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MINISTRY OF HEALTH, ETHIOPIA

ETHIOPIAN MEDICAL OXYGEN ROADMAP II

2022-2027

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Write up team	
Dr. Elubabor Buno	Medical Services Lead Executive Office, Chief Executive Officer (CEO)
Abas Hassen Yesuf (Ph.D.)	Health System Innovation and Quality Chief Executive Officer (CEO)
Mr. Mehadi Abdella	Deputy Director, Pharmaceutical and medical equipment Lead Executive Office, Lead
Dr. Amanuel Lulu	MoH, Medical Service Lead Executive Office, Hospital and diagnostic desk, officer
Mr. Alemayehu Berhanu	Technical Advisor, Medical Service Lead Executive Office, MoH
Dr. Ashenafi Beza	Technical Advisor, Medical Service Lead Executive Office, MoH
Mr. Biniam Kemal	MoH, Medical Service Lead Executive Office, Hospital and diagnostic desk, Lead
Mr. Benti Firomsa	CHAI
Mr. Dinkineh Bikila	Program Manager, CHAI
Dr Daniel Gebremichael	Senior Technical Advisor, PMU, Minister's Office
Dr. Simret Amha	MoH, Medical Service Lead Executive Office, specialty and rehabilitation desk, officer
Dr. Yared Tadesse	Technical Advisor, MNCH
Mr. Esayas Messele	Technical Advisor, Health System Innovation and Quality Lead Executive Office
Mr. Fitalew Dagnew	Technical Advisor, Health System Innovation and Quality Lead Executive Office
Mebratu Masebo (Ph.D.)	Senior Advisor to the Minister
Mr. Samuel Tadesse	JHPIEGO
Mr. Yakob Seman	Former Director, Medical Services General Directorate, DG
Mr. Mulugeta Mideksa	Former Senior Technical Advisor, Pharmaceutical and medical equipment Lead Executive Office

Write up team	
Mr. Tiliksew Bekele	CHAI
Mr. Demeru Yeshitila	JHPIEGO
Mr. Tesfaye Godana Amare	JHPIEGO

Acronyms

ASU	Air Separation Unit
CAPEX	Capital Expenditure
CBHI	Community-Based Health Insurance
COVID-19	Coronavirus Disease
DHIS2	District Health Information System 2
EFDA	Ethiopian Food and Drug Authority
EIC	Ethiopian Investment Commission
EPSS	Ethiopian Pharmaceutical Supply Service
Fio2	Fraction of inspired oxygen
FMoH	Federal Ministry of Health
GGHE	General Governmental Health Expenditure
HCF	Health Care Finance
HF	Health Facility
HMIS	Health Management Information System
ICU	Intensive Care Unit
IES	Institute of Ethiopian Standard
ISO	International Standard Organization
JV	Joint Venture
KPIs	Key Performance Indicators
LMIS	Logistic Management Information System
LoX	Liquid oxygen
LPM	Liter per minute
MDT	Multidisciplinary Team
MEMIS	Medical Equipment Management Information System
MOD	Medical Oxygen Device
MOMSSC	Medical Oxygen Multi Sectoral Steering Committee
Nm3/hr.	Normal Meter cubic Per hour
OPEX	Operational Expenditure
PPP	Public Private Partnership
PSA	Pressure Swing Adsorption
RDF	Revolving Drug Fund
RHB	Regional Health Bureau
SC	Steering Committee
SOPs	Standard Operating Procedures
TWG	Technical Working Group

Foreword

Medical oxygen is a lifesaving medicine used to treat various health conditions that, if left untreated, result in severe complications and death. In Ethiopia, nearly half of the deaths caused by the top 10 diseases are associated with hypoxemia. In children under five years of age, hypoxemia is a major complication of pneumonia, birth asphyxia, respiratory distress, and neonatal aspiration syndromes, accounting for 35% of the admissions. Hence, ensuring equitable access to medical oxygen is an effective intervention against mortality and morbidities from the spectrum of diseases and conditions.

In the past 5 years, Ethiopia has made great strides in increasing access to medical oxygen by increasing the manufacturing capacity by installing oxygen plants and procuring oxygen cylinders and hypoxemia diagnostic devices. This has been achieved through coordinating efforts of different stakeholders, including partners, donors, and the private sector. There have also been efforts to improve the clinical use of oxygen and the functionality of oxygen-related devices through building capacities of HCWs.

Despite several improvements in terms of production capacities and availability of oxygen devices, there are still unmet needs for oxygen therapy services that are more prominent at the primary healthcare level.

The Ministry of Health seeks a comprehensive approach to overcome the prevailing bottlenecks and improve access to medical oxygen, diagnostics, and hypoxemia management in health facilities at all levels as the country moves towards achieving targets set by HSTP II. This Roadmap recognizes these issues and considers newly developed strategic documents of the health sector. This will be accomplished by utilizing various programs for which medical oxygen is a crucial therapeutic component. The road map will lay a foundation for successfully implementing several strategies.

To that end, the road map has highlighted seven areas of action that will significantly increase the availability of oxygen and improve proper management of hypoxemia: 1. Improving policy and coordination 2. Improve equitable access to medical oxygen and diagnostics 3. Improve quality care and rational use of oxygen 4. Improve oxygen commodities management 5. Strength the regulatory capacities 6. Research and innovation 7. Sustainable financing mechanisms.

We believe this Roadmap will build on existing oxygen work to optimize the available resources in the public and private sectors and guide future investments from Government, partners, and private-sector actors.

To attain the objectives outlined in the road map, both public and private sector partners must collaborate to advocate the road map's implementation in a coordinated manner at the national and sub-national levels. I highly encourage all stakeholders to mobilize the necessary resources to improve access to medical oxygen significantly.

Dr. Dereje Duguma (MD, MIH)

State Minister
Program and Service Wing

Executive summary

In 2022, Ethiopia's population is estimated to be 121 million, making it Africa's second most populous country. Ethiopia's healthcare system has three tiers of care: primary, secondary, and tertiary. Depending on the tier level, promotive, preventive, curative, and rehabilitative services are being delivered despite suboptimal healthcare quality.

The country's health system has been tested for the past three years by the COVID-19 pandemic and other health emergencies. Despite its challenges and limited resources, the health system has shown that it overcame various challenges and addressed the country's health problems. Additionally, selected key indicators have also shown that remarkable gains have been registered during the implementation period of HSTP I.

The Ministry of Health (MOH) identified a severe shortage in access to medical oxygen before the COVID-19 pandemic and prepared the first National Medical Oxygen and Pulse Oximetry Scaleup Roadmap in 2016. The Roadmap focused on six major areas, namely (1) setting policy, (2) supply chain system and logistics, (3) sustainable supplies for diagnostics and consumables, (4) maintenance of oxygen equipment and supply of spare parts, (5) capacity building for healthcare workers (HCW) and (6) ensuring sustainable financing to support oxygen supply system. Since the launch of the Roadmap, significant improvements have been made to the country's medical oxygen ecosystem. The nation's oxygen production has increased tenfold in the last five to six years (from 330 M3/Hr. to 2904 M3/Hr.). An end-term evaluation was conducted in 2021 and found that several issues remain unresolved, pointing to the need for a new roadmap that can guide the medical oxygen ecosystem of the country into the future.

The MOH prepared a second roadmap to guide Ethiopia's efforts to optimize the medical oxygen ecosystem. The development process was led and chaired by the director of the Clinical Service Directorate and through the engagement of all mapped stakeholders working on the medical oxygen ecosystem of the country. An end-term evaluation was done to determine the former Roadmap's implementation status and to understand the current national medical oxygen ecosystem. The roadmap development process involved situation analysis, local and international benchmarking, projections and modelling, and consultative workshops. The costing exercise was done using the UNICEF oxygen quantification tool, and the MoH developed an additional tool to quantify missed oxygen-related medical devices, spare parts, and consumables related to medical oxygen.

It is therefore important to prepare this second Roadmap to address identified gaps, scale up the best practices from the previous roadmap implementation, and contribute to building a resilient health system. The Roadmap's overall purpose is to guide the nation's medical oxygen ecosystem and reduce preventable deaths and disabilities by ensuring sustainable access and quality to this essential drug at all levels of the health system, including but not limited to improved standardization and regulatory systems. Additionally, it will aid the MOH in attaining the HSTP

II goals and leveraging in-kind and cash investments in medical oxygen established by COVID-19 for long-term gains.
The Roadmap has identified seven strategic interventions that include

SI 1: Strengthen leadership and coordination of the medical oxygen system: By integrating medical oxygen into new and existing standards, guidelines, and policies, as well as by establishing and/or strengthening the structures of medical oxygen at MOH, RHBs, and health facilities, this focuses on enhancing coordination and leadership of medical oxygen in the health system. Moreover, establishing and implementing KPIs improves the monitoring, assessment, and feedback system.

SI 2: Improve Equitable Access to Medical Oxygen and Devices: Through capacity optimization of existing oxygen plants, the introduction of support systems for the private sector to produce medical grade oxygen, the placement of new oxygen plants that address regional equity, and sustainable access to oxygen-related consumables, this focuses on ensuring that medical grade oxygen is available around-the-clock in healthcare facilities. It aims to increase the effectiveness of the logistics operations of the refilling system for those without oxygen plants and the medical oxygen supply chain system in healthcare institutions. The other goal of this objective is to put in place a reliable oxygen quantification system at the national, subnational, and health institution levels.

SI 3: Improve the quality of medical oxygen service: This objective aims to strengthen the rational use of medical oxygen and appropriate management of medical devices related to oxygen through capacity building of health care professionals and to make medical oxygen one of the priorities for quality improvement projects. Moreover, to strengthen the quality of medical oxygen access and use at the facilities to enhance the safety, effectiveness, and efficiency of medical oxygen to increase the likelihood of desired health outcomes.

SI 4: Strengthen medical oxygen commodities management: This objective is about ensuring that medical oxygen products are acquisition, commissioned, utilized, and decommissioned correctly. This includes but is not limited to an oxygen plant, a medical gas pipeline system, oxygen therapy, a diagnostic and monitoring device, and spare parts and supplies (consumables).

SI 5: Strengthen the Medical Oxygen Regulation System: This objective is to strengthen Ethiopia's regulatory framework for the complete oxygen ecosystem and oxygen services in all healthcare settings, including home care. Additionally, it aims to strengthen the regulatory body's capacities and integrate oxygen regulation into the current regulatory framework. Furthermore, it aspires to create an environment where innovations can progress to local production.

SI 6: Enhance Research and innovation in the medical oxygen system: This objective focuses on building research and innovation hubs nationwide while identifying critical research priority areas of medical oxygen. It also intends to mobilize resources or combine medical oxygen with current grand challenges initiatives to promote local manufacture of oxygen-related goods.

Additionally, to use the research findings to improve policies and make decisions supported by evidence.

SI 7: Ensure a sustainable financing mechanism for medical oxygen system: This objective is to make sure the long-term availability of medical oxygen through sustainable sources of financing by improving the capacities of both individuals and organizations, establishing business plans for long-term financing, and devising cost recovery strategies for a sustainable oxygen supply.

The Ministry of Health and UNICEF OSPT tools were used to estimate costs for the roadmap. The roadmap will cost $213,793,714.49 to implement in its entire length. The roadmap will be cascaded to all levels of the health system. The indicators and goals established for the roadmap will be regularly used to track its implementation.

Introduction

Background

The Ministry of Health has successfully ended the first phase of the health sector Transformation Plan and is currently implementing the second phase (HSTP II), and the findings of the prior strategic plan implementation showed that Ethiopia is moving toward achieving the goals of the SDG. (2) Ethiopia's healthcare system has three primary, secondary, and tertiary tiers of care. Currently, there are 367 functional Hospitals, 3777 health centers, and 17,699 health posts in Ethiopia. (5).

Pneumonia accounts for around 15% of all deaths of children younger than 5 years globally. Most happen in resource-constrained settings and are potentially preventable. (1) In the same study, among all children with WHO-classified pneumonia, the Prevalence of hypoxia was 41% among those with very severe or severe pneumonia and 8% among those with non-severe pneumonia.

In 2022, Ethiopia's population is expected to reach 121 million, making it Africa's second most populous country. (2)(3) Hence, better access to oxygen in Ethiopia could help save the lives of more than 60,000 babies who would die in the first month of life, 30,000 children who would die from pneumonia each year, and 11,000 women who otherwise would die in pregnancy or childbirth. (4)

Based on recent reports, the top 10 causes of mortality in Ethiopia are pneumonia (6.9%) and birth asphyxia (6.3%), which ranked second and third consecutively; pneumonia is the leading cause of patient morbidity and admission, with 3,780,413 cases (9.6%) and 87,442 cases (9.5%), respectively. (5) And due to the epidemiological shift of diseases, there is a growing number of non-communicable diseases; in 2016, 52% of the total mortality in Ethiopia was due to non-communicable diseases and injuries (NCDs). Hence, it shows that there will be a growing demand for medical oxygen.

In the face of the global health community, supplemental medical oxygen did not receive the same attention and consideration as other medications before the COVID-19 pandemic, which is assumed to be a readily available commodity. (6) Cognizant of the high demand for medical oxygen in the country, the Government of Ethiopia developed and implemented its first National Medical Oxygen and Pulse Oximetry Scaleup Road Map in 2016, which spanned from 2016 to

2020/21. The road map has also provided a guiding document in availing medical oxygen and scaling up pulse oximetry use across the country during and before the COVID-19 pandemic. Following the end of the implementation period, an end-term assessment was carried out to identify key achievements, challenges encountered, and lessons learned, including identifying potential areas where further improvements are required.

The evaluation also noted that major stakeholders' engagements at national and regional levels were significant in developing, coordinating, and implementing the first National Medical Oxygen and Pulse Oximetry Scaleup Road Map. In contrast, the expected similar efforts at the facility level were suboptimal. At health centers, oxygen service provision increased by 23% from 8%, whereas in hospitals, it increased to 100% from 98% compared to the baseline study in 2016. While there has been noticeable improvement among HCs, less than a quarter of HCs provide oxygen services. Many health facilities (both Hosp & HC) were found to lack a reasonable amount of skill-oriented capacity-building support on the clinical use of medical oxygen, especially since there is a critical skill gap among healthcare workers in HCs and the number of oxygen plants has increased from the baseline 4 to 38. The majority (> 70%) of oxygen production comes from privately owned oxygen plants. (7)

To close the country's existing critical gaps concerning the overall aspects of medical oxygen access and their rational use across the country, developing the second National Medical Oxygen and Pulse Oximetry Strategic Road Map was found to be not only important but it requires new and additional interventions to effectively meet the needs in the next five years to come. Moreover, preparing this Roadmap will directly or indirectly affect the realization of other strategies and roadmaps prepared by the MoH and propel the realization of targets set in HSTP II.

Based on the mentioned challenges, medical oxygen and other gas systems necessitate proper direction, strategic guidance, and strong coordination for the country's sustainable access and production of medical oxygen. This will also assist the Ministry of Health leverage COVID-19 in kind and in-cash investments in medical oxygen and critical care for long-term progress.

Rationale

In 2016 the Ministry of Health prepared the first National Medical Oxygen and Pulse Oximetry scaleup roadmap (2016-2021). During the implementation period, many efforts have been exerted to scale up the national medical oxygen production capacity and access to and use pulse oximetry. Consequently, various significant gains have been realized to improve the medical oxygen ecosystem of the country. However, there are unaddressed challenges, as evidenced in the end-term evaluation assessment reports.

Additionally, the country's already fragile oxygen production and supply system could not meet the growing demands during the second wave of the COVID-19 pandemic, which imposed a great deal of strain on health facilities. Hence, future pandemics will pose inevitable threats requiring appropriate attention and consideration. As part of the Roadmap, a robust tracking and evaluation system will be established to track achievements and identify challenges; and a strong regulatory, Research and local innovation framework will be created to support medical oxygen service and oxygen devices.

Therefore, preparing this second Roadmap will address identified gaps, further scale up best practices from the previous roadmap implementation, and contribute to building a resilient health system.

Development Process

The development process of the national medical oxygen roadmap followed a series of recommended steps. These steps included a baseline assessment, coordination, demand forecasting, desk reviews, objective and intervention setting, consultations, and launching. The baseline assessment involved evaluating the current state of medical oxygen availability and usage in the country, serving as both a national end-line evaluation of the previous roadmap and a systematic review of other relevant documents.

It aimed to assess progress, achievements, and challenges while gathering comprehensive information from reports, studies, and research papers. Coordination was achieved through the establishment of a national Technical Working Group (TWG) with approved Terms of Reference (TOR), bringing together stakeholders for collaboration and decision-making. Demand forecasting analyzes factors like population growth and healthcare demands to estimate future oxygen needs. Extensive desk reviews ensured a thorough understanding of global, continental, and national contexts, incorporating relevant information and best practices.

The technical team set specific objectives and interventions based on data from assessments and reviews, defining desired outcomes and action strategies. Multiple consultative meetings with stakeholders allowed for input and expertise sharing and the resulting inputs were incorporated into the roadmap. Finally, the document was officially launched, marking the formal introduction and implementation of the roadmap's objectives and interventions.

Scope

This document is expected to set priorities and guide the medical oxygen ecosystem until 2027 and beyond. This Roadmap is a multi-sectoral, country-wide document that must be consulted in programming for medical oxygen and related systems and establishing the required enabling environment.

Guiding principles

The key guiding principles of the Roadmap are:

Equity: To the greatest extent possible, all differences that result in reduced opportunities for access to medical oxygen, whether rooted socially, economically, demographically or geographically, should be addressed.

Quality: Medical oxygen programs, interventions, and plans must be safe, effective, equitable, people-centred, efficient, and timely.

Evidence-based: The explicit and prudent use of the best available evidence to inform interventions, directions, and approaches to the medical oxygen system.

Innovation: The creation or adoption of new systems and product development should focus on responding to challenges in improving the medical oxygen system.

Partnership: The coordination for enhancing the medical oxygen system that promotes multi-sectoral collaboration and private-sector engagement, the arrangements of which should be backed up by relevant structures, resources, and monitoring frameworks.

Situational Analysis

The situational analysis was organized thematically, analyzing the seven aspects of the medical oxygen ecosystem that were decisive for enhancing the nation's sustainable supplemental medical oxygen availability. Several literature and assessment reports have additionally been explored to explain global and national knowledge related to medical oxygen. This information was then utilized to identify and frame the key areas that the MoH will implement over the next five years of the Roadmap. The (1) burden of hypoxemia, (2) capacity to deliver health services, (3) policy, leadership, and coordination, (4) access to medical oxygen, (5) standards and regulation of medical oxygen-related devices, (6) management of oxygen devices, and (7) finance and investment are the thematic areas of the situational analysis. Each theme area has been discussed below.

The burden of disease related to hypoxemia

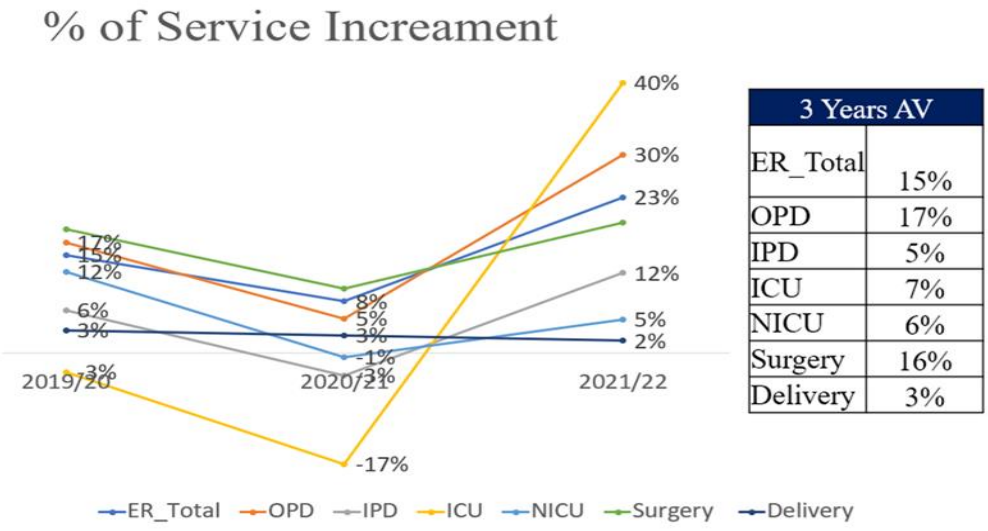
Pneumonia (58,959, 21.9%), newborn respiratory distress (7,002, 2.6%), birth asphyxia (8,998, 3.3%), and neonatal aspiration syndromes (4,213, 1.6%) accounted for around 30% of the top 10 causes of admission for children younger than 5 years old in 2021–2022. Pneumonia (596, 5.5%), birth asphyxia (1816, 16.6%), neonatal respiratory distress (903, 8.3%), shock (218, 2.0%), and sepsis (500, 4.6%) have each contributed around 40% to the top 10 causes of death in a similar year. Without reliable access to medical oxygen, the mortality and morbidity rates associated with certain illnesses and conditions cannot be reduced.

Similarly, diseases that influence the blood's oxygen concentration and necessitate supplemental medical oxygen were among the top 10 causes of morbidity, hospitalization, and mortality across all age groups. The leading cause of morbidity and admission was pneumonia, accounting for 4,408,722 (10%) and 209,162 (9.8%), respectively. 80% (n=8) of the top 10 causes of death across all age groups involved conditions requiring supplemental medical oxygen, which accounted for 36% (n=18,504) of all fatalities.

Health services delivery capacity

The latest report from MoH's health and health-related performance report has shown that the Outpatient (OPD) attendance per capita, admission rate, and the average length of stay are 1.09, 13.4, and 4.63, respectively.

It is well known that health facilities are heavily dependent on and required to use medical oxygen while providing effective ER, ICU, IPD, and surgical care.



3 Years AV	
ER_Total	15%
OPD	17%
IPD	5%
ICU	7%
NICU	6%
Surgery	16%
Delivery	3%

Figure 1. Service Volume Trend Analysis

As indicated in the above graph, in the last three years, ER service delivery trends have shown a significant incremental rate which is an average of 15% for each year. This might be due to many factors, mainly but not limited to the COVID-19 outbreak and the continued Government's palpable investments in ER service expansion and improvement. Similar factors might have also contributed to the average ICU service volume increment of 7%. The volume of patients also has been consistently increasing in the past four years, indicating the presence of concurrent oxygen demand.

Policy, leadership, and coordination on oxygen

The former national medical oxygen and pulse oximetry scaleup roadmap has been a policy guide for over five (5) years. The MoH and other sectors were utilizing it as a strategic document for improving the medical oxygen ecosystem of the country. This Roadmap created an enabling environment for coordination and response mobilization during preparing and responding to the COVID-19 pandemic.

The technical working group (TWG) has been established to provide technical guidance to MoH

on implementing the road map. However, the group was reactivated and was more active following COVID-19, which improved the coordination and response to the COVID-19 pandemic.

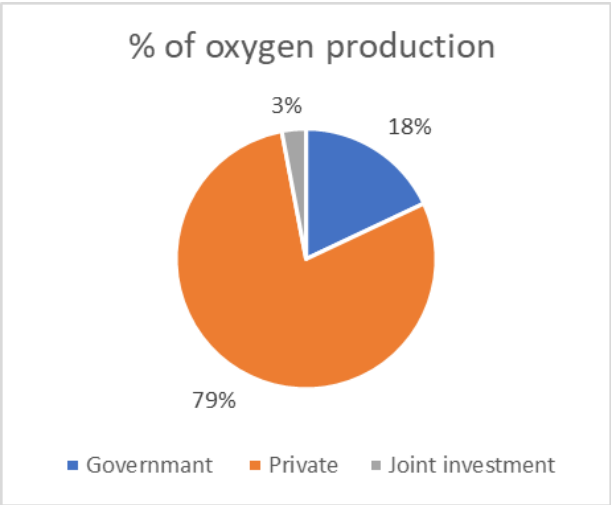
Due to the increasing engagement of policymakers and leadership of the Ministry, there has been a palpable increment in the health sector budget for oxygen. However, commitment and continuous leadership engagement are required to ensure a sustainable financing mechanism.

Although there have been initiatives regulating oxygen production, it has not been guided well. Among the identified reasons, the lack of standards coupled with weak regulatory capacity on the oxygen system makes regulating oxygen production a challenge.

In the past years, Research and innovation on medical oxygen were not given the required emphasis in the country. Hence, evidence generation on oxygen and promoting innovation for local production will be important in the future.

Equitable access to medical oxygen

According to the Roadmap's end-term assessment report by MoH in November 2021, there were 38 oxygen plants, out of which 50% were privately owned, 11 were non-functional, and 4 were not installed and/or commissioned (*see* Annex *2)*. The assessment showed that the country's oxygen production capacity has significantly improved in the last five years from 330 m3/hr. to 2904.5 m3/hr.



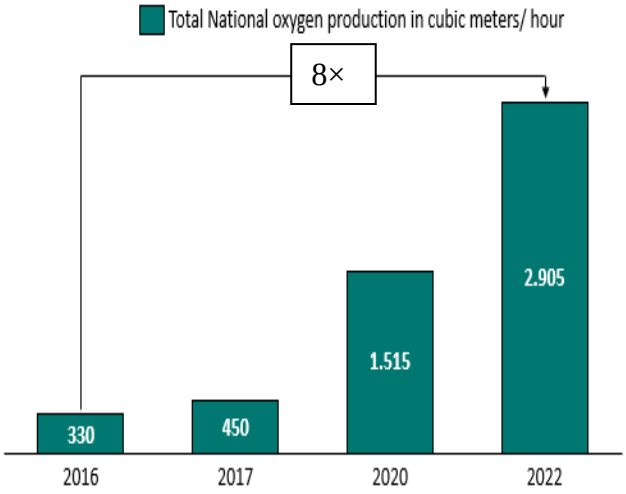


Figure 2. The trend of National Medical Oxygen Production

However, oxygen plants in Ethiopia only function at 55% of their potential capacity for various

reasons. This was mainly due to weak management of plants, shortages of spare parts, frequent power interruption, and limited technical capacity from experts (1). Furthermore, geographical equity has not yet been addressed; this difficulty has caused health institutions to pay additional logistics costs, which raises the price of oxygen for those facilities lacking oxygen-producing plants and/or located in remote areas. And based on the end-term assessment report, about 25% of the facilities are still located greater than 200 km away from nearby oxygen plants. The highest oxygen production potential capacity (public and private) is in Addis Ababa with 1180 M3/Hr., followed by Oromia 591 M^3/Hr. and Amhara 483 M^3/Hr.

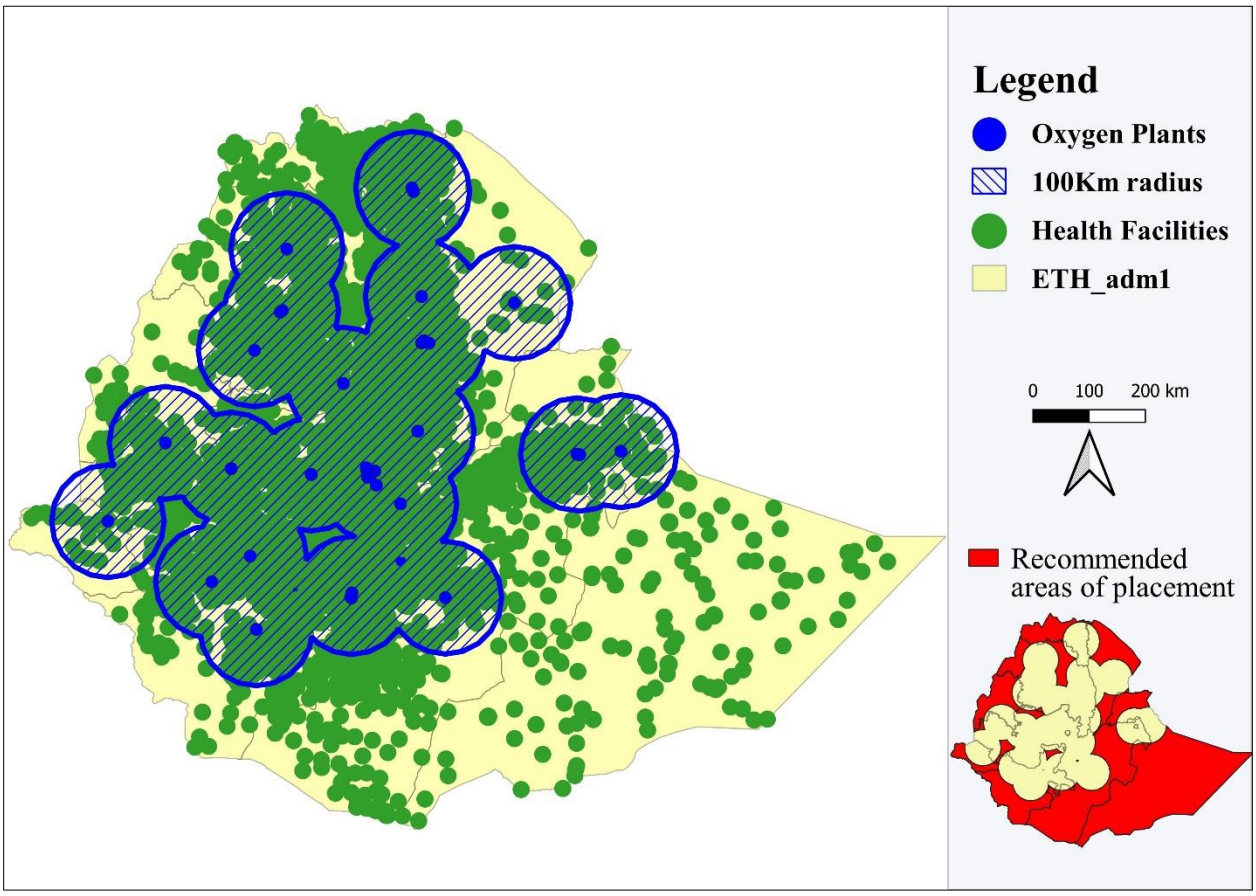


Figure 3:Geospatial analysis of currently placed oxygen plants against the location of health facilities

The above figure only illustrates the locations of oxygen plants and health facilities within the 100 Km radius.

Medical oxygen demand and supply in the country were quantified. It is predicted that the country will require 28,785,584.35 M^3/year of oxygen and that there will be a shortfall of 6,827,564.35 M^3. It was also assumed that oxygen plants would be operational for 21 hours per day, with around 75% of the production from private vendors going to healthcare facilities. This also takes into account potential health emergencies present and in the future. Furthermore, the country's oxygen demand is anticipated to rise by 3% annually.

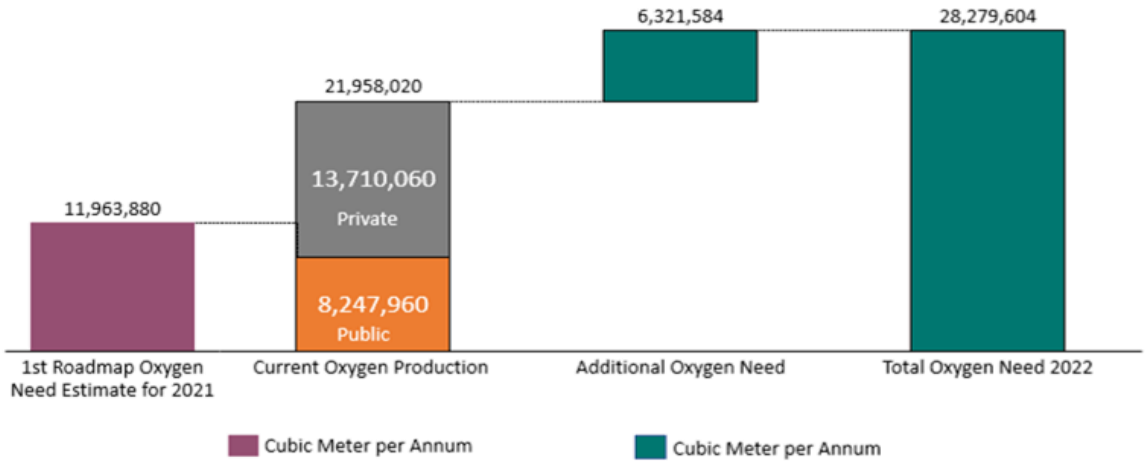


Figure 4. Ethiopia's Oxygen Demand

Cylinders are the primary source of oxygen for most health facilities in the country. The availability of oxygen cylinders and pulse oximetry was low at health centers (26% and 64%, respectively), making the early identification and management of hypoxia at the primary healthcare level a challenge.

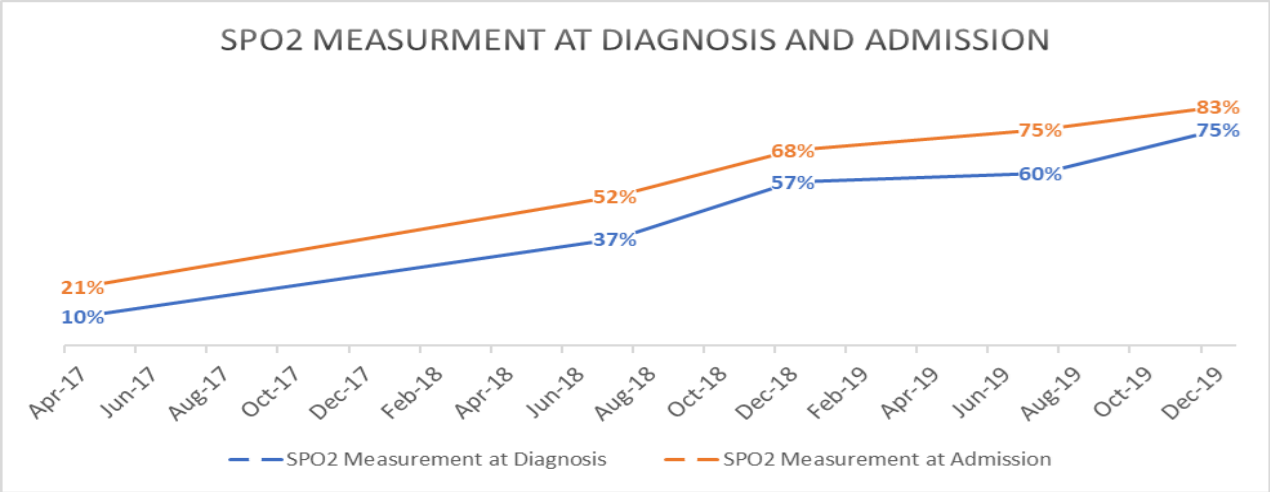


Figure 5. Trend analysis of blood oxygen saturation level during first measurement and after admission

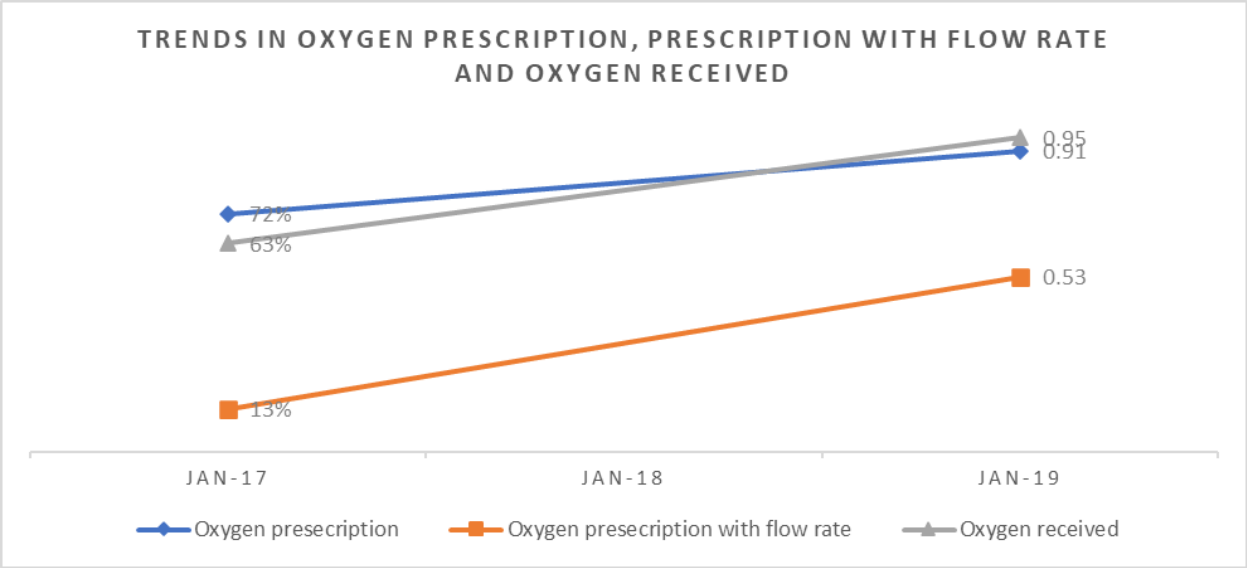


Figure 6. The trend of appropriate oxygen prescription and patients that received supplemental medical oxygen therapy

Quality of medical oxygen service

The availability of qualified staff for the rational use of medical oxygen in hospitals is limited. Similarly, 54% and 43% of general and primary hospitals reported a shortage of trained personnel.

In hospitals, the practices of detecting oxygen saturation upon diagnosis and admission have greatly improved in recent years (1). Significant improvement in guidelines compliance revealed an improvement in the process of providing oxygen therapy to patients (such as oxygen prescription, flow rate, and oxygen receiving status) (1).

Oxygen device management system

Biomedical engineers and/or technicians were present in all referral and general hospitals and 86% of primary hospitals. However, only 16% of hospitals have trained personnel on oxygen device maintenance. Less than half of the hospitals (47.5%) offered proper training on preventative maintenance to end users at various periods. In contrast, there were no training opportunities or exposure to oxygen device preventative maintenance at the health center/district level.

According to the end-term report, from oxygen service-providing facilities, 40% of referral hospitals, 54% of general hospitals, and 86% of primary hospitals lacked spare parts for oxygen concentrators. The availability of pulse oximetry spare parts was generally low at all facility levels.

Spare parts for pulse oximetry and cylinder were unavailable in 76% and 68% of the facilities. Furthermore, oxygen analyzers were found in 45% of referral hospitals and 8% of general hospitals during the visit.

The Medical Equipment Management Information System (MEMIS) has been adopted to strengthen medical equipment inventory and maintenance systems across the country. However, just a few hospitals (15%) used the Medical Equipment Management Information System (MEMIS), and the availability was very low at health centers (4%).

During the COVID-19 response, the MoH mobilized BME/T and other professionals, multiple maintenance campaigns were conducted, and a total of 146 pieces of medical equipment were maintained and operational. The performed maintenance operations saved a total of 12,054,404 ETB (2).

Financing and Investment

Over the last five years, the Government, private sector, and partner organizations have invested in the procurement of oxygen equipment. Few hospitals generate income by supplying oxygen to their catchment facilities, which ultimately might help ensure their oxygen plants' long-term viability. However, no clear national guidance outlines how health facilities can run their oxygen plants sustainably while covering operating costs.

The Amhara region has developed a comprehensive oxygen management system that includes production, delivery, and maintenance. Two oxygen plants based on this model were placed in this region. Furthermore, the MoH has collaborated closely with the Ministry of Finance and the Investment Commission to build the necessary legal foundations for implementing public and private partnership models at the national level.

To consistently avail medical oxygen, healthcare facilities often invest considerable money. As determined by data gathered from 15 Federal and University hospitals, the average cost of oxygen refills per year was roughly 4.1 million birrs. Approximately 10 million and 470,000 birrs were spent each at Worabe Hospital and Bule Hora University Hospital, the two hospitals with the largest and lowest expenditures. There are no defined systems for health facilities to recover their expenditures, which leaves them with a severe shortage of money and unable to render

normal services, except for a few facilities that recently instituted an oxygen service fee and are now recovering their costs.

Goal

To reduce preventable deaths and disabilities through ensuring a sustainable medical oxygen system.

Objectives

1. Strengthen leadership and coordination of the medical oxygen system
2. Improve equitable access to oxygen and oxygen devices
3. Improve the quality of medical oxygen services
4. Strengthen medical oxygen product management
5. Strengthen the medical oxygen regulation system
6. Enhance Research and innovation on the medical oxygen system
7. Ensure a sustainable financing mechanism for the medical oxygen system

Objectives and Strategic Interventions

1. Strengthen leadership and coordination of the medical oxygen system

Description

This objective incorporates leadership, governance, and coordination functions at all levels in line with national strategies such as health sector strategic plan, essential health services package, emergency preparedness, response, and risk management strategies, and national specialty service roadmap focusing on integration, structures and coordination and accountability mechanisms.

Interventions:

A. **Develop and integrate medical oxygen into new & existing national policies, legal frameworks, standards, and guidelines.**

Implementation of the Roadmap requires the development of new medical oxygen governing legal frameworks, standards, and guidelines while mapping and incorporating medical oxygen services into the existing strategic documents and plans.

B. **Establish and strengthen medical oxygen structures and coordination at all levels**

Structure and coordination platforms at all levels are vital to enhancing the medical oxygen system. The Government will ensure the establishment of a unit or focal for medical oxygen at all levels. At the facility level, the focal person will be part of the drug and therapeutic committee (DTC) and will be led by a medical director or facility head. At the national and regional levels, multi-sectoral coordination mechanisms must be established and implemented through the Steering Committee (SC) and the Technical Working Group (TWG).

C. **Create an accountability mechanism for medical oxygen services.**

One of the major pillars of leadership and governance is creating accountability mechanisms at all levels. Hence, the roadmap calls for medical oxygen KPIs and dashboards, regular monitoring, evaluation, and feedback mechanisms, as well as integrating medical oxygen performance indicators into existing recognition and incentive programs.

2. Improve Equitable Access to Medical Oxygen and Devices

Description

This objective describes the detailed interventions for improving the supply chain management focusing on scaling-up production capacity, quantification, procurement, and logistics management system (Inventory, distribution, and warehousing) of medical oxygen and oxygen devices.

Interventions:

A. Improve equitable national medical oxygen production capacity

Improving national medical oxygen production capacity is critical to equitable oxygen access and services. MOH will implement several mechanisms to improve national production capacity, including optimizing existing oxygen plants' production to full capacity, mapping and increasing efficiency of existing supply chain processes, including medical oxygen plants and oxygen delivery devices, guiding the procurement of oxygen technology supplies, consumables, and putting in place a support package so that the private sector can optimize its medical grade oxygen production capacity. Consideration must also be given to public health emergencies when determining the demand for medical oxygen.

B. Enhance quantification and procurement practice for medical oxygen at all levels

Proper oxygen delivery service requires the availability of medical oxygen and oxygen devices, supplies, and consumables. The medical oxygen supply management should always ensure the availability of medical oxygen 24/7. To ensure this, MOH should avail best practices for robust quantification and forecasting, develop a comprehensive tool and user-friendly medical oxygen and oxygen device, spare part and accessories quantification and forecasting tool considering particular scenarios of the country. Review, integrate and update supply plans regularly and procure oxygen technologies and supplies. Advocate the use of quantification and forecasting tools at all levels.

A. Improve the Medical Oxygen logistic management system

The Government is committed to improving the medical oxygen logistics management system. A sustainable medical oxygen system requires developing and implementing logistics management

manuals and SOPs, supporting facilities to enhance inventory management, update and adopting distribution processes & models for medical oxygen and technologies and supplies. The medical oxygen management system may also be improved by establishing a central pipeline and manifold systems in hospitals, integrating oxygen & diagnostics commodities into the current LMIS & MEMIS and improving warehousing of medical oxygen devices, spare parts, and accessories. Hub-spoke distribution systems will also be introduced to improve access to medical-grade oxygen.

3. Improve the quality of medical oxygen service

Description:

Improving the quality of medical oxygen service is crucial to halt preventable hypoxemia-related mortality. Quality improvement is intended to enhance safety, effectiveness, and efficiency to increase the likelihood of desired health outcomes. This objective deals with all those quality improvement endeavours to standardize care, improve the rational use of oxygen, and improve efficient utilization of oxygen and production.

Interventions:

A. Scale up the efforts to strengthen of rational use of medical oxygen

In collaboration with stakeholders, the Ministry will develop national guiding documents to standardize the rational use of oxygen, which health facilities will adopt and utilize. In addition to financial support, mentorship and supervision will be conducted to guide and monitor activities. The Ministry and regional health bureaus will have to enforce the inclusion and recording of oxygen saturation in patients' medical records in all health facilities to improve the quality of care. Additionally, the safe and rational use of medical oxygen will be integrated into home-based care guides, and HCW will deliver focused education to patients.

B. Develop capacity-building activities to improve the clinical use of oxygen.

The Ministry will provide standardized training materials for use at the facility level in collaboration with its partners. These training materials will be created to instruct physicians, nurses, clinical pharmacists, and other healthcare professionals on using oxygen therapy and pulse oximetry for various patient age groups and medical conditions. This training will be given to HCWs from public and private health facilities, and there will be training provided to have a

qualified pool of HCWs for cascading training, mentorships, and more. In addition, rational use of oxygen will be integrated into pre-service curriculums of medical and health sciences colleges and during clinical attachments and other platforms to improve clinical practice. It will be advantageous to institute a database for medical professionals with oxygen training.

C. Integrate medical oxygen system into existing quality improvement activities

The Ministry has implemented many initiatives in regard to healthcare quality improvement and has put in place a quality structure across the healthcare system to execute quality improvement-related activities. Consequently, these existing structures will be used to conduct clinical audits, quality improvement projects, and review recent technologies. Moreover, it would guarantee the facility-level implementation of national medical oxygen system standards and ensure adherence to clinical guides. In addition, a national experience-sharing and learning platform will be created, and a medical oxygen system will be made as an agenda during the annual professional society summits.

D. Ensure Medical oxygen quality at production and Clinical Use

Companies involved in manufacturing, controlling, storing, and distributing medicinal oxygen should document, implement and maintain a comprehensively designed and clearly defined quality management system. The quality system should incorporate the principles of good practice, which should be applied to the cycle stages of medical oxygen. This includes receiving raw materials, manufacturing, filling, testing, release, distribution, and container return after using a medicinal gas.

4. Strengthen Medical oxygen Product Management

Description:

Proper management of medical oxygen devices is crucial to ensure a safe and efficient oxygen delivery system. This objective is to ensure the proper acquisition, commissioning, utilization, and decommissioning of medical oxygen devices with the appropriate and relevant professionals. It includes an oxygen plant, medical gas pipeline system (central piping and manifold system), oxygen cylinders, concentrators, bulk storage tanks, and diagnostic and monitoring devices with their spare parts and supplies (consumables).

Interventions:

A. Reform the medical oxygen device acquisition system.

The acquisition system of the medical oxygen devices can be improved by introducing different acquisition techniques, standardizing and strengthening technology assessment and selection mechanisms, and placing Long Term Agreement (LTA) procurement systems on the medical oxygen device. This will be done by adopting technical specifications per normative guidance while selecting appropriate procurement technologies.

B. Ensure the timely installation and Commissioning of MODs

Proper site preparation, acceptance testing, follow-up, and coordination are indispensable to ensure the timely installation and commissioning of MODs. With the Ministry's and partners' support, the health facilities will coordinate the device and spare part information management through the available platform.

C. Develop a system for the safe operation, maintenance, and calibration of MODs,

To maintain the functionality of MODs, implementing regular inspection and maintenance programs, applications of safe handling practices, ensuring proper operation of devices, and establishing quality assurance systems are essential. In collaboration with partners and relevant stakeholders, the Ministry of Health should strengthen the capacity of maintenance workshops, health facilities, and professionals, improve the availability of spare parts and enhance the quality assurance system by providing technical support and guidance at all levels.

D. Establish a decommissioning and disposal system

Proper relocation or removal of medical oxygen devices from service for obsolete technologies, terminated life spans, and lack of after-sale services is crucial for efficient resource utilization. In guidance with available legal frames, these devices can be linked to refurbishment centers, implement resource sharing among HFs, donate to training institutes, implement cannibalization, and use spare parts. Finally, conduct the disposal as per international standards and company recommendations.

5. Strengthen the Medical Oxygen Regulation System

Description:

This objective is about regulating the entire oxygen ecosystem in Ethiopia across the healthcare tier system, which includes all standalone oxygen production centers, all facility-based oxygen production centers, oxygen devices, and oxygen services in all health facilities and home-based care. Ensuring compliance with rules and regulations is an important factor in creating quality. The Food and drug administration (FDA) needs a well-developed regulatory standard and enforcement strategy to reform the inspection process that encourages the highest possible compliance with regulations. It will also devise plans to give recognitions/offer specific incentives based on their level of compliance for facilities

Interventions:

A. Develop and Revise Minimum Regulation Standards

In collaboration with MOH and other national and international stakeholders, the FDA will develop a minimum standard specific to medical gasses, oxygen devices, and oxygen services. This standard will be registered and approved by the national standard agency. Advocacy and awareness creation efforts will be made to institutionalize the standards. These standards will help to standardize the oxygen ecosystem in the country.

B. Introduce a Regular Inspection System

In collaboration with national and international organizations, the FDA will establish a competent team to conduct regular onsite inspections for all standalone and facility-based oxygen production centers to ensure the safety of medical-grade oxygen production, storage, transportation, and distribution system. With a regular inspection, every oxygen production center will be licensed to produce oxygen, and they will be expected to renew their license based on the inspection recommendations. Accordingly, quality assurance/ control units for medical oxygen and oxygen device quality will be established at all levels, including at health facilities and oxygen plants.

C. Integrate Oxygen Regulation with a Routine Regulation System

Regular monitoring and regulation of oxygen production, distribution, storage, transportation, and use is a critical component of a national regulatory system. Based on the standards, the inspection

of oxygen services must be integrated with the current facility regulation system. The current medical devices regulation process can be revised to include the oxygen devices inspection. The integration of regulation can be realized with continuous discussion and collaboration with relevant stakeholders. This will help ensure continued safety as well as monitoring. It includes documenting and reporting complaints and field failures, communicating issues to manufacturers, and taking necessary regulatory action.

D. Capacity building of regulatory professionals

Human capital development is key to improving oxygen ecosystem regulation and standardization. Training materials will be developed for every regulation tailored to professionals. Training of professionals will be organized between FDA, MOH, and partners. By improving the capacity of regulatory professionals, the quality of oxygen services and devices in the healthcare system can be improved.

E. Advocacy and creating Ownership

The role of leaders, private owners, professionals, and community members is crucial to sustaining the implementation of regulatory standards and ensuring the standardization of the oxygen ecosystem in the country. Regular education and awareness creation can be done for the public, professionals, the private sector, and non-governmental organizations through written, electronic, and cable Media.

F. Establish a regulatory support system to translate innovations into local production

Building local production capacity is the way to create a resilient oxygen ecosystem in the country. Innovative ideas must be supported to translate into local production with an easy and transparent regulation system. The FDA will create a fast-track evaluation and feedback system to support the innovators.

6. Enhance Research and innovation in the medical oxygen system

Description:

This objective entails improving the oxygen ecosystem's efficiency and effectiveness through generating and synthesizing evidence, supporting innovation, developing a research community, and enabling informed decision-making.

Interventions:

A. Develop research priority areas

The MOH and other concerned bodies have conducted several assessments and gap analyses on oxygen systems – including production, equipment management, service delivery, and human resources. The implementing body will identify priority areas for further research, communicate these priority areas to the public through websites and other platforms, and review them periodically.

B. Establish a national oxygen research repository and use it for decision making

Considering the medical oxygen, oxygen device, and services as evolving ecosystems and promoting evidence-based decision-making, there are undergoing potentials and efforts to explore, evaluate, innovate and improve the ecosystem. The Ministry will collect their works, categorize them into relevant ways, launch an open access repository, disseminate and avail for evidence-based decision making. There will be regular Research and regular innovation conferences. Collect national, regional, and global available published research works, organize and post them in the research repository and prepare briefs to inform the decision-making process.

C. Establish medical oxygen research and innovation hubs

The national implementation body will identify regions and universities to establish innovation hubs for developing and testing new ideas for improving oxygen access and health outcomes. The national body will equip the hubs with the necessary resources to carry out their work and coordinate activities across the hubs to ensure strong collaboration, develop frameworks, guidelines, and SOPS, and link the hubs with local refurbishment centers. The hub will enhance and maintain its function through national and international experience exchanges.

D. Integrate the national medical oxygen grand challenge

To encourage and advocate for ongoing innovation and Research focused on medical oxygen, the MOH, in collaboration with relevant stakeholders, will develop a framework to govern the national medical oxygen grand challenge. In partnership with Grand Challenge Ethiopia at AHRI, the Ministry will mobilize resources and launch an annual award platform. The awarded body will receive a seed grant to incubate the innovation. The awardee will be linked to innovation hubs and bridged to local production through appropriate regulation.

E. Translate innovations into local production

Leveraging the available regulatory system is critical to realize innovation into clinically usable products. MoH will coordinate and facilitate production efforts in collaboration with other stakeholders. The Ministry will develop an enabling environment by establishing a multi-sectoral team to provide technical support, follow up the production path, create a regulatory framework, mobilize resources, and support the new product introduction effort.

7. Ensure a sustainable financing mechanism for the medical oxygen system

Description

A sustainable financing mechanism is needed to ensure medical oxygen availability. Therefore, the Government and its partners put in place different means, including resource mobilization, creating tools for efficient use of the resource, implementing innovative financing modalities, and cost recovery mechanisms for medical oxygen systems like in planning for replacement after the operational life of their existing oxygen plant/technology. Ensuring sustainable budgeting for all the objectives above will be crucial for realizing the rollout of this strategy and ensuring the sustainable supply of oxygen. Accordingly, a new approach to the medical oxygen financing mechanism at the facility level that is collective and connected to the overall healthcare financing strategy for domestic resourcing mobilizations leads to increased longer-term investments into sustainable activities.

Interventions:

A. Building MoH/RHB capacity for successful stakeholders' coordination and efficient and equitable deployment of medical oxygen with a sustainable financing strategy

Ensuring sustainable financing demands adequate capacity of professionals and institutions at all levels. MoH, in collaboration with regional health bureaus, will support developing business plans for long-term financing, advocate and implement differential accounting, employ incentive mechanisms through a merit-based approach, establish trust funds, and devise cost recovery approaches.

B. Coordinate Analytical activities, stakeholder consultation, and dialogue to develop better investment in producing and distributing medical gasses for public and private facilities.

Planning and implementation of analytical activity and stakeholder consultation sustainable financing of oxygen production and distribution at public and private health facilities are relevant. This can be achieved by developing resource mobilization strategies and advocacy, incorporating oxygen in government budget lines, conducting feasibility studies, incorporating medical oxygen into healthcare financing schemes, and advocating for leasing and tax exemptions.

Roadmap Implementation

Implementation Arrangement

The Roadmap depends on implementing the Health Sector Transformation Plan-II (HSTP-II) and the Sustainable Development Goals (SDG). The Roadmap seeks to address the gaps in realizing equitable access among regions, geographic locations, and use of services across regions and different communities to ensure universal access to quality-assured medical oxygen & devices interventions.

In the best-case scenario, by 2027, every person will have affordable access to high-quality and safe medical oxygen, and families and communities will be empowered to use the services offered. A pragmatic approach will be used to promptly take corrective action for identified implementation challenges at local or national levels. The Roadmap recommends close monitoring of the implementation of identified interventions with frequent progress reviews.

Governance Structure

The MOH's Medical Service Directorate will guide, lead, and oversee the roadmap implementation at the national level. The Maternal & Child Health Directorate and Pharmaceutical & Medical Equipment Directorate of the MoH will also be other major implementers of the Roadmap. A national and regional level multi-sectoral steering committee will be established, governed by terms of reference and consisting of key line ministries or bureaus, professional associations, partners, private sector representatives, and other stakeholders. The committee will advise and oversee the implementation and monitoring of the Roadmap.

The MoH will also establish a unit or focal for medical oxygen at all levels. The Medical Service Directorate will establish a unit or focal for medical oxygen at the national level, and regional health bureaus will also establish a focal at a sub-national level.

Health facilities will assign a responsible and dedicated unit for medical oxygen at the facility level, and this focal person will be part of the Drug Therapeutic Committee (DTC) will be put in place, which the medical director or facility head will lead. The committee members should have job descriptions designed by the health facilities based on their roles.

To ensure a reliable and equitable supply of medical oxygen at the regional level, a PPP model

will be set up as an enterprise, a cooperative, or another model.

Stakeholder Roles and Responsibilities

The medical oxygen roadmap is a multi-year, multi-stakeholder initiative that aims to transform medical oxygen and equipment into a vital part of the health system for those in critical need. Diverse groups of actors will be involved in implementing the medical oxygen roadmap under the leadership of the public sector at the federal, regional, zonal, and woreda levels *(See Table 1)*

Table: Roles and responsibilities

Table 1. Roles and Responsibilities of Stakeholders

Stakeholder	Roles and responsibilities	Remark
MoH	● Coordinate the development of comprehensive implementation plans, regular progress reviews, and roadmap revisions. ● Lead & coordinate national technical working groups and task forces ● Ensure the development and integration of medical oxygen and medical devices policies, legal frameworks, standards, guidelines, and training manuals integrated with other programs ● Ensure universal coverage of major interventions with a focus on equity and quality ● Improve health information systems and local use of data for decision making ● Ensure there are robust processes in place for the efficient and effective procurement, placement, management, logistics, and supply chain of medical oxygen systems at all levels, including the private sector ● Overall coordination of the medical oxygen system will be by medical services and led by the state minister of programs and services at the national level. ● Coordinates efforts on human resource development ● Build the managerial and clinical skills of program experts and clinical providers to improve the quality of medical oxygen-related services ● Support and coordinate implementation research and periodic surveys on medical oxygen-related interventions ● Ensure continuous performance monitoring, evaluation, and accountability mechanisms are in place ● Advocacy and resource mobilization & allocation of budget from the government & development partners for medical oxygen systems at the national level ● Coordinate efforts for putting quality assurance/control systems in place ● Coordinates documentation and sharing of best practices & lessons learned for scaleup ● Advocate innovations and coordinate local efforts to translate into products	

RHBs	● Develop a regional-level implementation plan for medical oxygen ● Establish a medical oxygen unit or focal at the regional level and support respective facilities to establish dedicated medical oxygen focal. ● Collaborate with MOH in implementing the Roadmap whenever it needs contextualization to be region-specific. ● Regularly supervise and provide timely feedback on the implementation of the medical oxygen roadmap at zone, wereda & health facility levels. ● Advocacy and resource mobilization on medical oxygen systems at the regional level	
Private sector	● Participate in the design and implementation of social marketing for medical oxygen and related supplies & devices ● Invest in both production and supply of medical oxygen and oxygen devices ● Enhance the application and use of local technology and innovations ● Demonstrate an improved adherence to local standards	
Regional Oxygen enterprise	● Coordinates the production and distribution of oxygen at the regional level ● Identifies quantification of oxygen demand with RHBs ● Generates income for its service sustainability ● Recruits its human resource ● Provides service at a subsidized price ● Develops an internal quality assurance system ● Provide preventive and curative maintenance to catchment facilities ● Provides capacity building for catchment facilities ● Conducts regular market surveillance. ● Establish sustainable Spare parts and consumables supply chain system ● Ensures compliance with national standards from production through to distribution	
Health facilities	● Ensure access to medical oxygen through possible modalities as per the national facility standards ● Establish dedicated medical oxygen focal at the facility level with TOR and regular monitoring mechanisms. ● Ensure availability of medical oxygen and devices for pre-hospital and hospital care & treatment ● Strengthen facility-level data capturing, data use, and reporting to the higher levels ● Establish a functional system to improve institutional supply chain management ● Ensure adequate budget allocation for the medical oxygen system ● Strengthen the existing system for regular preventive and corrective maintenance	

Partner organizations	● Provide technical and financial support toward the realization of the National medical oxygen roadmap ● Advocate the National medical Roadmap to the national and global communities ● Develop and harmonize a coordinated framework for a facility-level approach to medical oxygen interventions ● Develop a common harmonized platform for supervision, mentoring, and reporting ● Active technical & financial support for technical working groups and task forces under the coordination of the MoH ● Conduct annual, bi-annual, and/or quarterly joint program reviews meetings ● Support and maintain the functionality of TWGs, and coordinate committees at the region level	
Institute of Ethiopian Standard	● Coordinate the existing robust intersectoral collaboration platform ● Provide technical support for the implementation of the Roadmap ● Develop local production and product standards for medical oxygen ● Develop a standard for medical oxygen and devices technologies importation or local production, transportation, utilization, decommissioning, and disposal ● Support the establishment of a robust quality control mechanism	
Food & drug administration	● Enforce strong adherence to local standards by private and public sectors ● Coordinate the intersectoral collaboration for medical oxygen system regulation ● Lead the quality control activities for product and transportation of medical oxygen and devices ● Regularly update regulations and standards for licensing importers/producers	
Professional Societies	● Support continues professional development activities for the medical oxygen system ● Support the development of national oxygen-related protocols and treatment guidelines ● Advocate for rational use of oxygen	

Implementation Plan

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
Objective 1: Strengthen leadership and coordination of the medical oxygen system						
Intervention 1: Develop and integrate medical oxygen into new & existing national policies, legal frameworks, standards, and guidelines.						
Activity 1: Develop new medical oxygen governing legal frameworks, standards, and guidelines						MoH, EFDA, IES
Activity 2: Map and incorporate medical oxygen service into existing strategic documents and plans						MoH, RHB, HF
Activity 3: Disseminate and create awareness of medical oxygen documents						MoH, RHB
Activity 4: Advocate the national oxygen roadmap to national and global communities						MoH
Intervention 2: Establish and strengthen medical oxygen structures and coordination at all levels						
Activity 1: Establish a unit or focal for medical oxygen at the national and sub-national level						MoH, RHB, HF
Activity 2: Assign a responsible focal person for medical oxygen at the facility level						RHB, HF
Activity 3: Make the assigned focal person part of the Drug Therapeutic Committee.						RHB, HF
Activity 4: Establish a National and Regional level Medical Oxygen multi-sectoral steering committee and TWG						MoH, RHB, EFDA
Intervention 3: Create an accountability mechanism for medical oxygen services						
Activity 1: Develop and integrate Medical Oxygen KPIs and Dashboard at all levels like DHIS2/HMIS or LMIS						MoH, RHB, HF
Activity 2**:** In place regular monitoring and evaluation mechanisms for medical oxygen						MoH, RHB
Activity 3**:** Integrate medical oxygen performance on existing recognition and motivation mechanisms.						MoH, RHB
Objective 2: Improve Equitable Access to Medical Oxygen System						
Intervention 1: Improve equitable national medical oxygen production capacity						
Activity 1: Provide technical support and guidance to optimize production capacity for medical-grade oxygen production						MoH, RHB
Activity 2: Map existing supply chain processes, including existing commercial oxygen plants and oxygen devices for oxygen delivery systems						MoH, RHB
Activity 3: Guide Procurement of oxygen technologies and supplies, including public health emergencies						MoH, EPSS
Intervention 2: Enhance quantification and procurement for medical oxygen demand at all levels						
Activity 1: Adopt and document best practices for quantification and forecasting at the national level						MoH, RHB
Activity 2: Develop and promote the use of medical oxygen and spare parts quantification and forecasting tool						MoH, RHB
Activity 3: Create a robust quantification and forecasting of oxygen needs at facility-level						MoH, RHB, HF

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
Activity 4: Review and update supply plans regularly, in line with other supply plan review exercises						MoH, RHB, EPSS
Activity 5: Procure oxygen technologies and supplies to meet forecasted demand						MoH, EPSS, RHB
Intervention 3: Improve the medical oxygen logistic management system						
Activity 1: Develop and implement logistics management manuals and SOPs						MoH, RHB
Activity 2: Support facilities to improve inventory management						MoH, RHB
Activity 3: Review, update and adopt distribution processes and models for medical oxygen and related technologies and supplies, including public emergency scenarios						MoH, RHB
Activity 4: Ensure and sustain implementation of central pipeline and manifold system at Hospital levels						MoH, RHB
Activity 5: Ensure integration of oxygen and diagnostics commodities into the current LMIS and MEMIS						MoH, EPSS
Activity 6: Improve warehouses management practice for medical oxygen devices						MoH,RHB, EPSS, HF
Activity 7: Improve access to medical oxygen through the hub and spoke delivery model						MoH, RHB, HF
Objective 3: Improve the quality of medical oxygen service						
Intervention 1: Scale up the efforts to strengthen of rational use of medical oxygen						
Activity 1: Develop and distribute national guiding documents to standardize rational use of oxygen (SOPs, Pocket handbooks, charts, brochures, inpatient monitoring formats …….						MOH
Activity 2: Support, coordinate and conduct medical oxygen-focused clinical mentorships and supervisions on the rational use of oxygen.						MOH, RHB & HFs
Activity 3: Provide technical and financial support for regional health bureaus to conduct activities on the rational use of oxygen.						MOH
Activity 4: Advocate the national oxygen roadmap to national and global communities						MOH
Activity 5: Integrate the safe use of medical oxygen into home-based care guides and develop patient information brochures on the safe use of medical oxygen. (in all languages, ….)						MOH & RHB
Activity 6: Integrate rational use of oxygen into health literacy units at health facilities to deliver focused patient education.						MOH & RHB
Intervention 2: Develop capacity-building activities to improve the clinical use of oxygen						
Activity 1: Integrate clinical use of oxygen into pre-service curriculums of medical and health sciences colleges						MOH & MOE

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
Activity 2: Ensure teaching institutions make oxygen an area of focus during clinical attachments and other learning platforms						MOH, MOE & Universities
Activity 3: Implement in-service training modalities (linkage with CPD) on the use of oxygen and medical devices, including for home-based care providers.						MOH & MOE
Activity 4: Train a pool of well-qualified and skilled trainers on the clinical use of oxygen.						MOH
Activity 5: Institutionalize a database for trained clinicians and Biomed on oxygen.						MOH & MOE
Intervention 3: Integrate medical oxygen system into existing quality improvement activities						
Activity 1: Promote integrating rational use of oxygen into facility-based clinical audit processes.						MOH, RHB & HFs
Activity 2: Supporting the development and implementation of quality improvement projects on medical oxygen						MOH, RHB & HFs
Activity 3: Establish & scale up the engagement platform to ensure quality and safety in private health facilities.						MOH & RHB
Activity 4: Integrate oxygen utilization-related adverse effects/incidents reporting into existing FDA reporting systems, including hotlines.						MOH & RHB, FDA
Activity 5: Ensure integration of oxygen content into existing facilities-based emergency preparedness and response plan during a health emergency						MOH & RHB
Activity 6: Integrate oxygen into national-level experience-sharing or learning platforms.						MOH & RHB, hf
Activity 7: Implement in-house/internal quality assurance practices for medical oxygen plant productions						HFs & Private Owners
Activity 8: Implement quality checks of medical oxygen through conducting purity tests and cylinders free from bacteria and foreign bodies at health facilities.						HFs
Objective 4: Medical Oxygen Device Management						
Intervention 1: Update the medical oxygen device acquisition system						
Activity 1: Conduct regular MODs replacement planning and need assessment, and identify acquisition modalities						MOH & RHB
Activity 2: Institutionalize medical oxygen device technology assessment						MOH, EFDA & RHB
Activity 3: Standardization and selection of medical oxygen device						MOH & RHB
Activity 4: Implement Long Term Agreement (LTA) procurement system on medical device						MOH & EPSS
Intervention 2: Ensure timely installation and Commissioning of MODs						

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
Activity 1: Coordinate site preparation for medical oxygen device installations						MOH, RHB & HFs
Activity 2: Implement and strengthen acceptance testing and proper handover practices						MOH, RHB & HFs
Activity 3: Integrate and strengthen medical oxygen devices information to existing MEMIS						MOH
Intervention 3: Develop a system for the safe operation, maintenance, and calibration of MODs						
Activity 1: Strengthen and expand standard maintenance and centre-of-excellence workshops						MOH & RHB
Activity 2: Conduct medical Oxygen devices safe handling and maintenance training.						MOH, RHBs, Partner Orgs. & HFs
Activity 3: Conduct mentorship and supervision for regional workshops and health facilities						MOH, RHBs, Partner Orgs. & HFs
Activity 4: Avail SOPs, manuals, protocols and handbooks on using and maintaining oxygen devices.						MOH, RHBs, Partner Orgs.
Activity 5: In place a system for calibration and quality testing of medical oxygen devices						MOH, RHBs & HFs
Activity 6: Establish a national toll-free remote help desk for oxygen device maintenance support.						MOH & RHB
Activity 7: Set up a system and strengthen outsourcing and maintenance contract management for oxygen plants and central pipe systems.						MOH, RHB & Partners
Activity 8: Introducing medical oxygen devices spare part national and or regional hub						MOH & RHB
Intervention 4: Establish Decommissioning and disposal system						
Activity 1: Link the hospital with the refurbishment center on oxygen devices						MOH, RHB & HFs
Activity 2: Implement a system of resource sharing among HFs and donate to the training institute. Implement cannibalizing system and uses it as a spare part						MOH, RHB & HFs
Activity 3: Develop National decommission and disposal guidelines for MoD						MOH, RHB & HFs
Activity 4: Link the hospital with the refurbishment center on oxygen devices						MOH, RHB & HFs
Objective 5: Improve Medical Oxygen System Regulation						
Intervention 1: Develop and revise Regulation Standards						
Activity 1: Develop standards in line with the international ecosystem on medical oxygen, oxygen device, and						IES, MoH, EFDA

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
oxygen services (including refilling centers, portable cryogenic tanks, and home-based care services) during procurement, transportation, storage, and distribution processes						
Activity 2: Advocate and create awareness to institutionalize the standards						MoH, EFDA, RHB
Activity 3: Provide technical support and follow-up on the implementation through inspection and onsite visits						MoH, EFDA, RHBs
Activity 4: Develop standards (certification system) for local production and technology transfer						MoH, EFDA,ESA, ENAO
Intervention 2: Introduce a Regular Inspection System						
Activity 1: Establish a team to conduct a periodic end-to-end inspection (i.e., production, filling, labelling, storage, transportation, distribution) for both pre and post-placement of oxygen devices						MoH, EFDA, RHB
Activity 2: Equip the team with necessary inspection tools and materials						MoH, EFDA, RHB
Activity 3: Create licensing mechanism for medical oxygen production (Oxygen plants) and distribution system						MoH, EFDA, RHBs,
Activity 4: Organize periodic experience-sharing platforms to build harmonized working environment among the regulatory body, oxygen producers and service providers						MoH, EFDA, RHBs, HFs, Private sector
Activity 5: Establish a quality assurance/ control unit for the quality of medical oxygen and oxygen devices at all levels, including at health facilities and Oxygen plants (Eg. MoU with vendors, frequency of Cylinder cleaning, consistent use of medical grade cylinder, etc.)						MoH, RHB, EFDA, HFs
Activity 6: Establish a post-market surveillance system, including a procedure and system for recording, recalling, and complaint handling for oxygen devices.						MoH, EFDA, RHBs
Activity 7: Develop a system for spare parts and accessories by including a list of accessories as part of the product registration of oxygen plants and oxygen devices.						MoH, EFDA
Intervention 3: Integrate Oxygen Regulation with a Routine Regulation System						
Activity 1: Revise available facility regulation system to include medical oxygen and oxygen service						MoH, EFDA, RHBs
Activity 2: Conduct periodic evaluation of facilities						MoH, EFDA, RHBs
Activity 3: Provide comprehensive feedback and support the improvement process						MoH, EFDA, RHBs
Activity 4: Document the best facility experience and share in the system						MoH, EFDA,

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
						RHBs
Activity 5: Integration of disposal and decommissioning of oxygen devices into the existing system for other medical devices.						MoH, IES, EFDA
Intervention 4: Capacity building of regulatory professionals						
Activity 1: Develop training materials on the regulation of medical oxygen, oxygen devices, and service referring to national and international experience						MoH, EFDA,
Activity 2: Provide training for regulatory professionals						MoH, EFDA, RHBs
Activity 3: Integrate the training program as part of the CPD						MoH
Activity 4: Create a cloud resource center for regulatory professionals and promote continuous learning						MoH
Intervention 5: Advocacy and Creating Ownership						
Activity 1: Organize consultative platforms to develop an awareness-creation strategy						MoH, EFDA, RHBs
Activity 2: Identify target audience, key messages, and media pipelines, and tailor awareness-raising initiative						MoH, EFDA, RHBs
Activity 3: Conduct panel discussions and conferences						MoH, EFDA, RHBs
Activity 4: Introduce medical oxygen day						MoH, RHBs
Activity 5: Include the medical oxygen system as an agenda during annual review meetings, including summits of professional societies.						MoH, EFDA, RHBs
Intervention 6: Establish a regulatory support system to translate innovations into local production						
Activity 1: Organize consultative events to develop (by FDA and relevant stakeholders) a legal framework for fast-track licensing of local oxygen device producers						MoH, EFDA
Activity 2: Organize advocacy platforms and promote the legal framework to the private and public						MoH, EFDA,
Activity 3: Conduct a regular evaluation and feedback mechanism for local producers						MoH, EFDA,
Objective 6: Innovation and Research						
Intervention 1: Develop research priority areas						
Activity 1: Conduct desk review to understand national and global priorities						MoH
Activity 2: Develop a research priority handbook and revise it periodically						MoH, Universities

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
Activity 3: Communicate/distribute the handbook with relevant stakeholders						MoH,
Activity 4: Translate available evidence and research findings to impart clinical care practices						MoH, Universities
Intervention 2: Establish a national oxygen research repository and use it for decision making						
Activity 1: Develop a manual/guideline to establish a national oxygen research repository and use						MoH, partners
Activity 2: Support the development of an oxygen research website						MoH, partners
Activity 3: Establish an oxygen research advisory council						MoH
Activity 4: Conduct a regular collection of published articles						oxygen research advisory council
Activity 5: Upload compiled research articles on the website						oxygen research advisory council
Activity 6: Establish evidence-based best practice documentation and design a scale-up strategy						MoH
Intervention 3: Establish medical oxygen innovation hubs						
Activity 1: Develop innovation hub management protocol, SOPs, and guideline						MoH, MoIT
Activity 2: Establish five innovations/incubation hubs						MoH, MoIT, RHB
Activity 3: Equip the innovation hubs with the necessary equipment and tools						MoH, MoIT, RHB
Activity 4: Integrate oxygen devices into the system for devices clinical trials at existing institutions (e.g., AHRI).						MoH, AHRI
Activity 5: Build refurbishment capacity						MoH, RHB, Partners
Activity 6: Link the innovation centers with local production centers						MoH,
Intervention 4: Initiate the national medical oxygen grand-challenge						
Activity 1: Develop a framework to govern the innovation grand-challenge						MoH
Activity 2: Establish a grand-challenge steering committee and independent expert panel						MoH
Activity 3: Conduct annual grand-challenge						MoH
Activity 4: Mobilize funding for seed money for the awardees						MoH, partners
Activity 5: Link the awarded innovations with innovation/incubation hubs						MoH

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
Intervention 5: Translate innovations into local production						
Activity 1: Provide advocacy, technical and financial support in the national, local production, and technology transfer efforts						MoH, RHB
Activity 2: Establish a multi-sectoral team to guide the translation of innovation to production						MoH, MoIT
Activity 3: Establish a sustainable support system						MoH, MoIT, Private sector
Activity 4: Celebrate success after translation to production						MoH, MoIT
Objective 7: Ensure a sustainable financing mechanism for the medical oxygen system						
Intervention 1: Building MoH/RHB capacity for successful stakeholders' coordination and efficient and equitable deployment of medical oxygen with a sustainable financing strategy						
Activity 1: Develop business plan with sustainability criteria and continue measurements and gap analysis on long-term financing for medical oxygen systems for enterprises and facilities.						MoH, RHB
Activity 2: Capacity Building to produce and use different financial accounting at the facility or regional enterprise level						MoH, RHB
Activity 3: Devise Incentives mechanism to develop competing criteria for more investment at the facility and encourage by allocating annual subsidy for better performance						MoH, RHB
Activity 4: Establish a new flagship trust fund at the enterprise or facility level and establish a fundraising plan for yearly contributions from government, local trustees, and facility						MoH
Activity 5: Ensure medical oxygen is included in the benefits package for health insurance reimbursement						MoH, EHI
Activity 6: Device mechanisms for costing of medical oxygen services and integrate it with essential services in the cost recovery model						MoH,
Activity 7: Develop mechanisms for patients protection for the financially disadvantaged and to avoid out-of-pocket expenditure						MoH, RHB, HF
Intervention 2: Coordinate Analytical activities, stakeholder consultation, and dialogue to develop better investment in producing and distributing medical gases for public and private facilities.						
Activity 1: Develop resource mobilization strategy and advocacy documents to increase investment in the national oxygen system or incorporate oxygen into existing national resource mobilization strategies						MoH
Activity 2: Incorporate oxygen into existing mechanisms to allocate government budgets to ensure support is available for implementation coordination and procurement of oxygen technologies and supplies.						MoH, MoF

	Time Frame					Responsible
	2023	**2024**	**2025**	**2026**	**2027**	
Activity 3: Perform a feasibility study on sustainable funding mechanisms, including results-based financing, revolving drug funds, and public-private partnerships						MoH
Activity 4: Use a national coordinating mechanism to finance the procurement of new oxygen technologies						MoH
Activity 5: Integrate medical oxygen services into the national health care financing schemes.						MoH,
Activity 6: Advocate for lease financing and other models that incorporate medical oxygen private-public financing						MoH,
Activity 7: Support tax exemption and priority for forging currency						MoH, MoF

Oxygen devices quantification and forecasting

The UNICEF Oxygen Systems Planning Tool (OSPT) has been used to quantify oxygen devices and supplies needed for the coming 5 years. Input data were extracted from DHIS2(EFY 2014), Master Facility Registry, and assessment reports to feed into the OSPT. Global default values were used for input parameters that were provided by the tool in an event where there was no country-specific data. Additionally, experts' opinions were considered to refine the quantification further whenever there were shortcomings in the OSPT.

Furthermore, MoH's upcoming initiatives, like the operationalization of Comprehensive Health Posts, construction of OR blocks in selected Health Centers, and expansion of CEmONC services in health centers, were considered during the quantification exercise.

Similarly, manufacturers' recommendations and experts' opinions were used to quantifying spare parts of oxygen devices.

Recommended oxygen supply mix at different levels of health facilities

Setting up the mix of oxygen devices that needs to be available in each tier system is quite important since they have a varied context. Based on the availability of reliable power supply, bed capacity, patient/case mix, skilled health care workers availability, and distance from the refilling centers, appropriate oxygen source options are recommended as primary and secondary/backup sources for different levels of health facilities.

Hence, the primary oxygen source recommendation for Comprehensive Specialized Hospitals is to have their oxygen plant with central piping and manifold systems using cylinders and concentrators as backup oxygen sources. Likewise, with due consideration of the above characteristics, central piping with manifold systems will be a primary oxygen source recommendation for General Hospitals. However, depending on specific contexts, some General Hospitals might need their own oxygen plant.

For Primary hospitals, a balanced mix of oxygen cylinders and concentrators can be considered as distance to refilling centers, and reliable power supply availability is an equally important factor.

PULSE OXIMETERS AND ACCESSORIES	Upfront	Estimated device replacement and spare part quantities during total 4 years
Fingertip pulse oximeter	5104	5104
Handheld pulse oximeter	3163	1581
Monitor	2716	0
Adult handheld pulse oximeter probes	4744	9488
Pediatric handheld pulse oximeter probes	3163	6325
Neonatal handheld pulse oximeter probes	3163	6325
Spare parts package for monitors	716	2000
SPARE PARTS for 5 years		
Battery for Handheld	0	4744

OXYGEN DELIVERY SYSTEM

	Primary Recommendation		Secondary Recommendation	
Oxygen Source and Accessories	**Upfront**	**Estimated device replacement quantities during total of 5 years**	**Upfront**	**Estimated device replacement quantities during total 4 years**
CONCENTRATORS AND ACCESSORIES				
10 LPM Concentrators	3,408	0	0	0
5 LPM Concentrators	1,416	0	803	0
8 LPM Concentrator	822	0	1,638	0
Accessories for concentrators				
Flow splitters	1,416	0	803	0
Tubing (in cm)	12,148	24,296	6,091	12,182
Surge suppressors	5,343	0	2,351	0
Voltage stabilizers	5,343	0	2,351	0
Oxygen analyzers (for Biomed use)	567	0	810	0
Concentrator spare parts for 5 Years				
Spare part package for 10 LPM Concentrator	3,162	0	0	0
Spare part package for 5 LPM Concentrator	1,361	0	748	0

Spare part package for 8LPM Concentrator	820	0	1,603	0
Concentrator Power Backup				
UPS units	0	0	470	0
Grid-charged battery units	0	0	0	0
Grid-Solar hybrid Battery Units	0	0	0	0
Off Grid Solar Battery Units	0	0	0	0
CYLINDERS AND ACCESSORIES				
Monthly oxygen demand to be met using cylinders (in liters)	44,738,928	0	85,237,474	0
Number of Small (680 L) cylinders	1,392	0	2,481	0
Number of Medium (6800 L) cylinders	8,683	0	16,265	0
Number of Large (7080 L) cylinders	2,630	0	4,755	0
Regulators	2,921	2,760	7,395	0
Flowmeters	4,165	0	7,849	6,939
Humidifiers	4,165	0	7,849	0
PLANTS, REFILLING STATIONS & CENTRAL PIPEING				
Small (12 Nm3/hr.) oxygen plant	22	0	0	0
Medium (30 Nm3/hr.) oxygen plant	10	0	0	0
Large (50 Nm3/hr.) oxygen plant	0	0	0	0
Extra-large (100 Nm3/hr.) oxygen plant	0	0	0	0
Oxygen refilling station for small plant	11	0	0	0
Oxygen refilling station for medium plant	5	0	0	0
Oxygen refilling station for large plant	0	0	0	0
Oxygen refilling station for extra-large plant	0	0	0	0
Central piping and manifold systems	100	0	0	0
Spare part package for compressor	12	42		
Spare part package for plants	12	42	0	0

CONSUMABLES for 5 years			Upfront for the first year	Estimated consumable quantities during the next 4 years
Adult Nasal Cannula			862,980	3,451,920
Pediatric Nasal Cannula			311,420	1,245,680
Neonatal Nasal Cannula			120,710	482,840
Adult Facemask			90,208	72,166
Pediatric Facemask			90,208	72,166
Blenders			420	129

Monitoring & Evaluation

Introduction

Monitoring entails regular and systematic performance assessment, thus allowing an understanding the status of roadmap interventions in relation to planned results and enabling the identification of issues requiring action to accelerate progress. Monitoring allows real-time learning and feeds into evaluation. Evaluation refers to a systematic and impartial assessment of the roadmap interventions to determine their relevance, efficiency, effectiveness, impact, and sustainability. It seeks to strengthen roadmap accountability and learning. The design and effective implementation of M&E activities for the national medical oxygen roadmap is key to the overall success of the national medical oxygen roadmap implementation. Continuous progress monitoring and evaluation of inputs, outputs, and outcomes will provide the required evidence for decisions that foster the effective, efficient, and synergistic implementation of programs. Moreover, it will be integrated into knowledge management efforts to help document lessons and facilitate sharing of experiences nationally and internationally.

To help guide M&E activities, a Logical Framework for the roadmap has been developed to summarize, for each objective, the key activities planned for implementation, measurable indicators to assess progress and success, verification means, and key risks and assumptions underpinning the work. The Logical Framework makes clear links between these items to help underscore how each objective will be evaluated. Additionally, the Performance Management Framework below further defines each measurable indicator, the data sources for verifying the indicator, and sets out baseline and target values for measuring performance.

This M&E framework requires several key activities and structures to ensure successful implementation. This is crucial. The implementation of monitoring and evaluation (M&E) activities in the previous roadmap had suffered from inadequate data-capturing mechanisms and incomplete indicators. The end-term evaluation recommended strengthening the M&E activities and implementation for the revised roadmap.

Successful implementation of M&E activities will require effective coordination and collaboration between national, regional, and facility-level stakeholders.

Logical Framework	STATEMENT	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	Assumptions	Risks
Goal	To reduce preventable deaths and disabilities through ensuring a sustainable medical oxygen system	- Institutional hypoxemia-related death rate - Percentage of hypoxemic patients who have been treated with oxygen	HMIS	- Positive government attention - Strong inter-sectoral collaboration - Continued partner support - Global advocacy on oxygen access - Hospital Minimum Standards will be updated - Increased attention by the global community to do more research on oxygen	- Pandemic - Weak inter-sectoral collaboration - Economic crisis - Inflation - Conflict-Attrition of BME/T professions
Objective 1	Strengthen leadership and coordination of the medical oxygen system	- Proportion of health facilities with assigned or focal units for medical oxygen	Supportive supervision visits		-
Interventions	- Develop and integrate medical oxygen into new & existing national policies, legal frameworks, standards, and guidelines. - Establish and strengthen medical oxygen structures and coordination at all levels - Create an accountability mechanism for medical oxygen services.				
Objective 2	Improve equitable access to oxygen and oxygen devices	- Proportion of hospitals with central oxygen piping and/or manifold systems - Proportion of hospitals performing annual medical oxygen quantification - Proportion of facilities with functional medical oxygen services (disaggregated by facility type and service areas)	- Facility audits - Submission of medical oxygen quantification reports - Supportive supervision visits		
Interventions	- Improve equitable national medical oxygen production capacity - Enhance quantification and procurement practice for medical oxygen at all levels - Improve the medical oxygen logistic management system				

Objective 3	Improve the quality of medical oxygen services	- Proportion of health facilities with trained health care providers on medical oxygen - Proportion of patients that have had their oxygen saturation monitored with pulse oximetry at their first point of contact at the facility	- Training reports - HMIS - Clinical chart audits		
Interventions	- Scale up the efforts to strengthen of rational use of medical oxygen - Develop capacity-building activities to improve the clinical use of oxygen. - Integrate medical oxygen system into existing quality improvement activities - Ensure medical oxygen quality at the point of production & clinical use				
Objective 4	Strengthen medical oxygen device management	- Proportion of technical staff trained on oxygen systems operation and maintenance at the facility level	- Training reports		
Interventions	- Reform the medical oxygen device acquisition system - Ensure the timely installation and commissioning of MODs - Develop a system for the safe operation, maintenance, and calibration of MODs - Establish a decommissioning and disposal system				
Objective 5	Strengthen the medical oxygen regulation system	The proportion of oxygen plants that are licensed biannually fulfilling the minimum requirements.	Reports	-	-
Interventions	- Develop regulation minimum standards - Introduce a regular inspection system - Integrate oxygen regulation with a routine regulation system - Capacity building of regulatory professionals - Advocacy and creating ownership - Establish a regulatory support system to translate innovations to local production				
Objective 6	Enhance research and innovation on the medical oxygen system	- Number of research and innovation hubs established	-	-	-

Interventions	- Develop research priority areas - Establish a national oxygen research repository and use it for decision making - Establish medical oxygen innovation hubs - Integrate the national medical oxygen grand challenge - Translate innovations into local production				
Objective 7	Ensure a sustainable financing mechanism for the medical oxygen system	The proportion of the budget spent on medical oxygen as compared to the total budget spent	-	-	-
Interventions	- Build MoH/RHB capacity for successful stakeholders' coordination and efficient and equitable deployment of medical oxygen with a sustainable financing strategy - Coordinate analytical activities and stakeholder consultation and dialogue to develop better investment in the production and distribution of medical gasses for public and private facilities				

Performance Monitoring and Reporting Mechanism

National

- Medical Service at MoH will routinely monitor the overall performance of the roadmap implementation
- There will be nationally selected key indicators for regular monitoring of roadmap implementation at all levels
- The national desk will develop all necessary standardized data capturing tools/registers, reporting formats, assessment and supervision checklists
- The national team will provide regular capacity building on developed data capturing tools/registers, reporting formats, assessment and supervision checklists
- The national team collects quarterly performance reports from all RHBs and Health facilities and provides written feedback
- In collaboration with RHB and key stakeholders, the national team will conduct integrated supportive supervision of selected health facilities and RHBs on quarterly bases and provide written feedback
- The national team is expected to integrate medical oxygen with national assessments (such as; SPA, SARA, HSTP-II review, etc.)
- Make medical oxygen roadmap performance a standing agenda for JSC at least twice a year.

Regional

- The regional team will use selected key indicators for regular monitoring of roadmap implementation at the regional level
- Provide technical support to all health facilities on the standardized data capturing tools/registers, reporting formats, assessment and supervision checklists
- Quarterly collect medical oxygen performance reports from health facilities, compile and submit to MoH
- Based on the quarterly submitted reports, the RHB team will provide written feedback to all health facilities in the region
- The regional team will provide quarterly based integrated supportive supervision to selected health facilities and provide written feedback
- Integrate medical oxygen performance in major regionally existing monitoring platforms

Facility:

- Health facilities SMT is expected to ensure the availability of all standardized data capturing tools/registers and reporting formats
- Health facilities SMT is expected to monitor medical oxygen service performance every two weeks
- Health facilities are expected to share their approved quarterly performance report with both their respective RHB and MoH
- The health facilities Performance Monitoring Team (PMT) is responsible for supporting and monitoring the utilization of all standardized data capturing tools/registers and reporting formats

- Health facilities are expected to integrate medical oxygen service with existing service quality audit platforms

Performance Review and Feedback Mechanism

National

- National level performance review meeting (PRM) is expected to be held every quarter with RHBs, selected hospitals, and key partners
- Meeting agendas mainly include but are not limited to reviewing performance reports, sharing best practices and up-to-date research findings, identifying challenges, and setting common strategic decisions
- The national team is expected to integrate medical oxygen performance with major nation flagship initiative performance review platforms (such as; EHAQ, EPHAQ, I-CARE, ARM, etc.)

Regional

- Regional-level performance review meeting (PRM) is expected to be held twice a year with selected hospitals and key stakeholders
- The meeting agenda mainly include but is not limited to reviewing regional performance reports, sharing best practices and up-to-date research findings, identifying challenges, and setting way forwards
- The regional team is expected to integrate medical oxygen performance with major regional-level flagship initiative/performance review platforms (such as; EHAQ, EPHAQ, I-CARE, ARM, etc.)

Facility:

- Health facilities PMT and quality department/unit are expected to conduct medical oxygen service data capturing and reporting audits using existing and additional audit mechanisms (such as; LQAS, RDQA, etc.)
- Based on the audit findings, the PMT is expected to provide written feedback to all service units

Performance Measurement: Indicators

S.N.	Indicator	Type of indicator	Levels of data collection	Data source	Frequency of data collection	Baseline	Target
1	Institutional hypoxemia-related death rate	Outcome	All	Death review/HMIS	Quarterly	TBD	
2	Percentage of hypoxemic patients who have been treated with oxygen	Outcome	All	HOSPKPI	Monthly	58%	90%
3	The proportion of oxygen stockout in a day per month	Outcome	All	HOSPKPI	Monthly	48%	5%
4	The proportion of patients that have had their oxygen saturation monitored with pulse oximetry at their first point of contact at the facility per 24 hours (disaggregated by the emergency room, outpatient department)	Process	Health facility	Assessment	Monthly	59%	90%
5	The proportion of health facilities with assigned units or focal for medical oxygen	Input	All	Admin report	Quarterly	-	100%
6	Surgical cancelation rates due to lack of oxygen	Outcome	All	HOSPKPI	Monthly	-	
7	The proportion of acutely sick patients screened using pulse oximetry	Process	Health facility	Assessment	Monthly	-	100%
8	The proportion of hypoxemic children referred out	Process	Health facility	Assessment	Monthly	-	
9	The proportion of Facility based Oxygen utilization disaggregated by NICU, ICU, OR, ER, OPD, IPD	Output	Health facility	Assessment	Monthly	-	70%
10	The proportion of General and Tertiary hospitals with central piping and/or manifold system	Input	All	Assessment	Annual	30%	70%
11	The proportion of hospitals performing annual medical Oxygen quantification	Input	All	Assessment	Annual	-	80%

12	The proportion of health facilities with trained health care providers on medical oxygen	Output	All	Assessment	Annual	43%	100%
13	Facility based Incident rate due to oxygen safety issues	Output	All	Assessment	Annual	-	
14	Percentage of ambulances without oxygen	Input	MOH, RHB	Admin report	Annual	-	0%
15	The proportion of oxygen systems that remain functional 1 year after installation/repair (disaggregated new, repaired)	Input	All	Facility medical equipment inventory	Annual	-	100%
16	Percentage of functional medical oxygen devices (disaggregation by type)	Input	All	Facility medical equipment inventory	Annual	-	60%
17	The proportion of facilities with functional medical oxygen systems (Disaggregated by HF type (HCs and Hosp.) and (service areas, Pediatric, Neonatal, Maternity, Surgery, OPD, NCD)	Output	All	SARA	2 years	48%	90%
18	The proportion of technical staff trained on oxygen systems operation and maintenance at the facility level.	Input	All	Assessment	Annual	-	100%
19	Number of innovation hubs established	Input	MOH, RHB	Admin report	Annual	-	6
20	The proportion of the budget spent on medical oxygen as compared to the total budget spent	Input	All	Administrative and Financial Records	Annual	-	40%
21	The proportion of oxygen plants that are licensed biannually fulfilling the minimum requirements.	Output	All	Admin report	Biannual	-	100%

Costing and Financing

Costing Approach

To determine the estimated cost of the Ethiopia medical oxygen roadmap II, a list of consumables and devices related to medical oxygen by type was identified and plotted against all the three tier levels of facilities in the country based on service provided and standards. After gathering the necessary information, UNICEF's medical oxygen planning tool V2.1 was used to estimate health facility-level oxygen source options, oxygen demand at each health facility, and the capital and operating costs associated with the oxygen supply system. Moreover, the cost of the spare parts of medical devices is not included in UNICEF's tool, and for soft activities planned in the roadmap, various tools were developed by MoH using the previous roadmap experience.

The subsections below summarize the costing activities followed to come up with the cost estimates given in this document

Identification of cost items

The list of medical devices and consumables related to medical oxygen was adopted from WHO, and additional required parts were added. Then all the listed items were linked with the services provided according to the appropriate level of care. The soft activities were also costed based on the target set for that specific intervention activity. The initial capital cost of the items was taken from various sources from international market prices and implementing partners and manually entered into UNICEF's medical oxygen planning tool and MoH's annual planning tool.

Assumptions regarding Medical oxygen access in the country

A team of experts has reviewed the report made by the MoH on existing and future planned oxygen plants found in public health facilities with their respective production capacities and entered it into UNICEF's medical oxygen planning tool V2.1. Moreover, other private oxygen plants that supply oxygen to health facilities were also included.

Assumptions taken for medical Oxygen need and medical device quantification exercise

Medical oxygen and devices related to oxygen demand were quantified for 35, 108, and 319 tertiary, general, and primary public hospitals, respectively. As the number of beds in each unit or department was not available, the proportion for admission beds was calculated as follows using national assessments carried out and also adopted from the previous roadmap preparation; adult (64%), ICU (2%), OR/OT (2%), Neonatal (7%), paediatrics (15%) and OPD (1%), ER (9%) was used for determining the number of beds of each unit/ department. Moreover, a team of experts has set 280 beds as the minimum requirement to set up an oxygen plant.

The data reports required for the quantification exercise were extracted from DHIS-2 from 'HAMLE' 2013 up to 'SENE' 2014 E.F.Y., and the Bed turnover rate was calculated by dividing the annual Number of inpatient admissions by the number of beds reported in the fiscal year (Number of inpatient admissions/ Total Number of beds in the reporting period).

For hospitals with a ‘0 (zero)’ reporting status, like in the Tigray region, the mean from other hospitals with similar capacity was used for the total number of outpatient visits and bed number, bed occupancy, and bed turnover as a proxy for the missed parameters.

The demand for primary health care facilities (HC and HP) was also made for 4,147 facilities. The detailed assumptions taken for each tier level are explained in detail below;

Assumptions for Tertiary Hospitals

The assumption is made for 35 tertiary-level hospitals currently reported on DHIS-2. Other assumptions considered for tertiary hospitals are that they have ‘Good’ Oxygen availability, oxygen plants, and 22 hours of electrical power availability. The distance from the nearest oxygen plant was calculated using Google map for the rest of the hospitals with no oxygen plant.

Assumptions for General Hospitals

The assumption is made for 108 secondary-level hospitals per the master facility database/registry report (MRF). Other assumptions considered are that they have ‘Good’ Oxygen availability, as most exist in urban settings with better access to oxygen sources, and that there are 22 hours of electrical power availability. Based on the end-term evaluation of the first roadmap, the average distance from the nearest oxygen refilling plant was considered 120 Km.

Assumptions for Primary Hospitals

The assumption is made for 319 Primary hospitals as per the master facility database/registry report (MRF). Other assumptions taken into account include that they have "Good" oxygen availability despite minimal interruptions, that there are 22 hours of electrical power availability given that they are connected to a backup generator and a central power source and that the average distance from the closest oxygen refilling facility is 188 kilometres. These assumptions are based on the end-term evaluation of the first roadmap.

Assumptions for Primary health care facilities (Health centers and Health Posts)

Assumptions were made for three types of facilities under primary health care to quantify medical oxygen demand and other consumables and devices related to medical oxygen. According to the recent HEP roadmap and implementation guideline, a team of experts has identified the facilities that require and provide oxygen service were health centers providing CEmONC services, health centers not providing CEmONC services (non-CEmONC Health centers), and this is further classified into two as those with, and without inpatient service and comprehensive health posts. Hence, the total number of facilities considered was 4147 (see table below

Table 2. primary health care facilities disaggregated by type

S No.	Health facility type	Number
1	Total number of Health centers	3,789
2	CEmONC Health center	265
3	Non-CEmONC Health center with in-patient	1,596
4	Non-CEmONC Health center without in-patient	1,928
5	Comprehensive Health post	358
Total Health facility number		**4,147**

Even though optional, according to the 2021 health center minimum standard, a health center can provide in-patient services. And the minimum number of in-patient beds per health center was 10 beds. However, based on the annual report on DHIS-2 and practical lessons, a minimum of 5 in-patient beds per health center providing in-patient service was considered for the quantification exercise.

Therefore, health centers offering CEmONC service will have a total of 9 beds (2 operation tables, 5 in-patient beds, and 2 emergency beds); health centers offering in-patient service but not CEmONC will have a total of 7 beds (5 in-patient beds, and 2 emergency beds), and health centers providing neither CEmONC nor in-patient service will have a capacity of 2 emergency beds.

An average OPD visit of 17,213 was considered for health centers that had a '0 (zero)' reporting status, the average hours of reliable power availability in the health centers providing CEmONC services was taken as 20 hours as they all have at least one backup generators, the average hours of reliable power availability in the health centers were taken as 8 hours, the availability of oxygen was taken as 'poor' (based on the UNICEF oxygen planning tool). And the average distance to a nearby oxygen plant was taken as 250 km for all health centers.

Costing summary

Using the approaches and assumptions stated above, the total cost of implementing the roadmap is estimated to be $213,793,714.49 for the 5 years.

Table 3. CAPEX and OPEX cost of oxygen-related devices and consumables

	Pulse Oximetry	Primary Recommendation	Secondary Recommendation*
CAPEX	**$5,882,035**	**$47,081,209**	**$6,517,061**
Initial product cost	$4,934,920	$38,015,850	$1,879,520
Accessories	$206,200	$1,837,269	$1,731,316
Shipping	$463,072	$1,190,009	$306,201
Distribution	$231,536	$475,916	$180,542
Installation	$46,307	$1,066,165	$321,882
Power back up	$0	$4,496,000	$2,097,600
OPEX (for 5 years)	**$2,596,405**	**$90,403,908**	**$44,748,127**
Electricity costs	$0	$44,107,228	$3,788,673

Cylinder refill costs	$0	$16,477,902	$18,001,968
Transportation costs	$0	$10,633,418	$18,893,759
Spare parts	$1,632,793	$ 3,101,060	$178,435
Consumables	$0	$3,620,466	$2,646,222
Operation costs	$0	$3,953,253	$78,404
Maintenance	$69,461	$8,339,797	$765,502
Device replacement	$894,151	$170,784	$395,164
Training (one-time cost)	**$221,226**	**$771,040**	**$251,212**
TOTAL	**$8,699,666**	**$138,256,157**	**$51,516,400**

Total Estimated Sum **$198,472,223**

Category	Cost in ETB	Cost in $
Training	90,939,591.90	$ 1,715,841.36
Meeting Workshops	28,465,037.12	$ 537,076.17
Supervision	148,553,920.00	$ 2,802,904.15
Printing	3,532,000.00	$ 66,641.51
Other *	14,000,000.00	$ 264,150.94
Equip EFDA and establish a toll-free center	100,000,000.00	$ 1,886,792.45
Construction	426,548,500.00	$ 8,048,084.91
Total Cost	**812,039,049.03**	**$ 15,321,491.49**

* Supporting the development and implementation of quality improvement projects on medical oxygen and Performing feasibility studies on sustainable funding mechanisms, including results-based financing, revolving drug funds, and public-private partnerships

Financing Options

There should be a sustainable financing mechanism to ensure medical oxygen availability. Medical oxygen ecosystem management requires intensive resource mobilization to create equitable access to quality medical oxygen and oxygen devices. The cost associated with effective medical oxygen ecosystem management includes procurement, transport, customs, installation, maintenance, spare parts, consumables, operation, and capacity-building training costs. The Ethiopian government will put in place different mechanisms, including resource mobilization, creating mechanisms for the efficient use of resources, and implementing innovative financing modalities and cost recovery mechanisms for the medical oxygen system.

The FMOH will allocate the necessary budget and mobilize adequate resources through traditional

and innovative approaches from domestic and external sources, reduce out-of-pocket spending, enhance efficiency and effectiveness, and strengthen the public-private partnership. Revenue generated from community-based health insurance (CBHI) and revolving drug funds (RDF) helped some facilities cover the procurement and running costs for oxygen. Healthcare financing is one of the strategies to mobilize adequate resources from domestic and external sources, including health insurance mechanisms (SHI & CBHI).

Innovative financing mechanisms also could play a key role in additional resource mobilization for health; priority will be given to innovative mechanisms that increase funding over conventional resource mobilization and utilization mechanisms such as a flagship trust fund and earmarked sin tax tariffs on alcohol, tobacco, and chat.[1], and public-private partnerships (PPP).

[1] FMOH Health Care Financing Strategy 2017 – 2025

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Annex

Annex 1. Name list of consultative workshop participants

No	Participant Name	Name of Facility/Organization
1	Dr AMANUEL LULU	MoH, Medical Service Lead Executive Office, Officer
2	Mr. ALEMAYEHU BERHANU	Technical Advisor, MoH/Medical Service Lead Executive Office
3	Dr ASHENAFI BEZA	Technical Advisor, MoH/Medical Service Lead Executive Office
4	ABDI LEGGESE	OROMIYA RHB
5	AMARE BAYEH	PATH
6	ANDARGIE ATENAF	AMHARA RHB
7	AYERU FEKADU	EPSS
8	BINYAM SHIFERAW	SOUTH RHB
9	CHIENG MALUTH	GRHB
10	DALECHA DANGURA	SIDAMA RHB
11	DAWIT DEBEBE	AURORA P.L.C
12	DESALEGN ESHETU	IES
13	DR. MASRESHAW DEMELASH	ASSIST INT
14	DR. MELKA KENEA	SSE
15	DR. MOHAMMED KALIFA	ESEP
16	DR. YONATHAN ABEBE	ESAPA
17	ETSE-HIWOT GIRMA	OXYGEN HUB
18	EYOBED KALEB	MOH
19	FASIKA BERHANU	DDRHB
20	KASAHUN H/GIORGIS	OHB
21	MAZENGIA AYALEW	MOH
22	MELKAMU TIRUNEH	AARHB
23	MERKENI UMER	BGRHB
24	MIHRET KASSAHUN	MOH
25	MIKIYAS PETROS	EFDA
26	MINTESNOT ENDASHAW	SWE-RHB
27	MULATU SISAY	EHF
28	SHIMELIS AWEKE	AFAR RHB
29	SOLOMON BEDEMARIAM	GAST SOLAR P.L.C
30	TSION ZEWDU	AA
31	YONAS ALAMIREW	HRHB
32	ZIYAD NUR	SOMALI RHB
33	Aschalew Kassahun	M & E, CHAI
34	Salem Fisseha	M & E, CHAI

Annex 2. Current oxygen plants and their locations

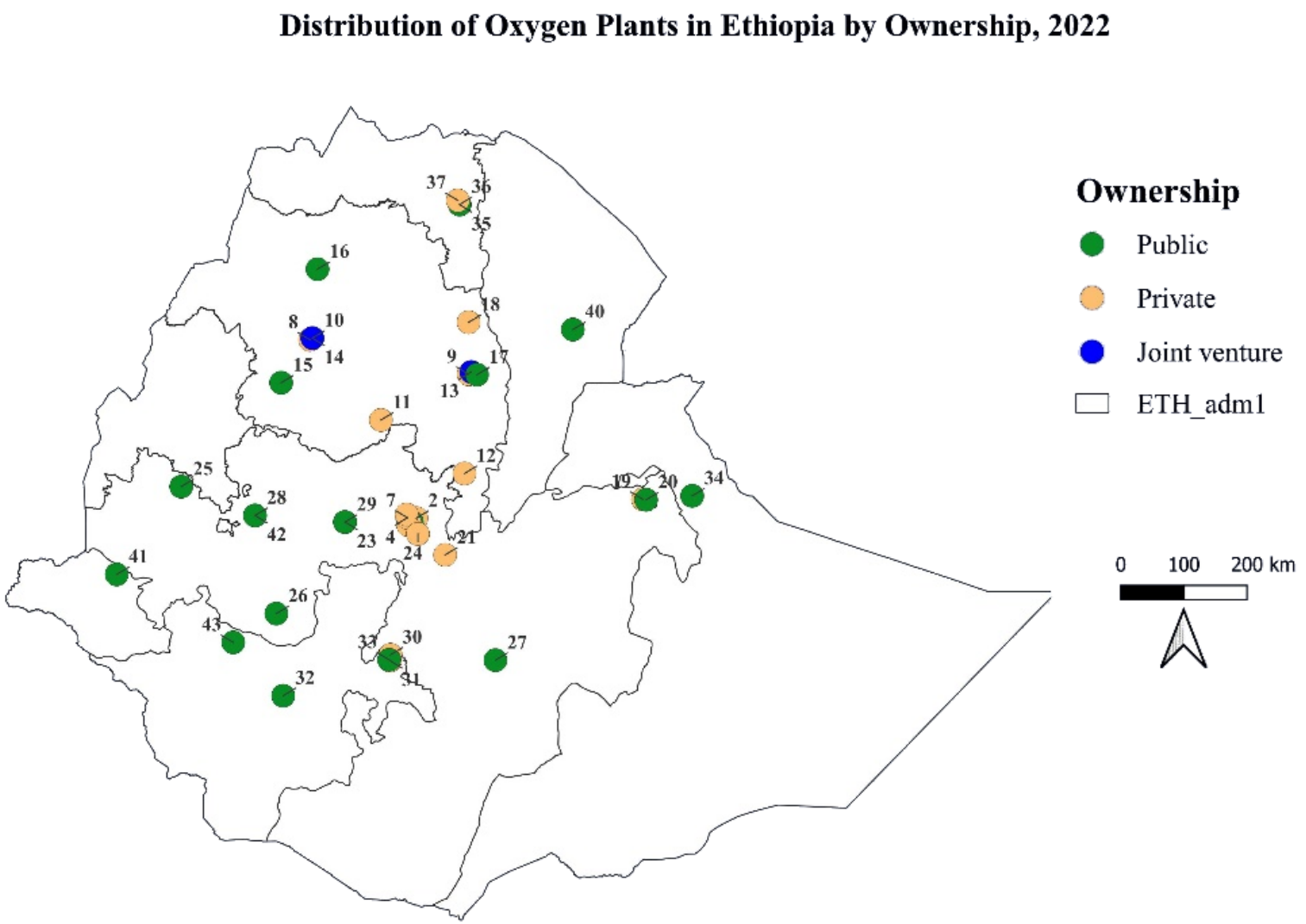

Table 4 Tabular representation of Oxygen Plants:

S.No	Name	Region	Ownership
1	Amaga/Chora	Addis Ababa	Private
2	Gast solar	Addis Ababa	Private
3	TASH	Addis Ababa	Public
4	SPHMMC	Addis Ababa	Public
5	Sol oxygen plant	Addis Ababa	Private
6	Wei yong	Addis Ababa	Private
7	Aurora chemicals Oxygen factory	Addis Ababa	Private
8	Amaga/Chora 2	Amhara	Private
9	Big Oxygen	Amhara	Private
10	Bahirdar University (Tibebe Ghion)	Amhara	Public
11	Berenta	Amhara	Private
12	Kea-med oxygen plant	Amhara	Private
13	Dessie General Hospital	Amhara	Public
14	Felegehiwot General Hospital	Amhara	Public
15	Injibara General Hospital	Amhara	Public
16	Gondar comprehensive specialized Hospital	Amhara	Public
17	Kombolcha General Hospital	Amhara	Public
18	Woldia Oxygen plant	Amhara	Private
19	Ashewa Meda Oxygen plant	Harari	Private
20	Hiwot fana Hospital	Harari	Public
21	Universal	Oromia	Private
22	IMAN/Sululta	Oromia	Private
23	Ambo1	Oromia	Public
24	Ambo2	Oromia	Public
25	Gab	Oromia	Private
26	Nedjo	Oromia	Public
27	Jimma	Oromia	Public
28	Madda Walabu University	Oromia	Public
29	Wollega/Nekemte	Oromia	Public
30	Liyana-oxy manufacturing	Sidama	Private
31	ATMA	Sidama	Private
32	Dilla Hospital	SNNPR	Private
33	Hawassa university	Sidama	Public
34	Jigjiga Hospital	Somali	Public
35	Ayder 1	Tigray	Public
36	Ayder 2	Tigray	Public
37	Velocity	Tigray	Private
38	Gast solar/Sardag	Tigray	Private
39	Getachew Baru P.L.C	Tigray	Private
40	Dubti General Hospital	Afar	Private
41	Gambella General Hospital	Gambella	Public
42	Nekemte Comprehensive specialized Hospital	Oromia	Public
43	Gebre Tsadik Shawo General Hospital (Bonga)	SWEP	Public