

## Technical assistance for the Procurement and Installation of PSA Oxygen Generation Plant in India

The World Health Organization (WHO) recognized in 2020 that “the ability to boost capacity to deliver oxygen therapy is the cornerstone of the overall approach to manage COVID-19 outbreaks and its implications for the functioning of the entire system.”<sup>1</sup> As the number of people losing lives to COVID-19 began surging in the middle of March 2021, marking the beginning of the second wave of the pandemic in the country, it exceeded the worst fears of experts and policy-makers not only in India but also globally. While the first wave of COVID-19 in India took almost ten months to infect more than ten million lives, the virus took just ten weeks to infect more than 11 million during the second wave. It created a daily oxygen demand ten times that of the pre-COVID period.<sup>2</sup>

Nearly 80 percent of the oxygen demand in the country was being met by liquid medical oxygen (LMO) during the second wave. Yet, despite the best efforts by the country, the demand for medical oxygen overtook the supply as most of the LMO manufacturers are based in the eastern states of India, whereas the high demand for medical oxygen was in the northern and western states.

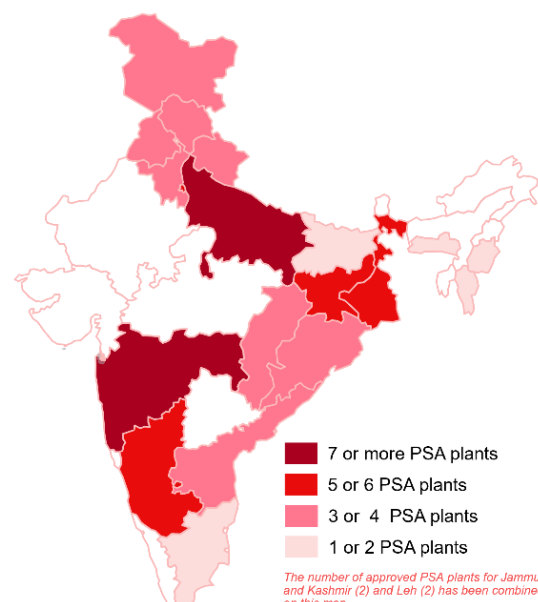
As the country faced challenges at various stages of LMO, such as manufacturing, logistics, and storage, and the hospitals were getting overwhelmed with demand for oxygen therapy, there was a realization to build captive capacity in the health facilities to generate medical-grade oxygen and ensure its availability anytime by reducing dependence on gas supply logistics. The crisis fueled a drive to build pressure swing adsorption (PSA) oxygen generation plants (OGPs) and supply medical oxygen to hospitals. The health experts have also long argued that tertiary hospitals in India need their PSA plants to reduce dependence on LMO not only to treat COVID-19 patients but also for other medical emergencies such as snake bites, accidents, and asthma attacks. To augment the supply of oxygen in the medical facilities, amid spiraling coronavirus cases in the country earlier in 2020, the Government of India (GOI) released the guidelines for the establishment of PSA plants in India and, further, in 2021, it sanctioned installation of more than 1,500 PSA OGP in public health facilities through the Prime Minister's Citizen Assistance and Relief in Emergency Situations (PM CARES) Fund across all states to augment medical oxygen. As of today, India is installing more than 4,500 PSA OGP.

It was during this time that many donors—philanthropic and corporate—initiated investments in providing a grant to aid to strengthen the respiratory care ecosystem in India. The Google grant was extended to PATH from June 2021 till December 2021 to set up 80 PSA OGP across the country and respond without restriction to request from the states for support in their journey to become self-sufficient in the production and rational use of oxygen. Mohammad Ameer, Head – Primary Health Care, Technology and Innovations at PATH reflects,

*“There are three partners in this initiative. Google, which provided the funding to procure and set up the PSA plants in hospitals not covered by PM CARES. Give India, which procured the PSA plants from Tata Advanced Systems Limited (TASL), and PATH to provide oxygen delivery solutions at the ground level, identify sites, prepare them for PSA plant installation, and get the plants commissioned on time. We also strengthened the capacity of various stakeholders such as nodal officials for oxygen, engineers, hospital management authorities, among others, to equip them with the correct knowledge on technical and operational issues related to PSA plants.”*

This journey has experienced its share of highs and lows. This case study documents the challenges PATH surmounted with the support of Google India to achieve the condition of oxygen self-reliance many states are in today.

Figure 1: 77 sites approved for Google Fund



<sup>1</sup>WHO interim guidance on oxygen sources and distribution for

<sup>2</sup>India Today

*“Despite the delays, there were many bright spots! We adopted a no-one-left-behind approach. The state teams were asked to ensure that the health facilities in difficult geographical regions that met PSA plant criteria but had experienced a severe crisis of oxygen during the second wave of COVID-19 were not left out. For this, the PATH teams travelled by road for many hours and sometimes by air, with multiple changeovers, to do site assessments. We have not only set up PSA plants in the high-altitude Kargil district in Ladakh but also the north-easternmost state of Mizoram.”*

Dr. Jayendra Kasar, Senior Program Officer, PATH

### **Starting up problems**

Missing and delayed approvals, incorrect allocations, new additions

The time, taken for administrative approvals for the PSA plant intervention varied from one state to another. *“We hit the problem button from the word Go!”* shares Anil Mishra, State Lead – Uttar Pradesh (UP), PATH.

*“PATH had offered seven PSA plants to the UP government. We followed up with them for a few months for their approval. During this period, the state government had received around 600 PSA plants from the PM CARES Fund and was, therefore, reluctant to absorb more plants. After repeated follow-ups with the government, when we did not receive formal communication from the government for installation of PSA plants in public health facilities, PATH decided to allocate PSA plants to non-governmental, charitable hospitals in the state.”*

As the other states were off to a quick start with the approval letters from the respective state governments to PATH to start the project, the first step they took in the process was the selection of health facilities where PSA plants could be installed. As the members of PATH's state teams began their consultations with various state governments to discuss the potential health facilities that would require a PSA OGP, they soon realized that the state governments had already earmarked nearly all high COVID-19 burden public health facilities, such as the district hospitals, the sub-district hospitals, the community health centers, for PSA plants through the PM CARES Fund. Dr. Anil MH, State Technical Officer, Karnataka, PATH, shares,

*“We were in a very tough situation. We had the mandate to help states with 800 liters per minute (LPM) PSA oxygen generation plants, but most of the public health facilities left out of PM CARES coverage did not have adequate case burden during the second wave and could not have sustained a PSA plant of this capacity.”*

The PATH team returned to the drawing board to revisit the commitments under the grant-in-aid and undertook course correction in consultation with the Google and

Give India teams. PATH expanded the health facilities for the installation of the PSA plants to a charitable trust–managed not-for-profit hospitals that shared the high burden of COVID-19 cases during the second wave. PATH, for instance, had seven PSA plants allocated for Uttar Pradesh under the grant, but due to lack of support from the state leadership and the government saturating its demand for 600 PSA plants with PM CARES Fund, PATH identified around 10 charitable trust run hospitals for extending support for the PSA oxygen plants.



Site visit at District Headquarter Hospital Malkangiri, Odisha with Electrical Engineer (EE), Assistant Executive Engineer (AEE), Sub Divisional Officer (SDO), Contractor of hospital and Technical Manager of PATH

In other states, where the administration allocated public health facilities for the installation of PSA plants through Google grant-in-aid, the PATH team jointly with the state health officials conducted site assessments. The PATH

team members used a checklist for a site assessment to determine whether a facility is appropriate for setting up PSA plants and, if it was, the capacity of the PSA plant that best suits the allocated facility. This checklist considered several factors such as bed availability, human resources, peak oxygen demand, oxygen sources, patient admission, space availability, and infrastructure. In addition to site assessment, the team also assessed the readiness and the ability of the health facility to meet the prerequisites for a PSA plant. In many cases, the PATH team at the end of site assessment and a needs assessment at the allocated sites observed that the facilities did not fit the need for an 800-LPM capacity PSA plant and the associated investment that came along with it such as Diesel Generator (DG) sets and electrical works.

*“In some cases, the state had given us the site for 800 LPM plant, but when the assessment was done, it was found that the facility did not require the capacity of 800 LPM oxygen plant. Such instances were particularly found in the case of CHC Kalka, located in Panchkula district of Haryana and Civil Hospital Dalhousie located in Chamba district of Himachal Pradesh. The PATH team had a series of meetings with the state and, finally, the state government agreed on our point and changed the sites for*

*these PSA plants.*” states Anil Sharma, State Lead, Punjab, reflecting on the rounds of visits he made to the state Secretariat to seek their appointments and undertake one-on-one meetings with the state officials to help them understand the need for the change in the sites for these particular PSA plants. Shaking his head, he adds, *“There were major delays!”* A few states because of lower caseloads and a few others because most of the high burden facilities there were already allocated to PM CARES-funded PSA plants sought lower 500-LPM capacity PSA plants. States such as Jharkhand needed PSA plants at the sub-divisional levels (tertiary care facilities at levels above a district) but could not afford the investment needed for meeting the prerequisites for a PSA plant. As many facilities that were allocated by the state governments were rejected after the site assessment due to reasons such as low bed capacity or inadequate space for the medical gas pipeline system (MGPS), in addition to the reasons stated above, the project experienced unanticipated delays in starting up. The joint field visits for site assessment proved a crucial exercise as it provided the state’s health department with the technical support, they wanted for actionable information for rejecting and accepting a particular facility to meet PSA plant installation requirements. In the cases, where the allocated health facilities did not meet the criteria for an 800-LPM capacity PSA plant, PATH consulted with the respective state governments to recommend another facility for site assessment that is likely to meet the PSA requirements.

have the electrical wiring and layout currently installed. There were also nonelectrical issues in some facilities, such as they did not have the right size and design of MGPS in place or the budget they had prepared for PSA plant installation was estimated much lower than the actual cost.

Dr. Abhijeet Sinha, State Lead, Jharkhand, PATH, observes, *“There was very limited knowledge on PSA plants and its various processes such as installing, commissioning and proper functioning at all levels. We realized that, as a result, many of them were being given information that was inaccurate, and they had no source to validate it. For example, a reputed manufacturer of PSA plants in the country had not given the technical specifications for the PSA plant site to the facility in-charge. They were constructing the shed for the PSA plant using incorrect dimensions. Our team, oriented the Health Department and Civil Works Department at state, district, and facility levels on the technical specifications for a PSA plant site and ensured that they had the right information to make informed decisions.”*



Site work is in progress for civil work in Bijapur, Chattisgarh

In another instance in Odisha, there was a communication gap observed among multiple stakeholders involved in site preparation. For example, the designs from suppliers could not be shared with the site preparation agencies before the coordination meeting.

PATH team organized orientation sessions and provided the site preparation team with technical references from credible sources, photographs, architectural designs and layouts, flow diagrams, charts, gas pipeline diagrams, among others to use as resource materials. PATH’s state teams made frequent visits to the PSA plant sites and regularly engaged with the vendors to ensure that the sites were constructed to meet the desired standards. The state teams coordinated with the Civil Surgeons and other hospital authorities to expedite site preparation. Dr. Ashalata Pati, State Technical Officer, Odisha, shares, *“Orientation workshops at state and district levels can play an important role in improving the ownership of health managers and hospital staff to the*



Site identification at DH Thoubal, Manipur, with the State Nodal Officer (SNO) and engineer of District Rural Development Agency (DRDA), Thoubal

### **It’s always the location**

#### **Readying the site for the installation of PSA oxygen plants**

As the project team completed the selection of facilities one-by-one and put teams to help these facilities prepare for PSA plant installation, they came across a new set of challenges. Some of the facilities did not have regular electricity supply or had low voltage through most of the day due to their remote location, whereas others did not

*construction of the PSA plant and will also help in its maintenance post-installation. We realized that besides orienting them, it is important that the hospital in-charges directly connect with the PSA plant suppliers to streamline its delivery, installation and commissioning. During our project duration, it is being facilitated by PATH team. We advocated for the SOPs to be issued for the public health facilities on the post- installation maintenance of the PSA plant.”*

In Uttarakhand, for example, the Rural Works Department had given to the Health Department a budget estimate for civil and electrical works for the PSA plant site, which was much higher than the market-based estimates PATH had. PATH facilitated a consultation between the hospital authorities and Rural Works Department to help them arrive at a realistic and agreeable rate for site construction. Dr. Devinder Sharma, State Lead for Uttarakhand, states, *“It was a big challenge to bring all the involved departments at a single platform. Many a time, just the effort to ensure that government agencies for the civil and electrical works fully understand the specifications for PSA plant installation took a lot of time, resulting in delays. However, as a team we are committed to streamlining such issues.”*

Mr. Simerjot Singh, Nodal Officer-cum-General Manager, District Industries Centre, Kapurthala, Punjab, observes, *“For me as a Nodal Officer, it was a great learning experience on-site preparation for the installation of PSA plant. We worked with different departments of the state government of Punjab as a team. The PATH state team gave their valuable technical support and helped us in preparing the sites meeting quality expectations, as per specifications and in time.”*

In many instances, the hospitals conveyed to PATH that the site would be ready in 15 days without having the civil works and electrical works vendor contracted in. Despite the PATH’s team members following up many times with them, they could not get the civil works started in time. There were times when PATH had to intervene at state levels to cascade down urgent instructions to clear civil and electrical vendors to begin site preparation for the PSA plant. In many states where PATH was facilitating the installation of PSA plants through this grant-in-aid, interdepartmental coordination presented several challenges. There were instances when the civil work for the PSA plant site was completed, it had the approval to dispatch the PSA oxygen plant from the vendor but the facility had not received the electrical connection or there was a delay in laying the MGPS. On another occasion, when issues cropped up between the health, the civil works, and the electricity departments in Bihar, PATH had to hold regular meetings with Bihar Medical Services and Infrastructure Corporation Limited (BMSICL) and consultations among all stakeholders to get them resolved. This led to unprecedented delays.

Recalling an incident where PATH had to make an extreme step, Parimal Chandra, State Lead – Bihar, PATH, shares, *“The electricity department refused to come for laying the electrical lines for the PSA plants at a few facilities as the cables meeting the design specifications were not available with the department and procuring them through government process would have taken time. Therefore, to expedite this, we did a market survey and found that we could source the desired cables from West Bengal, the nearest market for it. We asked the contractors deployed for the work, to get the cables and other required electrical fittings from West Bengal. This timely solution helped in completing the electrical work for the PSA plants on time.”*

### **Hurdles at the final stretch:**

#### **Dispatch, installation, and commissioning**

PSA plants were procured through Give India from TASL. In the initial stages of the project, PATH was coordinating with the agencies for early dispatch. There were coordinating issues initially for dispatch but later these were resolved.

Delivering the plant was a challenge as logistic arrangements were involved for the delivery. There were a few issues of reluctance from hospitals in Bihar, Jharkhand, Orissa, and Meghalaya, among others. PATH supported the logistical arrangements for the supply of the plant in these states. For example, the PATH team in Meghalaya facilitated the transportation of the PSA plant to the Nazareth Hospital, when the truck delivering the plant was unable to maneuver the mountainous roads due to its size as well as to the state’s traffic rules, which limited the timings for road use by heavy vehicles. The truck was held up around 13 kilometers from the hospital and the hospital authorities did not have the budget for the PSA plant transportation.

PATH organized three small trucks and a crane and worked overnight to complete the offloading of the PSA plant at the hospital site in the wee hours of the morning. When the PSA plants arrived at the health facilities, new sets of challenges emerged, as the technicians hired by the vendors did not have the complete knowledge

needed for the installation of PSA plants. In some cases, the technicians did not follow the specifications detailed by TASL. They had 200-mm cables instead of 300-mm cables. The PATH team was able to facilitate the transportation of PSA plant to an inaccessible site in Meghalaya.

In other facilities, the local vendor got the transformers of lower capacity than the specifications. For instance, they had a transformer of 200 kV capacity, and the requirement was 250 kV, as most of the other PSA plants in the state had a transformer of 200 kV. Dr. Satish Tajne, Lead-Google Oxygen Project, PATH, adds, “We had our people on the ground to ensure that the PSA plants with our grant-in-aid had high-capacity transformer capacity of 250 kV. We had to actively coordinate multiple approvals for the procurement of this kind of high-capacity transformer. Like, in the case of Sindhudurg, Maharashtra, the Civil Surgeon did not have the authority to order procurement of the 250-KV transformer as it was costly. So, we approached the District Collector and got the approval.” Reflecting on the overall installation timeframe, he adds, “Ideally the installation of a PSA plant is a one-day process, but it took more than 15 days at some places because of such delays and more. The vendor should send their teams to the site in one go and a representative of the original equipment manufacturer for the compressors should visit the site and examine the equipment, but it did not happen at a few places. We had to follow up so many times. These caused delays that could have been avoided.”



Unloading of the PSA plant at Nazareth Hospital, Meghalaya

analyzed the oxygen demand for the hospital and shared the findings with the Mission Director, National Health Mission of the state, and the Civil Surgeon of the district and further gave them a suggestion to have two 800-LPM PSA OGP installed in the same facility. Concurring with PATH's findings and recommendations, the state government approved the installation of another PSA plant. As a result, the Sadar Hospital now has two PSA plants, in addition to PM CARES 100-LPM plant, both of which are being installed with the Google grant-in-aid support to cater to the needs of 500-bedded Sadar Hospital, which is catering to a large vulnerable section of the state.

### Raising the level of engagement: The Health Minister intervenes in Chhattisgarh

The focus of state officials in Chhattisgarh was to prioritize the allocation of health facilities to PSA plants supported by the PM CARES Fund. The PATH team explored coordination with the state nodal officials but did not get any response from them. When even after several weeks of effort PATH did not get their audience, the state team decided to approach the state's Health Minister, who is considered approachable and responsive. PATH was given an appointment with the Health Minister where he was apprised of the situation of PSA plants and the commitment from the Google-supported initiative. This meeting resulted in mobilizing the state officials to include Google-supported installation of PSA plants in the state.

### Changing lanes: Coordinating with Nodal Officer (PSA) in Delhi to get gas pipeline systems in Delhi

Only one hospital of the four facilities where the PSA plant was getting installed with the support of Google had the MGPS facility and manifold system. PATH had been following up with medical superintendents (MS) of the three hospitals to persuade them to get the work started on priority but did not receive the desired response. With each passing day, PATH's Delhi team



Installation and commissioning of PSA plant at DHH Keonjhar, Odisha, with the TASL team

### **Bright, shining stars in a night sky:**

Encouraging stories that emerged during this process

### **Sadar Hospital, Ranchi, Jharkhand: Augmenting existing oxygen generation capacity**

Sadar Hospital is a government hospital that caters to the poor and the marginalized people of the states and surrounding areas. During a visit to the Sadar Hospital for site monitoring for PM CARES PSA plant, the PATH team observed that the hospital, that has a bed capacity of 500 beds, had only 100-LPM PSA oxygen plant sanctioned from PM CARES Fund. The PATH team

was moving more and more away from its committed timelines. The Delhi team decided to reach out to the Nodal Officer (PSA) for the state and requested his support to get the MGPS work in the three hospitals started. The Nodal Officer PSA supported PATH's request and instructed all the MS to expedite the MGPS work. All the hospitals have now started the civil work after this push from the Nodal Officer (PSA).

## **The Lessons**

We share them to ease the path for others

### **Be flexible from the beginning**

The "one-size-fits-all" condition of the 800-LPM capacity PSA plant would need a revisit as many facilities that served COVID-19 patients during the second wave need and have the ability to absorb lower capacity PSA plants. Many states have observed the 500-LPM PSA plant as a better fit to the needs of many facilities that were in dire need of oxygen.

### **Be selective but make smart choices**

The states where there were fewer allocations of PSA plants from the PM CARES Fund were more receptive to the Google grant support than the states where there were more allocations.

### **Be comprehensive, especially for those who have less**

In the northeast region, which gets less share of state funds, the PSA plant support can be more comprehensive to include end-to-end support such as support for the construction of the PSA site, MGPS, and manifold room, among others.

### **Be engaging, prepare people well and in advance**

Since PSA plant installation is a technical intervention, it should begin with orientation with all the stakeholders such as the Public Works Department (PWD) officials, technical engineers, health managers, medical staff, PSA plant vendors, and civil works vendors, among others, to clarify the technical aspects, establish clear roles and responsibilities, and agree on a timeline, among others.

### **Be supportive, technically and programmatically**

The involvement of a technical agency, such as PATH in this intervention, is very crucial as PSA oxygen plant installation is a technical intervention needing a combination of public health, medical, and engineering expertise at all stages of engagement.

### **Be inclusive, engage all stakeholders in decision-making**

Periodic joint review at the state and district levels chaired by senior officers of health and other departments, such as PWD and electrical, in coordination with development partners expedites the site works and supports district officials to take timely actions.

### **Be quality driven, never compromise**

Since India is witnessing large-scale PSA installation for the first time, maintaining quality standards for fire safety and purity in PSA plants becomes crucial. Ensure that the government's guidelines, original equipment manufacturers, and international bodies' recommendations are followed when procuring, installing, and commissioning the PSA plants.

### **Be prepared, from installation to operation and maintenance**

The priority of oxygen support from various states' end has been shifted from setting up of PSA plant to the maintenance of PSA plants. There is a need to still work on strengthening the technical capacity building of the health, civil, and electrical departments on the oxygen ecosystem.

## **Way forward**

The priority of oxygen support is shifting from establishing PSA plants to its operations and maintenance. The experience of setting up PSA plants highlighted the criticality of locally available spare parts, for which local markets and supply chain should be strengthened. The PSA plant can be used optimally by ensuring supply chain mechanisms even in the remotest parts of the states.

The PSA plants are considered to be expensive to operate in low-resource settings as they consume a lot of electricity. Greener options such as the use of solar energy should be explored to make the operations more sustainable.

The establishment of booster refilling plants can be very crucial, especially in serving the needs of smaller health facilities in the vicinity of a larger facility with a PSA oxygen plant.

Besides ensuring technical interventions, there is a need for sustainable investments in strengthening human resources for the maintenance of health equipment and adopting a health systems' strengthening approach, which comprehensively addresses primary and critical health care needs of the country.





PATH is a global nonprofit dedicated to achieving health equity. With more than 40 years of experience forging multisector partnerships, and with expertise in science, economics, technology, advocacy, and dozens of other specialties, PATH develops and scales up innovative solutions to the world's most pressing health challenges.

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