Bhutan
TNA Summary 2020

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Overview

Bhutan, a landlocked nation in the eastern Himalayas, is unique in adopting Gross National Happiness (GNH) to guide its development, which prioritizes sustainable development, environmental conservation, and equitable growth. As the world's only carbon-negative country, it maintains 71% forest cover. The economy is driven by hydropower, agriculture, and tourism, with hydropower contributing significantly to GDP. It faces several challenges, however, including a remote and rugged terrain, a small domestic market, youth unemployment, and extreme vulnerability to climate change. Despite these challenges, Bhutan is set to graduate from the Least Developed Country (LDC) category by 2023. Its ***Twelfth Five-Year Plan (2018–2023)*** prioritizes sustainable and inclusive growth, with Science, Technology, and Innovation (STI) as key drivers of economic diversification and resilience. Through strategic policies, Bhutan aims to build a self-reliant, knowledge-based economy while preserving its cultural and environmental heritage.

Agriculture	Industry	Services
18% of GDP (employs 54% and includes livestock and forestry)	**35% of GDP** (including hydropower as the main sub-sector, with mining, quarrying and construction)	**47%** of GDP (including health, education and tourism)

Priority Technology Needs

Bhutan Five-Year Plan (2018–2023) prioritizes the adoption of modern technologies to address sector-specific challenges, promote economic diversification, and enhance sustainability. The country faces significant gaps in infrastructure, skills, and access to advanced technologies, especially in rural and remote areas, limiting its ability to leverage innovation for growth. To bridge these gaps, in line with its GNH framework, Bhutan has identified priority technology needs across key sectors that include agriculture, environment, health, education, energy, and construction. By addressing these needs, Bhutan aims to enhance economic opportunities, improve quality of life, and build a more resilient, knowledge-based economy.

Agriculture and Food Security
Bhutan's agriculture and food sector faces challenges from climate change, limited irrigation, post-harvest losses, and low mechanization. To boost productivity and resilience, the country needs precision agriculture, including smart irrigation, climate-resilient farming, and mechanization. Strengthening organic farming requires bio-fertilizers, bio-pesticides, and certification systems. Post-harvest solutions, such as modern storage, cold chains, and supply chain optimization, are critical for reducing losses and improving market access. Additionally, capacity-building for farmers and extension agents is needed to promote modern techniques, soil fertility, and climate adaptation for sustainable agriculture.

Environmental Conservation & Climate Resilience
Bhutan's environment is increasingly threatened by climate change, deforestation, biodiversity loss, and urban pollution, along with natural disasters such as landslides, glacial lake outburst floods, and earthquakes. To enhance resilience, the country needs early warning systems, including satellite-based risk assessment, real-time flood and landslide detection, and automated alerts. Biodiversity conservation technologies, such as DNA barcoding, satellite imaging, and IoT-based forest monitoring, are also critical. Additionally, waste management solutions, including recycling systems and waste-to-energy technologies, are essential to combat urban pollution and uphold Bhutan's carbon-negative and sustainability goals.

Healthcare
To strengthen Bhutan's healthcare system, key challenges such as remote terrain, a shortage of medical professionals, and limited infrastructure must be addressed. Expanding telemedicine platforms and mobile diagnostics is vital for improving rural healthcare access. Digital health solutions, including electronic health records and AI-driven diagnostics, can enhance efficiency. It is also essential to boost R&D in traditional medicine in the local context, ensuring Good Manufacturing Practices (GMP) compliance and patenting traditional knowledge. Investing in emergency response technologies, such as drone-assisted medical deliveries and real-time health monitoring, is essential for a more resilient healthcare system.

Education
Bhutan's education sector faces significant challenges, including limited rural access to quality education, shortages of qualified teachers, and a widening skills gap. Expanding digital learning platforms, ICT infrastructure, and access to digital devices is essential, particularly in remote schools. Integrating AI, IoT, and VR into STEM curricula can help prepare students for future job markets. Additionally, enhancing Technical and Vocational Education and Training (TVET) is crucial to align education with labor market needs. Investing in teacher training, digital classrooms, and hands-on vocational programs will improve workforce readiness and support a knowledge-based economy.

Energy
Bhutan's energy sector relies heavily on hydropower, making it vulnerable to seasonal variations and climate risks. Diversifying with solar, wind, and bioenergy is essential. Implementing smart grids and energy-efficient technologies, including advanced storage solutions, will enhance reliability. Additionally, capacity building for energy auditors and promoting energy-efficient production processes can boost industrial productivity and competitiveness, strengthening Bhutan's overall energy resilience.

Bhutan's technology needs are diverse and sector-specific, reflecting its unique challenges and opportunities. A strategic focus on STI is essential for sustainable development, economic diversification, and climate resilience. By prioritizing renewable energy, digital education, telemedicine, precision agriculture, and ICT infrastructure, Bhutan aims to address climate vulnerability, healthcare accessibility, and employment generation. **Targeted investments, capacity building, and international collaboration are crucial in advancing these initiatives**. Aligned with Bhutan's GNH framework, these efforts will support a knowledge-based economy, a skilled workforce, and regional integration, fostering long-term resilience and prosperity.

Country Context & Science, Technology, and Innovation Landscape

Bhutan's STI ecosystem remains in its nascent stage, with limited R&D investment and the absence of a dedicated national STI policy. **While STI is referenced in various national strategies, weak stakeholder coordination and fragmented policies hinder its effective implementation**. The country has established Fab Labs, Tech Parks, and Start-up Centres to support innovation and entrepreneurship, but a shortage of skilled human resources and weak research capacity limit progress. Strengthening STI governance, enhancing funding mechanisms, and improving cross-sector collaboration are critical for advancing technological innovation, economic diversification, and long-term competitiveness.

Human Development Index Rank: 129/189 (UNDP, 2002)

735,553	26.9	7.5%	$3,080	37.8%	17%
Population *(NSB, 2017)*	**Median Age** *(NSB, 2017)*	**GDP Growth** *(NSB, 2017)*	**GNI per capita** *(NSB, 2018)*	**Urbanization** *(NSB, 2017)*	**Tertiary Enrollment** *(UNESCO, 2019)*

Frontier Technology Readiness Index (FTRI) Rank: 107/166 (UNCTAD, 2020)

694,249	N/A	$2M	100%	49.0	34%
Internet Subscribers *(2019)*	**R&D Expenditure**	**FDI Inflow** *(WB, 2019) (Decreased from 10.7M in FY18/19 to .2M in FY 19/20)*	**Access to Electricity** *(WB, 2019)*	**PCI** *(UNCTAD, 2019)*	**Financial Inclusion** *(WB, 2014)*

The Government of Bhutan has shown a strong commitment to leveraging STI for national development, particularly in priority sectors like renewable energy, digital infrastructure, agriculture, education, healthcare, and traditional medicine. The Five-Year Plan (2018–2023) and Economic Development Policy identified STI as essential for achieving economic diversification, resilience, and sustainable growth, reflecting its alignment with the GNH philosophy. While several initiatives, such as the Research Endowment Fund, entrepreneurship programs, fiscal incentives for ICT adoption, and technology procurement already exist, funding and resources dedicated to STI remain severely limited.

Bhutan's STI ecosystem remains nascent and fragmented, lacking a dedicated national STI policy and a central oversight body for coordination. STI-related roles are currently distributed across multiple government bodies without clear coordination, hindering effective policy alignment and integration. Bhutan also faces substantial constraints due to limited R&D funding, a shortage of skilled researchers, weak research infrastructure, and inadequate data on STI activities, including R&D expenditures and human capital. Research activities primarily focus on applied, problem-solving rather than the development of innovative products or processes, limiting commercial innovation potential. The education system struggles to keep pace with evolving industry demands, exhibiting gaps in STEM-focused curricula, technical and vocational training, and higher education frameworks, constraining workforce readiness.

Addressing these gaps through targeted investments, improved data, stronger policy coordination, and international collaboration represents significant opportunities. Enhancing the capacity and quality of higher education and research institutions, mobilizing skilled human capital from the diaspora, and fostering international partnerships could significantly boost the country's innovation capacity. Also, **Bhutan's global recognition as the only carbon-negative country provides a strategic advantage for attracting targeted investments**. These efforts are essential for Bhutan to effectively address societal challenges, achieve economic diversification, and secure graduation from LDC status.

Key Recommendations

- Establish a National Research and Innovation Council to oversee STI policy and implementation, ensuring clear goals, funding mechanisms, and cross-sectoral integration.
- Enhance STI governance and policy effectiveness by maintaining a balanced policy mix, improving oversight of R&D centers and Tech Parks, eliminating duplication, and continuously evaluating STI policies for impact.
- Build local STI capacity by offering specialized training programs, strengthening technical assistance, and improving workforce skills in research and innovation.
- Secure long-term STI funding by increasing financial support for research centers, universities, and start-ups while exploring crowdfunding, angel investment, and partnerships with other organizations and global seed funds.
- Strengthen STEM education and TVET by expanding scholarships, awareness campaigns, and skills training to attract women and youth to STI careers.
- Expand innovation infrastructure by scaling up Fab Labs, Tech Parks, and Start-up Centers and establishing Technology Transfer Offices to commercialize research and link academia with industry.
- Improve ICT/digital infrastructure, especially in rural areas, to support innovation, entrepreneurship, and e-learning.
- Prioritize technology needs in agriculture, healthcare, conservation, and education, focusing on renewable energy, organic farming, and digital health.
- Leverage Bhutan's global reputation to attract funding, expertise, and investment through partnerships with international organizations and the Bhutanese diaspora.

The United Nations Technology Bank for the Least Developed Countries, established in 2016, enhances science, technology, and innovation capacities in the world's 44 Least Developed Countries. Based in Türkiye, UN Technology Bank focuses on improving access to essential technologies and knowledge. Its key initiative, Technology Needs Assessments, identifies gaps and priorities in each country, creating a roadmap for impactful technology adoption aligned with national development goals.

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