

# Sustainability Guidance for PSA Oxygen Plants

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This document was developed by [Build Health International](https://www.bhioxygen.org) to support global medical oxygen infrastructure planning, site preparation, operation, maintenance, and sustainability. Additional technical resources are available at [www.bhioxygen.org](https://www.bhioxygen.org).

## Purpose

This document lists minimum considerations for sustainable operation of Pressure Swing Adsorption (PSA) oxygen plants funded fully or partially by The Global Fund (TGF) and UNICEF, UNDP, UNOPS. PSA plants, their supporting infrastructure, and operations are only one part of a complex national oxygen ecosystem. The considerations listed in this document could be relevant to each site or PSA plant or could be linked to sustainability discussions for the entire ecosystem or sub-system e.g. finance, energy, human resources. Facility management, administrators, technical and operations staff, health facility administrators, state and national policy (including oxygen strategies and roadmaps) and decision makers are all stakeholders in oxygen plant sustainability.

## Introduction

Sustainability discussions for any investment in equipment and its operations are useful and relevant at any point in the life cycle of the intervention. For PSA plants the listed considerations can be integrated into the design phase, procurement, pre-installation, site preparation and post-installation and during commissioning and daily operations and planning cycles. The reader can start discussions on any topic in the list below that is relevant depending on where they are in the phase of PSA plant implementation. Where available, links are provided to separate resource documents for more in-depth information as needed.

## Health Coverage Considerations

### 1. Plant Sizing to oxygen demand

- The PSA plant should be sized and fit for purpose to meet the facility needs and the needs of surrounding facilities that will be supported by the PSA plant. Need should **not** be estimated by current demand. Please find three different calculation methods in Section 3.1-3.2 of [WHO guidance here](#)
- Oxygen production should be compared to oxygen consumption (demand) annually.
  - If the plant is being underused, consider extending the Medical Gas Piping System (MGPS) or expanding the cylinder distribution to peripheral healthcare facilities.
  - Ensure adequate cylinders for distribution, inside and outside the PSA plant hosting health facility, management of cylinder stock, cylinder trolleys and distribution vehicles.
  - If the plant is being overused, consider procuring additional methods of oxygen production (secondary, tertiary sources) to supplement the existing plant.

### 2. Backup plan

- A back-up plan should be developed to ensure clinical oxygen needs are met in the case of a plant breakdown or shut down for scheduled service. Maximum number of days for plant shutdown

should be defined and an escalation procedure should be developed if this time threshold is exceeded.

## Infrastructure and Logistics

### 1. Location:

- Air pollution, flooding, and noise pollution risk should be mitigated through appropriate plant siting. Ensure final site selection is accessible by vehicles needed to deliver and install the plant.

### 2. Ventilation and Cooling:

- Extreme heat and cold environments impacting PSA operations should be mitigated.

### 3. Power Supply:

- Reliable power supply infrastructure must include properly balanced 3-phase power, reliably sized cables for distribution and appropriately sized protection from voltage fluctuation.
- Ensure appropriately sized backup power options. Consider renewable power instead of generators for both operational and financial sustainability.

## Finance

### 1. Capital Costs:

- Capital project costs include PSA plant equipment, plant house infrastructure, electrical upgrades, oxygen cylinders and transport carts, and MGPS installation or upgrades if applicable.

### 2. Operational Costing:

- Detailed operational costs include spare parts, scheduled maintenance, repair costs, electrical bills, diesel costs, distribution costs and salaries for staff. These costs can be integrated into the hospital's annual budget. See additional information [here](#).
- Innovative operational models such as private-public partnerships, cost recovery models, oxygen as a service models should be explored where possible in line with budgeting guidelines of the relevant funding organization.

### 3. Financial Planning & Monitoring:

- Incorporate all capital costs in initial project budgeting. This includes any upgrades to the hospital's existing electrical and structural and piping infrastructure necessary to support the PSA plant.
- Incorporate long-term financial planning to ensure sustainable funding for the oxygen plant's life cycle which is on average 10yrs. This includes setting aside funds for unexpected repairs or system upgrades.
- Regularly review and adjust the budget to accommodate any changes in operational demands or costs.
- Implement a system for regular financial monitoring and reporting to track expenses and ensure funds are being allocated and used efficiently.

## Human Resources

Planning for the operation of PSA plants, including human resource considerations, should be completed before installation.

### 1. Daily Checklists:

- Operations or technical staff should perform and record daily operational checklists for early identification of critical malfunction. See the [Daily Maintenance Checklist here](#), the [Preventative Maintenance Log here](#), and the [Repair Log here](#).
- Monitor and record the daily production of oxygen by the PSA plant, differentiating between direct distribution to MGPS and refilling cylinders.

- Monitor and record oxygen purity daily with at least two different analyzers.
- Have a site-specific operational plan including a pathway for escalation of malfunction needing immediate maintenance or repair.

## 2. Staff and Technical Training:

- It is recommended there is trained staff onsite during plant operations. Find further [staffing guidance here](#).
- The PSA plant needs an optimum number of trained staff and all necessary tools for daily operations and maintenance and oxygen distribution. See recommended tool list [here](#) and [here](#)
- HR competencies required should be defined prior to the complementary manufacturer training provided by the supplier. Capacity building programs should be prepared and performed as needed to supplement supplier training.

## 3. Strengthening oxygen demand and rational use at the point of care

- Train health care workers on the rationale of oxygen therapy.
- Routine hypoxia screening with pulse oximetry in key (or all) care areas. See available guidance [here](#).
- Ensure availability of patient delivery interfaces (consumables)

# Market Landscape

## 1. Warranty, Maintenance, and Service Providers:

- An understanding of the service provider market landscape is necessary to make informed decisions on maintenance contract conditions and repair options if needed.
- A long-term warranty and maintenance contract (5 years) is strongly advised. Warranty and service contract guidance can be found [here](#) and [here](#).
- When a maintenance or service agreement is established, its terms should be fully understood by service providers, plant operators, hospital management, and at the central governance level.
- Keep detailed contact information of the oxygen plant manufacturer, source of spare parts, local service agent (LSA) for repair requests.
- In the absence of an LSA, e.g. for previously installed and repaired PSA plants outside of warranty and maintenance contract, a maintenance plan to be executed by the host facility engineers should be developed. Staff may also need advanced training to execute the maintenance plan recommended by the manufacturers.

## 2. Spare Parts:

- Active communication with local and/or international spare part suppliers is necessary for inventory replenishment. An understanding of the spare parts market landscape is critical to replenish the spare part inventory quickly and affordably.
- A spare part inventory of at least two years is recommended, stored in a designated secure space. Inventory should be actively tracked and recorded.
- Spare parts inventory list should be developed after consultation with the manufacturer. Each plant's spare part list will vary depending on the manufacturer and design of the plant.

# Normative/Standards and Regulations

## 1. National Policy and Strategic Roadmap

- A national strategy for oxygen investment and capacity building should be developed which incorporates all aspects around sustaining medical oxygen production. If there is a policy working group, all stakeholders in PSA plant sustainability should participate.
- A quality assurance and regulatory protocol should be developed to ensure consistent medical grade oxygen production. At a minimum, purity should be measured daily with a handheld analyzer.

## 2. Occupational Health and Safety Protocols:

- Develop and enforce health and safety protocols to prevent injuries. Ensure staff wear appropriate PPE (e.g. gloves, protective glasses, hearing protection).
- Technical staff are trained on the proper handling and use of high-pressure oxygen cylinders.
- Ensure fire safety protocols are in place.
- Conduct regular safety drills and training sessions to keep staff prepared for emergencies.

## **2. Electrical Safety:**

- Regularly inspect and maintain electrical systems and infrastructure with the necessary personal protective equipment (PPE) to prevent hazards.
- Follow lockout/tagout procedures to ensure safety during maintenance.

## **3. Documentation and Reporting:**

- Maintain essential records of daily check lists, routine preventive and periodic maintenance, repairs performed by the staff and external service provider.

### **Additional resources:**

[Foundations of medical oxygen systems](#)

[WHO technical specifications for PSA plants](#)

[Daily Maintenance Checklist Template](#)

[Preventative Maintenance Log Template](#)

[Repair Log Template](#)

[Oxygen Plant Staffing Guidance](#)

[Recommended PSA Plant Maintenance Toolkit](#)

[Recommended PSA Plant Booster Compressor Maintenance Toolkit](#)

[PATH Oxygen Quantification and Costing Tool](#)

[UNICEF Oxygen System Planning Tool](#)

[Warranty Terms Guidance](#)

[Service Contract Guidance](#)

All BHI resource documents linked in this document can also be found at [www.bhioxygen.org](http://www.bhioxygen.org).