# Feasibility Study to Connect All African Higher Education Institutions to High-Speed Internet

## *Report 2: Annex 3 Mozambique Country Case Study Report*

DIGITAL DEVELOPMENT PARTNERSHIP

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# Abbreviations

| Term | Description |
|---|---|
| **ACM** | Academia de Ciencia e Tecnologia de Mocambique or Mozambique Academy of Science and Technology |
| **ABM** | Africa Bandwidth Maps |
| **ANEP** | Autoridade National de Educação Profissional or National Professional Education Authority |
| **ARECOM** | Autoridade Reguladora das Comunicacoes or Communications Regulatory Authority (formerly INCM) |
| **CAP** | Country Action Plan |
| **CapEx** | Capital Expenditures |
| **ccTLD** | Country Code Top Level Domain |
| **CIUEM** | Centro de Informática da Universidade Eduardo Mondlane or Computer Center of Eduardo Mondlane University |
| **CNAQ** | Conselho National de Avalição da Qualidade do Ensino Superior or National Council for Quality Assurance and Accreditation in Higher Education |
| **DE4A** | Digital Economy for Africa initiative |
| **DNS** | Domain Name System |
| **DS4DE4A** | Digital Skills for Digital Economy in Africa |
| **EASSy** | Eastern Africa Submarine System |
| **EDM** | Electricidade de Moçambique |
| **EMIS** | Education Management Information System |
| **FNI** | Fundo Nacional de Investigação or National Research Fund |
| **Gbps** | Gigabits per second |
| **GoM** | Government of Mozambique |
| **HEI** | Higher Education Institution |
| **IBE** | Instituto de Bolsas de Estudo or Institute of Scholarships |
| **ICT** | Information and Communications Technology |
| **INAGE** | Instituto Nacional de Governo Electronico or National Institute of Electronic Government |
| **INTIC** | Instituto Nacional de Tecnologias de Informação e Comunicação or National Institute of ICT |
| **IRU** | Indefeasible Right of Use |
| **ISP** | Internet Service Provider |
| **ITU** | International Telecommunication Union |

| Term | Description |
|---|---|
| **IXP** | Internet eXchange Point |
| **KCL** | Knowledge Consulting Ltd |
| **Mbps** | Megabits per Second |
| **MCTESTP** | Ministério da Ciência e Tecnologia, Ensino Superior e Tecnico-Profissional or Ministry of Science and Technology, Higher Education and Technical Professional |
| **MDAs** | Ministries, Departments and Agencies of Government |
| **MINEDH** | Ministério da Educação e Desenvolvimento Humano or Ministry of Education and Human Development |
| **MoRENet** | Mozambique Research and Education Network |
| **MOZIX** | Mozambique Internet Exchange |
| **MTC** | Ministério dos Transportes e Comunicações or Ministry of Transport and Communication |
| **NREN** | National Research and Education Network |
| **OpEx** | Operating Costs |
| **PEES** | Plano Estratégico do Ensino Superior or Strategic Draft-Final—Burkina Faso Country Case StudyPlan for Higher Education |
| **PoP** | Point of Presence |
| **PPP** | Public–Private Partnership |
| **PQG** | Plano Quinquenal do Governo |
| **RCIP** | Regional Communications Infrastructure Program |
| **RREN** | Regional Research and Education Network |
| **SDG** | Sustainable Development Goal |
| **Tbps** | Terabits per second |
| **TG** | Telegeography |
| **TVET** | Technical and Vocational Education and Training |
| **UIS** | UNESCO Institute of Statistics |
| **UNESCO** | United Nations Education Scientific and Cultural Organisation |
| **WBG** | World Bank Group |

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# Executive Summary

As part of the Digital Economy for Africa (DE4A[1]) initiative, the World Bank commissioned a feasibility study to develop an operational roadmap to connect all African higher education institutions (HEIs) to high-speed Internet. The initiative, in support of the African Union Digital Transformation Strategy for Africa (2020-2030)[2], aims to digitally enable every African individual, business, and government by 2030. Connecting universities and research institutions is crucial for expanding the opportunities for teaching, learning and innovation to foster relevant digital skills on the continent. This study has received funding from the Digital Development Partnership (DDP)[3].

This Case Study, one of four conducted to provide background information to the study, along with Burkina Faso, Côte d'Ivoire and Uganda, explores the connectivity challenge from a higher education[4] perspective (demand-side) as well as from the information and communications technology (ICT)-sector perspective (supply-side) in Mozambique.

The connectivity target is to achieve at least 2 Gbps per 1,000 students by 2025 (to be provided for in the initial World Bank planning period ending 2023), and at least 20 Gbps per 1,000 students by 2030. Given a forecast enrolment of 291,000 higher education students in Mozambique by 2025, higher education institutions will need at least 581 Gbps to serve the institutions' bandwidth requirements across the country. This will rise to 344,000 students and a 7 Tbps of bandwidth by 2030. To put these numbers into perspective, higher education enrolment in Mozambique grew from 103,850 students in 2010 to 239,000 students in 2020. In 2020, higher education students across Universities and TVETs shared 4.6 Gbps resulting in a bandwidth ratio of 19.2 Mbps per 1,000 students.

As summarised in the table below, the overall total estimated cost of connecting higher education institutions in Mozambique to high-speed broadband for a period of five years (2021 to 2025) is around USD 452 million. This includes the expense of providing devices to students and staff (USD 109 million), the cost of upgrading and maintaining campus networks (USD 238 million), core support to MoRENet (USD 10 million) and bandwidth cost for upstream connectivity (USD 95 million). The potential savings on bandwidth cost in Mozambique from demand aggregation, smart procurement strategies (e.g., benchmarking regional pricing) and procuring long-term leases are estimated at 61%.

| Category | Cost (USD, millions) | Potential Sources of Funding |
|---|---|---|
| **End-user devices** | | |

1 *See https://www.worldbank.org/en/programs/all-africa-digital-transformation.*
2 *https://au.int/en/documents/20200518/digital-transformation-strategy-africa-2020-2030.*
3 *https://www.worldbank.org/en/programs/digital-development-partnership.*
4 *We use the term Higher Education, also known as Tertiary Education in some countries, to refer to all post-secondary education, including both public and private universities, colleges, technical training institutes, and vocational schools https://www.worldbank.org/en/topic/tertiaryeducation.*

| | | |
|---|---|---|
| Students and Staff | 109 | Government, development partners, students, institutions |
| **Sub Total** | **109** | |
| **Upgrading campus networks** | | |
| Capex | 91 | Government, development partners |
| Opex | 147 | Institutions, government, development partners |
| **Sub Total** | **238** | **Using micro, mini, small, medium, large to very large campus sizes** |
| **Annual cost of connecting campuses upstream** | | |
| | **With Aggregation Savings** | |
| Using Student Enrolment & Regional Price | **95** | Development partners, institutions, students |
| **NREN development and support costs** | | |
| MoRENet core costs and NREN development related costs | **10** | Development partners, government |
| **Total Cost Estimate (USD, millions)** | **452** | **Using cost of connecting campuses upstream based on student enrolment and regional price** |

*Source: KCL calculations*

The Agenda 2025 of the Government of Mozambique (GoM) recognises the importance of education. It seeks to implement many platforms to provide the growing young population with the necessary skills to lead a successful life and develop the country. The Agenda also identifies inadequate coverage of information and communication technology (ICT) infrastructure and poor access to ICT services as major weaknesses that must be addressed. One of the priority areas identified in the Strategic Plan for Higher Education (*Plano Estratégico do Ensino Superior*, 2010-2020) is expanding access to higher education and improving quality through ICT among other measures. The guiding framework for the development of the ICT sector, the Information Society Policy (*Política para a Sociedade da Informação*, 2018) highlights education as a key priority for the country's action.

The higher education sector in Mozambique falls under the purview of the Ministry of Science and Technology and Higher Education and Vocational Training ((*Ministério da Ciência e Tecnologia, Ensino Superior e Tecnico-Profissional* or MCTESTP), which works in tandem with other line ministries, provincial governments, various government agencies as well as higher education institutions (HEIs) to deliver on the mandate expected of the higher education sector in contributing towards the Government's Agenda 2025. There are currently 53 higher education institutions—19 accredited universities, 27 institutes, 4 schools and 3 academies.

Student enrolment in higher education in 2020 stood at 240,000 students and is projected to grow to 380,000 by 2030. While the private sector accounts for 58.5% of all HEIs, the public sector still accounts for most student enrolment (61.5%).

Despite the growth in student enrolment, the Gross Enrolment Ratio for higher education in Mozambique was only 7.3% in 2018, below the estimated average for sub-Saharan Africa of 9.4%, and far below the world average of 38.8% for the same year. Some of the challenges that hinder progress in improving access and quality of higher education in Mozambique include: educational inequalities based on socio-economic status and geographical regions; increased demand for higher education versus a limited public budget; and poorly qualified teaching staff in higher education. These lead to low completion rates from the second cycle of secondary education and high drop-out and failure rates.

From a sector perspective, the following are factors that inhibit better connectivity as well as the use of ICTs in higher education:

i. ICT as a subject has not been fully incorporated into the curricula at all levels of education. This points to a lack of awareness among higher education institutions and other government agencies about the importance and potential benefits of ICT for both learning and the country's socio-economic development.

ii. Low digital literacy among lecturers/tutors compounded by insufficient computing equipment for students and staff.

iii. The high cost of broadband services;

iv. Limited or no training in the use of ICT in teaching and learning.

v. Lack of appropriate digital content to support teaching and learning.

The Ministry of Transport and Communication (Ministério dos Transportes e Comunicações or MTC) provides policy oversight of the telecommunication sector, while the Communications Regulatory Authority (Autoridade Reguladora das Comunicacoes or ARECOM, formerly INCM) regulates the sector. Mozambique adopted a technology-neutral licensing framework in 2016 and currently has 42 licensed operators. Despite this, the market is dominated by three major providers—Movitel, Tmcel and Vodacom. Mozambique is connected to two submarine cables —SEACOM and EASSy—that land in Maputo, the capital. The cost of broadband services is still very high, placing it beyond the reach of the majority of the population. GoM operates a data centre at the Maluana Science and Technology Park, in Manica, that supports e-government services provided by different government Ministries, Departments and Agencies (MDAs). The data centre hosts the Mozambique Internet Exchange Point (MOZIX) that facilitates the exchange of local traffic among 18 local networks, including the Mozambique Research and Education Network (MoRENet).

From an ICT sector perspective, there are still several barriers, many of which have already been identified by the World Bank's DE4A study for the country[5]. Some of the challenges that

5 *World Bank Group. 2019. Digital Economy for Mozambique Diagnostic Report. Washington, DC: World Bank.*

inhibit the use of ICTs in higher education and better connectivity include:

i. Inadequate development and deployment of ICT infrastructure to cover the whole country, particularly rural under/unserved areas;

ii. While geography has endowed Mozambique with a long coastline that can potentially host multiple landing points, the only landing stations are currently in the extreme south of the country. This raises cost of bandwidth distribution and reduces the quality of service for other parts of the country;

iii. Low quality and the limited geographical reach of the national electricity grid particularly in rural and peri-urban areas;

iv. The high cost of broadband services, which the majority of the population cannot afford due to poverty;

v. Lack of awareness among leadership of government agencies about the importance and potential benefits of ICT in developing their institutions as well as the socio-economic development of the country;

vi. Insufficient coordination and alignment among public institutions in relation to ICT projects and initiatives, resulting in duplication as well inefficiencies in public service delivery;

vii. Lack of sufficient numbers of qualified human resources to serve the ICT sector both in private and public institutions to ensure successful implementation of different ICT projects and initiatives;

viii. Poor integration of the ICT component within the objectives and strategic documents designed to guide the development of the country; and

ix. Lack of a vibrant and competitive local ICT sector that nurtures innovation and entrepreneurship in various technology areas.

The creation of the Mozambique Research and Education Network (MoRENet) and government commitment towards accelerating ICT adoption in education provides opportunities for addressing the supply and demand challenges and spurring higher education connectivity in the future. MoRENet, a project under MCTESTP, that has benefited from the country's Regional Communication Infrastructure Program (RCIP), is meant to address the higher education sector's research and education networking needs in Mozambique. The network currently provides broadband connectivity to 18 universities and 29 TVETs, although the bandwidth is still far below the recommended minimum. The bandwidth requirement for the current enrolment of 240,000 higher education students is about 240 Gbps (based on a minimum of 1 Gbps per 1,000 students), but MoRENet has only 4.6 Gbps (i.e., only 1.9 per cent of the estimated bandwidth requirement).

Following COVID-19 lock-downs of educational institutions, MCTESTP negotiated with the three major licensed operators to provide special rates that allow unlimited Internet access

for registered students and staff of higher education institutions to designated academic systems and content via their regular mobile phones.

Overall, Mozambique's progress indicates a potential for expansion of higher education connectivity through the work of MCTESTP and MoRENet. University and TVET leaders should play a key role in supporting access to devices by students and staff and facilitating the upgrade of campus networks. The private sector will also have a critical role to play in extending connectivity across the country.

# 1. Introduction

The Government of Mozambique's Agenda 2025 recognizes the importance of education within the country's development context. This agenda recognizes the challenge of the current poor access to information and communication technology (ICT) services and the low coverage of digital infrastructure. The Agenda, implemented through five-year plans (Plano Quinquenal do Governo or PQG), seeks, among other things to provide the youth with the necessary skills to lead a successful life and to develop the economic and social infrastructure to empower the country. The Agenda also highlights the important requirement of educating women who can act as a catalyst given their primary role as educators in the family.

The Information Society Policy (Política para a Sociedade da Informação, 2018) identifies education as one of the key priority areas for the country's action and one of the sectors that can benefit the most from the potential application of ICTs. Mozambique's higher education[6] sector is expected to play a critical role in this regard.

Mozambique's Information Society Policy identifies equipping schools with ICT equipment and better connectivity, integrating ICT into the education curriculum, capacity building in ICTs and training teachers to apply ICTs for teaching and learning, creating local educational content, developing a national research and education network as well as school management information systems as some of the critical interventions needed within the education sector. Educational institutions are identified as one of the seven key actors in implementing the policy and are charged with the critical role of developing the necessary human resource with the appropriate digital skills and devising ways to stimulate the use of ICTs among the wider population across the country.

ICTs can help address many of the challenges facing the education sector, including improving access to education, the quality of education, enhancing teacher training, and strengthening education institutions. Higher education institutions (HEIs) are identified as one of the key actors in implementing the policy. They are charged with the critical role of developing the necessary human resource with the appropriate skills and devising ways to stimulate the use of ICTs across the country's broader population.

As part of the Digital Economy for Africa (DE4A[7]) initiative, the World Bank commissioned a feasibility study to develop an operational roadmap to connect all African HEIs to high-speed Internet. The initiative, in support of the African Union Digital Transformation Strategy for Africa (2020-2030)[8], aims to digitally enable every African individual, business, and government by 2030. Connecting universities and research institutions is crucial for expanding the opportunities for teaching, learning and innovation to foster relevant digital

6 *We use the term Higher Education, also known as Tertiary Education in some countries, to refer to all post-secondary education, including both public and private universities, colleges, technical training institutes, and vocational schools https://www.worldbank.org/en/topic/tertiaryeducation*

7 *See https://www.worldbank.org/en/programs/all-africa-digital-transformation.*

8 *https://au.int/en/documents/20200518/digital-transformation-strategy-africa-2020-2030.*

skills on the continent. This study has received funding from the Digital Development Partnership (DDP)[9].

As part of the feasibility study, this report provides a detailed country-level assessment to connect all HEIs in Mozambique to high-speed Internet.

Following the Introduction in Chapter 1, the report provides a country overview in Chapter 2 to provide the national context. The connectivity gap has both a supply-side and a demand-side: Chapter 3 explores the demand-side, focusing on ICT in the education sector and the challenges impacting the use of information and communication technologies for teaching, learning, and research—creating the pull factors; and Chapter 4 examines the supply-side, the ICT sector's key components and the challenges affecting high-speed connectivity. The National Research and Education Network (NREN), the Mozambique Research and Education Network (MoRENet) is the higher education response created to close the gap between the demand-side and the supply-side, and Chapter 5 presents a high-level summary of the status of this NREN as well as its achievements and limitation in delivering high-speed connectivity to HEIs. Drawing on findings from the earlier chapters, Chapter 6 discusses the cost of connecting all higher education institutions in Mozambique to high-speed Internet. The conclusion is given in Chapter 7 followed by Appendices.

9 *https://www.worldbank.org/en/programs/digital-development-partnership*.

# 2. Country Overview

Mozambique is located in Eastern Africa along the Indian Ocean (see Figure 1). It covers an area of around 801,600 square kilometres and is part of the Sub-Saharan region. According to the United Nations projections, with an estimated 30 million people in 2019, the population is expected to grow to 36 and 41 million respectively by 2025 and 2030.[10]


***Figure 1: Administrative map of Mozambique***

Mozambique is divided into 11 provinces, one of which is the Capital City, Maputo as highlighted in Figure 1. In each province, the provincial capital is the largest urban centre, has

10 https://population.un.org/wpp/

most of the ICT infrastructure and is where higher education institutions are located. The provinces are subdivided into 129 districts, in-turn subdivided into 405 administrative posts.[11] About two-thirds of Mozambique's population lives in rural areas and are engaged in subsistence agriculture.

Mozambique's literacy rate is 60.7% of the population aged 15 years and older. The Gross Enrolment Ratio (GER) for primary education was 116% (in 2019), for secondary education it was 35% (in 2017), while for higher education it was 7% (in 2018). Government expenditure on education was about 18% of total government expenditure in 2018.[12] This implies that more students out of the official age group (coverage, early age and repeaters) are in primary education, and the number of students entering higher education remains very low, even when compared to the sub-Saharan Africa average of 9.4% or the world average of 38.8% (in 2018).

With a coastline (generally North-South) whose length is about 2,500 km; an inland East-West stretch of about 1,600 km at the Malawi border; and a total area of 801,600 sq km; it is evident that laying out sufficient national fibre to cover all areas is a major challenge. The long coastline however also provides opportunity for using extensive marine fibre segments to connect major coastal cities and complete the inland rings. The current very low HEI GER means that if this is brought closer to or above the regional average, current cost estimates of the cost of the recommended interventions in connecting all HEIs to broadband would need to be revised.

This national context sets the stage for the discussion of the demand and supply-side aspect relevant to access to broadband in Chapters 3 and 4.

11 *http://www.statoids.com/ymz.html*
12 *http://uis.unesco.org/en/country/mz*

# 3. Demand Side—the Education Sector

Within the context of the WBG DE4A initiative, which is the subject of this feasibility study, the education sector is the consumer that must generate the pull factors that will make the outcomes sustainable. Therefore, the potential size of this market, the ability to exploit broadband opportunities, and the ability to pay for the services are key matters of consideration.

This chapter examines Mozambique's education sector, brings out the opportunities and challenges, and points to key areas of necessary intervention.

## 3.1 Education Sector Policy and Governance

The higher education sector in Mozambique falls under the purview of the Ministry of Science and Technology and Higher Education and Vocational Training (MCTESTP), which works in tandem with other line ministries, provincial governments, various government agencies as well as higher education institutions to deliver on the mandate expected of the higher education sector in contributing towards the Government's Agenda 2025.

### 3.1.1 Key Policies and Regulations

The key education sector laws, policies and regulations that impact higher education include:

i. The National System of Education Law No. 6/1992 (of May 6) established the Mozambican education system, including the three primary, secondary, and higher education levels. Higher education includes the provision of TVET.
ii. Higher Education Law No. 27/2009 (of September 29) amends Law No. 5/2003 (of January 21) and adapts its content to consider the emergence of new higher education institutions in Mozambique while continuing to regulate the way higher education institutions conduct their activities.
iii. National System of Evaluation, Accreditation and Quality Assurance of Higher Education Decree No. 63/2007 (of December 31) and Decree 64/2007 (of December 31) instituted a framework for accreditation and quality assurance in higher education, establishing the National Council for Quality Assurance and Accreditation in Higher Education (Conselho National de Avalição da Qualidade do Ensino Superior or CNAQ).
iv. The Vocational Education Law No. 23/2014 (of September 23) established the National Professional Education Authority (Autoridade National de Educação Profissional or ANEP). This was subsequently amended and republished by Law No. 6/2016 (of June 16), to provide the framework of the reform of TVET across the country.
v. Decree 46/2018 (of August 1) approved the regulations of licensing and operation of Higher Education Institutions and revoked Decree 48/2010 (of November 11).
vi. Decree No. 28/2017 (of July 11) provides regulations for the licensing for public and

private TVET institutions across the country.

vii. The Education Strategic Plan (Plano Estratégico da Educação 2020–2029)[13] approved by the Council of Ministers in April 2020 provides the policy framework to coordinate the work of different stakeholders across the education sector as they implement activities and guide investment programs to increase and improve equitable access to quality education.

viii. The Strategic Plan for Higher Education (Plano Estratégico do Ensino Superior or PEES) (2010-2020)[14] recognises that higher education has peculiar needs that differ from other levels and provides a framework to address them. One of the priority areas identified in the PEES is the need to expand access to higher education and improve quality through ICT use.

ix. The Technology Plan for Education (Plano Tecnológico da Educação 2011) recognises the evolving nature and role of education in the development of Mozambique and the role that ICTs can play in transforming education in tandem with other school infrastructure and educational reforms to address this important role. The plan identifies strategic objectives, actors, areas of action, initiatives and an implementation plan to pursue as well as indicators to monitor and track progress.

### 3.1.2 Key Regulatory and Standards Institutions

Sector policy, oversight, standards, content, assessment, and regulation are handled by the Ministry of Science and Technology and Higher Education and Vocational Training (Ministério da Ciência e Tecnologia, Ensino Superior e Tecnico-Profissional).[15] MCTESTP coordinates Higher Education and Vocational training activities promotes higher education access, and ensures gender equality in collaboration with other governmental agencies. Some of these include:

- Ministry of Education and Human Development (Ministério da Educação e Desenvolvimento Humano or MINEDH)[16]—oversees lower levels of education including primary and secondary education.

- National Council for Quality Assurance and Accreditation in Higher Education (Conselho National de Avalição da Qualidade do Ensino Superior or CNAQ)[17]—the government agency responsible for regulating higher education in Mozambique through the evaluation and accreditation of courses, programs and Higher Education Institutions.

- National Professional Education Authority (Autoridade National de Educação Profissional or ANEP)[18]—the government agency that regulates and oversees the quality of Technical and Vocational Training (TVET) across the country.

13 *https://www.globalpartnership.org/content/strategic-education-plan-2020-2029-mozambique*
14 *https://www.pmaputo.gov.mz/por/content/download/5532/39794/version/1/file/Plano+Estrategico+do+Ensino+Superior+2012-2020.pdf*
15 *MCTESTP https://www.mctestp.gov.mz*
16 *MINEDH website http://mined.gov.mz*
17 *CNAQ website http://www.cnaq.ac.mz*
18 *ANEP website http://www.anep.gov.mz*

- Institute of Scholarships (Instituto de Bolsas de Estudo or IBE)—the government agency responsible for organising and coordinating the process of awarding scholarships for academic training within the country and abroad.

- National Research Fund (Fundo Nacional de Investigação or FNI)[19]—the government agency that promotes the training of researchers, scientific research and innovation and the dissemination of scientific knowledge.

- Mozambique Academy of Science and Technology (Academia de Ciencia e Tecnologia de Mocambique or ACM)—the institution that brings together academics, scientists, and innovators, and seeks to promote the development of knowledge and technology in the country by promoting research ethics, disseminating scientific advances and strengthening links among scientists both locally and internationally.

## 3.2 Market Size

Mozambique has a growing higher education sector in terms of student population and institutions. The number of students has grown from 10,800 in 2000 to 240,000 students in 2020. Despite the tremendous growth in student enrolment, the Gross Enrolment Ratio for higher education in Mozambique was only 7.3% in 2018, below the estimated sub-Saharan Africa average of 9.4% and far below the world average of 38.8% in 2018. The country has great potential to expand its higher education system to cater for secondary school-leavers, especially when secondary schooling becomes mandatory in 2023. Digital technologies present one of the avenues to increase access to higher education to this growing student number.

### 3.2.1 Target Institutions

In Mozambique, higher education is a subsystem of the National Education System and comprises different higher education institutions (HEIs). HEIs are either public or private and have a legal personality, with scientific, pedagogical, administrative, financial and patrimonial autonomy. The main source of funding for public HEIs is the government. Privately funded institutions may be further classified as for-a profit or non-profit institutions.

Based on their mission, HEIs in Mozambique are classified as:

i. Universities—these are institutions that have human and material resources for teaching, scientific research in various fields of knowledge, providing theoretical and academic training to the students. These institutions are authorised to confer academic degrees and diplomas;
ii. Higher Education Institutes—these are specialised institutions that may or may not be affiliated to a university, dedicated to training and research in the field of science and technology or professions. These institutions are authorised to confer academic degrees and diplomas;

19 *FNI website https://fni.gov.mz*

iii. Higher Polytechnic Institutes—these are institutions that may or may not be affiliated to a university, offering general studies or professional training and are authorised to confer certificates and academic degrees, excluding PhD;
iv. Higher Schools (Escola Superior)—these are institutions that may or may not be affiliated to a university, a higher institute or an academy, dedicated to teaching in a specific field of knowledge and are authorised to confer academic degrees and diplomas;
v. Academies—these are institutions dedicated to teaching in specific areas, namely arts, literature, technical skills such as military and police, specialised training and commerce. These institutions are authorised to confer academic degrees and diplomas.

The duration of the courses varies from 3 to 5 years depending on the area of specialisation.

There were 19 accredited universities, 27 institutes, 4 schools and 3 academies in Mozambique in 2020 as summarised in Table 1. The full list of accredited HEIs with their student enrolment is given in Appendix A:.

***Table 1: Number of higher education institutions***

| Description | Public | Private | Total |
|---|---|---|---|
| Universities | 9 | 10 | 19 |
| Institutes | 8 | 19 | 27 |
| Higher School | 2 | 2 | 4 |
| Academies | 3 | 0 | 3 |
| **Total** | **22** | **31** | **53** |

*Source: MCTESTP, 2020*

### 3.2.2 Student Enrolment

Higher education in Mozambique has grown tremendously both in terms of institutions and student enrolment since the early 2000s. The number of public institutions has grown from 10 in 2000 to 53 in 2020, and student enrolment (in both public and private institutions) has grown from 10,800 in 2000 to 240,000 in 2020. While the private sector in higher education accounts for most institutions with 58.5% (see Table 1), it accounts for only 38.5% of student enrolment. Figure 2 shows trends in student enrolment between 2010 and 2020, with a doubling of student numbers over the period.

*Source: MCTESTP and UIS data*

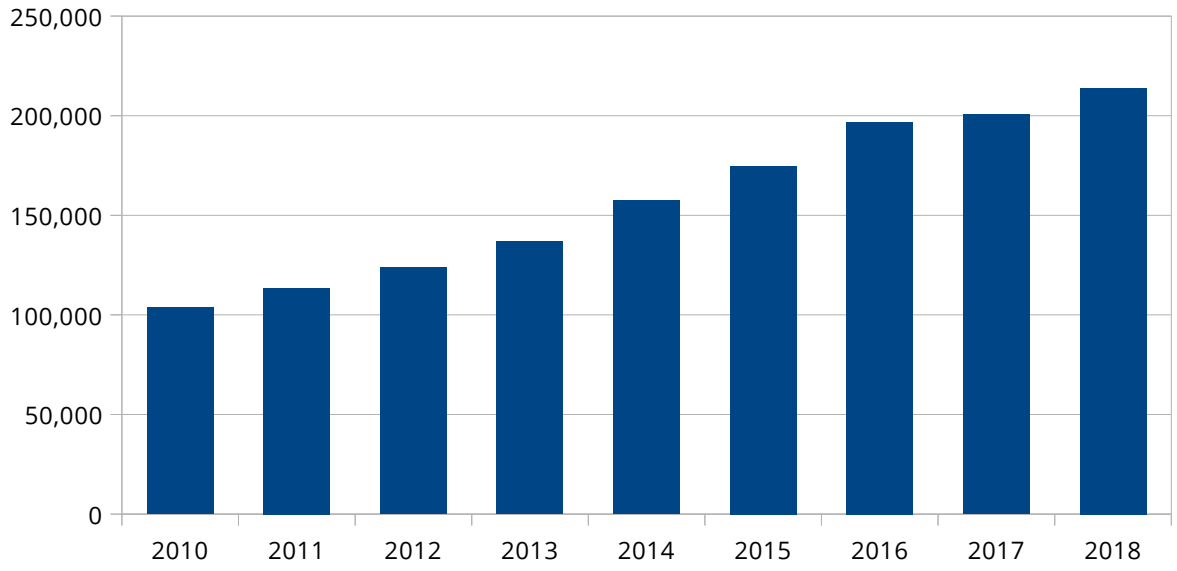


***Figure 2: Enrolment in higher education institutions***

Despite the tremendous growth in student enrolment, the Gross Enrolment Ratio for higher education in Mozambique was only 7.3% in 2018, below the estimated sub-Saharan Africa average of 9.4% and far below the world average of 38.8% in 2018.[20] Some challenges to further progress in terms of improving access and quality of higher education in Mozambique include:

- Notable educational inequalities based on socio-economic status and geographical regions,
- Increased demand for higher education versus a limited public budget, the low level of qualification of teaching staff in higher education,
- Low completion rates from the second cycle of secondary education coupled with high drop-out and failure rates,
- Graduates with lower knowledge and skills compared to the needs and expectations of the labour market.[21]

### 3.2.3 Bandwidth for Higher Education

Interviews with the Mozambique National Research and Education Network (MoRENet) indicate that universities in Mozambique buy bandwidth based on available resources rather than on their student needs. The result is far from sufficient. Based on the Gap Analysis Report, it is recommended that higher education institutions achieve connectivity of at least 1

20 *UNESCO UIS data, 2020*
21 *Education Sector Analysis (ESA) Final Report. July 2019 Maputo: MINEDH.*

Gbps for campuses that host 5000 students and staff in 2021 (see Table 11). The connectivity target is to achieve at least 2 Gbps per 1000 students by 2025 (to be provided for in the World Bank planning period ending 2023) and at least 20 Gbps per 1,000 students by 2030.

Table 2 indicates that Universities and TVETs in Mozambique will require a total of 628 Gbps by 2025 and 7.6 Tbps by 2030. To underscore the connectivity gap, MoRENet currently procures only 4.6 Gbps to serve connected universities and TVETs with a population of about 200,000 students. This would translate to about 23 Mbps per 1,000 students or just 23 kbit/s per student if all were logged on at the same time – barely enough to support SMS traffic rates. The current total connectivity to Mozambique for all national needs currently stands at 100 Gbps, far below the required minimum for higher education institutions in 2025. All this shows the work that has to be accomplished by the Government of Mozambique, higher education institutions, the private sector and MoRENet, not just by increasing external bandwidth, but by increasing the volume of local content, locally hosted content (like major caches) and traffic exchanged through IXPs.

***Table 2: Projections for student enrolment and bandwidth requirements (2025 & 2030)***

| Year | Higher education enrolment (rounded to nearest hundred) | Bandwidth Estimate (Gbps) |
|---|---|---|
| 2025<br>(2 Gbps per 1,000 students) | 313,900 | 628 |
| 2030<br>(20 Gbps per 1,000 students) | 381,200 | 7,624 |

*Source: KCL calculations*

## 3.3 Education Sector Challenges Impacting Leveraging ICT for Learning

From an education sector perspective, there are a number of challenges that inhibit the use of ICTs, particularly in higher education in Mozambique. These are clearly articulated in the Information Society Policy (section 3.3.3, pages 13-14)[22] and the Education Strategic Plan 2020-2029[23]. They include:

i. Lack of sufficient computing equipment and good broadband connectivity within higher education institutions for use by students and staff.

ii. ICT as a subject has not been fully incorporated into the curricula at different levels of education. Also ICT use to support teaching and learning within higher education is still limited due to the lack of appropriate digital and interactive content.

iii. Limited use of ICT to expand access to higher education through distance learning or quality through virtual laboratories.

22 *Política para a Sociedade da Informação, 2018*
23 *Plano Estratégico da Educação 2020–2029*

iv. Poor digital literacy among lecturers/tutors and use of ICT for teaching and learning because of limited training in the use of ICT as part of their pedagogy training and practice.[24]

v. Inadequate supporting infrastructure like communication networks and the electricity grid (which) are still found mainly in urban areas compared to rural areas where government is working on expanding access to higher education (to regions) that are more geographically dispersed.

vi. Lack of a vibrant ICT sector that can employ more young people (compared to other sectors) and support local content development.

vii. Lack of awareness among leadership of higher education institutions and other government agencies about the importance and potential benefits of ICT in developing their institutions as well as the socio-economic development of the country.

Public funding for higher education is currently inadequate and has not kept pace with the growth in demand and enrolment. While government has implemented cost-sharing policies as a mitigation measure, many students still have to rely on low-income families to afford higher education.[25] With the expected increase in demand resulting from the implementation of Law No. 18/2018 (of December 28) that makes lower secondary education mandatory starting in 2023, to complement the already mandatory primary education, regional inequalities will be exacerbated, further impacting the efficiency and quality of education particularly at the higher education level.[26]

24 *Salimo, G.I., 2018. The Challenges of the Digital Era in the Context of Higher Education in Mozambique.*

25 *Joaquim, J.A. and Cerdeira, L., 2020. Financial Accessibility in Cost-Sharing Policies in Higher Education in Mozambique. International Journal of Research-Granthaalayah, 8(9), pp.71-86.*

26 *Education Sector Analysis (ESA) Final Report. July 2019 Maputo: MINEDH.*

# 4. Supply Side—the ICT Sector

The policy and regulatory environments will influence the ease or difficulty in connecting all higher eduction institutions to broadband. For clarity, the regulatory environment also extends to the tax laws, the investment code, and other laws, for example, those which govern immigration. All these converge into the ease of doing business in the country.

This chapter examines the supply side, looking at both the environment and the service providers and the opportunities and challenges in trying to deliver broadband to all the target institutions. While NRENs are part of the supply side, the Mozambique Research and Education Network (MoRENet) is considered in a separate chapter because it has become a critical enabler for connecting universities and TVETs across the country.

## 4.1 ICT Sector Policy and Regulation

### 4.1.1 National Development Plans

The Government of Mozambique's Agenda 2025, which sets the country's direction, identified the poor access to ICT services and insignificant coverage of ICT infrastructure across the country as one of the weaknesses and a cause for regional imbalances. The just-completed third five-year plan (2015-2019) had five priority areas that included two with a direct bearing on ICT—developing human and social capital as well as developing economic and social infrastructure. As part of these priorities, the GoM earmarked projects to increase coverage and access telecommunication infrastructure providing services like telephones, radio and television across the country. The plan also included a number of proposals to restructure, merge and/or privatize some government-owned companies. Telecomunicações de Moçambique (TDM), the government-owned telecom incumbent, merged with its subsidiary Mozambique Cellular (Mcel) in 2019 to create Tmcel with better economies of scale to help improve access and coverage.

The fourth and newest five-year plan, Programa Quinquenal do Governo 2020-2024[27] seeks to build a diversified and competitive economy that will create more opportunities for the growing young population. The plan includes six strategic areas—agricultural production, economic and social infrastructure, fishing and aquaculture, tourism, mining and statistics. The plan identifies three priority areas and three pillars of support. Priority area two—boosting economic growth, productivity and job creation include a number of objectives and actions prioritizing investment in quality infrastructure, including energy and telecommunications, to expand access to telecommunications services. The plan includes specific targets like expanding access to 5G in all provincial capitals and 4G across all district

27 *https://www.parlamento.mz/index.php/processo-legislativo/plano-quinquenal-do-governo*

capitals, as well as increasing the number of internet users from 346,700 to over two million users by 2024.

### 4.1.2 Key Policies and Regulations

Some of the key ICT sector laws, policies and regulations that have an impact on various components of connectivity include:

i. Telecommunication Law of 1992: this established an independent regulator for the telecom sector—Instituto Nacional das Comunicações de Moçambique (INCM), and also set up the operator, Telecomunicações De Moçambique (TDM), which later merged with its subsidiary mCel to create Tmcel.
ii. Telecommunication Law, Law No. 4/2016: this brought in further market liberalisation, adopted a unified licensing framework in acknowledgement of convergence, and a regulatory framework for competition. It also introduced universal service access and consumer protection as well as the concept of infrastructure sharing among licensed operators.
iii. National Broadband Strategy, Resolution No. 43/2017: this provides a framework for GoM to extend broadband coverage across the country and improve access to affordable high-quality broadband services by incentivising network investment into a mix of fibre and fixed-wireless infrastructure using private and public-private partnership vehicles.
iv. The Regulation of Sharing Telecommunication Infrastructure and Other Network Resources No. 65/2018: this obligates licensed operators to share existing ICT infrastructure as an avenue to increase coverage and access to ICT services across the country, including in rural and remote areas.
v. The Electronic Transactions Law, 2016: this addresses like e-commerce, data security, privacy and cybercrime.
vi. The Information Society Policy (Política para a Sociedade da Informação, 2018)[28]: this provides a guiding framework for the development of the ICT sector in the country by articulating the vision, mission as well as the major intervention areas for Mozambique in its pursuit of making ICT relevant to the individual and development needs of the country.
vii. The Strategic Plan for the Information Society (Plano Estratégico para a Sociedade da Informação, 2019-2028)[29]: this complements the Information Society Policy by highlighting the priority areas that Mozambique intends to work on over a 10-year horizon to develop her ICT sector and addresses issues like governance, financing as well as monitoring during implementation.
viii. The Operational Plan for the Information Society (Plano Operacional para a Sociedade de Informação): this is a 5-year operation plan for implementing the Strategic Plan, providing a foundation for the annual activity plans of the entities involved in undertaking the different ICT projects and initiatives.

28 *https://www.inage.gov.mz/wp-content/uploads/2020/06/1-Politica-Sociedade-Informacao-aprovada-pelo-CM-em-20_03_2018.pdf*
29 *https://www.inage.gov.mz/wp-content/uploads/2020/06/4-Plano-Estrategico-ao-Conselho-de-Ministros-25_02_2019-Versao-aprovado-pelo-CM_compressed.pdf*

### 4.1.3 Key Policy and Regulatory Institutions

Ministério dos Transportes e Comunicações (Ministry of Transport and Communication or MTC)[30] regulates the transport and telecommunication sectors, providing the policy, technical guidance, as well as monitoring the performance of both sectors. MTC coordinates the activities of the telecommunication sector in collaboration with other governmental agencies. Some of these include:

- Ministry of Science and Technology and Higher Education and Vocational Training (Ministério da Ciência e Tecnologia, Ensino Superior e Tecnico-Profissional or MCTESTP). One of the directorates at MCTESTP—the National Directorate of Information and Communication Technologies and Projects (Direcção Nacional de Tecnologias de Informação e Comunicação e Projectos) is responsible for ICT-related activities of the MCTESTP.

- The Communications Regulatory Authority (Autoridade Reguladora das Comunicacoes or ARECOM, formerly INCM)[31]—an autonomous government agency under the MTC that is responsible for regulating the communications sector encompassing telecoms, broadcasting, film, and postal services and infrastructure.

- Mozambique Telecom (TMCEL)[32]—the largest telecommunication provider in the country is the former incumbent and has the most extensive fibre backbone network footprint. TMCEL's network infrastructure is owned by the Government of Mozambique, while public and private sector players can own TMCEL infrastructure for complementary services up to a limit of 50% of the share capital. TMCEL is an autonomous entity under the auspices of MTC.

- National Institute of Electronic Government (Instituto Nacional de Governo Electronico or INAGE)[33]—government agency under MCTESTP responsible for coordinating and implementing e-Government services. INAGE builds and manages shared ICT infrastructure for public departments, promotes the use of ICT among citizens across the country and plays a critical role in cybersecurity across the country.

- National Institute of ICT (Instituto Nacional de Tecnologias de Informação e Comunicação or INTIC)[34]—government agency under MCTESTP responsible for integration and support of Information Technology (IT) systems across government, as well as harmonisation of IT standards across the public sector. INTIC plays a foundational role in the preparation of different ICT policies for the country.

- The Computer Center of Eduardo Mondlane University (Centro de Informática da Universidade Eduardo Mondlane or CIUEM)[35]—Set up as a unit to support ICT

30 *MTC website, http://www.mtc.gov.mz*
31 *ARECOM website, www.arecom.gov.mz*
32 *TMCEL website, www.tmcel.mz/*
33 *INAGE website, www.inage.gov.mz/*
34 *INTIC website, www.intic.gov.mz*
35 *CIUEM website, www.ciuem.mz*

integration into the teaching and learning as well as research processes at Eduardo Mondlane University, CIUEM evolved to lead the development of Internet infrastructure and access in Mozambique. It set up the first Internet connection in the country for the University in 1992, becoming the first Internet Service Provider in the process and worked with telecentre.org to set up and maintain the first telecentres across the country in 1999 and continues to provide support to community access initiatives to this day.[36,37] CIUEM provided technical expertise and advice to government in respect of the ICT policy and implementation strategy in the early 2000s and continues to provide technical guidance to government on ICT issues. CIUEM is the current administrator for .mz the country code top level domain (ccTLD) of Mozambique, setup MOZIX, the only IXP in 2002 that it continues to maintain. It also helped create and nurture MoRENet, the Mozambican NREN[38] and now runs ICT incubation and innovation spaces for young ICT entrepreneurs at UEM.[39]

### 4.1.4 National ICT Indicators

National ICT indicators collected during the Gap Analysis phase also have a direct bearing on connectivity for higher education institutions at the country-level by influencing the savings that higher education institutions can accrue from aggregating their bandwidth needs. The most pertinent indicators that are integrated into the cost model include:

i. Whether the country is landlocked or has access to the ocean allows direct access to submarine cables. Direct access to submarine cables reduces base bandwidth cost. Mozambique has a coastline (generally North-South) whose length is about 2.300 km that provides plenty of opportunity for submarine cable landing points.
ii. Number of submarine cable landing stations. Mozambique currently has two (SEACOM and EASSy) that both land in the Capital, Maputo. Egypt has the most with 15. More landings improve competition amongst cable providers resulting in competitive pricing.[40]
iii. Internet eXchange Ladder Stage. Countries were categorised into 4 stages (see Table 3) depending on the number of IXPs and carrier neutral data centres they have as well as the interaction between these two important facilities.[41] Mozambique currently has one IXP—the Mozambique Internet Exchange Point (MOZIX)[42]. Government and MoRENet operate a data centre at the Maluana Science and Technology Park used by MDAs that also hosts the only Google Cache in the country. Mozambique is at Stage 2 of the ladder.

36 http://www.fmfi.org.za/wiki/index.php/CIUEM_MICTI:Project_Overview
37 *CIUEM Community Information and Communication Support Center (CAICC) project,* http://www.ciuem.mz/centro-de-apoio-a-informacao-e-comunicacao-comunitaria/
38 *https://www.afpif.org/2015/02/the-Internet-society-brings-african-interconnection-conference-to-mozambique/*
39 http://www.ciuem.mz/espaco-de-inovacao/
40 *TeleGeography, Submarine Cable Map, 2021*
41 *World Bank Group, 2020. National Data Infrastructure The Role of Internet Exchange Points, Content Delivery Networks, and Data Centres (was still in draft form)*
42 *Mozambique Internet Exchange Point* https://mozix.org.mz

***Table 3: Stages of the Internet Exchange Ladder***

| Stage | Status | Countries |
|---|---|---|
| Stage 0 | No IXP, internet traffic exchanged overseas | Algeria, Cabo Verde, Central African Republic, Chad, Comoros, Equatorial Guinea, Eritrea, Ethiopia, Guinea-Bissau, Lesotho, Libya, Mauritania, Niger, São Tomé and Príncipe, Seychelles, Sierra Leone, Somalia, South Sudan |
| Stage 1 | Domestic internet traffic between ISPs exchanged at IXP | Benin, Botswana, Burkina Faso, Cameroon, Congo, Côte d'Ivoire, Egypt, Eswatini, Gabon, Gambia, Guinea, Liberia, Madagascar, Malawi, Mali, Namibia, Rwanda, Senegal, Sudan, Tanzania, Togo, Tunisia, Zambia, Zimbabwe |
| Stage 2 | Diversity of participants at IXP, presence of global Content Distribution Networks (CDNs) | Angola, Burundi, Democratic Republic of Congo, Mauritius, Morocco, Mozambique, Uganda |
| Stage 3 | IXP located alongside carrier neutral co-location data center | Djibouti, Ghana, Kenya, Nigeria, South Africa |

*Source: NREN Survey and Interviews with CEOs, 2020*

iv. % Population within 10-km fibre coverage (reflects fibre network coverage of the country). Only 30.1% of Mozambique's population currently lives within 10-km of fibre coverage, mainly around the urban/provincial capitals. This has a direct bearing on the cost of connecting especially rural campuses.[43]

v. Regulatory score, which reflects the maturity of the regulatory environment. It is based on individual country scores from ITU Global Regulatory Outlook 2020.[44] Mozambique's score was 57.7 out of a possible 100. A good regulatory environment leads to more competitive connectivity offerings.

# 4.2 Sector Operations

## 4.2.1 Licensing, Market Structure and Service Providers

Mozambique adopted a technology-neutral licensing framework in 2016, introducing a new range of licenses to enhance competition, network interoperability and interconnection as well as infrastructure investment and sharing. The Unified license allows operators to establish networks using any technology and offer all types of service: the Class A license allows operators to develop telecom networks using any technology; the Class B license allows operators to provide all types of services; and the Class C license allows operators to supply, install and maintain, import and distribute ICT equipment and to provide supportive services. There is also a Numbering License that allows operators to provide network identification services. There are currently four operators with Class A licenses, 22 operators

43 *Africa Telecom Transmission Map, 2020. Hamilton Research Ltd.*

44 *https://www.itu.int/pub/D-PREF-BB.REG_OUT01*

with Class B licenses, one operator with Class C license and 15 operators with Numbering licenses, bringing the total number of licensed operators to 42.[45]

The market is dominated by the three unified licence holders—Movitel, Tmcel and Vodacom that together dominate the telecommunications market, with mobile voice services as the predominant service. The use of data services is still limited and access is still largely via mobile phones. Although competition has improved among the three top operators and their mobile broadband services, Tmcel holds a significant portion of the broadband market by virtue of its product offerings and shareholding in the two leading Internet Service Providers (ISPs)—Teledata and TV Cabo. ARECOM has worked to enforce measures related to infrastructure sharing, regulation of tariffs, and interconnection charges, but the prices of broadband services are still not affordable to most Mozambicans.[46]

### 4.2.2 Access to Broadband

Mozambique is connected to two different submarine cables that land near the Capital, Maputo, in the extreme south of the country, as indicated in Figure 3:

- SEACOM landed in Maputo in 2009. The cable spans 17,000 km along the Eastern and Southern coasts of Africa, landing in 5 African countries, from Mtunzini, South Africa to Djibouti to a Point of Presence (PoP) in Marseille, France as well as from Tanzania to India into a PoP in Mumbai;
- Eastern Africa Submarine System (EASSy) landed in Maputo in 2010. The cable spans 10,000 km covering 9 countries on the Eastern and Southern coasts of Africa, from Mtunzini in South Africa to Port Sudan in Sudan, with inland connections to at least ten landlocked countries. EASSy interconnects with other international submarine cable networks for onward connectivity to Europe, the Americas, the Middle East and Asia.

Together, SEACOM and EASSy currently deliver about 100 Gbps of International bandwidth capacity to Mozambique. These will soon be joined by Facebook's 2Africa submarine cable slated to land both in the south and northern parts of Mozambique.

Mozambique currently has about 47,600 km of operational fibre.[47] This includes the national fibre network, which covers all 11 provincial capitals as well as 52 (out of 164) district offices and 31 (out of 413) administrative posts as well as fibre optic running on top of the national grid operated by the national power company Electricidade de Moçambique (EDM). Duplication of fibre along certain routes as depicted in Figure 3 means that effective coverage is reduced, and the deployment of metro fibre networks has not kept pace with demand, limiting broadband access and coverage.

45 *Licensing in telecom sector* https://www.arecom.gov.mz/index.php/mercado/licenciamento-telecomunicacoes
46 *ResearchICTAfrica, 2019. Policy Paper No. 6, Vol. 5, After Access. The state of ICT in Mozambique*
47 *Africa Telecom Transmission Map, 2020. Hamilton Research Ltd,* www.africabandwidthmaps.com

*Source: Africa Telecom Transmission Map, 2020. Hamilton Research Ltd, www.africabandwidthmaps.com*

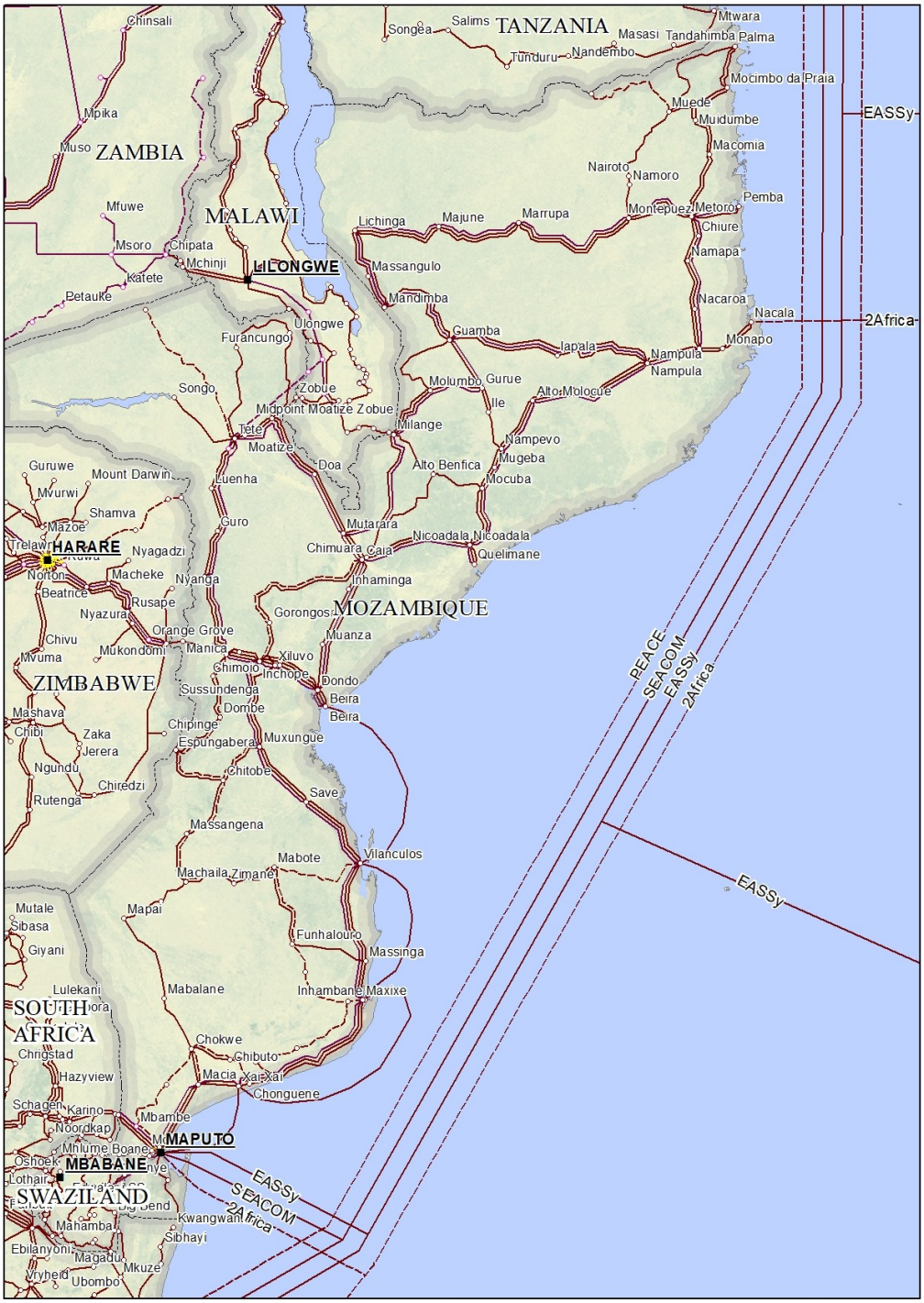


***Figure 3: Distribution of fibre networks across Mozambique***

The national fibre network has cross-border connections to Malawi via Milange, Swaziland via Namahacha, Zimbabwe via Machipanda, and South Africa via Ressano Garcia. The connections extend to cable landing stations, providing these countries with primary or alternative global connectivity. Fibre networks are particularly important because the high-speed broadband that higher education institutions need can only be sustainably provided via

such networks.

Currently, 82% of the population lives within reach of a 3G mobile network and 33% within reach of 4G according to recent data from ITU as indicated in Figure 4.[48] Despite this, the proportion of individuals using the Internet is still low at only 21% compared to an African average of 28% or a World average of 54%.[49]

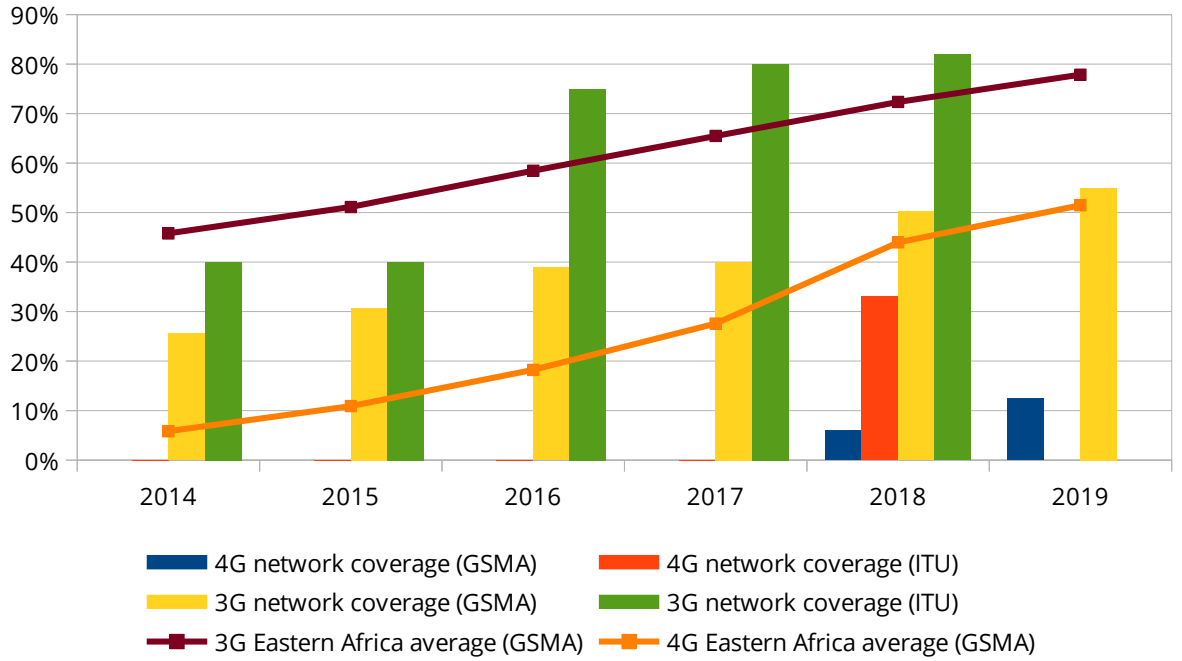


***Figure 4: Trends in the proportion of the population covered by different telecom networks***

Mobile cellular subscriptions continue to grow while fixed-telephone subscriptions decline. Mobile subscriptions dipped in 2015 due to ARECOM's enforcement of mandatory SIM card registration which came into force in 2010 with Ministerial Decree 153, but had never been fully implemented. ARECOM threatened the imposition of fines for non-compliant networks.

### 4.2.3 IXPs and Data Centres

Another mechanism for local Internet traffic aggregation and exchange is the Mozambique Internet Exchange Point (MOZIX).[50] MOZIX was started by the Computing Centre (Centro de Informatica da Universidade Eduardo Mondlane or CIUEM) at UEM in 2002, where it is still hosted to-date. Initially, most ISPs were reluctant to join the initiative, apparently due to a lack of trust.[51] The IXP has since grown from 5 peers in 2002 to having 18 operator networks (including MoRENet) that exchange about 1 Gbps of traffic on a daily basis.[52]

There is currently no carrier-neutral data centre in Mozambique[53] to support the emerging

48 *ITU data 2020*
49 *ITU 2019. Measuring Digital Development: Facts and Figures*
50 *Mozambique Internet Exchange Point https://mozix.org.mz*
51 *https://www.afpif.org/2015/02/the-Internet-society-brings-african-interconnection-conference-to-mozambique/*
52 *MOZIX statistics https://mozix.org.mz/index.php/traffic-graphs/*
53 *https://www.datacentermap.com/africa/*

digital ecosystem openly. The Government of Mozambique however operates a data centre at the Maluana Science and Technology Park, in the district of Manica.[54] The centre under MCTESTP provides data storage and processing to facilitate e-government services provided by different MDAs. MoRENet also has a PoP in Maluana Data Centre and it has the only Google Cache in the country that is used by all the licensed providers.

### 4.2.4 Cybersecurity

While there are a number of sectoral efforts to create Computer Emergency Response Teams (CERTs) involving MoRENet for higher education institutions,[55] licensed telecom providers and financial institutions, efforts to create a national CERT and coordination mechanism across the sector are still nascent.[56,57] A national working group to coordinate the effort—CERT-MZ has been set up under the auspices of INAGE.[58]

Higher education institutions possess large amounts of sensitive data including personal and academic information on their students and staff. As they seek to digitise their data and operations and to improve connectivity, higher education institutions will increasingly become a target for hackers and cyber criminals, even in Africa. The challenge is how to effectively manage cybersecurity while maintaining the openness associated with institutions of higher learning and necessary to spur cross-disciplinary collaboration and innovation. Improved connectivity is necessary for teaching and learning as well as to exchange large amounts of research data. At the same time, the improved connectivity also provides a good avenue for Cybercriminals to attack higher education institutions. Institutions will therefore need to invest in more highly skilled ICT staff, supported by better technical tools to monitor and respond to potential cybersecurity challenges. Institutions will also need to develop better usage policies and to educate their students and staff on how to effectively operate in this new environment. In addition, as the primary training, higher education institutions must produce ICT professionals that will protect other sectors of the economy from similar challenges.

The ITU Global cybersecurity Index (GCI)[59] seeks to gauge how countries are dealing with cyber threats. Using a range of indicators, the ITU compares countries in terms of knowledge for implementing cybercrime legislation, national cybersecurity strategies (NCS), computer emergency response teams (CERTs), capacity to spread awareness of developed strategies, and capabilities and programmes in the field of cybersecurity.

Mozambique's performance on the GCI has worsened, with the country sliding a number of positions from 108 to 132 out of 132 ITU member countries as indicated in Table 4. The decline is on account of poor performance on legal measures (like inadequate regulation), deficient technical measures (like lack of national and sectoral CERTs) as well as insufficient organizational and capacity building measures.

54 *https://clubofmozambique.com/news/maluana-data-centre-soon-to-be-in-operation-mozambique/*
55 *MoRENet CSIRT, https://csirt.morenet.ac.mz/en/home/*
56 *https://www.inage.gov.mz/?p=1903*
57 *https://www.itu.int/en/ITU-D/cybersecurity/Pages/national-CIRT.aspx*
58 *CERT-MZ, https://www.cert.mz/*
59 *ITU cybersecurity Index https://www.itu.int/en/ITU-D/cybersecurity/Pages/global-cybersecurity-index.aspx*

*Table 4: Country performance in ITU Global cybersecurity Index*

| Country | 2017 GCI | | | 2018 GCI | | |
|---|---|---|---|---|---|---|
| | Score | Regional (out of 44) | World Rank (out of 193) | Score | Regional (out of 44) | World Rank (out of 193) |
| Burkina Faso | 0.21 | 16 | 107 | 0.4 | 14 | 96 |
| Côte d'Ivoire | 0.42 | 8 | 73 | 0.46 | 9 | 86 |
| **Mozambique** | **0.21** | **17** | **108** | **0.16** | **26** | **132** |
| Uganda | 0.54 | 5 | 50 | 0.62 | 7 | 65 |

*Source: ITU Global cybersecurity Index (GCI) 2017 and 2018*

The Government of Mozambique has taken the challenge seriously and has, among other interventions, ratified the African Union Convention on Cybersecurity and Personal Data Protection in 2018, approved the Electronic Transactions Law and Digital Certification Regulations, is implementing the government CERT in the Maluana Data Centre and has designed public awareness campaigns on how to safely use ICT using a range of media.[60]

### 4.2.5 Electrification

Table 5 compares trends in electrification between Mozambique and the other case study countries—Burkina Faso, Côte d'Ivoire and Uganda. The country still has a low electrification rate, particularly in rural areas where most of the population lives, making improving connectivity more challenging.

*Table 5: Comparison of electrification rate among case study countries*

| | Proportion of the population with access to electricity | | | | | Population without access (million) |
|---|---|---|---|---|---|---|
| | National | | | Urban | Rural | |
| | 2010 | 2015 | 2019 | 2019 | 2019 | 2019 |
| Africa | 44% | 49% | 56% | 81% | 37% | 579 |
| Sub-Saharan Africa | 33% | 40% | 48% | 76% | 29% | 578 |
| Uganda | 14% | 19% | 29% | 66% | 17% | 32 |
| Côte d'Ivoire | 59% | 63% | 76% | >99% | 51% | 6 |
| Burkina Faso | 14% | 19% | 22% | 69% | 2% | 16 |
| **Mozambique** | **16%** | **28%** | **35%** | **57%** | **22%** | **20** |

*Source: IEA, World Energy Outlook-2020*

60 *https://www.mctestp.gov.mz/por/Ultimas-noticias/Noticias/GABRIEL-SALIMO-DEFENDE-CONSOLIDACAO-DA-LEGISLACAO-SOBRE-CRIMES-CIBERNETICOS*

### 4.2.6 COVID-19 Implications for Connectivity

Higher education in Mozambique has experienced disruptions due to the COVID-19 pandemic just like other countries worldwide. The disruptions have pushed higher education institutions to adopt the use of digital learning platforms much faster to support teaching and learning processes with the support of MCTESTP and MoRENet.[61]

MCTESTP has also worked with other government Ministries, Departments and Agencies (MDAs) to negotiate with three major licensed operators (Movitel, Tmcel and Vodacom) to provide special rates that allow unlimited Internet access for registered students and staff of higher education institutions to designated academic systems and content.[62]

MCTESTP has completed the implementation of a videoconferencing system to support virtual meetings between staff at MDAs. The system is part of the Government Electronic Network (GovNet) that interconnects governments MDAs. It is hosted at the government data centre in Maluana, with terminal equipment (cameras, microphones) distributed across each MDA. As part of this project, the bandwidth for all connected MDA sites has been increased to a minimum of 20 Mbps.[63]

## 4.3 Sector Challenges Impacting Broadband Connectivity

Three key documents—the Information Society Policy (section 3.3.3, pages 13-14)[64] the Strategic Plan for the Information Society (2019-2028)[65] and the Operational Plan for the Information Society highlight the critical challenges hindering the development of the ICT sector in Mozambique. These include:

i. Inadequate development and deployment of ICT infrastructure to cover the whole country, particularly rural under/unserved areas and support the effective roll-out of broadband services. This creates more challenges to TVETs and higher education institutions located in rural areas;

ii. Limited number of fixed broadband Internet providers, which minimises potential competition and resulting improvements;

iii. Poor quality and limited geographical reach of the national electricity grid particularly in rural and peri-urban areas.[66] Figure 5 compares trends in the proportion of the population with access to electricity in Mozambique to the other case study countries.

61 *https://www.mctestp.gov.mz/por/Ultimas-noticias/Comunicado-de-Imprensa/PONTO-DE-SITUAC-A-O-DE-OPERACIONALIZAC-A-O-DAS-MEDIDAS-DE-PREVENC-A-O-DA-PANDEMIA-DO-NOVO-CORONAVI-RUS-COVID-19-NOS-SUBSISTEMAS-DO-IES-E-ETP*

62 *https://simecacin.morenet.ac.mz/*

63 *https://www.mctestp.gov.mz/por/Ultimas-noticias/Noticias/MCTESTP-IMPLEMENTA-SISTEMA-DE-VIDEOCONFERENCIA-DO-GOVERNO*

64 *Política para a Sociedade da Informação, 2018*

65 *https://www.inage.gov.mz/wp-content/uploads/2020/06/4-Plano-Estrategico-ao-Conselho-de-Ministros-25_02_2019-Versao-aprovado-pelo-CM_compressed.pdf*

66 *Programa Quinquenal do Governo 2020-2024*

At the end of 2019, 57% of urban areas in Mozambique had access to electricity compared to only 22% of rural areas;[67]

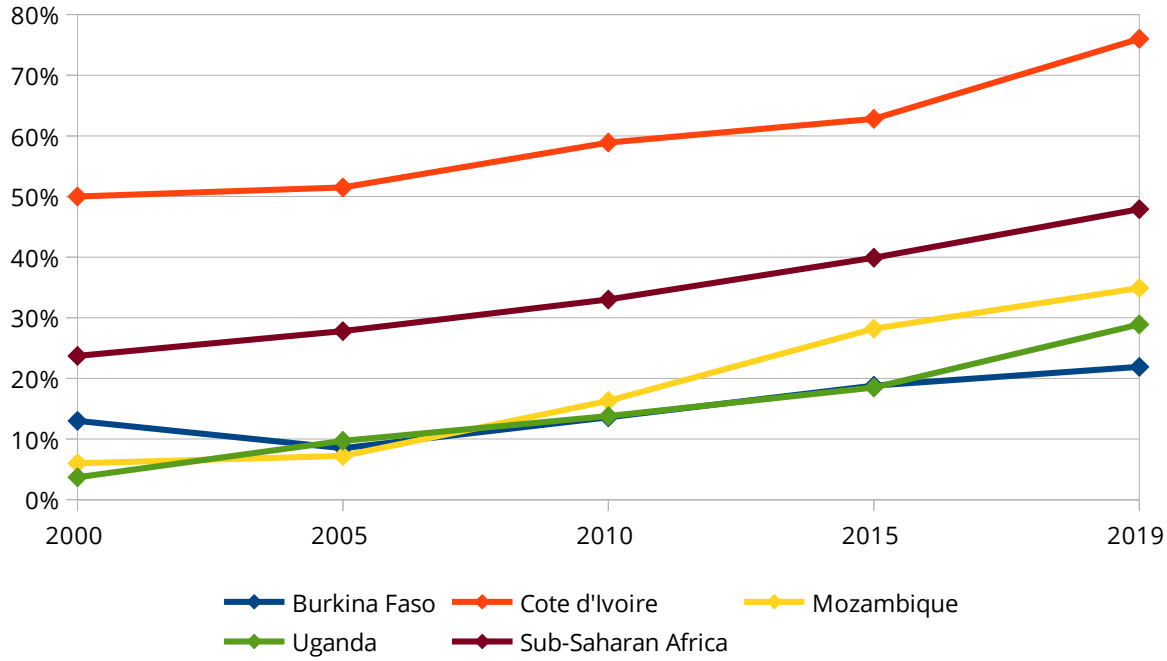


***Figure 5: Trends in the proportion of the national population with access to electricity***

iv. The high cost of broadband services, which cannot be afforded by the majority of the population due to poverty;

v. Inadequate implementation and enforcement of emerging ICT legislation and regulations that include the Electronic Transactions Act, the National Data Protection Policy and the National Privacy Policy among others;

vi. Lack of awareness among leadership of government agencies about the importance and potential benefits of ICT in developing their institutions as well as the socio-economic development of the country;

vii. Insufficient coordination and alignment among public institutions in relation to ICT projects and initiatives, resulting in duplication as well inefficiencies in public service delivery;

viii. Lack of sufficient numbers of qualified human resources to serve the ICT sector both in private and public institutions to ensure successful implementation of different ICT projects and initiatives;[68]

ix. Poor integration of the ICT component within the objectives and strategic documents designed to guide the development of the country; and

67 *International Energy Agency, World Energy Outlook-2020, https://www.iea.org/reports/world-energy-outlook-2020*

68 *Interviews with MoRENet and UbuntuNet Alliance, who all alluded to the need for continuous professional training for university ICT staff and the need to set aside resources to adequately cover this*

x. Lack of a vibrant and competitive local ICT sector that nurtures innovation and entrepreneurship in various technology areas to create more jobs for the youth compared to other sectors like agriculture and spur the creation of more local content.

# 5. Mozambique Research and Education Network

The Mozambique Research and Education Network (MoRENet)[69] was established in 2005 and is still a project under the Ministry of Science and Technology, Higher Education and Vocational Training. MoRENet is recognised by ICT regulators and other government MDAs and is considered as one of the pillars for the development of the Information Society Policy and the National Broadband Strategy in Mozambique. The NREN is one of the founding members of the UbuntuNet Alliance and is the predominant avenue through which universities and TVETs access broadband connectivity in the country.

MoRENet's logical network infrastructure is illustrated in Figure 6. The network has:

- An international connection through the UbuntuNet Alliance/SEACOM that provides 4.6 Gbps. A second connection through EASSy (WIOCC) of 1.25 Gbps was disconnected due to lack of financial resources to pay for the services;
- A managed bandwidth backbone of leased fibre at speeds of 500 Mbps;
- Six Points of Presence (PoPs) or aggregation sites distributed across the country in Niassa province, Nampula province, Tete province, Sofala province, Maputo province and Maputo City;
- MoRENet peers locally at UbuntuNet's Maputo PoP (10 Gbps) and Mozambique Internet Exchange Point (MOZIX) in Maputo (1 Gbps).

MoRENet works with a wide range of Licensed Service Providers, but primarily TDM and Movitel for the fibre backbone to back-haul traffic from across the country and last-mile connections to members. All PoPs and member institutions are connected to both TDM and Movitel fibre to ensure redundancy. The NREN's Muluana PoP, located in Muluana Data Centre, has the only Google Cache in the country that is used by all the licensed providers.

The network currently connects 142 campuses that include 18 Universities and 29 TVETs. Other connected institutions include 9 research institutions, 2 secondary schools and a number of institutions affiliated with the education sector. There are Plans to connect large campuses like UEM with at least 2 Gbps in 2021 (growing to 3 Gbps in 2022 and 4 Gbps in 2023); medium campuses with 100 Mbps in 2021 (growing to 500 Mbps in 2022 and 1 Gbps in 2023); and research institutions with 50 Mbps in 2021 (growing to 250 Mbps in 2022 and 500 Mbps in 2023).

69 *MoRENet website, http://www.morenet.ac.mz/*

*Source: MoRENet, 2020*

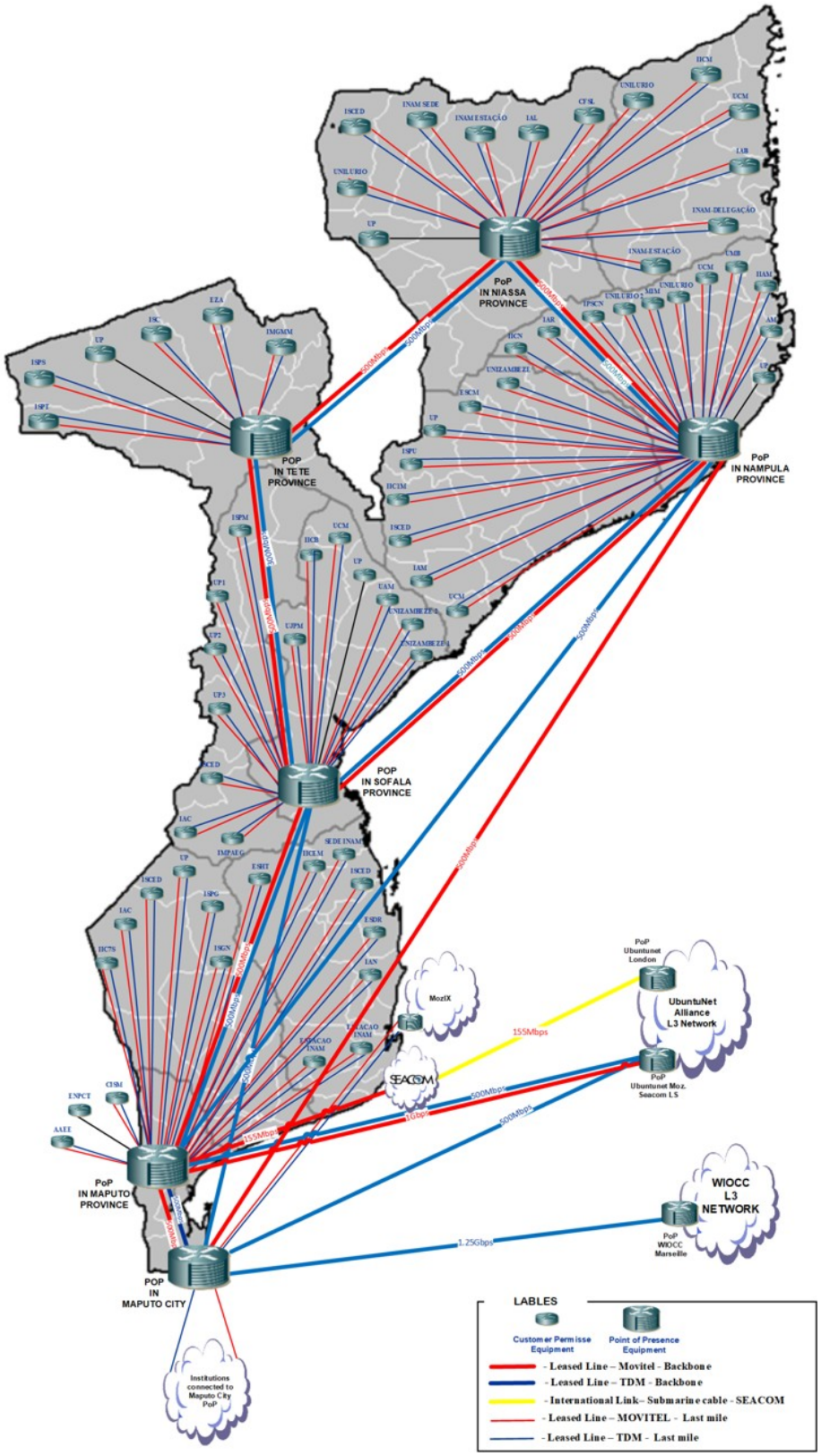


***Figure 6: Map of MoRENet network***

Member institutions currently pay USD 60 per Mbps per month, which encompasses all services provided by the NREN. Table 6 compares bandwidth pricing among selected African NRENs, showing that institutions that consume large volumes of bandwidth in Mozambique pay much more compared to some of their peers within the region.

***Table 6: Comparison of bandwidth prices across NRENs***

| NREN/Country | Cheapest (USD) | Bandwidth (Mbps) | Most Expensive (USD) | Bandwidth (Mbps) |
|---|---|---|---|---|
| KENET (Kenya) | 5 | ≥ 4,000 | 80 | ≤ 5 |
| MAREN (Malawi) | | | 85 | Does not vary with amount of bandwidth ordered |
| MoRENet (Mozambique) | | | 60 | -ditto |
| MARWAN (Morocco) | 3 | ≥ 5,000 | 21 | ≤ 100 |
| NgREN (Nigeria) | | | 25.5 | Does not vary with amount of bandwidth ordered |
| RENU (Uganda) | 10 | ≥ 5,000 | 50 | ≤ 99 |
| SomaliREN (Somalia) | 92 | ≥ 50 | 115 | ≤ 10 |
| TERNET (Tanzania) | 15 (in capital)<br>35 (outside capital) | ≥ 1,000 | 85 (in capital)<br>100 (outside capital) | ≤ 5 |

*Source: NREN Survey, KCL*

Although providing broadband connectivity to members is still the dominant service, MoRENet provides member institutions with a range of other services that include:

- eduroam
- Public key infrastructure and trust networks
- Email services
- Domain name registration
- Web hosting services
- Data Center services (e.g., Backup, Virtual Machines and Co-location of servers)
- Voice over IP (VOIP) and video conferencing (Zoom and BBB)
- Virtual libraries and content repositories
- DNS services (e.g., domain name translations and pointer records)
- Network Operations Centre (NOC) services (e.g., Traffic analysis and monitoring)
- Training and capacity building services (e.g., Workshops and Direct Engineering Assistance).

## 5.1 Critical Success Factors

Like other operational NRENs within the region, MoRENet has validated the assertion that if higher education institutions work together and aggregate their connectivity demand, they can improve access to high-speed connectivity while driving down the cost. There are a number of critical success factors that emerge from a review of the history and operations of MoRENet. The key ones include:

### i. Being a project under Ministry

MoRENet is an institution under MCTESTP. One of the objectives of the ministry is to improve access to quality education and use of ICT is recognised as one of the best avenues, particularly during this period of the COVID-19 pandemic. Being part of the Ministry has made it much easier to be part of national programmes related to connectivity, including the World Bank RCIP programme, which is helping MoRENet to increase the amount of bandwidth available for higher education and research institutions between 2021 and 2024.

### ii. Securing the collaboration of major network providers

MoRENet works with TDM and Movitel all across the country in terms of last mile connectivity. Every connected institution has two links, with one as primary and the other as backup, with the two providers guaranteeing transmission across the whole country. Vodacom provides the only international link between MCT PoP to SEACOM-UbuntuNet PoP.

### iii. Building a good technical team to manage the network

MoRENet currently has a team of nine full-time paid staff who are on the government payroll. These are supplemented by a team of ICT interns inspired to work at MoRENet because it provides an excellent training ground and extensive training opportunities, transforming interns into a high calibre and highly-skilled ICT staff. Currently, four interns are paid-staff while 10 are still in a volunteer capacity.

### iv. Being part of the Regional REN

Membership in the UbuntuNet Alliance (UA) has also greatly helped MoRENet improve connectivity among her members. Through UA, MoRENet aggregates her bandwidth demand with other countries in the region, increasing bandwidth volumes, which in-turn make it easier for member NRENs of UA to approach bigger regional carriers and submarine operators to buy bandwidth at cheaper rates. The UA has also built a regional network to distribute this bandwidth, exchange traffic among member NRENs, and connect them to other international RENs. MoRENet interconnects at the UA's local PoP in Maputo, which is co-located within SEACOM facilities. MoRENet has participated in the European Union-funded AfricaConnect project, now in its third phase since inception.[70]

70 https://www.africaconnect3.net/

### v. Negotiating for lower bandwidth cost

Currently, MoRENet charges members USD 60 per Mbps per month, which is much better than the commercial rate at USD 80 per Mbps per month. Despite this, MoRENet does not generate enough revenue to pay providers and cover the technical staff's salaries and has to rely on support from the government and other partners like the World Bank. During the interviews for this report, the connection through EASSy (WIOCC) had been switched off due to failure to pay.

## 5.2 NREN Maturity

Survey results show that African countries are at different levels of NREN development or maturity based on a number of indicators relevant to higher education connectivity. The most pertinent ones integrated into the cost model include:

i. Presence of NREN (1 point), (scored 1 out of 1). Mozambique has a formal NREN.
ii. NREN governance structure (1 point), (scored 1 out of 1). MoRENet is an institution under MCTESTP.
iii. Government recognition of NREN/NREN relationships (1 point), (scored 1 out of 1). MoRENet is part of MCTESTP and is recognised by Ministry in charge of ICT and the ICT sector regulator.
iv. Variety of funding sources for NREN (1 point each for membership fees, government grants and sale of bandwidth), (scored 2 out 3). MoRENet receives most of its funding from government as well as from the sale of bandwidth to members.
v. Whether has a network (network 1 point, national PoPs 2 points), (scored 2 out of 2). MoRENet has a network with six Points of Presence (PoPs) distributed across the country (Niassa, Nampula, Tete, Sofala, Maputo and Maputo City).
vi. Whether NREN has an Autonomous System Number (ASN) (1 point).[71,72] This facilitates routing within NREN network, exchange of routing information with other network operators and ability to directly peer with an IXP. MoRENet has an ASN.
vii. Whether at least one University or more has an ASN that facilitates multi-homing (1 point), (Scored 0). UEM and the American International School of Mozambique have ASNs
viii. Whether any ASN has networks that they peer with (1 point), (scored 1 out of 1).[73] MoRENet's network peers with other networks.
ix. NREN regional/global connectivity (transit in Africa 1 point, transit in Europe 2 points), (scored 1 out of 2 points). MoRENet has regional connectivity through the UbuntuNet Alliance.
x. Middle-ware services offered by NREN (1 point each for ICT training, DNS, NOC services), (scored 3 out of 3 points). MoRENet offers ICT Training, DNS and NOC services to members.
xi. Advanced services offered by NREN (1 point each for identity and access management,

71 *AfriNIC is the regional Internet registry that allocates these for the African region, https://afrinic.net/asn*
72 *AfriNic ASN Statistics https://stats.afrinic.net/asn/*
73 *AfriNic ASN Statistics https://stats.afrinic.net/asn/*

data centre services, video conferencing, research management tools), (scored 1 out of 4 points). MoRENet offers data centre services.

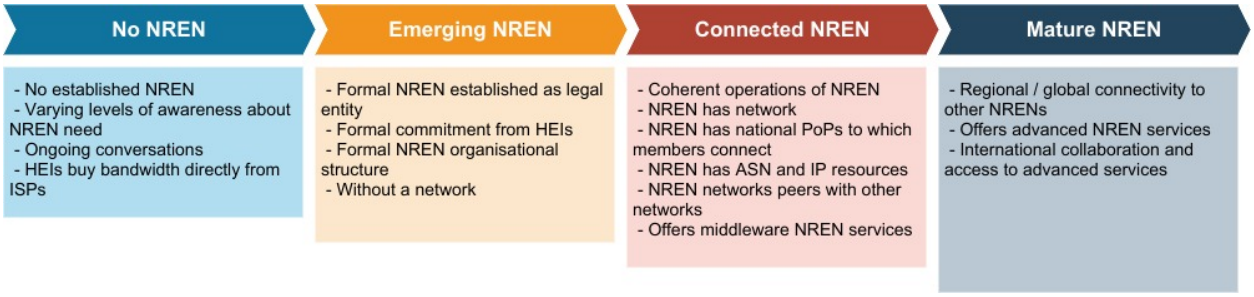


***Figure 7: Stages of NREN development***

Using a combination of Duncan Greaves' NREN Capability Maturity Model[74] and Mike Foley's levels of NREN development,[75] different African countries can be scored and organised into levels of NREN maturity. There are four broad groups summarized in Figure 7, that include:

i. No-NREN: no NREN, but varying levels of awareness about need and ongoing conversations (score 0).
ii. Emerging NREN: legal entity established, with formal organisational structure, but without a network (score 1-6),
iii. Connected NREN: has network of varying coverage, may have national PoPs to connect members, has ASN and IP resources that facilitate peering with other networks and offering middle-ware services (score 7-16), and
iv. Mature NREN: has high-speed regional (transit in Africa)/global (transit in Europe) connectivity to other NRENs and offering advanced services (score 17-20).

Table 7 depicts how the NRENs in different African countries can be categorised around these stages. It also shows the potential savings derived from demand aggregation of bandwidth requirements among higher education institutions and smart procurement strategies (e.g., benchmarking regional pricing), and procuring long-term leases. MoRENet is categorised as a Connected NREN.

***Table 7: Classification of Connectivity in African Higher Education***

| State of NREN development | Countries | Actions | Contribution to Saving via aggregation |
|---|---|---|---|
| No NREN | Angola, Cape Verde, Central African Republic, Comoros, Republic of Congo, Eritrea, Equatorial Guinea, Eswatini, Gambia, Guinea-Bissau, Lesotho, Mauritius, São Tomé | • Ensure access to bandwidth to all higher education institutions (2 years)<br>• NREN development (3 years) | 0% saving |

74 *Greaves, D. (2009). An NREN Capability Maturity Model. https://www.casefornrens.org/Resources_and_Tools/Document_Library/Documents/NREN%20Capability%20Maturity%20Model%20(CMM).pdf*
75 *Foley, M. (2016). The Role and Status of National Research and Education Networks in Africa. World Bank.*

| | | | |
|---|---|---|---|
| | and Príncipe, Seychelles, South Sudan | • Transition to full NREN model (5 years) | |
| Emerging NREN | Botswana, Burkina Faso, Burundi, Cameroon, Chad, Djibouti, Guinea, Liberia, Libya, Mali, Mauritania, Namibia, Niger, Sierra Leone, Sudan, Zimbabwe | • Strengthening NREN<br>• Ensuring that higher education institutions are connected to adequate Internet bandwidth | 30% saving |
| Connected NREN | Algeria, Benin, Cote d'Ivoire, DRC, Egypt, Ethiopia, Gabon, Ghana, Madagascar, Malawi, Morocco, Mozambique, Nigeria, Rwanda, Senegal, Somalia, Tanzania, Togo, Tunisia, Zambia | • Ensuring that higher education institutions are connected to adequate Internet bandwidth<br>• Provision of advanced services<br>• Transition to full-fledged NREN in three years | 60% saving |
| Mature NREN | Kenya, South Africa, and Uganda | • Provision of advanced connectivity and services | 90% saving |

*Source: KCL*

## 5.3 Challenges for MoRENet

Like NRENs in other parts of Africa, MoRENet faces a number of challenges that hinder better performance and delivery of high-speed connectivity to higher education institutions. MoRENet has attempted to address some, but does certainly need support from other partners to resolve many of them.

### i. Inadequate bandwidth to serve research and learning needs

Out of the 19 universities and 219 TVETs in the country, 18 universities and 29 TVETs currently connect to MoRENet, drawing a total of 4.6 Gbps. With the current enrolment 240,000 students in higher education and the 2021 target of 2 Gbps per 1,000 students, the total requirement is at least 480 Gbps, giving a deficit of about 470Gbps.

Table 18 shows current bandwidth at all public and private universities in Mozambique (ranked by student enrolment in 2019/20) and their projected bandwidth need based on a threshold of 2 Gbps per 1,000 students in 2021. It is evident that all institutions currently get less than 10%, and with most getting less than 1% of what would be globally considered the absolute minimum.

***Table 8: Current bandwidth and deficit at all public and private universities by enrolment (2019/20)***

| Name | Student Enrolment 2020 | Bandwidth Need 2021 (Mbps) | Current Bandwidth (Mbps) | % available compared to required |
|---|---|---|---|---|
| Universidade Eduardo Mondlane | 44,129 | 88,258 | 1,260 | 2% |
| Universidade Católica de Moçambique | 26,020 | 52,040 | 10 | <1% |
| Universidade Rovuma | 18,722 | 37,444 | 210 | <1% |
| Universidade Pedagógica de Maputo | 15,843 | 31,686 | 554 | 2% |
| Universidade Licungo | 15,569 | 31,138 | 120 | <1% |
| Universidade Save | 11,387 | 22,774 | 40 | <1% |
| Universidade Zambeze | 8,869 | 17,738 | 60 | <1% |
| Universidade Púnguè | 7,606 | 15,212 | 114 | <1% |
| Universidade São Tomás de Moçambique | 5,671 | 11,342 | 70 | <1% |
| Universidade Lúrio | 4,676 | 9,352 | 60 | <1% |
| Universidade Politécnica | 4,079 | 8,158 | 50 | <1% |
| Universidade Técnica de Moçambique | 3,134 | 6,268 | 20 | <1% |
| Universidade Joaquim Chissano | 2,869 | 5,738 | 30 | <1% |
| Universidade Wutive | 2,262 | 4,524 | 20 | <1% |
| Universidade Mussa Bin Bique | 671 | 1,342 | 20 | 2% |
| Universidade Nachingwea | 591 | 1,182 | 20 | 2% |
| Universidade Jean Piaget de Moçambique | 579 | 1,158 | 15 | 1% |
| Universidade Adventista de Moçambique | 502 | 1,004 | 10 | 1% |
| Universidade Metodista Unida de Moçambique | 65 | 130 | 10 | 8% |

*Sources: MCTESTP and MoRENet, 2020*

### ii. Perception by Commercial Service Providers as a competitor

MoRENet connects higher education and research institutions at prices that are better than market prices. Commercial providers perceive this as being unfair. Educational institutions prefer MoRENet because of these low prices and other value-added services that MoRENet provides to connected members.

### iii. Low awareness about the benefits of an NREN

Low awareness among potential members is still a big challenge. MoRENet organised a big annual conference during the third week of November 2018 where current and potential members were invited. Many educational institutions until then did not know about the potential benefits of being connected to MoRENet, after this, many institutions terminated their connectivity arrangements with commercial providers and joined the MoRENet network.

From then on, MoRENet hosts an annual members conference during the third week of November to share progress, disseminate information about new and existing services, talk about the quality of services, and also promote member interaction.

### iv. Inadequate public funding for ICT infrastructure

Many public higher education institutions lack sufficient resources to invest in reliable ICT infrastructure and to offer training to both users and technical staff. The contributions from the government are not sufficient to meet their operational budget. MoRENet is always on the lookout for potential support both through government, private and international partners. In 2014, MoRENet was able to set up wireless networks and infrastructure at 16 higher education institutions with support from the World Bank.

### v. Poor campus networks and low skilled ICT staff

Networks on the campuses of higher education institutions are extremely deficient, and some campuses actually have no networks due to the high cost of purchasing network equipment. There are a number of public universities where equipment has been allocated (routers, Wi-Fi access points, access controller, etc.) and networks installed, but because of a lack of skilled ICT staff, there is the failure to maintain the equipment and keep the networks operational.

# 6. Cost Estimates for Connecting Higher Education in Mozambique

Connectivity, recognized as a foundation for learning and innovation, has four major components, all of which need to be addressed to complete the value chain: end-user access devices; high quality campus networks to deliver a good broadband experience to the end-users; high quality national networks to interconnect campuses; and regional and global networks to join national networks to the global environment.

A schematic diagram for arriving at the cost of connecting African higher education institutions is shown in Figure 8. The pricing used to determine the cost estimates in this report is specific to Mozambique, and therefore provides more accurate projections compared to the general continental averaging.

## 6.1 Access to Computing Devices

To compute the cost of access to computing devices for students and staff that are necessary to facilitate the use of high-speed broadband delivered to higher education institutions, these assumptions were defined as part of the cost model:

Assumptions for projecting device costs for students and staff by country:

i. Used forecast of student enrolment and staff numbers in Mozambique for 2021 to 2025.
ii. 80% of students are undergraduate students who spend, on average three years at the university, 20% are graduate students who spend two years at the university.
iii. One third of undergraduates in a given year are assumed to be freshers while one half of graduate students are considered to be freshers at the start of any given academic year. This results in a weighted average of 36.7% that need to acquire devices at the beginning of any academic year.
iv. Predetermined scaling down of support from different partners for student devices. Support starts at 80% of the first-year students in 2021 and reduces by 20% year-on-year: 60% in 2022, 40% in 2023, and 20% in 2024.
v. All staff will get devices between 2021 and 2025. Staff devices are supported up to 100%, and new staff are given new devices after recruitment.
vi. Used an average figure of USD 400 per user laptop (including software) as economies of scale would reduce costs. All laptops come with a three-year warranty.

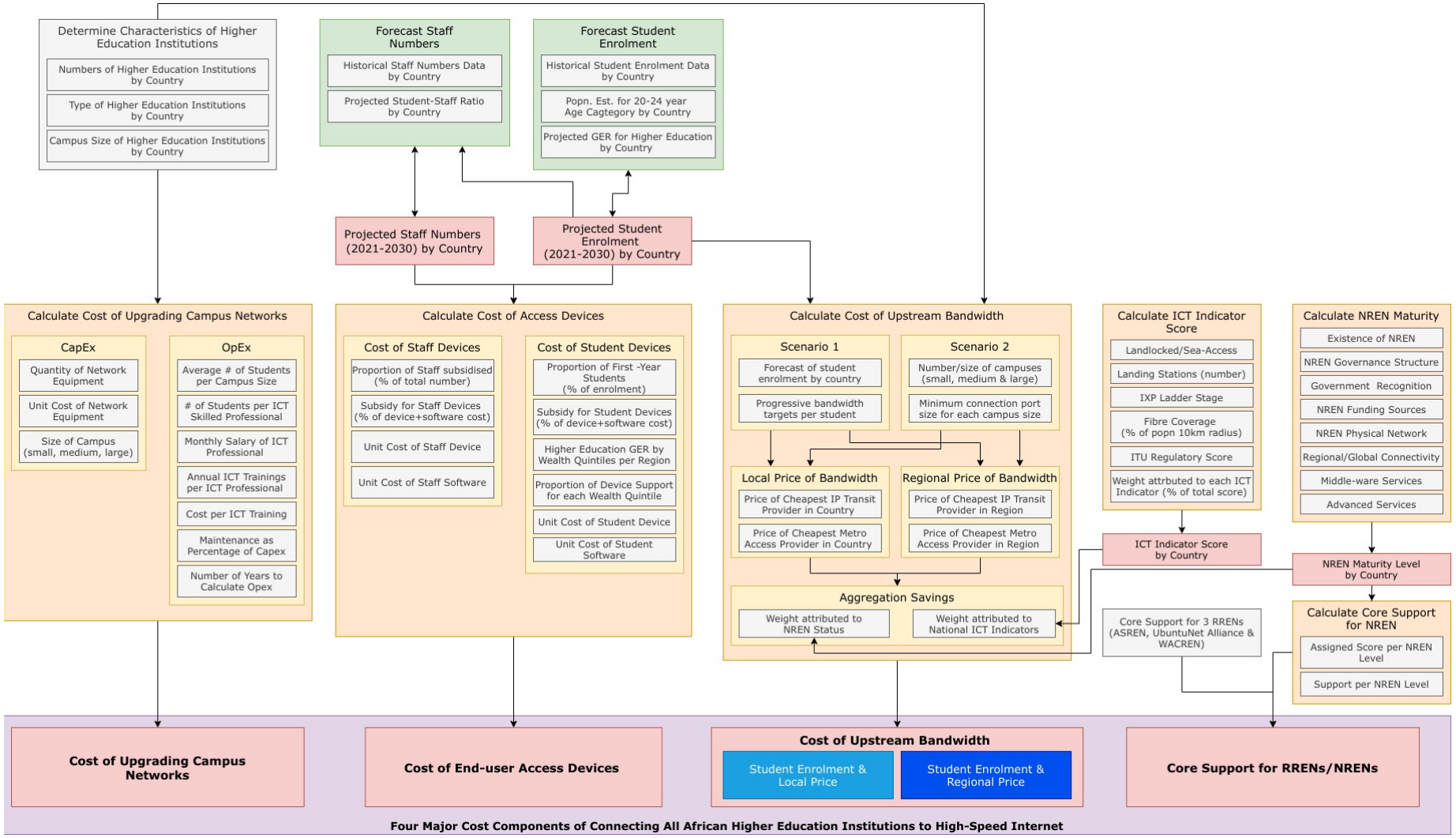


***Figure 8: A schematic diagram to estimate costs for connecting higher education institutions in Africa***

Based on the cost model, Mozambique needs USD 109 million to provide access devices for all first-year students and staff in higher education institutions between 2021 and 2025, as summarised in Table 9.

***Table 9: Cost of equipping students and staff with access devices (2021 to 2025)***

| Year | Forecast student enrolment | Forecast staff numbers | Estimated Average cost of devices (USD, million) |
|---|---|---|---|
| 2021 | 247,711 | 18,119 | 42.2 |
| 2022 | 258,411 | 18,470 | 25.7 |
| 2023 | 269,111 | 20,233 | 18.3 |
| 2024 | 279,811 | 20,585 | 21.2 |
| 2025 | 290,511 | 22,348 | 1.3 |
| **Total** | **1,345,555** | **99,755** | **109** |

*Source: KCL calculations*

## 6.2 Upgrading Campus Networks

Table 10 summarises the assumptions used for calculating the cost of upgrading campus networks.

***Table 10: Assumptions for calculating campus network upgrade costs in Mozambique***

| Area | Assumptions |
|---|---|
| Number of buildings | A micro campus has 1 large building, a mini campus has 1 medium and 1 building, a small campus has 2 medium and 3 large buildings, a medium campus has 4 medium and 6 large buildings, a large campus has 8 medium and 12 large buildings while a very large campus has 12 medium and 18 large buildings. |
| Length of fibre | A micro campus needs 1 km of fibre network, a micro campus needs 2 km, a small campus needs a 5 km fibre network backbone, a medium campus needs 10 km, while large and very large campuses need 20 km and 30 km, respectively. Assumed a unit cost of $20 per metre of laying fibre, including civil works. |
| Switching centres | A micro campus has 1 switching centre (with 1 core switch and 1 layer 3 switch) while mini and small campuses have 1 switching centre (with 1 border router and 1 core switch). Medium campuses have 1 switching centre (with 1 layer 3 switch and 1 core switch). Large and Very Large campuses have 2 switching centres (each with a core router) and one border router for large and 2 for very large campuses. Very large campuses have two border routers, giving the network ability to support 2 independent connections. Given the poor reliability of power in many African countries, each switching centre has a standby generator. |

| | |
|---|---|
| Data centre | A campus needs a small data centre (Tier I) with racks, centralised UPS and some servers. We budgeted 3 servers for the micro, mini and small campuses, 9 servers for medium, 12 servers for the large and 18 for very large campuses. The data centre, switching centre, and Network Operations Centre (NOC) should be co-located in the same location to save on costs. |
| Multimedia classroom | Micro, mini and small campuses have 1 fully integrated smart classroom with different technologies, including smartboards, projectors, cameras, speakers, audio equipment, lighting etc. A medium campus has 3 of these; a large campus has 5, while a very large campus has 7 smart classrooms. |
| Support to institutional library | A Local Area Network and PCs in the main library that is connected to an online public access catalogue (OPAC). |
| Skilled staff | At least 1 ICT skilled professional for every 450 students earns at least 1.5K per month to compete with the private sector. The staff should have access to one training opportunity per year in line with the needs of their institution. |
| Consulting and design support | Institutions should be able to access technical support to help the technical team implement various solutions that address their institution's needs. This can start with campus network design and span other areas, including installing and maintaining various systems and equipment. |
| Equipment supplies and maintenance | Institutions should be able to undertake corrective and preventive maintenance to extend the campus network's life and operation. |

Table 11 summarises the CapEx and OpEx costs for upgrading all university and TVET campus networks in Mozambique.

***Table 11: Estimate for upgrading University and TVET campus networks in Mozambique***

| **Size of HEIs** | **Number of HEIs** | **Capex (USD, millions)** | **Opex (USD, millions)** | **Total (USD, millions)** |
|---|---|---|---|---|
| Institutions with less than 5000 students (small campus) | 41 | 60 | 75 | **135** |
| Institutions with between 5000-15000 students (medium campus) | 7 | 19 | 29 | **48** |
| Institutions with more than 15,000 students (large campus) | 5 | 25 | 48 | **73** |
| **Total** | **53** | **104** | **152** | **255** |

*Source: KCL calculations*

The OpEx cost covers five years (default period that can be modified in the model) and includes a maintenance component for the campus networks (15% for hardware and software costs). The OpEx cost excludes bandwidth costs that are handled in the next section.

Table 11 shows that OpEx costs (excluding bandwidth) are higher than CapEx costs. Given the need for sustainability, this highlights the need for both higher education institutions and the government to budget these costs appropriately.

Table 12 indicates that small campuses account for 77.4% of all campuses and 52.9% of the total cost of upgrading campus networks. Given that the average enrolment for small campuses was only 1,481 students per campus, the small campus category has been refined into three categories—mini campus (500 students or less), micro campus (500 to 1,500 students) and small campus (1,500 to 5,000 students) as shown in Table 13. Similarly, large campuses have also been refined into two categories—large campus (15,000 to 25,000 students) and very large campus (25,000 or more students).

***Table 12: Distribution of Small, Medium and Large Campuses***

| | No. of HEIs | Average enrolment | % of HEIs | % of Capex + Opex |
|---|---|---|---|---|
| Small (<=5000) | 41 | 1,481 | 77.4% | 55.1% |
| Medium (5001-15000) | 7 | 8,467 | 13.2% | 17.9% |
| Large (>=15000) | 5 | 24,057 | 9.4% | 27.2% |
| **Total** | **53** | | **100.0%** | **100.0%** |

*Source: KCL*

***Table 13: Distribution of HEI campus sizes in Uganda***

| | Min enrolment | Max enrolment | No. of HEIs | Average enrolment | % of HEIs |
|---|---|---|---|---|---|
| Micro campus | 0 | 500 | 8 | 280 | 15.1% |
| Mini campus | 500 | 1500 | 16 | 785 | 30.2% |
| Small campus | 1,500 | 5,000 | 17 | 2,701 | 32.1% |
| Medium campus | 5,000 | 15,000 | 7 | 8,467 | 13.2% |
| Large campus | 15,000 | 25,000 | 3 | 16,711 | 5.7% |
| Very large campus | 25,000 | | 2 | 35,075 | 3.8% |
| **Total** | | | **53** | | **100.0%** |

*Source: KCL*

Refining the categories shown in Table 12 as shown Table 13 reduces the cost of upgrading campus networks from USD 255 million to 238 million, saving 6.8%. The savings from refining categories are minimal compared to other case studies countries like Côte d'Ivoire (savings of 38%) and Uganda (savings of 32%) with a higher proportion of small campuses with lower student enrolment.

## 6.3 Connecting Campuses Upstream

Drawing on global bandwidth use, it is recommended that higher education achieve connectivity of at least 1 Gbps for campuses that host 5000 students and staff in 2021 as indicated in Table 14. The connectivity target is to achieve at least 2 Gbps per 1000 students by 2025 (to be provided for in the World Bank planning period ending 2023) and at least 20 Gbps per 1,000 students by 2030.

***Table 14: Recommended Progressive Bandwidth Targets for African Universities and TVETs***

| Year | Minimum Bandwidth | Remarks |
|---|---|---|
| 2021 (targeted minimum) | 0.2 Gbps @1,000 | Translates to 1Gbps for a campus of 5,000; and 10 Gbps for a campus of 50,000 |
| 2021-2025 | 2 Gbps @1,000 | Translates to 10 Gbps for a campus of 5,000; and 100 Gbps for a campus of 50,000. *This should be the minimum entry level for the WBG intervention*. It should be noted that the general aspirational target of most African NRENs by 2025 or earlier is 1Gbps per 1000 students, but this is heavily influenced by current challenges and limitations. |
| 2025-2030 | 20 Gbps @1,000 | Translates to 100 Gbps for a campus of 5,000. Actual size for any campus to be based on the TENET approach: *"sufficient bandwidth to be able to use the prevailing applications of the day" with port sizes twice the normal usage.* |

*Source: KCL*

### 6.3.1 Estimating Bandwidth Requirements and Unit Cost

Figure 9 shows two ways to determine the Unit Price (USD/Mbps/month). The unit price of bandwidth varies widely depending on distance from fibre network, local access and transit costs, the maturity of NREN, national ICT situation and regulatory score. The Local Price comprises the cheapest cost of IP transit and the cheapest cost of local access to deliver the bandwidth with a metro or provincial capital area in Mozambique. IP transit is calculated based on 10 GigE volume or more from the cheapest provider in the country. Local metro access costs to deliver bandwidth to HEIs are calculated based on Gigabit Ethernet (GigE) circuits where available and smaller circuits in locations without big capacities, assuming that higher education institutions are located at most 15 km from a provider's PoP in a metro/urban area.

For ***Local Price (USD 52.5)***, we derive the unit cost of bandwidth (Mbps) by adding the cost of IP transit and local access to deliver the bandwidth in a metro area for the cheapest provider in a country. We then calculate a regional average using the WBG regions to cater for countries that lack data. For ***Regional Price (USD 14.3)***, we derive the unit cost of bandwidth (Mbps) by adding the cost of IP transit and local access to deliver the bandwidth in a metro area for the cheapest provider in the region that Mozambique is located. We then calculate a regional average using the WBG regions to cater for countries that lack data. Regional approaches to procurement are useful because the large volumes attract bigger players who bring in regional pressures on pricing.

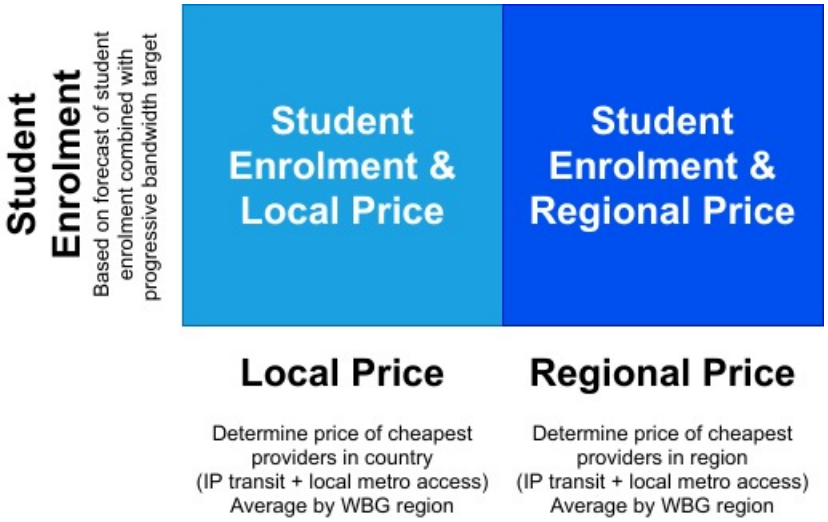


***Figure 9: Matrix for determining bandwidth cost***

Based on this, Table 15 shows the projected bandwidth requirements for Mozambican higher education institutions using Student Enrolment (Scenario 1), giving a total of 581 Gbps by 2025 and 6.9 Tbps by 2030.

### 6.3.2 Aggregation Savings

The Aggregation Savings calculated from Mozambique's NREN maturity and its performance on various national ICT indicators pertinent to connectivity is 61%. This reflects the cost savings that higher education institutions are expected to gain by aggregating their bandwidth demand, using smart procurement strategies (e.g., benchmarking regional pricing) and procuring long-term leases.

### 6.3.3 Cost of Connecting Campuses Upstream

***Table 15: Projected bandwidth and cost using Student Enrolment and Local Price (2021, 2025 & 2030)***

| Year | Student enrolment | Projected bandwidth (Gbps) | Projected cost (USD millions) no aggregation Savings | Projected cost (USD millions) with aggregation Savings |
|---|---|---|---|---|
| 2021 | 247,711 | 248 | 156 | 61 |
| 2025 | 290,511 | 581 | 183 | 71 |
| 2030 | 344,010 | 6,880 | 542 | 211 |

*Source: KCL calculations*

***Table 16: Projected bandwidth and cost using Student Enrolment and Regional Price (2021, 2025 & 2030)***

| Year | Student enrolment | Projected bandwidth (Gbps) | Projected cost (USD millions) | Projected cost (USD millions) |
|---|---|---|---|---|

| | | | no aggregation Savings | with aggregation Savings |
|---|---|---|---|---|
| 2021 | 247,711 | 248 | 43 | 17 |
| 2025 | 290,511 | 581 | 50 | 19 |
| 2030 | 344,010 | 6,880 | 148 | 58 |

*Source: KCL calculations*

## 6.4 Support to MoRENet

Discussions with NREN officials in Africa indicate that they spend about 60% of their OpEx on connectivity-related expenses and the remaining 40% on human resources and related costs. Given that member institutions cover connectivity-related expenses through payments for bandwidth, NRENs often struggle to cover core costs and costs related to ongoing capacity building for both internal staff and especially member institutions where the value of connectivity is realised. Shortage of funding also means NRENs fail to retain competent staff who are attracted by the much higher pay within the ICT private sector: this is especially a challenge in the development and growth stage of five to ten years. It is especially important to provide such support in order to reap the resulting value of the NREN to the delivery of broadband.

Based on the experience of the NRENs that have now reached maturity, MoRENet needs a support budget of USD 2 million per year. About 40% (USD 800,000) would be spent on human resources and 60% (USD 1,200,000) on NREN development-related costs. This gives a requirement of USD 10 million over five years.

## 6.5 Cost of Connecting HEIs in Mozambique

Table 17 summarises the cost elements for different components that make up the total cost of connecting all higher education institutions in Mozambique for a period of five years (2021-2025), including the cost of equipping students and staff with access devices and designing and upgrading campus networks. The overall cost is based on aggregation savings, that in turn, assume demand aggregation, use of smart procurement strategies (e.g., benchmarking regional pricing) and procuring long-term leases.

***Table 17: Summary of total 5-year cost of connecting all Mozambican higher education institutions to high-speed Internet***

| Category | Cost (USD, millions) | Potential Sources of Funding |
|---|---|---|
| **End-user devices** | | |
| Students and Staff | 109 | Government, development partners, students, institutions |
| **Sub Total** | **109** | |
| **Upgrading campus networks** | | |
| Capex | 91 | Government, development partners |
| Opex | 147 | Institutions, government, development partners |
| **Sub Total** | **238** | **Using micro, mini, small, medium, large to very large campus sizes** |
| **5-year cost of connecting campuses upstream** | | |
| | **With Aggregation Savings** | |
| Using Student Enrolment & Regional Price | **95** | Development partners, institutions, students |
| **NREN development and support costs** | | |
| MoRENet core costs and NREN development related costs | **10** | Development partners, government |
| **Total Cost Estimate (USD, millions)** | **452** | **Using cost of connecting campuses upstream based on student enrolment and regional price** |

*Source: KCL calculations*

# 7. Summary and Conclusion

This Case Study explores the connectivity challenge from Mozambique's education-sector perspective (demand-side) as well as from the information and communications technology (ICT)-sector perspective (supply-side). This chapter presents a summary of the key findings and recommendations.

i. Considering that the connectivity target is to achieve at least 2 Gbps per 1000 students by 2025 (to be provided for in the World Bank planning period ending 2023) and at least 20 Gbps per 1,000 students by 2030, the progressive estimates for connectivity for higher education institutions in Mozambique are 581 Gbps by 2025 and 7 Tbps by 2030.

ii. Mozambique currently has 19 accredited Universities and 34 TVETs (classified into Higher Education Institutes, Higher Schools and Academies). With a forecast of 262,117 students in 2021, enrolment in higher education is biased towards public universities and TVETs with the private sector in higher education, accounting for only 38.5% of students.

    a) Despite the tremendous growth in student enrolment, the Gross Enrolment Ratio for higher education in Mozambique was only 7.3% in 2018, below the estimated sub-Saharan Africa average of 9.4% and far below the world average of 38.8% in 2018. Based on the forecast of student enrolment and population in the age category 20-24, Mozambique's Gross Enrolment Ratio for higher education is estimated to reach 8.3% in 2025 and 8.6% in 2030;

    b) Mozambique faces many challenges in expanding access to higher education, including access inequalities based on socio-economic status and geographical regions, limited public funding for the sector, inadequate teacher qualifications, and high drop-out and low completion rates from secondary education.

iii. From an education sector perspective, some of the challenges that inhibit the use of ICTs in higher education and better connectivity include:

    a) ICT, as a subject, has not been fully incorporated into the curricula at different levels of education.

    b) Lack of sufficient computing equipment and good broadband connectivity within higher education institutions for use by students and staff.

    c) Poor digital literacy among lecturers/tutors and use of ICT for teaching and learning because of limited training in the use of ICT as part of their pedagogy training as well as practice.

d) Lack of appropriate digital and interactive content to support teaching and learning at the higher education level.

e) Lack of awareness among leadership of higher education institutions and other government agencies about the importance and potential benefits of ICT in developing their institutions as well as the socio-economic development of the country.

iv. Mozambique has had a technology-neutral licensing framework since 2016. There are currently four operators with Class A licences, 22 operators with Class B licences, one operator with Class C licence and 15 operators with Numbering licences, bringing the total number of licensed operators to 42. Three providers—Movitel, Tmcel and Vodacom dominate the market.

a) Mozambique is connected to two different submarine cables—SEACOM and EASSy that both land in the Capital, Maputo.

b) The Government of Mozambique operates a data centre at the Maluana Science and Technology Park, in the district of Manica, which supports e-government services provided by different MDAs. MoRENet also has a PoP in Maluana Data Centre that hosts the only Google Cache in the country that is used by all the licensed providers.

c) The Mozambique Internet Exchange Point (MOZIX), operated by the Computing Centre (Centro de Informatica da Universidade Eduardo Mondlane or CIUEM), facilitates exchange of local traffic between 18 local networks, including MoRENet.

d) There are a number of sectoral efforts to create Computer Emergency Response Teams (CERTs), including at MoRENet (for higher education institutions), licensed telecom providers and financial institutions. Steps to create a national CERT and coordination mechanisms across the sector under the auspices of INAGE, are still nascent.

e) MCTESTP, working with other government Ministries, Departments and Agencies (MDAs), has negotiated with the three major licensed operators (Movitel, Tmcel and Vodacom) to provide special rates that allow unlimited Internet access for registered students and staff of higher education institutions to designated academic systems and content during the COVID-19 pandemic.

v. From an ICT sector perspective, some of the challenges that inhibit the use of ICTs in higher education and better connectivity include:

a) Inadequate development and deployment of ICT infrastructure to cover the whole country, mainly rural under/unserved areas.

b) Low quality and limited geographical reach of the national electricity grid, particularly in rural and peri-urban areas.

c) The high cost of broadband services, which cannot be afforded by the majority of the population due to poverty.

d) Lack of awareness among leadership of government agencies about the importance and potential benefits of ICT in developing their institutions as well as the socio-economic development of the country.

e) Insufficient coordination and alignment between public institutions in relation to ICT projects and initiatives, resulting in duplication and inefficiencies in public service delivery.

f) Lack of sufficient numbers of qualified human resources to serve the ICT sector both in private and public institutions to ensure successful implementation of different ICT projects and initiatives.

g) Poor integration of the ICT component within the objectives and strategic documents designed to guide the development of the country.

h) Lack of a vibrant and competitive local ICT sector that nurtures innovation and entrepreneurship in various technology areas in order to create more jobs for the youth in comparison to other sectors like agriculture and spur the creation of more local content.

vi. The Government of Mozambique, through MCTESTP, established the Mozambique Research and Education Network (MoRENet) in 2005 to address the research and education networking needs of the higher education sector in Mozambique. One of the objectives of MCTESTP is to improve access to quality education and the use of ICT is recognised as one of the best avenues to accomplish this.

a) MoRENet's network infrastructure consists of dark fibre and a managed bandwidth backbone that covers the whole country. It has six Points of Presence (PoPs) or aggregation sites distributed across different provinces, and one international link —UbuntuNet/SEACOM provides 4.6 Gbps of international connectivity;

b) The network currently connects 142 campuses across the country that include 18 Universities and 29 TVETs. Other connected institutions include 9 research institutions, 2 secondary schools and a number of institutions affiliated with the education sector. Members currently pay USD 60 per Mbps per month, which encompasses all services provided by the NREN;

c) Like NRENs in other parts of Africa, MoRENet faces challenges including inadequate bandwidth to serve research and learning needs, low awareness about the benefits of an NREN, inadequate public funding for ICT infrastructure as well as poor campus networks and low skilled ICT staff;

d) Following COVID-19 lock-downs of educational institutions, MCTESTP negotiated working with the significant licensed operators to provide special rates that allow

unlimited Internet access for registered students and staff of higher education institutions to designated academic systems and content via their regular mobile phones.

Overall, Mozambique's progress indicates a potential for expansion of higher education connectivity through the work of MCTESTP and MoRENet. University and TVET leaders should play a key role in supporting access to devices by students and staff and facilitating the upgrade of campus networks. The private sector will also have a critical role to play in extending connectivity across the country.

# Appendix A: Tables

***Table 18: Number and enrolment of Accredited Higher Education Institutions in Mozambique***

| Name | Abbreviation | Status | Type | Enrolment |
|---|---|---|---|---|
| Universidade Pedagógica de Maputo | UP | Public | University | 69,126 |
| Universidade Eduardo Mondlane | UEM | Public | University | 44,129 |
| Universidade Católica de Moçambique | UCM | Private | University | 26,020 |
| Universidade Zambeze | UniZambeze | Public | University | 8,869 |
| Universidade São Tomás de Moçambique | USTM | Private | University | 5,671 |
| Universidade Lúrio | UniLúrio | Public | University | 4,676 |
| Universidade Politécnica | APOLITÉCNICA | Private | University | 4,079 |
| Universidade Técnica de Moçambique | UDM | Private | University | 3,134 |
| Universidade Joaquim Chissano | UJC | Public | University | 2,869 |
| Universidade Wutive | UNITIVA | Private | University | 2,262 |
| Universidade Mussa Bin Bique | UMB | Private | University | 671 |
| Universidade Nachingwea | UNA | Private | University | 591 |
| Universidade Jean Piaget de Moçambique | UJPM | Private | University | 579 |
| Universidade Adventista de Moçambique | UAM | Private | University | 502 |
| Universidade Metodista Unida de Moçambique | UMUM | Private | University | 65 |
| Universidade Save | UniSave | Public | University | |
| Universidade Púnguè | UniPúnguè | Public | University | |
| Universidade Licungo | UniLicungo | Public | University | |
| Universidade Rovuma | UniRovuma | Public | University | |

| Name | Abbreviation | Status | Type | Enrolment |
|---|---|---|---|---|
| Instituto Superior de Gestão, Comércio e Finanças | ISGECOF | Private | Institute | 11,127 |
| Instituto Superior de Ciências de Educação à Distância | ISCED | Private | Institute | 9,460 |
| Instituto Superior de Ciência e Tecnologia Alberto Chipande | ISCTAC | Private | Institute | 5,150 |
| Instituto Superior de Ciências e Tecnologias de Moçambique | ISCTEM | Private | Institute | 3,856 |
| Instituto Superior de Gestão e Empreendedorismo  Gwaza Muthine | ISGE-GM | Private | Institute | 3,855 |
| Instituto Superior de Ciências da Saúde | ISCISA | Public | Institute | 2,488 |
| Instituto Superior Politécnico de Tete | ISPT | Public | Institute | 2,377 |
| Instituto Superior de Comunicação e Imagem | ISCIM | Private | Institute | 2,370 |
| Instituto Superior Monitor | ISM | Private | Institute | 2,044 |
| Instituto Superior Politécnico de Gaza | ISPG | Public | Institute | 1,988 |
| Instituto Superior Politécnico de Manica | ISPM | Public | Institute | 1,924 |
| Instituto Superior Mutasa | ISMU | Private | Institute | 1,729 |
| Instituto Superior de Transportes e Comunicações | ISUTC | Private | Institute | 1,662 |
| Instituto Superior de Contabilidade e Auditoria de Moçambique | ISCAM | Public | Institute | 1,324 |
| Instituto Superior de Formação, Investigação e Ciência | ISFIC | Private | Institute | 971 |
| Instituto Superior de Artes e Cultura | USArC | Public | Institute | 816 |
| Instituto Superior de Estudos de Defesa | ISEDEF | Public | Institute | 787 |
| Instituto Superior de Educação e Tecnologia | ISET | Private | Institute | 760 |
| Instituto Superior Dom Bosco | ISDB | Private | Institute | 671 |
| Instituto Superior Maria Mãe África | ISMMA | Private | Institute | 529 |

| Name | Abbreviation | Status | Type | Enrolment |
|---|---|---|---|---|
| Instituto Superior Politécnico de Songo | ISPS | Public | Institute | 528 |
| Instituto Superior de Estudos e Desenvolvimento Local | ISEDEL | Private | Institute | 483 |
| Instituto Superior Cristão | ISC | Private | Institute | 370 |
| Instituto Superior de Ciência e Gestão | INSCIG | Private | Institute | 291 |
| Instituto Superior de Gestão de Negócios | ISGN | Private | Institute | |
| Instituto superior de Gestão, Administração e Educação | ISG | Private | Institute | |
| Instituto Superior de Ciências Empresariais e Tecnológicas | ISCET | Private | Institute | |
| Escola Superior de Economia e Gestão | ESEG | Private | Higher School | 2,966 |
| Escola Superior de Ciências Náuticas | ESCN | Public | Higher School | 1,320 |
| Escola Superior de Jornalismo | ESJ | Public | Higher School | 887 |
| Escola Superior de Gestão Corporativa e Social | ESGCS | Private | Higher School | |
| Academia Militar | AM | Public | Academy | 1,630 |
| Academia de Ciências Policiais | ACIPOL | Public | Academy | 1,063 |
| Académia de Altos Estudos Estratégicos | AAEE | Public | Academy | 192 |