STEID Research Development Initiative (RDI) White Paper

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Introduction and Background

In the 21st century, the global economic and technological landscape is evolving at an unprecedented pace. Breakthrough innovations in **artificial intelligence (AI)**, **quantum computing**, and **nuclear fusion** are capturing worldwide attention recently. For example, OpenAI's ChatGPT reached 100 million users just within two months of launch in November of 2022, the fastest adoption of any consumer application at the time (Hu, 2023). In late 2023, IBM unveiled the first quantum-computing chip exceeding 1,000 qubits, and in 2024/2025, Google and Microsoft have made similar advances, introducing new capable quantum-computing computing chips, demonstrating further science and engineering ingenuity (Castelvecchi, 2024, fortune, 2025). 2022, also saw a huge milestone in nuclear fusion as scientists at the Lawrence Livermore National Lab (LLNL) achieved **fusion ignition,** reaching Q of ~ 1.54, a significant milestone in controlled nuclear fusion, from an input of ~2.05 MJ and an output of 3.15 MJ, of laser input and output (Osolin, 2024, LLNL.gov). Fusion reactors continue to make more progress, breaking limits in the total amount of time of consistent plasma run at super-hot temperatures, which have exceeded temperatures in the sun. (U.S. Department of Energy, 2022).

These developments, while still emerging, indicate a new wave of technological potential. However, realizing their full potential will require sustained research and development (R&D) and a skilled workforce, as progress must transition from lab breakthroughs to real-world products. Already, private sector involvement is accelerating commercialization: **45 nuclear fusion startups worldwide have attracted over $7.1 billion in investment**, with optimistic timelines for grid power in the 2030s (Fusion Industry Association, 2024).

But this rapidly advancing technology landscape is also unfolding unevenly across different regions. Geopolitical factors and international economic policies strongly influence who leads or lags in innovation. For example, major economies have been racing to secure technological leadership by pouring resources into strategic R&D. For instance, the United States' 2022 CHIPS and Science Act is a $280 billion initiative to boost domestic semiconductor manufacturing, catalyze R&D, and expand the STEM workforce (Badlam et al., 2022). At the same time, the global competition in Artificial Intelligence (AI) and quantum technologies is intensifying: in 2023, the United States (US's) private investment in AI ($67 billion) dwarfed China's ($7.8 billion), reflecting efforts by each nation to outpace the other (Stanford HAI, 2023).

There are also national policies, from export controls to labor regulations, that shape the flow of knowledge and talent. International economic agreements, trade tensions, and defense considerations increasingly intersect with technology and innovation. For developing countries, these geopolitical currents can either create opportunities for collaboration or erect barriers that hinder access to cutting-edge science. A more recent example is the trade tension spearheaded by the United States, led by the Trump administration, against nations worldwide. Since 2022, the United States systematically restricted China's access to advanced AI and semiconductor technologies by escalating export controls. A more recent example is the Biden administration's October 2023 expansion of these measures, which further limited sales of high-performance AI chips to China and restricted third-country rerouting of controlled items (Allen & Goldston, 2025).

Through this white paper, we present an examination of the current global technology landscape and its implications for research and workforce development in emerging economies. The paper provides historical context on how scientific knowledge has driven economic growth from the Industrial Revolution to the present, then explores the **challenges faced by developing nations** in contributing to today's innovation frontline. In particular, we focus on the case of West Africa (Nigeria, Cameroon, and similar economies), highlighting the economic stakes of building scientific capacity. All these discussions lead to the introduction of the **STEID Research Development Initiative (RDI)**, an initiative to bridge global knowledge gaps through collaborative R&D and active learning. We outline how STEID RDI operates, its goals, and the benefits it offers to local communities and global stakeholders alike. The aim is to demonstrate a pathway for leveraging talent in developing countries to address global challenges, thereby fostering inclusive innovation and sustainable growth.

The Global Technology Landscape. Rapid Advances and New Frontiers

Modern economies are being reshaped by breakthroughs in **AI, computing, and energy** technology. Over the past decade, progress in these fields has accelerated markedly.

Artificial Intelligence. Thanks to advances in machine learning and big data, AI systems have achieved striking capabilities in vision, speech, and decision-making. AI is increasingly integrated into industry and daily life, from intelligent voice assistants to medical diagnostics. The 2022 debut of OpenAI's ChatGPT showcased AI's leap into mainstream use, as it was adopted by millions of users in a matter of weeks (Hu, 2023).

Governments and businesses worldwide are now investing heavily in **AI research** and applications, recognizing its transformative potential in sectors like finance, healthcare, and defense. *However, despite recent strides, AI technology still has far to go*, with issues like bias, explainability, and general intelligence which remain research frontiers (Kokina et al., 2025). Continued Research and Development (R&D) is needed to move beyond narrow applications to more generalized, trustworthy AI systems. As highlighted by Yann LeCun, Meta's Chief AI Scientist, in his 2025 talk expressed that he thinks today's Large language models are fundamentally limited, as they lack world understanding and reasoning capabilities, which make them naerly obsolete for achieving human-level AI (Snyder, 2025).

Quantum Computing. Long theorized, quantum computers are now becoming a reality. These machines leverage quantum physics to perform certain computations exponentially faster and better than classical computers would. In the past few years, the field reached notable milestones: Google's 53-qubit device demonstrated a task beyond classical reach in 2019, and then recently with the introduction of the "Willow chip" in early in the 4th quarter of 2024. Going even a few years back, IBM had also introduced a **1,121-qubit processor ("Condor")**, crossing the 1,000-qubit threshold (Castelvecchi, 2024).

Multiple countries (USA, China, EU members, and Japan) and technology companies are racing to overcome the challenges of **quantum error correction** and scaling. A global quantum ecosystem is taking shape, including national programs (such as the EU Quantum Flagship) and startups exploring technologies from superconducting qubits to trapped ions (IonQ, QUBT, etc.). While practical, large-scale quantum computers are not yet here, the current phase of progress suggests that within a decade or two, quantum computing could disrupt fields like cryptography, materials science, and optimization. Mastery of this field will confer significant strategic and economic advantages, making it a focal point of international competition and collaboration.

Nuclear Fusion and Advanced Energy. Alongside digital technology, physical science innovations are advancing solutions to humanity's energy and sustainability challenges. Nuclear fusion, which is "the process powering the sun," promises virtually limitless clean energy if harnessed on Earth. After decades of research, this field has entered a new era of optimism. In **December 2022, researchers at US, Lawrence Livermore National Laboratory achieved fusion ignition**, producing more energy from fusion than the input energy of the lasers. Q of ~ ~1.54, from an input of ~2.05 MJ and an output of 3.15 MJ (U.S. Department of Energy, 2022). More recently, between 2024 and 2025, researchers at China's EAST tokamak in January of 2025, reached a record 17minutes and 46 seconds, at 70 ^{o}C (with previous records of above 100 Million ^{o}C) and in February of 2025, France's CEA WEST tokamak reactor maintained a plasma reaction for 22minutes marking a new record, and maintained temperatures above 50 ^{o}C (Lea, 2025). These milestones also demonstrate that fusion energy is scientifically attainable, although engineering challenges remain to make it practical, (reaching the self-sustaining high temperature plasma phase) . Meanwhile, numerous private companies have emerged, innovating alternative fusion reactor designs (tokamaks, stellarators, inertial fusion, etc.) and have attracted billions in venture capital (Fusion Industry Association, 2024).

There are now over 4,000 employees across at least 45 fusion startups globally, nearly half of whom are engineers, and a quarter are scientists (Fusion Industry Association, 2024). Most of these firms are in the United States and Europe, with a few in Asia, underscoring the geographic concentration of advanced energy expertise. In parallel, other sustainable energy technologies (solar, wind, battery storage, nuclear and fission) continue to progress, but fusion is seen as a potential **game changer** for the latter half of the century. Achieving commercial fusion could provide a virtually inexhaustible, carbon-free power source that would fundamentally alter the global energy mix.

These cutting-edge fields are increasingly interdependent. AI is accelerating scientific discoveries (for instance, aiding fusion reactor control, materials science, and medicine). Quantum computing, if realized, could revolutionize high-level computing and processing. And solving the science and engineering barriers to nuclear fusion could provide a clear path for society to advance sustainably. Together, advances in **information, computation, and energy** form the foundation of what could be the "Fourth Industrial Revolution." Nations at the forefront of these technologies are well positioned to reap significant economic benefits, similar to how early industrializers gained wealth in the 19th century or how the IT revolution enriched leading economies in the late 20th century. The **value of advanced scientific and technical knowledge** in today's world is immense and growing, which could be comparable to prime real estate or critical natural resources in its ability to confer long-term economic advantages.

Knowledge-driven industries (software, biotech, advanced manufacturing) now account for a large share of global GDP and wealth creation. Knowledge- and technology-intensive (KTI) industries contributed approximately $11.1 trillion in global value in 2022, which accounted for about 11% of the global GDP (National Science Board, 2024). These industries are characterized by a high level of R&D intensity, which means that they invest a substantial portion of their output into R&D activities. This trend is only expected to intensify as automation and AI augment or replace many routine jobs, putting a premium on high-level human expertise in science and engineering.

However, the diffusion of these frontier technologies is far from equal. **Most R&D and high-tech innovation is concentrated in a few regions**, notably North America, Europe, and East Asia (led by China, Japan, and South Korea). Other parts of the world, including large portions of **Africa, Latin America, and South Asia**, have relatively minimal representation in these cutting-edge domains. This disparity in technological capacity has deep historical roots and significant implications for global equity, which we explore in the next sections.

Historical Context. Drawing from the Industrial Revolution to the Knowledge Economy

Throughout modern history, leadership in science and technology has been a decisive factor in national development. The **Industrial Revolution** of the late 18th–19th centuries first demonstrated this on a large scale. Originating in Britain and later spreading to Europe and North America, industrialization transformed agrarian societies into industrial powerhouses. Mechanized manufacturing, steam power, and new metallurgical processes dramatically boosted productivity. This period "**increased the overall amount of wealth and distributed it more widely**, helping to enlarge the middle class," as noted by historians (Mokyr, 1990, p. 129).

Countries that embraced industrial technologies achieved sustained increases in income per person for the first time in history (Allen, 2009). By contrast, regions that industrialized later or not at all experienced slower growth and remained economically marginalized during the 19th century (Nardinelli, 2008). By contrast, regions that industrialized later or not at all experienced slower growth and remained economically marginalized during the 19th century.

The pattern repeated with subsequent innovation waves. The late 19th and early 20th centuries (sometimes called the Second Industrial Revolution) brought electricity, mass production, chemicals, and the internal combustion engine, further boosting the fortunes of innovators like the U.S., Germany, and Japan. The mid-20th century saw breakthroughs in aerospace, nuclear energy, and computing (often spurred by World War II and Cold War investments), again led by a few advanced nations. By the late 20th century, the **digital revolution**, personal computers, the internet, and telecommunications were in full swing, driving growth in developed economies, while much of the Global South was still struggling with industrial-age development.

Across these eras, a clear lesson emerges: **countries that invest heavily in science and technology reap long-term economic rewards**, while those that fall behind struggle to catch up.

Empirical studies confirm a strong linkage between R&D investment and economic growth. Research by economists finds that increases in R&D spending (public or private) tend to spur higher productivity, which in turn raises incomes and living standards (Fieldhouse & Mertens, 2024).

Innovations create new industries and more efficient ways to produce goods, often yielding spillover benefits beyond the original invention. For example, government-funded R&D in the mid-20th century U.S. (e.g. through NASA and DARPA) not only helped win the space race and build defense capabilities but also seeded commercial innovations like satellites, microchips, and the internet propelling decades of economic expansion (Fieldhouse & Mertens, 2024).

The **"knowledge economy"** of today, in which intangible assets like intellectual property, expertise, and human capital are key drivers of value, is a culmination of these historical trends.

At the same time, history shows that technological revolutions can widen inequality before eventually spreading their benefits. In the 19th century, industrialization initially benefited a narrow set of countries and social classes, leading to stark global disparities. Only in the 20th century did industrial technology diffuse more broadly, enabling some latecomers to develop (e.g. the Asian Tigers). Today's cutting-edge tech might similarly create an ever-larger gap if left unaddressed: a **digital and scientific divide** where advanced economies surge ahead in AI, quantum, and fusion technological capabilities, while others remain consumers rather than creators of technology. Avoiding this scenario requires proactive efforts to **democratize access to knowledge and build R&D capacity globally**.

Crucially, the *value of investing in human capital and R&D* holds for developing nations as much as for rich ones. Countries like South Korea and China, which were developing economies in the mid-20th century, dramatically increased R&D spending and education in science and engineering. They have since become innovative leaders in certain fields. In contrast, countries that underinvest in higher education and research often face "brain drain" (losing talent abroad) and remain dependent on foreign technology. The next section will detail where emerging economies stand today in terms of scientific investment and output and the barriers they face.

Geopolitics and Policy: Shaping Innovation and Talent Flows

Technology and geopolitics are deeply intertwined. Nations compete for technological supremacy not just for economic gains but for strategic advantages. This competition manifests in policies that can both enable and constrain innovation globally:

National R&D Strategies. Many governments have explicit plans to dominate key technologies. The European Union's Horizon Europe program and various national AI strategies, China's *Made in China 2025* plan and massive funding for semiconductor and AI self-reliance, and the US CHIPS and Science Act are examples of deliberate policy-driven R&D boosts. These inject billions of dollars into domestic research programs, startups, and infrastructure (such as semiconductor fabs or AI supercomputing centers). For instance, the U.S. CHIPS Act allocates **$52.7 billion specifically for semiconductor R&D and manufacturing incentives** and authorizes even broader science investments to create regional technology hubs (Badlam et al., 2022). Such policies recognize that cutting-edge technology has become a matter of national security and economic resilience. However, they also mean that the **global innovation playing field is heavily skewed** by where big investments happen. Wealthy countries can afford large R&D subsidies, whereas developing nations often cannot match these sums, potentially widening the innovation gap.

Trade and Investment Policies. Geopolitical tensions can lead to export controls and trade barriers that affect technology transfer. A pertinent example is U.S. export restrictions on advanced microchips and manufacturing equipment to certain countries (notably China), aimed at slowing rivals' progress in AI and supercomputing. While targeted at major powers, such controls can incidentally limit developing countries' access to high-end hardware or research tools if they get caught in sanction regimes or if companies become more cautious about sharing technology. On the flip side, foreign investment in technology sectors can be a conduit for knowledge transfer e.g. multinational technology companies opening R&D centers or partnerships in emerging markets. But these flows depend on stable economic policies and intellectual property protection. Countries with unfavorable business climates or strict regulations may struggle to attract global technology investments that could build local capacity.

International Collaboration and Competition. Science has long been international, with collaborations like CERN (the European Organization for Nuclear Research) or the International Space Station pooling resources. In emerging areas like fusion energy, international projects such as ITER (International Thermonuclear Experimental Reactor) bring together expertise from many countries (though notably, no African nations are full partners in ITER). Global frameworks (e.g. under the International Atomic Energy Agency for peaceful nuclear research or the United Nations for sustainability goals) encourage knowledge sharing to some extent. However, in practice, cutting-edge research is often concentrated within G7 and G20 states and their alliances. Geopolitical competition can hamper otherwise beneficial collaboration; for example, restrictions on Chinese researchers in certain Western projects and vice versa. Smaller or lower-income countries are often outside the main networks where new research directions and standards are set. This exclusion makes it harder for their scientists to contribute to or benefit from the frontiers of science.

Talent Mobility and Workforce Policies. One of the most critical factors in innovation is human talent. Here, **immigration and education policies** play a big role. Historically, the U.S. and Europe have benefited enormously by attracting top scientists and engineers from around the world (a form of "brain gain"). Many developing countries, in contrast, experience "brain drain," as their best-trained graduates migrate to pursue opportunities abroad due to limited prospects at home. Some nations are now implementing policies to retain or reclaim talent, and a few (like China and India) have seen diaspora researchers return as local opportunities improve. Meanwhile, some developing countries impose *local content rules* to ensure foreign companies employ and train local people. For example, **Nigeria's Oil and Gas Industry Content Development Act (2010)** mandates that all junior and mid-level positions in oil projects be filled by Nigerians, and any foreign expert can occupy a post for a limited time before a Nigerian must take over (Miriam, 2016).

The idea is to cultivate domestic expertise and jobs. However, in high-tech sectors that require extremely specialized skills (such as quantum physics or fusion engineering), strict local hiring quotas can backfire if there are not enough qualified locals leading to project delays or deterrence of investment. **Balancing talent importation with indigenous workforce development is a delicate policy challenge**.

In summary, global geopolitics can either facilitate a **virtuous cycle** of innovation diffusion or a **vicious cycle** of technology protection. On one hand, international cooperation and open exchange of ideas (through scholarly collaboration, conferences, open-source projects, etc.) help spread new technologies beyond borders. On the other hand, when technological leadership is seen as zero-sum, it can result in a fragmented world where only a few nations dominate critical technologies. Developing countries must navigate this landscape carefully, leveraging international partnerships and advocating for fair technological access, while also formulating **national policies** that build their own innovation ecosystems (investing in education, research institutions, and enabling business environments).

The Economic Imperative of Scientific Knowledge in Emerging Economies

For emerging economies, building strength in science and technology is not a luxury but an increasing necessity for sustainable development. The **economic implications of scientific and technical knowledge** are profound, especially as traditional growth models (based on commodity exports or low-cost labor) face limits. Here's why boosting R&D capacity and STEM skills is economically critical for countries in West Africa like Nigeria and in East Africa like Kenya.

Driving Future Industries. Many developing nations have young, growing populations and are searching for industries to employ millions of people in the coming decades. As automation reduces the competitiveness of low-skill manufacturing, *knowledge-intensive industries* offer a more viable path to create high-quality jobs. Sectors like renewable energy, biotech, advanced agriculture, fintech, and telecommunications can thrive in emerging markets if there is a skilled workforce and research base. Nigeria, for instance, has a vibrant fintech scene and Nollywood film industry, indicating entrepreneurial potential but lags in areas like heavy engineering and high-tech manufacturing. By investing in science and engineering education and research, Nigeria could nurture home-grown industries in areas such as solar panel production, medical technology, or even niche areas of aerospace and defense, which few have begun to emerge within the region. These industries not only create jobs but also have stronger export potential and value-add than raw commodities.

Increasing Productivity and Resilience. Empirical evidence shows that nations with higher R&D intensity tend to have higher productivity growth (Fieldhouse & Mertens, 2024). In a resource-rich developing country like Nigeria (a major oil producer) or Cameroon, this is crucial for diversification. Reliance on extractive industries often leads to volatile growth and little innovation spillover. By contrast, building a knowledge economy where **researchers, innovators, and highly trained technicians** contribute to multiple sectors increases overall productivity. It also makes the economy more resilient to shocks: knowledge and innovation can continuously unlock new efficiencies or alternatives (for example, developing drought-resistant crops domestically can mitigate climate shocks to agriculture). As noted, productivity gains fuel higher living standards in the long run (Fieldhouse & Mertens, 2024). Thus, cultivating scientific knowledge is akin to planting seeds for long-term economic resilience and prosperity.

Capturing Value from Global Innovation. The global technology boom can either be a boon or a bane for emerging economies, depending on their preparedness. On one hand, new technologies can help solve local problems e.g. AI-driven tools for education and healthcare in remote areas, or "fusion energy" eventually providing abundant clean power. On the other hand, if a country remains only a passive consumer of imported technologies, most of the economic value (profits, high-paying jobs, intellectual property royalties) flows back to the inventors abroad. Consider renewable energy: Africa has huge solar potential, but if all solar panels and wind turbines are imported, local value capture is minimal. By developing some domestic R&D and manufacturing capability (even if not at the cutting edge initially), countries can retain more economic value and expertise. The same applies to pharmaceuticals, agricultural technologies, and others. Local research capacity means solutions can be tailored to local needs and scaled commercially at home. Essentially, **scientific capacity enables an economy to take a seat at the table of global innovation**, rather than paying a perpetual premium to foreign IP owners.

Human Capital and Demographic Dividend. Many emerging economies have young populations. Nigeria, for example, is about 216 million people today and is **projected to reach 400 million by 2050**, becoming the world's third most populous country (Federal Ministry of Finance and Budget and Planning, 2023). This "demographic dividend" could either transform into an economic engine or a crisis of unemployment. The outcome hinges largely on education and skill development. If a significant share of these youth are trained in STEM fields and innovation, they become a massive workforce for solving national challenges and contributing to global technology development. We've seen glimpses of this in the proliferation of West African and East African technology start-ups and engineers in recent years. But currently, opportunities for advanced scientific training or research careers in west Africa are scarce, leading many talented students to either leave the field or leave the country after graduation (Simpkin et al., 2019). A focus on building R&D initiatives and research-oriented companies can channel the energies of this young population into productive avenues, turning a potential unemployment crisis into a **talent boom**. In essence, **talent is the new oil**, a resource that, if developed, is far more sustainable and versatile than any natural commodity.

Global Challenges, Local Relevance. Lastly, the major challenges of our era like climate change, pandemics, and energy transition are global in scope but often acutely felt in developing regions. African countries, for instance, are on the frontlines of climate impacts and energy poverty. **Scientific and technical knowledge equips countries to address these issues head-on** rather than wait for outside aid or solutions. For example, local institutes researching drought-resistant crops or engineers improving grid technologies for better renewable integration can directly improve livelihoods. Moreover, emerging economies can contribute unique perspectives and innovations when they join global R&D efforts. A diversity of researchers worldwide increases the chances of breakthroughs (**different problems prioritized, different approaches tried**). The economic benefit is twofold: solving pressing domestic problems and potentially exporting those solutions to other countries with similar needs. In other words, investing in R&D not only helps an emerging economy catch up to richer nations but also empowers it to leapfrog in certain areas and **lead in innovations relevant for the developing world**.

Despite these clear benefits, **most emerging economies significantly under-invest in R&D and science/engineering education** today. As the next section details, Africa and other developing regions allocate only a tiny fraction of GDP to research, and they produce only a small share of global scientific output. Overcoming this gap is challenging due to various barriers, but the potential return, an innovative, self-sufficient economy, makes it an imperative.

Challenges for Developing Countries in Global Innovation

Countries in Africa, Latin America, and parts of Asia face a host of **barriers in accessing or contributing to global technological innovation**. Recognizing these challenges is the first step toward addressing them. Key barriers include:

Low R&D Investment. Perhaps the most fundamental issue is the chronic underinvestment in research and development. Wealthy nations often spend between 2% and 2%–4% of their GDP on R&D; in contrast, **most developing countries spend well under 1%**. Africa's total R&D expenditure is about 0.5% of GDP on average (Webadmin, 2021).

In 2015, the entire sub-Saharan Africa region averaged only **0.4% of GDP on R&D (**Simpkin et al., 2019). Nigeria, despite being Africa's largest economy, is estimated to invest around *0.2–0.3% of GDP* on R&D (Simpkin et al., 2019). This is far below the **African Union's target of 1%** (a goal set in 2007 which remains largely unmet) (Simpkin et al., 2019). The consequences of low investment are evident: lack of research infrastructure (laboratories, equipment), inadequate funding for projects, and poor incentives for researchers (low salaries, grant scarcity). Science agencies and universities in these countries struggle to support even small-scale research, let alone big innovation programs. By contrast, the **world average R&D spending is about 1.7–2.2% of GDP** (United Nations Department of Economic and Social Affairs, 2023), and regions like North America & Europe spend ~2.6% (United Nations Department of Economic and Social Affairs, 2023). The disparity in funding translates directly into disparity in output.

Limited Research Output and "Knowledge Gap". Unsurprisingly, low investment yields low output. Developing countries contribute a disproportionately small share of global scientific publications, patents, and innovations. **Africa produces about 2–3% of the world's scientific publications** (despite having 15% of the global population) according to Simpkin et al. (2019). In recent years there has been some improvement. Africa's share of publications rose from 1.4% in 2015 to ~1.8% in 2019 for sub-Saharan Africa (Webadmin, 2021) but the region still accounts for a tiny fraction of research citations and patents. This global knowledge gap means most new discoveries and technologies are coming from outside the developing world. Local industries and policymakers must rely on external expertise, which can be expensive and may not address context-specific issues. It also means that talented youth in these countries see few role models of scientists or inventors from their own communities, potentially dampening their aspirations. The situation is slowly changing with initiatives to boost research in African universities, but significant strides are needed to close the gap. The **global scientific community is missing out on contributions** from a huge portion of humanity, and conversely, developing nations are not fully tapping into the problem-solving potential of science.

Brain Drain and Human Capital Flight. A major challenge is retaining skilled professionals. When opportunities for cutting-edge work or adequate compensation are lacking at home, scientists, engineers, and programmers often emigrate to countries where they can better use their skills. Africa has lost many PhD holders and medical specialists to North America and Europe in the past decades. This brain drain creates a cycle: the absence of experts makes it harder to build research capacity, which then discourages the next generation. Some countries (e.g. India, China) experienced brain drain in earlier decades but have since managed to attract many expatriates back by building world-class facilities and industries. Some African nations are beginning to attempt similar strategies (creating diaspora networks, offering special research grants, etc.), but results have been modest so far. **Poor working conditions, political instability, and insecurity** in some countries exacerbate the talent flight. For example, ongoing conflicts or instability (in parts of the Sahel, Middle East, etc.) disrupt education systems and push educated youth to leave if they can. The net effect is a shortage of qualified STEM educators, researchers, and innovators on the ground in developing regions, precisely where they are needed most.

Inadequate Education and Training. The pipeline issue begins early. Many developing countries struggle with the quality of primary and secondary education, especially in science and math. University systems are often underfunded and overcrowded, with outdated curricula that may emphasize rote learning over practical skills and creativity. Research-based graduate programs (Masters, PhDs) are few, and those that exist may not meet international standards or align with industry needs. Thus, students often graduate without hands-on research experience or exposure to cutting-edge topics. **Infrastructure for education** from basic needs like electricity and internet in schools to advanced needs like research laboratories and high-performance computing can be lacking. Even bright and motivated students may not have the tools to fully develop their talents. Gender disparity is another concern: in many places, girls are underrepresented in STEM fields due to cultural norms and biases, meaning half the potential talent pool is underutilized. Addressing these educational gaps requires systemic investment in teachers, facilities, and modern pedagogy (including problem-solving, critical thinking, and interdisciplinary work). There are promising efforts by organizations and some governments to improve STEM education (for instance, coding bootcamps and innovation hubs in cities like Lagos, Nairobi, etc.), but scaling these across entire countries remains a challenge.

Infrastructure and Resource Constraints. Beyond education, broader infrastructure issues impede research and innovation. **Reliable electricity, high-speed internet, transportation, and laboratory facilities** are essential for modern R&D. In many African countries, power outages are frequent, and broadband internet is limited to major cities. A simple example: a research lab needs uninterrupted power for sensitive equipment or long experiments without it, work is slowed or impossible. Access to scientific literature and databases can be limited by poor internet connectivity (or the high cost of journal subscriptions for institutions). Furthermore, funding for consumables and equipment maintenance is sparse. Researchers often find it difficult to obtain advanced materials or parts locally and must import them, causing delays and higher costs. This environment makes research cumbersome and discouraging, contributing to lower productivity. By contrast, scientists in developed nations usually take for granted the stable infrastructure that allows them to focus on science itself. Additionally, venture capital and financing for tech startups are only just emerging in many developing economies. Entrepreneurs with tech ideas struggle to find seed funding, as local investors may be wary of unfamiliar tech business models and foreign investors focus on more mature markets. This limits the commercialization of whatever innovations do arise from local research.

Policy and Governance Issues. Science and innovation thrive in an ecosystem supported by sound policy and governance. Unfortunately, in some developing countries, **political instability, bureaucracy, and corruption** pose significant barriers (Simpkin et al., 2019). Inconsistent government commitment to science (e.g. frequent changes in priorities or leadership) can derail long-term research programs. There are cases where pledged budgets for research are not fully released due to fiscal crises or mismanagement (Merkle, 2017). Regulatory red tape can stifle innovation, for example, difficulty in registering new businesses, or antiquated regulations that don't accommodate new technologies (like drones or telemedicine). On the flip side, a lack of regulatory frameworks in areas like data protection or biotech can hinder international collaboration (partners may be hesitant if standards are unclear). Intellectual property protection is another factor: inventors and companies need confidence their patents or IP will be respected, otherwise they have little incentive to innovate locally. Encouragingly, several African nations have in recent years developed national science, technology and innovation policies (often under the guidance of the **African Union's Science, Technology and Innovation Strategy for Africa 2024**, STISA-2024 (Simpkin et al., 2019). The success of these will depend on implementation and funding. Overall, improving governance ensuring transparency, rule of law, and stable support for R&D initiatives are key to creating an environment where innovation can flourish.

Cultural and Awareness Barriers. Lastly, there can be softer barriers such as public perception and cultural value placed on science. In regions where immediate development needs (jobs, basic services) are pressing, both the public and politicians might view investing in research as a low priority or an elitist pursuit (Kpanake & Sorum, 2022). The benefits of R&D are long-term and diffuse, making them a harder sell compared to say, building a hospital or a road which has visible short-term impact. This leads to a lack of **political will** to champion science funding. Moreover, certain scientific fields face public skepticism due to misconceptions for example, nuclear energy (including fusion) may be viewed with the same fear as nuclear weapons or accidents, causing resistance to related projects (IAEA, 2023). Similarly, biotechnology may raise ethical or religious concerns where public science literacy is low (Pew Research Center, 2022). Public outreach and science communication are often underdeveloped, so misunderstandings persist. Changing this requires efforts to raise awareness about the importance of science and its role in solving everyday problems. Programs that engage the public science festivals, media features on local innovators, involving communities in citizen science can gradually build a culture that respects and supports scientific endeavors.

To summarize, developing countries face a **web of interrelated barriers, from** tangible resource shortages to intangible issues of perception and policy. Overcoming these is not easy and will take concerted action on many fronts. However, it is crucial to recognize that these barriers are surmountable. Several middle-income countries have made significant progress in a couple of decades by focusing on education and targeted development of technology (e.g. Brazil in aerospace and agriculture, India in space and ICT, and Rwanda recently in digitization). International agencies, such as UNESCO, the World Bank, and the United Nations, have programs to assist countries in strengthening their innovation systems, for instance, helping set up centers of excellence or providing funding for research training. The **International Atomic Energy Agency (IAEA)** also supports nuclear science education and research in developing nations (e.g. through coordinated research projects and technical cooperation). And regional bodies like the **African Union** are encouraging collaboration through frameworks like STISA-2024 and Agenda 2063, which envision an "Africa that is a global hub of scientific excellence" (Simpkin et al., 2019). It is against this backdrop of both **urgent need and opportunity for change** that the STEID Research Development Initiative has been founded. By directly addressing several of the above barriers in a focused program, STEID RDI aims to demonstrate a model of how emerging economies can accelerate their journey towards becoming sources of innovation, not just consumers.

STEID Research Development Initiative (RDI). A Model for Inclusive Innovation

Science, Technology, Engineering, and Innovation Dynamics (STEID) is an organization founded on the principle that solving global challenges requires tapping talent and ideas from every part of the world. STEID's mission is to **"innovate and inspire"** by advancing research and fostering innovation that addresses critical global challenges (such as clean energy).

Within STEID, the **Research Development Initiative (RDI)** is a program focused on workforce development through active engagement in R&D projects. In simple narrative, STEID RDI provides a pathway for prospective minds in innovation, especially in developing regions to gain cutting-edge research experience **while working on real-world problems**. This section describes how the RDI program functions, its goals, and the value it creates for both local communities and global stakeholders.

Vision and Goals of STEID RDI

The vision of STEID RDI is to **bridge the global knowledge gap** by educating the next generation of scientists and engineers in emerging economies through direct participation in high-impact research and engineering projects. We recognize **that talent is universal, but opportunities are not**. Thus, RDI aims to **identify promising students and young professionals in STEM and related fields (initially focusing in West Africa)** and provide them with the resources, mentorship, and project-based experience needed to become world-class innovators. This aligns with the broader STEID mission of addressing sustainability challenges, as we believe that empowering local researchers to tackle issues like energy, health, and infrastructure will yield both local solutions and contributions to global science.

Specific objectives of STEID RDI include

Fast Skill Development. Participants will acquire advanced technical skills and research methodologies through a "learning by doing" approach. In addition to the academic background that participants come with, RDI fellows will work on projects or research in emerging fields like Plasma physics and engineering, AI, and quantum computing. thereby accelerating the skill development and learning curve for industry or higher education readiness. This hands-on experience is a robust complement to formal education and will help develop problem-solving, critical thinking, and innovation skills that employers and industries need.

Innovation and Intellectual Contribution. The aim is not just to train individuals, but to produce meaningful research outputs. Each RDI project will be chosen for relevance to societal needs and scientific merit. For example, a project might involve designing a low-cost plasma device for medical sterilization or conducting simulations relevant to fusion reactor materials. RDI teams will be expected to produce publishable results, prototypes, or novel data. Over time, this builds a portfolio of innovations emerging from regions like Africa, contributing to global scientific literature and potentially leading to patents or startup ventures. It is a deliberate strategy to demonstrate a narrative showcasing that cutting-edge innovation can happen in West Africa, given the right support.

Address Local and Global Challenges. There will be an intentional balance in project selection to cover both **global "frontier" research** (like fusion, quantum computing, and AI) and **local applied research** that benefits the community. We will aim for Some RDI projects to directly target local problems for instance, developing a solution for fast internet access in remote institutions for students, skill development exercises and training in modern and efficient techniques for manufacturing and craft, community engagement focusing on the conflict between innovation, local cultures, traditions or beliefs, especially as in concerns wellness and sustainability in the Cameroon or Nigerian context.

Others involve collaborating on international "big science" efforts (e.g. contributing data analysis for fusion experiment abroad like ITER). By engaging in both types, participants will experience the spectrum of how science can make an impact. It also ensures the RDI's work has tangible benefits at home (not just abstract research): e.g. a hands-on engineering project could result in a pilot installation of locally developed tools to aid in farming coffee, cocoa, and other foods, given that current majority of natives are farmers in West Africa. This approach also aligns with the *United Nations Sustainable Development Goals*, leveraging science for societal benefit.

Collaboration and Global Integration. This initiative seeks to be a bridge connecting upcoming developing-world researchers with the global scientific community. One way to achieve this will be to partner RDI projects with established research institutions and universities around the world. For example, an RDI fellow in Nigeria working on a plasma physics project might have co-mentors from a U.S. national lab or a European fusion program. There may be exchange visits, joint workshops, or remote collaborations. This gives participants exposure to international best practices and networks. It also helps overcome the isolation often felt by researchers in developing countries. In parallel, collaboration will be encouraged **within** Africa and the developing world creating a south-south network of innovators. This will eventually normalize African and developing country participation in major scientific endeavors and to facilitate knowledge sharing beyond borders.

A Viable Model for Workforce Development. On a meta level, the STEID RDI seeks to create a **replicable business model** for research-driven workforce development. If successful, this can be scaled up or adapted to different regions and fields, to attract sustainable innovation and funding. The intent will be to demonstrate to policymakers and investors that funding such programs yields high returns in terms of human capital and innovation. Part of this involves tracking the outcomes of RDI: how many fellows secure employment in high-skill jobs or pursue further research, how many startups or patents arise, how the program might feed talent into global companies or local ventures (creating value for investors), etc. supporting this to success will eventually expand the initiative, institutionalizing the linkage between academic research, skill training and economic development.

Structure and Operation of the RDI Model

How does/will the STEID RDI work in practice? This can be understood as a pipeline that takes in talented individuals and outputs both skilled professionals and innovative solutions.

Talent Selection. Work with universities, professors, and professional associations in the target region to identify candidates such as undergraduates, recent graduates (B.Sc./M.Sc.), or early-career professionals. Candidates go through a selection process (application, tests or interviews) emphasizing not only academic determination but also creativity, motivation, and problem-solving aptitude. The aim is to find those who have high potential but lack opportunities to fully develop it. Initially, the focus has been in West Africa (Cameroon & Nigeria) but this could expand to other communities if successful.

Project Pairing. Each RDI fellow will be **matched with a research project and mentor**. This will come from in-house projects from STEID or projects in collaboration with partner organizations. Projects will be selected based on alignment with areas in STEM or Society (e.g. Fusion Energy Research, Renewable Energy Technology, Advanced Computing, Physics Agriculture and Engineering, etc.) and the availability of expertise to mentor the fellow.

For example, one project could be "Simulations of plasma instabilities in Magnetic Confinement in Fusion Reactors" where a fellow works under a mentor who is an expert in fusion plasma modeling, etc. Another could be "On the Role of AI in Satellite control and space navigation-to support local space initiatives in space research and exploration efforts. " with mentorship from a local or international students/university or a technology company's AI team. Each project will have defined goals and deliverables suitable for a 6 to 12 month fellowship period (with possibility of extension). Fellows may work individually or in small teams, depending on the project's scope.

Mentorship and Training. A key goal through the RDI will be to provide a structured mentorship framework, where a fellow has at least one technical mentor (a subject matter expert) and additionally a program mentor (to help with soft skills, career development). Mentors may be drawn from STEID's network of volunteer scientists (including diaspora Africans in academia abroad), or from partner institutions like national labs or universities willing to supervise an RDI fellow remotely. Regular meetings (virtual or in-person) could be held to guide the research, troubleshooting issues, and ensure progress. In parallel, RDI offers training sessions to fill gaps in the fellow's background for example, workshops on scientific writing, coding skills, or experimental techniques. Fellows thus effectively undergo an intensive apprenticeship, learning the norms of research (literature review, hypothesis testing, experiment design, data analysis, etc.) in a very hands-on manner. Active **learning** philosophy means a fellow might be, say, helping build a prototype or running simulations from week one, rather than spending months on theoretical coursework. This approach can accelerate competency.

Infrastructure and Resources. One key recognition is the infrastructure gap in key west African education communities. STEID will establish a local research infrastructure, and will explore support from seed or investors or through partnership with labs and innovation hubs to provide physical space and equipment for the fellows. As of now, we are working to set up a modest central laboratory space that will be equipped with 3D printers and computers (for modeling, computations, and simulation projects) for training purposes. Project specific materials and equipment will also be provided as needed (sensors, electronics, etc.) using program funds. Part of the funding is also being allocated for operations, such as ensuring reliable power and internet connectivity for participants, to mitigate common infrastructure issues. With multiple participants we can justify the need to have and maintain this research infrastructure, which individual students could not. This gives participants a platform to work that approaches global standards as the infrastructure gradually improves. Additionally, the RDI will provide stipends to fellows to cover living expenses, so they can commit full-time attention. This is crucial in contexts where economic pressure might otherwise force talented individuals to take unrelated jobs.

Collaboration and Knowledge Exchange. Participants will not work in isolation. Cohorts of fellows will meet regularly (virtually or in-person) to share updates on their projects, fostering a multidisciplinary peer learning environment. There will also be connections with the international community: for instance, RDI fellows participate in hackathons, submit papers to conferences, or join online seminars of groups like the IAEA, APS, or IEEE. Such exposure can help participants(fellows) build confidence and communication skills and sometimes directly yield opportunities (e.g. an RDI fellow might co-author a paper with a foreign research group or secure a PhD placement as a result of the collaboration). In essence, the RDI acts as an incubator, connecting local talent to global networks.

Evaluation and Progression. Each project/fellowship is expected to culminate in concrete outcomes, and this could be a research paper, a prototype/demo, a contribution to a larger project, or a community implementation. Fellows will undergo evaluations based on these outcomes and their skill development. Upon completion, STEID assists in the next steps, where some may transition to full-time roles in industry (after earning attractive practical R&D experience), some may pursue graduate studies (with RDI mentor recommendation support), and others might continue within STEID on new projects or join as mentors for future cohorts, creating a sustainable talent pipeline. This initiative will also have potential for entrepreneurship: if a team or fellow’s project has commercial potential, they may go on through startup incubators or investors. This way, the outcomes of RDI projects can translate into real economic activity (startups, patents, spin-offs) in the region. We think that over time, a **local innovation ecosystem** will begin to form, self-reinforced by each succeeding cohort of RDI trainees as alumni of the program assume positions in academia, industry, or their own ventures.

Funding Model and Sustainability

A critical aspect of STEID's RDI is how it is funded and how it plans to sustain and scale operations. The RDI currently functions as a **non-profit initiative** and is currently supported and funded through means of bootstrap. But we are looking for a mix of funding through grants, partnerships, and in-kind contributions from goodwill people or investors.

Seed Funding and Grants. The initial phase of STEID RDI has been supported by in-house funds or bootstrap from founder(s). Moving forward we plan to explore grants from international organizations focused on education and sustainable development, as well as seed funds from private donors who believe in the cause. These grants will be used to cover ongoing operations/set-up costs, fellow stipends, and basic equipment

Corporate and Industry Partnerships. A critical part of the RDI is to forge partnerships with technology companies and energy firms that have an interest in expanding their talent pipeline and R&D footprint to new regions. The model here is **co-sponsorship of fellows or projects** that align with a company's or institution's interests. For example, an energy company could sponsor an RDI project on their technology, providing mentorship to the fellow and potentially hiring them afterwards. In return, the company can get early access to skilled trainees and any intellectual property from the project (with fair agreements in place). Several multinational companies have Corporate Social Responsibility (CSR) programs that fund STEM education and the RDI can offer them a high-impact avenue to fulfill those goals. This will be implemented by initiating discussions with global engineering firms, especially those in emerging technology that seek to expand into international markets. There could be more industry buy-ins, as this goes on to succeed with a good reputation. Eventually, a **fraction of RDI funding could also come from contract research or consulting projects** done by fellows for clients (providing real-world experience and revenue), effectively a social enterprise model.

Government and Institutional Support. A long-term goal is to integrate RDI with national development initiatives. If we demonstrate clear benefits, we will seek backing from the government (e.g. the Ministry of Science and Technology, or Education in Cameroon) to fund expansion. This could mean public funding to support STEID RDI at universities or to increase the number of fellows supported per year. Given tight budgets, this is challenging, but one strategy is to highlight how RDI aligns with national policy targets (like Nigeria's aspiration to increase R&D spending or create jobs in technology). There would also be engagement with local universities to contribute by recognizing RDI projects as partial fulfillment of degree requirements or providing faculty time as mentors. As an example, if a professor supervises an RDI fellow's research and it leads to a thesis or publication, the university essentially hosts part of the program at minimal cost. Over time, one could envision RDI evolving into a **public-private partnership** where government funds core operations and infrastructure, while private and international partners fund specific projects and fellows.

Efficiency and Scale. The RDI model is designed to be **cost-effective** by leveraging existing resources and focusing on human capital over heavy infrastructure. By using virtual collaboration tools and shared facilities, we can minimize overhead cost. A lot of advanced research today (especially in computer science and theory) can be done with just a laptop and internet, and we aim to capitalize on this where possible. For more resource-intensive science like fusion, we will look for partner options so that expensive experiments are done in collaboration with well-funded labs abroad, while RDI fellows can contribute analysis or design work remotely. This way, even fields that would normally be out-of-reach for a developing-country lab become accessible learning opportunities. As such, the cost per fellow in RDI would be relatively reduced compared to, say, sending students abroad for training. Demonstrating this efficiency is key to convincing donors that their investment in RDI can yields high "bang for buck."

In terms of scaling, our plan is to **incrementally increase the number of fellows and locations** as funding allows. Currently there are few fellows (less than dozen) prior to a full-scale pilot. The next step after a pilot will be to scale the RDI with more resource and infrastructure support , and in the future possibly expand to other regions or multiple universities (e.g. in West Africa, and in East Africa, etc.) and perhaps grow to dozens or more fellows per year.

Benefits to Local and Global Stakeholders

The structure of the Research Development Initiative (RDI) can deliver multi benefits.

For the Fellows (Individuals). Participants will gain from a transformative experience that fast-tracks their career. In a context where job markets are tough for STEM graduates or similar fields (it's noted that in West Africa many physics or math graduates end up underemployed), the RDI gives them practical experience, making them far more employable. They will emerge with not just a certificate, but a portfolio of real project work, recommendations from mentors, and often international exposure. In addition, the RDI can be a passive or full employment opportunity based on the projects a participant is involved in, while gaining the benefits of career advancement. This opens doors whether it is later securing a high-tech job locally, earning scholarships for further study, or starting a technology venture. Perhaps most importantly, it instills confidence and an innovative mindset. Participants learn how to tackle problems systematically and research solutions, a mindset they carry into any future endeavor. Most universities in west Africa do not follow up with their students with programs for career placements post-graduation, a gap that the RDI can cover.

For the Local Economy and Society. Participants who go on to complete the RDI program will enter the workforce or start companies, they also contribute to the knowledge economy locally. Even a few dozen highly skilled professionals can make a big difference and might become the nucleus around which new research projects form, or **they fill critical gaps in industries that require expert skill or knowledge that would otherwise hire expatriates at high cost**. If some RDI projects translate into local solutions, (e.g. a successful prototype for water purification) those could be deployed to improve community life, possibly with government or NGO support. Additionally, RDI's presence helps raise the profile of STEM in the public eye. Local communities see young people engaging in cutting-edge work that has a positive impact, which can inspire schoolchildren and build trust in science. Over time, this could influence more students to pursue STEM and more public support for R&D initiatives. This may also reduce the effect of so-called "brain drain" where talented youth see they need not go abroad to do world-class research.

For Global Stakeholders (Industry and Academia). The global scientific and business community stands to gain from STEID RDI as well. Industries, especially in technology and energy, are constantly looking for new talent and diverse perspectives. By supporting RDI, they gain access to a **new talent pool** from regions they might not traditionally recruit from. There is evidence that diverse teams often drive better innovation, therefore incorporating researchers from different backgrounds can spur creativity. Companies might also find solutions from RDI projects that they can integrate or scale, for example, novel technology developed by RDI fellows could be licensed. Academic and research institutions benefit by fulfilling their global outreach and diversity goals. Collaborating with RDI fellows provides them with eager, fresh minds and expands their research impact to new regions (which can be a criterion in some grant funding). There's also **a moral and strategic incentive: to solve global problems like climate change, we simply need more scientists and engineers worldwide**. Supporting RDI increases the global talent base working on these issues, which ultimately helps everyone. An Initiative like RDI can be seen as aligning with objectives of inclusive capacity building, especially for organizations like the IAEA.

Knowledge Sharing and Cultural Exchange. A perhaps a less tangible but important benefit is the fostering of international goodwill and understanding. Collaborative links will be created between people who might otherwise never interact. A professor in Europe working with a student in Nigeria, an American engineer mentoring a team in Ghana, etc. These exchanges **break down stereotypes and build mutual respect in the scientific community**. Alumni of such programs often become **science ambassadors** who advocate international collaboration and can navigate cross-cultural environments effectively. In a world where there are divisions and mistrust, science collaboration is a powerful diplomat. By widening the circle of who gets to participate in advanced R&D, programs like the RDI help make the global innovation system more inclusive and just, which is a value in itself aligned with the principles of top organizations like the United Nations.

Conclusion and Recommendations

The STEID Research Development Initiative (RDI) offers a hopeful narrative at the intersection of technology and development: that a young person in Buea, or Lagos can contribute to unlocking fusion energy, that a team in Nairobi can help advance AI research and that in doing so, they not only uplift their own careers but also bring benefits to their communities and the world. We have outlined how global trends in technology and geopolitics have heightened the stakes for developing countries to build scientific capacity. History and current data make clear that **ignoring the knowledge economy is not an option** if these nations wish to achieve sustainable growth and solve pressing challenges. Programs like the STEID RDI show a way forward, by tackling tiny portions of the problem, education, infrastructure, mentorship, global integration through one integrated model.

Recommendations

To reinforce and expand upon the work of STEID RDI, we close with some recommendations for various stakeholders and readers.

Policymakers in Emerging Economies. Prioritize science and innovation in national budgets and policy agendas. This includes meeting or exceeding the **1% of GDP R&D investment target** agreed under the African Union (Simpkin, V., Namubiru-Mwaura 2019). Consider funding for programs like STEID RDI or replicating them nationally (e.g. a government-funded "National Research Fellows" program) to systematically develop talent. Reduce bureaucratic hurdles for research activities, simplify import procedures for scientific equipment, provide tax incentives for companies that conduct R&D or partner with educational institutions, and strengthen IP laws. Foster public-private partnerships in research and create "innovation zones" or hubs with special support. Importantly, stabilize commitments: make scientific capacity-building a non-partisan, long-term national mission (as countries like South Korea did), surviving political cycles.

International Agencies and Donors. Increasing support for scientific capacity building in developing countries is crucial. This doesn't only mean funding large infrastructure (though that can help) but also funding people-centric programs like the RDI that ensure skills transfer. Organizations like UNESCO, the World Bank and regional development banks, etc could expand on integration of science training components into development projects. For example, an energy project can include funding for local engineers to train via fellowships. Support south-south cooperation by funding networks of developing country researchers to share resources.

Private Sector and Investors. Look beyond traditional geographies for talent and innovation. Companies in tech and engineering should see training programs in emerging markets not just as philanthropy but as an investment in their future workforce and markets. By engaging with initiatives like the RDI, firms can shape curricula to their needs and gain early access to high-potential individuals. Big technology firms have started opening AI research labs in Africa and this is promising and should extend to other sectors (e.g. pharma companies sponsoring chemistry research at African universities). Impact investors and venture capitalists focusing on frontier markets could consider funding startups that emerge from local universities or programs like the RDI in the future, as well as the programs themselves (via CSR or dedicated funds). There is a business case: more innovators in Africa means more locally relevant products and bigger markets in the long run. **It's akin to how investing in emerging Asian markets in the 1990s paid off as those countries grew. Similarly, energy companies might find their future fusion reactor operators or quantum computing firms, their future researchers from these cohorts.** Early engagement can secure loyalty and great talent.

Academic and Research Institutions. Universities in the developed world should expand partnerships with counterparts in developing countries. This can mean exchange programs, joint degree arrangements, or remote co-advising of doctoral students. Incorporate global challenges into research agendas in a way that includes developing country contexts e.g. if studying solar technology, collaborate with a Sub-Saharan African university to test in their environment. Also, leverage sabbaticals or postgraduate service encourage professors or PhD graduates to spend some time teaching/mentoring abroad (programs like Fulbright have done this, but scale can be increased). Embrace initiatives like STEID RDI by offering to host fellows for short research visits or including them in projects; the cost is low but the impact high**. Importantly, treating such collaborators as equal partners, not just aid recipients' joint authorship, shared credit will build genuine research capacity**. For academies and professional societies, creating more slots for conference travel grants or recognition for scientists from low-income countries can integrate them further. A practical suggestion is to create an "**open lab**" platform where Western labs can remotely include a developing country student in their research meetings and technology task makes this feasible, and it can be mutually enriching.

STEID and Similar Initiatives. Continue refining the RDI model based on lessons learned. Collect data on outcomes to make a strong evidence-based case for its effectiveness (e.g. track alumni career progression, quantify skill gains via assessments, measure the innovations produced). This data will help in securing more funding and institutional support. Strengthen the alumni network for mentorship and possibly financial support for new fellows. Explore hybrid models like online research internships to reach more students at low cost (not all can be full fellows on-site, but maybe a wider community can do mini projects under RDI guidance virtually). Publicize success stories in media to build public and political support, as nothing convinces better than tangible examples of local youth solving problems or contributing to big science. Lastly, coordinate with other initiatives for instance, if there's a government scheme for innovation hubs or an incubation program, link RDI fellows to those so there is a continuum from research to market.

In conclusion, the challenges that STEID RDI seeks to address are vast and systemic, but not insurmountable. The pace of global technological change makes it obligatory that no region is left behind both from a moral standpoint of equal opportunity and from a practical standpoint of tapping all talent to solve humanity's shared problems. The experience of STEID RDI as it matures will confirm that given the chance, **young scientists and engineers in developing countries are eager and able to contribute at the highest levels**. They are not lacking in talent or ambition; often, only the platform and mentorship have been missing. By providing those, RDI and initiatives like it can ignite a cycle of innovation. A future is envisioned where breakthroughs in AI might come from a lab in Lagos, or a cheap clean-energy device invented in Nairobi finds global adoption. These outcomes benefit everyone on the planet. Achieving this future will require continued commitment and collaboration across borders.

Call to action, what can you do

We invite anyone who has read this (Policy maker, Stakeholder, engineer or Scientist, and people of goodwill etc) and has a strong alignment to consider providing constructive support as advise, recommendation or grant donations.

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