Human Capital - Energy Sovereignty of Kazakhstan

Introduction

Energy sovereignty is conventionally understood through the lens of physical infrastructure: pipelines, power plants, transmission grids, and the natural resources reserves that feed them. It is usually measured in barrels per day, gigawatts of installed capacity, and the diversification of supply routes. Yet this framing, however analytically useful, complicates a dependency that is no less strategic and substantially harder to build: the human capital[1] that designs, operates, maintains, and governs energy systems. Without a sufficient, skilled, and nationally rooted workforce, even the most resource-rich country remains operationally dependent on external expertise, vulnerable to "brain drain", and unable to exercise true sovereignty over its own energy future.

The country's three flagship hydrocarbon projects: Tengizchevroil [TCO], North Caspian Operating Company [NCOC], and Karachaganak Petroleum Operating [KPO], were structured under a stabilized contract and production sharing agreements [PSAs] negotiated in the 1990s, when Kazakhstan lacked capital, technology, and an up-to-date skilled workforce to develop its reserves independently. Three decades later, those agreements are approaching expiry, and the question of whether Kazakhstan has built the human capital necessary to assume true operational control is both urgent and unresolved. Simultaneously, the country faces mounting demand for more technologically advanced workforce competencies across emerging energy domains: the nuclear fuel cycle, as Kazakhstan advances its civilian nuclear programme; clean coal technologies, as reflected in the National Coal Generation Plan targeting 7.6 gigawatts [GW] of generation capacity; and the application of artificial intelligence in energy operations, from predictive maintenance to grid optimization. These domains require a workforce profile that Kazakhstan's current educational and training systems are not yet calibrated to supply in full.

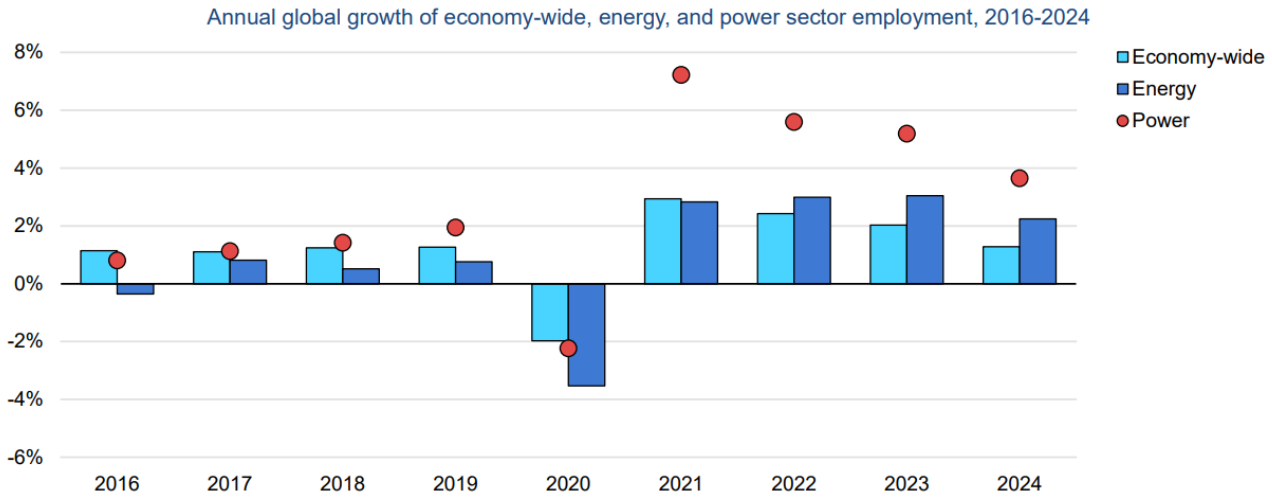
The concept of energy sovereignty in human capital refers to a country's capacity to staff, develop, retain, and govern its energy workforce in a manner consistent with its strategic interests and independent of foreign expertise. It is not a call for a "closed economy," but

[1] Human capital refers to the knowledge, technical skills, and professional competencies embedded in individuals, and should be distinguished from the concept of human resources which is mere the organizational function of managing personnel.

rather a framework for identifying the points at which human capital dependencies become vulnerabilities and for designing policies that reduce those vulnerabilities over time. The four methodological factors (diversification, infrastructure integrity and capacity management, geopolitical and physical security, and demand-side policy) are adapted from the energy sovereignty dimensions by ENERGY Insights & Analytics and reinterpreted through the lens of labor markets, skills, and institutional capacity.

Human Capital in the Global Energy Sector

Total energy sector employment reached 76 million workers in 2024 as per the World Energy Employment 2025 by the International Energy Agency [IEA], growing at 2.2% annually, nearly double the economy-wide rate of 1.3%. This growth is not evenly distributed: «clean» energy technologies, such as solar, wind, electric vehicles, heat pumps, and energy efficiency, now account for the majority of new energy jobs, while fossil fuel employment has plateaued or begun to decline in most advanced economies. The energy sector is not merely expanding; it is restructuring, and the skills it requires are changing faster than most national education and training systems can adapt.



Note: Power includes employment in power generation and transmission, distribution and storage

Source: World Energy Employment 2025, IEA [December 2025]

Applied technical workers, such as electricians, pipefitters, welders, instrumentation technicians, and process operators, now constitute 54% of the global energy workforce, more than double their 25% share in the broader economy. These are not roles that can be filled by retraining white-collar workers or importing "generic" labor; they require years of vocational training, hands-on experience, and sector-specific certification. Yet the pipeline of new entrants into these occupations is thinning precisely as demand accelerates.

Graduations from relevant vocational programs grew by only 9% between 2015 and 2022, while demand for applied technical workers increased by 16%. The gap between supply and demand is not temporary market friction; it is an observable deficit that is widening with each passing year.

Global occupational employment shares, economy-wide and energy sector related, 2024

Source: World Energy Employment 2025, IEA [December 2025]

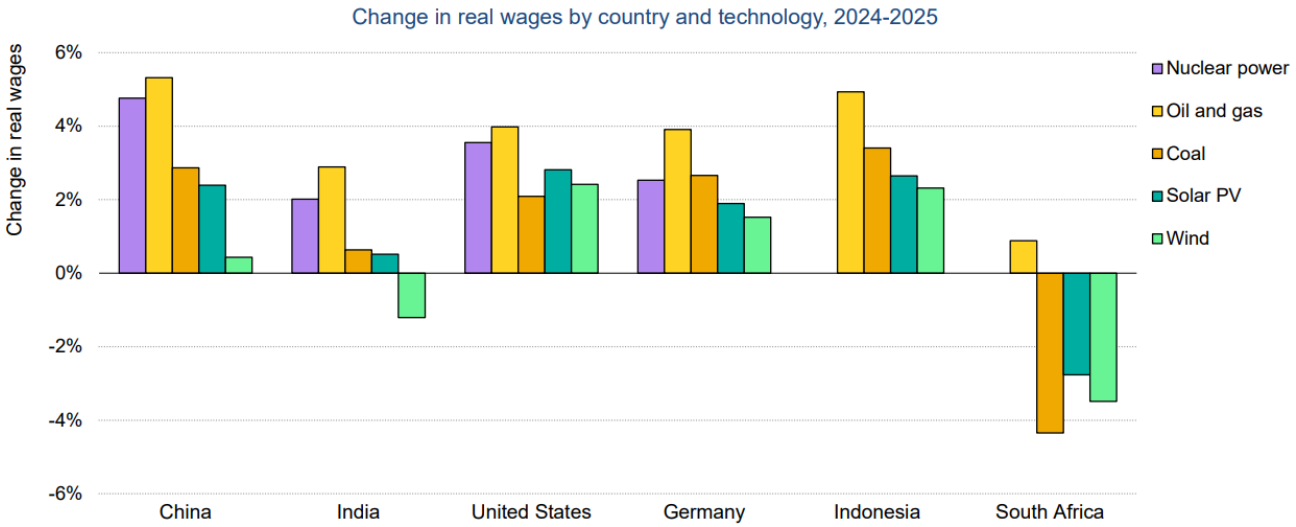
The aging of the existing energy workforce compounds this challenge. In many advanced economies, a significant share of the most experienced energy professionals, those who carry the tacit knowledge of complex operations that cannot be codified in manuals or transferred in classrooms, are within a decade of retirement. The energy sector's workforce is older than the economy-wide average in most regions, and the rate of youth entry has been declining, partly because of the sector's image problem and partly because of competition from the technology and finance industries, which offer comparable compensation with greater perceived prestige and flexibility. The result is a double squeeze: experienced workers leaving faster than they can be replaced, and new entrants arriving with skills that are not yet calibrated to the sector's evolving needs.

The talent shortage is not a future risk; it is a present operational constraint. 71% of energy sector employers report struggling to find the skilled talent they need, while 81% are actively recruiting for green jobs[2]. The financial stakes are correspondingly large: the global cost of delayed energy projects attributable to workforce shortages is estimated at $2 trillion, a figure that dwarfs the investment required to close the skills gap if it were deployed preventively.

Real wages in the energy sector have been rising across all subsectors, but the increases are not uniform. Oil and gas saw average real wage growth of 3.7% in 2025, the highest

[2] Green jobs refer to roles focused on building, operating, and maintaining "green/clean" and sustainable energy systems: renewables and energy efficiency to grid modernization and low-carbon technologies.

among energy subsectors, while nuclear followed at 3.2%. These premiums reflect genuine scarcity; the skills required for complex hydrocarbon operations and nuclear plant management are rare, internationally mobile, and in high demand from a shrinking pool of qualified candidates. For resource-rich developing countries like Kazakhstan, this creates a visible dilemma: the wage levels required to retain top technical talent in the domestic energy sector are increasingly set by international benchmarks, while the institutional capacity to compete for talent through compensation, career development, and working conditions remains uneven across employers and subsectors.



Source: World Energy Employment 2025, IEA [December 2025]

The global picture is of a sector growing rapidly, fundamentally restructuring, and facing a human capital bottleneck that threatens to become the binding constraint on energy evolution. For Kazakhstan, these global dynamics are not abstract; they are the external environment within which the country's own workforce vulnerabilities play out, and they set the terms of the international competition for talent that Kazakhstan must navigate if it is to achieve true energy sovereignty.

Sovereignty of the Energy's Human Capital

The four factors established by the methodological framework in the ENERGY Insights & Analytics article on energy sovereignty were reinterpreted through the lens of human capital, revealing a vulnerability that conventional energy security analysis tends to overlook: not the absence of reserves or the fragility of infrastructure, but the misalignment between the workforce Kazakhstan has and the workforce its energy ambitions require. Taken together, the four factors tell a comprehensible story: Kazakhstan's energy sector is not short of talent in the aggregate, but that talent is concentrated in the nonoptimal places, calibrated to the

unsuitable investment cycle, increasingly mobile across borders, and not being replenished at the rate or quality that the coming decade demands.

Diversification

In the context of energy sovereignty, diversification refers to a national energy system's capacity to distribute its workforce equitably across technologies, geographies, and employer types, so that no single sector, region, or corporate structure becomes a systemic dependency. A truly diversified energy workforce is one that can absorb shocks in any one segment without cascading into broader operational failure.

Constraints. The western regions (Atyrau, Mangystau, and West Kazakhstan) host the country's three flagship hydrocarbon projects: TCO, NCOC, and KPO. Together, these projects account for approximately 70% of Kazakhstan's total oil output and represent the primary destination for the country's most experienced petroleum engineers, drilling specialists, process technicians, and HSE professionals. The gravitational pull of these projects has effectively created a two-speed labor market: a high-wage, internationally benchmarked "enclave" in megaprojects, and a relatively less sophisticated technical workforce in the rest of the country. The National Company KazMunayGas group of companies bears a disproportionate share of the workforce development burden, as it is simultaneously expected to supply qualified Kazakh nationals to joint ventures, staff its own operations, and build the institutional capacity ahead of the TCO's stabilized contract and PSAs between 2033 and 2041.

Coal still accounts for approximately 74% of Kazakhstan's power generation, concentrated in the Ekibastuz basin in the Pavlodar region. This concentration is set to deepen rather than diminish: the National Coal Generation Plan envisions expanding Ekibastuz GRES-2 from 1 GW to 2.1 GW and constructing the new Ekibastuz GRES-3 at 2.64 GW, while the planned "Valley of Data Centers" in the region will generate substantial additional baseload demand anchored to coal-fired capacity. This creates a second geographic cluster of energy employment that needs attention.

Risks. A prolonged investment freeze at megaprojects would release a large cohort of highly specialized workers into a domestic labor market with limited absorptive capacity. In Ekibastuz, the risk is inverted: the planned expansion of GRES-2, construction of GRES-3, and the "Valley of Data Centers" create acute demand concentration in a single region, where workforce shortfalls will directly translate into delays in the delivery of critical energy capacity.

Strategic options. First, the government should develop geographic workforce strategies anchored in next-generation energy technologies (nuclear and clean coal), linking major infrastructure investments to technical training capacity outside Kazakhstan's West; the

proposed fourth refinery offers a concrete precedent for such geographic deconcentration of oil and gas employment. Second, geographic deconcentration of coal-related employment should be pursued through the National Coal Generation Plan, which envisages new and modernized heat and power plants in Kurchatov, Kokshetau, Semey, Oskemen, and Zhezkazgan. Third, workforce nationalization requirements across major energy projects should extend beyond headcount targets to include true competency and responsibility transfer; Kazakhstan needs more programs modelled on Chevron's initiative, under which five Kazakh nationals were selected for five-year placements at Chevron's headquarters to prepare for sovereign operational leadership.

Infrastructure integrity and capacity management

Within the energy sovereignty framework, infrastructure integrity and capacity management refer to the ability of a national energy workforce to sustain continuous, safe, and efficient operations across the full investment cycle. A workforce calibrated only to peak construction demand, or misaligned with the operational phase of major assets, represents a hidden threat to energy security.

Constraints. The primary constraint is the workforce transition generated by the conclusion of the construction phase of the TCO's Future Growth Project / Wellhead Pressure Management Project [FGP/WPMP], a $46.7 billion expansion of the Tengiz oilfield. At its peak, the project mobilized approximately 45,000 workers. With the FGP/WPMP entering operational mode in 2024, the long-term operational workforce required is a fraction of that figure, releasing large cohorts of non-operational workers.

Project delays at Kazakhstan's two most strategically important upstream assets compound the problem. At Kashagan, investors remain hesitant to proceed with further phases amid arbitration proceedings expected to stretch until at least 2028. At Karachaganak, the gas processing plant [GPP] construction has been mired in disputes over cost escalation and contractor control. The human capital consequence is ironic: the absence of active major project phases freezes the pipeline of vacancies that would normally absorb Kazakhstan's most experienced specialists, accelerating their emigration and/or absorption by international employers.

The wage premium in oil and gas creates a further constraint. Real wage growth of 3.7% in 2025, the highest of any energy subsector globally, concentrates Kazakhstan's best technical talent in hydrocarbons and makes cross-sectoral mobility extremely difficult. A technician who has spent a decade working at Tengiz or Kashagan is unlikely to accept a power sector role at a fraction of the salary, even where the national interest would be served by such a transition.

Risks. Demobilized FGP/WPMP workers without organized transition pathways face unemployment or emigration, depleting the national talent pool precisely when Kazakhstan's power sector requires an influx of qualified operations personnel. The IEA's World Energy Employment 2025 report confirms that globally, around 60% of energy companies already report labor shortages affecting infrastructure integrity.

Strategic options. Kazakhstan should develop a national energy workforce planning function with a longer horizon than existing efforts, such as "The workforce demand analysis for 2022–2024" by Atameken National Chamber of Entrepreneurs, mapping supply and demand across the full investment cycle. Stakeholders should consider wage-bridging mechanisms or retraining subsidies to incentivize mobility from oil and gas into power sector roles during periods of project inactivity. A replicable model already exists: the Ministry of Labor has proposed that Chevron establish advanced retraining centers for workers released between major project cycles, offering to scale the approach sector-wide.

Geopolitical and physical security

In the energy sovereignty framework, geopolitical and physical security refer to the degree to which a country's energy workforce is insulated from external pressures that could compromise its availability, loyalty, or operational effectiveness. These pressures take two principal forms: the outward flow of skilled nationals to more attractive labor markets abroad ["brain drain"], and the inward dependence on foreign expertise to fill roles the national workforce cannot yet perform ["the local content challenge"]. Both dynamics are present in Kazakhstan's energy sector and have intensified in recent years.

Constraints. Kazakhstan's migration picture has shifted materially: since 2023, the country has recorded a positive net migration balance for three consecutive years, reaching +16,153 in 2025, as inflows (23,761) significantly outpaced outflows (7,608). However, an emigration of 311,690 people over the 2015-2025 period represents an actual erosion of the country's human capital base that no short-term recruitment programme can easily reverse. The energy sector is particularly exposed because petroleum engineering, project management, and HSE credentials are internationally transferable, making Kazakh professionals trained at Tengiz, Kashagan, or Karachaganak highly attractive to employers in the Gulf, Europe, and beyond. The local content challenge is equally consequential: KazMunayGas's share in megaprojects is limited to one-fifth or less, and the nationalization of ~~key~~ technical roles remains incomplete.

Risks. Kazakhstan can face a progressive hollowing-out of the mid-career technical cohort - the engineers, project managers, and HSE specialists who form the operational backbone of the energy sector. If Kazakhstan approaches stabilized contract and PSAs expiry in the 2030s without a cadre of nationals capable of operating these assets self-sufficiently, it will face a

stark choice between extending agreements on unfavorable terms or accepting operational deterioration of assets. The combination of outward brain drain and incomplete nationalization of the workforce creates a compounding vulnerability: the country simultaneously loses the professionals it has trained and remains dependent on foreign expertise it cannot fully control.

Strategic options. The strategic response requires both defensive and offensive measures. Defensively, Kazakhstan should develop and enforce a national retention strategy addressing non-wage drivers of emigration, including environmental quality, housing affordability, and institutional transparency, alongside competitive compensation benchmarking. Offensively, the government should require all major employers across the oil and gas and power sectors to take direct responsibility for developing and retaining the talent they will need - investing now in training pipelines, succession planning, and long-term workforce commitments ahead of future demand. KAZENERGY's led Sectoral Agreement for 2026-2028 provides an existing institutional platform for embedding these commitments in a social partnership framework.

Demand-side policy

In the energy sovereignty framework, demand-side policy refers to the instruments through which the state and industry shape the supply, quality, and distribution of energy workforce skills not by directly employing workers, but by influencing the educational pipeline, qualification standards, wage-setting mechanisms, and social partnership structures. This is the most institutionally complex of the four factors, requiring coordination across ministries, educational institutions, employers, and labor representatives, with effects operating over long-term time scales.

Constraints. Established universities supply the bulk of petroleum engineers, power systems, and technical graduates. Examples include the Kazakh British Technical University, Satbayev University, Utebayev Atyrau University of Oil and Gas, and the Almaty University of Power Engineering and Telecommunications. The vocational system, which is the primary pipeline for applied technical workers who constitute 54% of the global energy workforce, remains underdeveloped and underutilized: graduations from relevant programs grew by only 9% between 2015 and 2022, while demand increased by 16%. This is a global figure, but it likely applies to Kazakhstan as well. Even if it does not, the resulting international talent competition pulls skilled workers out of the country. A persistent prestige differential between university and vocational education further suppresses enrollment in the trades, the sector most urgently needs.

At the institutional level, the National Qualifications System [NQS], aligned with the Sectoral Agreement for 2026–2028 led by the KAZENERGY Association, represents a significant step in connecting collective bargaining to the qualifications architecture, though the practical impact depends on the quality and pace of implementation. At the social partnership level, the General Agreement for 2024-2026 and its successor for 2026–2028 establish wage floors,

occupational health standards, and professional development obligations that help energy employers compete for talent. This architecture is a genuine institutional asset, but its effectiveness depends on whether commitments translate into measurable workforce outcomes rather than remaining declarative.

Risks. A continued 9% tech graduation growth rate against 16% demand growth implies a widening workforce deficit. As noted above, these are global figures, but the same logic applies to Kazakhstan-specific risks as well, given the intensifying international talent competition. Fewer than 25% of energy firms globally report meaningful involvement in curriculum development. This is a gap that, if replicated in Kazakhstan, would mean the vocational system will continue producing graduates misaligned with industry needs.

Strategic options. Kazakhstan should scale up investment in vocational education for energy-relevant trades, aiming to achieve a meaningful increase in graduates by the end of the current decade. Expanding training capacity globally would require approximately $2.6 billion per year, less than 0.1% of global public education spending, suggesting that the binding constraint is institutional coordination rather than fiscal capacity. The Sectoral Qualification Council's activities should be formalized through mandatory employer co-design requirements for vocational programs, with annual compliance reporting. The prestige gap should be addressed through a specialized scholarship and wage premium scheme for graduates of priority energy trades, modeled on approaches proven effective in Germany and South Korea. Kazakhstan can accelerate this process by leveraging its existing network of international university branches alongside specialized vocational centers such as the APEC Training Center, where curricula are already aligned with industry standards.

The Bottom Line

Kazakhstan's energy future will not be determined solely by the volume of its hydrocarbon reserves, the capacity of its power grid, or the terms of its production sharing agreements. It will be determined, in equal measure, by whether the country can build, retain, and deploy the human capital necessary to operate its energy system with true sovereignty. Kazakhstan faces a set of serious, interconnected, and addressable vulnerabilities, but only if they are recognized as strategic priorities rather than administrative inconveniences.

The four factors examined in the article (diversification, infrastructure integrity and capacity management, geopolitical and physical security, and demand-side policy) are not independent variables. They form a system of interdependencies in which weakness in one dimension amplifies vulnerability in others. The geographic concentration of skilled labor in the western oil and gas region makes the system less resilient to project delays. Project delays, in turn, accelerate brain drain by eliminating the domestic career opportunities that might otherwise retain experienced professionals. The cumulative outflow of skilled

specialists (even amid a positive overall migration balance since 2023) has eroded the technical competencies needed for long-term workforce self-sufficiency. In turn, the weakness of the vocational training pipeline means that the next generation of energy workers is not being produced at the scale or quality required to address any of these challenges. Breaking this cycle demands not incremental adjustments but a coherent, cross-cutting human capital sovereignty strategy.

Several elements of such a strategy are already visible in Kazakhstan's institutional landscape. The up-to-date Social partnership framework, the emerging National Qualifications System, the broadening of workforce development obligations to all employers in the oil and gas and power sectors, the network of international university branches and specialized vocational centers, and the government's stated commitment to new technology adoption all provide platforms on which a more ambitious human capital sovereignty policy could be built. What is missing is the integrating logic - the recognition that workforce development is not a social policy add-on to energy investment, but a core component of energy security in its own right.

The worldwide competition for energy talent is intensifying, wages in the most sought-after specializations are rising at rates that outpace domestic salary benchmarks, and the new tech/AI is creating new skill demands that existing educational systems are struggling to meet. Kazakhstan is not uniquely exposed to these pressures, but its unique combination of constraints and risks means that the window for building true energy sovereignty in human capital is narrower than it might appear. The country that manages this transition will not only secure its energy future; it will have demonstrated that resource wealth and human capital development are not alternatives but complements and that sovereignty, in the twenty-first century, is ultimately a function of the people who make a system work.

ENERGY Insights & Analytics

Analytical center "ENERGY" LLP (ENERGY Insight & Analytics) is a joint venture between the KAZENERGY Association and the IT company AppStream. The company aims to become a priority source of data, analytical information, and recommendations for Kazakhstan's oil, gas, and electric power industries, allowing decision-makers to analyze and predict the most significant industry indicators with details on leading market players. Activities of ENERGY Insight & Analytics incorporate the whole analytics cycle with consequent stages: Descriptive, Diagnostic, Predictive, and Prescriptive analytics.

The key tool and product of ENERGY Insight & Analytics is internally developed software - the Analytical Platform EXia, aimed to identify, localize, format, and present data most efficiently for the specified use cases.

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