GOVERNMENT OF LESOTHO

MINISTRY OF HEALTH

National Medical Oxygen Strategy and Scale-up Plan

2023 - 2028

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Hypoxaemia is commonly associated with mortality in developing countries. This condition is common among children and adults admitted to hospital and it is associated with increase of death if not identified and managed early. Medical Oxygen therapy is the only standard medicine for treatment of hypoxemia. Since hypoxemia occurs in all patient age groups and disease conditions, medical oxygen therapy is therefore essential for reducing morbidity and mortality from illnesses and conditions including pneumonia, birth asphyxia, and obstetric emergencies. The situation of hypoxemia in Lesotho is not adequately documented.

However, evidence shows majority of patients settling like those of Lesotho are not being diagnosed and treated for hypoxemia. This has been further revealed by the COVID-19 pandemic that has caused a tremendous increase in oxygen demand for management of severe and critically individuals. Despite widespread recognition of the importance of oxygen therapy for treatment of hypoxemia, its use and implementation remain inadequate in resource constrained settings including in Lesotho. Lesotho still faces challenges along the entire medical oxygen delivery continuum, from production and storage, distribution, to clinical delivery. This includes gaps in national policy and strategic guidance, oxygen supply and sourcing, routine data collection, maintenance of equipment, capacity building.

The Ministry of Health recognizes these and more challenges that relate to the goals and objectives of the National Health Sector Strategic Plan that aims to ensure universal health coverage for all. Therefore, this National Medical Oxygen Strategy and Scale-up plan 2022/3 – 2026/7 represents the efforts and commitments of the Government of Lesotho, through the Ministry of Health, to ensuring quality emergency medical services and sustainable access to medical oxygen at all levels of care within the health system. Implementation of this strategy and scale-up plan, within the provisions of the strategic guidelines, is targeted to reduce morbidity and mortality due to hypoxemia by up to two thirds by 2027.

This document was developed through a stakeholder-wide consultative process, and it sets forth the country's ambitions to enable access to medical oxygen over the next five years. Under the four interdependent strategic objectives, the strategy provides policy and implementation framework for scaling up medical oxygen within the system. It also guides resource mobilization to implement and sustain priority interventions and targets all stakeholders along the medical oxygen continuum.

While the Ministry will lead implementation of this strategy and scale-up plan, I call upon all our Health Partners to refer to this document as reference for the plan to scale-up access to medical oxygen in Lesotho and thus rally efforts and resources towards its successful implementation.

Nyane Letsie (Dr.)
Director General Health Services
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ACKNOWLEDGMENTS

The National Medical Oxygen Strategy and its Scale-up plan was developed through an inclusive process led by the Ministry of Health and in consultation with stakeholders under the platform of the National Medical Oxygen Taskforce under the Directorate of Clinical Services. This strategy aims to reduce morbidity and mortality due to hypoxemia in all disease conditions.

The Ministry of Health wishes to acknowledge Clinton Health Access Initiative (CHAI) for funding the process, printing of this document, and playing the secretariat role to the National Medical Oxygen Taskforce. We thank all institutions and organizations that contributed technically towards the development of this first National Medical Oxygen Strategy and Scale-up Plan. The Ministry of Health further appreciates all individuals who took part in drafting, reviewing the different versions of this document and further thanks to those that produced the final document.

I call on all stakeholders to embrace the national strategic direction and support its successful implementation to achieve set goals and targets.

Dr. Lucy Mapota- Masoabi
Director Clinical Services
Ministry of Health

LIST OF ABBREVIATIONS

CHAI:	Clinton Health Access Initiative
CHAL:	Christian Health Association of Lesotho
CME:	Continuous Medical Education
COPD:	Chronic Obstructive Pulmonary Disease
COVID-19:	Corona virus disease
DHMT:	District Health Management Team
EEL:	Essential Equipment List
EHP:	Essential Healthcare Package
GDG:	Guideline Development Group
GoL:	Government of Lesotho
HCWs:	Healthcare workers
HMIS:	Health Management Information System
LOX:	Liquid Oxygen
LSL:	Lesotho Loti
MDR-TB:	Multi-drug Resistant Tuberculosis
MoH:	Ministry of Health
NHP:	National Health Policy
NTGs:	National Treatment Guidelines
PHN:	Public Health Nurse
PSA:	Pressure Swing Adsorption
QMMH:	Queen Mamohato Memorial Hospital
SARS-CoV-2:	severe acute respiratory syndrome coronavirus 2
SCM:	Supply Chain Management
SpO2:	Oxygen saturation
SSA:	Sub-Saharan Africa
UHC:	Universal Health Coverage
VHWs:	Village Health Workers
VIE:	Vacuum Insulated Evaporator
WHO:	World Health Organization

EXECUTIVE SUMMARY

Medical Oxygen therapy is the only standard medicine for the treatment of hypoxemia. Medical oxygen a vital component of healthcare delivery as it cuts across emergency care, surgery, disease management, as well as maternal, neonatal and child health. While the Lesotho national hypoxemia situation is not yet documented, in 2017 and 2018, respiratory tract infections were the leading conditions recorded amongst outpatient patients. This is in addition to the fact that pulmonary TB and pneumonia combined, are the leading causes of admissions and deaths (26%) amongst adults and children in Lesotho. The recent outbreak of COVID-19 pandemic has caused a tremendous increase in oxygen demand for management of severe and critically individuals.

Over the past two decades, the Government of Lesotho and partners have invested in health systems strengthening interventions to the level of health sector reforms with the aim of improving the quality, access, and cost-effectiveness of healthcare at all levels. Despite these efforts, oxygen – an important element of a functional health system – was not prioritized. This created a serious gap in the care and treatment of hypoxemia. The country is estimated instantaneous need for oxygen in "normal" hypoxemia prevalence estimates is approximately 39 million litres of oxygen. While the country instantaneously produces an estimated 45 million litres of oxygen, this is not accessible to all areas of need. The main barriers to availability and access include inequitable distribution of available oxygen sources, limited production and storage capacity/equipment, supply and distribution infrastructure, limited technical expertise and aligned funding to sustain the national ecosystem. These are in addition to limited provider knowledge and skills of pulse oximetry and oxygen therapy delivery, supply chain issues, and inadequate availability of oxygen therapy related supplies.

Despite recent response to immediate pandemic relief and continued health system strengthening interventions, oxygen availability and improvements to oxygen systems remain unmet needs. Hence, a comprehensive National Medical Oxygen Scale-up Strategy and Scale-up Plan 2022/3 – 2027/8 has been developed to articulates the country's approach to implementing a rational and sustainable oxygen ecosystem and provide a framework for robust oxygen therapy service delivery at facility-level. The strategy addresses the entire continuum of oxygen production and storage, distribution and delivery and safe use and includes considerations for resilience and adaptability to changing consumption and demand needs. The national strategy is aimed to reduce the burden of morbidity and mortality related to hypoxemia in all disease conditions by 60% by 2028. This will be achieved through the following four strategic objective areas guide prioritization of key interventions along the medical oxygen delivery continuum. These are:

1. Establish national strategic framework for scaling-up medical oxygen supply and safe utilization.
2. Ensure a resilient national medical oxygen supply/production, distribution, and delivery capacity.
3. Enhance capacity to manage and safely utilize oxygen in health facilities.

4. Define policy and strategic basis for resource mobilization and financing medical oxygen priorities.

The national oxygen ecosystem cuts across various aspects of health system organization, patient care inputs, processes, and outcomes. The strategy and its implementation arrangements are aligned to the national health sector strategic plan and the agenda for universal health coverage and embraces principles of primary health care. The strategy be implemented through cost-effective implementation arrangements like integration at all levels. The MoH will provide policies, guidelines, build capacity, monitor, and coordinate partners to support the decentralized levels in implementation.

The total estimated cost of delivering the national strategy and scale-up plan over the next five years is LSL 275 million which includes both capital investments (LSL 111 million) and operating expenditure needs (LSL 163.9 million) for operations. Majority of the estimated capital costs have been committed by health partners within the first and second year of implementation. The projected resource commitments by health partners over the strategic period of five years is LSL 147 million and the estimated funding gap against total cost LSL 118 million with an average annual resource gap of LSL of LSL 23.7 million.

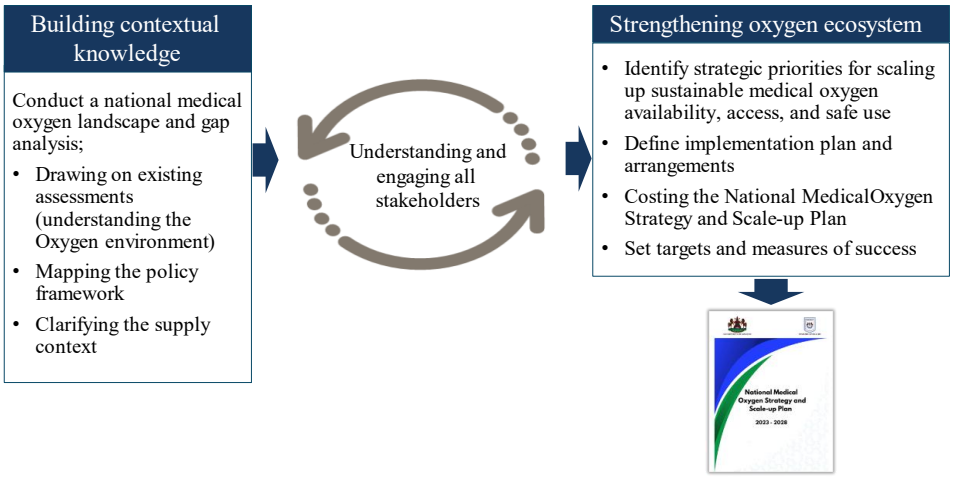
Performance of the strategy will be monitored and evaluated. Key performance indicated towards the goal of reducing hypoxemia related morbidity and mortality have been set. A baseline study on national prevalence of hypoxemia will be undertaken to further inform evaluation monitoring indicators.

PROCESS OF DEVELOPING THIS DOCUMENT

The National Medical Oxygen Strategy and Scale-up 2022/3 – 2027/8 was developed under the stewardship of the Ministry of Health, through the National Medical Oxygen Taskforce under the Directorate of Clinical Services. The process to develop this document involved 3 phases.

The first phase involved processes of building consensus and establishing contextual knowledge of the national medical oxygen landscape. This included review of policy, technical and strategy documents, stakeholder mapping and consultations, national medical oxygen resources mapping, and an analysis oxygen systems and readiness across 21 hospital level facilities. This was planned and executed by the National Medical Oxygen Taskforce and through a series of coordinated engagements.

Figure 1: Processes to develop of the national medical oxygen and scale-up plan.



In the second phase, a three (3) days' stakeholder consultative and strategy design workshop was held and consensus on the national strategic framework, scale-up priorities and interventions and implementation arrangements was reached. A secretariat and writing team to continue drafting the document was selected. The draft strategy and scale-up plan document was presented and reviewed through a series of meeting and feedback provided on draft editions from all stakeholders before costing and consensus on activities was achieved.

In the third phase, the strategy was costed using activity-based costing and verifiable measures of implementation success were defined at impact and outcome level. The costed strategy was validated in a stakeholders' meeting before the final version produced.

1 BACKGROUND

1.1 INTRODUCTION

Low blood oxygen levels (hypoxaemia) are common among children and adults admitted to hospital and associated with a 5-fold increase in odds of death and thus requires prompt detection and treatment. Medicinal oxygen therapy is a standard and essential medicine for treatment of hypoxemia, with no substitution. It is used to treat both acute and chronic conditions which result in hypoxemia, which is an abnormally low concentration of oxygen in the blood. For adult patients with chronic hypoxemia from primary lung disease or heart failure, long term oxygen therapy is a well-established cornerstone of management, improving survival and quality of life.

Medical oxygen is therefore essential for reducing morbidity and mortality from illnesses and conditions including pneumonia, birth asphyxia, and obstetric emergencies (e.g., hemorrhage, eclampsia, and pulmonary embolism), which are leading causes of preventable deaths. Respiratory tract diseases are the leading causes of child and adult deaths, and it has been estimated that in countries with high burdens of child pneumonia, access to oxygen and pulse oximetry could reduce mortality by 35%. The simplest way to identify patients who are hypoxemic is by measuring oxygen saturation of the blood with a pulse oximeter, which uses infrared light refraction to non-invasively measure the percentage of oxygen in red blood cells. However, a study in one sub-Saharan African country found that only 14.4% of all children admitted and 19.4% of hypoxemic children in secondary level hospitals, received oxygen therapy.

The COVID-19 pandemic has caused a tremendous surge in oxygen demand, as well as increased global recognition of the criticality of oxygen supply and delivery systems. However, many low- and middle-income countries are under resourced in terms of medical oxygen systems from supply/production, distribution, and clinical delivery. Despite widespread recognition of the importance of oxygen therapy for treatment of hypoxemia, its use and implementation remain inadequate in resource constrained settings. There is need to ensure that medical oxygen remains extremely high and investments in production, distribution, supply sourcing, routine data collection, maintenance of equipment, training, and many other areas are sustained.

1.2 LESOTHO CONTEXT

Lesotho is a small lower-middle income country with a public health delivery system that consists of 1 tertiary hospital, 2 secondary hospitals, 2 specialized hospitals, and 16 primary hospitals. At the community level, Village Health Posts deliver services through a network of more than 6,000 village health workers: alongside other cadres of community-based health workers. The government of Lesotho (GoL) owns most health facilities in the country including several primary healthcare centres and general hospitals, and finances outsourced health services from the Christian Health Association of Lesotho (CHAL). In addition, GoL operates the country's only tertiary hospital – Queen Mamohato Memorial Hospital (QMMH). Lesotho also traditionally relies on South Africa to provide complementary secondary and tertiary healthcare.

Over the last two decades, the country has faced a growing burden of disease which has driven GoL to intensify efforts to improve the quality, access, and cost-effectiveness of healthcare at all levels. Health sector reforms were initiated in the early 2000s to spearhead the development of health policies, together with standards and guidelines for coordinated delivery of health services; underpinned by a commitment by GoL to increase financial allocations to the health sector and to attain geographic equity in resource allocation and distribution. Through these efforts, an Essential Services Package (ESP) for Lesotho was developed in 2005, and several sectoral policy documents were created, including the National Health Policy in 2011, as well as the National Health Sector Strategic Plans. These initiatives were augmented by the development of policies by individual departments within the Ministry of Health (MoH), covering essential public health interventions such as: immunization, communicable diseases control, sexual and reproductive health, and essential clinical services including non-communicable diseases and mental health. Despite these efforts, oxygen – an important element of a functional health system – was not prioritized, creating a serious gap in the care and treatment of hypoxemia. The demand for medical oxygen was exacerbated and highlighted during the COVID-19 pandemic.

There is limited data about hypoxemia recognition and oxygen provision across sub-Saharan Africa (SSA), with most existing data focusing on acute oxygen needs among children and neonates. The Lesotho national prevalence of hypoxemia is not documented, and any estimates are limited by systemic challenges along the entire hypoxemia management continuum including lack of policy strategy basis and implementation guidance for scaled-up access to medical oxygen. According to the Ministry of Health 2017/18 annual joint health sector review report, cough and flu were the leading conditions recorded amongst outpatient patients. This is in addition to the fact that pulmonary TB and pneumonia combined, are the leading causes of admissions and deaths (26%) amongst adults and children in Lesotho. Medical oxygen is a vital component of healthcare delivery as it cuts across emergency care, surgery, disease management, as well as maternal, neonatal and child health. There is need for a comprehensive oxygen scale-up strategy and implementation plan that articulates the country's approach to implementing a rational and sustainable oxygen ecosystem and provide a framework for robust oxygen therapy service delivery at facility-level.

1.3 HYPOXEMIA AND ITS ASSOCIATED CONDITIONS

Hypoxemia, a situation of abnormally low levels of oxygen in the blood, is a life-threatening condition that requires early diagnosis and treatment. It is one of the four major categories of hypoxia (inadequate supply of oxygen to the tissue). It can occur during surgery, is a common complication of chronic diseases in adults, and is a significant contributor to mortality in newborns and young children. The clinical signs and symptoms of hypoxemia include vary with age and include headache, difficulty breathing or shortness of breath (dyspnoea), Rapid heart rate (tachycardia), coughing, wheezing, confusion, and bluish colour in skin, fingernails, and lips (cyanosis).

Surgery: Hypoxemia is one of the serious risks faced by patients during anaesthesia and surgical care and poses a significant safety concern because of its potential impact on end organ function and long-term patient outcomes. Hypoxemia in surgery may compromise wound healing, cause severe complications such as brain disfunction, or lead to early mortality**.**

Chronic Diseases: The predominant causes of hypoxemia include chronic obstructive pulmonary disease (COPD), acute asthma and pneumonia. Patients with these conditions typically show signs of dyspnoea (shortness of breath or laboured breathing); which can help guide diagnoses of underlying conditions. During the COVID-19 pandemic, it was generally observed that some patients with severe coronavirus disease often exhibited extremely low oxygen levels without dyspnoea (silent hypoxemia).

Neonatal and Child Health Conditions: Neonatal hypoxemia is the most common cause of death and disability in neonates and is associated with motor, sensory and cognitive impairment. Neonatal hypoxemia has many causes including birth asphyxia, birth trauma, prematurity, respiratory disease, airway obstruction, or sepsis. Hypoxemia in children is a frequent complication of pneumonia, bronchitis, and asthma; and can occur in severe cases of malaria, anaemia, and malnutrition. Hypoxemia in children is associated with mortality due to pneumonia as well as poor outcomes for other diseases.

1.4 HYPOXEMIA DIAGNOSIS AND TREATMENT

The presence of hypoxemia can be determined through physical examination, pulse oximetry, or measurements of arterial blood gases. In low resource settings, the World Health Organization (WHO) recommends pulse oximetry as the most accurate and cost-effective, non-invasive, method for diagnosing and monitoring hypoxemia – mainly because reliance on observational or clinical signs commonly results in misdiagnosis or failure to diagnose hypoxemia, especially in neonates or young children. Furthermore, because patients with severe coronavirus disease may not exhibit clinical signs of hypoxemia, pulse oximeters are an invaluable tool for detecting, treating, or referring patients who are critically ill with COVID-19 disease, thus ensuring the best outcomes for these patients. Pulse oximetry must be applied by trained health providers because misunderstanding may lead to misdiagnosis, inappropriate evaluation, and inappropriate treatment of patients. Once hypoxemia is diagnosed, oxygen therapy should be initiated immediately in conjunction with supplemental interventions targeting the underlying cause.

2 SITUATION ANALYSIS AND RATIONALE

In November 2021, the Ministry of Health, through a multi-stakeholder National Medical Oxygen Taskforce and supported by Clinton Health Access Initiative (CHAI), conducted a national medical oxygen landscape analysis to inform development of the national medical oxygen strategy and its implementation plan. The analysis included a comprehensive oxygen biomedical equipment (BME) survey and healthcare provider capacity assessment on pulse oximetry and oxygen therapy; across 21 tertiary or secondary hospital-level health facilities, in all the 10 districts in the country. Analysis of national medical oxygen capacity, demand and

distribution/supply was conducted. Specifically, the analysis was carried out with the following objectives:

1. **To establish the quantity of medical oxygen produced and stored in the country.**
    - The landscape analysis assessed the available types of medical oxygen production sources, their distribution across the country, and their production capacity (BME).
2. **To assess the system-level conditions that enable or inhibit the accessibility of oxygen therapy provision and respiratory care in health facilities.**
    - The landscape analysis looked at the availability and distribution of medical oxygen delivery infrastructure and devices at health facilities.
3. **To determine the barriers and enablers of medical oxygen service delivery by health workers.**
    - The landscape analysis assessed the availability of healthcare workers (HCWs) trained in pulse oximetry and oxygen therapy, as well as the availability of trained personnel to maintain the available oxygen equipment.
4. **To quantify the medical capacity and oxygen needs of the country.**
    - Using some of the data inputs from the BME and health facility assessment, the average monthly demand for medical oxygen was calculated using the UNICEF System Oxygen Planning Tool. This tool calculates the theoretical need for oxygen using clinical assumptions that mimic medical oxygen use under various health system conditions – from a "no-COVID-19" (planning[1]) scenario to projected need during various COVID-19 surge scenarios.
5. **To identify considerations for a sustainable oxygen supply model for the country**
    - Stakeholders used findings on the total oxygen production capacity, as well as the quantification of the country's oxygen supply needs, to identify needs for an optimal mechanism for sustainable supply of oxygen within Lesotho – considering current and planned investments in oxygen production sources, including Pressure Swing Adsorption (PSA) plants and bulk liquid oxygen tanks.

2.1 NATIONAL OXYGEN CAPACITY, EQUIPMENT AND SUPPLY SYSTEMS

The choice of oxygen sources by facilities depends on a comprehensive assessment of oxygen demand at the facility, cost of procuring oxygen, storage capability, as well as the ability to coordinate logistics for delivery of portable oxygen sources like filled cylinders. Facilities that want to invest in oxygen production or bulk storage sources must consider the cost of installing oxygen production systems, the availability of reliable power source either from the central grid or generators, access to spare parts (e.g., for PSA plants and concentrators), availability of medical gas piping, and any necessary oxygen delivery infrastructure. Bedside concentrators and filled cylinders are the least complex oxygen sources to install, deliver, and maintain, and are therefore the primary sources of medical oxygen in most health facilities.

[1] The no-COVID-19 Scenario represents the national medical oxygen systems planning scenario while the surge scenario informs the need surge considerations in sizing the national capacities across the ecosystem.

Policy, implementation guidance and governance: There are existing policy and operational guidelines within which oxygen use for management of hypoxemia has been defined. These include national treatment guidelines for critically ill patients, neonatal care and COVID-19 case management, among others. The National Critical Care strategy that is under development provides the clinical basis for use of oxygen therapy as an essential input in the care pathway for the critically ill, regardless of underlying disease condition. However, medical oxygen delivery requires various sub-systems and processes for production and packaging, distribution, and clinical delivery to the patient – for which the country lacks guidance. This includes the need to guide primary oxygen sources, relevant equipment and supplies, national oxygen distribution and supply processes, clinical application and safety precautions for management and use of medical oxygen. Such guidance needs to be disseminated and adapted at health facility level.

The above policy gaps are attributable to the lack of a governance and coordinating structure for the oxygen delivery ecosystem. Whereas medical oxygen as an essential commodity, is applicable in various disease conditions complicated by hypoxemia, there is need to provide for a specific coordination and governance structure at national and subnational level. These structures will allow for designation of roles and responsibilities of actors across the oxygen delivery continuum including coordinating implementation of set priorities and policies.

Demand for medical oxygen: Through this national landscape analysis, the total national demand for oxygen in a no-COVID-19 scenario was estimated to be 39,375,000 litres of gaseous oxygen per month. In a surge covid scenario, the national oxygen demand was estimated to be 79,608,000 litres of gas.

Table 1: Location of PSA existing plants and production capacities

PSA Location/Hospital	PSA Plant Capacity (Nm^3/hr)
Motebang Hospital	15.7
Maluti Hospital	6.6
Maluti Hospital	30
Berea Hospital	2.37
Mafeteng Hospital	15.7
Paray Hospital	15
Scott Hospital	Obsolete
Berea Hospital	36
Machabeng Hospital	11
Mokhotlong Hospital	11

Medical oxygen production

Oxygen production from PSA plants: The country currently has 9 PSA plants located at Botsabelo-MDR TB Clinic, Motebang, Mafeteng, Scott, Paray, Maluti Adventist and Berea hospitals. Maluti Adventist and Paray hospitals have two plants each onsite while the plant at Scott hospital is obsolete. The total oxygen produced by the operational PSA plants is 21,641,000 litres of gas. There are three additional PSA plants, one each, at Berea, Machabeng and Mokhotlong hospitals; and these will increase the monthly production capacity to 35,561,000 litres of gas.

Oxygen production from concentrators: Total instantaneous production[2] capacity from available concentrators was estimated at roughly 69,898,000 litres of gas. However, concentrators have several limitations which make them a sub-optimal oxygen source, specifically for high-volume health facilities:

- They need continuous access to electricity.
- They have a working lifespan of as little as 3 years.
- Most concentrators have no storage capacity, and for those that have storage technology, the cost of running concentrators to produce volumes for storage and pressurizing the oxygen for cylinder storage is prohibitive.
- They cannot meet the oxygen needs of all patients because of pressure and flow rates requirements.

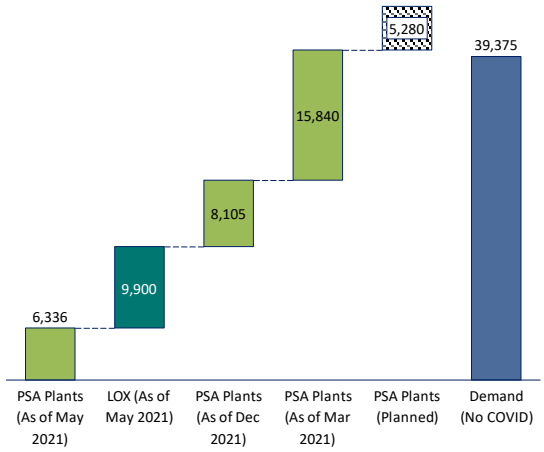
Sourced oxygen

Liquid Oxygen: There is one cryogenic tank at QMMH hospital, with a capacity of 31,561 litres (equivalent to 9.9 million litres of gaseous oxygen), which is directly piped into the facility[3]. This tank is leased from Afrox South Africa, which takes responsibility for servicing and maintenance of the tank. The tank is refilled every 6 and 8 weeks when it is ½ to 2/3 exhausted at an estimated ZAR 350,000 per refill round.

High-pressure oxygen gas cylinders: Oxygen cylinders have been the primary source of oxygen across most facilities in Lesotho. A total of 598 cylinders were found across the 21 facilities assessed and approximately 40% of all cylinders were leased from private gas suppliers.

Medical Oxygen availability and access and gap analysis

Figure 2: Trend of increasing monthly medical oxygen production capacity from PSA plants since May 2021 ['000 litres]



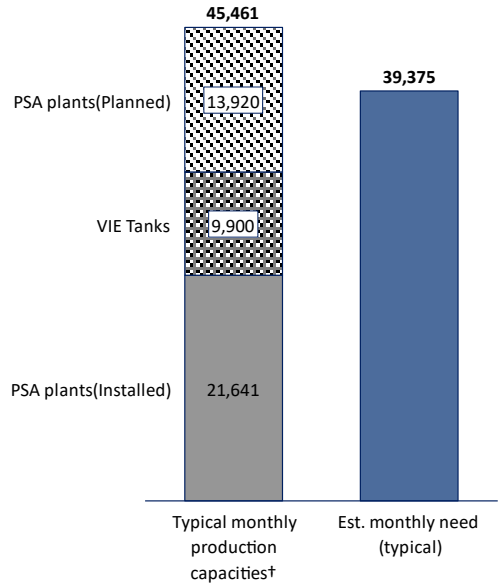
The COVID-19 pandemic exponentially increased the medical oxygen demand in the country which, in-turn, catalysed MoH and partner investments in the production and sourcing of oxygen to meet increased demand.

Under normal health sector conditions(no-COVID-19), the PSA plants together with the sourced liquid oxygen for the cryogenic tank have a total estimated oxygen production capacity of 44,378,000 litres per month. This capacity exceeds the estimated typical monthly need across all hospitals by 19%, or an estimated 7,236,000 litres though oxygen sources are not equally distributed across the country.

[2] Instantaneous production capacity is the estimated/measured amount of oxygen produced from a given source at any given instant, in this case, the amount of oxygen then can be produced by the available functional oxygen concentrator machines.
[3] Dedicated supply to the hospital with no provision for cylinder filling

Estimated "typical" national demand and production capacity.

Figure 3: Estimated "typical" national medical oxygen production capacity vs need ['000 litres]



On aggregate, Lesotho produces and sources sufficient medical oxygen to meet the national estimated overall demand; however, oxygen production sources are not equitably distributed across the country, so there are substantial gaps in access to oxygen at district and facility level. In addition, the excess production capacity in some health facilities with onsite bulk sources is not readily and cost-effectively redistributable to meet demand in other facilities without onsite bulk production sources.

Facility readiness for safe oxygen management and use: There are approximately 2,309 beds across 21 hospital level facilities in the country, including 36 High Dependency Units and 23 Intensive Care Unit beds. However, only 12% of hospital beds (278/2039) in the country have access to piped oxygen to enable reliable bedside delivery of oxygen to patients. The national referral hospital is the only health facility that is supplied from a bulk liquid oxygen storage tank[4] and has all beds with bedside piped oxygen access. In addition, only one PSA plant is directly piped to supply 36 high-flow (high dependency unit) beds at Berea Hospital while other PSA plants are used to fill cylinders that are used by the bedside to deliver oxygen to patients in all other health facilities. Therefore, health facilities relying on cylinders for oxygen delivery need to keep a stockpile of filled oxygen cylinders to avoid instances of stockout, yet hospitals lack safe cylinder storage facilities. Furthermore, while the cylinder can be refilled by commercial or industrial oxygen suppliers, this has been the most expensive source of oxygen in the country. This is in addition to the size and weight that make cylinders less convenient to move around the facility or ward.

In addition, most of the equipment necessary from oxygen production to delivery require connection a reliable power source to function. Due to unreliable national power grid supply, and 19 out of 21 hospitals have generators as an alternative power source. However, generators must be sized to the demand for oxygen and other connected equipment and should be routinely serviced to keep them running.

[4] The national referral hospital is the only facility supplied using Liquid oxygen source while all other onsite production sources are PSA plants.

Use of oxygen for hypoxemia treatment: In Lesotho, medical oxygen comes from three main sources: bedside concentrators, PSA (Pressure Swing Adsorption) plants and a bulk medical liquid oxygen (mLOX) tank. For hypoxemic patients to receive the appropriate oxygen therapy services, health facilities require trained health workers, appropriate diagnostic equipment, and the necessary oxygen delivery systems; and these elements are not always available at all levels of the public health system. During the COVID-19 pandemic, Lesotho, like many other countries, experienced a dramatic increase in the demand for oxygen and endured critical shortages of this commodity across health facilities.

Healthcare worker capacity: The most recent national data from across 21 hospital level facilities indicates lack of knowledge in pulse oximetry and oxygen therapy whereby a third of all providers reported not having been trained on Pulse oximetry and oxygen therapy management. The gaps are more prevalent amongst the cadre of nurses and midwives whereby more than a third of providers lack training on hypoxemia management. Since recent healthcare worker trainings have been driven by the COVID-19 case management intervention that was mainly hospital based, the lack of knowledge and experience could be more profound amongst providers in lower-level health facilities. Hypoxemia diagnosis relies on having functional and appropriate pulse oximeters, however, there is a gap of 310 and 228 for tabletop and handheld pulse oximeters respectively, across 21 hospitals in the country.

Only 11 hospitals have a dedicated individual for supporting medical oxygen operations in the facility and there are no guidelines for managing and or tracking medical oxygen operations at all levels. This is in addition to lack of trained personnel in oxygen ecosystem operations including lack of trained biomedical engineers/technicians for equipment routine maintenance and servicing whereby up to 70% of hospitals are relying on untrained personnel to install and maintain medical equipment.
In addition to the infrastructural gaps, lack of a knowledgeable health workforce with capacity to manage hypoxemia by safely using oxygen and being able to maintain equipment can lead to low utilization of oxygen and reduced lifespan of oxygen equipment. Thus, the different healthcare worker cadres should be capacitated to diagnose and manage hypoxemia in any disease condition and safely use oxygen and maintain related equipment as necessary.

Procurement planning: Procurement planning and financing for oxygen ecosystem is a national level process that should be based on national need. While the critical supplies for oxygen therapy, like intubation sets and delivery interfaces, are part of the existing procurement process, however, oxygen delivery related equipment and spare parts are not currently part of the routine sector procurement listing and processes. Medical oxygen sourcing is not aligned with national forecasting and quantification and procurement planning, including resources allocation for identified priorities. The country has no dedicated financing mechanisms and allocation for procurement of medical oxygen and equipment for oxygen therapy delivery. The lack of a national essential biomedical list limits national planning and resources allocation for oxygen related procurements.

Demand for oxygen therapy: Community knowledge and awareness of hypoxia is assumed to be increasing because of the recent increased use of oxygen in treatment of COVID-19 critical cases. In our settings, demand for oxygen is low due to misconceptions of oxygen therapy in the community and among care givers because of its association with terminally ill patients. Therefore, in addition to health system related factors like limited oxygen supply, low provider knowledge and skills, patient education and counselling for oxygen therapy is important to break patient and caregiver-held misconceptions to regard oxygen therapy as a routine treatment of low oxygen in blood.

3 THE NATIONAL MEDICAL OXYGEN STRATEGY AND SCALE-UP PLAN [2023 – 2028]

Oxygen is an essential commodity at all levels of patient care. Current challenges, limitations, and prevailing opportunities to ensure medical oxygen access in the country dictate the need to conceive comprehensive and contextual national medical oxygen systems at all levels. This should include the entire continuum of oxygen production and storage, distribution and delivery and safe use. It is recommended that oxygen systems should be designed with considerations for resilience and adaptability to changing consumption and demand needs.

The main function of the national medical oxygen ecosystem is to ensure sustainable (cost-effective), reliable and quality oxygen supply and safe use at all levels of need and care. The oxygen ecosystem is an integral part of the national health system; therefore, all critical health system inputs will be needed for a fully functional medical oxygen ecosystem. In addition, oxygen ecosystem specific critical inputs like equipment maintenance and servicing, and an optimized supply model should be prioritized and strengthened. This requires a strategically optimized mixed source system (sourcing, production, and storage) that is based on investment and health care delivery guiding principles.

3.1 STRATEGIC GUIDING PRINCIPLES

To ensure reliable access and use of medical oxygen access, priorities and implementation arrangements of this strategic plan shall be guided by key strategic healthcare financing and health services delivery principles and are aligned to the national health sector strategic plan 2017 – 2022. These guiding principles form the basis for decision making and implore the need for action by different constituencies of the health sector at different levels from the national to community/individual level.

Evidence-based decision-making: This strategic plan was based on available relevant local evidence of a national landscape analysis that includes in-depth review of current capacity and gaps that need to be addressed. Local evidence was complemented with global and international practice and recommendations as applicable. Implementation of planned priorities will continue to yield field learning and evidence that will be utilized to inform period planning and effective execution.

Primary healthcare approach ensures that essential healthcare services are universally accessible and affordable for all in need. Through this plan, the GoL shall ensure medical oxygen is universally accessible and affordable to all Basotho and as part of integrated healthcare service delivery.

Decentralization: The Local Government Act aims to promote, deepen, and consolidate a sustainable and effective system of local governance for improved service delivery and enhanced quality of life. Like all healthcare services, oxygen (an essential health commodity)

shall be delivered to the people of Lesotho using a decentralized approach where local governments shall be responsible for service delivery at the district and lower levels of care.

Equity involves ensuring fair and just access to services by removing disparities at all levels of the health system. Access to basic quality healthcare is a constitutional right that should be enjoyed by all Basotho. The national medical oxygen ecosystem will ensure capacity and resources are rationally distributed to address oxygen access disparities.

Affordability: Oxygen is an essential healthcare commodity that should be available and affordable to all in need and at all levels of care. Affordability of medical oxygen to the patient includes removing financial and other access barriers; and starts from making cost-effective sourcing, production, and distribution decisions. Oxygen gas, oxygen generator plants and delivery equipment must be strategically sourced at affordable prices in order to reduce the overall cost of availing oxygen by the government. The minimum Essential Healthcare Package of services is provided free of charge or highly subsidized and this shall include access to medical oxygen.

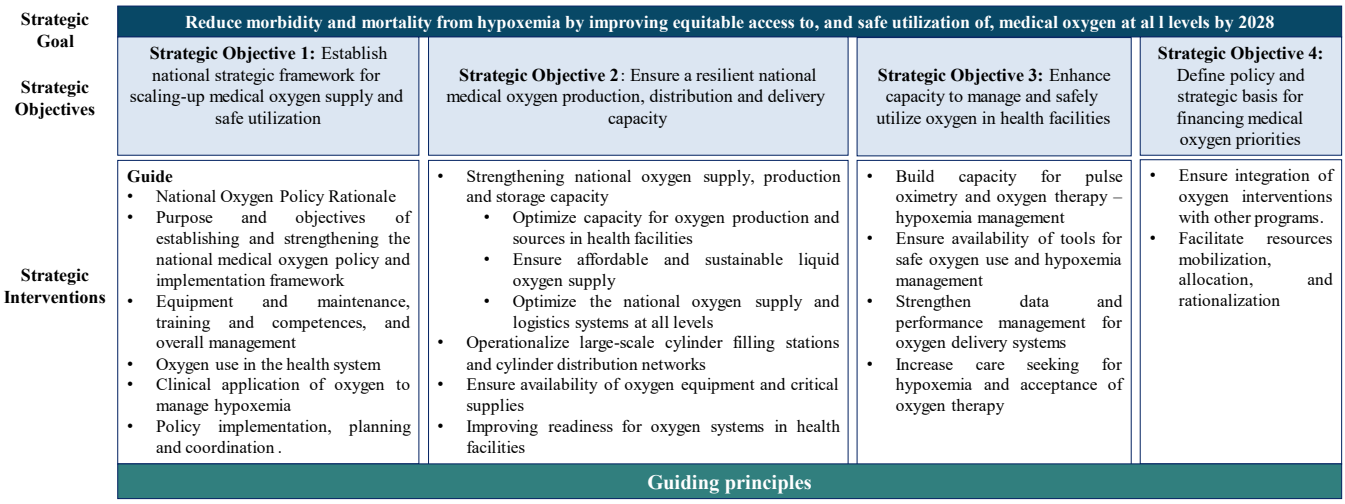
Political Commitment by both political, civil, and cultural leadership is important to facilitate resource allocation and ensure policy implementation at all levels. There are broad policy and implementation instruments at the disposal of political leaders to ensure social protection of the population. This should guide priority-setting and resource allocation to the health sector, including medical oxygen systems.

Community involvement: Demand and utilization of health services is dynamic and influenced by, among other factors, the level of awareness and knowledge amongst the target population. Access to and use of oxygen therapy is increasing. In order to ensure sustained utilization, communities shall be sensitized and made knowledgeable of medical oxygen therapy and its availability at different levels of care as part of essential health services. Empowered communities tend to own-up and sustain community projects in their areas. This will be necessary for oxygen systems and infrastructure across the country.

3.2 THE NATIONAL MEDICAL OXYGEN STRATEGIC FRAMEWORK FOR SUSTAINABLE ACCESS AND SAFE USE

The national framework is aimed at ensuring equitable access to quality oxygen by reaching more patients, at the right time and in a more sustainable way. The overall goal of this national medical oxygen strategy and its implementation plan is to reduce the burden of morbidity and mortality related to hypoxemia in all disease conditions by 60% by 2028. This shall be realized by removing barriers to equitable access to, and safe use of oxygen at all levels of care by end of the 5 years' strategic period in 2028.

Figure 4: The strategic framework for sustainable scaled-up access to medical oxygen in the country



To achieve the overarching goal, four strategic objective areas have been identified to guide prioritization of key interventions across the entire medical oxygen continuum. The four strategic objectives are:

1. Establish national strategic framework for scaling-up medical oxygen supply and safe utilization.
2. Ensure a resilient national medical oxygen supply/production, distribution, and delivery capacity.
3. Enhance capacity to manage and safely utilize oxygen in health facilities.
4. Define policy and strategic basis for resource mobilization and financing medical oxygen priorities.

4 STRATEGIC OBJECTIVES AND PRIORITY INTERVENTIONS

Specific priorities have been identified for implementation to achieve the national strategic goal. This section defines and describes the different interventions under each of the four objectives areas.

4.1 STRATEGIC OBJECTIVE 1: TO STRENGTHEN NATIONAL POLICY FRAMEWORK AND GUIDANCE FOR SCALING-UP MEDICAL OXYGEN SUPPLY AND SAFE DELIVERY AND USE

4.1.1 Introduction and rationale for policy and standard guidance

Medical oxygen is a lifesaving commodity/medicine with no substitute and is used for treatment of hypoxemia which can occur in advanced stages of many medical conditions and is a major risk factor for death in all age groups. Access to safe oxygen, defined as a trained health worker (Nurses, midwives, doctors, and other patient care healthcare worker cadres) delivering oxygen from a reliable source and assisted by tools such as pulse oximeters, has the

potential to decrease morbidity and mortality from all disease conditions that may require oxygen therapy.

Whereas oxygen therapy is not a new intervention in our health services, this strategy and plan is the first national guiding instrument for scaled access to and safe use of medical oxygen in the country. There is need for national policy perspective that establishes a framework for scaling-up access to and use of medical oxygen and guides alignment and complementarity of efforts among non-state and state actors at all levels. The policy framework should ensure an enabling environment for implementation of interventions to strengthen oxygen ecosystems and ultimately service delivery to patients in need.

The first objective of this strategy and scale-up plan defines and describes the national medical oxygen policy framework and standard guidance necessary to facilitate implementation. The policy framework and guidance are defined within scope of the National Vision 2020 that envisions a healthy and well-developed human resource base. This is further interpreted in the national health policy (NHP 2016) and the National Health Sector Strategic Plan 2017/8 – 2024/5, that, in consideration of regional and international commitments, prioritise achievement of universal health coverage (UHC) with a vision of a healthy population living a quality and productive life. The national medical oxygen policy direction is anchored in the national Essential Medical and Referral Services Policy and Strategy of the Ministry of Health.

The policy and standards guidance described provides a basis for all other supporting policies, guidelines, protocols, and procedures for the management of hypoxemia at all levels of care in the country. In line with the overall goal of this strategy and plan, the aims of the policy intonations stated hereunder are t:

1. Ensure scaled-up sustainable access to, affordable, available, and safe provision of oxygen therapy (including pulse oximetry) at all levels of care.
2. Facilitate rational oxygen use to treat hypoxemia in all disease conditions in children and adult patients.
3. Guide appropriate clinical practices and skills strengthening in the management of hypoxemia.

The below subsections provide specific guidance from organizing the national medical oxygen ecosystem up to clinical use of oxygen in management of hypoxemia while the other three (3) objectives of this strategy and plan document provide implementation guidance for the set national strategic priorities over the next 5 years.

This policy section of the strategy will be reviewed every five years or as deemed necessary by the Ministry of Health in consultation with stakeholders and guided by national, regional, and global practices and recommendations. The Ministry of Health will provide leadership for planning, implementation, and monitoring of the national medical oxygen ecosystems at all levels.

4.1.2 National medical oxygen policy statements and guidelines

4.1.2.1 Organization of the national medical oxygen ecosystem

Oxygen production and storage: Despite being an essential medicine, oxygen is a complex product, and it needs to be produced by a medical device or industrial plant. Oxygen also requires a whole system to safely reach patients. In Lesotho, a mixture of oxygen sources will be used, and the source will be tailored to the catchment area needs with cost-effectiveness and sustainability considerations in perspective. The sources shall include:

1. **Medical Liquid Oxygen** [mLOX] storage tanks as the main source for filling cylinders for regional supply and direct supply of piped gas to regional referral and national referral hospitals. mLOX refills will be sourced from manufacturers based on agreed/long-term supply arrangements.
2. **Pressure Swing Adsorption [PSA]** oxygen plants for onsite generation and use in hard-to-reach catchment areas and where the unit cost of oxygen produced using the PSA plant is cheaper than filled cylinders supplied from large-scale liquid oxygen-based cylinder filling stations.
3. **Cylinders** filled from strategically located oxygen (liquid oxygen and PSA plants-based) cylinder filling stations will be supplied to all health facilities within defined catchment districts. A national medical oxygen and cylinder supply and distribution system will be designed to ensure cost-effective and reliable supply and availability of oxygen and filled cylinders in all health facilities. All hospital level health facilities using filled cylinders will be piped and equipped with manifold systems to facilitate feasible oxygen therapy delivery to the bedside. All health facilities shall be supported with infrastructure to safely store and manage oxygen in cylinders.
4. Oxygen **Concentrator machines** are available in varying capacities across all hospital levels. Because of the associated limitations, concentrators will be primary used in health centres at community level (like for portable concentrator machines) and in settings where cylinder supply is not feasible or limited.

Oxygen Gas quality: Medicinal oxygen reaching patients should be tested to meet authorized specifications for identity, purity, and content. In addition, appropriate practices for production, storage and distribution of medicinal oxygen should be followed. The World Health Organization provides guidance on the expected quality/purity of medical oxygen depending on the source used.

Table 2: Sources and Oxygen Concentration levels

Oxygen production source	Percentage oxygen concentration
Liquid Oxygen produced by air-separation and liquefaction process	Not less than 99.5% v/v of oxygen
Pressure Swing Adsorption (PSA) plants	93% ±3 from Ambient air
Oxygen concentrator machines	> 82% from room air (21%)

4.1.2.2 Oxygen equipment and maintenance, training and competencies, and overall management

Ensuring safe oxygen access and use requires that relevant equipment and supplies are readily available and functional and healthcare workers are knowledgeable and skilled to deliver oxygen to the patient. Therefore,

- Functional medical oxygen production and storage facilities, as applicable, should be available in all health facilities.
- A functional and clinically appropriate pulse oximeter must be available at each location where oxygen is used.
- Functional oxygen delivery systems, like gas pipelines, in all hospitals level facilities.
- Functional oxygen analysers must be made available.
- Any qualified health professional can initiate oxygen therapy in an emergency situation at any level of care.
- All healthcare workers involved in prescribing or administering oxygen should be familiar with clinical guidelines on medical oxygen.
- All healthcare professionals should receive regular and continuous training and tailored mentorship support on pulse oximetry and oxygen therapy delivery.
- Biomedical engineers and equipment technicians should receive regular and continuous training on maintenance of oxygen equipment.

It is important to note that these policy guidelines are for general use within all clinical settings and the guidance should be disseminated to all health institutions and compliantly implemented.

4.1.2.3 Oxygen use in the health system

The national health system is comprised of three (3) levels of healthcare service delivery [primary, secondary, and tertiary] and medical oxygen shall be provided at all these levels. In addition to use in health facilities, some patients will require oxygen aboard ambulances during referral/transfer from one level to another. The levels of care and respective care units/spaces shall include:

Figure 5: Oxygen use at different levels of care/health facilities.

The national minimum essential healthcare services package defines the different disease conditions and care services provided at the different levels of care. The Ministry of Health will develop and ensure availability of comprehensive oxygen therapy and hypoxemia management guidelines at different levels.

4.1.2.4 Clinical application

Provision of supplemental oxygen is an essential element of appropriate management for a wide range of clinical conditions. Like other drugs, oxygen requires prescribing in all situations and failure to administer oxygen appropriately can result in serious harm to the patient or loss of life. Therefore, oxygen therapy administration together with appropriate monitoring is an integral component of all patient care.

Thus, oxygen shall be administered in operating theatres and when hypoxemia is detected in all patient categories and conditions, for example:

Children and neonates: Prematurity, birth asphyxia, acute sepsis, shock, severe pneumonia, meningitis, brain injury, coma, anaemia, severe malaria, heart failure, and acute asthma.

Adults: Chronic obstructive pulmonary disease (COPD), acute asthma, pneumonia, interstitial lung disease, pulmonary sarcoidosis, lower and upper respiratory infections, pneumoconiosis, meningitis, and ischemia.

Therefore,

1. Oxygen should be used to treat hypoxemia and not breathlessness or dyspnoea.
2. Pulse oximetry is included as part of routine monitoring of vital signs for all patients.

3. All patients with SpO2 <90% on pulse oximetry with clinical signs of hypoxemia should receive oxygen therapy. In addition, for severe anaemia, heart failure, shock, severe sepsis or brain injury/infection/coma, it is also recommended as appropriate to administer oxygen when the patient's SpO2 is ≤94%.

NOTE

1. WHO defines hypoxaemia, a low peripheral arterial oxyhaemoglobin saturation (SpO2), as <90% taken using a pulse oximeter.
2. The definition of severe COVID-19 includes oxygen saturation SpO2 < 90% on room air. However, the WHO Guidelines Development Group noted that the oxygen saturation threshold of 90% to define severe COVID-19 was arbitrary and should be interpreted cautiously when defining disease severity. For example, clinicians must use their judgment to determine whether a low oxygen saturation is a sign of severity or is normal for a given patent with chronic lung disease. Similarly, clinicians may interpret a saturation of 90–94% on room air as abnormal in the patent with normal lungs, and as an early sign of severe disease in patents with a downward clinical trajectory. Generally, in cases where there is doubt, the GDG suggested erring on the side of considering disease as severe.
3. The clinical signs of hypoxemia vary with age. Preterm infants and neonates respond to hypoxemia with ventilatory depression, with or without bradycardia. Older infants and children respond with tachypnea and either tachycardia or bradycardia. Cyanosis, pallor, restlessness, or altered mental status may be evident, depending on the degree of hypoxemia. All these signs can be masked by anesthesia

4. All critically ill patients should be given oxygen by any clinician at their respective level of care including Paramedics, like during referral, Nurses or other healthcare cadres while awaiting full patient history taking and review by a Medical Officer or Specialist.
5. All patients who require supplemental oxygen should receive it in line with the National Treatment Guidelines (NTG) recommendations for oxygen therapy.

The National Treatment Guidelines shall provide specific recommendations on the appropriate screening for hypoxemia, treatment and care for all patients requiring oxygen therapy at all levels of care and in different disease conditions. In addition, to facilitate application of hypoxemia treatment and patient care guidelines, other supporting policy and implementation reference materials and documents shall be reviewed and updated to reflect global recommendations for medical oxygen use to enable streamlining and integration of hypoxemia management and patient care. These shall include, but not limited to, the following:

- Essential Medicines List (EML),
- National Treatment Guidelines
- The Essential Healthcare Package (EHP)
- National HMIS indicators, data tools and systems (HMIS forms and DHIS2)
- Essential Equipment List (EEL),

- Provider training materials, including training curricula and job aids.
- Healthcare worker policies

Other necessary tools and guidelines that do not currently exist, like; medical oxygen safety handling procedures, oxygen equipment maintenance and servicing guidelines, will be developed or adapted to facilitate full-scale implementation of set strategic priorities.
All updated and adapted implementation guidelines and tools shall need to be widely disseminated at all levels and requisite user support provided to ensure compliant application.

4.1.2.5 Implementation, planning and coordination.

Implementation of these recommendations and guidance requires effective implementation planning and concerted implementation efforts by both government and partners and at all levels. The Ministry of Health at national level is instrumental to creating the enabling environment for public-private partnerships to thrive, and to create sustainable oxygen delivery and financing schemes that will make medical oxygen accessible and affordable to patients. At the facility level, health care personnel including doctors, nurses, community health extension workers, biomedical engineers, and equipment technicians are key to ensuring adequate management of hypoxemia. Interventions for strengthening delivery of oxygen and oxygen therapy will be implemented within the framework of existing implementation arrangements. The Ministry of Health will lead implementation of this strategy and recommendations in collaboration with all health partners including the private sector and donor agencies.

At **national** level, the areas of focus in this framework seek to integrate programs and activities for improving hypoxemia management. The key gaps identified in the national medical oxygen landscape analysis include lack of policies to support implementation of pulse oximetry and oxygen therapy interventions; service provision standards and capacity to introduce the standards; data for planning and monitoring. At the **national** level the following broad activities and outputs are expected:

- Establishing a national multi-disciplinary advisory technical working group to advocate for, coordinate different efforts to implement medical oxygen related interventions and provide policy and technical guidance for implementation including monitoring, evaluation, and research on oxygen therapy.
- Formulating a specific national plan for providing district support to strengthen medical oxygen interventions at different levels. This includes guidance and tools to ensure hypoxemia management and other oxygen systems, outcome monitoring and reporting.
- Reviewing, developing, and disseminating, guidelines, standards, information education and communication materials on medical oxygen at all levels, including collaboration with the education sector to produce guidelines for pre-service training on oxygen therapy including pulse oximetry.
- Designing or adapting an integrated in-service health worker training package covering pulse oximetry and oxygen therapy as part of care for critically ill and other hypoxemia related disease conditions

- Garner strong political will to ensure the prioritization of efficient oxygen delivery systems in health facilities. This should be translated into annual operational budgets, and other functional national and district level services and programs to improve the value chain for oxygen delivery. This includes private sector engagement for affordable oxygen supply and oxygen generation/storage and systems/equipment maintenance.

District level is where it is most appropriate to link local priorities with national policy guidelines and resource allocations, and for coordination between health delivery services and communities, between government and private sector, and between the health and other sectors.

The following broad activities and outputs are expected.

- Establishing medical oxygen committees consisting of regional representation of hospitals and District Health Management Teams (DHMTs); including hospital clinical specialists, financial administrators, and relevant health partners to champion medical oxygen and support lower-level health facilities and communities in the catchment area to ensure sustainable access, availability, safe delivery, and use.
- Ensuring routine health facility readiness for medical oxygen systems and use including ensuring proper equipment management and maintenance planning and execution with support from the national level structures like Estates and Supply Chain Management departments.
- Mobilizing existing resources, including hidden resources (local organizations, traditional structures, groups) to leverage or build on current hypoxemia management entry interventions such as Covid-19 Case Management and others.
- Facilitating effective clinical governance and outcomes monitoring to ensure that healthcare teams are delivering the best service to hypoxemic patients.

4.2 STRATEGIC OBJECTIVE 2: ENSURE A RESILIENT NATIONAL MEDICAL OXYGEN SUPPLY/PRODUCTION, DISTRIBUTION, AND DELIVERY CAPACITY

4.2.1 Introduction

It is necessary to ensure adequate capacity of each element of the medical oxygen ecosystem for sustainable access and safe use of oxygen at all levels of healthcare and this capacity should be set within local contexts. These elements include supply and/or production, storage, distribution, and delivery and use at all levels of care.

4.2.2 Interventions

4.2.2.1 Strengthening national medical oxygen supply, production, and storage capacity

Optimize capacity for oxygen production and sources in health facilities: There are various sources of oxygen for health facilities including bulk medical liquid oxygen tanks, PSA plants, high pressure filled medical oxygen gas cylinders, and oxygen concentrator machines. The choice of medical oxygen sources by facilities depends on a comprehensive assessment of oxygen demand at the facility, cost of procuring medical oxygen, storage capability, as well as the ability to coordinate logistics for delivery of portable oxygen sources like filled cylinders.

Facilities that want to invest in oxygen production or bulk storage sources must consider the cost of installing oxygen production systems, the availability of reliable power source either from the central grid or industrial generators, access to spare parts (e.g., for PSA plants and concentrators), availability of medical gas piping systems, and any other necessary oxygen delivery infrastructure. Bedside concentrators and filled cylinders are the least complex oxygen sources to install, deliver, and maintain, and are therefore the primary sources of medical oxygen in most health facilities.

Integrating and scaling-up mLOX in the national hybrid oxygen ecosystem will enhance overall national oxygen resilience capacity, improve cost-effectiveness and affordability at all levels of medical oxygen investment by the Government. Therefore, the Government will adapt a mixed sources national oxygen system that includes all at-scale sources backed up with concentrator machines at facility level. Based on context, the different bulk sources (medical liquid oxygen and PSA plants) will be strategically located for cost-effective and sustainable liquid oxygen refills, cylinder filling and distribution to catchment districts and health facilities in the geographical catchment areas.
The following guidance (table 3) will form the basis for installing primary, back-up and emergency supply sources at different levels of health facilities.

Table 3: Primary oxygen sources for different levels/categories of health facilities in the country

Level of care	~ # of beds	Ecozone location [Lowlands/ highlands]	Onsite cost per unit produced/delivered of oxygen		Cost/J-size cylinder filled		Cost of J-size cylinder LOX hub [≥LSL180]	Cost-effective primary O_2 source
			Onsite PSA[5]	LOX system	PSA	Liquid oxygen		
National Referral Hospital	>420 beds	Lowlands	n/a	~LSL10 per m^3 O_2 gas supplied	>LSL135	~LSL85	n/a	LOX direct piping to all beds
Regional Referral Hospital	≥150 beds	Lowlands	~LSL17 per m^3 O_2 produced	~LSL10 per m^3 O_2 supplied	>LSL135	~LSL85	N	LOX direct pipping to all beds and cylinder filling station
District and other Hospital	100 – 150 beds	Any	~LSL17 per m^3 O_2 produced[6]	n/a	n/a	n/a	N	PSA[7] and Cylinder supply
	100 – 150 beds	Any	n/a[8]	n/a	n/a	n/a	Y	Direct piping to all beds and cylinder supply
Filter Clinics	<20 in-patient beds	Any	n/a	n/a	n/a	n/a	Y	Cylinder supply
Health Centres	<10 in-patient beds	Any	n/a	n/a	n/a	n/a	Y	Cylinders supply
Community/ Home	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Cylinders supply Portable concentrators

[5] Assuming the PSA plants runs a minimum of *16hours/2 shifts per day and one day* of maintenance every after 4,000 running hours.
[6] District hospitals with onsite production/large-scale storage sources.
[7] Assuming that the PSA Plant is directly piped to the facility.
[8] District hospitals without onsite production/bulk storage sources.

Note:

- Sizing of recommended production/supply capacity should be able to meet the health facility's estimated demand with built-in reserve capacity for surge demand (resilience)
- Oxygen concentrator machines are available in all hospital level health facilities and will provide back-up oxygen.

Ensure affordable and sustainable liquid oxygen supply: This applies to the supply of mLOX to refill VIE tanks at QMMH, and the two regional referral hospitals of Motebang and Mafeteng and respective large scale medical oxygen cylinder filling stations to be established as part of implementation of this strategy. mLOX is currently used at QMMH with a leased VIE tank of ~35 tonnes. There is no capacity in the country to produce mLOX and therefore reliable supply of mLOX is based on long-term supply agreements between the Government and a private supplier.

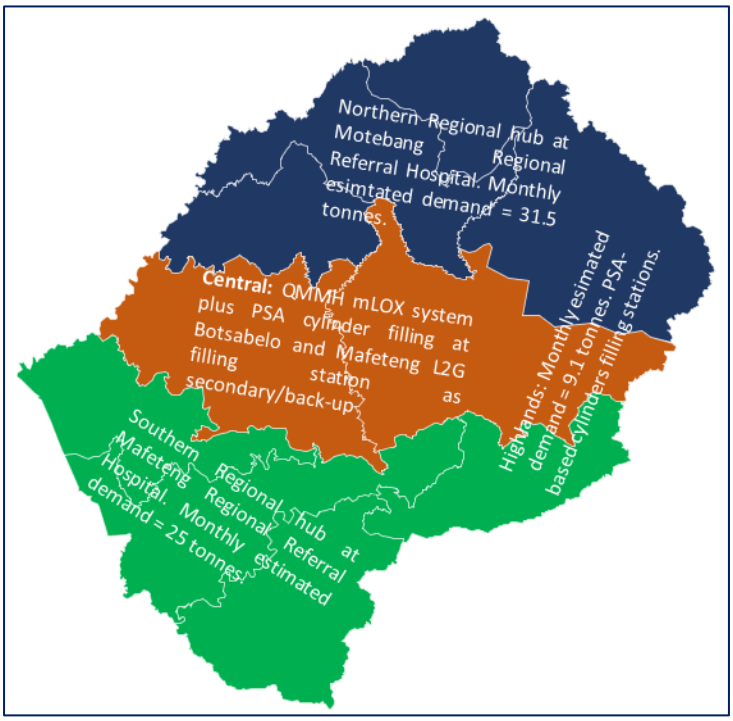
With the Government's strategic direction to integrate and scale-up use of mLOX as part of the hybrid national medical oxygen sources system, there is need to ensure access to affordable supply of mLOX. The Government will work with partners to facilitate negotiations with regional manufacturers and suppliers for reduced and affordable prices per tonne of delivered mLOX. To facilitate sustainable access and lock negotiated prices, the Government will enter a long-term liquid oxygen and associated technical services supply agreement. The negotiated prices will be applicable to all facilities with on-site mLOX storage in the country.

Optimize the national oxygen supply and logistics systems at all levels: Expanding access to oxygen delivery systems that are suitable, sustainable, and economically feasible at a national, subnational, or health facility level requires an examination of the local context and the policy and funding environments. Availability of medical oxygen in health facilities and at all levels of need, depends on having an "effective closed-loop supply and distribution system". This includes ensuring availability of infrastructure and hardware (cylinders, delivery trucks and other relevant cylinder handling devices), human resources to support country-wide system operations, availability and maintenance of biomedical equipment and systems for monitoring performance. This strategy will ensure overall national medical oxygen supply system optimization to improve cost-effectiveness of the entire national oxygen operations at the stages of production, cylinder filling and distribution. The national system is informed by a detailed cost analysis of cost per unit of oxygen at the point of use. Therefore, under the guiding principles for this strategy, the country will strategically allocate oxygen resources for universal and equitable access to oxygen across the entire country cost-effectively.

Implementation of this strategy will include establishment of two (2) liquid to gas cylinder filling stations: one at Mafeteng Regional Referral Hospital and the other at Motebang Regional Referral Hospital for the Southern and Northern geographical regions respectively. The two stations will fill cylinders of all sizes and for all health facilities in their catchment districts [figure 6 below]. In addition, for districts and health facilities where it is not cost-effective to supply them with filled cylinders from the two Liquid Oxygen hubs, they will be served using

PSA oxygen plants and enabled to fill cylinder for catchment health facilities – PSA-based cylinder filling stations. [figure 6 below].

Figure 6: National medical oxygen bulk sources and cylinder filling stations.



In addition to these bulk filling stations, there are hospitals that will continue to utilize onsite PSA plants that had already been commissioned before this strategy. The setup of the national supply system is intended to ensure that all health facilities including those running onsite PSA plants can be supplied with cylinders filled from the two regional oxygen cylinder fillings stations, in case of emergencies and breakdown of PSA plants or during planned service intervals. In addition, all health facilities will be provided with appropriate capacity oxygen concentrator machines as back-up oxygen sources to the primary sources. QMMH hospital will continue to be supplied using liquid oxygen system installed with direct piping to all beds.

4.2.2.2 Operationalize bulk cylinder filling stations and cylinder distribution networks.

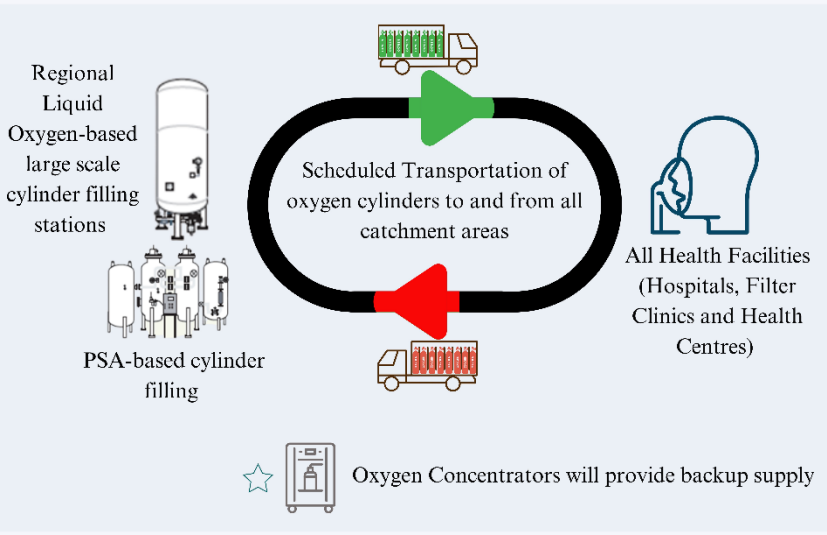
The country has no established oxygen supply and cylinder filling and distribution system. This is partly because of positioning of existing PSA plants, in addition to limited availability of cylinders. A well-functioning oxygen supply system must consist of effective logistics and management, inventory control, adequate production capacity, adequate financing, human resources, and distribution capacity among others. The current uncoordinated supply and distribution arrangements need to be optimized to ensure a sustainable oxygen supply system to all service delivery points. This will require standardizing the types of oxygen supply sources at various facility types (as defined above under the section of optimizing capacity for oxygen production and sources in health facilities), improving the supply base, procurement, setting up systems for refilling cylinders and supply related information management.

Supply and distribution of oxygen at all levels will be coordinated and managed by the Ministry of Health Supply Chain (SCM) Directorate and working through the decentralized structures in the districts and at health facilities hosting cylinder filling stations. Oxygen forecasting and quantification will be done to inform planning and safeguarding the system from unanticipated surge demand. The MoH SCM Directorate will develop or adapt tools for routine forecasting and quantification at health facility level. This process requires availability of routine and

reliable data on oxygen capacity and consumption in the country and at individual health facility level.

Further to the above description of the national medical oxygen production and storage sources, at each bulk cylinder filling station, a closed-loop, hub and spoke cylinder and oxygen distribution system[9] will be implemented between hospitals/districts and the bulk cylinder filling hubs. This, in addition to the strategically located hubs, will reduce overall costs of oxygen supply and distribution. To functionalize this approach, cylinder transport trucks will be required, and relevant processes and systems will need to be put in place. Other innovative cost-sharing approaches to further subsidize costs of the supply and distribution will need to be explored, for example, affordable supply of oxygen cylinders to the private sector and using generated revenues to finance national ecosystem operations. This will be critical for ensuring sustainable financing of the supply operations by the government.

Figure 7: Closed loop "Hub & Spoke" distribution of filled cylinders.



Standard operating procedures for filling station operations and overall national medical oxygen supply chain at all levels will be developed. These procedures will include both technical (plant and system operations and safety) and operational supply routine processes like ordering, dispatch, stock monitoring and management, oxygen management among others. In addition, innovative technological tools for supply chain management including dashboards for monitoring oxygen availability and consumption at all levels will be adapted to improve overall system efficiency and ensure sustained and reliable access to oxygen.

Distribution and delivery of bulk oxygen cylinders from filling stations is intended to cover all hospital level health facilities in the country and under respective filling station catchment areas. All hospitals without onsite oxygen production sources will be provided with adequate cylinders matched to hold the estimated oxygen volumes needed by the facility for at least 4 weeks from request date. Therefore, sized cylinder storage areas will be built at all hospitals and other high-volume facilities like selected filter clinics, depending on their oxygen demand and required cylinders stockpile.

[9] This is a model of distribution that relies on a central location (the hub) and a number of spokes leading out from that hub. The main hub is where filled medical oxygen cylinders will be stocked, and the spokes represent the various health facilities that are under the geographical catchment of the hub.

Within the district, the DHMTs, will be responsible for managing distribution of oxygen to health centre level facilities as needed. Oxygen is one of the essential commodities and will require to be integrated into the national supply chain system for essential medicines at all levels. Health facilities will be responsible for placing orders for oxygen cylinder refills.

4.2.2.3 Ensure availability of oxygen equipment and critical supplies

The typical medical equipment/device lifecycle includes seven steps: selection, set-up, use, decontamination, corrective maintenance, preventive maintenance, and decommissioning. Ensuring tidiness across the lifecycle is important for maintaining a well-functioning medical devices stock. Delivery of oxygen to the patient relies on several equipment being readily available and functional all the time. The medical oxygen continuum spans from oxygen supply/production to bedside oxygen therapy delivery and this involves various moving parts and equipment that require timely repair, replacement, or both.

The national inventory includes a large proportion of non-functional equipment and items across the oxygen therapy continuum. In addition, most of these items are donated and not sourced from the same manufacturers, and this is one of the complications to repair and maintenance and sourcing of spare parts affordably and in time.

Maintenance of oxygen equipment and continuous and dependable supply of spare parts is the responsibility of the MoH Health Estates Directorate, MoH SCM and Procurement unit and user programs. The government is yet to amass the necessary technical capacity to adequately maintain and repair oxygen related equipment in health facilities and has, over the past several years, relied on outsourced capacity from private service providers, which has been costly.
Building a system and capacity for maintenance and repair within the current government system, is crucial for regular functionality of the devices. There is a need to build capacity within the MoH Estates Department on specifications, procurement and installation of oxygen equipment that includes concentrators and plants and other oxygen delivery and patient monitoring equipment.

In this strategic period, the government will strengthen the capacity of Estates Management Directorate regarding equipment maintenance and repair. Regular planned preventive maintenance will be a responsibility of equipment users and Biomedical Engineers/Technicians posted in all hospital level facilities. DHMTs will be expected to consider allocating funds for planned preventive maintenance and repair of biomedical equipment as per recommended schedules and this will enable hospitals to take responsibility availability of functional equipment all the time. In addition, the Ministry of Health will establish movable oxygen equipment maintenance and repair workshops at regional level. These maintenance and repair workshops will benefit from long-term technical, and operations support to recruit and train critical human resources and establish systems for operations. In addition, a national medical equipment inventory/asset management system will be adapted, and capacity for assets management will be built at all levels of health facilities. The oxygen related BME will provide

an entry point to establishing a functional national inventory. Furthermore, the MoH will develop guidelines for various facility levels, like, standard operating procedures for guiding effective and efficient use of oxygen therapy, and for biomedical engineering personnel relating to equipment management and maintenance, including equipment decommissioning.

Procurement planning and related processes are important activities that ensure availability of appropriate oxygen equipment and supplies at service delivery points. During this strategic period, the Government will standardize the national medical oxygen equipment, spare parts (including incorporation and adaptation of technical specifications from global resources like, WHO/UNICEF) into procurement process) and supplies and map suppliers for cost-effective strategic purchasing with associated long-term servicing and maintenance arrangements. Equipment standardization is critical to ensure that the right specifications and quality are sources; for example, pulse oximeters need to be purchased with patient age considerations whereby burden of hypoxemia is highest in the youngest ages (e.g., the neonates, infants, and children) and these often lack appropriate pulse oximeter access.

Procurement processes for oxygen equipment should be integrated into its existing medical equipment and supplies procurement system and procedures and supporting partners will be expected to support this streamlining by working with the relevant stakeholders along the procurement process. This will enhance cost competitiveness, value for money and quality of equipment and supplies.

4.2.2.4 Improving readiness for oxygen systems in health facilities

Health facilities should have the requisite infrastructure to enable them to safely manage and deliver oxygen to patients. Recent data shows that 33% of all hospitals in the country have oxygen gas piping to only a few beds in the hospital. Medical gas piping systems are a critical component of overall readiness of health facilities regarding oxygen systems and delivery.
In line with the national medical oxygen supply and cylinder distribution plan set out in this strategy, all hospital level facilities, the Ministry of Health with support from partner will ensure that medical gas piping systems installed as part of health facility readiness strengthening. Capacity of the MoH Estates Directorate regarding requirements, guidance and standards for medical gas piping systems will be built to ensure ongoing technical operations support, sourcing and coordination of systems maintenance and repair.

4.3 STRATEGIC OBJECTIVE 3: ENHANCE CAPACITY TO MANAGE AND SAFELY UTILIZE OXYGEN IN HEALTH FACILITIES

4.3.1 Introduction

Achieving the safe management, delivery, and utilization of oxygen in health facilities necessitates the collaboration of various professionals. This includes clinicians who possess the expertise to identify and treat patients with hypoxemia, biomedical engineers/technicians responsible for the maintenance of equipment, and administrators who ensure a continuous supply of oxygen, equipment availability, and spare parts. Therefore, there is a need to ensure that capacity is built for all professionals along the entire oxygen management, safe delivery

and use continuum. Safe and appropriate use of medical oxygen includes considerations of oxygen conservation at different levels of the oxygen delivery ecosystem.

Training healthcare workers in appropriate use and routine care of pulse oximetry and monitors prolongs the lifespan of the equipment. Furthermore, it is crucial to provide Biomedical engineers/technicians with training in equipment maintenance and repair. They should also be equipped with the necessary tools, such as oxygen gas analysers, to effectively monitor and troubleshoot oxygen systems and ensure the quality and purity of the oxygen gas.

As described under strategic objective 2 above, hospital-level health facilities will be provided with designated storage areas for safe oxygen cylinder storage, along with tools and guidance for inventory management. This will enable administrators to effectively monitor and maintain appropriate stock levels to meet the facility's requirements. Additionally, administrators will be responsible for reporting and coordinating equipment maintenance and repair to ensure uninterrupted access and use of oxygen within the facility.

4.3.2 Interventions

4.3.2.1 Build capacity for pulse oximetry and oxygen therapy– hypoxemia management.

In the recent past, the outbreak of Covid-19 pandemic has augmented in-service capacity building of healthcare providers on pulse oximetry and oxygen therapy delivery as part of Covid-19 case management. Provider training in critical care covers oxygen therapy as part of care for the critically ill. The entry point to providing oxygen therapy is ensuring that all patients are checked for blood oxygen levels using pulse oximetry. This should be done at all levels in order to identify cases, initiate oxygen therapy or immediately refer the patient to where oxygen therapy can be provided in time. Therefore, healthcare providers at all levels of care should be provided with functional pulse oximeters with guidance for hypoxemia diagnosis and oxygen therapy initiation. The national oxygen/medical equipment standardization will provide guidance on allocation and expected numbers of pulse oximeters and other relevant equipment per unit of care in the health facility. It is recommended that care units/levels of increasing complexity be established in order to rationally allocate both the human and technological resources necessary for the management of patients based on severity of the disease. Furthermore, a functional **referral** system will be critical for ensuring that all patients in need of oxygen therapy can be transferred to the most appropriate levels of care in time.

It is estimated that approximately 50% of healthcare providers in hospitals have received training in pulse oximetry and/or oxygen therapy. Provider capacity gaps are more profound regarding management of hypoxemia in children. There is need to ensure integrated and **harmonized** training content and guidance for hypoxemia management. Improved provider capacity (knowledge and skills) and availability of appropriate tools and technical guidance, among others, can increase feasibility and acceptability of pulse oximetry and oxygen therapy in health facilities.

In addition to theoretical classroom-based training, follow-up onsite **mentorship** and supportive supervision should be considered to reinforce provider knowledge and skills. Since oxygen use involves various appliances and accessories, there is need to consider focused initial mentoring on use and maintenance of these devices and bridge any knowledge and skills gaps. This could be started and focused on high-volume facilities, facilities with newly recruited staff, and those where new equipment/devices have been provided. Onsite mentorship is resource intensive and there are already existing programs with well-established mentorship mechanisms. Therefore, efforts should be made to **integrate** pulse oximetry and oxygen therapy priorities with such programs like SRMNH, TB/HIV and immunization programme.

Furthermore, with increasing national capacity for critical care in selected hospitals, **onsite** training at these hospitals (practicum sites) could be considered to have trainees engage in practical drills. Therefore, capacity building for hypoxemia management should ensure that:

- Administrators and healthcare managers at different levels are aware of technical aspects of oxygen supply chain, accessories, and requirements.
- Healthcare workers are trained in relevance and early detection of hypoxemia (use of pulse oximetry) and clinical use of oxygen and its monitoring (oxygen therapy management), including patient education/counselling.
- Healthcare workers be trained in the fundamentals of oxygen equipment, including their operation, routine maintenance, basic care, and safe use.

To sustain this capacity building and ensure a knowledgeable workforce from health training institutions, hypoxemia detection and its management should be included in preservice training curricula for healthcare workers where it is currently not included. This is in addition to the opportunity to leverage continuing medical education (CME) sessions in health facilities to reinforce certain topics and practices for safe and rational oxygen use and management.

At community level, management of hypoxemia (entry level Pulse oximetry) by village health workers (VHWs) will be implemented. The VHWs will be trained and equipped to identify and refer hypoxemia patients to the nearest health facility for appropriate management.

4.3.2.2 Ensure availability of tools for safe oxygen use and hypoxemia management

A drug is used rationally when patients receive it according to their clinical needs, in doses appropriate to their individual needs, for an appropriate period, and at a low cost to them and their community. To prevent negative consequences, such as reduced efficacy due to issues related to oxygen storage, distribution, and administration, it is essential to provide guidance on the appropriate and rational use of oxygen and actively promote it. Managing available oxygen sources and supply systems is critical in order to ensure continuous supply and this requires that various measures are implemented as conservation strategies to prevent wastage of oxygen. Some of these measures include optimal oxygen therapy, careful monitoring, and escalation as well as de-escalation of oxygen therapy when indicated. Rational use of oxygen also involves controlling waste due to leaks in storage and distribution systems, incorrectly

prescribed flows and pressures, and incompatible connections between equipment, among other problems. Another aspect to consider is the provision of adequate technical support for all oxygen production systems, in terms of maintenance and calibration, availability of power, and specific knowledge about these systems.

To facilitate application of knowledge and skills and in addition to making sure that healthcare workers have appropriate equipment and accessories, there is need to ensure that standardized tools and protocols for ensuring appropriate oxygen therapy and hypoxemia management are in place in all health facilities. This will ensure universal and traceable practices of oxygen management and clinical application. The Ministry of Health will develop/adapt tools and protocols in form of job aids, flowcharts/algorithms, checklists, and forms among others, including:

1. Safe oxygen supply and management
    - Medical oxygen fire risk management protocol
    - Oxygen cylinder safety protocol
    - Medical gas pipeline systems management and safety
    - PSA plant routine maintenance and troubleshooting protocols.
    - Basic oxygen equipment maintenance and use protocols, e.g., for oxygen concentrator machines and their accessories, pulse oximeters, flowmeters, and patient ventilators.
    - Oxygen stock management protocols (e.g., for store and patient level consumption monitoring)
2. Pulse oximetry, oxygen therapy and its escalation
    - Hypoxemia detection (use of pulse oximetry) as appropriate for different patient age groups
    - Initiation, escalation and weaning of oxygen therapy for different patient age groups and conditions.
    - Administration of oxygen from different sources like bedside cylinders, , concentrators and direct piped bedside oxygen.

Note: the above tools and materials should be used alongside (and will not replace) manufacturer recommendations/ documentation for specific brands/models.

4.3.2.3 Strengthen data and performance management for oxygen delivery systems.

Hypoxemia management is not currently being tracked in the mainstream national health management information system (HMIS). Management of hypoxemia is a cross-cutting intervention associated with various disease conditions that are already being tracked via HMIS. Therefore, there is need to review and update existing data collection tools at all levels to provide for capturing of key oxygen ecosystem and hypoxemia management indicators including pulse oximetry and oxygen therapy. Data on hypoxemia management should be routinely summarized and utilized to inform decision making (accountability, planning, oxygen supply management and resources allocation) at facility, district, and national level.

Furthermore, scaling-up hypoxemia management and access to oxygen is a new endeavour that will require continuous learning/research and improvement; hence availability of reliable data on processes, inputs, and outcomes, at different levels is a critical input.

4.3.2.4 Improve healthcare seeking behaviour for critical/acute illness and acceptance of oxygen therapy.

While levels of knowledge and acceptance of oxygen therapy among healthcare workers at hospital levels is known, there is no local data of the same among patients and caregivers. There is a need to undertake a knowledge, attitudes and acceptance study among hypoxemic patients and their caregivers. Literature shows that patients are at times uncertain regarding the purpose and benefits of oxygen therapy. However, there is also an underlying faith in healthcare workers that is apparent, and this faith can be leveraged to foster acceptance of a lifesaving therapy, despite the impact, burden, and incomplete understanding. Increasing knowledge of pulse oximeters, oxygen therapy among patients with hypoxemia and their caregivers is central to increasing demand/care-seeking for hypoxemia, and acceptance of oxygen therapy and ultimately improved outcomes for hypoxemic patients.

Local community-level knowledge of perceptions and beliefs associated with oxygen therapy will provide formative reference to design a nation-wide community awareness and education campaign to increase knowledge and acceptance of pulse oximetry and oxygen therapy in the country. Specific community education messaging and information will be provided using different platforms including in-facility education opportunities and platforms and mass media platforms. For communities, the purpose of the messaging shall be to educate them on how to identify both the symptoms and danger signs of hypoxemia and seek immediate care. Tools for patient education and counselling on the benefits of oxygen therapy for hypoxemic patients will need to be provided to healthcare providers.

4.4 STRATEGIC OBJECTIVE 4: DEFINE POLICY AND STRATEGIC BASIS FOR RESOURCES MOBILIZATION AND FINANCING MEDICAL OXYGEN PRIORITIES

4.4.1 Introduction

Since the beginning of the COVID-19 pandemic in the country in May 2021, there has been increased oxygen demand and the corresponding recognition of how critical oxygen supply and delivery systems are to the health system. As a result, there is increasing resource commitments to enable access to medical oxygen by both government and non-government partners. However, the need for oxygen as an essential commodity remains and investments in supply sourcing, production and storage, distribution, maintenance of equipment, training, and many other areas must be sustained. Oxygen therapy, paired with pulse oximetry, should be available at all levels of care and this will require sustained investment in strengthening and maintaining oxygen delivery systems from production and storage, distribution and delivery and use. The Government has developed this strategy to ensure and guide implementation of sustainable programming, budgets, and supply management for medical oxygen. In line with the strategic guiding principles of the national health sector strategic plan and this national

medical oxygen strategy and principles of UHC, the following will be prioritized to enable continued financing of national medical oxygen interventions.

4.4.2 Interventions

4.4.2.1 Ensure integration of oxygen interventions with other programs

This national medical oxygen strategy has taken a system-wide approach regarding design and prioritization. Similarly, its implementation will not only consider how oxygen delivery can be integrated into programs, but also into efforts focused on strengthening overall service delivery, procurement, and supply chain management. This is because oxygen delivery is a crosscutting issue and requires integration into a variety of existing national plans and programs across the health system and thence leverage existing platforms and capacities for increased sustainable access at scale. Additionally, expanding access to oxygen delivery systems will benefit other populations, including those suffering from non-communicable diseases, trauma, and other disorders. Therefore, the Ministry of Health, working with implementing partners and in collaboration with other government agencies, will ensure integration at policy and implementation levels in order to improve overall efficiency of sustaining equitable access to medical oxygen. Integration will also be pursued along the health system building blocks.

At the policy level, the aim is to strengthen integration of oxygen delivery across relevant national processes, policies, plans and guidelines. The following policies, plans and guidelines will be reviewed to ensure integrated planning, implementation and financing including for medical oxygen delivery systems.

Table 4: Considerations for integrating and streamlining medical oxygen delivery priorities across the health sector.

Process, policies, plans, tools, and guidelines	Medical oxygen integration considerations
NHSP and other operational plans	• Incorporate medical oxygen delivery system as a cross-cutting priority and key driver of system performance. Integrate guidance on planning and budgeting for oxygen delivery systems at all levels and programs
National Treatment Guidelines	• Includes updated guidance for the management of hypoxemia at all levels, including pulse oximetry and oxygen therapy management at different levels of care
Essential Medicines List (EML)	• List oxygen as an essential and vital medicine for the management of hypoxemia in all age groups and classified as vital
Supply chain management guidelines/manual	• Integrates medical oxygen supply chain management processes and tools as an essential commodity (including qualification and reporting processes and tools) and at all levels of care. This includes procurement, technical specifications, and quality requirements of oxygen and oxygen devices and supplies including pressure equipment like high pressure gas cylinders and bulk tanks and ancillary equipment like medical gas pipelines. • Provides guidance on cylinder distribution systems for LOX hub and spoke networks.

Human Resources Policy and Plan	• Include and prioritize cadres and professions relevant to oxygen delivery systems including Biomedical Engineers/Technicians, Critical care specialists
Health infrastructure planning and implementation	• Make considerations for oxygen delivery systems in the planning and implementation health infrastructure projects at all levels
Essential Healthcare Package	• Define levels of availability and provision of pulse oximetry and oxygen therapy are defined
National HMIS	• Includes indicators for monitoring and managing performance of oxygen ecosystems, pulse oximetry and hypoxemia management patient outcomes for use at different levels of the health system
National Priority Medical Devices List	• Includes all priority oxygen delivery equipment and access and categorized as vital; to be used as a foundation for the national assets management system.
Governance, Coordination and Engagement	• Set-up an Emergency Medicine and critical care desk under Clinical Services Directorate to coordinate stakeholders' engagement, implementation, monitoring, and evaluation of critical care interventions including oxygen delivery systems, interventions, and outcomes. • Strengthen the capacity of the Estates Management Directorate to manage the national medical oxygen ecosystem in coordination with other programs and units in the Ministry of Health • Establish functional regional medical oxygen oversight teams along with the regionalized national oxygen supply and distribution system
Health facility supportive supervision and provider mentorship	• Integrate oxygen delivery systems monitoring and continuous capacity building in program/disease specific and the integrated national guidelines and tools for supportive supervision and provider mentorship.
Health Promotion and Education	• Integrate patient education on pulse oximetry and oxygen therapy in routine health messaging in different platforms and programs/interventions
Healthcare provider training	• In-service – includes the management of hypoxemia in training curricula for related disease conditions. • Pre-service – include the management of hypoxemia in training curricula for all healthcare cadres where it is not included.

4.4.2.2 Facilitate resources mobilization, allocation, and rationalization.

Ensuring sustainable budgeting for all the set objectives is critical for the implementation of the strategic plan priorities and ensuring resilient and effective supply of oxygen. At the national level, the Ministry of Health will allocate resources for oxygen delivery systems in both capital and recurrent budget votes under the Estates Management Directorate. This is in addition to programs-level priorities for improving patient care management including hypoxemia management. However, a National Estates and Facilities Management and Maintenance Strategy and Plan needs to be developed under the Estates Management Department. At subnational level, in line with principles of decentralization, districts will be guided to plan and prioritize resources for sustained access to oxygen in catchment facilities.

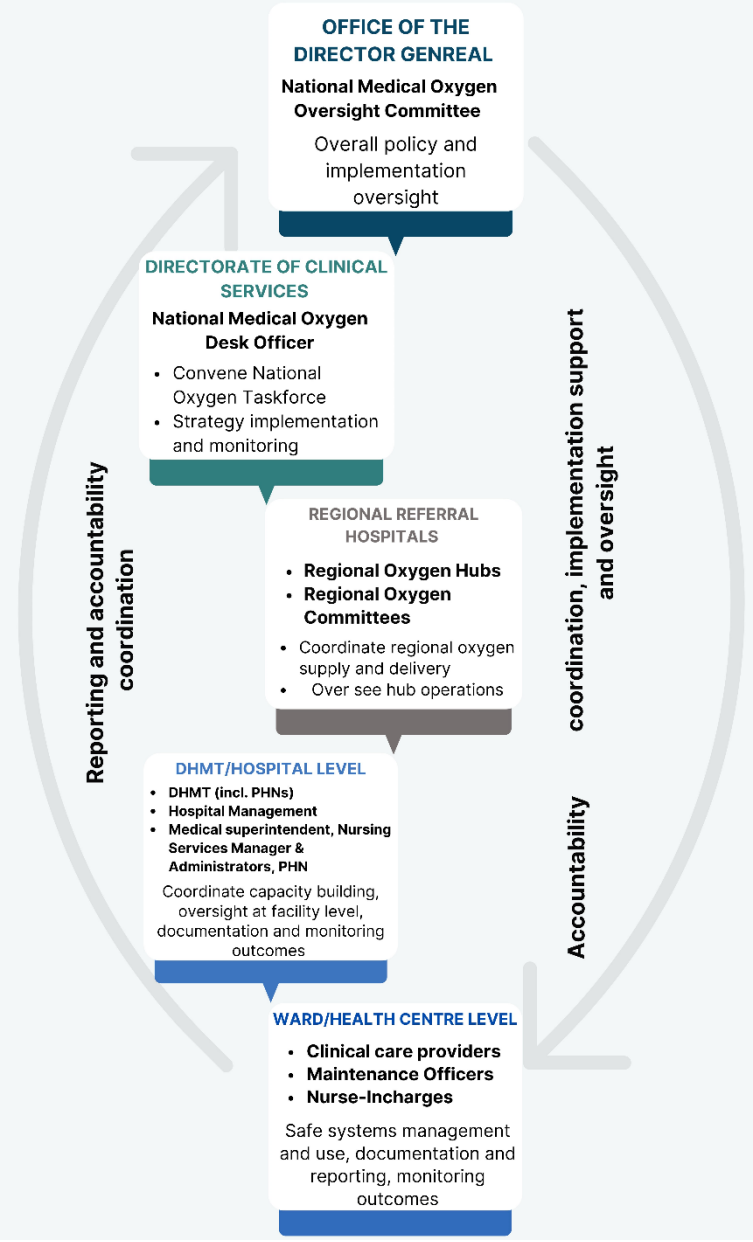
At all levels, planning and resources allocation will be informed by data on demand and consumption within unique contexts of each district or health facility. The Ministry of Health will work with partners to finance capital oxygen ecosystem investments and budget for annual operational costs annually. The national budget allocations will cater for procurement of oxygen production, storage, distribution and delivery equipment, spare parts and other oxygen delivery supplies, procurement of liquid oxygen supply, and other oxygen generation equipment. Additionally, the funding will be dedicated to support recruitment and deployment of qualified personnel to support operations of cylinder filling stations and PSA plants (in government-owned hospitals), maintenance and servicing and other overall macro-oxygen ecosystem operations at national level. In addition, districts, through regional medical oxygen oversight teams and with support from the national oxygen desk (role is further defined in the next section), will ensure sustained distribution of oxygen in catchment areas, and safe use and delivery (management of hypoxemia) in health facilities. In addition, facilities hosting PSA plants onsite will allocate resources for meeting electricity needs to run the plants.

This strategic plan is aimed at rallying all available support and resources towards a common goal of reducing hypoxemia related morbidity and mortality by ensuring equitable access to oxygen at all levels of care. While financing implementation of this strategy is Government-led, the MoH will guide health partners to rationalize resources and align to national priorities and leverage the private sector to better use available funds from all sources. This will include maintaining an up-to-date mapping of available resources and commitments against the four (4) strategic objectives and effectively engaging stakeholders through the national multi-disciplinary working group to improve collaboration and complementary with the purpose of improving overall efficiency of the national medical oxygen ecosystem.

5 IMPLEMENTATION MECHANISMS

The national oxygen ecosystem cuts across various aspects of health system organization, patient care inputs, processes, and outcomes. The national strategy is set to reduce morbidity and mortality due to hypoxemia by enabling equitable access to oxygen and safe use of oxygen at all levels of care by 2028. The strategy is aligned to the national health sector strategic plan and the agenda for universal health coverage which embraces principles of primary health care. This strategic plan is intended to guide priorities for rational, cost-effective, and coordinated investment in the national oxygen ecosystem by both government and supporting partners. This is in addition to providing guidance for oxygen systems strengthening at all levels through cost-effective implementation arrangements like integration. Therefore, governance responsibility and leadership for this strategy and meeting the targets set in this strategy lies with the Ministry of Health. The MoH will provide policies, guidelines, build capacity, monitor, and coordinate partners to support the decentralized levels in implementation. This section describes proposed management structures and institutional coordination arrangements necessary to ensure successful implementation of set strategic priorities.

Figure 8: Strategy implementation structures.



5.1 IMPLEMENTATION MANAGEMENT, COORDINATION, AND ACCOUNTABILITY

This strategy was developed based on a shared priority of reducing the burden of hypoxemia by all stakeholders at different levels. The **Ministry of Health** will be the steward in planning, financing, implementation, and performance monitoring of the strategy within existing governance structures at national and subnational levels. The MoH will be responsible for updating national policies, clinical guidelines, regulations, and other standards, and disseminating them to relevant

stakeholders for implementation. The Ministry of Health will create a national medical oxygen coordination desk under the Clinical Services Directorate to lead the activities of the national coordinating mechanism (National Medical Oxygen Taskforce) for the scaled-up access to oxygen in the country.

This strategy proposes the establishment, at national level, of the **National Oxygen Oversight Committee** chaired by the **Director General Health Services**, that will be responsible for policy decisions and direction for the strategy as well as determining any changes to the implementation approach, if needed. The membership and terms of reference for the committee will be developed. The committee will be reinforced through respective programs and directorates, health partners and other stakeholders that will provide continuous oversight on implementation pace and direction.

The **Director Clinical Services**, through the National Medical Oxygen Desk, will be the convener of the **National Medical Oxygen Taskforce**; this is an establishment of the MoH as multidisciplinary platform for collective oxygen policy and programmatic support including performance reviews.
The national oxygen taskforce has led the process of developing this strategy and its implementation plan. This is a demonstration that effective **governance** and **coordination** of all efforts and **partners** is critical to effective scaling-up of access to medical oxygen and ultimately implementation of this strategy. The Taskforce is operating on set terms of work and defined membership that will be reviewed annually to be aligned towards ensuring representation and focused action across the four (4) **strategic objectives**. This broad engagement aims to ensure participation, resources mobilization, evidence generation, advocacy, technical collaboration, and accountability. The Oxygen Taskforce will constantly cooperate with other working groups to address unique cross-cutting issues of safe and reliable oxygen access and use at all levels. Furthermore, academic institutions shall be engaged in the pursuit and dissemination of knowledge through research, education, and training.

This strategy further proposes to establish **Regional Medical Oxygen Committees** that will be a representation of hospitals and District Health Management Teams (DHMTs) including hospital clinical specialists, financial administrators, and relevant health partners. The committees will be functionalized in the four geographical zones and clustered around **large-scale oxygen supply hubs** in the South, North Central and Highland areas. The committee's roles will include coordination of oxygen supply in catchment areas and provide a platform for review of performance management of oxygen supply, safe delivery and use in the region and health facilities. However, **decentralization** of the management to implement the strategic plan will require districts and facilities taking responsibility and being empowered for effective support.

In health facilities, **management committees/boards** will play an oversight role in line with the national strategy of reducing the burden of hypoxemia. The **Medical Superintendent** and **Nursing Services Managers** will be responsible for ensuring clinical readiness in respective

jurisdictions and monitoring hypoxemia management patient outcomes routinely. This is additional to coordinating capacity building for clinical staff on safe oxygen delivery and use.

In addition, the **Hospital Administrators** will be responsible for managing oxygen ecosystem operations including coordinating oxygen supply chain and safe management, equipment management and maintenance (including capacity building of technicians) and emergency referral services.

The **District Principal Health Nurse (PHN)** will be responsible for ensuring availability of oxygen in all catchment health centre level facilities. Working with the Supply Chain Directorate, the PHN will plan and coordinate ordering and delivery of oxygen cylinders to all health centres. In addition, they will be responsible for coordinating healthcare worker training/mentorship and equipment maintenance and repairs for health centres.

The **Health Centre Nurse in-charges,** and all other healthcare workers providing clinical care, will be responsible for ensuring safe management and use of oxygen in the facility including documentation and reporting of oxygen use.

Oxygen systems **performance** and hypoxemia management outcomes will be reviewed and discussed on a quarterly basis at national, DHMT, Hospital and Health Centre **Management meetings**.

6 SUMMARY IMPLEMENTATION PLAN

Table 5: Summary activity and implementation plan

Strategic Objectives	Implementation year				
	2023/4	2024/5	2025/6	2026/7	2027/8
Strategic Objective 1: Establish national strategic framework for scaling-up medical oxygen supply and safe utilization					
Priority 1: Accountable medical oxygen ecosystem operations and management	X	X	X	X	X
Strategic Objective 2: Ensure a resilient national medical oxygen production, distribution, and delivery capacity					
Priority 1: Ensure affordable and sustainable liquid oxygen supply	X				
Priority 2: Optimize the national oxygen supply and logistics systems at all levels	X	X	X	X	X
Priority 3: Operationalize centralized bulk cylinder filling stations and cylinder distribution networks	X	X	X	X	X
Priority 4: Ensure availability of oxygen Equipment and critical supplies	X	X	X	X	X
Priority 5: Strengthening Health facility distribution and delivery infrastructure readiness for oxygen systems	X				
Strategic Objective 3: Enhance capacity to manage and safely utilize oxygen at all levels of care					
Priority 1: Build capacity for pulse oximetry and oxygen therapy – hypoxemia management	X	X	X	X	X
Priority 2: Ensure availability of tools for safe oxygen use and hypoxemia management	X				
Priority 3: Strengthen data and performance management for oxygen delivery systems	X	X	X	X	X
Priority 4: Improve healthcare seeking behaviour for critical/acute illness and acceptance of oxygen therapy	X	x	X	x	X
Strategic Objective 4: Define policy and strategic basis for resources mobilization and financing medical oxygen priorities					
Priority 1: Ensure integration of oxygen interventions with other programs	X	X	X	X	X
Priority 2: Facilitate resources mobilization, allocation, and rationalization	X	X	X	X	X

Monitoring and Evaluation					
Activity 1: National baseline hypoxemia survey/study	X				
Activity 2: Annual national oxygen ecosystem performance review (aligned to the Annual Health Sector Joint Review Mission process)	X	X	X	X	X
Activity 3: Mid-term implementation and strategy review			X		
Activity 4: End-term implementation and strategy evaluation					X

See annex 5 for detailed activity implementation plan.

7 COSTING AND RESOURCE REQUIREMENTS FOR IMPLEMENTING THE STRATEGY AND SCALE-UP PLAN

The key assumptions used in generating intervention level cost estimates are outlined below.

- The unit price of the commodities is based on multiple sources to cover the different commodities and equipment and spare parts. These sources included indicative price index of UNICEF, CHAI, and the Global Fund. Program specific costs (program management, governance, training) are derived from prevailing GoL and partner standing rates and are computed using activity-based costing (ABC). The estimates covered in this strategy are based on the health systems and services perspective and thus do not fully include societal costs.
- It is assumed that effective coverage of access to medical oxygen at scale will be achieved by end of 2023/24 financial year. Therefore, in estimation of costs, it was assumed that coverage of all interventions would be maintained at 2023 levels by 2028 and hence additional costs are presented as incremental estimates required to scale up interventions above the 2023/4 level.
- Reported commitments from partners are disaggregated by strategic objective/priority and as such directly comparable to costed estimates using activity-based costing which is based on detailed activity/intervention costs.

7.1 COST ESTIMATES FOR NATIONAL PRIORITIES

This national strategy and scale-up plan prioritizes delivery of four codependent strategic objectives to achieve sustainable and equitable access to, and safe utilization of, medical oxygen at all levels by 2028 and reduce morbidity and mortality from hypoxemia across all disease conditions. Scaling up access to medical oxygen will take both capital and operations (CAPEX and OPEX) expenses. Broadly, the following broad areas of the national oxygen ecosystem have been costed for scaling-up access to medical oxygen in the country over the next 5 years.

- Stakeholder coordination for implementation monitoring and support.
- Training programs, guidelines development, and support tools for pulse oximetry and oxygen therapy
- Procurement of liquid oxygen, new equipment such as oxygen production, storage and delivery equipment, pulse oximeters, and ventilators
- Transport and delivery of devices or routinely managed inventory such as oxygen cylinders.
- Human resources to administer oxygen therapy.
- Maintenance and servicing of equipment
- Maintenance and improvement of infrastructure such as pressure swing adsorption plants, oxygen piping systems, and electricity to support oxygen equipment.
- Management of inventory such as consumables, accessories, oxygen cylinders, and spare parts for devices

- Maintenance and improvement of information systems to track indicators related to oxygen therapy.

The total estimated cost of delivering the national strategy and scale-up plan over the next five years is LSL 275 million. This includes an estimated LSL 111 million (40%) capital costs (CAPEX) and LSL 163.9 million (60%) for operations (OPEX). Majority (>70%) of capital costs are required from health facility infrastructure upgrades (~46%) for oxygen systems including piping of all hospital level facilities and procurement and installation of oxygen production and storage systems (25%). However, capital costs are highest in the first and second year of implementing the strategy while operating costs increase from the second year of the strategy. Operating costs are mainly driven by clinical and biomedical technical capacity building, equipment servicing and maintenance and sustaining operation of oxygen plants.

Table 6: Overall costs estimates for implementing the strategy [2023 - 2028]

Investments (CAPEX)	Total (LSL)
Oxygen Plants	27,482,296
Generators	3,255,000
Piping of Hospitals	50,868,000
Trucks	7,500,000
Infrastructure (e.g., cylinder storage cages)	420,000
Oxygen related Equipment	21,569,343
Sub-total	**111,094,639**
Investment (OPEX)	
Plants Operations	15,412,500
Clinical capacity building	75,688,900
Services and maintenance	28,005,450
Coordination	7,810,200
Technical assistance	720,000
Other operation costs	16,891,450
LOX Procurement	12,000,000
Monitoring and evaluation	7,411,500
Sub-total	**163,940,000**
TOTAL cost estimates	**275,034,639**

The estimated resources are based on projected implementation timelines for set interventions. Below is the projected distribution of resource need over the strategic period, presented by each strategic objective and priority intervention areas.

Table 7: Summary cost estimates by strategic objective and priority intervention area level (LSL)

Strategic objective/priorities	Phasing				
	2023/4	2024/5	2025/6	2026/7	2027/8
Strategic objective 1: Establish national strategic framework for scaling-up medical oxygen supply and safe utilization	**967,060**	**370,560**	**370,560**	**370,560**	**370,560**
1.1 Ensure accountable medical oxygen ecosystem operations and management	967,060	370,560	370,560	370,560	370,560
Strategic objective 2: Ensure a resilient national medical oxygen production, distribution, and delivery capacity	**125,779,804**	**26,097,708**	**26,097,708**	**26,097,708**	**26,097,708**
2.1 Ensure affordable and sustainable liquid oxygen supply	300,000	0.00	0.00	0.00	0.00
2.2 Optimize the national oxygen supply and logistics systems at all levels	36,523,636	5,786,340	5,786,340	5,786,340	5,786,340
2.3 Operationalize centralized bulk cylinder filling stations and cylinder distribution networks	23,726,700	12,654,000	12,654,000	12,654,000	12,654,000
2.4 Ensure availability of oxygen Equipment and critical supplies	15,097,369	8,917,369	8,917,369	8,917,369	8,917,369
2.5 Improving readiness for oxygen systems in health facilities	51,392,100	0.00	0.00	0.00	0.00
Strategic objective 3: Enhance capacity to manage and safely utilize oxygen in health facilities	**6,474,700**	**3,229,500**	**3,579,500**	**3,229,500**	**3,479,500**
3.1 Build capacity for pulse oximetry and oxygen therapy – hypoxemia management	4,307,700	3,229,500	3,229,500	3,229,500	3,229,500

3.2 Ensure availability of tools for safe oxygen use and hypoxemia management	658,800	0.00	0.00	0.00	0.00
3.3 Strengthen data and performance management for oxygen delivery systems	120,000	0.00	0.00	0.00	0.00
3.4 Increase care seeking for hypoxemia and acceptance of oxygen therapy	1,388,200	0.00	350,000	0.00	250,000
Strategic objective 4: Define policy and strategic basis for financing medical oxygen priorities	**3,010,500**	**0.00**	**0.00**	**0.00**	**0.00**
4.1 Ensure integration of oxygen interventions with other programs	1,572,300	0.00	0.00	0.00	0.00
4.2 Facilitate resources mobilization, allocation, and rationalization	1,438,200	0.00	0.00	0.00	0.00
Monitoring and evaluation activities	1,372,500	1,647,000	1,647,000	1,372,500	1,647,000
National hypoxemia baseline study		274,500.00			
Annual national oxygen ecosystem performance review	1,372,500	1,372,500	1,372,500	1,372,500	1,372,500
Mid-term implementation and strategy review	0.00	0.00	274,500.00	0.00	0.00
End-term implementation and strategy evaluation	0.00	0.00	0.00	0.00	274,500

7.2 MAPPING PARTNER COMMITMENTS AND BRIDGING THE FINANCIAL GAP

Understanding existing resources and commitments from various funding sources towards the national oxygen ecosystem is critical to putting together a complete financing plan for implementation of this strategy and scale-up plan. The commitments towards supporting the national medical oxygen ecosystem by different health partners were established from the analysis of resources mapping from September 2021 to July 2022. The mapping process was participatory and used dialogue processes with all stakeholders in the medical oxygen space. Government commitments are not included since there is not yet a running budget line for medical oxygen. All identified partners supporting medical oxygen systems and delivery in the country completed the mapping tool and provided resource commitments against timelines of the strategy and scale-up plan.

Majority of partner commitments are spread over the initial year of the strategy (2022/3) and mainly targeted towards capital investment needs. Data collected on intervention-linked commitments and quantities (where available) are used to estimate the annual average resource commitments. It is estimated that approximately 80% and 40% of estimated annual capital and operational costs, respectively, will be supported by through health partners. Table 8 below shows estimated health partner commitments against the four codependent strategic objectives.

Table 8: Estimates of resource needs, commitments, and funding gap (LSL)

Estimated Resources/Year	2023/4	2024/5	2025/6	2026/7	2027/8
Resource Needed					
Capital Investment	98,949,675	4,313,869	4,313,869	4,313,869	4,313,869
Operational costs	38,400,800	27,641,400	28,265,900	27,641,400	28,165,900
Resource Commitments (including projections)					
Capital Investment	79,159,740	2,156,934	2,156,934	2,156,934	2,156,934
Operational costs	15,360,320	11,056,560	11,306,360	11,056,560	11,266,360
Resource gap					
Capital Investment	19,789,935	2,156,934	2,156,934	2,156,934	2,156,934
Operational costs	23,040,480	16,584,840	16,959,540	16,584,840	16,899,540
Estimated total gap	42,830,415	18,741,774	19,116,474	18,741,774	19,056,474

The national medical oxygen strategy and scale-up plan is costed in the assumption that the current scale-up objectives are feasible and will be maintained and is estimated to cost LSL 269.3 million for the next five years. The projected resource commitments by health partners over the strategic period of five years is LSL 147 million and as a result, the estimated funding gap is LSL 118 million with an average annual resource gap of LSL of LSL 23.7 million.

The cost analysis indicates that an estimated LSL 111 million is the required investment to meet the country capital investments in oxygen production and storage facilities in the country's hybrid medical oxygen ecosystem that includes liquid oxygen, PSA plants and

concentrators. The reported health partner commitments towards the national strategy are estimated to meet all the country's need for capital investments in oxygen plants/systems, storage, and delivery equipment/systems. This includes establishment of regional large scale oxygen cylinder refill stations based on liquid sources at Mafeteng and Motebang Regional Referral Hospitals, procurement, and installation PSA plants in highland and hard to reach districts/hospitals where cylinders delivered from LOX hubs cost more than onsite production from PSA plants – these PSA plants will also supply filled cylinders to catchment facilities. Furthermore, partners have committed resources to set-up medical gas piping systems in all hospital level facilities in the country. In addition, health partners have committed support to the government to procure their own up to date liquid oxygen VIE system at QMMH and replace the currently leased tank.

Furthermore, partners have committed catalytic investments in operationalizing the national medical oxygen supply and distribution system. This includes commitments to ensure access to negotiated liquid oxygen prices, short-term guarantee for take-or-pay liquid oxygen supply agreements and ensuring that there is adequate oxygen operations and clinical delivery capacity at all levels for optimum oxygen consumption and sustainable market conditions in the country. Whereas there is significant funding commitment to meet the country's capital expenditure investments versus estimated need, there is no reported funding commitment towards procurement of trucks to distribute oxygen cylinders. In addition, there are significant clinical and technical training are also supported. However, sustaining these catalytic investments will require continued government funding commitments.

The most significant proportion of the strategic resources' gap relates to ensuring sustained operations of the national medical oxygen ecosystem including the need for adequate and skilled human resources along the oxygen delivery continuum.

Limitations of the commitments/resources mapping

- There is no geographical distribution of commitments against the 10 districts in the country.
- Priorities reported were too broad where most of the partners reported very broad resource commitments making it difficult to accurately allocate the activities/cost areas, objectives, and cost drivers of strategy and scale-up plan.
- Most partners only provided resources for 2022/3 as they were not able to provide resource commitments for all the five years of the strategy hence implementation period of 2022/3 is considered as having near complete data on partner resources.
- Although commitments have been validated during various stakeholder meetings, periodic update and validation of the presented data may be needed as part of implementation monitoring of the strategy and scale-up plan.
- Partner commitments have not been presented in monetary form, hence difficult to what proportion of need has been covered by partner commitments.

7.3 BRIDGING THE ESTIMATED RESOURCES GAP

In bridging the estimated LSL 118 million funding gap, this national medical oxygen strategy and scale-up plan prioritises linkages with the National Health Sector Strategic plan and related financing strategies at different levels of the health system. However, this is the first national oxygen strategy and expands funding needs for the health sector. The following strategies and priorities will provide options for ensuring resources are mobilized and allocated to implementation of this strategy and scale-up plan:

1. Prioritizing domestic resources for the national medical oxygen ecosystem in the national health sector through evidence-based needs and priorities at sectoral level and in program specific budgets. Oxygen needs (quantification), financing and expenditure information will be tracked through the defined implementation and oversight structures and processes, and the overall national oxygen data (need, consumption, and operations) will be used to inform resources allocation by the government.
2. Increasing efficiency and effectiveness from the existing resources by strengthening mechanisms of governance and accountability, aligning partners to the "best buys" presented in this strategy and scale-up plan and ensuring rationalization and additionality. More efficiency gains are expected from long-term implementation and operations support arrangements as proposed in this strategy and scale-up plan; including opting for a mixed sources oxygen ecosystem, negotiated and affordable sourcing/supply of liquid oxygen, and strategic location of large-scale cylinder filling stations for lowest unit of delivered oxygen to all hospitals.
3. Increase amount and predictability of external resources for implementation of the national strategy and scale-up plan. This will require health partners to remain a major financing source for medical oxygen in Lesotho. Building onto the practice of resources and commitments mapping under the national medical oxygen taskforce arrangement, partners pledges and commitments will continue to be collected and tracked for fulfilment. The implementation oversight mechanisms for this strategy and sale-up plan will provide platforms and opportunities for harmonized and pooled support from supporting partners and this is expected to improve predictability of external financing and increase efficiency.

8 PERFORMANCE MONITORING, EVALUATION, AND MANAGEMENT

The core purpose of this performance monitoring, evaluation, and management section is to outline a monitoring and evaluation strategy for the country in line with Lesotho National Medical Oxygen Strategy and Scale-up Plan – 2022/3 – 2027/8. Measuring performance against set targets in the strategy and scale-up plan will guide investment and operational planning. In the context of this strategy and scale-up plan, performance monitoring is the collection, tracking and analysis of data to determine what is happening, where, and to whom. A set of core monitoring indicators and targets linked to the strategic goal and objectives will provide timely and accurate information for progress and performance reviews and decision-making processes and ensure effective strategic implementation. Performance evaluation will build upon routine monitoring data and undertake deeper analysis by relating results with expected outcomes and impact within the implementation context changes.

Effective implementation and performance monitoring of this strategy and scale-up plan will require an all-encompassing policy and institutional environment, including multi-stakeholder coordination mechanisms which should position oxygen ecosystem and its performance as an integral component of the national health service delivery strategy. This is in addition to the need for appropriate well-functioning data sources including routine facility information systems, facility surveys, administrative data sources such as, logistical information systems, disease and public health and surveillance among others. Ensuring a strong institutional capacity for data collection, management, analysis, use and dissemination at all levels will be critical for successful performance monitoring, evaluation, and management.

Figure 9: High-level logic framework for the national the strategy and scale-up plan.

Strategic Goal : Reduce morbidity and mortality from hypoxemia by improving equitable access to, and safe utilization of, med ical oxygen at all levels by 2028				
Outcome 1: National strategic framework for scaling-up medical oxygen supply and safe utilization established	**Outcome 2**: National production, distribution and delivery capacity enhanced	**Outcome 3:** Capacity to management safely use oxygen enhanced	**Outcome 4:** Financing of the national oxygen ecosystem improved and sustained	**Impact and Outcomes**
Verifiable intermediate results 1. Functional national medical oxygen taskforce 2. Annual oxygen operation plans developed 3. National Oxygen Ecosystem implementation structure defined at all levels 4. Tools and guidelines for equipment procurement, distribution maintenance developed 5. Key competencies for Oxygen and Oxygen therapy management defined	**Verifiable intermediate results** 1. Long-term affordable LOX supply agreement signed between GoL and Supplier 2. Large-scale regional HPG oxygen cylinder filling statins established 3. National medical oxygen supply and distribution plan and guidelines developed and implemented 4. Annual oxygen equipment and supplies quantification (procurement planning and execution) 5. Regional workshop for repair and maintenance of movable medical devices established 6. Capacity of technicians to maintain and operate oxygen equipment and installations developed 7. National standard medical equipment list developed 8. All hospital level facilities piped, and manifold systems installed 9. Cylinder storage facilities established in all hospital	**Verifiable intermediate results** 1. National hypoxemia management guidelines and protocols developed and applied 2. HCWs at all levels of care trained in Hypoxemia management 3. Regional skills-hubs for provider training established (critical care) 4. Protocols and tools for safe oxygen management developed and disseminated 5. Indicators for monitoring he national oxygen ecosystem defined and integrated 6. National communication strategy on oxygen therapy and hypoxemia developed and implemented	**Verifiable intermediate results** 1. Oxygen Ecosystem priorities integrated in disease programs and other cross-cutting intervention/operations 2. Hypoxemia management integrated in all clinical disease condition (care for the critically ill) 3. National costed Estates and facilities management strategy developed and implemented 4. Funding for the oxygen ecosystem allocated	**Inputs and Outputs**

Outcome and impact performance monitoring, evaluation, and management of the strategy and scale-up plan will mainly rely on data from the existing HMIS/DHIS2 (to be updated with core oxygen ecosystem monitoring indicators), support supervision and other ecosystem operational data systems. However, there will be need to strengthen the process monitoring, data analysis and review capacity for oxygen systems, to generate M&E products relating to the oxygen

production to delivery continuum including procurements, operations like oxygen distribution, related financial expenditures, source of funds, geographic coverage of oxygen systems and output level results aligned to the set strategy targets at different levels of implementation.

Key performance indicators are hinged on strategic and scale-up priorities and will be used to assess performance progress towards achievement of the intermediate results. Indicators will be monitored at different levels of strategy implementation including at national, regional, district and health facility level.

Table 9: Summary logframe for the national medical oxygen strategy and scale-up plan

Level of measurement	Objectively verifiable indicators	Monitoring and verification		
		Data sources	Timing of data collection	Responsible
Impact: Morbidity and mortality from hypoxemia reduced	• Proportion of deaths due to hypoxemia reduced by 60% by 2028. • Rate of hypoxemia screening in health facilities increased by 85% by 2028.	HMIS/DHIS2 and health facility records	Annually	MoH M&E unit and Clinical Services Directorate
Outcome 1: National strategic framework for scaling-up medical oxygen supply and safe utilization established	• Functional national medical oxygen stakeholders' engagement platform by 2022 • National guidelines for medical oxygen ecosystem developed by 2023.	Meeting reports Review of policy documents	Annually	MoH – Clinical Services Directorate, Health Policy, and Planning unit
Outcome 2: National production, distribution, and delivery capacity enhanced	• Oxygen production/storage infrastructure capacity/ by 70% by 2024 • Availability of oxygen at all levels of care increased by 80% by 2025. • Price per tonne of LOX delivered to Lesotho reduced by 50% by 2023. • Rate of equipment repair and maintenance from increased 14% to 80% by 2028. • Proportion of piped hospital-level patient beds increased from 12% to 100% by 2024.	National BME inventory Oxygen distribution/delivery data LOX supply agreement Supervision reports Special surveys	Quarterly, annually	MoH (National, District and Health Facility)
Outcome 3: Capacity to management safely use oxygen enhanced	• Knowledge on oxygen therapy and oxygen therapy amongst HCWs increased from 50% to 85% by 2024. • 100% of health facilities have relevant protocols and tools for safe	HMIS/DHIS2 Supervision reports Special surveys	Quarterly, annually	MoH (National, District and Health Facility)

	management and use of O_2 by 2024 • 80% increase in reporting of hypoxemia by health facilities by 2025.			
Outcome 4: Financing of the national oxygen ecosystem improved and sustained	• 50% increase in government budget allocation to medical oxygen by 2025	Annual Sector and programs budgets	Annually	MoH – Directorate of Clinical Services, Health Policy and Planning, DHMTs and Hospitals

8.1 PERFORMANCE MANAGEMENT

Establishing national baseline for hypoxemia prevalence and management

There is no baseline reference for medical oxygen use and hypoxemia management in Lesotho. Therefore, a reconnaissance study will be conducted at the beginning of implementation of this strategy and further inform design of implementation and performance monitoring indicators. This will be a country-wide study conducted at all levels of care.

Performance monitoring

Reviews will be used to gather evidence through monitoring and evaluation processes to assess progress and performance.

Quarterly reviews: At the end of each quarter, in keeping with reporting obligations, all partners with a role within the oxygen scale-up space will submit summary performance reports to the Ministry of Health and discuss in National Oxygen Taskforce meetings. Successes and challenges will be presented with the aim of jointly forming strategic interventions on the way forward.

Annual reviews: This will be focused on the indicators and targets specified in annual operational plans. This will mainly include input, process and output performance indicators and where available and possible performance against outcome/scale-up indicators will be reviewed. The annual reviews will be part of the national MoH Joint Health Sector Performance Review (AJR) process and reporting.

Midterm-term review and evaluation: This will be conducted halfway through implementation of this strategy and scale-up plan. The mid-term review will cover all targets of the strategic period including outcome and impact indicators along with other ecosystem operational indicators. The mid-term review and evaluation will coincide with the third-year implementation annual review. Results of the mid-term review and evaluation will inform adjustments in priorities and objectives of scaling-up access to medical oxygen and reducing morbidity and mortality due to hypoxemia.

End-term evaluation: This will involve a comprehensive analysis of progress and performance for the whole strategic period and implementation of the strategy and scale-up plan priorities. The end-term review and evaluation will build on results of the mid-term review and combine with other available medical oxygen scale-ups in the country to inform conclusions and define the future strategic focus.

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10 ANNEXES

Annex 1: Mapping cost-effective primary sources of oxygen supply in health facilities.

Facility Name	District	Facility Level	Geography	Primary Oxygen Source
Berea Hospital	Berea District	District hospital	Lowlands	Cylinder supply
Botshabelo Hospital	Maseru District	Specialized Hospital	Lowlands	Cylinder supply
Butha-Buthe Hospital	Butha-Buthe District	District hospital	Lowlands	Cylinder supply
Machabeng Hospital	Qacha's Nek District	District hospital	Highlands	PSA Plant
Mafeteng Hospital	Mafeteng District	Regional Referral hospital	Lowlands	LOX with cylinder filling
Makonyane Hospital	Maseru District	District hospital	Lowlands	Cylinder supply
Maluti Hospital	Berea District	District hospital	Lowlands	Cylinder supply
Mamohau Hospital	Leribe District	District hospital	Lowlands	Cylinder supply
Maseru Private Hospital	Maseru District	District hospital	Lowlands	Cylinder supply
Mokhotlong Hospital	Mokhotlong District	District hospital	Highlands	PSA Plant
Motebang Hospital	Leribe District	Regional Referral hospital	Lowlands	LOX with cylinder filling
Ntshekhe Hospital	Mohales' Hoek District	District hospital	Lowlands	Cylinder supply
Paray Hospital	Thaba-Tseka District	District hospital	Highlands	PSA Plant
QMMH	Maseru District	National Referral hospital	Lowlands	LOX with direct piping
Queen II hospital	Maseru District	District hospital	Lowlands	Cylinder supply
Quthing Hospital	Quthing District	District hospital	Lowlands	Cylinder supply
Scott Hospital	Maseru District	District hospital	Lowlands	Cylinder supply
Seboche Hospital	Butha-Buthe District	District hospital	Lowlands	Cylinder supply
St James Hospital	Thaba-Tseka District	District hospital	Highlands	PSA Plant
St Joseph Hospital	Maseru District	District hospital	Lowlands	Cylinder supply
Tebellong Hospital	Qacha's Nek District	District hospital	Highlands	PSA Plant

Annex 2: Detailed/additional costing assumptions

Item	Costing assumption
Workshops	30 Participants, receiving Meals and transport Reimbursement. Design workshop (5 days), Validation workshop (3 days) and Dissemination workshop (1 day)
Generator	200 KW unit at LsL 155,000
PSA Plants	Unit price @ based on global fund data.
Oxygen Cylinders	50L Cylinders quantified at LsL3,795 ($253). 3376 units quantified
Piping costs	Piping is costed at LsL27,000 ($1,800) per bed. 1884 beds quantified
Clinical trainings	Cost for reaching health workers through on job training and mentorship
Service and maintenance	Costed at 5% of CAPEX cost per year
Operational cost	Costed at 5% of CAPEX cost per year and to grow at 2% per year

Technical Assistance	LsL 30,000 per month for 1 consultant
Coordination	Includes costs of advocacy meetings, negotiation meetings, technical working group meetings, workshops, review meetings and supervision
Cylinder distribution	Assumes a truck carrying 100 cylinders per trip, making 2 trips a week, 5 trucks available. Fuel cost at 3000 per trip

Annex 3: Projected Health Partners' commitments to priorities of the national oxygen ecosystem (LSL)

Strategic objective/priorities	Phasing				
	2023/4	2024/5	2025/6	2026/7	2027/8
Strategic objective 1: Establish national strategic framework for scaling-up medical oxygen supply and safe utilization	-	386,824	148,224	148,224	148,224
Strategic objective 2: Ensure a resilient national medical oxygen production, distribution, and delivery capacity	711,592	90,189,995	12,818,630	12,818,630	12,818,630
Strategic objective 3: Enhance capacity to manage and safely utilize oxygen in health facilities	-	2,689,720	1,291,800	1,431,800	1,291,800
Strategic objective 4: Define policy and strategic basis for financing medical oxygen priorities	-	1,204,200	-	-	-
Monitoring and evaluation activities	-	549,000	549,000	658,800	549,000

Annex 4: List of individuals/stakeholders that engaged at different levels and stages of the strategy development process.

Name	Organization/affiliation
1. Lucy Mapota-Masoabi	MoH – Clinical Services Directorate
2. Lieketseng Petlane	MoH – Director Dental Health
3. Mosilo Mosehle	MoH – Estates Department Directorate
4. Palesa Mashoai	MoH – Director Planning and Statistics
5. Liketso Mochochoko	MoH, Berea DHMT
6. Mpoetsi Makau	MoH – Director Nursing Services
7. Motsoko Leokaoke	MoH Estates Department
8. Mamorena Ramabolu	MoH, Berea District Hospital
9. Mosa Tlahali	MoH, Mokhotlong DHMT
10. Ramatseka J. T	MoH
11. Matshidi Seisa	MoH, Mafeteng District/Regional Referral Hospital
12. Henri Mahandimby	MoH, Ntshekhe Hospital, Mohale's Hoek District
13. James Fan	MoH
14. Kabelo Matjeane	MoH, Mokhotlong District Hospital

15. Thato Motjope	MoH, Motebang District/Regional Referral Hospital, Leribe
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19. Raul Gonzalez	WHO AFRO
20. Afom Andom	PIH Lesotho
21. Justine Miremebe	USAID Lesotho
22. Vincent Kabeya	CHAL, Maluti Hospital, Berea District
23. Mpho Khoabane	Right to Care Lesotho
24. Eric McCollum	JHPIEGO
25. Danielle Sham	PIH Lesotho
26. Mabala Letseka	Right to Care Lesotho
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30. Seutloali Morebotsane	JHPIEGO Lesotho
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37. Adam Limbumba	CHAI Lesotho
38. Mope Khati	CHAI Lesotho
39. Nyika Mahachi	JHPEGO Lesotho
40. Patrick Aliganyira	CHAI Lesotho
41. Mathabo Kepa	CHAI Lesotho
42. Hatane Hatane	CHAL, Paray Mission Hospital, Thaba-Tseka District
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4. Makoae Mosothoane	Right to Care Lesotho

Annex 5: Detailed implementation activity plan

Strategic Goal: Reduce morbidity and mortality from hypoxemia by improving equitable access to, and safe utilization of, medical oxygen at all levels by 2028			2023/4	2024/5	2025/6	2026/7	2027/8
Strategic Objectives	**Strategies/Priorities**	**Activities**					
Strategic Objective 1: Establish national strategic framework for scaling-up medical oxygen supply and safe utilization	**Priority 1: Ensure accountable medical oxygen ecosystem operations and management**	1.1: Conduct quarterly National Oxygen Taskforce engagement meetings	X	X	X	X	X
		1.2: Develop annual medical oxygen costed operational plans	X	X	X	X	X
		1.4: Establish Regional Medical Oxygen oversight committees (south, north, and central plus highland areas).	X	X			
		1.4: Establish a national medical oxygen desk at the MoH Headquiarters		X	X		
Strategic Objective 2: Ensure a resilient national medical oxygen production, distribution, and delivery capacity	**Priority 1: Ensure affordable and sustainable liquid oxygen supply**	2.1.1: Negotiate with mLOX supplier/manufacturers for reduced/affordable mLOX pricing/tonne delivered to all Lesotho mLOX facilities		X			
		2.1.2: Establish a long-term mLOX purchasing/agreement for the country		X	X		
		2..1.3: Procure and install a new VIE tank at QMMH		X			
	Priority 2: Optimize the national oxygen supply and logistics systems at all levels	2.2.1: Establish two regional mLOX-based bulk oxygen sources [at Mafeteng and Motebang Regional Referral Hospitals]		X	X		
		2.2.2: Install additional 2 PSA Plants to serve as filling stations for highland areas/districts of Mokhotlong, Thaba Tseka and Qacha's Nek			X		
		2.2.3: Procure and distribute back-up concentrator machines to all health facilities		X	X		
	Priority 3: Operationalize centralized bulk cylinder filling stations and cylinder distribution networks	2.3.1: Develop the national medical oxygen supply chain management guidelines		X			
		2.3.2: Develop and disseminate Tools and Standard Operating Procedures for oxygen supply chain management		X	X		
		2.3.3: Conduct training of health facilities on the national oxygen supply chain operations [tools and processes]		X	X		
		2.3.4: Adapt and roll-out a digital oxygen supply chain management system [dashboard]		X	X		

		2.3.5: Recruit relevant staff for operating bulk filling stations and SCM activities at filling stations			X	X	
		2.3.6: Procure and deploy bulk cylinder distribution trucks for all geographies			X		
		2.3.7: Establish bulk oxygen cylinder storage facilities at each hospital-level facilities.	X	X			
	Priority 4: Ensure availability of oxygen Equipment and critical supplies	2.4.1: Conduct a national oxygen biomedical equipment and oxygen supplies quantification and forecasting		X	X	X	X
		2.4.2: Establish a national BME inventory and assets management system		X	X		
		2.4.3: Recruit and deploy technicians for oxygen and other systems/infrastructure maintenance in all hospitals		X	X	X	X
		2.4.4: Conduct training of maintenance officers in all health facilities on routine oxygen BME maintenance [concentrators, PSA plants, Manifolds, and other accessories]		X	X		
		2.4.5: Establish two (2) workshops for maintenance of movable BME at Motebang and Mafeteng Regional Referral Hospitals			X	X	X
		2.4.6: Develop a national standard medical equipment list [incl. spare parts]			X		
		3.4.7: Establish an up-to-date compendium of BME and other medical oxygen accessories		X			
		2.4.8: Establish long-term/strategic purchasing/supply agreements with BME and spare parts suppliers within the region			X		
		2.4.9: Procure and distribute oxygen biomedical equipment and supplies to fill gaps identified in all districts	X	X	X	X	X
		2.4.10: Procure and distribute pulse oximeters to all levels of care including community-level		X	X		X
	Priority 5: Strengthening Health facility distribution and delivery infrastructure readiness for oxygen systems	2.5.1: Establish technical specifications and guidance for health facility-level oxygen infrastructure systems in the country		X	X		
		2.52: Install medical gas piping and automated manifold systems [MGPS] in all hospital-level facilities	X	X	X		
		2.5.3: Develop/adapt and disseminate guidelines and SoPs for MGPS routine maintenance		X	X		

		2.5.4: Procure and commission generators as alternative power sources for all health facilities reliant on onsite PSA plats as primary oxygen source		X	X		
		2.5.5: Procure and distribute appropriate HPG medical oxygen cylinders [different capacities] for all health facilities	X	X	X		
Strategic Obj. 3: Enhance capacity to manage and safely utilize oxygen at all levels of care	**Priority 3.1: Build capacity for pulse oximetry and oxygen therapy – hypoxemia management**	3.1.1: Adapt and harmonize the national hypoxemia management training curricular for both in and pre-service healthcare workers	X	X	X		
		3.1.2: Conduct tailored training on hypoxemia management for all healthcare workers [all levels]	X	X	X	X	X
		3.1.3: Adapt and disseminate SoPs and protocols for the continuum of hypoxemia management in health facilities including triaging and referral.		X	X		
		3.1.4: Conduct training on routine equipment [various] maintenance and repair for all technicians in health facilities		X	X	X	
		3.1.5: Establish regional skills-based [practicum sites] hypoxemia management training centres for healthcare workers.			X	X	
		3.1.6: Conduct targeted onsite healthcare workers mentorship and support on hypoxemia management	X	X	X	X	X
		3.1.7: Develop/Adapt national guidelines and protocols for community-level hypoxemia identification and management [referral]			X	X	
	Priority 3.2: Ensure availability of tools for safe oxygen use and hypoxemia management	3.1.8: Develop/adapt and disseminate protocols and SoPs for safe management of oxygen in health facilities		X	X	X	
	Priority 3.3: Strengthen data and performance management for oxygen delivery systems	3.3.1: Integrate hypoxemia management and outcome indicators in the national HMIS			X	X	
		3.3.2: Establish a national medical oxygen dashboard for monitoring oxygen delivery systems and performance [operations and clinical]			X	X	
	Priority 3.4: Increase care seeking for hypoxemia and acceptance of oxygen therapy	3.4.1: Conduct formative research on community knowledge and perceptions and acceptance of pulse oximetry and oxygen therapy		X			
		3.4.2: Design and implement an awareness creation campaign to increase demand and acceptance of pulse oximetry and oxygen therapy		X	X		

		3.4.3: Develop and disseminate provide and patient education materials on pulse oximetry and oxygen therapy		X	X		
		3.4.4: Integrate hypoxemia messaging in health education materials for health facilities and VHWs		X	X	X	
Strategic Obj. 4: Define policy and strategic basis for resources mobilization and financing medical oxygen priorities	**Priority 4.1: Ensure integration of oxygen interventions with other programs**	4.1.1: Review and integrate medical oxygen priorities in cross-cutting and disease specific strategic and operational plans	X	X	X	X	X
		4.1.2: Review and integrate medical oxygen in national healthcare service delivery guidelines and standards			X		
		4.1.3: Review and integrate hypoxemia management in heath facility support and management process			X	X	
	Priority 4.2: Facilitate resources mobilization, allocation, and rationalization	4.2.1: Develop a costed national health estates and facilities management strategy and plan		X	X		
		4.2.2: Develop and disseminate guidance on hospital-level oxygen quantification and forecasting/planning		X	X	X	
		4.2.3: Establish a budget vote for medical oxygen systems [capital and recurrent] within the sector's budget				X	X
		4.2.3: Maintain and disseminate an up-to-date mapping of resources and partners committed towards the national oxygen strategic priorities					
Monitoring and evaluation activities		National Hypoxemia baseline study	X				
		Quarterly monitoring and performance reviews	X	X	X	X	X
		Annual monitoring and performance reviews	X	X	X	X	X
		Mid-term performance monitoring and evaluation			X		
		End-term performance monitoring and evaluation					X

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