

What are gas companies doing to scale up access to liquid medical oxygen?

APRIL 2023

The gas companies that dominate the global market for medical liquid oxygen have a key role to play in increasing and sustaining long-term access to this lifesaving product. This report tracks initiatives six global gas companies have undertaken to increase access and provides insights on what they can do to supply medical liquid oxygen both during public health emergencies and to meet the day-to-day health needs of people living in low- and middle-income countries.

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About this report

This report is part of the Access to Medicine Foundation's Medical Oxygen Programme. By assessing how the major global gas companies that also produce medical liquid oxygen (medical LOX) are responding to the chronic lack of access to this essential healthcare product in low- and middle-income countries (LMICs), the Foundation aims to incentivise these companies to do more to expand access to medical LOX in these countries.

This first published research report follows gas companies' initiatives to ensure sustainable access to medical LOX and identifies six priority areas for action that these companies can focus on to expand access in LMICs over the long term.

What has the Access to Medicine Foundation done so far?

In order to develop and identify solutions to the issues limiting access to medical oxygen in LMICs, the Access to Medicine Foundation has co-hosted a series of roundtables that have convened representatives from gas companies, global health organisations, investors and policymakers.

Since early 2020, as the COVID-19 pandemic unfolded, these roundtables have developed a roadmap of expectations for different stakeholders, including gas companies. The Foundation co-hosted three roundtable events with the Every Breath Counts Coalition (EBC) in September and December 2020 and June 2021, and a fourth with Chatham House in October 2022, all focused on the subject of access to medical oxygen in LMICs.

The Foundation also participates in key oxygen groups, including the ACT-Accelerator Oxygen Emergency Taskforce, the EBC and the Lancet Global Health Commission on Medical Oxygen Security, and regularly engages with relevant stakeholders on this topic.¹⁻³

How this report was developed

This report analyses initiatives undertaken by six global gas companies to increase access to medical LOX. The analysis is based on publicly available information as well as original data provided by some of these companies in response to a questionnaire set by the Foundation which focused on long-term access to medical LOX initiatives. The report is further informed by insights from the four roundtables hosted by the Foundation. These were held under the Chatham House Rule and all participants remain anonymous. Information was crosschecked directly with gas companies to ensure accuracy, where possible.

SCOPE OF RESEARCH



Companies

The global market for medical LOX is concentrated and dominated by a few companies.⁴ In scope of this report are six of the largest global gas companies: Air Liquide, Air Products, Linde, Messer*, Nippon Sanso Holdings Corporation** and SOL Group***.

In this report, 'gas companies' refers to companies that produce industrial gases such as nitrogen, hydrogen and oxygen, among others.⁵⁻¹⁰ Some of these gases, such as oxygen, are also produced for medical use.

Of the six gas companies in scope, Air Products and Messer did not respond to requests for additional data, or crosschecking of information. The actions of one smaller medical LOX producer, HAWA del Sur, are also highlighted in this report to show how smaller players are addressing needs in access.



Product

Medical oxygen is produced in three different ways:¹¹⁻¹⁴

- Cryogenic Air Separation Units (ASUs) are larger plants that produce medical LOX via cryogenic fractional distillation which can either be delivered to hospitals and stored in bulk medical LOX tanks and piped to a patient's bedside by transforming it into gaseous form, or transformed and delivered in gaseous form via cylinders which supply the piping network or the patient directly at their bedside. A small group of multinational companies produces and distributes the global supply of liquid oxygen produced by ASUs.
- Concentrators are medical devices that provide a gaseous supply of medical oxygen to a patient at their bedside. Concentrators function via Pressure Swing Absorption (PSA) technology. The market for concentrators is less concentrated than the market for ASUs.
- PSA plants are larger systems that produce gaseous medical oxygen, typically on site at the hospital. PSA plants function via PSA technology. The market for the production of PSA plants is also less concentrated than the market for ASUs, and PSA plants can be owned by both public and private entities.

Each of these three methods has its advantages and disadvantages, depending on the usage and setting.^{11,12} Enabling the steady supply of oxygen through a variety of mechanisms permits health facilities to choose which form best meets their needs for specific situations, including health emergencies.

This report focuses on access to medical LOX. The companies in scope produce both industrial and medical LOX, but only medical LOX is suitable for human use.¹⁵ Medical LOX is tested to meet authorised specifications to ensure its identity, purity and content and production, storage and distribution using appropriate processes.

When referring to 'medical LOX' in this report, the Foundation is referring to medical oxygen produced via cryogenic fractional distillation at cryogenic ASUs. This term encompasses all methods of distribution, e.g., as bulk LOX or in cylinders after transformation to gaseous form.



Countries

Using the same country inclusion criteria as set out in the methodology for the 2022 Access to Medicine Index, this report focuses on the actions of the gas companies in scope across 108 LMICs.¹⁶ A full country list can be found in the appendix.

*Messer is the name used in this report to encompass both the Messer Group and the Messer Industries Group.

**Nippon Sanso Holdings Corporation will be referred to as Nippon Sanso going forward in this report.

***In this report, the Foundation uses company names as referred to in company annual reports. Where applicable, the parent company name is highlighted in addition to, in parentheses, the subsidiary name.

Executive summary

The devastating impact of the COVID-19 pandemic has starkly demonstrated how many deaths could be prevented if health systems were better equipped with medical oxygen as part of their arsenal of health products. But while it has taken a pandemic to expose major underlying inequities in access to medical oxygen in low- and middle-income countries (LMICs) the deeper problems preventing access to this lifesaving product have long been neglected.

Historically, medical liquid oxygen (medical LOX) has played a small part in the business operations of gas companies, with the production of industrial gases as their primary focus.¹⁷⁻²⁰ However, given the fact that just a handful of gas companies produce medical LOX, it is critical to the wellbeing of people living in LMICs that these companies expand or develop their roles and responsibilities as manufacturers of this lifesaving health product, and that they elevate it as an important part of their overall business operations.

This report sets out six priority areas for action (see right) that gas companies can engage in to scale up and sustain access to medical LOX in LMICs. Starting with a high-level overview of companies' responses to the COVID-19 pandemic, the report analyses whether companies are taking action in these areas.

Agile responses to COVID-19, but more long-term initiatives are needed

Gas companies' responses to the surges in demand for medical LOX during the COVID-19 pandemic illustrate what can be achieved when these companies engage in efforts to scale up the supply of their product in LMICs. Notably, some gas companies redirected their industrial liquid oxygen production and distribution assets towards medical LOX and also collaborated with a range of governments, global health partners, and other private sector companies to enable wider distribution of medical LOX.

However, now that the immediate public health emergency has passed, it is not always clear whether gas companies will continue to address gaps in access over the long term. Of the companies examined in this analysis, Air Liquide is currently the only company with a clear access-to-medical oxygen strategy targeting LMICs.

The Foundation's analysis identifies some efforts from companies that could lead to a more sustainable supply of medical LOX in more LMICs over the long term. For example, since the start of the COVID-19 pandemic, both Air Liquide and Linde have reported providing medical LOX in regions they did not previously supply. Four companies, Air Liquide, Air Products, Messer and Nippon Sanso have installed or acquired new LOX-producing Air Separation Units (ASUs) in LMICs, including in South Africa, China, Egypt, India, Vietnam and Thailand. Such ASUs have the potential to supply large populations with medical LOX.

Both Air Liquide and Linde have also formalised long-term partnerships aimed at addressing access gaps in medical LOX beyond the COVID-19 pandemic by entering into Memoranda of Understanding (MoUs) with Unitaid and the Clinton Health Access Initiative (CHAI).

In preparing for future health emergencies, three companies, Messer, Nippon Sanso and SOL Group have reviewed and institutionalised some of their successful emergency approaches to establish pre-emptive emergency plans.

What needs to happen next?

Access to medical oxygen needs to be a corporate priority for gas companies – with company leadership driving this change. Critically, clear targets need to be set at the highest level of a company, with progress being measured and publicly disclosed. Institutional investors who invest in these gas companies can also encourage further progress via monitoring company action and holding company leadership to account.

By considering all of the priority areas identified in this report, companies can commit to taking tangible action to expanding medical LOX in LMICs – both during emergencies and to ensure routine delivery.

PRIORITY AREAS FOR ACTION

This report identifies six priority areas for action that companies can focus on to provide access to medical LOX in LMICs, both in emergencies and to provide routine delivery, and examines what is already being done in each area:

- 1 Prioritise, measure and report progress on access to medical liquid oxygen
- 2 Enable improved affordability for different populations and health systems
- 3 Provide sustainable supply of medical liquid oxygen
- 4 Develop and maintain long-term partnerships to close access gaps
- 5 Support health systems & the human resources required to operate & maintain medical liquid oxygen systems & administer oxygen therapy
- 6 Plan proactively for future emergencies

Recognising the unmet medical need

Medical oxygen is an essential, lifesaving product that every person should have reliable and affordable access to when they need it.²² It is a necessary treatment for such a broad variety of conditions and diseases – and is needed in such a wide range of medical situations – that it can be hard to quantify just how essential it is to people's quality of life and survival.

Aside from medical oxygen's recent high-profile use for patients suffering from severe COVID-19, medical oxygen is also a critical treatment for other communicable conditions such as pneumonia, malaria and tuberculosis.³ Non-communicable diseases that can lead to a need for medical oxygen include chronic obstructive pulmonary disease (COPD), asthma and heart disease. Many of these conditions, as well as a multitude of other illnesses, can lead to life-threatening hypoxemia (low blood oxygen), for which medical oxygen is an essential treatment (see figure 1).²³

Healthcare facilities also require medical oxygen for routine and daily medical procedures, including trauma, during surgery and for mothers and babies during birth.^{3,14}

Despite this high clinical need – and medical oxygen being listed on the World Health Organization (WHO) Model List of Essential Medicines, with no substitute – critical access gaps in medical oxygen have remained persistent across LMICs.^{3,14,22,24} Both the unmet and unrecognised need for medical oxygen is high in these countries, and many health facilities have severely limited or unreliable medical oxygen services.³

The Executive Board of WHO recently announced that it will recommend the first Access to Medical Oxygen Resolution for adoption at the 76th World Health Assembly (WHA) in May 2023, which further demonstrates the critical need to scale up access to medical oxygen in LMICs as a global health priority.^{25,26}

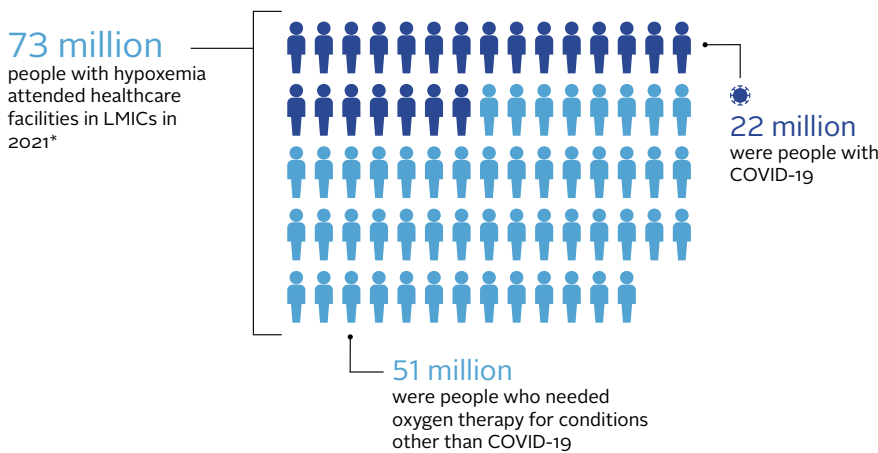


The World Health Organization defines medical oxygen as “lifesaving and an essential medicine used to ensure safe surgical, emergency and critical care services. It is used at all levels of the healthcare system and is crucial for the treatment of COVID-19 and other life-threatening conditions such as severe pneumonia, severe malaria, sepsis caused by a wide variety of pathogens, trauma and complications of pregnancy or birth. Unlike many medicines, it has no substitute.”¹⁴



Despite the high need for oxygen therapy, approximately half of healthcare facilities in Africa do not have reliable access to essential oxygen.²⁷⁻²⁹

FIGURE 1 Visualising the critical need for oxygen in LMICs



Source adapted from Asian Development Bank. *Strengthening Oxygen Systems in Asia and the Pacific*. 2022.⁴

*This number is a conservative estimation and does not include people who needed oxygen for other reasons, for example for resuscitation or during anaesthesia for surgery or childbirth.

What is limiting access to medical oxygen in LMICs?

There are several challenges hampering access to medical oxygen in LMICs. These include, among others: market concentration, fragmented supply chains, weak health facility oxygen infrastructure, transport challenges and unreliable energy resources for production.³⁰

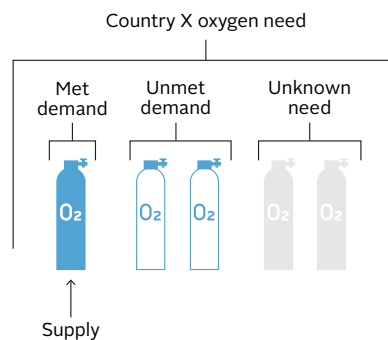
The COVID-19 pandemic has also revealed a longstanding lack of awareness of the critical importance of access to medical oxygen within health systems, which has led to chronic underinvestment in oxygen systems and staff training in administering oxygen therapy.^{3,30,31} Furthermore, where medical oxygen is available, it is often unaffordable.^{30,32,33}

Another key challenge repeatedly raised during roundtable events co-hosted by the Foundation is the low visibility of demand for medical oxygen in LMICs.^{30–32,34} While it is an effective treatment for a significant number of medical conditions, the lack of quantifiable data on oxygen need and service capacity is resulting in underestimated demand for medical oxygen in LMICs.³⁰

Additionally, patients and health systems do not necessarily 'demand' a drug or commodity which has never been available in their setting. This makes it difficult for gas companies and policymakers to quantify the potential opportunity for medical oxygen production in these countries.

FIGURE 2 The mismatch between oxygen need, demand and supply

Official estimates of how many patients will need oxygen each year, the quantity of oxygen needed and the conditions driving this demand are currently unavailable.²⁶ This data is crucial to enable countries to ensure appropriate supplies of medical oxygen are available in their health systems.



*To accurately reflect data sources, units of weight have been described as either 'tonne' or 'ton' in this report. These are different units of measurement, with one 'tonne' (1,000 kg) being metric and one 'ton' (907 kg) an alternate measure.

Medical liquid oxygen presents a promising long-term supply solution

Meeting high demand for oxygen has been a particular issue noted during the COVID-19 pandemic, with Pressure Swing Absorption (PSA) plants that produce gaseous medical oxygen sometimes unable to fully meet health facilities' high demand.^{35,36} Air Separation Units (ASUs), which produce medical LOX, have the capacity to produce large volumes, of 300-5,500 tonnes*/day, making them optimal to meet high demand and supply of large hospitals in urban and peri-urban areas with bulk medical LOX storage tanks.^{13,14,37}

In addition, medical oxygen produced at ASUs can be distributed in cylinders to smaller or rural facilities via a 'hub-spoke' distribution model from larger hospitals with bulk medical LOX tanks, or separate medical LOX bulk storage sites with cylinder filling stations.³⁷

Although the cost-effectiveness of this solution depends on the local road infrastructure and availability of bulk storage tanks and piping networks in health facilities, it can allow for a sustainable, long-term supply chain due to ASUs' ability to meet higher oxygen demands, while transporting less-voluminous liquid oxygen.^{14,37}

How gas companies can help close the access gap

The group of companies in scope of this report is largely responsible for the supply of medical LOX globally. Any changes in their business practices and policies that prioritise access to medical LOX can significantly impact the accessibility and affordability of this essential healthcare product in LMICs.³⁸

These gas companies have engaged in initiatives to, for example, support healthcare facilities and increase supply of medical LOX in LMICs that were worst affected by the COVID-19 pandemic between 2020 and mid-2021.^{39,40} However, many of these efforts were limited in reach and primarily focused on responding to demand surges during the peak of the pandemic, with few initiatives identified to address the pre-existing gaps in access to medical oxygen.

In 2023, COVID-19 continues to present a large unmet need for medical oxygen, at the same time as chronic gaps in access for medical oxygen also remain unmet in many LMICs.^{3,24}

Ensuring sustainable access to medical LOX in LMICs is a long-term endeavour. Global health partners have also noted the need for further investments in medical LOX in LMICs, as this form of medical oxygen could be outfitted in more locations than is currently the case.³⁰ It must be noted that some locations where ASUs could be outfitted already have operational PSA plants, with some of the major gas companies citing this as a challenge for investing in ASUs in these locations.

However, some regions are already at a stage of development where they have sufficient infrastructure to benefit from access to medical LOX.³⁰ Where this is the case, gas companies can act now to establish long-term supply. Gas companies can also find innovative ways of working in non-urban, more remote settings, as is evidenced by some of their efforts analysed in this report.

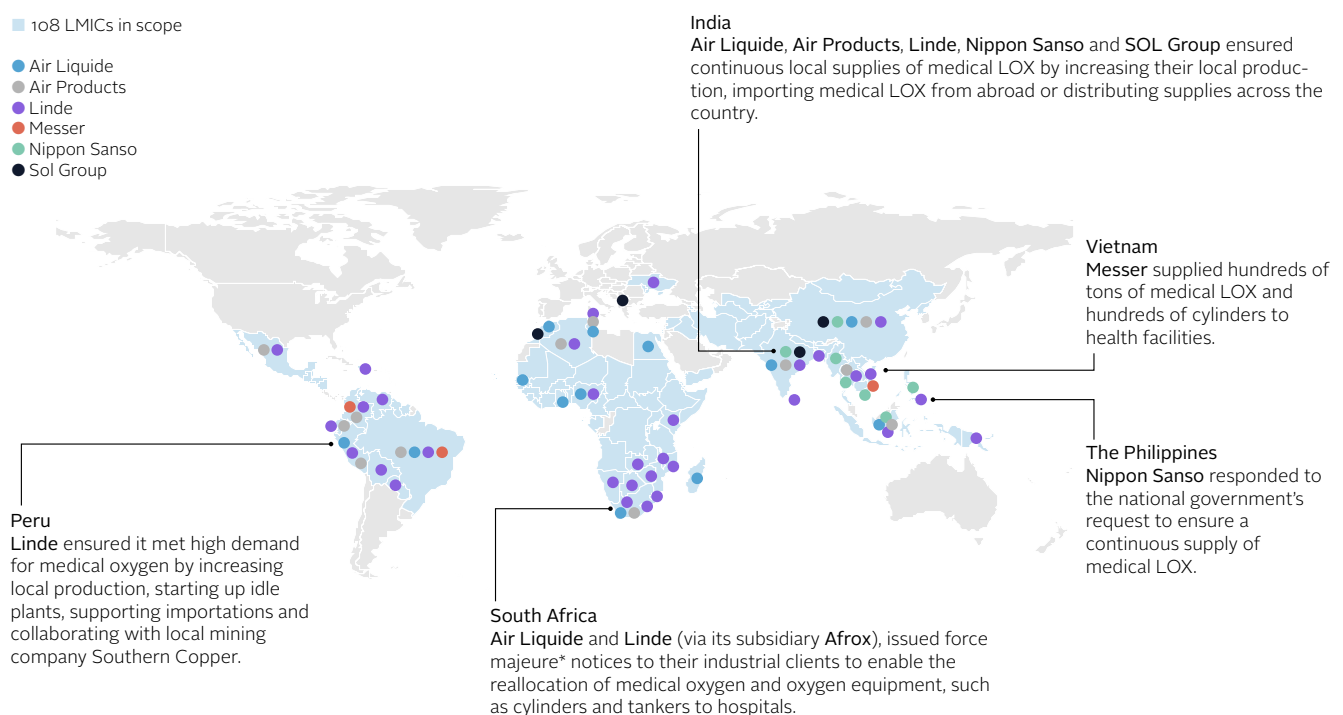
Responding to the COVID-19 pandemic

Gas companies have utilised various approaches that were key to prioritising and delivering medical LOX in LMICs during the COVID-19 pandemic (see map). The industry provided bulk supplies of medical liquid oxygen (medical LOX) and transformed bulk medical LOX to gaseous oxygen to fill cylinders, particularly for countries where healthcare facilities lack the infrastructure to transform this on site. However, these efforts have often relied on existing supply contracts with industrial clients, supply from neighbouring countries and collaborations with governments, global health partners and the private sector.

Despite taking these steps, companies' efforts during the COVID-19 pandemic have had a limited geographical reach. Across the six major gas companies covered by this analysis, initiatives to increase the supply of medical LOX have been reported, publicly or directly to the Foundation, in only 39 of the 108 LMICs in scope – approximately one third.

FIGURE 3 Snapshot of gas companies' initiatives to improve access to medical LOX in LMICs during the COVID-19 pandemic

These examples are not exhaustive, but are illustrative of some of the efforts led by gas companies to improve access to medical LOX in LMICs during the COVID-19 pandemic.^{19,21,41–49}



Reallocation of industrial LOX capacity to produce medical LOX

Due to the medical oxygen emergency during the COVID-pandemic, some local governments requested gas companies to reallocate their LOX production capacity to produce medical LOX.⁵⁰⁻⁵³ This was possible because, typically, ASUs have a dual medical and industrial LOX production capacity and may also produce other cryogenic liquids.

Many of the gas companies pivoted their existing local production and distribution capacity of industrial LOX to medical clients, which enabled them to scale up medical LOX supplies in LMICs. To unlock the extra production capacity needed to meet the increased demand, it was essential for governments to engage directly with gas companies and request that they prioritise the supply of gases to medical institutions rather than other industries. Some companies, including Air Liquide and Linde, responded to such requests by issuing force majeure* notices to industrial gas clients who use LOX in industrial processes.²¹ To be able to reallocate their production capacity from industrial to medical LOX, gas companies had to comply with stringent regulations and standards, which differed across countries.¹⁴

During the COVID-19 pandemic, Air Liquide fully dedicated its local LOX production capacity to medical use in Tunisia, South Africa and India.⁴²

Air Products also took action by, for example, dedicating 90% of its capacity in Indonesia to medical LOX and starting up idle plants in Peru and Thailand.^{36,44,53}

Linde had a similar response. The company started up idle plants in Peru to meet increased local demand, as well as in most LMICs where it had idle LOX production assets.⁴¹

Efforts to widen distribution of medical LOX

Other approaches included the use of agile and efficient distribution mechanisms that enabled the companies to supply much higher quantities of medical LOX to health facilities and over much greater distances. These included the use of various types of transport, including via rail, air freight and shipping, to overcome issues of country border closures and logistics capacity, and facilitate both international importation and national supply and distribution in LMICs.²¹

For example, Linde ensured the supply of medical LOX across India by collaborating with Indian Railways to fill and transport tankers of medical LOX on the 'Oxygen Express' trains.⁴⁵ Nippon Sanso also supported the filling and transportation of tankers of medical LOX in the 'Oxygen Express' trains by assisting the Indian government.⁴⁶ In striking scenes, whole medical LOX tankers and trailers were 'airlifted' into LMICs via specially chartered aircrafts. Messer transported 400 cylinders from Austria to India by air freight to supply hospitals that were lacking medical oxygen and storage tanks.⁵⁴

The ability to import medical LOX and medical LOX tanks; contract more drivers; authorise night deliveries; increase the number of deliveries to health facilities; and implement more rotations to refill and retrieve bulk LOX cryogenic mobile containers and medical oxygen cylinders was also key to ensuring an increased supply of medical LOX.^{21,41,42,44,54-57} For example, Air Products had a fleet of 550 transport tanks and 600 drivers to ensure the supply of medical LOX to over 800 hospitals in India.⁵⁸

As mentioned above, companies including Air Liquide and Linde, also applied force majeure notices to distribution equipment and increased the number of available medical-grade cylinders and cryogenic transport tankers by converting industrial equipment.^{21,59} Linde, via its subsidiary, Afrox, worked with local authorities to receive approval to convert several thousand industrial cylinders and some of its industrial tanker fleet for medical LOX use in South Africa and several other LMICs.

Unprecedented efforts by a range of stakeholders helped meet surges in medical oxygen demand

This section of the report analyses gas companies' responses during the COVID-19 pandemic. However, it should be noted that a range of other stakeholders, including governments and global health organisations, have also worked to secure medical oxygen supply in LMICs during the COVID-19 pandemic. This includes the The ACT-Accelerator Emergency Oxygen Taskforce, established in 2021, which is currently chaired by Unitaid. The Access to Medicine Foundation is a member, as are the Africa Centres for Disease Control and Prevention (Africa CDC); the World Health Organization (WHO) and its Biomedical Consortium; UNICEF; UNOPS; The Global Fund to Fight AIDS, Tuberculosis, and Malaria (The Global Fund); the World Bank; USAID; the Clinton Health Access Initiative (CHAI); PATH; Save the Children; the Bill & Melinda Gates Foundation; and the Pan American Health Organization (PAHO).²

Also included as a member of the taskforce is the Every Breath Counts (EBC) Coalition, a public-private partnership to support national governments to end pneumonia deaths, which encompasses not only many of the aforementioned organisations, but also some private companies.

Global health organisations, and multi-stakeholder coalitions such as these, have played a critical role in responding to the global health crisis caused by the COVID-19 pandemic – with work on solving long-term access to medical oxygen ongoing.

*Force majeure events are usually defined as certain acts, events, or circumstances beyond the control of the parties [...]. A force majeure clause typically excuses one

or both parties from performance of the contract in some way following the occurrence of such events.⁶⁴ These clauses were exercised during the COVID-19 pan-

demic by gas companies with their industrial clients to reallocate their medical LOX resources to medical clients.

Despite these efforts to increase medical LOX supply up to tenfold compared to pre-pandemic levels, demand from hospitals in LMICs was not always met.⁶⁰⁻⁶² Among other factors, distribution constraints inhibited efforts to meet demand in LMICs, including limited ability to exchange materials between countries due to differing standardisation systems. Further constraints, such as insufficient tanks and cylinders to transport and store medical oxygen; a lack of piping networks capable of handling larger volumes of medical oxygen at hospitals; and a shortage of staff who were trained and experienced with handling medical oxygen, also inhibited efforts.^{21,36,52,55,56,61,63}

FIGURE 4 Types of activities undertaken by gas companies to improve access to medical LOX during the COVID-19 pandemic

Type of activity	Air Liquide	Air Products	Linde	Messer	Nippon Sanso	SOL Group
Increased production of medical LOX at cryogenic Air Separation Unit(s)	●	●	●	●	●	●
Converted industrial LOX supplies and equipment for medical use, including examples where force majeure notices were issued	●	●	●		●	
Imported medical LOX as bulk LOX or cylinders, or medical LOX equipment from high-income countries or from other LMICs	●	●	●	●		●
Adapted distribution mechanisms, including delivery speed	●	●	●	●	●	●
Donated medical LOX as bulk LOX or cylinders; donated other medical oxygen-related equipment	●	●		●	●	●
Engaged in collaborations with public health partners	●		●			
Engaged in collaborations with governments	●	●	●		●	●
Engaged in collaborations with other private sector companies		●	●			
Supported health systems capacity building, including by installing bulk LOX tanks and piping networks	●	●	●	●		●

What can gas companies do to ensure sustainable access to medical liquid oxygen?

The following sections of this report consider examples* of initiatives from gas companies – many of which stemmed from their responses to the COVID-19 pandemic – to determine whether further action is being considered to address long-term access to medical LOX.

While there are companies that have already demonstrated some progress in a few of these areas, recommendations are provided at the end of each section to encourage further action that can address both emergency supply and sustainable access to medical LOX over the long term.

PRIORITY AREAS FOR ACTION

This report identifies six priority areas for action that companies can take to expand access to medical LOX in LMICs:

- 1** Prioritise, measure and report progress on access to medical liquid oxygen
- 2** Enable improved affordability for different populations and health systems
- 3** Provide a sustainable supply of medical liquid oxygen
- 4** Develop and maintain long-term partnerships to close medical oxygen access gaps
- 5** Support health systems & the human resources required to operate & maintain liquid oxygen systems & administer oxygen therapy
- 6** Plan proactively for future emergencies

*The examples analysed in this report are illustrative of some of the efforts led by gas companies to improve access to medical LOX and were sourced from information in the public domain, as well as from original data provided by the companies in scope. These are not exhaustive.

1. Prioritise, measure and report progress on access to medical liquid oxygen

Access to medical oxygen in LMICs has only recently become a strategic priority for some gas companies. Achieving greater access for patients living in these countries, both during emergencies and for routine service delivery, requires companies to give LMICs an important place in their business operations. This is not only vital as part of their role within the global health system, but also presents companies with the opportunity to expand their business operations in underserved LMICs, many of which are potentially large markets with untapped demand for medical liquid oxygen (medical LOX).

Establishing an access-to-medical-oxygen strategy

The Foundation's Access to Medicine Index, first published in 2008 and now in its eighth edition, measures and tracks how the world's leading R&D-based pharmaceutical companies perform on expanding access to medicine in LMICs.⁶⁵ The Index has found that, when a pharmaceutical company establishes an access-to-medicine strategy with clear measurable objectives, and embeds this in its overall corporate strategy, this can be an indicator of the relevance of access to the company's long-term growth.

Following on from this, one tangible way for a gas company to make access, and medical oxygen, more central to its core business is by establishing an access-to-medical-oxygen strategy within its overall corporate strategy, with measurable Key Performance Indicators (KPIs) included. The company may elect to implement a strategy related to medical oxygen more broadly, rather than medical LOX specifically, to ensure that access to other forms of medical oxygen can be prioritised in areas where the provision of bulk medical LOX is challenging.

Measuring and reporting progress on access to medical oxygen

Companies can be transparent about their approach to access by publishing details of their access strategies and relevant KPIs in a centralised, accessible format in, for example, their corporate annual reports or in dashboards on their websites.⁶⁵ The 2022 Access to Medicine Index also notes that access is more likely to be an important goal of an organisation when senior management, and especially the CEO, has KPIs specifically linked to access-to-medicine objectives, instead of sales-based KPIs. Gas companies can take a similar approach to ensure that access to medical oxygen is prioritised at the top level and remains high on the corporate agenda by, for example, including access targets in LMICs as part of the CEO's access KPIs.

Investors are increasingly looking for evidence of such measurable metrics as part of active ownership and investment decision-making activities.⁶⁶ As pointed out by stakeholders at several roundtable events co-hosted by the Access to Medicine Foundation, the industrial gas industry is coming under greater scrutiny to develop and implement these kinds of strategies.^{30,32}

Air Liquide has made some progress in this domain. Air Products, Linde, Messer, Nippon Sanso and SOL Group are also taking some steps in the right direction, with broad commitments to health but with no specific targets related to medical oxygen or LMICs (see box-outs on page 14). Linde reports that it does have local access-to-medical oxygen strategies established within its subsidiaries.

The sustainability reports of all six companies demonstrate a strong focus on environmental goals, including via decarbonisation, to align with the Paris Agreement and achieve the environmental United Nations Sustainable Development Goals (SDGs). Several of these companies have also secured top rankings in high-profile sustainability lists.⁶⁷⁻⁶⁹ However, equitable access to lifesaving medical oxygen is another imperative dimension of sustainability that deserves similar attention and investment.

Access KPIs that gas companies can consider

To signal their commitment to access initiatives, gas companies can consider the following measurable KPIs in their access-to-medical-oxygen strategies:

- the number of LMICs where a company's medical LOX is supplied;
- the quantity of medical LOX generated in or delivered to LMICs;
- the number of people reached in LMICs; and
- the number of full-time employees working on access to oxygen.

These KPIs have been adapted from examples published by pharmaceutical company Novartis.⁷⁰

Appointing internal teams to focus on access

In recognising their position within the global health landscape, it would be beneficial for gas companies to have dedicated internal teams focused on access to medical oxygen and who report directly to the CEO. These teams should have knowledge of navigating the complex global health system and can be tasked with creating flagship access initiatives that are targeted towards specific LMICs.³⁰ As an example of this, Air Liquide has already established its 'Access Oxygen' team, which the company reports as promoting accessibility to medical oxygen in LMICs.⁷⁶

When such access initiatives are put in place, the next crucial step is to monitor, track and evaluate progress towards defined objectives and publicly disclosing access outcomes to facilitate accountability and transparency.

WHAT HAVE COMPANIES DONE SO FAR?

Air Liquide established an access-to-medical-oxygen strategy in March 2021, titled 'improving access to medical oxygen, in low- and middle-income countries'. This strategy is integrated within its corporate environmental, social and governance (ESG) strategy under one of its three pillars, 'Acting for Health' which is central to its new company strategic plan, ADVANCE 2025.^{17,71} This long-term strategy also included a specific, measurable KPI based on the number of people living in LMICs who received access to medical oxygen through Air Liquide.¹⁷

The company reports measuring its KPI yearly, by estimating population numbers surrounding local health centres. In 2021, the company said it was able to facilitate easier access to medical oxygen for 1,032,000 people living in LMICs.⁷¹ Air Liquide reports on its progress publicly in its annual Sustainability Report and Annual Report.^{17,71} These resources are available in a centralised, comprehensive manner on the company's website, and include references to some of its specific access-to-oxygen initiatives, enabling easier public accountability and tracking of progress.

Updates on its access-to-medical-oxygen strategy and initiatives in LMICs are included in its 2022 Sustainability Report, published in March 2023.

Air Products included a broad target within the 'Care' pillar of its sustainability framework to 'make products that enable health' to meet SDG 3, 'Good health and well-being' in its 2022 Sustainability Report.⁷²

Linde broadly highlighted the efforts of its healthcare business to improve access to medical oxygen in health facilities during the COVID-19 pandemic in its 2020 and 2021 Sustainable Development Reports, linking these to the UN Sustainable Development Goal (SDGs) targets.^{73,74} The company also reported that one of the targets in its Sustainable Development Targets for 2028 is to increase the proportion of its revenue associated with its Sustainability Portfolio, which includes oxygen therapy.^{74,75} However, no specific corporate strategy related to medical oxygen in LMICs was included within the targets.

Messer listed some of its COVID-19 pandemic-related initiatives within its 2021 Corporate Responsibility Report, as well as its commitment to the 17 UN SDGs.¹⁹

Nippon Sanso included a broad commitment to 'contributions to the medical field' in its NS Vision 2026 medium-term management plan within its updated 'non-financial programs' in its 2022 Integrated Report.⁴⁹ This plan started in 2022 and is linked to the UN SDGs. One specific LMIC initiative linked to the COVID-19 pandemic to improve access to medical oxygen is listed elsewhere in this Integrated Report.

SOL Group highlighted the central place of the 'health sector' in its 2021 Sustainability Report, which it links to the UN SDGs.⁴⁷

WHAT CAN COMPANIES DO NEXT?

- ▶ Air Products, Linde, Messer, Nippon Sanso and SOL Group can establish a specific access-to-medical-oxygen strategy targeting LMICs and can incorporate this within their business strategy. Such an access strategy can include measurable KPIs and can be reported on publicly.
- ▶ Air Liquide can make further progress with its existing access strategy by explaining in more detail how its KPIs are measured.
- ▶ All six gas companies can also ensure that when their access-to-medical-oxygen strategy is implemented, it is also implemented, or replicated, across the subsidiaries or local companies through which they typically operate in LMICs.
- ▶ Air Products, Linde, Messer, Nippon Sanso and SOL Group can build internal access-to-medical-oxygen teams.

2. Enable improved affordability for different populations & health systems

There has been some evidence to suggest that there has, at times, been a disparity in the price of medical oxygen, including medical liquid oxygen (medical LOX), between countries.³³ While the cost of producing and distributing medical oxygen is influenced by several complex factors (see sidebar), addressing affordability is crucial to enabling access to underserved populations, so that all people can access oxygen treatment when they need it.⁷⁷

Gas companies have the ability to improve affordability of medical LOX by implementing policies, such as equitable pricing strategies in LMICs. Equitable pricing strategies aim to improve access to medicine for those in need by taking the ability to pay of individuals and healthcare systems into account in a manner that is locally appropriate.¹⁶ Implementing equitable pricing based on a buyer's ability to pay will not only ensure fairer pricing, but will unlock demand, and can present a business opportunity for gas companies.

Ad-hoc donations only offer temporary solutions

During the COVID-19 pandemic, Air Liquide, Air Products, Messer and SOL Group engaged in some initiatives to increase affordability of medical LOX in LMICs. However, these were primarily donations-based initiatives (see box-outs on page 16).

While donations can be a temporary solution to addressing public health needs, sustainable affordability approaches need to be prioritised.⁶⁵ Unfortunately, concrete evidence of access initiatives aimed at promoting long-term affordability, such as the implementation of equitable pricing strategies, is lacking among the major gas companies in scope of this report.



Medical oxygen prices have been reported as being up to seven times higher in Africa than industrial oxygen, despite both types being produced at the same type of plant.³³

Factors influencing the cost of medical oxygen, including medical LOX

- A small group of companies is responsible for the majority of global medical LOX, resulting in an oligopoly market where a few companies exert significant control, including on individual companies set for their products.^{4,30,33,50,63}
- Accurate demand forecasting is difficult in LMICs, making it hard to plan for production and distribution.⁷⁸ Consequently, reactive procurement and surges in demand can lead to high prices due to misalignment between demand and available supply.^{30,31,79}
- Transport and electricity costs for the production and distribution of medical LOX strongly impact the cost of this essential medicine in LMICs.³⁶ These costs vary between countries and regions, and are affected by the size of an ASU and its distance to a healthcare facility. Human resource costs also need to be factored in.
- At the individual level, many patients pay out-of-pocket for their health expenses in LMICs, with high costs of medical oxygen creating a barrier to access.^{80,81}

WHAT HAVE COMPANIES DONE SO FAR?

Air Liquide

Countries: India, Nigeria

During the COVID-19 pandemic, Air Liquide (Air Liquide India) donated several hundred tons of medical LOX to India.⁸²

Air Liquide (Air Liquide Nigeria Plc) also donated approximately 20 cylinders of oxygen to health facilities in Lagos in partnership with Health Emergency Initiative (HEI). It also donated 30 flow meters and 30 humidifiers.^{83,84}

Air Products

Country: Thailand

Air Products (Bangkok Industrial Gas Co., Ltd) donated ten oxygen cylinders to field hospitals during the COVID-19 pandemic.⁸⁵

Messer

Country: Vietnam

During the COVID-19 pandemic, Messer (Messer Hai Phong Industrial Gas Co., Ltd) donated 100 tons of medical LOX and lent a storage tank free of charge to C Thai Nguyen hospital.⁴⁸

Using innovative finance mechanisms to overcome affordability challenges

To date, gas companies have raised the lack of a large industrial local market for LOX and insufficient demand in LMICs as reasons for a lack of investments in local LOX production and distribution assets. The consequence is that, with the high costs of importation, medical LOX remains expensive in many LMICs. This is particularly the case in countries lacking bulk LOX infrastructure.

To overcome these challenges, innovative finance mechanisms such as pooled procurement and volume guarantees can offer solutions.^{30,34} These financing solutions can reduce the risk perceived by companies in investing in access to medical oxygen in LMICs, including by guaranteeing demand.³⁴ However, these tools require multi-stakeholder collaboration and buy-in.

The Global Fund to Fight AIDS, Tuberculosis and Malaria (the Global Fund) already utilises pooled procurement for oxygen and oxygen equipment, consumables and infrastructure.^{86,87} UNICEF also supported the procurement of oxygen therapy supplies, among other therapeutics, diagnostics and immunisations, through its pooled fund, the ACT-A Supplies Financing Facility.⁸⁸ Wider use of pooled procurement for medical oxygen could help aggregate demand, providing greater clarity for suppliers and potential suppliers.³⁰

Pooled procurement, as defined by WHO, is a formal arrangement whereby financial and other resources are combined across different purchasing authorities to create a single entity for procuring health products on behalf of individual purchasing authorities.⁸⁹

Volume guarantees, as described by MedAccess, are agreements with the objective to increase demand and ensure stable, affordable supply. In the health sector, a guarantor enters a partnership with a manufacturer and a government or another procurer.⁹⁰ If product sales are less than the agreed-upon target, the guarantor will make up product sales shortfalls for the manufacturer.

WHAT CAN COMPANIES DO NEXT?

- ▶ All six companies can address affordability of medical LOX via initiatives that invest in health systems and by taking a payer's ability to pay into account in their equitable pricing strategies.
- ▶ In parallel, all six companies can consider participating in innovative finance mechanisms to enable the provision of medical LOX in more LMICs with a reduced financial risk. Examples include pooled procurement – through established mechanisms such as the Global Fund – and volume guarantees.

3. Provide a sustainable supply of medical liquid oxygen

Medical liquid oxygen (medical LOX) supply chains in low-and middle-income countries (LMICs) are complex and this fragility has only been brought to the fore by the COVID-19 pandemic. Even countries with local medical LOX production capacity, such as India, experienced shortages and supply bottlenecks.⁹¹

Beyond solutions for oxygen delivery during emergencies, gas companies have a vital role to play in ensuring regular, long-term, sustainable medical LOX supplies to healthcare facilities in LMICs. To achieve this, companies can expand their reach and increase their local production capacity.

Most initiatives to expand reach limited to COVID-19 demand surges

Cryogenic Air Separation Units (ASUs) are typically located near industrial clients, with some countries having no in-country ASUs.⁴ However, medical LOX can be transported to neighbouring countries and even internationally where transport infrastructure can facilitate this. During the COVID-19 pandemic, the major gas companies in scope of this report made efforts to prioritise and deliver medical LOX, via bulk medical LOX or cylinders, to at least 39 LMICs across Latin America, Asia, the Middle East and Africa (see box-outs below).

Air Liquide and Linde report that since the emergence of COVID-19, they have extended their reach to regions and countries in which they did not previously supply medical LOX, ranging further than the typical 200-250km radius of an ASU.⁴ Air Liquide reports that in LMICs where it has existing production assets, its geographical footprint could be expanded. Linde, Nippon Sanso and SOL Group also acknowledge their ability and express willingness to expand their reach further in LMICs, moving forward from the global health emergency caused by COVID-19. However, no specific commitments have been made and such expansion is currently contingent on their industrial gas business.

WHAT HAVE COMPANIES DONE SO FAR?

Air Liquide

Countries: Brazil, Chile, Tunisia

Air Liquide (Air Liquide Chile) responded to requests from the Chilean Ministry of Health to support the supply of 160 tons of emergency medical LOX via cryogenic trailers from its production sites in Chile to its neighbour, Peru, for a month.

To supply hard-to-reach regions such as Manaus in Brazil, which is typically accessed via boat or plane, Air Liquide (Air Liquide Brazil) collaborated with the Brazilian Federal Government to transport six tanks of approximately 100,000 m³ of medical LOX via road and barge.^{92,93} Air Liquide did not distribute medical LOX here prior to the COVID-19 pandemic.

For several months, Air Liquide (Air Liquide Tunisia) imported medical LOX into Tunisia from other countries via ship. At the peak of the demand, it was importing 45 containers a week.

Linde

Countries: Brazil, Indonesia

Linde (Linde Indonesia) collaborated with both the Indian and Singaporean navy to increase the availability of containers for bulk medical LOX for health facilities in Indonesia, a country where it did not produce medical LOX prior to the COVID-19 pandemic.⁹⁴

Linde (White Martins) also supplied 75,000 m³ of medical LOX via a multiple day process consisting of both truck and boat transportation from its ASUs outside of the Amazonas state in Brazil.^{92,93}

Some efforts to make greater use of existing local production capacity, but long-term plans unclear

ASUs have the potential to supply large populations with medical LOX. By continuing to allocate some of their existing local ASU LOX manufacturing capacity to medical LOX beyond the COVID-19 pandemic, companies can help ensure a sustainable medical LOX supply in LMICs over the long term. Using available local production capacity is also particularly important to reduce the need for costly importations.

Air Liquide confirms that it can produce and distribute medical LOX in countries where it has industrial LOX production capacity, including South Africa, Egypt, Tunisia, India, Brazil and China. SOL Group also reports an approach to increasing its medical LOX production when needed. The company clarified that it typically only dedicates a very small proportion of its total ASU production capacity to medical LOX production. However, it has company policies in place that prioritise the health needs of countries in which its local companies operate. If such a need is identified, it can increase the proportion of its existing industrial LOX production capacity dedicated to medical LOX to 100%.

While this willingness to pivot their existing industrial LOX production to medical LOX is promising, it is not clear whether these companies will only do this in times of emergency.

In order to know whether companies will address the overall lack of access to medical LOX in LMICs, more information is needed about the proportion of their local production capacity that they are planning on allocating to medical LOX in the future. For example, Air Liquide owns 16 ASUs in South Africa, with a daily oxygen production capacity of 42,000 tonnes, and operates a 17th ASU with a capacity of 5,000 tonnes.^{60,95,96} These ASUs collectively form the biggest oxygen production site in the world – and ensuring that some of this capacity is consistently dedicated to medical LOX production could significantly increase access to medical LOX in LMICs across Southern Africa.

Steps towards adding new LOX production capacity, but impact on medical LOX supply not yet identifiable

A few other promising long-term supply solutions are emerging, including the installation of new ASUs (see box-outs on page 19). Air Liquide, Air Products, Messer and Nippon Sanso demonstrated this with the installation or acquisition of new LOX-producing ASUs including in South Africa, China, Egypt, India, Vietnam and Thailand.^{49,97–105} Although further clarity is needed on whether these ASUs will be used on an ongoing basis to produce medical LOX, these initiatives represent potential towards ensuring sustainable medical LOX supplies in LMICs.

Between 2021 and 2023, Air Products, via its affiliate INOX Air Products, demonstrated clear examples of long-term-focused initiatives to expand its manufacturing capacity of medical LOX in India by installing new ASUs (see box-out on page 19).

Although Linde confirms that it continuously assesses whether to add new LOX production capacity based on local demand, the company reports that its LOX production capacity investment decisions are based on combined demand volumes for both its industrial and medical oxygen business segments. Similarly, Nippon Sanso also reports that it will increase its production capacity based on demand for its industrial gases.

However, in many LMICs, particularly those with weaker healthcare, road and energy infrastructure, gas companies often do not operate ASUs. In these settings efforts to increase access to medical LOX appear to have been more limited. That said, Air Liquide has demonstrated efforts to improve the sustainable supply of medical LOX via long-term partnerships with local healthcare facilities by supplying medical oxygen cylinders originating from medical LOX in ASUs from other regions (see page 19). Air Liquide also reports that it is willing to support local entrepreneurs to set up appropriate infrastructure and human resource capacity in LMICs



“A single ASU may produce sufficient liquid oxygen to supply the medical needs of entire provinces or even multiple small countries [...]”⁴

Innovations in medical oxygen production

The production of hydrogen through the electrolysis of water creates oxygen as a by-product.^{106,107} Oxygen produced in this manner could help bolster the supply of medical oxygen and diversify supply chains. This innovation can be further explored by gas companies, some of which have already invested in these types of plants, to both improve access to medical oxygen in LMICs while working towards decarbonisation.^{108,109}

where it does not operate, and that it has already set up a company, Access Oxygen SAS, to support these social entrepreneurs.

A smaller Bolivia-based medical LOX producer also demonstrated an innovative and more sustainable approach to ensure medical LOX was supplied in this type of setting (see below).

WHAT HAVE COMPANIES DONE SO FAR?

Air Products

Country: India

In 2021, Air Products (INOX Air Products) announced plans to build eight new ASUs across India to double its medical LOX production capacity.^{43,110} In 2022, it also announced plans to build a second ASU in Jharkhand which would enable a 50% increase in availability in Eastern India.¹¹¹ In 2023, Air Products inaugurated another ASU in Tamil Nadu, bringing its total to five ASUs in this state.¹¹² This plant was commissioned in 20 months and will produce medical LOX to fulfil the demand of more than 100 hospitals, as well as the needs of industrial clients.

HAWA del Sur

Country: Bolivia

HAWA del Sur created a cylinder filling unit in a mobile medical LOX tank, which transported medical LOX to hospitals and filled cylinders on site. Using this tank during the COVID-19 pandemic allowed HAWA del Sur to supply public health facilities in Southern Bolivia with medical oxygen. This initiative helped the company to overcome some of the difficulties in supplying medical oxygen to health facilities lacking medical LOX infrastructure, as well as the inefficient logistics and high costs of transporting cylinders between health facilities and its ASU for refilling.³³ HAWA del Sur hopes to support others by sharing its learnings to establish a similar strategy in Peru and Ecuador.

HAWA del Sur has also committed to investing 5% of the profits from this initiative in other similar projects in other LMICs, if it is able to find partners to implement this.

Air Liquide

Countries: Senegal, South Africa, Kenya

Air Liquide (Air Liquide Senegal), via its initiative Access Oxygen, in partnership with UNICEF and Senegal's Ministry of Health, has provided oxygen back-up cylinders to over 80 rural healthcare clinics in Senegal since 2016 and helped respond to the COVID-19 crisis in Senegal.^{71,113,114} In just one year, the company was able to provide treatment to over 1,000 patients.¹¹⁵

Air Liquide (VitalAire) has partnered with Unjani Clinics – a network of primary healthcare clinics in South Africa – to expand supplies of VitalAire oxygen equipment, including cylinders.^{17,116} Supplies have been provided to 132 Unjani Clinics in South Africa, and Air Liquide aims to increase access to medical oxygen for more than 700,000 people in peri-urban and rural communities in the country as part of a five-year partnership.

Air Liquide has established a similar partnership with the Centre for Public Health and Development (CPHD) to increase access to medical oxygen in primary health facilities in rural areas in Kenya.

WHAT CAN COMPANIES DO NEXT?

- ▶ All six gas companies can further clarify how they plan to prioritise access to medical LOX in LMICs, including by providing clear information on whether they plan to establish, maintain and expand their medical LOX footprint in LMICs, and, if so, where. Where companies do not have production sites in these settings, they can consider supplying medical LOX from neighbouring countries where they do operate.
- ▶ All six gas companies can share their long-term plans to ensure a sustainable supply of medical LOX. This includes publicly disclosing information about what proportion of their existing ASU production capacity they will allocate to medical LOX and whether new ASUs will supply medical LOX.
- ▶ All six gas companies can continue to dedicate a proportion of their ASU production capacity to medical LOX.
- ▶ Air Products, Linde, Messer, Nippon Sanso and SOL Group can also make commitments to supply settings that have no bulk LOX infrastructure. Air Liquide can continue its work and can expand these types of commitments to supply other LMICs.

4. Develop and maintain long-term partnerships to close access gaps

At all four roundtables co-hosted by the Foundation, participants have highlighted the need for increased and closer collaboration between gas companies and other stakeholders to help overcome access barriers and close the longstanding gaps in access to medical oxygen.^{30–32,34}

Existing public-private partnerships in the global health space, for example, have demonstrated that such collaboration can be effective and impactful in advancing public health goals by aligning business objectives and public health outcomes.³²

Forming partnerships across the medical oxygen space could increase the effectiveness and reach of multilateral responses by leveraging different partners' resources and expertise to, for example, address current distribution challenges and health systems' capacity constraints.³¹

As gas companies' efforts have demonstrated during the COVID-19 pandemic, collaborations with governments enabled clearer alignment on local medical oxygen needs to help increase supply to healthcare facilities.³⁰ Efforts were further strengthened via gas companies' partnerships with global health organisations and the private sector. However, it is not always clear whether such collaborations will be formalised and maintained over the long term.

To continue to serve markets in LMICs, and prepare for future emergencies, it is crucial that gas companies carry on engaging in such collaborations sustainably, so that LMICs do not need to rely on receiving ad-hoc contributions when demand soars due to a global health emergency.

Public-private partnerships

Partnerships can be formed between gas companies and national governments, as well as with regional governmental authorities, where these exist, such as the African Union.¹¹⁷ Partnerships with global health partners can also address access to medical LOX in LMICs.

Partnerships with governments

During the height of the COVID-19 pandemic, Air Liquide, Air Products, Linde and SOL Group worked with national authorities, including ministries of health and armed forces, as well as international governments, to provide medical LOX in LMICs, including Brazil, Ecuador, India, Kosovo, Madagascar, Morocco, Peru, South Africa, Thailand and Tunisia.^{21,44,45,47,71,93,118–121} Nippon Sanso also worked with national authorities in the Philippines.⁴⁹

However, among the companies in scope, only one example of a long-term partnership by Air Liquide Madagascar with a government could be identified, based on publicly available evidence and information submitted to the Foundation by the companies in scope. This partnership, as well as some of the other collaborations between companies and governments during the COVID-19 pandemic, are highlighted below.

WHAT HAVE COMPANIES DONE SO FAR?

Air Liquide, Air Products, SOL Group

Country: India

Air Liquide (Air Liquide India) collaborated with the French government and Indian health authorities to import over 200 tonnes of medical LOX to India. This was done by flying five cryogenic mobile containers from Europe to Qatar for filling before being shipped to hospitals in India. Once used, the tanks were returned to Qatar for new rotations.⁷¹

Air Products (INOX Air Products) worked with the Indian Air Force to refill its cryogenic tankers which were then transported by train to supply health facilities across the country.⁵²

SOL Group (SOL India), in collaboration with the Indian army, transported supplies of medical LOX from the UK to health facilities in India.

Air Products, Nippon Sanso

Countries: Peru, the Philippines

Air Products (Air Products Peru) and Nippon Sanso (Nippon Sanso Ingasco, Inc.) collaborated with national authorities in Peru and the Philippines respectively to maintain a continuous supply of medical LOX to local health facilities during the COVID-19 pandemic.^{49,121}

Air Liquide

Country: Madagascar

Since 2020, Air Liquide (Air Liquide Madagascar) has collaborated with the Ministry of Health and UNICEF in Madagascar to ensure a sustainable supply of medical oxygen cylinders in the country alongside another company, EO₂LE.¹¹⁸

Collaborations with global health partners

During the COVID-19 pandemic, Linde (Afrox) and Air Liquide (Air Liquide South Africa) partnered with USAID in South Africa, to facilitate an estimated eightfold increase in their production and provision of medical oxygen locally, in support of the South African National Department of Health (NDoH).^{32,122} This partnership was supported by a USD 3.5 million fund from the US government, through USAID.

Air Liquide and Linde are the only companies that could be identified as having formed formal long-term partnerships with global health organisations aimed at addressing gaps in access to medical LOX beyond the COVID-19 pandemic (see box-out below).

WHAT HAVE COMPANIES DONE SO FAR?

Air Liquide, Linde

In June 2021, Air Liquide and Linde each entered into unprecedented Memoranda of Understanding (MoUs) with Unitaid and the Clinton Health Access Initiative (CHAI) – two members of the ACT-Accelerator Oxygen Emergency Taskforce – to facilitate equitable access to oxygen, including medical LOX, in a number of LMICs they have identified as priorities.^{123,124} The MoUs aim to increase access to medical oxygen in LMICs through, among others, more stable funding, LMIC oxygen infrastructure investments, and supporting the creation of a framework for local contractual oxygen agreements. They may also include purchase commitments and volume guarantees.

Through the MoU entered by Linde, the company's subsidiary, Afrox, was able to collaborate with CHAI and the Zambian Ministry of Health to increase the availability of medical oxygen in Zambia during the COVID-19 pandemic. The volume guarantee, and initial order by CHAI for 10 weeks of cylinder refills at USD 19/refill with 30-60-day payment terms, incentivised Afrox to reallocate its LOX production capacity from industrial to medical LOX and convert its industrial cylinders to medical cylinders. This enabled the refilling of 10,000 medical oxygen cylinders. Subsequently, CHAI and Afrox signed an agreement to establish a medical LOX storage tank at a hospital in Zambia to enable six-monthly refills.¹²⁵

Private sector partnerships

By partnering with companies outside of their industry, gas companies have been able to increase the production and supply of their medical LOX during the COVID-19 pandemic. In particular, these initiatives enabled increased local supplies and cross-country transport of medical LOX (see box-outs below).

Gas companies can build on this approach by exploring further private sector partnerships to enable wider-ranging and sustainable supply. These could include partnerships with companies in other industries, as well as with other gas companies that produce medical LOX.³²

Gas companies can also strengthen access-to-oxygen policies and initiatives in LMICs by engaging with their national, regional or global industry associations, such as the International Oxygen Manufacturers Association (IOMA) and their members such as the Asia Industrial Gases Association (AIGA), European Industrial Gases Association (EIGA), Japan Industrial and Medical Gases Association (JIMGA) and the Compressed Gas Association (CGA).¹²⁶ Through these collaborations, gas companies can ensure a coherent coordinated approach to improving access to medical oxygen and work on cross-cutting issues such as cross-country standardisation of equipment, which has an impact on access.

WHAT HAVE COMPANIES DONE SO FAR?

Linde

Country: India

Linde (Linde India) partnered with ITC Limited (a company operating outside the gas industry) to transport 24 cryogenic containers from Asia to help supply hospitals with medical LOX.⁴²

Linde acquired an additional 24 cryogenic containers to transport medical LOX, in partnership with the Tata Group and the Indian government, via air transport from other countries.⁴⁵

Air Products

Countries: Thailand, India

Air Products (Bangkok Industrial Gas Co., Ltd) partnered with PTT Public Company Limited, a chemical company, to operate a new ASU to increase the production and supply of medical LOX, including to five hospitals in the Rayong province and in the Bangkok area.^{127,128} The companies aimed to provide 360 tons of medical LOX to help approximately 400 severe COVID-19 patients.

Air Products (Bangkok Industrial Gas Co., Ltd) collaborated with other private companies, including Cryotech Asia Company Limited and Best Logistics Global Company Limited, as well as the Indian Air Force, to transport medical LOX and containers from Thailand to India.⁴⁴

WHAT CAN COMPANIES DO NEXT?

- ▶ All six gas companies can formalise more access-to-oxygen partnerships with the public sector, including LMIC governments and regional governmental authorities (e.g., African Union).
- ▶ Air Liquide and Linde can continue their work via their MoUs with CHAI and Unitaid, and all six gas companies can also consider entering long-term partnerships with global health partners.
- ▶ All six gas companies can further explore private sector partnerships both with other gas companies and companies in other industries.
- ▶ By continuing to engage with their industry associations, all six companies can work collectively to close gaps in medical oxygen access in LMICs.
- ▶ All six gas companies can share and disclose more information publicly about their partnerships with governments, global health partners and private sector partners.

5. Support health systems & the human resources required to operate & maintain liquid oxygen systems & administer oxygen therapy

Ensuring sustainable medical liquid oxygen (medical LOX) supplies in low-and middle-income countries (LMICs) requires strong health systems with reliable medical oxygen infrastructure and equipment, technical staff who can maintain it, as well as healthcare professionals who can appropriately administer oxygen.

Although the responsibility for strengthening these health systems ultimately falls with LMIC governments, capacity building is another way gas companies can help improve access to medical LOX and address issues in availability and accessibility in LMICs over the long term.^{30,65}

As an example, gas companies can offer comprehensive service packages in contracts with healthcare facilities in LMICs that provide the supply, installation and maintenance of medical LOX equipment, as well as training to healthcare facility staff.

Such offerings can be linked to the Good Practice Standards for capacity building initiatives set out in the 2022 Access to Medicine Index, to ensure that:⁶⁵

- Good governance structures are in place (including mitigating or preventing conflicts of interest);
- Goals align with or support the partnered institutional goals;
- Initiatives are guided by clear, measurable goals or objectives;
- Outcomes, including approaches, progress and learnings, are publicly shared;
- Initiatives have long-term aims or achieve integration within the health system.

Supply, installation and maintenance of medical LOX equipment

Key equipment needed to use bulk medical LOX at healthcare facilities includes cryogenic storage tanks and appropriately sized piping networks. Storage tanks, in particular, are key to ensuring buffer stock and helping to reduce the high costs of transporting highly pressurised gaseous oxygen.^{13,57}

Support and maintenance services are essential to ensure the efficacy, safety, and extended performance of this oxygen equipment and these services can be sustained at healthcare facilities through multi-year contracts with gas companies.¹²⁹ While procurement tenders are typically the responsibility of governments, companies can strive to establish long-term contracts with healthcare facilities where possible.

Several initiatives undertaken during the COVID-19 pandemic by five of the gas companies in scope highlight the potential positive impact that can be made by these companies through supplying and installing medical LOX equipment in LMIC healthcare facilities. (See box-outs on page 24.)

By including installation and maintenance service elements within their contracts with healthcare facilities, both SOL Group and Air Liquide have made longer-term commitments to ensuring access to LOX.

SOL Group reports to the Foundation that the installation of bulk LOX tanks is typically included in its contracts and that the tanks and piping systems it installed during the COVID-19 pandemic will remain in place indefinitely, which has enabled better planning for supply logistics.

Air Liquide reports that it typically includes the installation and maintenance of bulk LOX tanks in its service offerings. The company further demonstrates its forward-looking service approach as it has provided maintenance support for several years to health clinics in Senegal. Air Liquide Access Oxygen teams contact healthcare facility staff every three months to ensure all the oxygen equipment that it provides is functional.¹¹⁵ As part of its Access Oxygen Initiative in Senegal, Air Liquide has also provided pulse oximeters to healthcare staff, which enable the detection of hypoxemia in patients.

Both SOL Group and Air Liquide report that maintenance and upgrades of piping networks are typically only provided if requested by healthcare facilities. In submissions to the Foundation, Linde and Nippon Sanso both highlighted their capacity to install bulk LOX tanks and piping networks and to provide maintenance. Nippon Sanso also reports that it provides maintenance as standard practice in almost all its supply contracts.

WHAT HAVE COMPANIES DONE SO FAR?

Air Liquide (Air Liquide South Africa) installed or upgraded bulk medical LOX storage tanks in healthcare facilities in South Africa. The company upgraded over 100 medical LOX installations, including LOX storage tanks in the country.

Air Products (INOX Air Products and Air Products Peru) installed or upgraded bulk medical LOX storage tanks in healthcare facilities in India and Peru.^{63,111} Air Products installed over 130 medical LOX storage tanks in India, and also commissioned a medical LOX tank in just one week in the country.^{111,119}

Air Products (Air Products Indura Ecuador) installed 738 metres of piping and a 20-ton medical LOX tank to supply 152 beds in a temporary hospital in Ecuador.¹³⁰

Messer (Messer Colombia and Messer Vietnam Industrial Gas Co., Ltd) installed bulk medical LOX storage tanks in healthcare facilities in Colombia and Vietnam.^{131,132}

Linde installed or upgraded bulk medical LOX storage tanks in healthcare facilities in India (Linde India) and in many other LMICs.⁹⁴

The company also installed piping and a bulk medical LOX tank at several hospitals in Kenya (BOC Kenya PLC) and in many other LMICs.¹³³

SOL Group (SOL India) installed or upgraded bulk medical LOX storage tanks in health facilities in India. The company also reported doubling the size of existing health facility pipeline systems in India. This was crucial as most hospitals' infrastructure capacity could typically only handle a fraction of the higher flow needed for both individual COVID-19 patients and the unprecedented number of patients simultaneously requiring oxygen therapy. Some hospitals were administering up to 400% more oxygen than their designed storage tank and pipeline system capacity.²¹

Training of healthcare facility staff

As part of long-term service offerings, companies can also provide training to healthcare facility medical and technical staff to ensure the safe and effective handling and administration of oxygen, as well as to enable the correct maintenance of oxygen equipment.^{30,31,129} As highlighted by several companies in their submissions to the Foundation for this report, all efforts to expand access must consider safety as a priority, particularly because working with medical oxygen involves handling extremely cold, liquefied, or high-pressure gases.

In their submissions to the Foundation, Air Liquide and SOL Group provided insights into the types of training they offer to healthcare facility medical or technical staff, which are detailed in the box-outs on page 25. Linde and Nippon Sanso also report providing some form of training to healthcare facility staff, with Nippon Sanso confirming that it always provides users with training on safe handling of its products, including medical LOX and cylinders.

WHAT HAVE COMPANIES DONE SO FAR?

Air Liquide provides workshops or training sessions which are adapted to the healthcare facilities' needs and trainee profiles, including nurses, biomedical or technical staff. These workshops may touch on topics such as safety, maintenance, use of equipment and respiratory physiology, although these sessions are usually provided as an add-on service if requested by customers.

In Senegal and South Africa, Air Liquide also ensured that it completed its comprehensive medical oxygen solution by providing healthcare staff with training and oxygen education to the wider community as part of its long-term partnerships.^{71,115}

SOL Group reported that it always provides health facility staff training as part of its medical LOX provision in India. This includes both theoretical and practical training for healthcare facility technicians and/or engineers within its contracts with health facilities. Its technicians provide this training at the beginning of a new contract and when requested by the healthcare facility.

This training is provided by SOL Group technicians and ensures the safe handling, management, and disposal of medical oxygen in bulk LOX tanks or cylinders.

Monitoring oxygen usage and communicating with healthcare facilities to meet local demand

Successful cooperation and communication with healthcare facilities in LMICs is also essential to ensure medical oxygen supply appropriately meets local demand, and to allow for efficiency in terms of logistics in delivering medical LOX from ASUs to patients.³⁰ Several of the companies in scope report steps they have taken to try and meet local medical LOX demand.

Based on the analysis of publicly available information, Messer has proactively communicated with healthcare facilities and monitored medical oxygen usage in Brazil during the COVID-19 pandemic.¹³⁴

Air Liquide, SOL Group and Linde report using telemetry to meet healthcare facilities' demand for medical LOX and to ensure efficient distribution. However, Air Liquide and SOL Group report only providing this service if requested to do so by healthcare facilities. SOL Group confirms that it uses yearly LOX consumption data to help forecast demand and production plans for the following year. Utilising this type of approach can enable companies to meet demand more accurately in the countries where they operate. Whether this type of tool is used by other gas companies is unclear.

Telemetry enables companies to monitor supplies of bulk LOX in tanks at healthcare facilities and schedule their deliveries accordingly.^{136,137} This is a way in which companies can help ensure a continuous, appropriate supply of medical LOX for health systems, which would also support improved demand forecasting if this data is shared with local partners.

How companies can raise awareness of their comprehensive service packages

Healthcare facilities may not always be aware of the benefits of requesting these comprehensive service packages, and therefore may not request these services if unprompted.

To ascertain demand for medical LOX, as well as the comprehensive service packages they can offer in countries or regions where they do not yet provide such services, gas companies may first need to make these available locally to uncover the potential unrecognised need. By conducting feasibility assessments via pilot initiatives, for example, gas companies could gain an understanding of the actual demand that exists for their product, as well as any comprehensive service packages they could offer.¹³⁵

WHAT CAN COMPANIES DO NEXT?

- ▶ Air Products and Messer can be more transparent about the service package they offer for medical LOX in LMICs. Where this is not implemented, they can consider a comprehensive service package in all their contracts with healthcare facilities.
- ▶ Air Liquide, Linde, Nippon Sanso and SOL Group can continue to make efforts to scale up the comprehensive and sustainable medical oxygen service packages in all of their new and existing contracts across all LMICs.

6. Plan proactively for future emergencies

Although gas companies reacted quickly during the COVID-19 pandemic, the shortages experienced in LMICs highlighted the need for all partners who are working to improve access to medical oxygen, including gas companies, to be better prepared for future emergencies.⁶¹

Some gas companies in scope have demonstrated that they are considering ways in which to be better prepared for future shocks by establishing emergency plans and institutionalising their successful emergency approaches, but clearer plans need to be communicated.

Messer and SOL Group provided concrete examples of how they have reviewed and institutionalised some of their successful emergency approaches to establish pre-emptive emergency plans. Messer and SOL Group's approaches include learnings from initiatives undertaken during the COVID-19 pandemic (see box outs). Nippon Sanso has established a company Business Continuity Plan, which includes emergency processes for medical gases.

Linde reports that it had emergency procedures in place prior to COVID-19. These have subsequently been reviewed and amended, although further details have not been shared. The company also reports that it has established some post-COVID-19 pandemic discussions with authorities in select LMICs to discuss future emergency planning. Similarly, Air Liquide reports that it can increase the proportion of its local production dedicated to medical LOX to its maximum during emergencies with support from governments in LMICs. However, no information has been shared about concrete elements of Air Liquide's current emergency preparedness plans.

WHAT HAVE COMPANIES DONE SO FAR?

Messer has established cloud-based systems to enable production facilities to be accessible remotely. The company did this following difficulties in accessing onsite expert support at its ASUs during the 2020 typhoon season in Vietnam and during the COVID-19 pandemic.¹⁰⁵

SOL Group is prepared to rapidly reallocate its industrial LOX production capacity to medical LOX within a 24-hour timeframe during future emergencies. To enable this, the company has strengthened its regulatory affairs processes and has a regulatory affairs department in place to facilitate the release of medical LOX in line with local regulations.⁴⁷

WHAT CAN COMPANIES DO NEXT?

- ▶ Messer, Nippon Sanso and SOL Group can continue to build on their current work by ensuring that their emergency plans are reviewed, remain active, and are at the ready for deployment when required.
- ▶ Air Liquide, Air Products and Linde can communicate about the components of their established emergency plans more transparently. Where these are not implemented, they can institutionalise successful approaches utilised during emergencies and address inefficiencies, including those identified during the COVID-19 pandemic.
- ▶ In future, if not already standardised, all six gas companies can ensure that force majeure clauses are standard in all their contracts with industrial clients, where possible, to allow them to respond proactively and not reactively during emergencies.
- ▶ All six gas companies can pre-establish plans with governments, global health partners and other companies based on the successful collaborations from the COVID-19 pandemic, where these have not yet been established.

NEXT STEPS

The path to long-term access

Scaling up access to medical oxygen in low- and middle-income countries (LMICs) is an urgent global health priority that cannot be resolved until gas companies further commit to, and take action on, expanding and sustaining long-term access to the lifesaving product they produce.

While this report has identified some initiatives from the six companies in scope to increase the supply of medical LOX to meet demand surges caused by the COVID-19 pandemic, these have been limited in geographic reach. Some companies have demonstrated the steps they are taking to improve access over the long term, but clear commitments are lacking and overall efforts remain disjointed.

How companies can implement long-term access planning

The priority areas for action set out in this report show gas companies what they can do to prioritise and invest in LMICs, be proactive in finding new ways of increasing supply, and engage in long-term sustainable approaches to access. Prioritising LMICs in their business operations, for example, will not only help achieve this vital health mission but can position gas companies to expand their businesses to markets that have been largely underserved.

Company leadership can play a key role in driving this by endorsing the expansion of access to medical oxygen in LMICs as a corporate priority. This includes establishing clear access-to-medical-oxygen strategies with measurable targets, as well as appointing internal access teams that can create and implement long-term access initiatives, including, for example, equitable pricing strategies. Companies can ensure transparency by publicly reporting on these targets to show where progress is being made and highlight where gaps remain.

Increasingly, investors are looking for evidence of metrics and data on how gas companies are addressing access to medical oxygen in LMICs.⁶⁶ The companies in scope already actively report on their environmental, social and governance (ESG) initiatives. By considering access to medical oxygen as part of their ESG strategies, for example as an essential component of their sustainability efforts, companies can be proactive about meeting investor expectations. In doing so, they will raise the bar for other gas companies and can stimulate progress across the sector.

It is also important to acknowledge that, while parent companies can drive action to improve access to medical oxygen, access can also be prioritised and actioned by their subsidiaries. Parent companies can then build on innovative ideas and good practices from their various subsidiaries, as well as from their competitors.

The Foundation acknowledges that there are several challenges to improving access to medical oxygen in LMICs, including healthcare facility infrastructure and a fragmented supply chain involving complicated logistics and distribution networks. However, as the few major producers of medical LOX, the gas companies in scope of this report can play a critical role in helping to overcome some of these challenges.

Opportunities to help overcome challenges in LMICs

As outlined in this report, during the COVID-19 pandemic, most companies demonstrated agile approaches to help increase the supply of medical LOX in LMICs, including pivoting their industrial LOX capacity towards the production of medical LOX. While achieving this was complex and was aimed at meeting the surges in

demand as a result of the pandemic, allocating more capacity to medical LOX on an ongoing basis can also help strengthen sustainable supply in LMICs – both on an emergency basis and to meet routine medical oxygen needs.

While the strength of health systems in LMICs is ultimately the responsibility of governments in these countries, gas companies can respond to local needs by building capacity in certain areas. For example, companies can strive to develop long-term contracts with healthcare facilities in LMICs that include comprehensive service packages that provide the supply, installation and maintenance of medical LOX equipment, as well as providing training to healthcare facility staff.

Critically, in recognising their role within the broader global health system, companies can pursue long-term partnerships with governments, as well as with global health organisations, such as the ACT-Accelerator Oxygen Emergency Taskforce (ACT-A Taskforce), that are working on solutions to facilitate access to medical oxygen.

Another key challenge highlighted in this report is quantifying and forecasting demand for medical oxygen in LMICs. Through the Lancet Global Health Commission for Medical Oxygen Security, key academics and global health stakeholders are engaging in a large body of work to uncover the burden of hypoxemia, define and measure access to oxygen, better understand effective oxygen solutions and exploring oxygen financing for transformational change.³ Gas companies can continue to contribute and collaborate to build the evidence base to help map out medical oxygen needs more clearly and work towards establishing sustainable and appropriate supply solutions.

With this increased attention on addressing the longstanding gaps in access to medical oxygen, and global stakeholders actively working to pursue long-term solutions, gas companies now have an opportunity to help further progress – and ensure that people living in LMICs can receive the vital oxygen treatment they need, when they need it.

Catalysers for expanding access to medical liquid oxygen

The focus of this report and the Foundation's Medical Oxygen Programme is to encourage gas companies to take action and bolster their efforts to prioritise health and expand access to medical liquid oxygen (medical LOX) in low- and middle-income countries (LMICs), as well as to provide a tool for institutional investors to use in engaging with gas companies.

However, in terms of expanding access to medical LOX, other stakeholders also have a role to play within the broader medical oxygen ecosystem. For example, LMIC governments and global health organisations can continue long-term investment in medical oxygen needs and help 'catalyse' the expansion of access to medical LOX in LMICs and speed up gas companies' progress. This can be achieved by:

Establishing national oxygen policies and roadmaps: This is critical to ensure long-term and effective planning for sustained access to medical LOX and can also include guidance on emergency strategies.³⁰ Ethiopia, Nigeria, Uganda, Kenya, Zambia, Malawi, Liberia, India and some other LMICs have already published national roadmaps which set expectations for industry and other key stakeholders, but the majority of LMICs are yet to do so.¹³⁸

Providing sustainable public sector financing for local oxygen investments: Energy price and supply, transport costs and reliability, and health facility oxygen infrastructure present access challenges in LMICs.^{30,32,34} By prioritising and investing in local infrastructure, LMIC governments can incentivise gas companies to extend their reach further in LMICs and supply medical LOX in more countries where it is an appropriate solution. Storage tanks in particular are key to ensuring buffer stock and helping to reduce the high transport costs of moving highly pressurised gaseous oxygen.^{13,57} Innovative solutions to ensure cost-effective investments can include lower-cost oxygen storage, piping solutions and solar power to strengthen energy systems.^{30,31}

Increasing public-private coordination: Partnerships between governments, the private sector, and global health organisations are key to achieving global public health goals.^{30,32,34} While some coordination emerged for medical LOX during the COVID-19 pandemic (e.g. the ACT-Accelerator Oxygen Emergency Taskforce), much closer collaboration is needed to help funders determine the most suitable oxygen production systems for different settings, as a lack of clarity, especially on PSA plant investments, is currently hampering further gas company investments. This can enable clear, rational, and cohesive country approaches to building robust and sustainable solutions to provide long-term access to medical oxygen in LMICs.³⁰

Uncovering unrecognised medical LOX needs: Pulse oximeters are an essential tool for health staff to detect hypoxemia (low blood oxygen) in patients, a condition for which oxygen therapy is an essential treatment.²³ In LMICs, there are issues with the availability of these devices, their quality, safety, and overestimation of blood oxygen levels in people with darker skin pigmentation.¹³⁹⁻¹⁴¹ LMIC health systems need access to pulse oximetry to identify patients in need of oxygen therapy. Improving the awareness and understanding of LMIC healthcare staff and patients regarding the value and appropriate use of pulse oximetry and oxygen therapy is essential to help uncover unrecognised oxygen needs.^{140,142} This will also ensure oxygen therapy is appropriately administered.

Quantifying and increasing visibility of demand for medical LOX: Measuring the hypoxemia burden in LMICs, and consequently quantifying the local unmet need for medical LOX, is critical for gas companies to provide adequate supplies of medical LOX.^{30,31,34} By highlighting existing gaps in access to medical LOX, more accurate demand data, including forecasts, can be shared with gas companies, by health facilities and governments, which can inform medical LOX production plans which are typically set far in advance. Current efforts by global health partners, academic institutions and LMIC governments, including the Lancet Global Health Commission on Medical Oxygen Security, are critical to quantifying the hypoxemia burden in LMICs.³ Governments can also institutionalise or implement oxygen-related data systems to increase the visibility of demand.³⁰

APPENDIX
COUNTRIES IN SCOPE OF THE MEDICAL OXYGEN PROGRAMME

The geographic scope for the Medical Oxygen Programme consists of 108 low- and middle-income countries (LMICs) as defined and outlined in the 2022 Access to Medicine Index.¹⁶

TABLE 1 Geographic scope

Countries in scope of the Medical Oxygen Programme

East Asia & Pacific		Nicaragua	LMIC	Ethiopia	LIC
Cambodia	LMIC	Paraguay	MHDC	Gabon	MHDC
China	HiHDI	Peru	HiHDI	Gambia	LIC
Indonesia	LMIC	Suriname	HiHDI	Ghana	LMIC
Kiribati	LMIC	Venezuela	HiHDI	Guinea	LIC
Korea, Dem. People's Rep.	LIC			Guinea-Bissau	LIC
Lao PDR	LMIC	Middle East & North Africa		Kenya	LMIC
Micronesia, Fed. Sts. LMIC	LMIC	Algeria	LMIC	Lesotho	LMIC
Mongolia	LMIC	Djibouti	LMIC	Liberia	LIC
Myanmar	LMIC	Egypt, Arab Rep.	LMIC	Madagascar	LIC
Papua New Guinea	LMIC	Iran	HiHDI	Malawi	LIC
Philippines	LMIC	Iraq	MHDC	Mali	LIC
Samoa	LMIC	Morocco	LMIC	Mauritania	LMIC
Solomon Islands	LMIC	Palestine, State of/ West Bank Gaza	LMIC	Mozambique	LIC
Thailand	HiHDI	Syrian Arab Republic	LMIC	Namibia	MHDC
Timor-Leste	LMIC	Tunisia	LMIC	Niger	LIC
Tonga	LMIC	Yemen, Rep.	LMIC	Nigeria	LMIC
Tuvalu	LDC			Rwanda	LIC
Vanuatu	LMIC	South Asia		São Tomé and Príncipe	LMIC
Vietnam	LMIC	Afghanistan	LIC	Senegal	LIC
		Bangladesh	LMIC	Sierra Leone	LIC
Europe & Central Europe		Bhutan	LMIC	Somalia	LIC
Armenia	LMIC	India	LMIC	South Africa	MHDC
Kosovo	LMIC	Maldives	HiHDI	South Sudan	LIC
Kyrgyz Republic	LMIC	Nepal	LIC	Sudan	LMIC
Moldova	LMIC	Pakistan	LMIC	Swaziland/Eswatini	LMIC
Tajikistan	LMIC	Sri Lanka	LMIC	Tanzania	LIC
Turkmenistan	MHDC			Togo	LIC
Ukraine	LMIC	Sub-Saharan Africa		Uganda	LIC
Uzbekistan	LMIC	Angola	LHDC	Zambia	LMIC
		Benin	LIC	Zimbabwe	LIC
Latin America & Caribbean		Botswana	MHDC		
Belize	HiHDI	Burkina Faso	LIC		
Bolivia	LMIC	Burundi	LIC		
Brazil	HiHDI	Cabo Verde	LMIC	LIC	Low-income country
Colombia	HiHDI	Cameroon	LMIC	LMIC	World Bank income classifications
Dominican Republic	HiHDI	Central African Republic	LIC	LDC	Lower-middle income country
Ecuador	HiHDI	Chad	LIC	LHDC	World Bank income classifications
El Salvador	LMIC	Comoros	LIC	MHDC	Least Developed Country
Guatemala	LMIC	Congo, Dem. Rep.	LIC	HiHDI	ECOSOC LDC List
Guyana	MHDC	Congo, Rep.	LMIC		Low Human Development Country
Haiti	LIC	Côte d'Ivoire	LMIC		UN Human Development Index
Honduras	LMIC	Equatorial Guinea	MHDC		Medium Human Development Country
Mexico	HiHDI	Eritrea	LIC		UN Human Development Index
					High Human Development Country with high inequality
					UN Inequality-Adjusted Human Development Index

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