility accounting for the vast majority of growth. However, this expansion has also intensified competition for critical materials such as lithium, nickel, and cobalt, creating new supply-chain and price-volatility risks.

For Oman, participation in battery manufacturing could complement national strategies for renewable energy and industrial diversification. The sector aligns with the goal of achieving 30 percent renewable electricity by 2030 and supporting the broader net-zero 2050 commitment. Local battery production could strengthen energy security, reduce import dependency, and stimulate linkages with supporting industries such as logistics, maintenance, and material processing. Nevertheless, the domestic market remains limited, and regional competitors—particularly Saudi Arabia—are already investing heavily in large-scale battery ecosystems, making it difficult for Oman to secure a competitive position.

While the industry offers potential spillover benefits through material supply, equipment services, and technology learning, its workforce impact would be modest. Employment would centre on plant operations, maintenance, and technical supervision, while high-skill research and design roles would largely depend on international partnerships. Building local expertise would require targeted training and education programmes in electrochemistry, materials science, and advanced manufacturing.

The sector's capital intensity also poses a barrier. Large-scale production facilities demand significant upfront investment in infrastructure, automation, and clean-production systems. Despite these challenges, battery manufacturing remains financially attractive at the global level due to its market maturity and stable demand outlook. For Oman, however, feasibility is limited by the absence of a domestic supplier base and supporting industrial ecosystem.

China continues to dominate global battery manufacturing, accounting for more than half of raw-material processing and the majority of cell-production capacity. This concentration heightens Oman's exposure to external supply and cost risks. Furthermore, battery production carries a notable carbon footprint, requiring careful investment in low-emission processes and circular-recycling systems to align with Oman's sustainability objectives.

In conclusion, while the global environment for battery manufacturing is highly dynamic, Oman's entry into the sector would remain challenging under current conditions. Without long-term partnerships, investment incentives, and dedicated skill-development initiatives, establishing a domestic manufacturing base would be capital-intensive and dependent on imports. Nonetheless, pursuing targeted collaboration in component assembly, recycling, or research could provide valuable learning opportunities and incremental progress toward industrial diversification.

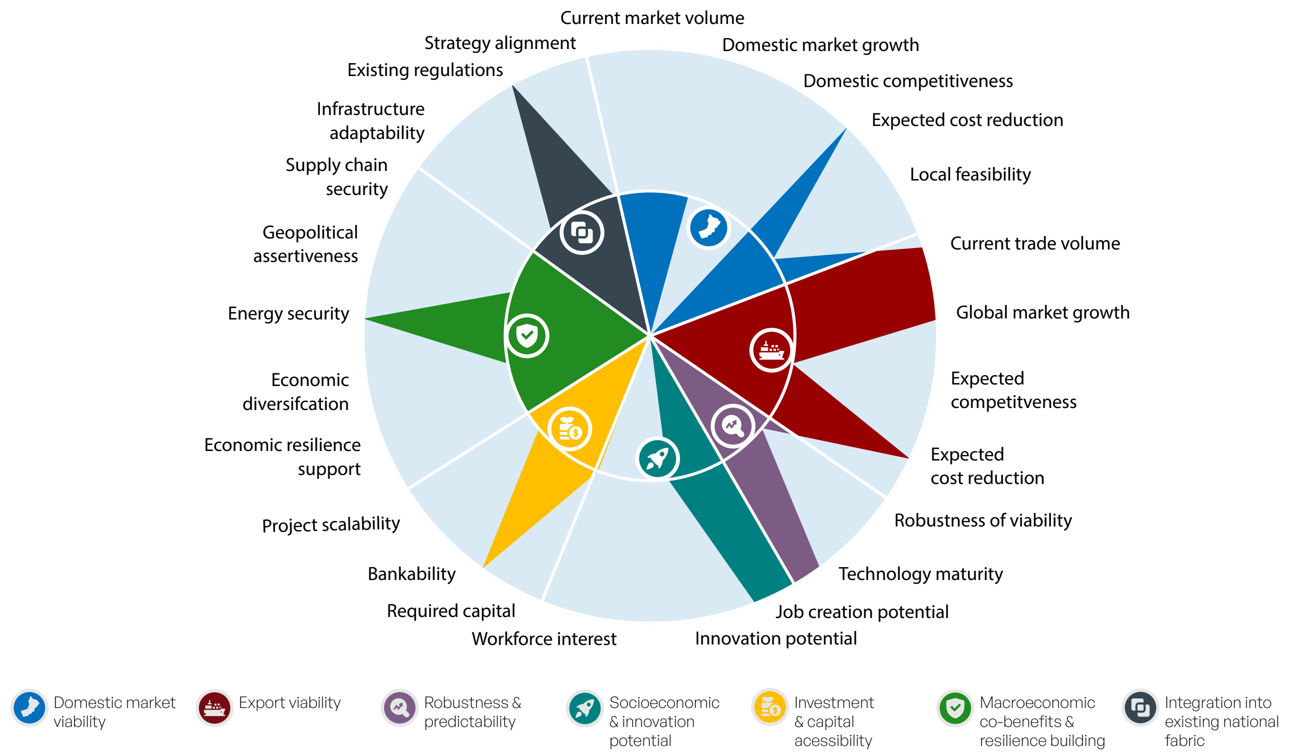


Figure 18: Sector profiling, battery manufacturing.

Carbon Capture Technology Manufacturing

Carbon capture technologies represent a critical pathway toward achieving net-zero emissions, targeting residual carbon dioxide that cannot be eliminated through efficiency measures or renewable-energy substitution. They include carbon capture and storage (CCS)—which separates CO_2 from industrial streams for long-term geological storage—and direct air capture (DAC), which removes CO_2 directly from the atmosphere. CCS has been deployed for decades in natural-gas processing and fertiliser production, but its expansion into harder-to-abate sectors such as cement, steel, and heavy chemicals remains limited due to high costs and technological complexity.

For Oman, carbon capture aligns closely with national decarbonisation objectives. The National Strategy for an Orderly Transition to Net Zero by 2050 identifies CCS as one of six priority technologies for emission reduction. This policy direction, combined with the country's strong oil-and-gas base, provides a platform for adaptation. Oman's industrial infrastructure, skilled engineering workforce, and project-management experience create favourable conditions for early deployment—particularly in retrofitting refineries and gas-processing plants.

Economically, global momentum for CCS and CCUS (carbon capture, utilisation and storage) is increasing as industries seek to decarbonise. Market forecasts suggest steady growth over the coming decade, supported by policy incentives in major economies such as the European Union and the United States. Oman could position itself to participate in regional supply chains by producing components, modular capture units, or ancillary systems for nearby markets. Unlike other clean-energy technologies, the supply of materials required for CCS—such as steel and sorbents—is not heavily concentrated, which could enhance local manufacturing feasibility.

However, domestic deployment remains uncertain. A carbon-capture manufacturing base does not yet exist in Oman, and large-scale implementation would depend on sustained policy frameworks and predictable carbon-pricing mechanisms. The sector's capital requirements are substantial, ranging from pilot-scale demonstration projects to full industrial plants, while project bankability is closely linked to international climate-finance instruments and long-term emissions-reduction commitments.

Oman's established engineering and industrial capabilities could support research partnerships focused on advanced capture materials, process design, and modular system integration, particularly in collaboration with international firms. Nevertheless, workforce readiness is limited, as few academic or technical programmes currently address carbon-capture technologies. Dedicated incentives and targeted training will be essential to develop local expertise and attract skilled professionals.

In summary, Oman's readiness for carbon-capture technology manufacturing is moderate. The sector offers strong strategic relevance and potential geopolitical significance but faces notable challenges in capital intensity, policy dependency, and uncertain domestic demand. If integrated effectively into the national decarbonisation framework, carbon capture could evolve into a cornerstone of Oman's climate-transition agenda—enhancing industrial competitiveness, supporting energy-system resilience, and reinforcing the country's position as a regional leader in low-carbon innovation.

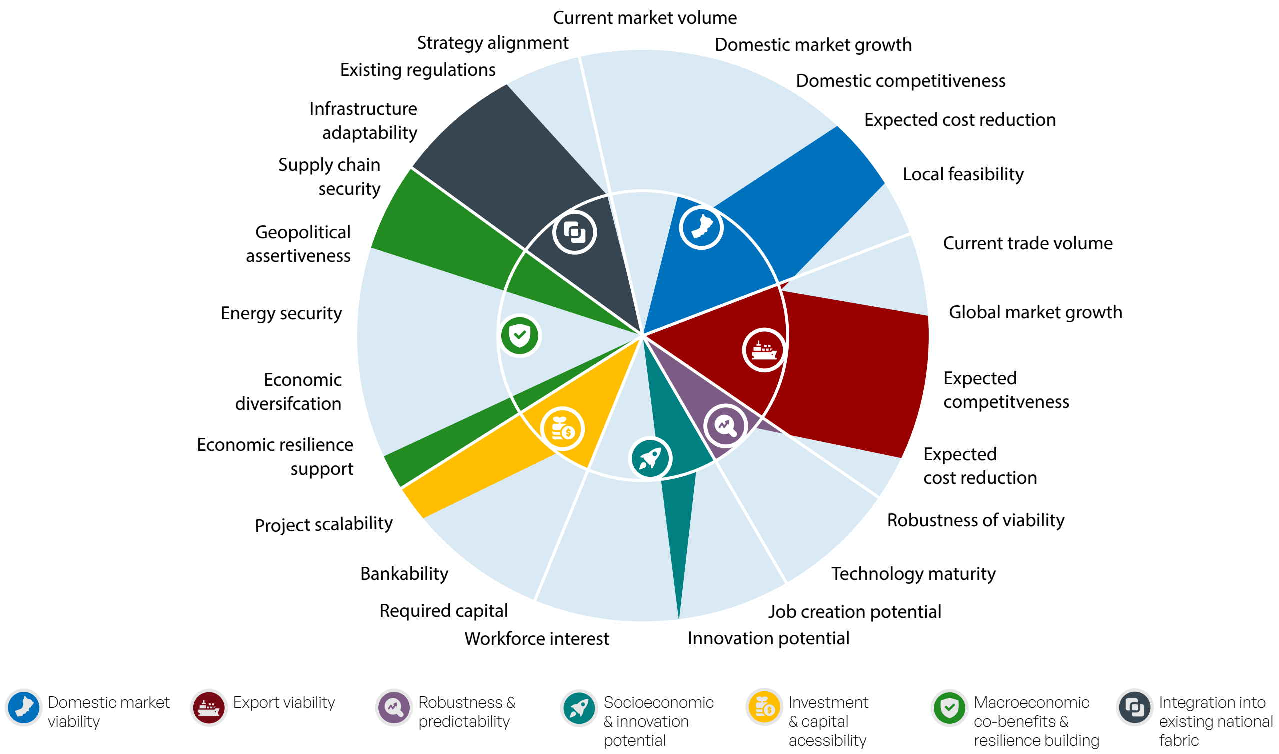


Figure 19: Sector profiling, carbon capture technology manufacturing.

Concentrated Solar Technology Manufacturing

Concentrated Solar Power (CSP) technologies generate electricity from sunlight by converting thermal rather than direct electrical energy. The manufacturing process involves the production of solar collectors that concentrate sunlight onto receivers, heat-transfer systems that absorb and transport the thermal energy, and specialised turbines and storage units that convert and retain this heat for electricity generation. Globally, the CSP industry remains smaller than the photovoltaic sector but continues to expand, with major markets including Spain, the United States, China, and South Africa.

For Oman, the establishment of a CSP-component manufacturing base could contribute to energy security and industrial diversification. Local production would reduce reliance on imported equipment and support the creation of value chains linked to existing industrial infrastructure. Oman's engineering experience in large-scale energy and construction projects provides a solid foundation for gradual localisation. Furthermore, CSP technologies align with national renewable-energy policies and could complement the country's long-term transition objectives.

However, the manufacturing of CSP technologies is highly capital-intensive. Facilities for mirrors, receivers, and thermal-storage components require significant upfront investment, while the commercial viability of projects remains uncertain due to limited global demand. Although the technology is mature, the cost of electricity from CSP remains considerably higher than from solar PV, and competitiveness depends on very large project scales. Without targeted incentives, concessional financing, or international partnerships, private investment is likely to remain limited.

Workforce development presents another challenge. CSP manufacturing requires advanced expertise in materials science, mechanical design, and thermodynamics—skills that are still developing in Oman. While the sector could create employment opportunities, workforce interest remains low, and innovation potential is constrained by dependence on imported technology and foreign intellectual property. Building a skilled talent base would demand long-term investment in education, research, and structured technology-transfer programmes.

Environmental and geographic conditions further shape feasibility. CSP deployment depends on areas with high direct normal irradiance and adequate water resources for cooling—factors that limit suitable sites within Oman. Globally, despite modest market growth, export competitiveness is constrained by China's dominant manufacturing position and the high capital intensity of CSP production.

In summary, CSP technology manufacturing could play a complementary role in Oman's energy transition by expanding the country's industrial base and supporting renewable diversification. Yet, given the substantial investment requirements, limited short-term innovation prospects, and continued reliance on international expertise, CSP manufacturing should be viewed as a long-term opportunity rather than an immediate priority for industrial expansion.

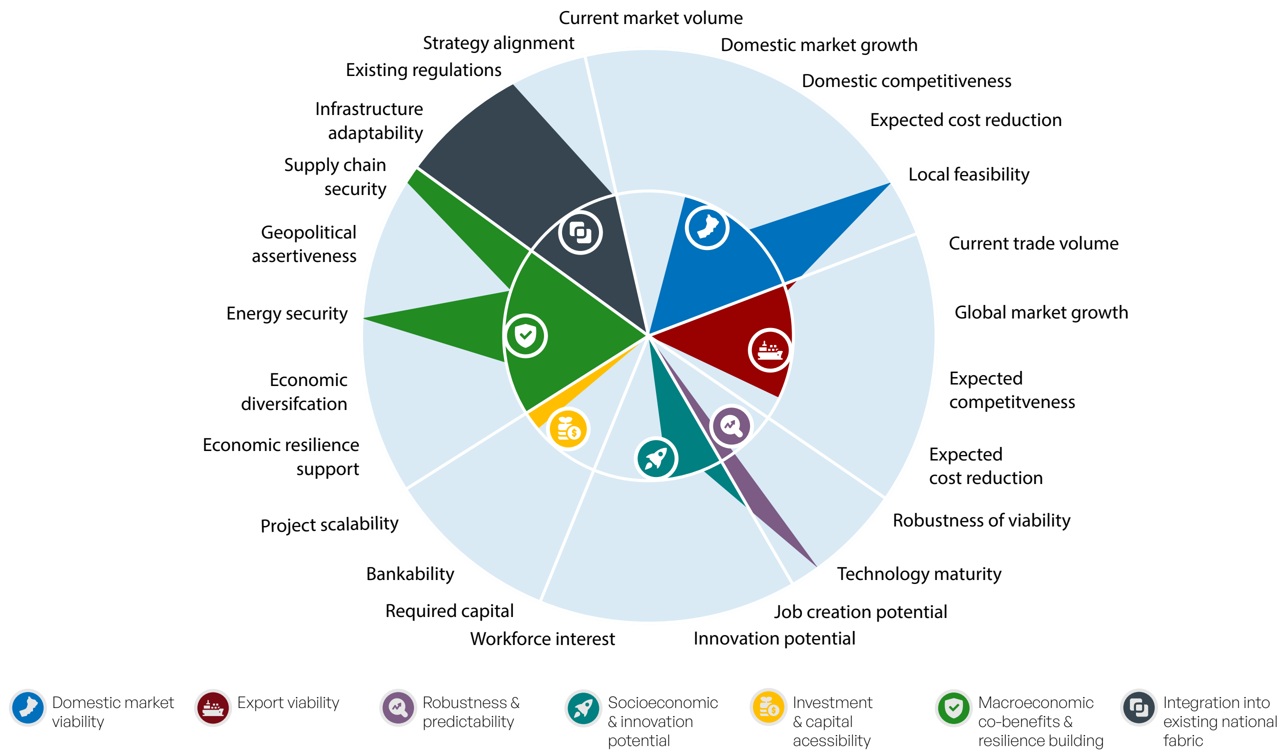


Figure 20: Sector profiling, concentrated solar technology production.

Electrolyser Manufacturing

Electrolysers lie at the heart of low-carbon hydrogen production, converting water into hydrogen and oxygen through the application of electricity sourced from renewable or low-carbon systems. Their manufacturing process is technologically complex and relies on critical materials such as platinum-group metals, electrodes, and specialised membranes—creating high supply-chain dependency and sensitivity to global material markets.

Oman's National Hydrogen Strategy positions the country among the world's leading future hydrogen exporters, targeting the production of 1 to 1.3 million tonnes annually by 2030 and up to 8.5 million tonnes by 2050. To achieve these goals, electrolyser capacity would need to scale to around 11.5 GW by 2030 and exceed 5,000 units by 2050, underscoring the magnitude of Oman's ambition. For comparison, total global installed capacity in 2022 stood at only about 11 GW.

Domestic electrolyser manufacturing would offer several strategic benefits. It would enhance energy security, reduce import dependency, and anchor a new industrial base around hydrogen technologies. The Oman Investment Authority's USD 50 million partnership with Electric Hydrogen and Siemens Energy to establish a 1 GW factory by 2026 reflects early institutional commitment and signals the country's intent to build local capability. The initiative supports Oman's broader industrialisation and diversification agenda, particularly within renewable-energy and heavy-industry clusters.

Oman's well-developed infrastructure and strong engineering capacity, inherited from decades of oil-and-gas operations, provide a practical foundation for this emerging industry. Access to capital is relatively strong through state-backed financing and private-sector partnerships. With few regional competitors currently manufacturing electrolysers at scale, Oman has a window of opportunity to position itself as a regional supplier.

Nonetheless, the sector faces several structural challenges. Electrolyser manufacturing is highly capital-intensive, with profitability dependent on achieving economies of scale and stable global demand. Technology is evolving rapidly—between alkaline, PEM, and solid-oxide designs—creating uncertainty over which platform will dominate. Although global production costs are expected to fall by up to 40 percent by 2030, consistent demand and competitive scale will be essential to sustain operations.

Resource availability presents another constraint. Oman has no domestic supply of platinum-group metals, around 90 percent of which are mined in South Africa, Russia, and Zimbabwe. This dependence introduces price volatility and geopolitical risk, highlighting the importance of strategic sourcing and recycling initiatives.

Innovation potential and workforce readiness remain moderate. While Oman can leverage its engineering talent and industrial experience, expertise in electrochemistry, materials science, and precision manufacturing is still emerging. Dedicated training programmes and international R&D collaborations will be necessary to develop a skilled workforce and promote technological learning.

In summary, electrolyser manufacturing offers Oman a strategically significant but high-risk opportunity. It aligns directly with national hydrogen ambitions and presents strong export potential, yet its success depends on sustained policy commitment, continued investment in research and human capital, and robust international partnerships. With these foundations in place, Oman could establish itself as a key manufacturing and technology hub in the global hydrogen economy.

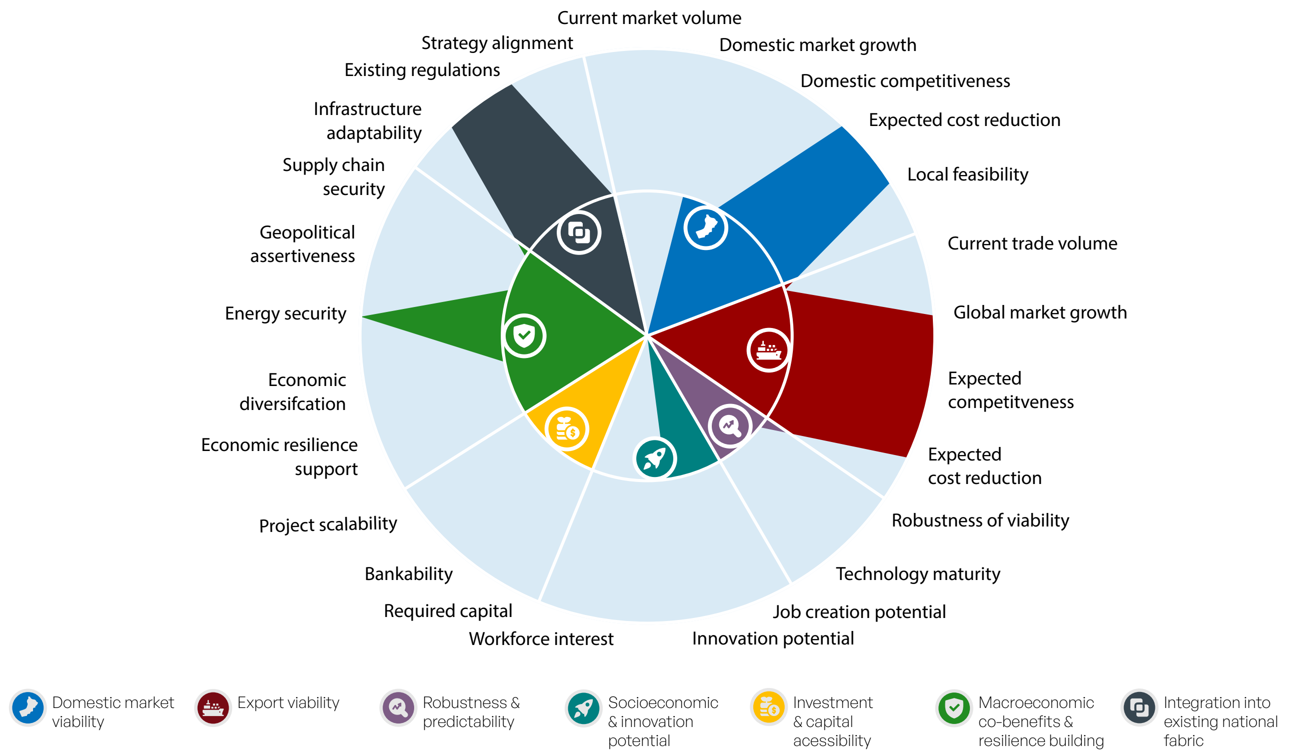


Figure 21: Sector profiling, electrolyser manufacturing.

Heat Pump Manufacturing

Heat pump manufacturing involves the design and production of systems that transfer heat efficiently for both heating and cooling applications, typically through the compression and expansion of a refrigerant. The sector encompasses a range of technologies, including air-to-air and air-to-water heat pumps for residential, commercial, and industrial use. Core components such as compressors, heat exchangers, and valves rely on widely available materials—primarily steel, aluminium, and copper—making the industry globally scalable and technically accessible to emerging markets, including Oman.

Globally, the heat pump market is experiencing sustained expansion, driven by policy incentives, rising energy costs, and advances in efficiency. Manufacturing investments exceeding USD 4 billion have been announced in recent years, largely concentrated in Europe, while the Asia–Pacific region remains the leading market for deployment. The technology is gaining prominence as a key enabler of low-carbon heating and industrial decarbonisation, complementing renewable-energy systems and energy-efficiency measures.

For Oman, developing local manufacturing capabilities in heat pump technologies could make a meaningful contribution to national energy diversification and decarbonisation efforts. Heat pumps can be applied in buildings, district cooling, and industrial processes to enhance energy efficiency and reduce emissions. The technology's compatibility with Oman's existing infrastructure and renewable-electricity supply provides strong potential for integration. In addition, its high innovation potential and opportunities for cost reduction make it an attractive target for technology localisation.

However, several challenges would need to be addressed. High upfront costs and intense global competition could constrain the development of a domestic manufacturing base in the short term. The sector's moderate job-creation potential also means that success will depend more on industrial competitiveness than on scale. To attract investment and establish market presence, Oman would need targeted fiscal incentives, stable regulatory frameworks, and public–private partnerships to support both production and deployment.

Building technical capacity will be equally important. Manufacturing heat pumps requires specialised knowledge in thermodynamics, mechanical systems, and refrigerant technology. Strengthening local expertise through training programmes, R&D initiatives, and international collaboration would help create the skilled workforce necessary to sustain the industry.

In summary, heat pump manufacturing represents a moderate-growth, high-efficiency opportunity for Oman. While the sector faces capital and competitiveness barriers, it aligns well with the country's energy-transition objectives and industrial capabilities. With strategic policy support, targeted incentives, and focused skill development, Oman could position itself as a regional hub for efficient heating and cooling solutions that complement its broader low-carbon agenda.

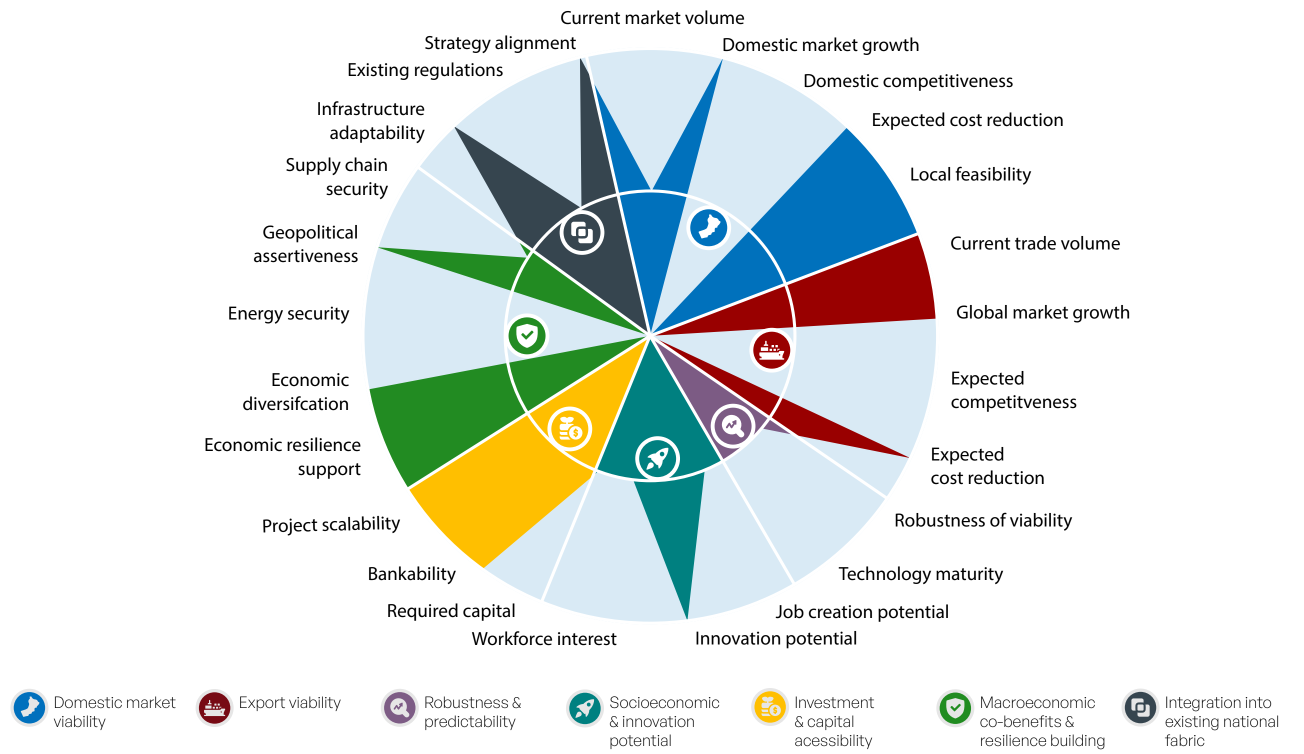


Figure 22: Sector profiling, heat pump manufacturing.

Fuel Cell Manufacturing

Fuel cell manufacturing involves the production of electrochemical systems that convert hydrogen or other fuels directly into electricity without combustion. The process includes designing and assembling stacks, electrodes, membranes, separators, and control systems—components that demand high precision and advanced material engineering. The principal fuel-cell types are polymer electrolyte membrane (PEM), solid oxide (SOFC), direct methanol (DMFC), and alkaline (AFC) systems, each suited to specific applications across transport, stationary power, and portable devices.

Globally, the fuel-cell industry is expanding, driven by efforts to decarbonise heavy transport and distributed power generation. Valued at around USD 7 billion in 2023, the sector is projected to continue strong growth over the coming decade. The United States, Japan, Germany, and South Korea currently lead global production and R&D, reflecting decades of policy support and sustained public–private investment.

For Oman, the establishment of a domestic fuel-cell manufacturing base would remain limited in scope. Local demand for such technologies is negligible, and the international market is highly competitive and dominated by established players with extensive intellectual-property portfolios. The capital intensity of manufacturing—combined with complex global supply chains—makes large-scale localisation difficult in the near term.

Nevertheless, Oman possesses several enabling factors that could support selective participation. The country's industrial estates, logistics infrastructure, and clear regulatory environment could accommodate component-assembly or system-integration activities. These initiatives could complement national diversification goals, particularly if integrated into the broader hydrogen-economy framework. However, relatively high domestic energy costs present a structural barrier to energy-intensive green manufacturing, while dependence on imported platinum-group metals—essential to PEM and DMFC systems—creates additional supply-chain risk.

Although the sector offers strong innovation potential and could contribute to knowledge development in electrochemistry and clean-power technologies, its short-term economic impact would be modest. Export competitiveness, job creation, and capital accessibility all remain constrained, and cost reductions are expected to occur gradually rather than rapidly.

In summary, fuel-cell manufacturing represents a high-risk, low-return pathway for Oman under current market conditions. Its success would require sustained government support, targeted investment incentives, and international partnerships focused on technology transfer and workforce development. In comparative terms, other clean-energy manufacturing segments—such as electrolysers or solar PV—offer more immediate opportunities for scale, employment, and return on investment. Consequently, fuel-cell manufacturing should be treated as a long-term strategic option rather than a near-term industrial priority.

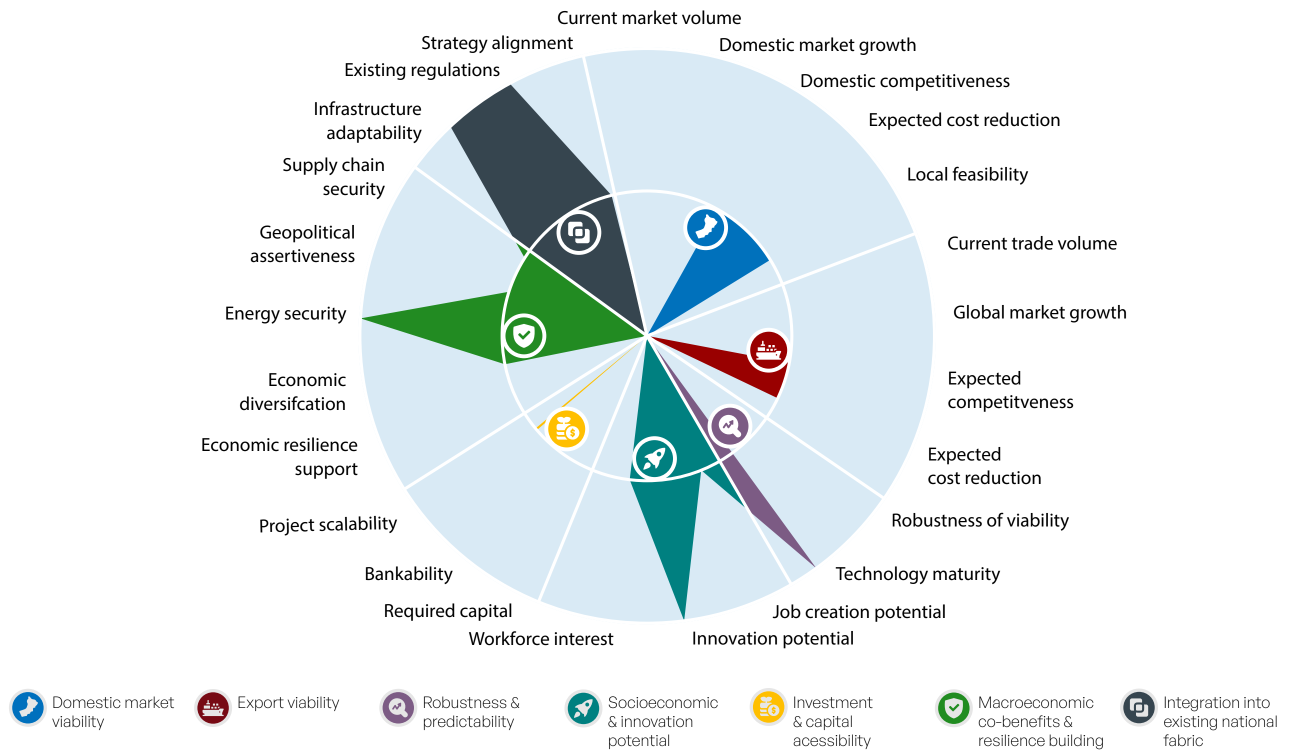


Figure 23: Sector profiling, fuel cell manufacturing.

Inverter Manufacturing

Inverters play a vital role in modern energy systems by converting direct current (DC) electricity from solar photovoltaic (PV) systems—or conditioning variable-frequency output from wind turbines—into alternating current (AC) suitable for grid integration. Beyond renewables, inverters are also essential in battery storage, industrial motor drives, and telecommunications, making them a cornerstone of global electrification and digitalisation efforts.

Globally, the inverter manufacturing market is valued at approximately USD 15 billion in 2024 and is projected to exceed USD 40 billion by 2030, driven by the rapid expansion of solar and energy-storage technologies. Because inverter production is closely tied to solar PV deployment, the sector's growth potential in Oman would depend largely on progress in renewable power and green hydrogen projects under the National Energy Strategy 2040.

Oman's industrial base offers several enabling factors for developing a local inverter manufacturing segment. The country benefits from established supply chains in aluminium, copper, and steel—key inputs for power-electronics fabrication—and possesses the engineering capacity to support industrial assembly. Developing inverter production could also stimulate adjacent industries such as semiconductor packaging, printed circuit board (PCB) manufacturing, and electrical testing services, generating indirect employment and fostering technological spillovers.

From a strategic standpoint, local inverter production could enhance energy security by reducing reliance on imported equipment and strengthening Oman's position within regional renewable-energy value chains. It would also support the government's broader diversification agenda by deepening industrial linkages with the solar and hydrogen sectors.

However, the global inverter market is highly consolidated and competitive. The top ten manufacturers control more than 85 percent of total global output, with Chinese firms alone holding roughly half the market share, supported by extensive R&D investment and large-scale production capacity. Entering this market would require significant capital, scale, and sustained policy backing. Furthermore, Oman's domestic demand remains small, limiting opportunities for large-scale manufacturing and export-oriented production in the near term.

The technology itself is relatively mature, with incremental innovation focused on improving efficiency and digital control systems. Consequently, Oman's potential role in the inverter value chain would likely centre on assembly, testing, and integration rather than full-scale component fabrication. Strategic joint ventures or partnerships with established international firms could provide practical entry points and build local expertise over time.

In summary, inverter manufacturing presents Oman with a moderate-opportunity, low-risk industrial pathway that complements its renewable-energy ambitions. Given the dominance of global producers and limited regional demand, Oman should prioritise assembly and integration partnerships as an initial step toward localising renewable-technology supply chains. This approach would strengthen the country's technical capabilities and industrial ecosystem while minimising exposure to high capital costs and global market volatility.

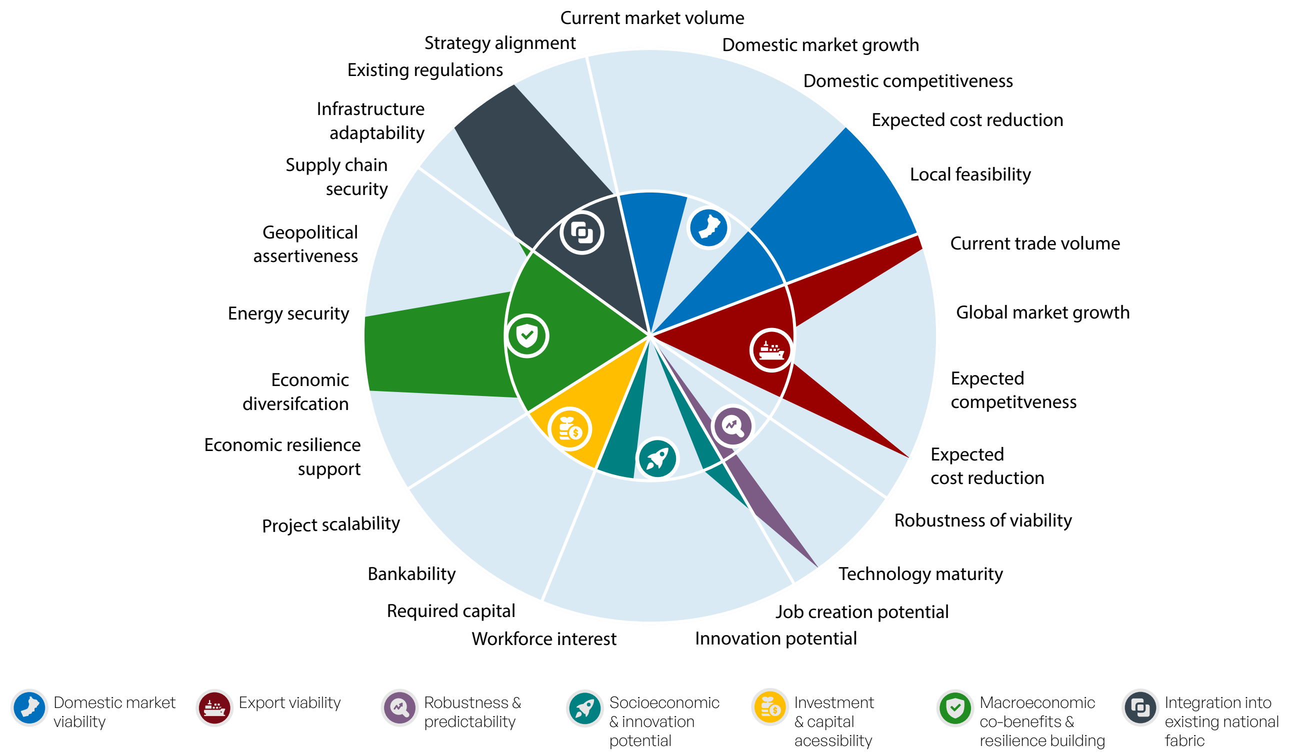


Figure 24: Sector profiling, inverter manufacturing.

Minerals/ Metals Processing

Key clean-energy technologies—including solar panels, wind turbines, electrolysers, and electric vehicles—depend heavily on processed critical minerals and metals. The processing phase, which encompasses crushing, grinding, refining, and purification, forms a vital link in global clean-energy supply chains, determining both the availability and cost of high-quality materials used in renewable-energy systems.

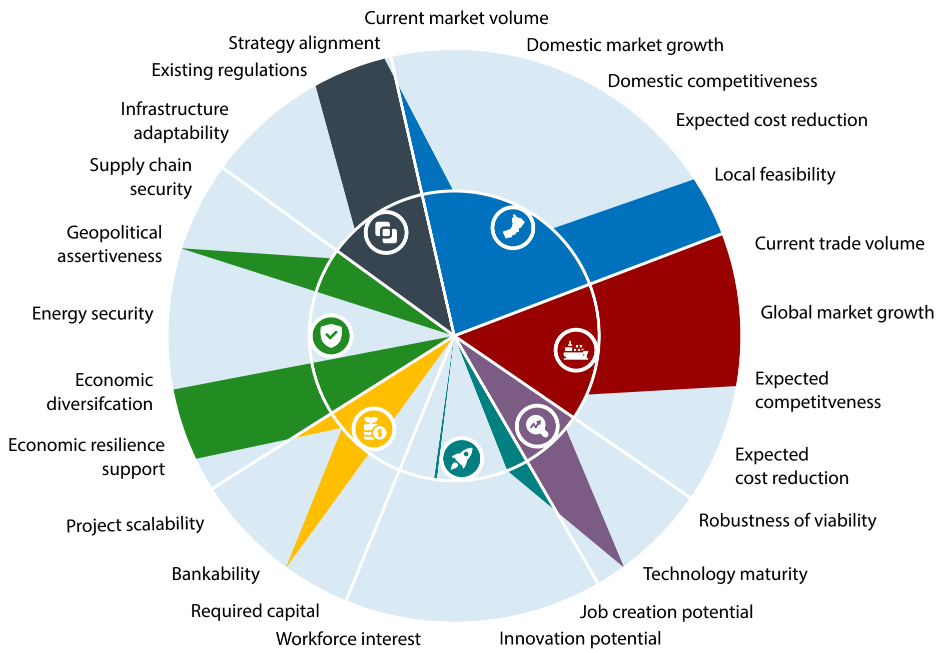
At present, the global mineral-processing landscape is highly concentrated. China accounts for roughly 80 percent of refining capacity for key materials such as lithium, cobalt, nickel, and rare earth elements. This dominance creates supply-security risks and exposes global markets to price volatility, highlighting the need for alternative processing hubs—particularly in resource-rich and energy-competitive countries such as Oman.

Oman possesses notable reserves of copper, nickel, cobalt, and lithium, with copper being the most commercially developed. The Sohar region hosts an established copper-mining and smelting base, supported by modern port and logistics infrastructure. Geological assessments in 2022 identified approximately 2.8 million tonnes of commercial copper ore, reinforcing the country's potential to become a regional processing centre. Access to renewable-energy resources, abundant natural gas, and competitively priced electricity further enhances Oman's attractiveness for energy-intensive refining and metallurgical operations.

Developing the processing sector would be both feasible and strategically aligned with national priorities. Leveraging its extraction industry and industrial clusters, Oman could expand its role along the value chain—from raw-material production to refined-metal exports—thereby improving supply-chain resilience and increasing domestic value addition. Rising global demand for processed critical materials also creates a strong export case, while the sector's technological maturity ensures high bankability and manageable investment risks. In addition, forward linkages to downstream manufacturing and regional trade could yield broader macroeconomic benefits.

Nonetheless, scalability remains constrained by the relatively limited volumes of non-copper mineral reserves and by the dominance of large, vertically integrated global processors. Market entry would therefore require sustained government incentives, targeted foreign-investment partnerships, and long-term contracts to guarantee offtake. Employment impacts are expected to be moderate, as modern processing facilities are highly automated and capital-intensive

In summary, Oman is well positioned to expand its mineral-processing capacity, particularly in copper, to strengthen export competitiveness and supply-chain security. A gradual development pathway—focused on efficiency improvements, renewable-powered operations, and incremental value addition—would allow the country to establish a resilient foothold in global clean-energy supply chains while maintaining balanced investment exposure.



Domestic market viability | Export viability | Robustness & predictability | Socioeconomic & innovation potential | Investment & capital acessibility | Macroeconomic co-benefits & resilience building | Integration into existing national fabric

Figure 25: Sector profiling, minerals & metals processing.

Solar PV Panel Manufacturing

Solar photovoltaic (PV) manufacturing encompasses a multi-stage industrial process that begins with refining raw materials such as quartz and metallurgical-grade silicon and extends through wafering, cell fabrication, and final module assembly. The global PV manufacturing market, valued at around USD 170 billion in 2023, continues to expand steadily, supported by falling technology costs, sustained investment, and robust policy incentives promoting clean-energy deployment.

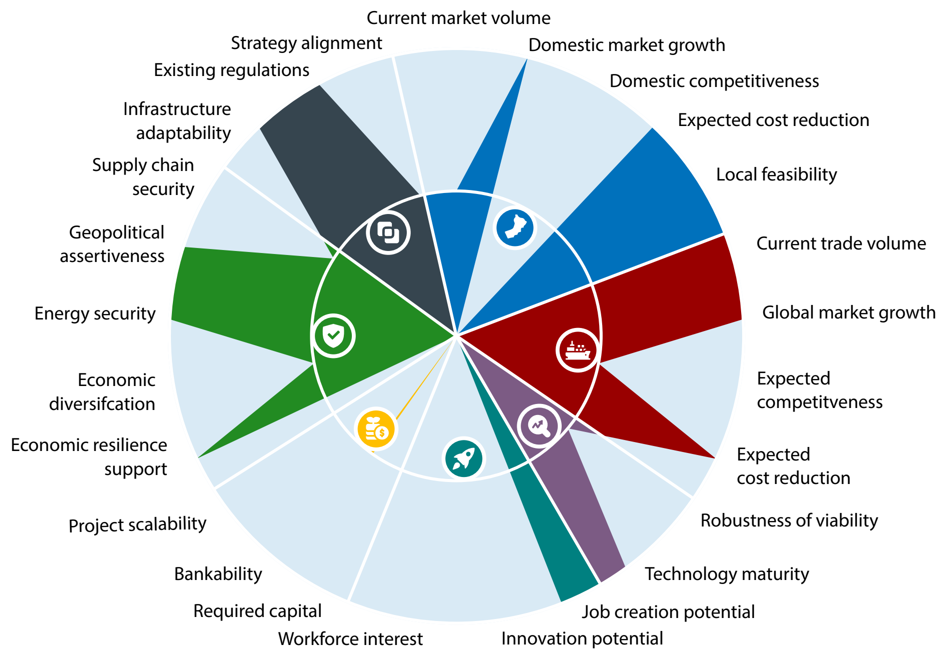
In Oman, solar PV manufacturing aligns directly with the country's clean-energy ambitions and its goal of scaling up renewable electricity and green-hydrogen production. Estimates indicate that achieving national hydrogen targets could require the installation of roughly 300 million solar panels, underscoring the scale of future demand. The solar-panel manufacturing plant under construction in the Sohar Freezone, Oman's largest industrial hub, marks a significant first step toward localisation of renewable-energy technology production.

Favourable regulation, modern industrial infrastructure, and high technological maturity make local PV production feasible. The sector also promises moderate job creation—typically 2 to 10 jobs per megawatt of installed capacity—and could stimulate indirect demand across construction, logistics, and maintenance services.

However, the global PV manufacturing landscape is highly concentrated. China dominates the supply chain, controlling about 80 percent of polysilicon refining and nearly 97 percent of ingot and wafer production. This concentration enables Chinese firms to achieve unmatched cost efficiencies, creating a mature, low-margin market where competitiveness depends on scale, capital investment, and advanced integration. Although the average cost of solar-panel manufacturing has fallen by more than 75 percent over the past decade, establishing a large-scale domestic industry remains capital-intensive and only marginally bankable.

For the near term, Oman's most realistic opportunity lies downstream in panel assembly and the production of subcomponents such as frames, junction boxes, and mounting systems. This strategy would allow gradual entry into the global solar-supply chain while supporting local employment and skills development. Partnerships with established international manufacturers could accelerate knowledge transfer and improve technological readiness.

In summary, while full-scale PV manufacturing faces strong competitive barriers, Oman's strategic approach should prioritise assembly and integration activities. Leveraging the SOHAR Freezone project as a foundation for learning and capability building would enable the country to strengthen its renewable-technology ecosystem and advance its broader industrial-diversification goals in a measured and financially sustainable manner.



Domestic market viability | Export viability | Robustness & predictability | Socioeconomic & innovation potential | Investment & capital acessibility | Macroeconomic co-benefits & resilience building | Integration into existing national fabric

Figure 26: Sector profiling, solar panel manufacturing.

Mechanical Storage Manufacturing

With the growing integration of variable renewable-energy sources into power grids, mechanical electricity storage has emerged as an important complement to electrochemical systems. It is particularly well suited for large-scale and long-duration applications, making it essential for maintaining grid stability and mitigating the intermittency of renewables. Mechanical storage manufacturing involves the design and production of core components for technologies such as pumped hydropower, compressed-air energy storage (CAES), flywheel systems, and gravity-based storage.

For Oman, these technologies could offer strategic advantages in advancing sustainable diversification. Their relatively high technological maturity, lower environmental footprint, and reliance on abundant and recyclable raw materials position them as lower-risk investment options compared with battery-based systems. The existence of regulatory frameworks supporting renewable integration, together with Oman's industrial experience in engineering and construction, could further reduce project-development risk.

Nevertheless, several constraints temper this potential. Capital requirements are substantial, as mechanical-storage facilities demand significant civil-works investment and extensive site adaptation. Geographic and climatic factors present additional challenges. While Oman possesses certain favourable geological formations, its arid climate and limited surface-water resources make pumped-hydro storage particularly difficult and costly to implement. These natural limitations, combined with the large spatial footprint of such projects, restrict scalability and raise overall project costs.

The domestic market for mechanical storage is currently small, reflecting limited grid-scale storage demand and competition from alternative technologies such as batteries. Export prospects are equally constrained: the global market is dominated by established turbine, compressor, and flywheel manufacturers with decades of operational experience. Moreover, mechanical-storage technologies are mature, leaving limited scope for significant cost reductions or rapid innovation. Collectively, these factors result in moderate bankability and modest prospects for near-term industrial localisation.

Before allocating major investment or policy resources, Oman would benefit from a targeted market-assessment phase to identify specific demand segments—such as utility-scale grid balancing, desalination-plant integration, or remote-area energy storage—and to evaluate the trade-off between economic feasibility and environmental or energy-security gains.

In summary, mechanical-storage manufacturing offers Oman niche potential rather than immediate industrial opportunity. While the technologies are proven and environmentally advantageous, their dependence on site-specific conditions and high capital intensity limit short-term scalability. Focused feasibility studies and selective pilot projects could nevertheless provide valuable insights into their long-term role within Oman's energy-transition and infrastructure-resilience strategy.

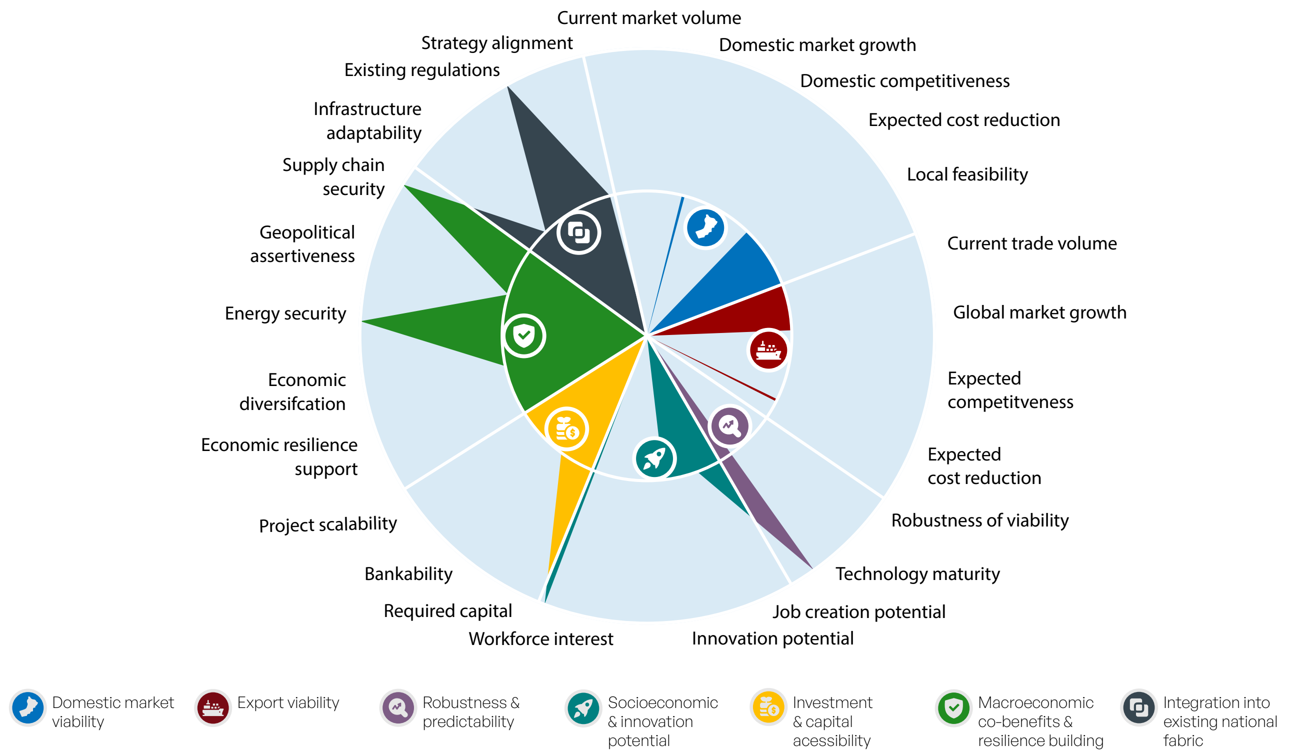


Figure 27: Sector profiling, mechanical storage manufacturing.

Variable Speed Drive Manufacturing

Variable Speed Drives (VSDs)—also known as adjustable-speed drives or frequency inverters—are electronic systems that control the rotational speed and torque of electric motors. By matching motor output to actual process demand, they improve energy efficiency, enhance process control, and reduce mechanical wear in applications ranging from industrial manufacturing and HVAC systems to water treatment and transportation.

Globally, the variable-frequency-drive market is valued at around USD 28 billion (2024) and is expected to approach USD 40 billion by 2030, reflecting steady growth of nearly six percent annually. This expansion is underpinned by rising industrial automation, digitalisation, and energy-efficiency regulations that have made VSDs a standard component of modern industrial systems.

For Oman, establishing local VSD manufacturing represents a feasible and cost-efficient industrial opportunity. Unlike capital-intensive sectors such as solar-panel or turbine manufacturing, VSD production primarily involves electronic assembly, testing, and quality control—activities well supported by Oman's existing electrical-engineering capabilities and industrial infrastructure. The country's regulatory framework, aligned with energy-efficiency and decarbonisation targets, further enhances feasibility while reducing the need for major workforce retraining.

Although domestic demand is likely to remain modest due to Oman's limited heavy-industrial base, export potential is notable. Expanding regional markets for automation equipment and global demand for affordable, efficient drives could enable Oman to position itself as a secondary manufacturing hub within the GCC. The technology's maturity and predictable demand profile provide a degree of investment stability uncommon among emerging green industries.

Challenges remain. The global VSD market is moderately competitive, with established players holding significant market share. Access to financing for early-stage projects may prove difficult, and limited scope for cost reductions could constrain economies of scale. Nonetheless, the sector's relatively low capital requirements and proven technology base make it an attractive option for incremental localisation within Oman's industrial diversification agenda.

In summary, VSD manufacturing aligns strongly with Oman's National Decarbonisation Strategy and its objective to boost industrial efficiency. By fostering a local manufacturing base for energy-saving technologies, Oman can improve productivity, enhance energy resilience, and cultivate a sustainable export niche built on its existing strengths in electrical and mechanical engineering.

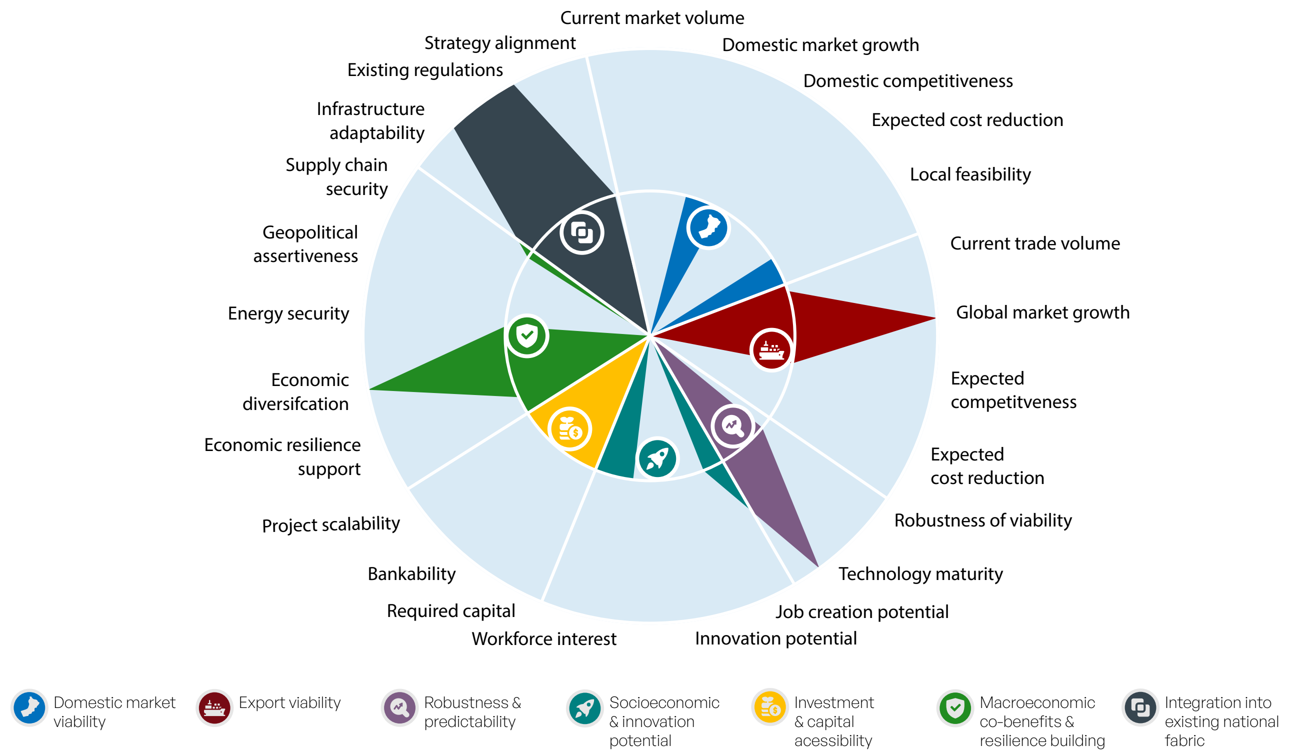


Figure 28: Sector profiling, variable speed drive manufacturing.

Water Filtration Membrane Manufacturing

Water-filtering membrane manufacturing underpins modern desalination and water-treatment systems by producing thin polymeric films capable of removing salts and contaminants through microfiltration, ultrafiltration, nanofiltration, and reverse-osmosis processes. These technologies are central to ensuring a reliable supply of high-purity water for municipal, industrial, and hydrogen-related applications.

Oman faces chronic water scarcity, making desalination and advanced filtration technologies indispensable to both its national development goals and its renewable-hydrogen strategy. The country aims to produce 1 million tonnes of hydrogen by 2030, rising to 3.75 million tonnes by 2040 and 8.5 million tonnes by 2050. Meeting this ambition will require large volumes of ultra-pure water for electrolysis—creating strong future demand for efficient filtration and desalination systems.

Oman has already made substantial progress in expanding its desalination capacity. The Barka V plant (100 000 m^3/day) is fully operational, while Ghubrah III (300 000 m^3/day) is under construction and expected to begin operations by 2027. Other major plants, including Ghubrah II, Qurayyat, and Sur II, collectively supply hundreds of thousands of cubic metres of potable water daily, forming a solid industrial base for integrating local membrane production.

Establishing a domestic membrane-manufacturing sector would be strategically valuable and technically feasible. The technology is mature, capital requirements are moderate, and integration with Oman's existing desalination infrastructure would be straightforward. Localising production could enhance water-supply security, reduce reliance on imports, and provide a stable input for hydrogen and industrial water systems.

However, the sector's innovation potential and job-creation capacity are limited. Manufacturing processes are standardised and highly automated, offering fewer opportunities for research-driven differentiation. On the export side, competition from established Asian and European producers is strong, keeping margins narrow and price competition high.

Despite these constraints, water-filtering-membrane manufacturing represents a low-risk, high-relevance opportunity. It is relatively simple to establish, directly supports Oman's desalination and hydrogen objectives, and strengthens long-term resilience across the water–energy nexus. Pursued as part of a targeted localisation strategy, the sector could become a practical and stable contributor to Oman's sustainable-industrial portfolio.

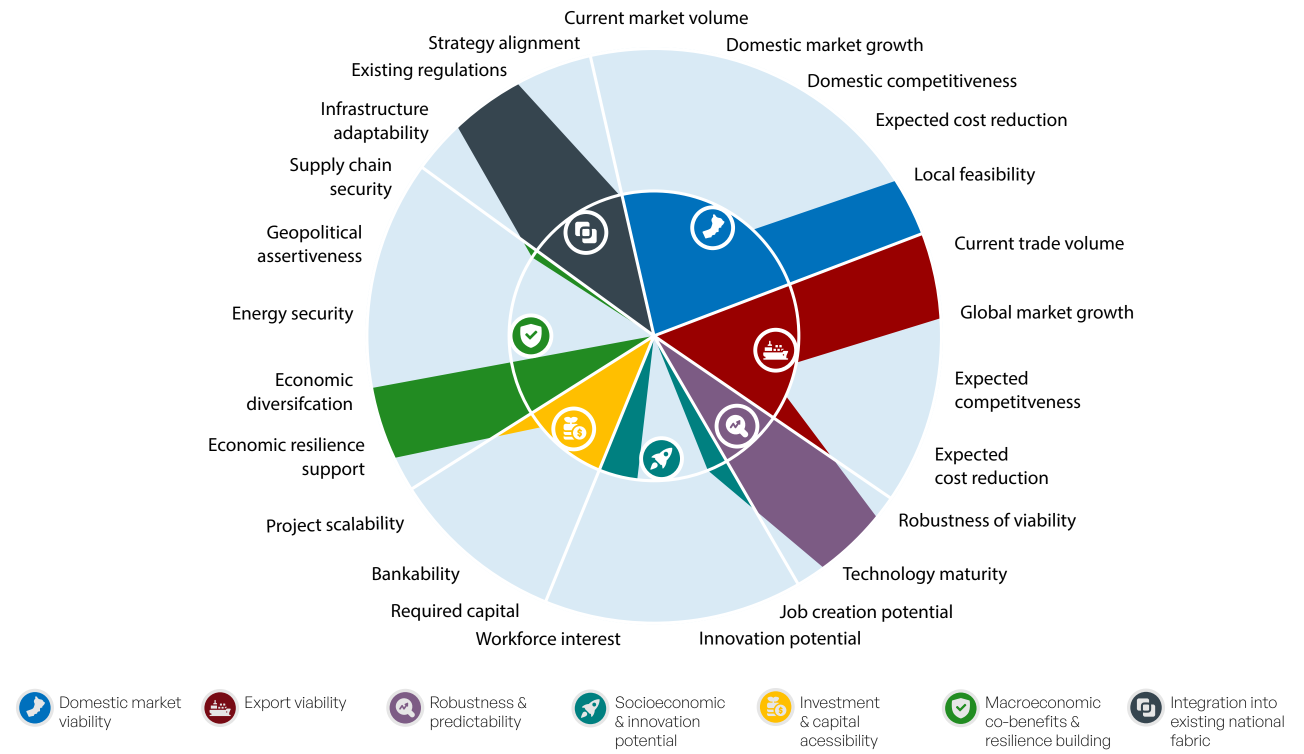


Figure 29: sector profiling, water filtration membrane manufacturing.

Wind Turbine Manufacturing

Wind-turbine manufacturing encompasses the design, fabrication, and assembly of key components—rotor blades, nacelles, and towers—integrating advanced aerodynamics, structural mechanics, and power-conversion systems. The global industry continues to expand despite supply-chain pressures, high capital intensity, and fluctuating policy environments, remaining one of the most dynamic segments of the clean-energy economy.

Currently, capital cost of wind generation remains relatively high, yet these costs are projected to fall moderately by 2030, reflecting incremental improvements in turbine design and manufacturing efficiency rather than the rapid cost declines seen in previous decades.

For Oman, local production or assembly of wind-turbine components could strengthen supply-chain security, lower logistics costs, and enhance energy-system resilience. Manufacturing large components such as blades and towers within the country would be particularly advantageous, as their transport over long distances is expensive and technically demanding.

However, domestic market potential remains limited. Oman's high-quality wind resources are concentrated mainly in the southern governorates—especially Dhofar and Duqm—while most northern regions exhibit moderate-to-low capacity factors. Although existing infrastructure and regulatory frameworks are conducive to industrial investment, the scale of local demand is insufficient to support full-scale turbine manufacturing without a strong export orientation.

Globally, production is highly concentrated: around 60 percent in China, 19 percent in Europe, and 9 percent in the United States. This dominance reflects high entry barriers, substantial R&D requirements, and deep supply-chain integration. Consequently, Oman would struggle to compete directly with established manufacturers but could credibly position itself as a regional assembly and maintenance hub serving MENA markets, where demand for onshore wind capacity is expected to rise.

Capital access is a further constraint. Turbine manufacturing is capital-intensive, often requiring investments exceeding USD 1,500 per kW for onshore systems and USD 6,000 per kW for offshore facilities. Competitive participation would necessitate large-scale financing, public-private partnerships, and potentially sovereign backing.

From a labour perspective, the sector is construction-intensive but operation-light. Onshore wind projects typically generate 2–3 full-time-equivalent job-years per megawatt during construction and about 0.2 per megawatt in operations and maintenance. Offshore projects are more labour-demanding—6 to 27 job-years per megawatt during construction and around 0.7 in ongoing operations. Oman would therefore need dedicated training and technical-education programmes to build a qualified workforce and ensure effective knowledge transfer.

In summary, wind-turbine manufacturing aligns closely with Oman's industrial-diversification and energy-transition strategies but faces steep scale and capital barriers. While the domestic market is small, Oman's geographic position, port infrastructure, and growing renewable portfolio offer long-term potential for regional specialisation in turbine assembly and maintenance. The sector should thus be pursued as a strategic, export-oriented opportunity—one that evolves gradually through partnerships and capacity-building rather than immediate large-scale deployment.

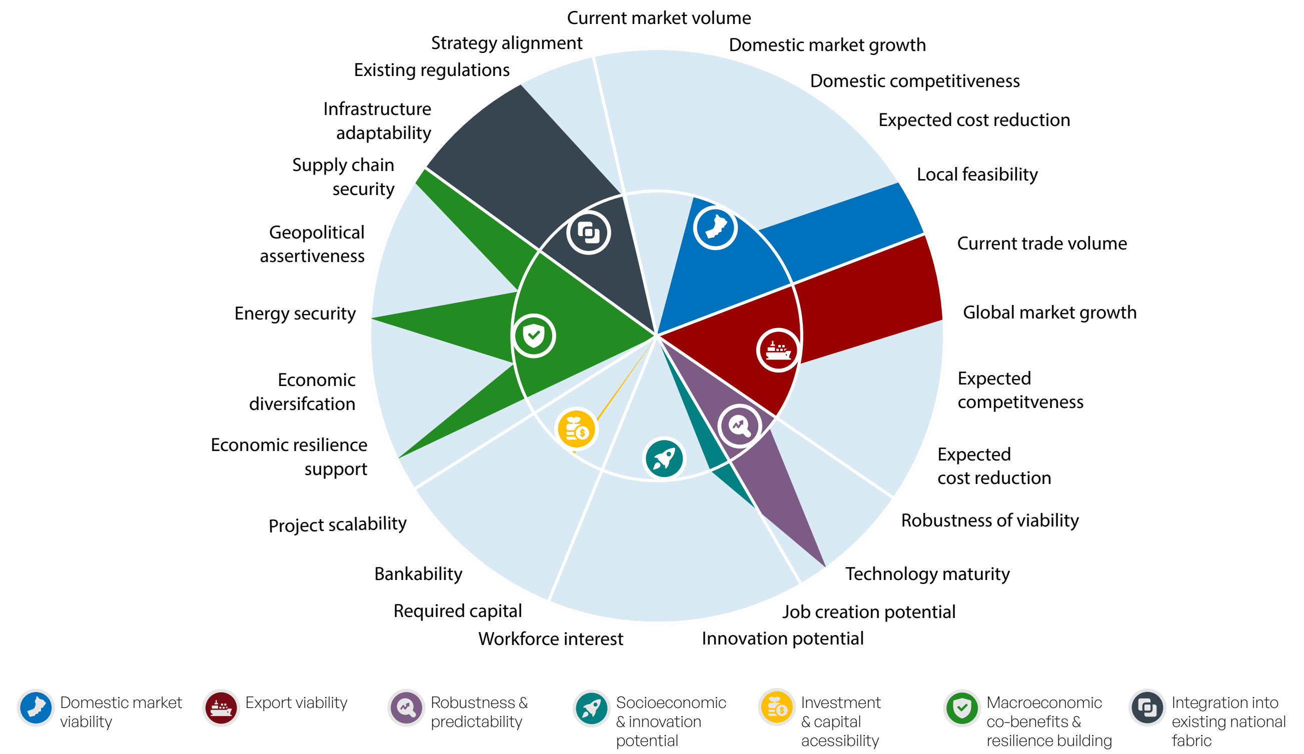


Figure 30: Sector profiling, wind turbine manufacturing.

Clean Cement/Concrete

Cement and concrete remain foundational materials for construction and infrastructure—from buildings and transport networks to industrial and energy facilities. Yet cement production is among the most energy- and carbon-intensive of all manufacturing activities, with energy costs accounting for roughly 20–40% of total production expenses. Most of this energy is consumed in calcination, the process of converting limestone into clinker—the key binding component of cement.

Decarbonising the cement sector is uniquely difficult. Around two-thirds of total emissions arise directly from calcination, making them unavoidable through energy efficiency alone. Emerging mitigation pathways include the use of carbon capture, utilisation and storage (CCUS), clean hydrogen, and renewable electricity, though these technologies remain largely at pilot and demonstration stages globally.

According to the IEA Technology Roadmap, global cement production is expected to reach 3.7–4.4 billion tonnes by 2050, growing by about 1% annually from 2006 levels. Even under moderate-efficiency scenarios, this results in rising output and persistent direct CO_2 emissions—highlighting the structural challenge of decarbonising this essential material.

In Oman, the cement industry presents both domestic and export potential. The Oman Cement Company (OCC) has announced a USD 300 million investment to expand its production capacity through a new 10,000-tonne-per-day line at its Rusayl plant, incorporating modern energy-efficient technologies. At the same time, the International Process & Industrial Applications Company (IPIAC) is developing the region's first low-carbon-cement (LC3) plant, expected to reduce emissions by up to 40% relative to conventional processes.

Oman's strong resource base—including abundant limestone, clay, and gypsum reserves—provides a natural advantage for scaling low-carbon cement manufacturing. Progress in CCUS readiness and clean hydrogen production further enhances long-term competitiveness, particularly for export-oriented production targeting regional and global markets.

Nonetheless, the sector faces notable constraints. Cement manufacturing remains highly capital-intensive, innovation is incremental, and financing large-scale retrofits or new facilities can be challenging. While regulatory frameworks and sustainability commitments are improving, additional policy incentives and carbon-accounting mechanisms will be needed to accelerate investment in low-carbon technologies.

In summary, clean cement manufacturing aligns closely with Oman's 2050 Net-Zero Strategy and broader goals of industrial diversification. By combining its strong raw-material base with modern production technologies, Oman can strengthen supply-chain resilience, reduce import dependencies, and emerge as a regional supplier of low-carbon cement. Continued investment, supportive regulation, and targeted partnerships will be key to turning this opportunity into a long-term industrial success.

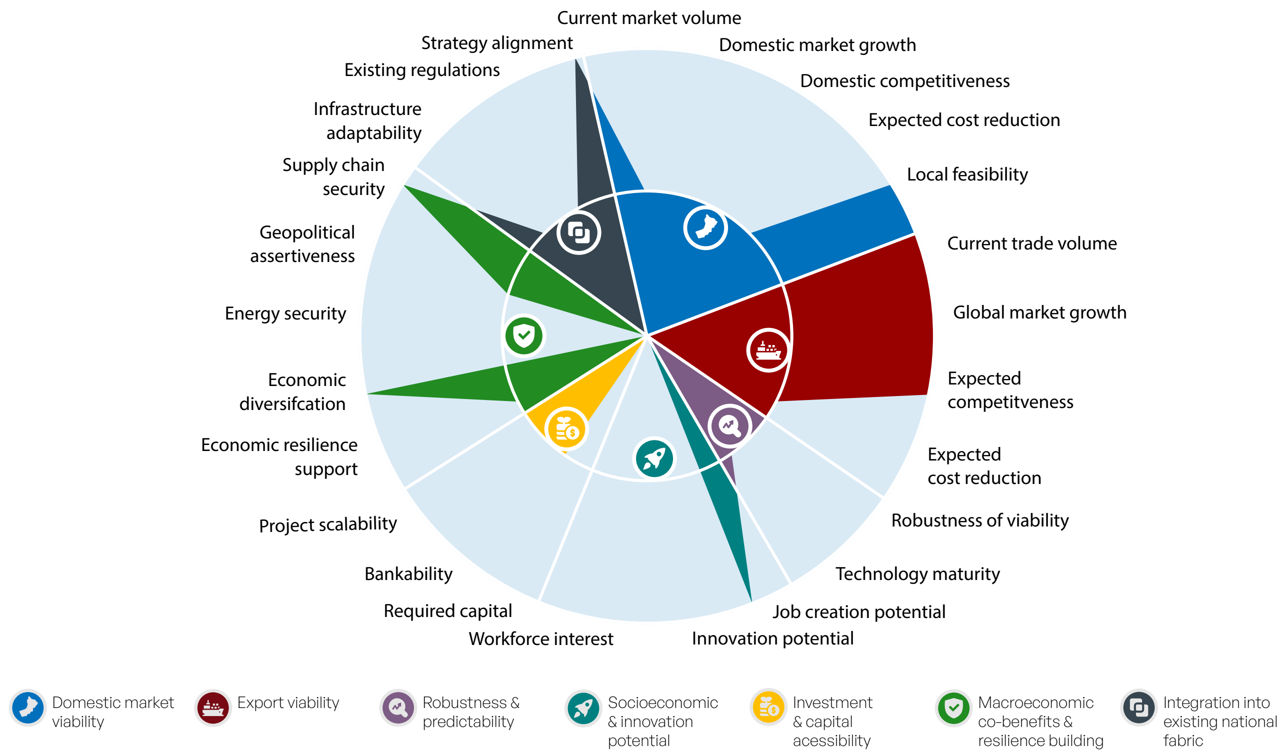


Figure 31: Sector profiling, clean cement and concrete.

Clean Steel/Aluminum

Steel and aluminium underpin modern infrastructure—spanning water systems, transport networks, construction, and renewable-energy facilities. Producing these materials cleanly requires tackling both direct process emissions and indirect emissions from electricity use. Shifting to renewable-powered operations can eliminate indirect emissions, while carbon-capture and utilisation (CCUS) technologies offer routes to mitigate the process-related carbon released during smelting and reduction.

Globally, demand for steel is projected to rise by more than one-third by 2050, with over half of total output needing to originate from low-carbon technologies to remain consistent with net-zero trajectories. Aluminium demand is also set to increase steadily through mid-century, driven by its critical role in lightweight vehicles, power-grid infrastructure, and solar components. China currently dominates both sectors, producing more than half of global steel and nearly half of global aluminium, shaping pricing and supply-chain dynamics worldwide.

In Oman, several initiatives mark a shift toward clean metals production. The Sohar Aluminium Smelter, in partnership with Rio Tinto, is advancing efforts to reduce emissions by integrating renewable electricity and improving process efficiency. These efforts complement broader national strategies promoting low-carbon industrial development and renewable-energy integration.

The domestic clean-steel market shows moderate short-term growth potential, yet high local feasibility owing to abundant solar and wind resources and a well-developed industrial base. Together, these conditions could enable Oman to build export competitiveness as global demand for low-carbon metals expands. However, the country's lack of bauxite and iron-ore deposits exposes producers to import dependency and price volatility. Moreover, while regulatory frameworks and infrastructure are improving, limited access to capital and institutional readiness remain transitional challenges.

Labour demand in metals production is substantial, offering opportunities for employment and skills development, though innovation capacity is constrained by the absence of large-scale research and technology centres. Building domestic R&D partnerships—particularly in process efficiency and material recycling—will be essential to sustain competitiveness.

In summary, clean-steel and aluminium manufacturing align strongly with Oman's Vision 2040 and 2050 Net-Zero Strategy, offering economic diversification, industrial resilience, and deeper participation in global value chains. While resource limitations and financing hurdles persist, Oman's strategic location between Africa, Asia, and Europe positions it well to serve as a regional hub for low-carbon metal production and export. Realising this potential will depend on targeted investment incentives, renewable-power integration, and collaboration with established international partners.

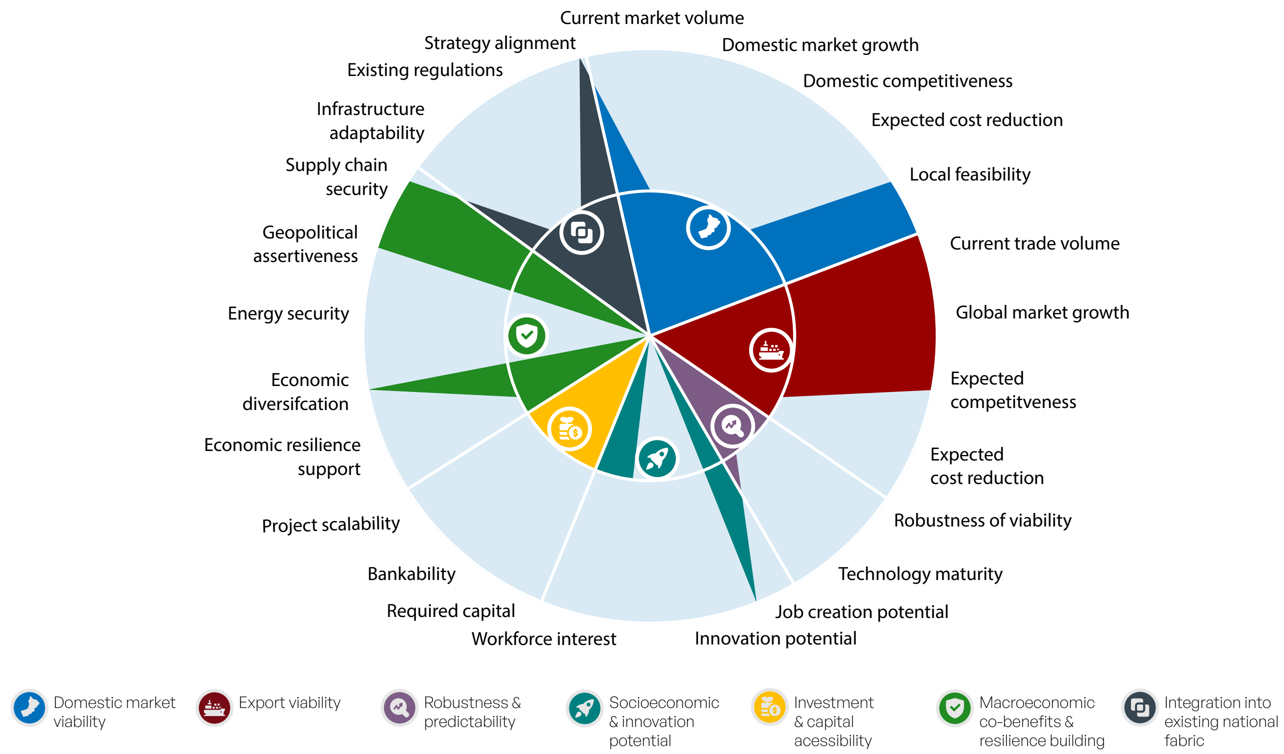


Figure 32: Sector profiling, clean steel and aluminum.

Hydrogen-based Fuels

Hydrogen-based fuels—including pure hydrogen, ammonia, methanol, and other hydrogen-derived compounds—represent a critical pathway for decarbonising sectors that cannot easily be electrified, such as heavy industry, maritime transport, and long-distance power generation. Produced from low-emission hydrogen, these fuels bridge renewable energy and industrial demand, serving both domestic and export markets.

Globally, ammonia accounts for nearly half of total hydrogen use, with production capacity projected to expand steadily by 2030. Methanol production, meanwhile, has nearly doubled over the past decade, largely driven by strong industrial demand in China. Conventional fossil-based ammonia and methanol remain inexpensive to produce, but shifting to renewable or low-carbon alternatives can increase costs several-fold—posing a significant challenge to rapid global adoption. Nevertheless, falling renewable electricity prices and growing policy support are narrowing the gap between conventional and clean production routes.

In Oman, hydrogen-based fuels form a central pillar of the national hydrogen strategy. Existing industrial complexes in Sur, Sohar, and Salalah already produce ammonia and methanol using conventional feedstocks, providing a ready platform for transition to renewable production. Several new projects—particularly in Duqm and Salalah—aim to produce green ammonia and methanol for export. The combination of low-cost renewable resources, port infrastructure, and industrial expertise gives Oman a strong foundation for local manufacturing and global competitiveness.

Focusing on hydrogen-based fuels would expand export potential, reinforce energy security, and strengthen macroeconomic resilience by reducing exposure to fossil fuel price fluctuations. The levelised cost of renewable ammonia in Oman is among the lowest globally, reflecting the country's solar and wind resource advantages, while long-term cost declines are expected as technologies scale up and supply chains mature.

However, key challenges remain. Oman's infrastructure and regulatory frameworks are still geared toward fossil-fuel production, and the legal and market systems governing hydrogen-derived fuels are under development. The industry's capital intensity and dependency on international certification and trade rules add to investment uncertainty. Furthermore, while technological readiness is improving, domestic innovation capacity and research expertise are still limited, reinforcing the need for partnerships with established global technology providers.

In summary, hydrogen-based fuels present a high-value but complex opportunity for Oman. They offer strong alignment with the country's hydrogen strategy and export ambitions, but success will depend on regulatory clarity, continued investment, and technological collaboration. With careful planning and targeted partnerships, the sector could evolve into a core pillar of Oman's clean-energy transition, driving industrial diversification and consolidating the nation's position in emerging global hydrogen markets.

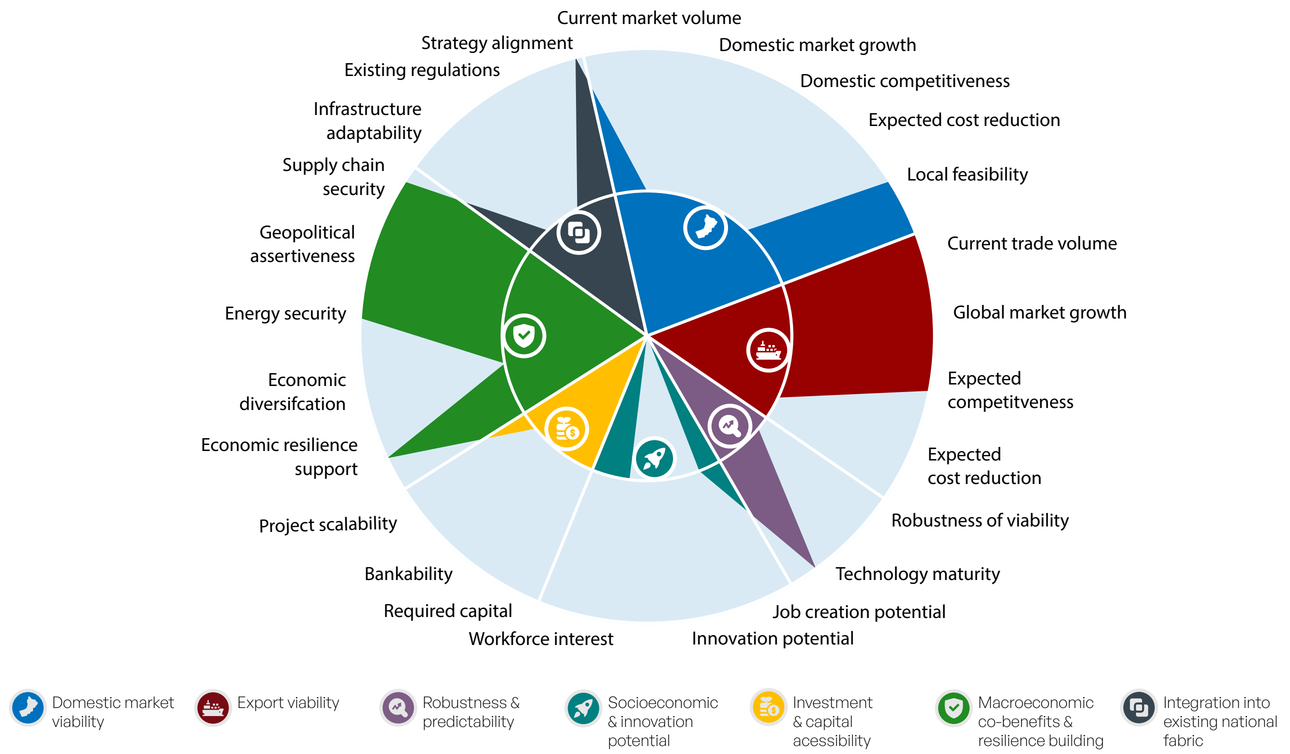


Figure 33: Sector profiling, hydrogen-based fuels.

Non-Conventional Construction Materials

Non-conventional construction materials—such as waste-infused cement and bio-based alternatives like bamboo or hemp—offer promising pathways toward low-carbon construction. By reducing the embodied emissions of traditional materials like cement and steel, they support a more sustainable and circular building sector. However, widespread adoption remains limited due to integration challenges, lack of standardisation, and low technological readiness, particularly in arid regions where testing and certification frameworks are still evolving.

In Oman, waste-infused cement represents the most practical and near-term opportunity for sustainable material innovation. The approach relies on locally abundant resources—limestone, sand, water, and waste aggregates—making it highly feasible. A key example is Be'ah's initiative to supply Tire-Derived Fuel (TDF) to the Oman Cement Company, replacing a portion of fossil fuel in kiln operations and simultaneously reducing waste and emissions. This initiative directly supports national sustainability objectives aimed at minimising landfill waste and enhancing industrial resource efficiency.

The domestic market for green materials, however, remains nascent. Sustainable construction products are not yet embedded within Oman's core energy or industrial policies, and the absence of a formal regulatory framework limits visibility for investors. Moreover, technological maturity is low, with issues of material durability, performance, and safety—especially under hot and dry climatic conditions—requiring focused research and field validation.

From an economic standpoint, non-conventional materials manufacturing offers moderate capital requirements and high scalability due to relatively simple production processes. While this underpins strong local feasibility, project bankability remains weak because of uncertain market demand, limited investor familiarity, and the absence of certification standards. Nonetheless, the innovation and employment potential are considerable—particularly in recycling, testing, and design services—where startups and academic institutions could play a catalytic role in developing domestic expertise.

Internationally, export prospects remain limited. Although global demand for green materials is rising, Oman's restricted waste availability and limited biomass feedstock—a result of its arid environment—constrain industrial scale-up. Moreover, most advanced material technologies are being pioneered in Asia and Europe, reinforcing Oman's position as a potential follower rather than a first mover.

In summary, non-conventional construction materials represent a strategic niche for Oman's industrial and environmental diversification. While short-term market feasibility is modest, targeted R&D funding, clear policy direction, and pilot-scale programmes could establish a foundation for long-term growth. With appropriate institutional support, this emerging field could evolve into a credible contributor to Oman's circular economy and low-carbon industrial strategy.

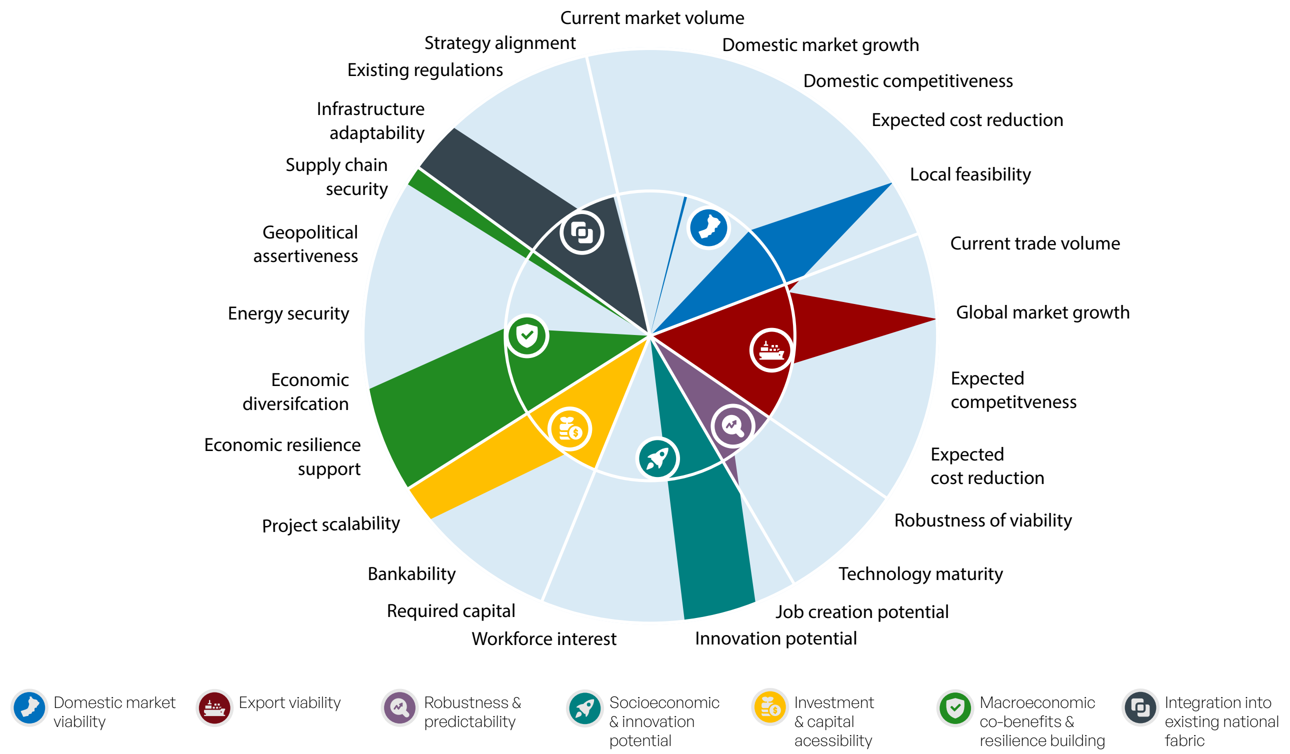


Figure 34: Sector profiling, non-conventional construction materials.

Interdependency analysis

- **Economic viability does not guarantee significant employment or innovation, indicating a need for careful consideration of sector impacts beyond mere financial success.**
- **The financial requirements for export-oriented sectors are less predictable than domestically strong sectors, presenting varied investment challenges.**

This chapter examines the interconnections among factors shaping new investment opportunities within Oman's emerging clean economy. The analysis highlights strong links between domestic and export market performance, largely driven by shared cost and competitiveness dynamics. While these similarities suggest common underlying drivers, the differences that emerge indicate that market orientation influences how these factors manifest across sectors.

A clear connection is observed between economic viability and the ease with which sectors can be integrated into existing regulatory and legislative frameworks. This relationship reflects the cumulative impact of previous governmental initiatives, which have contributed to a conducive enabling environment for new industrial activity.

However, the analysis also shows only a weak relationship between economic viability and socio-economic impact or innovation potential. This suggests that economically promising sectors do not necessarily generate substantial employment or drive major innovative outcomes. The finding highlights an important strategic consideration: sectors that strengthen macroeconomic performance may not always advance broader societal objectives.

The financial landscape further demonstrates that domestically oriented sectors tend to be more affordable overall, whereas this relationship is less consistent for export-oriented sectors. The resulting variation underscores the complexity of sector-specific cost structures and financing needs.

A key insight concerns the trade-off between predictability and employment potential. Sectors that are less exposed to external risks and therefore more predictable typically offer fewer jobs per unit of investment. This dynamic highlights the need for calibrated decision-making that balances certainty against socio-economic returns.

It is important to recognise that these findings operate at an aggregate level and do not capture the specificities of individual sectors. To address this limitation, the subsequent analysis groups sectors into archetypes and clusters. This deeper examination provides more granular insights to support targeted policy planning and strategic prioritisation.

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	Domestic market viability	Export viability	Robustness & predictability	Socioeconomic & innovation potential	Investment & capital accessibility	Macroeconomic co-benefits & resilience-building	Integration into the existing national fabric
Domestic market viability	1	0.73	0.48	0.068	0.4	0.18	0.85
Export viability	0.73	1	0.39	0.029	0.16	0.35	0.79
Robustness & predictability	0.48	0.39	1	-0.13	0.44	0.049	0.76
Socioeconomic & innovation potential	0.068	0.029	-0.13	1	0.18	-0.001	0.15
Investment & capital accessibility	0.4	0.16	0.44	0.18	1	-0.2	0.54
Macroeconomic co-benefits & resilience-building	0.18	0.35	0.049	-0.001	-0.2	1	0.22
Integration into the existing national fabric	0.85	0.79	0.76	0.15	0.54	0.22	1

Figure 35: Correlation between indicators

Establishing sectoral archetypes

Clustering analysis of Oman's energy sectors reveals distinct archetypes for strategic decisions:

- **Key Opportunities: High viability, low-risk sectors with strong socio-economic potential for immediate implementation.**
- **Familiar Exporters and High-Risk, High-Returns: Export-oriented sectors balancing certainty with investment needs.**
- **Supportive Back-Ups and Demanding Profits: Specialized roles in economic diversification and long-term growth.**

The sectors assessed in this report serve as representative samples of broader industrial activities relevant to Oman's future clean economy. While each sector exhibits distinct characteristics, shared patterns allow them to be grouped into archetypes that support strategic decision-making.

To identify these archetypes, k-means clustering was applied (see Appendix C). As an unsupervised algorithm, it forms clusters based on structural similarities in the underlying indicators. The resulting archetypes provide decision-makers with a structured view of how these sectors compare. Figure 36 presents a visual summary of the clusters.

Key Opportunities: High priority

These sectors offer high returns with virtually no risk. They are affordable, economically viable, predictable, easy to integrate into existing institutional frameworks, and characterised by strong socio-economic benefits. Examples in the Omani context include solar photovoltaic development and building energy efficiency. These sectors combine robust economic performance with significant job creation and long-term development gains. They should be prioritised due to their favourable risk-benefit profile.

Supportive Back-Ups: Innovation with caveats

This group comprises sectors with uncertain or modest economic prospects but which provide meaningful opportunities for innovation, job creation, or strategic positioning. Examples include emerging technologies such as advanced bioenergy. While they contribute to diversification and capability-building, their economic uncertainties mean they are less suitable for prioritisation during periods of limited capital or when major projects are already underway.

Niche Ventures: Limited but targeted relevance

These sectors generally perform less favourably across most indicators. They tend to have lower economic opportunities, weaker predictability, and higher costs. However, their lower rankings do not imply they should be disregarded entirely. Rather, they are best considered for highly specific policy objectives not captured in the broader assessment. They should not be prioritised over stronger-performing sectors.

Familiar Exporters: Certain but less innovative

These sectors demonstrate stable export potential and are relatively insulated from external shocks. Their predictability stems from established manufacturing processes and mature business models. While they may not drive strong domestic market performance or innovation, they integrate easily into existing institutions and offer reliable export-oriented growth. Their job-to-investment ratio, however, is relatively low.

High-Risk, High-Returns: Promising yet uncertain

These sectors provide strong economic opportunities—sometimes exceeding those of Key Opportunities—particularly in export markets. However, they are investment-intensive and highly sensitive to external conditions, making them comparatively risky. Their long-term value depends on factors such as global demand, technological trajectories, and geopolitical developments. Any investment in these sectors should include mechanisms to manage or hedge associated risks.

Demanding Profits: Certainty at a cost

These sectors feature strong economic and export prospects combined with relatively high predictability. However, they are capital-intensive, and although they can generate substantial numbers of jobs, they typically require significant financial outlays to realise employment objectives. Mining is an example. These sectors are reliable but costly and should be considered where certainty is prioritised and capital is available.

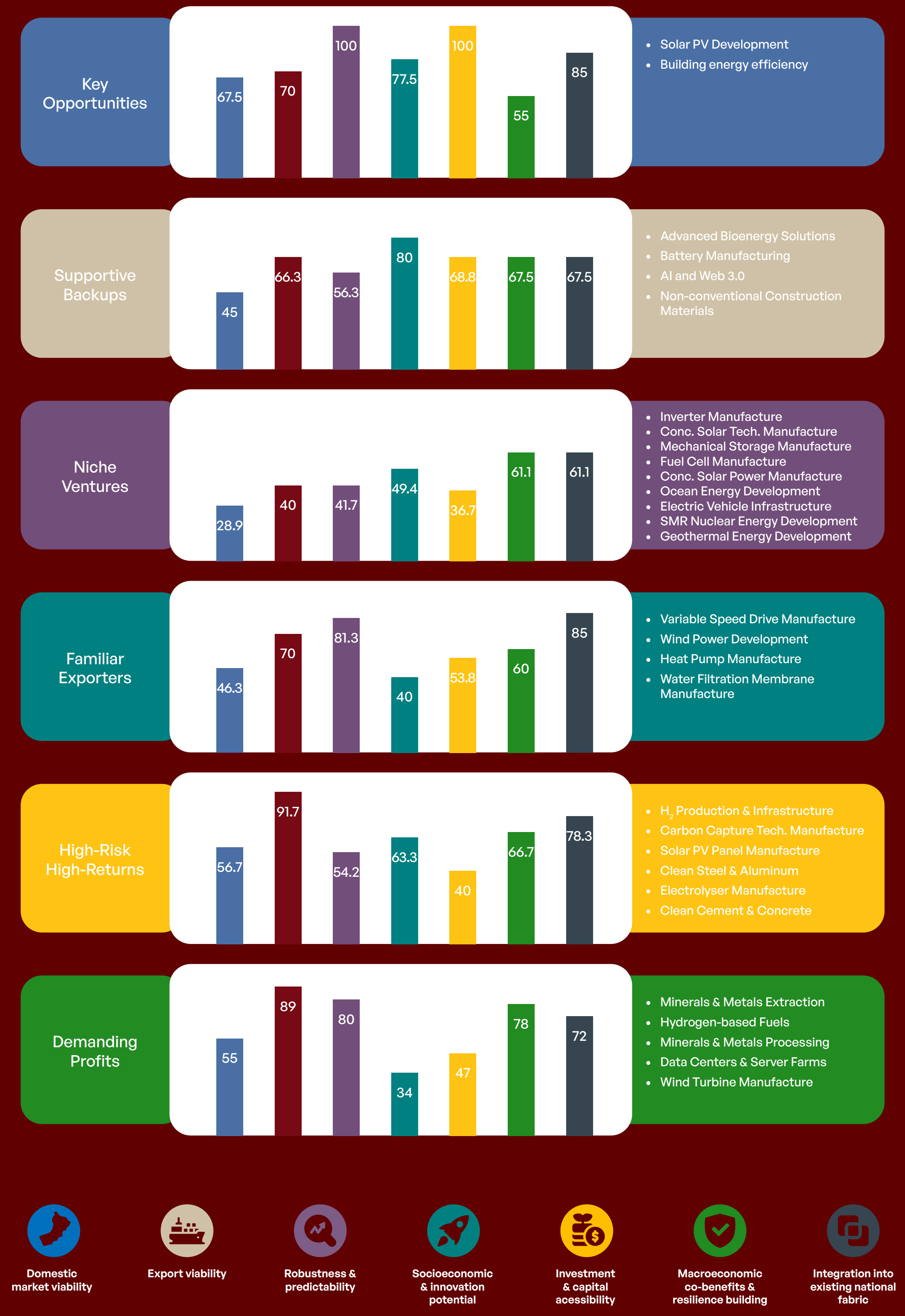


Figure 36: Cluster archetypes

Insights & Recommendations

Oman's future lies equally in its past and its present. This overarching principle, which has shaped strategy in heritage, culture, society, and many other fields, also applies to Oman's economy. The oil, gas, and related sectors will, for what is likely to be a significant time to come, continue to serve as the backbone of the Omani economy—albeit with possible modifications. However, and equally, Oman's future economy requires new sectors that can secure future economic prosperity, social equality, and strategic assertiveness. As this report has shown, Oman's green economy—meaning clean energy and related industries—can be a central vehicle for expanding the country's economic base.

At the same time, this report, alongside the other publications in this series—namely the *Oman Clean Energy Labour Outlook "Building Workforce Readiness"* and the *Case Study Insights report "Developing Clean Energy Industries and Workforce"*—has shown that building these new sectors is anything but easy. Challenges include the extensive reliance on mostly foreign-owned technology, the capital-intensive nature of the clean energy economy, and numerous uncertainties—particularly around international offtake. The latter illustrates that, perhaps even more than in the case of fossil fuel industries, the market for clean goods and the viability of clean energy sectors is shaped by external factors—including geopolitical shifts, global climate policy, and technological progress. These dynamics are emblematic of the VUCA world: one that is volatile, uncertain, complex, and ambiguous.

Setting the course for Oman's energy-economic future, therefore, requires not only careful charting of the terrain—as has been done in this report—but also a combination of boldness, humility, and agility.

Boldness, because building the new economy will require significant investment. While foreign direct and internationally active investors may contribute substantially, it is both desirable and necessary for the national economy itself to take a leap and invest in its future.

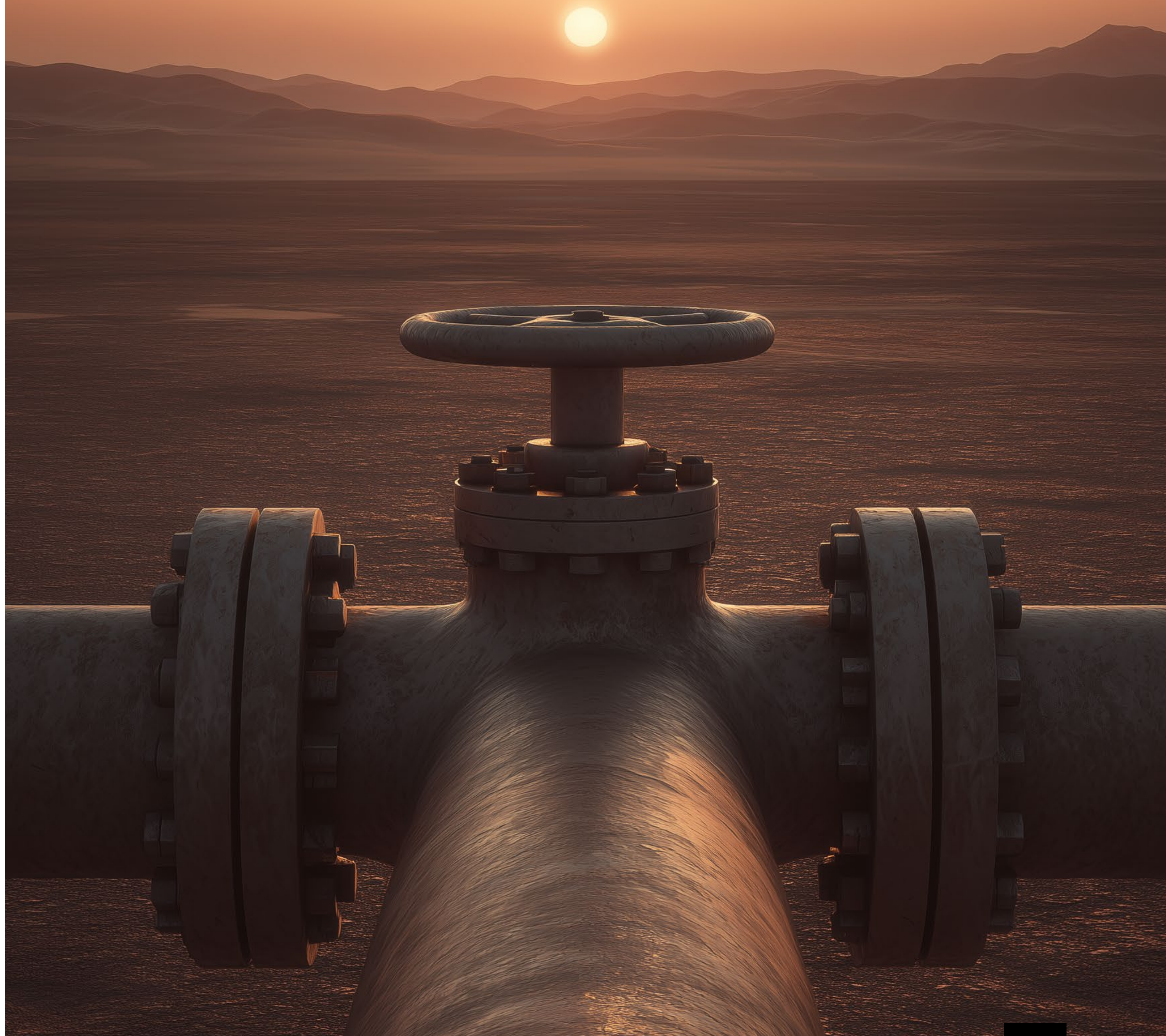
Humility, in recognising that the green economy—as a vehicle for new jobs, value creation, and strategic importance—will neither emerge overnight nor should it be taken for granted. Laying the foundations for entirely new value and supply chains will require time, as well as the right enabling conditions. Stakeholders must also accept that while most paths taken will prove correct, not every single investment will succeed. Some may require adjustment along the way.

Agility, because the development of a green economy cannot rely on a fixed strategy. The course must be adjusted as conditions shift. As global dynamics and domestic experiences evolve, Omani policymakers and sectoral stakeholders must remain responsive and adapt their decisions accordingly.

Does this mean that all the sectoral mapping and analysis conducted at this stage will become obsolete? By no means. A careful charting of the playing field is essential—not only to enable the best possible decisions, even if some must later be revised—but also to prepare sectors, the economy, and society for the range of future opportunities and risks that may emerge.

Importantly, the measures taken and the path forward cannot be steered by any single government department or agency. Broad coordination across actors will be essential: both to ensure that strategic decisions are coherent and robust, and to guarantee that they are effectively cascaded through the system to the many institutions responsible for building Oman's future energy economy.

The following subsections therefore outline key fields and lessons for policymaking derived from this study. They move from a macroscopic strategic overview, to sectoral and industrial policy, to investment and capital mobilisation, and finally to issues of governance and strategic learning.



Strategic Objectives and Trade-offs

An important feature of this analysis is that it has vividly demonstrated how the green economy can be connected to a variety of different objectives and criteria. This applies equally to the criteria used for assessing viability, as well as to the broader objectives that different actors may seek to derive from it. One source of misalignment between government actors and of inefficiencies in embarking on the “correct” pathway may lie in precisely this diversity of aims.

Beyond Financial Gains: The Full Economic Picture

When referring to the economic value of expanding a new sector, the term *economic* does—and should—extend well beyond financial gains. Economic benefit may be highly tangible, such as direct value added to the economy or, perhaps most importantly, employment opportunities created. But it may also be intangible or indirect. These effects include economic spillovers, benefits to other sectors, or systemic stabilisation. For example, a new sector may not initially appear financially viable. Yet in a broader economic assessment, it may contribute significant value to the country. These benefits can, eventually—even if tacitly or indirectly—translate into financial terms, including aspects such as credit ratings. Conversely, persistent unemployment or lacking economic dynamism may erode financial resilience and negatively affect national assets.

Public Finances and Development: A Balancing Act

Public finances are a key concern—particularly the need to reduce deficits, keep debt levels sustainable, and maximise the returns on public investment. However, these financial objectives should not override the broader goal of economic stabilisation in both the short and long term. Overall economic development must remain the guiding aim of all institutions. In the end, prosperity is the most reliable way to stabilise public finances. Greece’s experience during the Euro crisis illustrates this point well. A narrow focus on expenditure reduction worsened the public-debt ratio, while more comprehensive economic safeguards might have prevented further deterioration.

Balancing national development objectives with financial constraints requires precise calibration. This is not hypothetical—it is already being practised by several sovereign wealth funds across the GCC. If done successfully, such balancing can unlock long-term financial returns, support economic stabilisation, and generate sustained growth.

To put this into practice, existing efforts to involve state actors—particularly sovereign wealth funds—in future-oriented industries need to be expanded. For these investments, it is essential that public entities adopt a broader investment lens. Decision-making should move beyond traditional financial returns or narrowly defined quantitative KPIs, as these are insufficient to capture the full set of intangible factors needed to grow the economy and may obscure the picture.

Employment: A Strategic Lever

As noted earlier, employment is a particularly important factor. The GCC region faces a distinct challenge: it combines high national wealth with rapid population growth. This creates pressure to broaden the economic base in ways that uphold—or ideally improve—living standards. Employment is central to this effort. On one hand, it serves social goals by promoting inclusion and mobility. Citizens gain access to national wealth through wages, which supports social cohesion. On the other hand, employment is a cornerstone of economic development. In this sense, labour is both an opportunity and a responsibility.

It is an opportunity because a well-prepared national workforce can become a strategic asset. It is also a responsibility, because underutilised labour creates economic costs elsewhere. Jobseekers may require financial support or welfare transfers, and high unemployment can produce wider unintended effects across the economy. As is already the case in many contexts, generating sufficient and meaningful employment opportunities must be a central goal for the entire state apparatus. If managed correctly, such efforts will improve public finances and enhance long-term economic resilience.

Strategic Sectoral Choices and Economic Security

Beyond these core objectives, sectoral choices often carry additional strategic weight—especially in terms of geoeconomics. These may not appear economic in the short term, but they often are in the long term. Consider, for example, a critical good or technology input that becomes inaccessible during a crisis because supply chains were not sufficiently localised. These supply gaps can create ripple effects across entire value chains, weakening the broader economy.

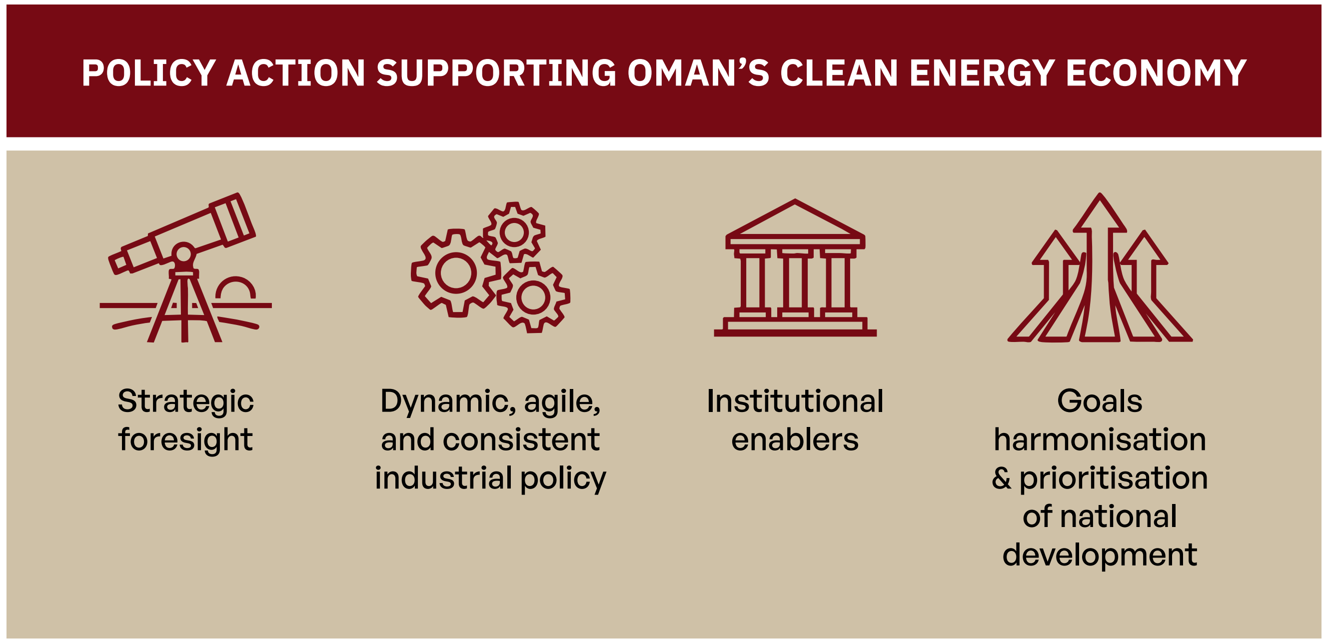
The more intangible and long-term these risks and benefits become, the harder it is to capture them in quantitative KPIs. Nonetheless, their economic impact is real. These long-term effects must be included in the calculus of public investment decisions and strategic goal-setting. For this reason, it is essential to incorporate geopolitical and strategic risk analysis into the evaluation of new investments.

From Trade-offs to Alignment

To summarise: there may indeed be short-term trade-offs between core objectives—economic development, employment, financial performance, and strategic resilience. But over the long run, these objectives are not inherently in conflict. Many of them become mutually reinforcing. Eventually, they may all be reflected in economic and financial outcomes. It is therefore important not to view these aims as competing, but rather to seek areas of alignment. A more holistic approach should aim to harmonise them in both analysis and policy execution.

This integration can be structured in several ways. One option is to centralise responsibility under a broad mandate, with multiple ministries working toward a centralised authority. Such a model can enable faster, more coherent decisions. However, it requires careful design to ensure that the central entity takes all relevant objectives into account. It also requires strong coordination across the contributing ministries.

A second option is to distribute the mandate horizontally across institutions. In this case, coordination can be supported by dedicated interfaces—such as inter-ministerial councils or cross-cutting coordination committees. While this model appears administratively simpler, it requires a high degree of coordination and institutional maturity to function effectively.



A third option is to strengthen and enrich the existing economic and financial decision-making bodies by integrating additional perspectives. This could mean structurally bringing together functions related to economy, finance, investment, employment, and strategic foresight. Institutional proximity between these domains could lead to more balanced and evidence-based decision-making.

Climate Targets and Environmental Objectives: Strategic Considerations

Another possible objective—one that has purposefully only been dealt with marginally in this report—relates to environmental and climate targets. As extensively shown in the economic literature, adverse environmental and climate developments—such as resource depletion, extreme weather events, or health effects—do ultimately map into economic variables, in some cases significantly. Policymakers are therefore broadly advised to include environmental risks and objectives in their strategic calculus.

However—and this has been one of the central points of this report—the relevance of the green economy does not rely on environmental targets alone. Green economic development and green industrial strategies can represent win-win solutions for both the economy and the environment, even before considering any deliberate overlap between the two.

There is, however, one noticeable caveat. Without domestic and intrinsic climate and environmental targets, potential producers of green goods may lack a domestic end market. This can ultimately reduce their strategic agency. Indeed, this issue is discussed in the political economy literature, particularly in relation to hydrogen. The concentration of global offtake—especially in a small number of import-oriented economies—can shift power and strategic autonomy toward those offtakers. This dynamic has been captured with exceptional clarity in the scenarios developed in this report, particularly *Raging Storms* and *Shifting Winds*, both of which illustrate a divergence between global and local climate ambitions.

A second caveat is that climate policy in Oman and the wider GCC should, at this stage, be understood through the lens of the carbon abatement curve. Climate action can be ranked based on the extent to which it avoids economic loss—or even creates economic benefit. For the most part, Oman and other GCC countries are still positioned on the "negative-cost" side of the curve. This means that many potential climate actions—such as renewable energy deployment, which reduces electricity generation costs—offer direct economic gains.

Countries should therefore focus first on these win-win measures, which align climate and economic goals. Only once these options are exhausted should they move to higher-cost or economically adverse interventions. For this reason, it would be inefficient to adopt overarching climate targets in a purely top-down, vision-style manner and delegate their implementation across all government departments. Such an approach would risk triggering economically suboptimal actions. For example, an individual department might pursue pre-emptive climate measures that incur net economic losses, instead of focusing on cost-saving opportunities.

Instead, a central government authority should be tasked with developing a national climate action plan that is explicitly sequenced along the carbon abatement curve. The central body would then coordinate with other authorities and departments, involving them in implementation once the timing and economic rationale for action is clearly defined—rather than cascading broad mandates without tailored planning.

Selected Strategic Enablers and Institutional Anchors

Realising Oman's full employment and industrial potential will not result from sector prioritisation alone. Strategic coherence in how resources are allocated, how implementation is managed, and how public investment is channelled is equally decisive. This section outlines key system-level enablers that could help ensure that labour market and industrial ambitions translate into implementation—while reducing risk and increasing investor confidence. These enablers are not rigid prescriptions but institutional levers that may be tailored to the realities of sector development and national planning.

Aligning sovereign investment with strategic employment goals

The role of public capital in shaping national development paths is central—not peripheral. While foreign direct investment (FDI) will remain essential, Oman may not be able to rely solely on external investors to build critical sectors, shape value chains, or generate employment at scale. Strategic investment from within the country is equally, if not more, important—both to drive domestic economic development and to support the long-term sustainability of the Sultanate's financial wealth.

Sovereign wealth institutions and national investment platforms could serve as powerful enablers of structural transformation. To do so effectively, their investment mandates would ideally be aligned with long-term sectoral and employment objectives. This includes explicitly targeting the development of domestic capabilities across selected green and industrial sectors—not only for commercial returns, but also for broader developmental outcomes such as job creation, skills transfer, value addition, and export capacity. As highlighted in previous chapters, such alignment appears vital to crowd in private capital, close investment gaps, and strengthen Oman's role in regional and global supply chains.

The aim is not to substitute market actors entirely but to catalyse their participation by reducing early-stage risk and enhancing project bankability.

Strategic sovereign investment may also generate positive feedback loops. By building robust domestic industries and services, it could strengthen Oman's fiscal base and economic resilience—thereby indirectly safeguarding the very assets of the sovereign fund itself. Moreover, internally driven investment would allow Oman to retain greater policy autonomy and shape its industrial strategy in line with national priorities rather than external conditionalities.

Such an approach would complement existing FDI attraction efforts and add an essential pillar to the employment–investment nexus. It could be a prerequisite for unlocking higher value-added activities and advancing toward a resilient and clean industrial economy.

Multi-year fiscal planning to unlock private investment

Across the sectors assessed in this report, long-term investment is essential—but is often hindered by fiscal volatility and fragmented budgeting. Annual public budgeting cycles, closely tied to oil prices, remain out of sync with the multi-year planning horizons required for infrastructure, utilities, and workforce preparation. This mismatch increases uncertainty and raises capital costs.

To support employment-rich green and industrial investments, a more predictable and rolling medium-term fiscal framework could be institutionalised. Such a framework would enable multi-year commitments to critical infrastructure—such as grid extension, water systems, industrial logistics, and hydrogen corridors—while keeping recurrent spending aligned with long-run fiscal sustainability. Sovereign borrowing might be focused on productivity-enhancing assets, with stabilisation buffers used to smooth volatility. In this context, a transparent calendar for green bonds or project bonds could also help tap into domestic institutional capital, such as pensions or insurers, thereby reinforcing national financing ecosystems.

This would allow employment-intensive projects in the clean economy to proceed with greater clarity and lower financing risk, and would help orient private investment decisions toward long-term national objectives.

Resource envelopes that align with sectoral planning

Sectoral development plans, however well designed, may not succeed if key enablers—such as land, energy, water, and skills—are not available at the right time and in the right place. In the current planning setup, these resources are often treated in isolation from each other, making coordination across sectors difficult and timelines uncertain.

To reduce bottlenecks and improve implementation coherence, indicative resource envelopes could be established for each industrial area or economic zone. These envelopes, updated on a rolling basis, would set out the expected availability of key inputs such as grid capacity, gas bands, industrial water, plot-ready land, vocational training seats, and renewable energy integration. Rather than fixed quotas, these envelopes would serve as a transparent planning signal to both investors and policymakers, improving cross-agency coordination and allowing training providers and developers to align with sectoral timelines.

Such a system could significantly lower perceived risk for private actors and help sequence infrastructure investment, workforce preparation, and industrial licensing in a more structured way.

Unified delivery systems and proactive investor facilitation

Timely implementation and institutional coordination are essential for employment generation. To that end, project execution and permitting systems may need to be streamlined to reduce delay and transaction costs. A centralised delivery interface—potentially anchored in Invest Oman or a comparable institutional platform—could help reduce fragmentation across permitting, land allocation, and utility connections. Where feasible, defined permitting clocks (e.g. 90 or 180 days) and structured escalation channels would support predictable execution.

A publicly available timetable for project readiness—spanning permitting, connections, and service activation—can further enhance credibility. Over time, Oman could develop an integrated infrastructure delivery calendar that spans 24 to 36 months and is aligned with the needs of clean and industrial sectors. To improve institutional responsiveness to external shocks—such as commodity or trade disruptions—pre-agreed automatic stabilisers might be introduced. These would enable proactive, rather than reactive, policy adaptation.

The aim is to build institutional reliability—critical for long-term private investment and industrial job creation.

Linking industrial development to high-value service ecosystems

This report's sectoral deep dives show that employment and value creation are increasingly shaped not just by physical production facilities but by the service ecosystems that surround them. These include engineering, logistics, certification, export support, and digital infrastructure. In both industrial and consumer-facing sectors, these service layers determine time-to-market, compliance, and cost efficiency.

To help ensure that these layers are embedded in emerging sectors, Oman could require every major project to include a transition plan outlining which digital, environmental, and service functions will be integrated and when. These could include electrification measures, use of renewable energy and storage, digital twins, predictive maintenance, carbon certification, and logistics coordination. Over time, policy indicators—such as service revenue per rial of industrial output or export value—might help track ecosystem deepening.

Such an approach also creates jobs across a broader skill range, including ICT, digital services, and quality assurance—while enabling smoother and faster integration into export markets.

Regional integration and opportunities for soft industrial exports

As highlighted throughout this report, regional integration remains one of the most effective levers for scaling up Omani production and employment. This applies not only to large industrial sectors but also to consumer-facing products such as fragrances, modest fashion, personal care, and wellness—where GCC demand patterns are already converging. Oman could leverage its unique inputs and cultural assets to develop high-value consumer brands that target this unified market.

This would require supportive ecosystem elements—such as packaging facilities, compliance templates, pre-approved retail listings, and export finance instruments. Shared brand platforms or collectives may offer smaller firms access to infrastructure and route-to-market networks. These initiatives also build skills in design, marketing, and logistics, while relying on the same hard infrastructure as larger industrial projects.

Such diversification efforts offer fast-turnaround opportunities that could complement the longer gestation periods of heavy industry—thereby enhancing resilience, employment absorption, and export visibility.

Both energy-related industries and abovementioned consumter-facing products share one central requirement and enabler: establishing Oman as a noticeable brand across investors, large-scale clients, and consumers.

Sectoral and Industrial Policy

There is not only a broad range of long-term objectives that inform decisions around Oman's future energy economy. There is also a diversity of assessment criteria—each shaping how sectoral choices are evaluated and prioritised. As demonstrated through the sectoral screening, these criteria often lead to differing outcomes.

Differentiating Market Types and Assessing Viability

Even from a purely economic standpoint, important distinctions must be made—for example, between domestic and export market viability. For both, however, the central question remains: *how competitive can Oman be in this sector?* As discussed in the *Case Study Insights report "Developing Clean Energy Industries and Workforce"* within the Labour Market Intelligence Analysis series, this requires identifying Oman's competitive niche. As further illustrated by the *Rising Tide* scenario, long-term success may also depend on developing mechanisms for a co-owned and integrated GCC green economy.

The regional landscape adds urgency to this question. GCC countries are not only competing for investments, but also for positioning within green value chains. While many structural similarities exist across the region, they are accompanied by differing levels of ambition, resource endowments, and industrial strategies. Oman must therefore determine in which specific niche it holds a relative advantage over regional peers. This could stem from natural resource access or infrastructure readiness, but—as suggested in the scenarios—may also be linked to historical ties, diplomatic relations, or forms of regional political leverage.

Moving Beyond Viability: A Multi-Criteria Perspective

Beyond questions of economic viability and competitiveness, a wider set of criteria also plays a role. These include employment creation, social development potential, financial feasibility, and broader strategic considerations. The sectoral screening has shown that there is no universal trade-off between these dimensions. In other words, some opportunities may align well across multiple objectives.

However, and as an important caveat, the analysis has also not revealed strong positive correlations between these criteria. While alignment is possible, it does not occur systematically. This underscores the importance of dynamic, multi-criteria assessment rather than one-dimensional ranking or rigid sequencing. Each sector must be understood in relation to the broader landscape of national goals, comparative advantages, and future uncertainties.

From Fragmented Production to Industrial Ecosystems

One particularly important criterion—already treated as a guiding principle in several GCC countries, as well as in Morocco (see also the Case Study Report in this series)—is the need to focus on entire supply and value chains, and on integrated industrial ecosystems, rather than limiting development to singular stages of production.

Between the 1970s and early 2000s, much of the economic platform planning across the GCC centred on identifying individual production stages that promised the highest returns. Here, "beneficial" often meant high-margin or high-rent segments of the value chain, with policy and investment strategies heavily concentrated on those points—while leaving the remainder of the value chain abroad. In some cases, this meant that even by the 2010s, some GCC countries had made only minimal investments in refineries, despite being major crude oil producers.

While this planning paradigm has been effective in generating high-value focus areas, it has also created significant long-term vulnerabilities. From an economic and supply chain resilience perspective, this focus on isolated segments of the value chain has made several sectors more susceptible to external disruptions—and to the extensive consequences they may trigger. This was vividly demonstrated during the COVID19 crisis, when even key infrastructure systems and supply chains came under severe strain.

Integrated ecosystems, by contrast, create interdependencies between firms, suppliers, service providers, and educational institutions. These interconnections generate circular flows of inputs, demand, and knowledge. As a result, ecosystems support economies of scale, promote learning effects, and allow capabilities to accumulate over time—enhancing overall competitiveness in ways that isolated production segments cannot.

This logic is not only theoretical; it is reflected in successful examples across the region and beyond. Morocco's and Saudi Arabia's automotive industries developed on the basis of highly integrated clusters, where upstream, midstream, and downstream activities reinforce one another. Similarly, Morocco's plans for its hydrogen economy rely explicitly on geographically concentrated industrial clusters that bring together production, conversion, and industrial offtake. In the GCC, Oman's own industrial estates—such as Sohar and Duqm—have long followed this principle by integrating petrochemicals, metals, logistics, and manufacturing activities into coherent ecosystems.

Why Future Sector Development Must Be Ecosystem-Based

Even more importantly, the singular-production paradigm does not align with the aim of employment creation, nor does it generate the economic linkages needed to build competitiveness—an essential condition for longterm viability.

First, the sectors that provide the highest profit margins are not necessarily the ones that generate the most jobs. Second, both employment and the creation of resilient, competitive sectors require an entire ecosystem to thrive. A national workforce can only form a robust labour base if the sector operates at sufficient scale *and* if it contains enough linkages to support an education, training, and skills ecosystem.

Third, partial participation in value chains—especially in capitalintensive cleaneconomy sectors—struggles to become viable because domestic demand is limited, knowledge bases are thin, and neither internal nor external economies of scale can emerge. Without these elements, production remains too small and too costly to compete internationally. Integrated industrial ecosystems, by contrast, enable scale, generate learning effects, and help anchor demand—thus making investments sustainable.

It is therefore imperative that future sectoral development prioritises the creation of full industrial ecosystems and the holistic planning of supply chains. The central question should not only be which specific technology or niche to pursue. That approach risks obscuring the broader picture—and failing to deliver either economic or employment outcomes.

Instead, new sectors should be conceived as part of integrated portfolios that reinforce one another and contribute to a growing network of industries, knowledge systems, and skills economies.

Sectoral Choice: You Can't Have It All—But You Can Build Smart Portfolios

However, in terms of sectoral choice, the analysis shows that there are interdependencies to consider when making individual decisions. As mentioned in the previous section, new sectors should ideally be embedded within a broader industrial ecosystem and developed in tandem with related sectors to achieve full impact.

Two sectors stand out as highly promising across nearly all assessment criteria.

The first is solar PV development. It consistently ranks high due to its versatility, strong linkages to other sectors, and resilience across a range of future scenarios. Solar PV is not only a key technology in nearly every plausible energy and industrial trajectory, but it also holds the potential to anchor a broader value chain. This could be pursued through the expansion of Oman's existing national champion in

PV design or, alternatively, by fostering the growth of smaller private companies. Both approaches carry distinct advantages and limitations, but each would contribute to deeper domestic capabilities.

The second is the development of a sector that promotes energy efficiency in building, such as (mandatory) energy auditors. This sector excels primarily because of its rapid deployment potential, minimal dependence on other sectors, and dual ability to deliver immediate employment and long-term economic returns. It, too, could be built through either SMEs or a larger national entity. However, effective uptake will require clear regulatory support: including updated building codes, minimum efficiency mandates, and potentially targeted subsidies or credit instruments. These efforts should build on the handful of existing ventures and capabilities already present in the domestic market.

Beyond these examples, there is no universal or static answer to the question of which sectors are most favourable for Oman. Instead, sectoral selection must be dynamic, responsive to developments in other parts of the portfolio, changes within Oman itself, and the evolution of global markets. As such, higher-risk opportunities should be strategically balanced with more robust, lower-risk bets. The clusters identified earlier in this paper offer a useful reference point for such balancing.

An important caveat applies: some sectors examined in this analysis offer limited economic benefits beyond their environmental contributions. While niche technologies may be symbolically relevant or help signal ambition, they should not be prioritised at this stage. Instead, focus should remain on sectors that are robust across scenarios, capable of delivering meaningful employment, and which have realistic prospects of becoming globally competitive components of Oman's future economy.

Strategic Outlook and the Role of Foresight

Oman's future—in energy and beyond—can take various different pathways. This simple yet powerful conclusion has been vividly shown through the foresight process and the scenarios outlined therein. As such, policymakers require anticipatory action and dynamic decision-making in order to harness opportunities and mitigate possible risks of these various futures.

The various sub-sectors of the green economy are, with few exceptions, only viable under specific external developments—many of which lie beyond the direct control of domestic actors and are shaped instead by global and regional dynamics. At the same time, the scenarios have also vividly shown that Oman's role in these varying global futures need not be a passive one. Proactive decision-making and dynamic updating enable decision-makers to make the very best of each possible global setting and to ensure Oman's strength, stability, and prosperity under all circumstances. This applies not only to the complex question of sectoral choice, but also to general regulatory frameworks and broader strategic agendas.

Utilising the outcomes of this report will therefore require policymakers to follow up on the Foresight exercise and its results—for instance, by establishing an early-warning system to help detect which scenario or drivers are unfolding over time. This would allow sectoral choices, investment patterns, and regulatory schemes to be updated in an anticipatory fashion. A possible next step could be the development of a robust indicator framework to track the unfolding trajectories, and the creation of a dedicated follow-up unit to translate these insights into dynamic policy advice.

The Green Economy Demands a New Kind of Foresight

More broadly, Oman's future will require more foresight. We are entering the VUCA world—one that is increasingly volatile, uncertain, complex, and ambiguous—due to fast-paced geopolitical and technological developments. Crucially, the rise of the green economy will not lessen this uncertainty; rather, it will intensify the need for forward-looking governance.

Whereas the conventional energy economy was, from a structural point of view, relatively concentrated, linear, and easy to map, the green economy is inherently more complex. Its supply chains are longer and more geographically dispersed, stretching from upstream critical raw materials to downstream equipment manufacturing and end-use applications. These chains are not only more fragmented, but also more prone to bottlenecks—often at unpredictable points. As a result, both dependencies and opportunities for structural leverage are harder to track and anticipate, making foresight not a luxury, but a necessity.

From One-Off Exercises to Permanent Foresight Capacity

Hence, there is a general need for Oman to establish foresight more deeply and permanently within the institutional landscape. In terms of instruments, this should include both one-off exercises such as this scenario development process—and future iterations or expansions thereof—as well as the creation of permanent foresight infrastructure, such as dedicated units tasked with tracking weak signals of change and supporting anticipatory policymaking.

A comprehensive foresight system must go beyond reporting—it must enable continuous adjustment. These facilities should not only generate insight but also support mechanisms to translate these insights into concrete institutional decisions.

Centralised or Decentralised? Designing the Right Institutional Architecture

Two broad approaches to institutionalising foresight are possible, each with its own strengths and limitations.

The first is a centralised model, whereby a foresight unit is embedded within a strategic coordinating institution—such as the General Secretariat of the Council of Ministers or the Ministry of Economy—and tasked with developing high-level foresight narratives and visions to inform the rest of the institutional landscape. This model enables a high degree of alignment and coherence, ensures that diverse actors can be convened around common frameworks, and allows resources to be used with high efficiency. However, a centralised approach may struggle to generate the depth of insight required by individual sectoral departments. And without institutional redundancy, such systems are more vulnerable to blind spots, analytical gaps, or even biases—defeating the purpose of system-wide preparedness.

The second option is a decentralised model, where individual ministries or clusters of institutions each operate their own foresight capacities, tailored to their specific policy domains. This enables greater detail, depth, and contextual relevance—improving the actionability of foresight insights. Yet this approach comes at a higher resource cost, and requires deliberate effort to ensure that different units bring sufficient diversity of perspectives, while also avoiding fragmentation or duplication. It also raises the need for cross-ministerial coordination and institutional learning.

Strategic Implications Across Scenarios: Turning Uncertainty into Opportunity

The scenarios presented in this report have, in an impressive way, showcased the need for more foresight. They illustrate four plausible, yet extreme, visions of Oman's possible future energy economy. The overarching message of these scenarios is twofold. On the one hand, Oman's future possibilities and chances are to a large extent dependent on external factors. On the other hand, the second key insight is that anticipatory governance can turn each situation into a win for Oman—be it broad-scale success, as illustrated in *Rising Tide*, or be it, in quotation marks only, the strength, resilience, and independence found in the case of *Raging Storms*.

Old Friends, Shifting Grounds: Managing External Relations Proactively

This applies very much to geopolitical shifts, which are considered one of the key uncertainties. As the scenarios showcased, however, Oman is able to—albeit to different extents—capitalise on various geopolitical settings. For instance, the rather harmonic setting in *Rising Tide* allows Oman to build strong trade relations with both East and West. However, even the security disruptions in *Constant Current* provide distinct opportunities for Oman. The central policy takeaway here is neither to ignore nor to resist geopolitical shifts, but instead to closely observe and actively manage diplomatic relations and sectoral choices based on actual developments. Changing geopolitics might indeed mean that partners change. For instance, Oman's relation to the West could weaken in certain future conditions. However, there are always new bridges to build. It is just important that Oman focuses on them.

Aside from dynamically calibrating Oman's relation with swing countries, the scenarios have also showcased that in almost all futures it will be beneficial for Oman to focus on its historically strong relations with other Global South partners along the former Omani Empire—particularly the East African coast and parts of South Asia. However, these trade relations will not emerge on their own, and the private sector by itself will not be able to forge them. Instead, Oman's diplomatic missions and foreign policy instruments must work closely with economic policymakers and stakeholders to co-shape the country's future (energy) economy.

Gulf Integration: Factual Collaboration Over Formal Unity

Regional geopolitics might be an even more decisive factor for Oman. The scenarios showcase the profound impact that different modes of collaboration within the GCC can have—and demonstrate that actual economic collaboration is even more important than formal political integration. The GCC Future Industries Fund, the centrepiece of the *Rising Tide* vision, showcases how much can be achieved if GCC countries collaborate economically while also integrating politically and creating joint institutions that help elevate their economies to true global leadership.

However, even in *Shifting Winds*, where formal integration stagnates or is even rolled back, factual economic and innovation collaboration continues to expand—and the overall environment remains beneficial for Oman. In contrast, the two non-collaboration scenarios show negative consequences. In *Constant Current*, competition for new industries leads to frequent relocations and prevents the realisation of economies of scale and fully integrated value chains. In *Raging Storms*, regional disintegration results in supply chain disruptions and limited market access.

Proactive policy toward not only political integration but also deeper, practical collaboration within the GCC is essential. Oman should position itself as a proactive force in this domain. Importantly, such collaboration is ultimately a win–win for all GCC countries and should be pursued even on purely pragmatic grounds.

Climate Policy: A Global Dilemma, a Strategic Opportunity

Another crucial driver of the scenarios is the extent and convergence of global and local climate policy. A future in which both local and global actors pursue strong climate policy can create a win–win for Oman: the negative impacts of climate change are mitigated, while Oman capitalises on the expanding green economy. However, global climate policy remains a prisoner's dilemma. As shown in the *Raging Storms* scenario, a situation in which Oman is the only actor moving forward with climate policy must be prevented.

This has two implications. First, Oman should actively shape global climate policy—whether by lobbying for the recognition and regulation of technologies such as carbon capture and storage, where Oman is one of the very few countries globally able to mineralise CO_2, or by steering hydrogen-related standardisation and governance. Second, Oman may benefit from taking measured leadership steps, positioning itself as a credible and pragmatic regional role model. Pathways such as the regional carbon market will require progressive and anticipatory action that Oman might ultimately benefit from.

At the same time, as *Shifting Winds* and *Raging Storms* illustrate, climate policy that is out of sync with economic realities can easily backfire. It may erode public support for climate action or manoeuvre Oman into a position where it voluntarily sacrifices economic prosperity—without having a meaningful impact on global emissions. Avoiding this trap requires targeted diplomacy and flexible sequencing of climate action.

In light of the diverse scenarios and structural uncertainties, Oman must approach sectoral development not as a fixed list of priorities, but as a dynamic portfolio—constantly adjusted to reflect new developments, shifting global trends, and evolving domestic capabilities. Some sectors, such as solar PV and building energy efficiency, are robust across most scenarios. Others may only become viable under specific geopolitical or technological conditions. Rather than placing singular bets, Oman's strategy should aim for a balanced mix: combining foundational sectors that provide resilience and jobs with high-risk, high-reward areas that could deliver future competitiveness.

This requires a new type of industrial policy—one that is modular, iterative, and anticipatory. Sectoral development plans should be tied to scenario signals and forward-looking indicators, allowing decision-makers to fast-track some industries, pause or recalibrate others, and test emerging opportunities through pilot projects and time-bound support mechanisms. This is especially relevant for nascent green technologies or value chains where global demand, partner readiness, and local capability are all evolving in parallel. A dynamic portfolio approach is the only way to ensure coherence between foresight and delivery, and to maintain policy credibility in a shifting environment.

Final reflections

Oman stands at a strategic crossroads, but not as a passive observer. The foundations laid across energy, industry, and institutional capacity position the country to act with purpose and vision. The clean economy is not a distant ambition—it is already taking shape. With the right policy tools and continued alignment across sectors, Oman can consolidate its strengths and build a globally competitive future grounded in innovation, resilience, and long-term value creation.

This report has provided the tools to navigate complexity: credible scenarios, rigorous sector analysis, and a strategic lens that integrates foresight into economic planning. These are not blueprints, but instruments of agency. They enable decision-makers to prepare—not only for what is likely, but for what is possible. The ability to steer under uncertainty will define future success, and Oman is increasingly well-positioned to do so—guided by evidence, shaped by collaboration, and driven by shared national goals.

What lies ahead is not a single pathway, but a space of opportunity—one that Oman is ready to enter with clarity and ambition. With continued commitment, adaptive strategy, and bold investment in its people and capabilities, the clean economy can become a cornerstone of prosperity. The momentum is there. The moment is now.

Appendix A: Foresight process

Scenarios are hypothetical, often extreme, yet plausible events illustrating how the future might unfold. They do not aim to show the most likely futures or what to expect; rather, they broaden horizons highlighting unlikely yet momentous future events. The goal of using scenarios strategically is to be prepared for a wide range of contrasting and unprecedented outcomes. Preparing for vastly different scenarios ensures readiness for a broad range of uncertainties, increasing the likelihood of thriving in various future conditions.

Today's use of scenarios has its origins in the aftermath of World War II by Herman Kahn, an American military strategist and the father of scenario planning. He adapted the meaning and concept of scriptwriting to war planning to *"think the unthinkable"* and thus coined the method of scenario planning. Meanwhile, in France, Gaston Berger's more formal and data-driven approach emerged independently of the progress in the US as a response to growing uncertainty about the future. Berger, a French philosopher, argued that people's thinking about the future is always guided by their experience of the past. Consequently, the impact of unprecedented events is neglected, rendering traditional forecasting methods useless.

Furthermore, scenarios are not meant to be overly formal, although they can and should be supported by quantitative calculations or similar methods. Scenarios serve as narrative instruments that help to visualise and prepare for the future. Using various stylistic devices and forms, they are intended to evoke a "memory of the future" in decision-makers by pretending to be in the future in which certain events have already taken place. In this way, they engage stakeholders as vividly as possible and enable them to prepare their constituents and organisations for the risks and opportunities of these scenarios. Importantly, scenarios do not by themselves outline different decision options for decision-makers. Instead, they often assume that decision-makers will naturally do their best in any given situation. Scenarios focus on external developments to set the scene, helping decision-makers understand what to prepare for and what heuristic opportunities might arise. Metaphorically speaking, scenarios are not maps showing where to sail; instead, they are maps of the waters that surround and must be navigated.

Developing scenarios is typically a multi-stage, facilitated process involving collaborative and participatory techniques to foster creativity and anticipation while reducing bias and its impact. The four scenarios presented here were developed in an eight-stage process. A facilitator from The Majan Council outlined a series of individual stages:

» Scoping
» Environmental scanning
» Factor assessment
» Key assumption check
» Projection formation
» Scenario construction
» Analysis and evaluation of scenarios
» Processing and elaboration

The process spanned from March 2024 to June 2024, with a qualified and experienced person from The Majan Council leading the effort. Participants included representatives from Oman, Saudi Arabia, Germany, the UK, Italy, Bahrain, and Qatar, covering a range of disciplines including engineering, business, economics, development, law, and political science. The group consisted of members from Omani ministries, public companies, supra-ministerial offices (Vision 2040 Office), think tanks, the General Secretariat of the Council of Ministers, universities, and international foundations.

The foresight process sought to answer the following question: Which global, regional, and local drivers will affect (new) energy industries in the Sultanate of Oman towards 2040? The scenarios are therefore interdisciplinary and incorporate insights from various fields, with special emphasis on the race for innovation and global supply chains, modes of cooperation and collaboration within the GCC, the interplay between global and regional climate change regimes, and shifts in the global order, including the emergence of multipolarity and the geo-economisation of the Global South.

The process began by delineating research questions and themes. The foresight team conducted internal discussions and preparatory work in March 2024. In early April 2024, an online survey was used for environmental scanning, where participants identified 110 factors influencing the geoeconomics and future development of Oman. The foresight team clustered and condensed these factors to 51.

In mid-April 2024, during the main workshop, participants undertook a key assumption check, assessing the key assumptions they considered true, rating them as solid, caveated, or unsupported. These assumptions became truisms or "rules of the game" for further analysis.

Participants then rated the 52 factors in terms of impact and uncertainty, identifying seven key uncertainties and three key trends as primary drivers for the morphological field. Working in groups, participants formed projections and constructed scenarios. Working pairs initially created mutually exclusive realisations of the identified key uncertainties (projections). The entire group then selected four scenarios based on the criteria of 1) consistency, 2) plausibility, and 3) relevance (see Table 4). Adherence to these three criteria is critical to both the initial assumptions made and the final presentation of the scenarios. Throughout the process, the team ensured that the key assumptions were relevant to the research question and the decision making process, and that they were combined in a coherent way to create plausible outcomes.

From May to June 2024, a small team conducted further analysis and evaluation of the scenarios, focusing on the risks and opportunities of each. This team consisted of affiliates from The Majan Council, University College London, the German Institute for International and Security Affairs, Qatar Foundation, Imperial College London, the General Secretariat of the Council of Ministers Oman, and Oman Think Urban. Based on the scenarios developed, the team also identified potential Omani and regional policy objectives and proposed strategic options for management in the respective scenarios. A windtunneling exercise assessed which technologies and sectors were particularly viable within each scenario. Measures that proved effective in all four scenarios were considered "robust"; those showing detrimental effects in any scenario were flagged as "not robust."

Processing and elaboration of the scenarios took place from April to June 2024. After the facilitator summarized the initial results in May 2024, the team revised and refined the scenarios in June 2024. This involved closing plausibility gaps, introducing new actors, deepening event chains, and conducting a new strategic analysis with participant feedback.

The team updated and expanded the windtunneling analysis and created a set of indicators to help observers and decision-makers track elements of the scenarios as they materialize. In June 2024, additional regional experts and participants from the original foresight process reviewed the draft to maintain the participatory nature of the scenarios.

Table 3: Impact-uncertainty assessment of identified factors, with scores and aggregated standard deviation from the foresight participant group

No	Factor	Uncertainty	Impact	SD
1	GCC economic and political integration (including aspects such as weekend structure)	3.05	3.01	2.83
2	Household lifestyle choices (e.g., use of certain products; preferences for mobility); shifts in social norms (e.g., working hours, family systems)	2.22	2.80	1.79
3	Global innovation in new (energy) technologies (including energy efficiency and carbon engineering)	2.20	3.29	2.85
4	Demographic development within Oman (population growth, migration between cities, new urbanisation)	2.14	2.35	0.64
5	Global climate policy and efforts (extent and geographical cohesion); climate "propaganda"	2.74	2.88	3.24
6	Evolution of artificial intelligence, and other innovative IT	2.03	3.06	0.57
7	Global population growth and tendency towards urbanisation	1.96	2.92	1.63
8	Positioning of traditional/emerging (global) powers (e.g., convergence or divergence); shifts to the global order	3.00	2.63	3.89
9	Status of social welfare in Oman and promotion of social inclusion within governmental visions and strategies	2.29	1.95	1.10
10	Psychological aspects (e.g., towards nuclear power)	2.75	2.15	1.79
11	Level of relevant education and skills for new sectors within the Omani workforce and availability of that workforce	1.87	2.81	1.65
12	Establishment of regional carbon trading and taxation schemes (e.g., CBAM, emissions trading in the GCC)	2.95	2.45	0.71
13	Alignment of legal and regulatory frameworks (regional and international) for new energies & general stability of the legal system	2.90	2.65	1.76
14	Impacts of climate change and environmental change (e.g., temperature increase, water scarcity)	1.59	3.05	1.56
15	Technological and social adaptability of new fuels and energy forms (for both households and industry)	2.31	2.89	1.51
16	Bankability of clean energy projects	2.82	3.17	2.79
17	Dynamics in oil, coal, and gas (price, supply, demand, shortages...)	3.78	3.22	1.79
18	Global demand for raw materials (including minerals and metals)	2.16	2.92	0.98
19	Competition and cooperation in the GCC; industrial policy of Oman's neighbours (e.g., new sectors, SWF action)	3.05	2.89	2.45
20	Attractiveness of (foreign) investments in Oman, domestic openness to trade, and supporting legal framework	2.24	2.91	1.40
21	US sanctions on Iran	2.73	1.73	2.20
22	Cultural and societal acceptance of environmental and climate policy	2.57	2.20	0.71
23	Shifts to the labour composition in Oman; new labour laws (including working hours); new forms and styles of labour (due to Generation Z); changes to the situation of expatriates	2.37	2.35	1.33
24	Local climate action, local environmental policies; national push for cleaner industries, products, and energy	2.76	2.80	1.33
25	Investments into Oman's electricity grid	1.93	2.33	2.31
26	Domestic political stability in Oman	1.89	2.45	1.57
27	Growth of economy and energy demand in Asia (India, China, Pakistan, Indochina)	1.60	2.94	1.76
28	Regional growth in (especially East Africa) with new investment and trade opportunities and increased education	2.07	2.48	2.75
29	Changing global geopolitics, patterns, and modes of trade (e.g., multilateralism, globalisation, regionalisation)	3.01	3.09	2.57
30	Regional stability and security	3.21	3.00	3.05
31	Ability and encouragement of SME growth and entrepreneurship in the energy sector	2.53	2.81	1.84
32	Security and freedom of Palestine; development of the current conflict	3.29	2.15	2.31
33	Ability of new sectors to create jobs and local content	2.39	2.87	2.35
34	Advances in desalination technology	1.97	2.02	0.41
35	Dominance of China (energy technologies, innovation, diplomacy, or other fields)	2.25	2.61	1.29
36	Increase of Islam across the world	2.50	1.39	2.66

No	Factor	Uncertainty	Impact	SD
37	Global conflict and security situation	3.50	3.39	3.06
38	Tendencies toward nationalising the energy sector	2.09	2.01	1.67
39	Cost development and upscaling of mature (energy) technologies	2.34	2.79	1.78
40	Efforts and success of economic diversification efforts	3.22	3.01	1.38
41	Oman's investment and credit rating; financial capacities of Oman	2.60	2.93	1.29
42	People moving to Oman	2.74	2.04	0.97
43	Inclusivity in global technology transfer and collaboration in R&D and deployment; technological spillover	3.20	2.47	1.87
44	Oman's diplomatic capacity and involvement (in and across the region)	2.50	2.32	2.59
45	Global and regional concentration of raw materials supply chains	2.95	3.11	2.52
46	Advances in exploration, extraction, recycling of raw materials	2.06	2.58	1.06
47	Technological progress in infrastructure enabling new energy industries	2.47	2.33	2.04
48	Distribution of leadership between public and private sectors throughout the value chain	2.65	2.25	1.29
49	Global increase in the tendency toward cyber warfare or terrorism	2.23	2.48	1.76
50	Attitude of supergovernmental organisations (e.g. OPEC) towards the energy transition	3.34	2.45	2.04
51	Extent to which the West takes GCC efforts toward climate neutrality for serious ("greenwashing" argument)	3.07	2.47	2.75

Table 4: Morphological fields for four scenarios

	Scenario			
Projections	**Constant Current**	**Raging Storms**	**Rising Tide**	**Shifting Winds**
Fossil fuel dynamics	Moderate development	High prices & low domestic production	High prices & high domestic production	Low prices & high domestic production
Innovation setting	Strong innovation & monopolised technologies	Weak innovation & monopolised technologies	Strong innovation & distributed technology ownership	Weak innovation & distributed technology ownership
Global and local climate action	Moderate on both levels	Weak global & strong local action	Strong local & strong global action	Strong global & weak local action
Geopolitical climate	Weakened security in a fragmenting global order	Weakened security in a fragmenting global order	Enhanced security in a fragmenting global order	Enhanced security in a stable global order
Interaction within the GCC	Integrated but rivalrous	Divergent & rivalrous	Integrated & cooperative	Divergent but cooperative
Financial viability for clean energy projects	High bankability but limited local capital for energy projects	Low bankability & limited local capital for energy projects	High bankability & abundant local capital for energy projects	High bankability but limited local capital for energy projects
Assumptions				
Rise of Asia	*Given*			
Climate change impact and environmental damages	*Present and increasing*			
Level of skills and labour availability in Oman	*High and available*			

Appendix B: Screening methodology

Table 5: Sectoral definitions

Sector name	Definition
Solar PV development	The process of developing, planning, installing, maintaining, and marketing solar photovoltaic systems that convert sunlight directly into electricity.
Concentrated solar power (CSP) development	The process of developing, planning, installing, maintaining, and marketing systems concentrate sunlight to produce heat for electricity generation.
Wind power development	The process of developing, planning, installing, maintaining, and marketing wind power systems, onshore or offshore, that generate electricity.
Geothermal energy development	The process of developing, planning, installing, maintaining, and marketing systems to generate electricity from Earth's heat.
Advanced bioenergy solutions	The process of developing, planning, installing, maintaining, and marketing systems that draw energy from organic materials.
Ocean energy development	The process of developing, planning, installing, maintaining, and marketing systems that draw energy from ocean resources.
Small-scale nuclear energy development	The process of developing, planning, installing, operating, maintaining, and marketing small-scale nuclear reactors.
Hydrogen production & infrastructure	The process of producing, storing, transporting, and distributing hydrogen for energy generation and industrial applications.
Electric vehicle (EV) infrastructure	The development and maintenance of charging networks, servicing facilities, and related infrastructure supporting the operation of electric vehicles.
Building energy efficiency	The design and deployment of semi-automated systems that improve energy efficiency in buildings and industries, including energy auditing, monitoring, and retrofitting.
Artificial Intelligence (AI) & web 3.0	The application of advanced computational algorithms and blockchain-based technologies to enable intelligent automation, decentralised energy trading, and large-scale data analytics.
Minerals & metals extraction	The process of retrieving valuable minerals and metals from natural deposits for use in industrial production and manufacturing.
Data centres & server farms	Facilities that house servers and networking equipment for storing, processing, and distributing data and digital services.
Solar panel fabrication	Process of manufacturing solar panels, which involves assembling photovoltaic cells into modules that convert sunlight into electricity.
Inverters manufacturing	Process of produce devices that convert direct current (DC) electricity from sources such as solar panels into alternating current (AC) suitable for use in homes and businesses.
Concentrated solar power (CSP) manufacturing	Manufacturing components for CSP systems, including solar towers, parabolic troughs, and other specialized parts. These components are considered highly capital-intensive due to their complex manufacturing processes.
Wind turbine manufacturing	The process of producing wind turbines and their components – such as rotor blades, nacelles, and towers – that convert kinetic wind energy into electricity.
Electrolyser manufacturing	The process of producing electrolysers, which use electricity to split water into hydrogen and oxygen for clean hydrogen production.
Fuel cell manufacturing	The process of producing devices that generate electricity through electrochemical reactions between hydrogen (or another fuel) and oxygen without combustion.
Battery manufacturing	The process of producing rechargeable batteries, including cell fabrication, module assembly, and system integration for energy storage or mobility applications.
Mechanical storage production	Manufacturing of systems that store mechanical energy, such as flywheels or compressed air, and pump hydro for later use in various applications.
Cabon capture tech innovation & manufacturing	Innovation and manufacturing involve developing and producing systems that capture carbon dioxide emissions, utilising methods like absorption, adsorption, and membrane technologies.
Variable speed drives (VSD) manufacturing	The process of producing electronic controllers – such as rectifiers, inverters, and control interfaces – that regulate the speed and torque of electric motors to improve energy efficiency.
Heat pump manufacturing	The process of producing heat pumps that extract and transfer heat from sources such as air, water, or the ground to provide efficient heating and cooling.
Water filtering membranes manufacturing	The process of producing specialised materials that remove impurities from water through microfiltration, ultrafiltration, nanofiltration, or reverse osmosis technologies.
Minerals & metals processing	The process of refining, purifying, and transforming extracted minerals and metals into materials suitable for industrial and manufacturing use.
Clean steel & aluminium production	Clean steel and aluminium production using low-emission methods, captures emissions, or employs renewable energy and advanced technologies.
Clean cement & concrete production	Production of clean cement and concrete involving low-carbon routes, capturing emissions, and switching to renewable and clean fuels. The technologies are in the early adoption stage, and while cement production isn't new in Oman, existing infrastructure can be repurposed.
Hydrogen-based fuels	The production of hydrogen-based fuel already exists in Oman and can be achieved through low-carbon routes, including emission capture or renewable energy adoption. Some technologies are mature, and the project
Non-conventional construction materials	Using non-conventional construction materials involving alternatives to traditional materials like concrete and steel, including date palm waste concrete, plastic waste concrete, and hempcrete. Additionally, existing infrastructure can be repurposed.
Water filtering membranes manufacturing	The production of materials that selectively remove impurities from water, ensuring clean and safe drinking water.

Table 6: Sectoral screening criteria

Indicator name	Definition
Domestic market viability	The extent to which a sector can establish a technologically, environmentally, and financially feasible business model that is profitable and sustainable within the Omani market.
Export viability	The extent to which a sector can develop a technologically, environmentally, and financially feasible business model that is profitable and competitive in international markets.
Robustness & predictability	The degree of certainty, stability, and resilience associated with a sector's future growth trajectory and market performance.
Socioeconomic and innovation potential	The ability of a sector to contribute to the wellbeing and livelihoods of Omanis and a thriving, multidisciplinary innovative economy
Investment and capital accessibility	The manageability and flexibility of the financial resources required to develop the sector
Macroeconomic co-benefits and resilience-building	The ability of a sector to strengthen Oman's broader economy by supporting other industries, contributing to national strategic goals, and enhancing long-term economic resilience.
Integration into the existing national fabric	The ease with which a sector can be incorporated into Oman's existing physical infrastructure, regulatory frameworks, and strategic policy landscape.

Table 7: Sectoral screening rating process

Number	Sub-Indicator name	Definition	Weighting (within the indicator group)	Method of evaluation	Evaluation raster
1.1	Current market volume	Sales of the goods produced in the sector by 2024	10%	Literature-based research	0: None/Marginal - The sector has minimal or no existing domestic market for its final goods or services. 1: Volumes in the Scale of Millions of Dollars - The sector has an established domestic market with sales volume in the millions of dollars annually. 2: Volumes in the Scale of Billions of Dollars - The sector has a significant domestic market with sales volume reaching billions of dollars annually.
1.2	Domestic market growth	Prospective domestic market growth towards 2040	30%	Own analysis & expert survey	0: Low - The domestic demand for the good/service is expected to experience minimal or stagnant growth by 2040. 1: Medium - The domestic demand for the good/service is expected to experience moderate growth by 2040. 2: High - The domestic demand for the good/service is expected to experience significant growth by 2040.
1.3	Domestic competitive-ness	Ability of local industry to compete with potential imports of the good	40%	Literature-based research	0: Low 1: Medium 2: High (Evaluation based on sub-sub indicators concerning mobility, ease of transport, and competition analysis)
1.4	Expected cost reduction	Prospective reduction in costs of the sector towards 2040	10%	Literature-based research	0: Low (Less than 25% cost reduction) - The sector is not expected to experience significant cost reductions by 2040. 1: Medium (25% to 50% cost reduction) - The sector is expected to experience moderate cost reductions by 2040. 2: High (More than 50% cost reduction) - The sector is expected to experience significant cost reductions by 2040.
1.5	Local feasibility	Physical and environmen-tal possi-bility to run the sector in Oman	10%	Own analysis	0: Low - The sector faces significant challenges due to environmental constraints 1: Medium - The sector presents some environmental hurdles in Oman 2: High - Minimal or no environmental barriers in Oman

Number	Sub-Indicator name	Definition	Weighting (within the indicator group)	Method of evaluation	Evaluation raster
2.1	Current trade volume	Quantity of the good traded internationally by 2024	10%	Literature-based research	0: None - The sector has minimal or no existing international trade for its goods or services. 1: Millions of Dollars - The sector has some established international trade with export volume reaching millions of dollars annually. 2: Billions of Dollars - The sector has a significant global presence with export volume in the billions of dollars annually.
2.2	Global market growth	Prospective global market growth towards 2040	30%	Own analysis & expert survey	0: Low - The global demand for the goods/services offered by this sector is expected to experience minimal or stagnant growth by 2040. 1: Medium - The global demand for the goods/services offered by this sector is expected to experience moderate growth by 2040. 2: High - The global demand for the goods/services offered by this sector is expected to experience significant growth by 2040.
2.3	Export competitiveness	Ability of Omani industry to compete in export markets with other suppliers abroad	50%	Literature-based research	0: Low 1: Medium 2: High (Evaluation based on sub-sub indicators concerning mobility, ease of transport, and competition analysis)
2.4	Expected cost reduction	Prospective reduction in costs of the sector towards 2040	10%	Literature-based research	0: Low (Less than 25% cost reduction) - The sector is not expected to experience significant cost reductions by 2040. 1: Medium (25% to 50% cost reduction) - The sector is expected to experience moderate cost reductions by 2040. 2: High (More than 50% cost reduction) - The sector is expected to experience significant cost reductions by 2040.

Number	Sub-Indicator name	Definition	Weighting (within the indicator group)	Method of evaluation	Evaluation raster
3.1	Robustness of viability	Ability to sustain viability in a broad set of futures and external factors	50%	Own analysis	0: Low Robustness - The sector appears viable only in a limited number future scenarios (1 or less). This suggests high vulnerability to potential disruptions or changing market conditions. 1: Medium Robustness - The sector appears viable in some, but not all, future scenarios (more than one but not all). This suggests some level of resilience but also potential weaknesses depending on how the future unfolds. 2: High Robustness - The sector appears viable across a wide range of future scenarios (all scenarios).
3.2	Technological maturity	Readiness for adoption and operational effectiveness	50%	Literature-based research	Technology Readiness Levels (TRL) 0: Low Maturity (< TRL 5 or Laboratory-based) - The technology is in the early stages of development, with limited practical applications or still being tested in a Laboratory environment. 1: Medium Maturity (TRL 5-7 or Pilot testing) - The technology has progressed beyond the lab and is undergoing pilot testing or demonstration projects. 2: High Maturity (TRL ≥ 8 or Industrial scaling) - The technology is well-established, commercially available, and operating at an industrial scale.
4.1	Job creation potential	Ability and efficiency in job creation, given a fixed investment into the sector	70%	Expert survey	0: Capital-intensive technology / low job-to-investment ratio 1: medium job-to-investment ratio 2: Labour intense technology / high job-to-investment ratio
4.2	Innovation potential	Ability to offer R&D opportunities for Oman	10%	Literature-based research	0: Low Innovation Potential (< 30) - The sector has a limited track record of innovation and offers minimal opportunities for R&D within Oman. This could be due to factors like established technologies with limited room for improvement or a lack of existing R&D infrastructure in Oman for this sector. 1: Medium Innovation Potential (30-59) - The sector offers some potential for R&D activities in Oman. This could indicate opportunities for incremental innovation or adaptation of existing technologies to the Omani context. 2: High Innovation Potential (>= 60) - The sector presents significant opportunities for R&D within Oman.

Number	Sub-Indicator name	Definition	Weighting (within the indicator group)	Method of evaluation	Evaluation raster
4.3	Workforce interest	Appeal of working in the sector to the Omani Youth	10%	Own analysis	0: Low Workforce Interest - The sector holds minimal appeal to Omani job seekers, based on a recent survey. 1: Medium Workforce Interest - The sector holds some appeal to Omani job seekers, based on a recent survey. 2: High Workforce Interest - The sector is highly attractive to Omani job seekers, based on a recent survey.
5.1	Required capital	Amount of financial resources needed to establish and sustain the sector, including infrastruc-ture	40%	Literature-based research	0: High Capital Requirement (High Volume) - The sector requires a significant amount of upfront investment to become operational. 1: Medium Capital Requirement (Medium Volume) - The sector requires a moderate amount of upfront investment to launch. 2: Low Capital Requirement (Low Volume) - The sector requires a relatively low amount of upfront investment to initiate operations.
5.2	Bankability	Creditwor-thiness and availability for the sector	30%	Expert survey	0: Low Bankability - Projects in this sector face significant challenges in obtaining financing from banks or other lenders. 1: Medium Bankability - Projects in this sector have some potential for securing financing, but lenders might require stricter terms or additional security. 2: High Bankability - Projects in this sector are considered highly attractive to lenders and can readily access financing.
5.3	Project scalability	Efficiency of the sector in the small scale	30%	Literature-based analysis	0: Low Scalability - Investments in this sector are difficult to break down into smaller projects. This could be due to factors like the need for significant upfront infrastructure development or economies of scale that are lost with smaller projects. 1: Medium Scalability - Investments in this sector can be partially broken down into smaller phases or stages. This suggests some flexibility in project development and potential for phased investment. 2: High Scalability - Investments in this sector can be readily broken down into smaller, well-defined projects.

Number	Sub-Indicator name	Definition	Weighting (within the indicator group)	Method of evaluation	Evaluation raster
6.1	Economic resilience support	To which extent is this sector able to stabilise (or expand) Oman's economy on a sectoral level?	20%	Own analysis	0: Low Economic Resilience Support - The sector has limited potential to contribute to Oman's economic stability or growth. 1: Medium Economic Resilience Support - The sector offers some potential to contribute to Oman's economic resilience. 2: High Economic Resilience Support - The sector has significant potential to strengthen and diversify Oman's economy.
6.2	Economic diversification	Does this sector help diversify the Omani economy (against the backdrop of the dominance of the oil and gas industry)?	20%	Own analysis	0: Low Diversification Impact (Supports Fossil Fuels) - The sector directly supports the production of fossil fuels (oil and gas). 1: Medium Diversification Impact (Non-Fossil Energy Production) - The sector focuses on the production of non-fossil fuel energy sources (e.g., renewable energy). 2: High Diversification Impact (Non-Energy Production) - The sector supports the development of entirely new economic activities outside the energy sector altogether (e.g., manufacturing, green technologies).
6.3	Energy security	Does this sector help Oman to gain energy security?	20%	Own analysis	0: Low Contribution to Energy Security - The sector has no direct impact on energy security. 1: Medium Contribution to Energy Security - The sector contributes to energy security by promoting energy efficiency or conservation measures. 2: High Contribution to Energy Security - The sector directly contributes to energy security by producing reliable and affordable energy within Oman.
6.4	Geopolitical assertiveness	Does this sector, e.g. via the products/ services it provides, help Oman gain influence on a geopolitical level?	20%	Expert survey	0: low 1: medium 2: high

Number	Sub-Indicator name	Definition	Weighting (within the indicator group)	Method of evaluation	Evaluation raster
6.5	Supply chain security	Can the inputs for this sector be sourced from various origins, or will raw material/ component supply foster new dependence from its exporters?	20%	Literature-based analysis	0: Low Supply Chain Security - The sector relies heavily on a single source or a small number of geographically concentrated sources for critical raw materials and components. 1: Medium Supply Chain Security - The sector's supply chain for critical materials and components is somewhat diversified, with sources distributed across multiple regions. 2: High Supply Chain Security - The sector has a well-diversified supply chain for critical materials and components, with sources distributed globally.
7.1	Infrastructure adaptability	Possibility to use or adapt to available infrastruc-ture	40%	Own analysis	0: Entirely New Infrastructure Necessary - This indicates that the sector requires entirely new infrastructure to be built, with limited potential to leverage existing assets. 1: Some Existing Infrastructure Can Be Used (or Costly Repurposing) - This suggests that some existing infrastructure can be partially utilized by the sector, but significant modifications or upgrades might be necessary. 2: All Existing Infrastructure Can Be Re-used or No Infrastructure Necessary - This indicates a high degree of compatibility between the sector and Oman's existing infrastructure.
7.2	Existing regulations	Readiness of regulations for the sector in Oman	40%	Literature-based survey	0: No Existing Regulations or Institutions - There are currently no regulations or relevant institutions in place to govern the sector within the context of Oman's energy transition. 1: Some Existing Regulations or Institutions - There might be some existing regulations relevant to the sector, but they might be outdated or not fully comprehensive in the context of the energy transition. 2: Thorough Regulations and Institutions Available - There is a well-established regulatory framework in place that effectively governs the sector within the context of Oman's energy transition strategy.
7.3	Strategy alignment	Alignment with national policy frameworks	20%	Literature-based survey	0: Not Considered - The sector receives no mention in key national energy transition documents like Vision 2040 or the Net Zero strategy. 1: Implicitly Considered - The sector is not explicitly mentioned in national strategies, but it might be tangentially relevant to broader goals or objectives. 2: Explicitly Considered - The sector is clearly identified and supported in Oman's national energy transition strategies.

In addition to the formally cited literature (see Literature), the screening analysis has also relied on supplementary information from the following sources: Advanced Bioenergy Solutions; Ahead of the Herd; Allied Market Research; AlNadabi, A.; American Clean Power Association (ACP); American Iron & Steel Institute (AISI); ARC Advisory Group; Arij Global Trading; Authority for Public Services Regulation (APSR); AZoM; BBC; Battery Council International; Be'ah – Oman Environmental Services Holding Company; Benfield, I.; BloombergNEF; Business Fortune (BF); California Department of Toxic Substances Control; Center for Security and Emerging Technology (CSET); CNBC; DiCaprio, A.; EDCO Fabrication; Emirates Global Aluminium (EGA); Energy Systems; Environmental and Energy Study Institute (EESI); Environmental Authority (EA); Enel Green Power; ERM; ESMAP; European Commission; Frier, S.; Fortune Business Insights; FutureCoal; German University of Technology in Oman (GUtech); Global Wind Energy Council (GWEC); Global Wind Atlas; GlobalData; Government of British Columbia (GOV-BC); Grand View Research (GVR); Green Hydrogen Innovation Centre (GHIC); Greenlogic; Guidehouse Insights; H2@Scale (Energy.gov); Hannah Ritchie; Heating Ventilating and Plumbing Magazine (HVP); HOLCIM; Huawei; Hydro Review; Hydrom – Oman; IBM; IEEE Innovation at Work; Institute for Energy Economics and Financial Analysis (IEEFA); International Energy Agency (IEA); International Renewable Energy Agency (IRENA); Intellias; Khan, G.; Lens; McKinsey & Company; Masdar; Methanol Institute; Ministry of Commerce, Industry and Investment Promotion; Ministry of Energy and Minerals (MEM); Ministry of Transport, Communications and Information Technology (MTCI); Mordor Intelligence; Muscat Daily; NetZero Cities; Nostromo Energy; NREL; Nuclear Energy Institute (NEI); OEC World; Oman Electricity Transmission Company; Oman Environmental Authority; Oman Investment Authority (OIA); Oman Observer; Oman Power and Water Procurement Company (OPWP); Oman Vision 2040 Implementation Follow-up Unit; Omanuna; OPWP; Our World in Data; Physics Forums; PricewaterhouseCoopers (PwC); Prime Professional Engineering LLC (PrimePro); Reuters; S&P Global; Sustainable Energy Authority of Ireland (SEAI); SkyQuest Insights; SLB; Solar Atlas; SparkCharge; SpreadCharts; Statista; SunGrow; Team T.W.; Technology Networks; The Insight Partners; TheGreenAge; Trade Economics; TÜV Rheinland; U.S. Chamber of Commerce – TEC; U.S. Department of Commerce; University of Michigan; University of Virginia; UpTime Institute (UI); USAID; Van-Koningsloo & Chmielewski; Vestas; Verified Market Reports; Vision 2040 Implementation Follow-up Unit; Vulcan Green Steel; Wakud; Wood Mackenzie; World Nuclear Association (WNA); World Platinum Investment Council (WPIC); Zawya.

Appendix C: Clustering methodology

K-means clustering is a machine learning method used to group similar data points together. It starts by picking K central points, called centroids. Each data point is then assigned to the nearest centroid, creating initial groups. The centroids are then adjusted to be the average of the points in their group, and the process repeats until the centroids don't change much. This method helps in identifying patterns and especially for large datasets. It reveals distinct clusters of data points, each characterized by their proximity to a centroid, effectively grouping similar entities together based on shared attributes. Each cluster generated by K-means clustering exhibits internal cohesion among its data points while maintaining separation from other clusters, facilitating clear differentiation and analysis of distinct patterns within the dataset.

Principal Component Analysis (PCA) transforms high-dimensional data into a smaller set of principal components, capturing the maximum variance and enabling clearer visualization and interpretation of underlying patterns, which aids in efficient data exploration and feature identification across various fields.

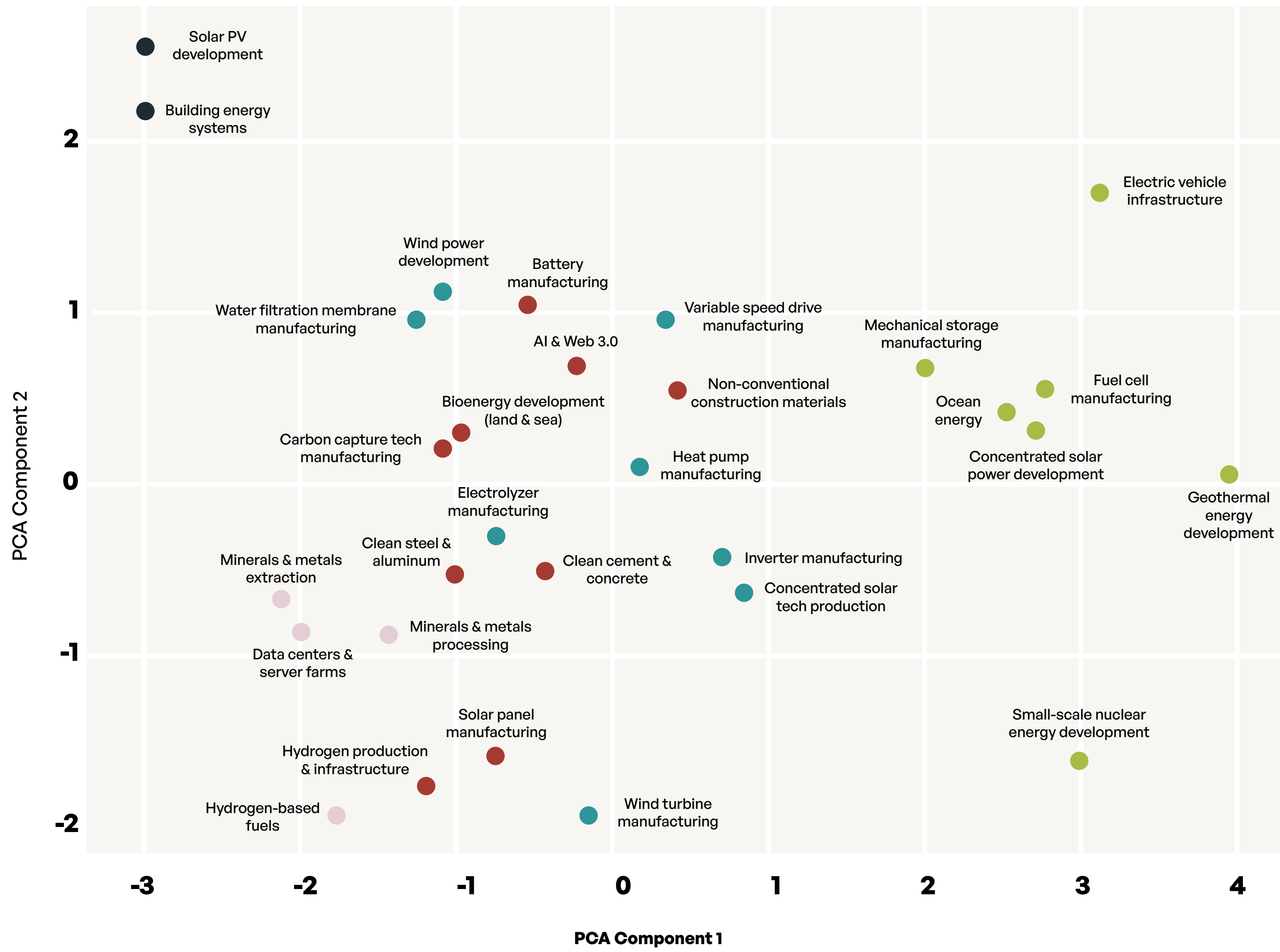


Figure 36: PCA of analysed sectoral scores with clusters

Appendix D:
Screening - Additional tables

Sector	Domestic Market Viability							Export Viability						Robustness & Predictability			
	1.1 Current Market Volume	1.2 Domestic Market Growth	1.3 Domestic Competitiveness	1.4 Expected Cost Reduction	1.5 Local Feasibility	**Overall (Exact Score)**	**Overall (Rounded Score)**	2.1 Current Trade Volume	2.2 Global Market Growth	2.3 Export Competitiveness	2.4 Expected Cost Reduction	**Overall (Exact Score)**	**Overall (Rounded Score)**	3.1 Robustness of Viability	3.2 Technological Maturity	**Overall (Exact Score)**	**Overall (Rounded Score)**
Solar PV Development	1	2	1	1	2	**70**	**1**	2	2	1	1	**70**	**1**	2	2	**100**	**2**
Building Energy Efficiency	0	2	1	1	2	**65**	**1**	2	2	1	1	**70**	**1**	2	2	**100**	**2**
Minerals and Metals Extraction	1	1	1	0	1	**45**	**1**	2	2	2	0	**90**	**2**	2	2	**100**	**2**
Hydrogen-Based Fuels	1	1	1	1	2	**55**	**1**	2	2	2	1	**95**	**2**	1	2	**75**	**2**
Minerals & Metals Processing	1	1	1	1	2	**55**	**1**	2	2	2	1	**95**	**2**	1	2	**75**	**2**
Water Filtration Membrane Manufacturing	1	1	1	1	2	**55**	**1**	2	2	1	1	**70**	**1**	2	2	**100**	**2**
Hydrogen Production and Infrastructure	2	1	1	2	2	**65**	**1**	1	2	2	2	**95**	**2**	1	1	**50**	**1**
Data Centres and Server Farms	1	2	1	1	2	**70**	**1**	2	2	2	1	**95**	**2**	1	2	**75**	**2**
Carbon Capture Technology Manufacturing	0	1	1	2	2	**55**	**1**	1	2	2	2	**95**	**2**	1	1	**50**	**1**
Solar PV Panel Manufacturing	1	2	0	2	2	**55**	**1**	2	2	1	2	**75**	**2**	1	2	**75**	**2**
Wind Power Development	1	1	1	2	2	**60**	**1**	2	2	1	2	**75**	**2**	1	2	**75**	**2**
Advanced Bioenergy Solutions	0	1	2	1	0	**60**	**1**	1	1	2	1	**75**	**2**	1	1	**50**	**1**
Clean Steel and Aluminium	1	1	1	1	2	**55**	**1**	2	2	2	1	**95**	**2**	1	1	**50**	**1**
Electrolyser Manufacturing	0	1	1	2	2	**55**	**1**	1	2	2	2	**95**	**2**	1	1	**50**	**1**
Battery Manufacturing	1	1	0	2	1	**35**	**1**	2	2	1	2	**75**	**2**	1	2	**75**	**2**

Sector	Socioeconomic & Innovation Potential					Investment & Capital Accessibility					Macroeconomic Co-Benefits and Resilience-Building							Integration into The Existing National Fabric					Overall Total	
	4.1 Job Creation Potential	4.2 Innovation Potential	4.3 Workforce Interest	**Overall (Exact Score)**	**Overall (Rounded Score)**	5.1 Required Capital	5.2 Bankability	5.3 Project Scalability	**Overall (Exact Score)**	**Overall (Rounded Score)**	6.1 Economic Resilience Support	6.2 Economic Diversification	6.3 Energy Security	6.4 Geopolitical Assertiveness	6.5 Supply Chain Security	**Overall (Exact Score)**	**Overall (Rounded Score)**	7.1 Infrastructure Adaptability	7.2 Existing Regulations	7.3 Strategy Alignment	**Overall (Exact Score)**	**Overall (Rounded Score)**	Overall Total (Exact Score)	Overall Total (Rounded Score)
Solar PV Development	2	0	0	**70**	**1**	2	2	2	**100**	**2**	1	1	2	0	1	**100**	**1**	2	2	1	**90**	**2**	79	79
Building Energy Efficiency	2	1	1	**85**	**2**	2	2	2	**100**	**2**	2	1	1	0	2	**60**	**1**	2	1	2	**80**	**2**	79.5	80
Minerals and Metals Extraction	1	0	1	**40**	**1**	1	2	1	**65**	**1**	2	2	0	2	2	**80**	**2**	1	2	2	**80**	**2**	73.5	74
Hydrogen-Based Fuels	1	0	1	**40**	**1**	1	1	1	**50**	**1**	2	1	2	2	2	**90**	**2**	1	1	2	**60**	**1**	69	69
Minerals & Metals Processing	1	0	1	**40**	**1**	0	2	1	**45**	**1**	2	2	0	2	1	**70**	**1**	1	2	2	**80**	**2**	68.5	69
Water Filtration Membrane Manufacturing	1	0	1	**40**	**1**	1	1	1	**50**	**1**	2	2	0	0	1	**50**	**1**	2	2	1	**90**	**2**	68	68
Hydrogen Production and Infrastructure	1	2	2	**65**	**1**	0	1	1	**30**	**1**	1	1	2	2	2	**80**	**2**	1	2	2	**80**	**2**	67.5	68
Data Centres and Server Farms	0	1	1	**15**	**0**	0	2	2	**60**	**1**	2	2	0	2	1	**70**	**1**	1	1	1	**50**	**1**	67.5	68
Carbon Capture Technology Manufacturing	1	2	0	**55**	**1**	1	1	2	**65**	**1**	2	0	0	2	2	**60**	**1**	2	2	1	**90**	**2**	67	67
Solar PV Panel Manufacturing	2	0	0	**70**	**1**	0	1	0	**15**	**0**	2	1	2	2	1	**80**	**2**	2	2	1	**90**	**2**	66.5	67
Wind Power Development	1	0	2	**45**	**1**	1	2	1	**65**	**1**	1	1	2	0	1	**50**	**1**	1	2	1	**70**	**1**	65	65
Advanced Bioenergy Solutions	2	1	2	**90**	**2**	1	1	2	**65**	**1**	2	1	2	0	2	**70**	**1**	1	1	1	**50**	**1**	64.5	65
Clean Steel and Aluminium	2	0	1	**75**	**2**	1	1	1	**50**	**1**	1	2	0	2	2	**70**	**1**	1	1	2	**60**	**1**	65.5	66
Electrolyser Manufacturing	1	1	0	**45**	**1**	1	1	1	**50**	**1**	1	1	2	1	1	**60**	**1**	2	2	1	**90**	**2**	64.5	65
Battery Manufacturing	2	1	0	**80**	**2**	1	2	1	**65**	**1**	1	1	2	1	1	**60**	**1**	1	2	1	**70**	**1**	64.5	65

Note: Sub-indicators are assessed on a 0/1/2 raster. Aggregated results are computed based on the weights mentioned in Appendix B and projected onto 100 points

Sector	Domestic Market Viability							Export Viability						Robustness & Predictability			
	1.1 Current Market Volume	1.2 Domestic Market Growth	1.3 Domestic Competitiveness	1.4 Expected Cost Reduction	1.5 Local Feasibility	**Overall (Exact Score)**	**Overall (Rounded Score)**	2.1 Current Trade Volume	2.2 Global Market Growth	2.3 Export Competitiveness	2.4 Expected Cost Reduction	**Overall (Exact Score)**	**Overall (Rounded Score)**	3.1 Robustness of Viability	3.2 Technological Maturity	**Overall (Exact Score)**	**Overall (Rounded Score)**
Clean Cement and Concrete	1	1	1	1	2	**55**	**1**	2	2	2	1	**95**	**2**	1	1	**50**	**1**
Wind Turbine Manufacturing	0	1	1	1	2	**50**	**1**	2	2	1	1	**70**	**1**	1	2	**75**	**2**
Artificial Intelligence and Web 3.0	1	2	0	2	2	**55**	**1**	2	2	0	2	**50**	**1**	1	1	**50**	**1**
Heat Pump Manufacturing	0	1	0	2	1	**30**	**1**	2	2	1	2	**75**	**2**	1	2	**75**	**2**
Non-Conventional Construction Materials	0	1	0	1	2	**30**	**1**	1	2	1	1	**65**	**1**	1	1	**50**	**1**
Variable Speed Drive Manufacturing	0	1	1	0	1	**40**	**1**	1	2	1	0	**60**	**1**	1	2	**75**	**2**
Inverter Manufacturing	1	1	0	2	2	**40**	**1**	2	1	1	2	**60**	**1**	0	2	**50**	**1**
Concentrated Solar Tech. Manufacturing	0	1	1	1	2	**50**	**1**	1	1	1	1	**50**	**1**	0	2	**50**	**1**
Mechanical Storage Manufacturing	0	1	0	1	1	**25**	**1**	1	1	0	1	**25**	**1**	0	2	**50**	**1**
Fuel Cell Manufacturing	0	0	1	1	1	**30**	**1**	0	0	1	1	**30**	**1**	0	2	**50**	**1**
Concentrated Solar Power Development	0	1	0	2	1	**30**	**1**	1	1	1	2	**55**	**1**	0	1	**25**	**1**
Ocean Energy	0	0	1	1	0	**25**	**1**	1	0	1	1	**35**	**1**	0	2	**50**	**1**
Electric Vehicle Infrastructure	0	0	1	2	0	**30**	**1**	1	1	0	2	**30**	**1**	0	1	**25**	**1**
Small-Scale Nuclear Energy Development	0	0	1	0	1	**25**	**1**	2	1	1	0	**50**	**1**	0	1	**25**	**1**
Geothermal Energy Development	0	0	0	1	0	**5**	**0**	1	1	0	1	**25**	**1**	0	2	**50**	**1**

Sector	Socioeconomic & Innovation Potential					Investment & Capital Accessibility					Macroeconomic Co-Benefits and Resilience-Building							Integration into The Existing National Fabric					Overall Total	
	4.1 Job Creation Potential	4.2 Innovation Potential	4.3 Workforce Interest	**Overall (Exact Score)**	**Overall (Rounded Score)**	5.1 Required Capital	5.2 Bankability	5.3 Project Scalability	**Overall (Exact Score)**	**Overall (Rounded Score)**	6.1 Economic Resilience Support	6.2 Economic Diversification	6.3 Energy Security	6.4 Geopolitical Assertiveness	6.5 Supply Chain Security	**Overall (Exact Score)**	**Overall (Rounded Score)**	7.1 Infrastructure Adaptability	7.2 Existing Regulations	7.3 Strategy Alignment	**Overall (Exact Score)**	**Overall (Rounded Score)**	Overall Total (Exact Score)	Overall Total (Rounded Score)
Clean Cement and Concrete	2	0	0	**70**	**1**	0	1	1	**30**	**1**	1	2	0	1	2	**60**	**1**	1	1	2	**60**	**1**	62	62
Wind Turbine Manufacturing	1	0	0	**35**	**1**	0	1	0	**15**	**0**	2	1	2	1	2	**80**	**2**	2	2	1	**90**	**2**	61	61
Artificial Intelligence and Web 3.0	1	2	1	**60**	**1**	1	2	2	**80**	**2**	2	2	0	2	1	**70**	**1**	2	1	2	**80**	**2**	60	60
Heat Pump Manufacturing	1	0	0	**35**	**1**	1	1	1	**50**	**1**	1	2	1	0	2	**60**	**1**	2	2	1	**90**	**2**	59.5	60
Non-Conventional Construction Materials	2	2	0	**90**	**2**	1	1	2	**65**	**1**	2	2	1	0	2	**70**	**1**	2	1	1	**70**	**1**	58.5	59
Variable Speed Drive Manufacturing	1	0	1	**40**	**1**	1	1	1	**50**	**1**	1	2	1	0	1	**50**	**1**	2	2	1	**90**	**2**	58	58
Inverter Manufacturing	1	0	1	**40**	**1**	1	1	1	**50**	**1**	1	2	2	1	1	**70**	**1**	2	2	1	**90**	**2**	55	55
Concentrated Solar Tech. Manufacturing	1	1	0	**45**	**1**	1	0	1	**35**	**1**	1	1	2	1	2	**70**	**1**	2	2	1	**90**	**2**	54	54
Mechanical Storage Manufacturing	1	1	0	**45**	**1**	2	1	1	**70**	**1**	1	1	2	1	2	**70**	**1**	1	2	1	**70**	**1**	45.5	46
Fuel Cell Manufacturing	1	2	1	**60**	**1**	0	0	1	**15**	**0**	0	1	2	1	1	**50**	**1**	2	2	1	**90**	**2**	43.5	44
Concentrated Solar Power Development	1	1	2	**55**	**1**	0	1	1	**30**	**1**	1	1	2	0	1	**50**	**1**	2	0	1	**50**	**1**	40.5	41
Ocean Energy	0	2	2	**30**	**1**	1	0	2	**50**	**1**	1	1	2	0	2	**60**	**1**	1	0	1	**30**	**1**	39	39
Electric Vehicle Infrastructure	1	1	1	**50**	**1**	1	1	1	**50**	**1**	1	1	0	0	2	**40**	**1**	1	2	2	**80**	**2**	39	39
Small-Scale Nuclear Energy Development	1	2	2	**65**	**1**	0	0	1	**15**	**0**	2	1	2	2	1	**80**	**2**	0	0	0	**0**	**0**	36	36
Geothermal Energy Development	1	1	2	**55**	**1**	0	0	1	**15**	**0**	1	1	2	0	2	**60**	**1**	2	0	1	**50**	**1**	34	34

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