

Regulating Technology Transfer for Development: Addressing Infrastructure and Capability Gaps in Cameroon

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ABSTRACT

Technology transfer is frequently presented as a pathway through which developing countries can accelerate economic development. Across Africa, governments increasingly look to innovation, digital transformation and emerging technologies as answers to long-standing structural challenges. However, experience shows that technology on its own does not automatically produce development. Where infrastructure is unreliable, institutions are fragmented and regulatory systems lack coordination, even advanced technologies struggle to generate lasting impact. This article examines technology transfer in Cameroon through the innovation-infrastructure lens, arguing that the failure of technology transferred to translate into development, is rooted less in the absence of technology, but more in the inadequacy of the infrastructures that support its absorption and use. Adopting a doctrinal and qualitative methodology, the study analyzes the legal and regulatory environment governing technology transfer and identifies key infrastructural constraints and capability gaps, with particular attention to the energy sector. It demonstrates that, Cameroon has made progress in facilitating access to foreign technology, regulatory fragmentation, infrastructural deficits and capability gaps continue to impede effective learning, adaptation and diffusion. This means that, technology is introduced but not domesticated. The article thus, contends that regulating technology transfer for development requires moving beyond innovation-focused only, towards governance strategies that prioritize infrastructure development, institutional coherence and long-term capability building. It concludes by advancing context-specific recommendations aimed at aligning technology transfer regulation with Cameroon's development realities.

Key Words: Africa, Cameroon, capability building, development, energy sector, infrastructure, regulatory reform, technology transfer.

INTRODUCTION

Across Africa, governments and development partners increasingly frame innovation, digital transformation and emerging technologies as engines of growth, capable of overcoming long-standing structural constraints. Despite this emphasis, Africa continues to occupy a marginal position in global technological production, accounting for less than one 1% of global patent applications and exhibiting limited domestic technological capability.¹ The emerging consensus is that where basic infrastructure is weak, innovation risks becoming superficial, that is, it will be present, but not transformative.² Research has shown that, persistent deficits in electricity, transport, telecommunications and digital infrastructure continue to reduce economic growth and productivity across the continent.³ The critical question here is that, should African economies prioritize building new technologies, or fixing what is already broken? The implication is that; innovation cannot thrive in isolation. Digital platforms for example require reliable electricity, broadband connectivity, skilled labour and predictable regulation.

¹ Tech in Africa. (2025). *Africa's technology transfer gap: Innovation without infrastructure*.

<https://techinafrica.com/reports/technology-transfer-gap-2025>.

² Brookings Institution. (2025). *Africa's infrastructure paradox: Why access does not equal impact* (pp. 4–9).

<https://www.brookings.edu/articles/africas-infrastructure-paradox>.

³ African Development Bank Group. (2024). *African economic outlook 2024: Driving Africa's transformation through inclusive growth* (pp. 71–89).

Advanced technologies demand institutions capable of governance, enforcement and learning. Without these foundations, technology transfer may increase access to tools without generating the capabilities needed to use them productively.

This tension is clearly reflected in the Cameroon, where over the past decades, the country has actively sought access to foreign technology through multiple channels, including foreign investment, infrastructure projects, digital services and cross-border partnerships. Advanced machinery, telecommunications networks and digital platforms are now present across key sectors of the economy. Yet, these technological inflows have not produced corresponding gains in domestic innovation, industrial upgrading or technological self-reliance.⁴ The persistence of this gap raises a fundamental question as to why technology transfer fails to deliver development goals that meet local realities.

1.1 Technology Transfer Imperative in African Development

Technology transfer has emerged as a central mechanism through which developing economies can accelerate industrialization, enhance productive capacity and achieve sustainable development objectives in an increasingly knowledge-intensive global economy. This recognition is reflected in the Sustainable Development Goals, especially SDG 17⁵ which explicitly frames international cooperation on technology transfer as essential for reducing global inequalities and achieving shared prosperity. The urgency of technology transfer in Africa becomes clearer, when viewed against the continent's exposure to contemporary development challenges. Climate change continues to impose disproportionate economic and human costs, while limited access to adaptation and mitigation technologies constrain effective responses.⁶ The COVID-19 pandemic further exposed structural weaknesses in technological capability, especially in pharmaceutical production. Africa remained heavily dependent on external suppliers for vaccines and essential medical technologies.⁷ At the same time, although digital technologies present opportunities for economic leapfrogging, large parts of the continent remain digitally disconnected, with internet usage and digital skills lagging behind global averages.⁸ Yet, despite the existence of international and regional frameworks such as TRIPS, OAPI and the African Continental Free Trade Area, technology transfer outcomes remain limited.⁹ Existing literature records barriers including regulatory fragmentation, infrastructure deficits and weak absorptive capacity, but enough attention has not been paid to how these factors interact to reinforce one another within national regulatory systems. Understanding this interaction is essential for designing regulatory approaches that move technology transfer beyond access toward meaningful capability building.

1.2 Rationale for Regulatory Support of Infrastructural Development

⁴ United Nations Conference on Trade and Development. (2023). *World investment report 2023: Investing in sustainable energy for all* (pp. 145–156). <https://unctad.org/publication/world-investment-report-2023>.

⁵ <https://www.google.com/search?client=firefox-b-d&q=sustainable+development+goals>.

⁶ United Nations Conference on Trade and Development. (2025). *Technology and innovation report 2025: Climate resilience and green transitions*. UNCTAD. <https://unctad.org/publication/technology-and-innovation-report-2025>

⁷ United Nations Economic Commission for Africa. (2023). *Building pharmaceutical manufacturing capacity in Africa*. UNECA. <https://www.uneca.org/publications/pharmaceutical-manufacturing-africa>.

⁸ World Bank. (2024). *Africa's pulse: Digital transformation and inclusive growth*. World Bank Group. <https://www.worldbank.org/en/publication/africas-pulse>.

⁹ These are legal frameworks which govern intellectual property protection, trade, and technology-related economic integration in Cameroon. TRIPS provides the global baseline by setting minimum standards for intellectual property protection and recognizing technology transfer as a development objective, albeit largely through soft and non-enforceable provisions. OAPI operationalizes these standards at the regional level through a centralized patent and IP system under the Bangui Agreement, harmonizing protection across member states but placing limited emphasis on mandatory technology transfer or local capacity development. The AfCFTA, at the continental level, seeks to promote industrialization, regional value chains, and innovation-led growth, with emerging protocols that may support technology diffusion, though these mechanisms remain largely aspirational and underdeveloped. These frameworks prioritize market access, legal certainty, and rights protection, but they lack effective coordination and enforceable obligations aimed at ensuring that intellectual property protection translates into meaningful technology transfer and domestic capability building.

It is important to note that much of the existing literature on technology transfer, approaches regulation and infrastructure as distinct areas of research. Legal and policy studies, tend to examine regulatory frameworks in isolation, focusing on intellectual property regimes, licensing rules, approval procedures and the coherence of investment and innovation policies.¹⁰ In parallel, infrastructure-oriented research highlights deficits in electricity, telecommunications, transport networks and digital connectivity, analyzing how these constraints limit technology adoption and utilization.¹¹ While both strands recognize that regulation and infrastructure shape technology transfer outcomes, they rarely examine how these factors interact in practice or how regulatory design is influenced by persistent infrastructural constraints. This separation obscures important dynamics, given that regulatory frameworks do not operate independently of infrastructural realities. In contexts where, for instance, access to electricity remains limited and digital connectivity is uneven, regulators are asked to approve technology transfer arrangements that depend on infrastructure that does not yet exist at scale.¹² Institutional capacity constraints within regulatory agencies, often linked to shortages of technical expertise and resources, further shape regulatory behaviour. Rather than implementing systematic, risk-based oversight, regulators may rely on transaction-by-transaction approval mechanisms as a way of managing uncertainty and protecting scarce public resources.¹³ However, this approach creates delays and unpredictability that discourage technology partnerships, even where formal approvals are eventually granted. At the same time, regulatory architecture influences infrastructure investment and technology diffusion. Transaction-intensive regulatory systems, characterized by fragmented authority and overlapping approvals, increase the costs and risks associated with technology-intensive projects, thereby discouraging the very investments needed to close infrastructure gaps.¹⁴ Regulatory uncertainty surrounding cross-border data transfers, which are essential for cloud services and digital platforms, further constraining digital infrastructure development.¹⁵ Over time, these dynamics produce a self-reinforcing cycle in which weak infrastructure limits absorptive capacity, prompting restrictive regulation that raises transaction costs and deters investment, thereby perpetuating infrastructural and institutional weaknesses. Understanding technology transfer therefore requires moving beyond isolated barriers to examine the systemic interaction between regulation, infrastructure and capability formation.

1.3 Technology Transfer Governance in Cameroon

Cameroon offers a particularly revealing context for examining how regulation and infrastructure shape technology transfer outcomes. As the economic anchor of the Central African Economic and Monetary Community (CEMAC) and host to the headquarters of the African Intellectual Property Organization (OAPI) in Yaoundé, Cameroon occupies a position of both regional influence and regulatory exposure. The country's long-term development strategy, Vision 2035, explicitly seeks to transform Cameroon into an emerging economy, a goal that necessarily depends on substantial technological upgrading across agriculture, manufacturing and infrastructure.¹⁶ Despite this ambition, technology transfer outcomes remain modest. Investment in research and development hovers around 1% of GDP, while firm-level engagement in technology transfer activities has been described as negligible, indicating persistent weaknesses in domestic technological capability.¹⁷

The regulatory environment governing technology transfer in Cameroon is also characterized by a several fragmented governance structure. At the regional level, OAPI administers intellectual property rights for

¹⁰ Pela, R. (2023). Intellectual property regulation and technology diffusion in developing countries. *Journal of Law, Technology & Development*, 15(2), 201–224.

¹¹ United Nations Economic Commission for Africa. (2024). *Economic report on Africa 2024: Transforming Africa's institutions for inclusive growth*. UNECA. <https://www.uneca.org/era2024>

¹² Brookings Institution. (2025). *Africa's infrastructure paradox: Why access does not equal impact*. <https://www.brookings.edu/articles/africas-infrastructure-paradox>

¹³ U.S. Department of State. (2025). *Investment climate statements: Cameroon*. <https://www.state.gov/reports/2025-investment-climate-statements/cameroon/>

¹⁴ Supra, note 8

¹⁵ LexAfrica. (2025). *Cameroon's new data protection regime: Implications for technology and cross-border data flows*. <https://lexafrica.com/2025/01/cameroon-data-protection-law>

¹⁶ World Intellectual Property Organization. (2024). *WIPO Director General's visit to Cameroon: Strengthening innovation ecosystems*. https://www.wipo.int/about-wipo/en/news/2024/news_0003.html

¹⁷ United Nations Economic Commission for Africa. (2023). *Technology transfer and industrial development in Africa* (pp. 22–29).

seventeen member states through the Bangui Agreement, creating a “one jurisdiction” system under which a single registration confers protection across all member countries.¹⁸ While this arrangement offers administrative efficiencies and legal certainty for rights holders, it significantly limits national flexibility to tailor intellectual property policy to local technology transfer and innovation needs. These limitations were openly acknowledged during the 2024 visit of the Director General of the World Intellectual Property Organization, who called for a shift away from registration-focused administration toward more innovation-oriented institutional mandates.¹⁹ At the sub-regional level, CEMAC frameworks regulate financial transfers, telecommunications, and cross-border economic activity, introducing additional approval requirements and compliance layers.²⁰ At the national level, sector-specific rules are administered by multiple ministries and agencies, often without effective coordination or shared regulatory objectives.²¹ Constraints in electricity supply, telecommunications networks, transport systems, and digital connectivity continue to limit the effective absorption and use of transferred technologies, even where access is formally secured. These regulatory complexities operate against a backdrop of significant infrastructure deficits. This cuts cross Africa, where inadequate infrastructure is estimated to reduce economic growth by up to 2% annually and to lower productivity by as much as forty per cent, challenges that Cameroon shares in full.²²

Table 1: Regulatory Fragmentation in Cameroon’s Technology Transfer Governance

Governance Level	Relevant Law / Instrument	Responsible Institution(s)	Coordination Gaps / Conflicts
International (TRIPS)	TRIPS Agreement (WTO, 1994); Art. 66.2	WTO / Ministry of Trade	Obligations largely aspirational; no domestic enforcement mechanism
Regional IP (OAPI)	Bangui Agreement (Revised 2015); Annex I (Patents)	OAPI (Yaoundé); Ministry of Scientific Research	Centralized registration limits national flexibility; no compulsory licensing coordination
Sub-regional (CEMAC)	CEMAC Regulation on Financial Transfers; Telecom Framework Directive	BEAC; CEMAC Commission; MINPOSTEL	Overlapping approvals for cross-border transfers and ICT licensing; delays in tech-intensive FDI
National – Energy	Law No. 2011/022 (Electricity Sector); Decree 2012/0882 (ARSEL)	ARSEL; MINEE; ENEO	Split mandates between ARSEL and MINEE; unclear jurisdiction over renewable energy transfers
National – Data & Digital	Law No. 2024/017 (Data Protection); Law No. 2010/012 (Cybersecurity)	APDP (not yet operational); ANTIC; MINPOSTEL	APDP non-operational; inconsistency between

¹⁸ OAPI. (2023). *Bangui Agreement (as revised)*. African Intellectual Property Organization.

<https://www.oapi.int>

¹⁹ Supra, note 16

²⁰ Chambers and Partners. (2025). *Investing in the CEMAC region: Regulatory and financial controls*.

<https://practiceguides.chambers.com>

²¹ Op.cit

²² United Nations Economic Commission for Africa. (2024). *Economic report on Africa 2024: Transforming Africa’s institutions for inclusive growth* (pp. 71–89).

<https://www.uneca.org/era2024>

Governance Level	Relevant Law / Instrument	Responsible Institution(s)	Coordination Gaps / Conflicts
			cybersecurity and data protection regimes
National – Investment	Investment Charter (Law No. 2002/004); CEMAC Foreign Investment Code	API; Ministry of Finance; Ministry of Trade	No single-window authority; parallel approvals; no technology content requirements

Source: Compiled from OAPI Bangui Agreement (2015); CEMAC Regulations; Republic of Cameroon Legislation; U.S. Department of State Investment Climate Statements (2025); WIPO (2024).²³

Recent regulatory developments in Cameroon, further illustrate the interaction between legitimate policy objectives and institutional capacity gaps. Law No. 2024/017 on personal data protection introduces comprehensive controls over cross-border data transfers, a core component of contemporary technology partnerships involving cloud services, software platforms and digital applications.²⁴ Although firms have been granted a transition period to align with the new framework, the Personal Data Protection Authority has yet to become operational, creating uncertainty around compliance standards and approval procedures. This combination of ambitious regulation and weak implementation capacity exemplifies how regulatory frameworks, even when well-intentioned, can unintentionally raise transaction costs and deter technology-intensive investment. Taken together, Cameroon reflects many of the broader challenges facing technology transfer across Africa, while also offering specific insights into how regional harmonization frameworks interact with national institutional and infrastructural realities. As host of OAPI, Cameroon provides a unique vantage point on the consequences of regional intellectual property integration for domestic innovation policy. As a CEMAC member, it illustrates the tensions between sub-regional coordination and national development priorities. And as a lower-middle-income country pursuing rapid transformation under Vision 2035, it highlights the difficulty of leveraging technology transfer for development where regulatory complexity and infrastructure gaps continue to constrain absorptive capacity.

INFRASTRUCTURE AND CAPACITY GAPS IN CAMEROON’S TECHNOLOGY TRANSFER REGULATION

Even when regulatory obstacles are overcome and technology partnerships successfully negotiated, infrastructure deficits fundamentally constrain the capacity to absorb, adapt and effectively utilize transferred technologies. This section deals with limitations in key infrastructures such as electricity, telecommunications, digital connectivity and human capital deficiencies, that create absorptive capacity barriers which interact with regulatory impediments to generate compound effects exceeding the sum of individual obstacles. The idea of absorptive capacity, first developed by Cohen and Levinthal,²⁵ explains how firms learn from and use external knowledge, which is useful for understanding technology transfer at the national and institutional level. By this, it is underscored that, technology transfer does not succeed simply because laws allow it or contracts are approved. It rather depends on whether a country has the basic conditions needed to actually use what is transferred. For example, reliable electricity is required to run digital systems and industrial equipment. Another important aspect is human capital, people with the skills to operate, maintain and adapt new technologies to local

²³ OAPI Bangui Agreement (2015); CEMAC Regulations; Republic of Cameroon Legislation; U.S. Department of State Investment Climate Statements (2025); WIPO (2024)

²⁴ Republic of Cameroon. (2024). *Law No. 2024/017 of 23 December 2024 on the protection of personal data*. Official Gazette.

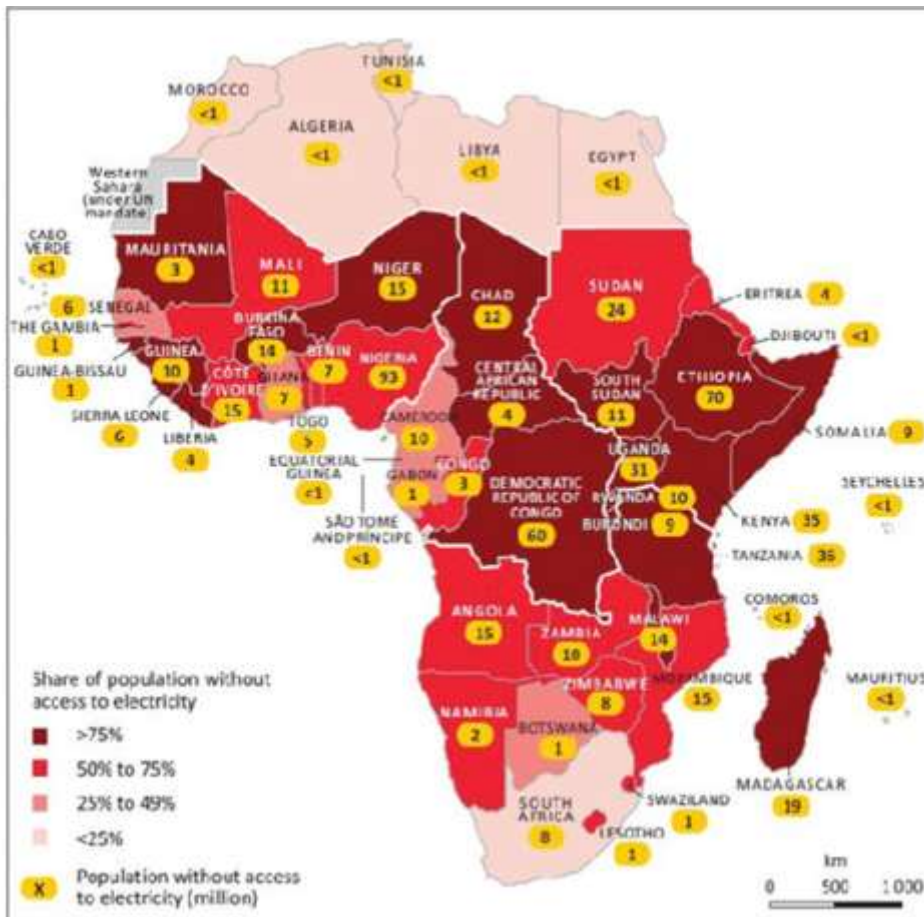
²⁵ Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128-152. <https://doi.org/10.2307/2393553>

conditions are often overlooked.²⁶ Where these foundations are weak or uneven, transferred technologies often remain underused or fail to deliver meaningful benefits. This is the reality that shapes regulatory behaviour. Faced with limited infrastructure and skills, regulators may become cautious, relying on strict, transaction-by-transaction approvals in an effort to manage risk and accountability. While understandable, this approach can unintentionally discourage technology partnerships, reinforcing a cycle in which weak absorptive capacity justifies restrictive regulation and restrictive regulation further limits opportunities to build capacity.

2.1 Energy Infrastructure Constraints and Limitations on Development

Electricity is not a sector on its own, but can be viewed as a backbone that sustains all modern economic and social activity. Without reliable energy, technology transfer, infrastructural development and institutional reform cannot translate into real outcomes. Reliable electricity is the most basic requirement for modern technology transfer, yet it remains one of Africa’s most persistent structural weaknesses. No energy will mean no development. Across the continent, nearly 600 million people, about 43% of the population, still lack access to electricity, with sub-Saharan Africa accounting for the largest share of this deficit.²⁷ The breakdown by population shown in the image below highlights the scale and uneven distribution of electricity access across the African continent.

Figure 1- Electricity Access Deficits Across Africa²⁸



The figure above, shows both the percentage of the population without electricity (using color intensity) and the absolute number of people affected in millions (shown in yellow circles). Even where grid connections

²⁶ Hafeez, A., Shamsuddin, A. B., & Saeed, B. (2023). An empirical investigation of absorptive capacity on technology transfer effectiveness through organizational innovation. *International Journal of Professional Business Review*, 8(2), e01550. <https://doi.org/10.26668/businessreview/2023.v8i2.1550>

²⁷ Brookings Institution. (2025). *Africa’s electricity access gap and economic consequences*. <https://www.brookings.edu>.

²⁸ <https://qph.cf2.quoracdn.net/main-qimg-a1d05455a9d97a10ce46c925aa667c44>

exist, electricity supply is often unstable, marked by frequent outages, voltage fluctuations, and rationing during peak demand periods. As seen in the figure, Sub-Saharan Africa is the most affected region, with many countries, particularly in Central, East and parts of West Africa having more than 75% of their population without access to electricity. Countries such as Nigeria, Ethiopia, the Democratic Republic of Congo and Niger stand out, not only for high percentages but also for very large absolute numbers of people living without power. North African countries like Morocco, Algeria, Tunisia, Egypt, show comparatively low electricity access deficits, reflecting stronger grid development and higher levels of infrastructure investment. It should be noted that, population size matters: Nigeria and Ethiopia illustrate that even where access rates improve, the sheer size of the population means tens of millions remain without electricity, creating enormous pressure on development planning. The implication for development is that, regions with the darkest shading correspond closely with areas facing challenges in industrialization, healthcare delivery, digital connectivity, education and technology adoption. This reinforces the idea that electricity access is not just an infrastructure issue but a foundational development constraint.

These disruptions impose direct economic costs. African businesses are estimated to lose between 2% and 4% of annual sales due to power outages, with technology-intensive firms suffering even greater losses when interruptions corrupt data, damage equipment, or halt digital operations altogether.²⁹ Cameroon reflects these continental challenges in particularly stark form. While national electrification stands at approximately 62%, this figure conceals sharp inequalities between urban and rural areas. Urban centers enjoy access rates of about 92%, whereas rural regions, home to roughly 43% of the population struggle with access levels closer to 20%.³⁰ Installed generation capacity of around 1,600 MW falls short of peak demand exceeding 1,800 MW, making load shedding a regular feature of the power system.³¹ Cameroon's heavy reliance on hydroelectric power, which supplies roughly three-quarters of national generation, further exposes the system to seasonal vulnerabilities during dry periods when water levels drop and output declines. Electricity transmission and distribution remain under the control of the state-linked utility ENEO, whose network suffers from chronic underinvestment. Transmission losses approach 25%, aging infrastructure breaks down frequently, and maintenance backlogs undermine service reliability.³² As a result, many industrial and technology-oriented businesses rely on diesel generators to maintain operations, increasing electricity costs by an estimated 15–30%. For technology-intensive activities such as data centers, telecom infrastructure and digital services, intermittent power is not merely inconvenient; it fundamentally undermines feasibility. These technologies require consistent power quality, not just occasional availability, regardless of whether regulatory approvals for technology transfer have been secured.

2.1.1 Cross-Sectoral Development Effects of Energy Infrastructure on Development

Electricity constraints affect technology transfer in different ways depending on the type of technology involved and the sector. Energy infrastructure underpins the functioning of all modern economic and social systems. Where power supply is unstable or unavailable, the benefits of technology transfer are significantly reduced, regardless of regulatory approvals or investment inflows. Electricity constraints therefore shape development outcomes unevenly across sectors, affecting how different types of technologies perform and the extent to which they contribute to broader economic and social transformation. Reliable electricity is not only essential for basic services but also determines whether transferred technologies can be effectively deployed, maintained, and scaled. The following sectors further illustrate this.

2.1.1.1 Hygiene and Sanitation

Reliable energy infrastructure is a foundational requirement for effective hygiene and sanitation systems, especially in contexts where modern water and waste management technologies have been introduced through technology transfer. Electricity is essential for the operation of water abstraction, treatment, purification,

²⁹ African Finance Corporation. (2025). *State of Africa's infrastructure report 2025*. AFC.

³⁰ *ibid*

³¹ U.S. Department of State. (2025). *Investment climate statements: Cameroon*. <https://www.state.gov>

³² *ibid*

pumping, storage, and distribution systems, as well as for sewage collection and wastewater treatment facilities. Where electricity supply is unreliable, waterborne diseases increase, sanitation systems fail, and public health risks rise sharply.³³ Technologies such as chlorination units, ultraviolet (UV) disinfection systems, membrane filtration plants, and mechanized boreholes are all energy-dependent. Where electricity supply is unstable or absent, these technologies cannot function consistently, regardless of their availability or technical sophistication. In settings characterized by frequent power outages, transferred water and sanitation technologies often operate below capacity or are abandoned entirely, leading to system breakdowns and service discontinuity. This significantly undermines public health outcomes, as interruptions in water treatment and waste disposal increase exposure to waterborne and sanitation-related diseases. The World Health Organization identifies unreliable electricity supply as a key structural constraint affecting the sustainability of water, sanitation, and hygiene (WASH) interventions in low- and middle-income countries.³⁴ From a technology transfer perspective, the absence of reliable energy infrastructure reduces the absorptive and operational capacity of recipient communities and institutions. Imported sanitation technologies are often designed for environments with stable electricity and minimal downtime. When deployed in energy-constrained contexts, these technologies require frequent adaptation, manual overrides, or costly backup solutions such as diesel generators, which are rarely sustainable in the long term. As a result, the intended developmental benefits of transferred technologies, such as improved health outcomes, reduced disease burden, and enhanced human productivity, are substantially weakened. Moreover, inadequate energy supply exacerbates inequality in access to sanitation services. Urban centers or elite enclaves with relatively stable electricity are more likely to benefit from modern sanitation technologies, while rural and semi-urban communities remain reliant on unsafe water sources and rudimentary waste disposal methods. This uneven distribution reinforces health disparities and limits the transformative potential of technology transfer in the sanitation sector.³⁵ In this sense, electricity infrastructure functions not merely as a supporting input but as a precondition for effective technology transfer in health and sanitation. Without stable and affordable energy, sanitation technologies remain technically present but functionally ineffective, highlighting the interdependence between infrastructure development and sectoral technology outcomes.

2.1.1.2 Agriculture and Food Processing

Energy plays a quiet but decisive role in how agriculture functions and evolves. From irrigation to storage and processing, electricity is what allows farming activities to move beyond basic production into something more stable, efficient, and profitable. When power supply is unreliable, even the most promising agricultural technologies struggle to deliver results. In Cameroon, agriculture remains the backbone of livelihoods for much of the population, particularly in rural areas. While modern farming and processing technologies, such as irrigation pumps, milling machines, cassava processing machines, rice hullers, palm oil presses, and cocoa drying equipment have gradually found their way into farming communities, their usefulness often depends on whether electricity is available. In many areas, weak grid coverage and frequent outages mean that farmers cannot rely on these technologies consistently. As a result, equipment lies idle, production slows, and farmers fall back on manual methods that are time-consuming and less productive.

One of the clearest consequences of this energy gap is the problem of post-harvest losses. Without reliable electricity, cold storage and refrigeration facilities are rare or unreliable, making it difficult to preserve perishable produce such as fruits, vegetables, fish, meat and dairy products.³⁶ In Cameroon, this leads to significant spoilage before goods reach markets, especially during peak harvest periods. Across Africa, losses of up to 30-40% have been linked directly to poor storage and energy infrastructure, and Cameroon reflects this broader pattern. Energy constraints also limit farmers' ability to move beyond subsistence production. Agro-processing technologies are

³³ African Development Bank (AfDB). (2024). *African economic outlook: Infrastructure and energy transition*.

³⁴ World Health Organization. (2019). *Water, sanitation and hygiene in health care facilities: Practical steps to achieve universal access*. WHO Press.

³⁵ World Bank. (2018). *Electricity access, reliability, and the performance of water and sanitation services in developing countries*. World Bank Group.

³⁶ Food and Agriculture Organization. (2019). *The state of food and agriculture 2019: Moving forward on food loss and waste reduction*. FAO <https://www.fao.org/3/ca6030en/ca6030en.pdf>

meant to add value, improve food safety, and increase income, but they require steady power to operate efficiently. When electricity is unstable, processing becomes costly, inconsistent, and risky. This makes it difficult for small-scale farmers to enter commercial markets or participate meaningfully in agro-industrial value chains, despite the presence of suitable technologies.³⁷ In this context, electricity is not simply an added advantage for agriculture, it is a basic requirement. Without reliable energy, agricultural technologies remain underused, food losses remain high, and the broader promise of technology transfer in improving food security and rural livelihoods in Cameroon remains difficult to realize.

2.1.1.3 Healthcare

Healthcare systems are among the sectors most directly affected by energy infrastructure, yet this connection is often taken for granted in policy discussions on technology transfer. Modern healthcare increasingly depends on electricity to function safely and effectively. From basic clinical services to advanced diagnostic and treatment technologies, reliable power supply determines whether transferred medical technologies can actually save lives or merely exist on paper. Healthcare delivery depends heavily on uninterrupted electricity. Hospitals require power for diagnostic technologies such as X-ray machines, ultrasound scanners, laboratory equipment, vaccine refrigeration and electronic health records. Where power supply is unstable, medical personnel are forced to rely on guesswork rather than technology-driven diagnosis, increasing the risk of misdiagnosis and ineffective treatment.³⁸ No electricity in hospitals often means no modern medicine. In health and agriculture, electricity deficits raise questions of operational viability. Medical technologies such as diagnostic equipment, vaccine cold chains, and electronic health records require stable power to function reliably. Frequent outages compromise accuracy and safety, discouraging investment in technological upgrades.

Healthcare facilities in Cameroon, particularly district hospitals, health centers and rural clinics, frequently operate under conditions of unstable or inadequate electricity supply. Many essential medical technologies introduced through government programs, donor support or international partnerships are highly energy-dependent. These include laboratory diagnostic equipment, imaging technologies such as X-ray and ultrasound machines, vaccine refrigeration systems, oxygen concentrators, sterilization units, and digital health information systems. When electricity supply is unreliable, these technologies cannot be used consistently, leading to service interruptions, delayed diagnoses, and compromised patient care. Energy instability has especially serious implications for maternal and child health, emergency care and disease surveillance. Power outages during surgical procedures, deliveries, or blood transfusions pose immediate risks to patients and healthcare workers alike. Cold-chain failures caused by inconsistent electricity undermine vaccination programs by reducing vaccine potency and increasing wastage. In rural areas of Cameroon, where backup power systems are often absent or poorly maintained, healthcare workers are frequently forced to rely on manual methods or refer patient's long distances to better-equipped facilities, delaying treatment and increasing mortality risks. Weak energy infrastructure significantly reduces the functional absorption of imported medical technologies. Many health technologies are designed for settings with continuous power supply and technical maintenance support.³⁹ When deployed in energy-constrained environments, they require frequent adaptation or expensive auxiliary solutions such as generators, which increase operational costs and are rarely sustainable. As a result, sophisticated medical equipment may remain underutilized or fall into disrepair, limiting the long-term impact of technology transfer initiatives in the health sector. Energy constraints are also seen to deepen inequalities within the healthcare system. Urban hospitals and private clinics with more reliable electricity are better positioned to adopt and benefit from transferred technologies, while rural and under-resourced public facilities lag behind. This uneven distribution of functional healthcare technologies reinforces disparities in access to quality care and undermines broader goals of universal health coverage and health equity. In this context, electricity infrastructure is not merely a supporting service for healthcare delivery; it is a core determinant of

³⁷ International Fund for Agricultural Development. (2020). *Rural development report: Creating opportunities for rural youth*. IFAD <https://www.ifad.org/en/web/knowledge/publication/asset/41996031>

³⁸ United Nations Development Programme. (2020). *Energy and health: Improving health outcomes through modern energy services*. UNDP. <https://www.undp.org>

³⁹ World Bank. (2021). *Cameroon health sector support project: Energy access and service delivery challenges*. World Bank Group. <https://www.worldbank.org/en/country/cameroon>

whether medical technology transfer translates into improved health outcomes. Without reliable and affordable energy, investments in healthcare technology risk producing limited and uneven benefits, weakening both the efficiency and the social value of technology transfer in Cameroon's health system.

2.1.1.4 Education

Education systems are increasingly digital. Online learning platforms, digital libraries, research databases and virtual classrooms require electricity and internet connectivity. Printed textbooks quickly become outdated, while digital resources allow real-time updates and global access to knowledge. Electrifying schools is therefore essential to modern education and skills development. Without power, students are excluded from digital learning opportunities critical for participation in today's knowledge economy.⁴⁰ COVID-19 pandemic demonstrated severe limitations in Cameroon's educational technology infrastructure when schools closed and remote learning proved infeasible for most students lacking devices, connectivity, or digital literacy. Technology transfer for education platforms, learning management systems, and digital content delivery confronts these fundamental constraints. Even when schools or universities acquire technology partnerships, effective utilization requires reliable electricity for device charging, internet connectivity for content access, and teacher digital literacy for platform facilitation, conditions frequently absent especially in rural areas serving disadvantaged populations most needing educational quality improvements.

2.1.1.5 Manufacturing

Manufacturing depends on continuous power for machinery operation, automation systems, quality control and environmental regulation. Power outages disrupt production lines, damage equipment, and raise operating costs. As a result, countries with unreliable electricity struggle to attract technology-intensive manufacturing investment, limiting industrialization and job creation. Manufacturing technologies face similar challenges. Technology transfer in sectors such as food processing, textiles, light manufacturing, and component assembly requires stable electricity for machinery, quality control, and environmental regulation. Power interruptions disrupt production lines, spoil raw materials, damage sensitive equipment, and compromise product quality. Advanced manufacturing models that rely on just-in-time production become impractical in such conditions. Increasingly, technology licensors include minimum power quality requirements that Cameroon's grid cannot reliably satisfy, effectively excluding many firms from accessing modern production technologies.

2.1.1.6 Logistics and Transport

Airports, ports, rail systems and warehouses require constant electricity to operate navigation systems, security controls, communications and safety mechanisms. Airports for example, must remain permanently connected to reliable power grids to avoid catastrophic failures in air traffic control and safety systems.⁴¹ Energy reliability is therefore a non-negotiable requirement for transport and trade. Key trade infrastructure, in Cameroon especially the Port of Douala and major international airports, relies heavily on electricity to function efficiently and safely. Power disruptions lead to operational delays, increased costs, congestion and safety risks, undermining the effectiveness of transferred logistics technologies and weakening trade performance.⁴² Air transport is especially sensitive to energy instability, as uninterrupted power is essential for air traffic control, runway lighting, and emergency systems. Although backup generators are used in major Cameroonian airports, these solutions raise operating costs and do not fully eliminate systemic risks.⁴³ Beyond ports and airports, unreliable electricity also constrains cold-chain logistics, warehousing, and freight tracking systems, reducing competitiveness in agricultural and pharmaceutical trade.⁴⁴ Overall, energy reliability is not merely supportive but a precondition for effective technology transfer, transport safety, and trade efficiency in Cameroon.

⁴⁰ World Bank. (2024). *Education and digital transformation in Africa*.

⁴¹ ICAO. (2023). *Airport infrastructure and operational safety standards*.

⁴² World Bank. (2020). *Cameroon transport sector development and logistics performance assessment*. World Bank Group.

⁴³ International Civil Aviation Organization. (2018). *Safety management manual* (4th ed.). ICAO.

⁴⁴ African Development Bank Group. (2019). *Central Africa transport corridors and infrastructure constraints*. AfDB.

2.1.1.7 Communications

Telecommunications infrastructure is entirely energy-dependent. Mobile base stations, internet servers, fiber-optic networks and data centers require continuous power to function. Without electricity, telecom towers shut down, internet access collapses and digital services cease. In Africa, high energy costs and unreliable grids significantly raise the cost of telecommunications services, deepening the digital divide and slowing technology adoption. Telecommunications infrastructure also illustrates the depth of the problem. Mobile networks, fiber-optic systems, and switching facilities require uninterrupted power to function. Telecom operators in Cameroon, compensate for grid instability by deploying extensive backup solutions, diesel generators, battery banks, and solar installations. While these measures preserve network continuity, they add an estimated 20–30% to infrastructure costs, costs that are ultimately passed on to consumers through higher service prices, slowing adoption and entrenching digital divides. Efforts to extend digital connectivity to rural areas are particularly constrained, as off-grid solutions must fully replace absent electricity infrastructure.⁴⁵ Data-intensive technologies such as cloud computing, artificial intelligence, digital platforms and big-data analytics depend on uninterrupted power for servers, storage systems and continuous connectivity. International providers typically require uptime standards above 99.9%, levels that are routine in advanced economies but prohibitively expensive to guarantee in Cameroon's context.⁴⁶ Where grid reliability is insufficient, local partners must invest in backup generation systems, sharply increasing capital and operating costs. For example, a modest data facility requiring continuous 500 kW power can incur annual diesel fuel costs exceeding USD 200,000, an expense that can quickly outweigh anticipated benefits from technology adoption.⁴⁷

2.2 Human Capital Constraints and Absorptive Capability Limitation

In the discussion of infrastructural challenges and capability gaps in technology transfer regulation in Cameroon, human capital remains one of the most determinants of technology transfer outcomes. While infrastructure, regulatory frameworks and financial inputs often dominate policy discussions, the effectiveness of any transferred technology ultimately depends on the people expected to deploy, manage, adapt, and sustain it. Technology requires human competence, judgment, and learning, it does not function anonymously. In this sense, absorptive capacity is as much a human and institutional phenomenon as it is a technical or legal one. Persistent skills deficits and limitations in human capital formation continue to undermine the capacity of firms, institutions, and public agencies to fully benefit from technology transfer initiatives.⁴⁸

At the foundational level, educational attainment shapes the breadth of the technology-ready workforce. Although Cameroon has made progress in expanding access to basic education, learning outcomes remain uneven. Primary school enrolment is relatively high, yet completion rates decline sharply, with persistent disparities along gender, geographic and socio-economic lines. Secondary and tertiary education enrolment remains limited relative to population size, and concerns about educational quality persist across levels. Many learners complete formal schooling without acquiring functional literacy, numeracy or problem-solving skills, competencies that form the cognitive foundation for technical training and technology-enabled work.⁴⁹ These gaps limit the pool of individuals capable of engaging with even basic technological systems, let alone advanced or imported technologies that require interpretive and adaptive capacity. Technical and vocational education and training was designed to bridge this gap by providing practical skills aligned with labor market needs, yet in practice it has struggled to fulfill this role. Training curricula frequently lag behind technological change, equipment is outdated, and links between training institutions and industry remain weak. As a result, graduates

⁴⁵ International Telecommunication Union. (2022). *Connecting Africa: Off-grid solutions and rural connectivity*. ITU https://www.itu.int/en/ITU-D/Regional-Presence/Africa/Pages/Events/2022/Connecting_Africa.aspx

⁴⁶ International Energy Agency. (2023). *Electricity and digitalization: Energy requirements of data-driven technologies*. IEA. <https://www.iea.org/reports/electricity-and-digitalisation>

⁴⁷ Uptime Institute. (2022). *Annual outage analysis and cost of power disruptions in data centers*. Uptime Institute. <https://uptimeinstitute.com/2022-annual-outage-analysis>

⁴⁸ Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128–152.

⁴⁹ U.S. Department of State. (2025). *Cameroon country report on human capital and education*. U.S. Government Publishing Office.

often possess theoretical exposure without meaningful hands-on experience with modern technologies. This mismatch becomes particularly visible when foreign technologies are introduced into production systems or public services and local technicians lack the confidence or competence to operate or maintain them independently.⁵⁰ The consequence is prolonged reliance on foreign technicians or external consultants, increasing costs and reducing local learning opportunities.

Beyond basic technical competence, contemporary technology transfer increasingly requires advanced digital and systems-oriented skills. Software-driven platforms, automated systems, data analytics tools and digital service infrastructures dominate sectors ranging from finance and healthcare to agriculture and logistics. Effective absorption of such technologies requires skills in system administration, cybersecurity, data management, cloud computing, and digital integration. However, advanced digital skills remain scarce in Cameroon. University programs in computer science and engineering often emphasize theoretical foundations rather than applied competencies aligned with global industry standards. Professional certifications and industry-recognized credentials are rare, and continuous upskilling mechanisms are limited.⁵¹ This skills gap becomes a structural barrier when technology transfer arrangements presume local capacity that does not yet exist. The impact of this deficit is practical and immediate. Firms entering technology licensing agreements or digital partnerships must confront the challenge of implementation. Without locally available expertise, organizations are forced to choose between hiring scarce specialists at high cost, relying on expatriate support, or investing in prolonged training programs that delay operational readiness. Each option raises transaction costs and reduces the attractiveness of technology transfer, particularly for small and medium-sized enterprises. Over time, this reinforces a cycle in which sophisticated technologies remain underutilized or operate far below potential, not because they are inappropriate, but because human capacity has not kept pace.⁵²

Human capital constraints also affect technology entrepreneurship and innovation capacity. Technology transfer is not limited to the passive adoption of foreign technologies; it also encompasses adaptation, incremental innovation and the eventual development of locally appropriate solutions. These processes require entrepreneurial capabilities alongside technical knowledge. Entrepreneurs must identify opportunities, design viable business models, mobilize capital, navigate regulatory systems and manage growth. In Cameroon, the technology entrepreneurship ecosystem remains underdeveloped, with limited access to venture financing, weak mentorship networks, and insufficient institutional support for early-stage innovation.⁵³ Many potential innovators lack exposure to entrepreneurial training or innovation management, further constraining the capacity to transform transferred technologies into sustainable local enterprises. The human factor challenge is intensified by persistent brain drain. Skilled professionals, engineers, researchers, and technology specialists often migrate in search of better compensation, career prospects, and research environments. This outward flow depletes domestic talent pools precisely at the moment when local expertise is most needed to absorb and adapt transferred technologies. Although diaspora engagement initiatives exist, their impact remains uneven and insufficient to offset net talent losses. The result is a paradox in which technology transfer efforts increase demand for skilled labor while the supply of such labor continues to shrink.

At the institutional level, research and innovation capacity plays a critical role in supporting technology transfer. Universities and public research institutes are expected to serve as nodes of knowledge generation, adaptation, and dissemination. Yet research systems in Cameroon remain constrained by limited funding, inadequate infrastructure, and weak incentives for applied research. Public investment in research and development remains low by international standards, resulting in poorly equipped laboratories, limited research output, and minimal engagement with industry.⁵⁴ Without robust institutional research capacity, technologies introduced from abroad cannot be adequately contextualized, tested, or optimized for local conditions.

⁵⁰ World Bank. (2023). *Skills development and TVET reform in sub-Saharan Africa*. World Bank Group.

⁵¹ World Bank. (2024). *Digital skills and technology readiness in Africa*. World Bank Group.

⁵² Organization for Economic Co-operation and Development. (2021). *Innovation, skills and learning in developing economies*. OECD Publishing.

⁵³ United Nations Development Programme. (2022). *Human development report: Uncertain times, unsettled lives*. UNDP.

⁵⁴ United Nations Economic Commission for Africa. (2023). *Science, technology and innovation in Africa*. UNECA.

Weak university-industry linkages further limit the role of academic institutions in technology transfer. Formal mechanisms such as technology transfer offices, incubators, and commercialization frameworks are underdeveloped or absent in many institutions. Academic promotion systems prioritize traditional scholarly output over applied research or industry collaboration, reducing incentives for faculty engagement with technology diffusion. Consequently, even when research with practical relevance is produced, pathways to commercialization or practical application remains unclear. This disconnect reinforces dependence on foreign expertise and limits opportunities for domestic learning and innovation.

Taken together, these human capital constraints reveal that absorptive capacity is not merely a technical attribute but a systemic condition shaped by education systems, labor markets, institutional incentives, and migration patterns. Technology transfer initiatives that focus exclusively on legal agreements, infrastructure provision, or investment flows risk failure if they do not address the human foundations necessary for technology mastery. In the Cameroonian context, strengthening human capital is therefore not a complementary objective but a central requirement for meaningful and sustainable technology transfer. Without deliberate investment in skills development, institutional capacity, and talent retention, transferred technologies will continue to generate limited and uneven developmental outcomes, reinforcing dependency rather than enabling technological transformation.⁵⁵

CONCLUSION

This article examined how the regulation of technology transfer affects development in Cameroon, with particular attention to the country's infrastructure and capability gaps. The analysis suggests that Cameroon's difficulties in benefiting fully from technology transfer are not mainly due to a lack of policy ambition. Rather, they stem from a structural challenge in which complex regulatory systems and weak infrastructure reinforce each other. Cameroon provides an important case in this regard because of its strategic role within regional institutions such as CEMAC and OAPI and its long-term development ambitions under Vision 2035. The findings show that the country's technology transfer framework operates within multiple layers of regulation at the regional, sub-regional and national levels. While these frameworks are designed to regulate intellectual property and guide technology-related partnerships, they often create practical difficulties for firms and institutions seeking to transfer technology. Lengthy approval procedures, regulatory overlaps and administrative uncertainty can raise transaction costs and discourage potential collaborations, especially smaller partnerships focused on knowledge sharing and capacity building. At the same time, persistent challenges in electricity supply, digital infrastructure and skilled human resources limit the country's ability to effectively absorb and utilize new technologies even when such transfers take place. These challenges are closely interconnected. Weak infrastructure can lead regulators to adopt cautious or restrictive approaches in an effort to manage risks, while fragmented and complex regulation may discourage the very investments that could strengthen infrastructure and technological capability. As a result, technology transfer becomes caught in a cycle where regulatory barriers and capacity limitations reinforce one another. However, this situation is not fixed or inevitable. With better coordination among regulatory institutions, clearer and more proportionate oversight mechanisms, and targeted investments in infrastructure and human capital, Cameroon can gradually improve its technology transfer environment. By shifting regulatory approaches toward facilitating learning, innovation, and collaboration, technology transfer can become a more effective tool for development. Addressing the infrastructure and capability gaps identified in this study is therefore essential if Cameroon is to transform technology transfer into a practical driver of innovation, economic growth, and long-term development.

POLICY RECOMMENDATIONS

Cameroon's challenges in technology transfer cannot be solved through isolated regulatory reform or infrastructure investment alone. The evidence shows that weak infrastructure, fragmented regulation and limited institutional capacity reinforce one another, producing barriers that are far greater than the sum of their parts.

⁵⁵ Grimpe, C., & Hussinger, K. (2008). Formal and informal technology transfer from academia to industry. *Research Policy*, 37(8), 1517–1531.

Effective reform therefore requires a coordinated and phased approach that reduces transaction costs, strengthens absorptive capacity and aligns national priorities with regional frameworks, while remaining realistic about fiscal and institutional constraints.

1. At the regulatory level, Cameroon should move away from transaction-by-transaction control toward coordinated, risk-based oversight. Establishing a high-level inter-ministerial coordination mechanism would immediately reduce fragmentation by allowing parallel reviews, clearer timelines and consistent guidance across ministries and regulators. This does not require dismantling existing institutions, but rather improving how they work together. In the same vein, recently adopted laws, particularly in data protection, must be operationalized quickly and pragmatically. An emphasis on guidance, standard contractual tools, and gradual enforcement would reduce uncertainty for technology partners while safeguarding legitimate public interests.

2. Regulatory reform, however, will have limited impact unless infrastructure constraints are addressed strategically. Given resource limitations, Cameroon should prioritize reliability over universal expansion in the short term. Dedicated, high-reliability power and connectivity zones for technology parks, industrial clusters, and innovation hubs would create spaces where transferred technologies can function effectively.

3. At the regional level, Cameroon should use its position within OAPI, CEMAC, and AfCFTA to advocate for reforms that support innovation rather than mere registration and compliance. While regional harmonization brings benefits, it must allow flexibility for national development priorities. Cameroon can complement regional frameworks with national support mechanisms that fill gaps in technology facilitation, licensing support, and industry-research linkages. At the same time, targeted investments in mini-grids and last-mile connectivity in productive rural areas can support agriculture, health, and digital inclusion. These interventions should be sequenced to demonstrate viability and attract private co-investment, rather than attempting nationwide transformation at once.

4. Institutional and human capacity building is equally essential. Technology transfer succeeds when people can use, adapt, and improve imported technologies. Cameroon should therefore invest heavily in digital literacy, modernized technical and vocational education, university–industry collaboration, and support for technology entrepreneurship. Innovation financing mechanisms, combining public seed funding with private capital can help convert transferred knowledge into locally rooted enterprises, reducing long-term dependence on foreign technology providers.

5. Implementation should follow a phased strategy. Early actions should focus on coordination, guidance and pilot programmes that deliver quick wins and build confidence. Medium-term efforts should consolidate infrastructure reliability, institutional capacity and skills development. Longer-term reforms should scale successful initiatives and embed monitoring systems that allow continuous adjustment. Throughout, transparency, stakeholder engagement and evidence-based evaluation will be critical. To give effect to this monitoring commitment, the following Key Performance Indicators (KPIs) should be adopted and publicly reported on an annual basis:

(i) Reduction in electricity transmission and distribution losses, targeted at below 15% by 2030 from the current ~25%.

(ii) Increase in national electrification rate to 75% by 2030 and 90% by 2035.

(iii) Reduction in time required to obtain technology-related regulatory approvals from multiple ministries to a maximum of 60 days through a coordinated single-window mechanism.

(iv) Increase in gross domestic R&D expenditure as a share of GDP to at least 0.8% by 2030.



(v) Increase in the proportion of the workforce with certified digital or technical skills by 20% within five years of programme inception; (vi) annual increase in the number of technology licensing agreements registered and operationalized through the OAPI framework; and

(vii) Year-on-year improvement in Cameroon's ranking on the Global Innovation Index, with a target of reaching the top three within CEMAC by 2030. These indicators should be tracked by a designated inter-ministerial monitoring body, with results published in an annual technology transfer performance report and used to inform iterative policy adjustments.