

## Many a twist in the tale of pressure swing adsorption plant installation at the District Combined Hospital in Pilibhit, Uttar Pradesh, India

The sudden onset of the second wave of the COVID-19 pandemic in India had a tremendous impact on the health and humanitarian situation across states. The rising number of cases overwhelmed health systems in April and May 2021. The most pressing issue was the acute shortage of oxygen, which created a scramble in the hospitals and on the streets. The demand for medical oxygen in the country peaked at nearly 9,000 metric tons (MT) a day during the second wave as compared to the peak of 3,095 MT a day during the first wave (Source: Economic Times, 2021). Besides increasing the production and procurement of liquid medical oxygen (LMO) and oxygen concentrators, the Government of India sanctioned procurement of over 1,500 pressure swing adsorption (PSA) oxygen generation plants to make the healthcare facilities self-reliant on oxygen generation, storage, and provision.

Uttar Pradesh, a state in north India, received 395 of over 2,500 PSA plants sanctioned by the Government of India and donated through CSR initiatives. This is because the state's share of total COVID-19 cases was nearly 10 percent (Source: Ministry of Health and Family Welfare). The second wave of the pandemic was brutal on Uttar Pradesh, nearly crippling the state's medical infrastructure.

Pilibhit was among the 41 districts in the state that reported a large number of COVID-19 cases. The Government of Uttar Pradesh allocated 29 PSA plants (including those procured through PM CARES, state funding, and donations) for installation and improving access to medical oxygen.



District Combined Hospital

This case study documents PATH's technical assistance to the District Combined Hospital (DCH) at Pilibhit in Uttar

Pradesh in installing and commissioning a PSA plant and achieving oxygen self-reliance. It also shares lessons that organizations working in medical oxygen ecosystem can take away from PATH's experience.

### COVID-19 in Pilibhit and the district's response

The Pilibhit district in Bareilly recorded 10,193 COVID-19 cases (Source: National Informatics Centre, India) during the second wave, and in response to it, the District Magistrate set up a control room to address COVID-19-related queries. Under the new system, the district administration identified different health centers as Level 1 (L1), Level 2 (L2), and Level 3 (L3) facilities. L1 handled non-critical COVID-19 patients, and L2 and L3 were designated to manage more complicated and critical cases.

Like many parts of the country, Pilibhit also started facing shortage of medical oxygen, as the stock of medical oxygen depleted sharply in most hospitals. The condition in the hospitals became so distressed that several hospitals reportedly turned patients away and advised their families to take them to bigger healthcare facilities such as medical colleges.



Plant room civil work in progress

During the peak of the second wave, the DCH in Pilibhit managed 125 patients on 100 beds. The facility had 55 oxygen beds connected to the medical gas pipeline system, 50 oxygen concentrators and oxygen cylinders (40 B-type and 10 D type), and ten ICU beds. As the oxygen supply with the DCH was not sufficient to meet the respiratory care requirement of the rapidly rising COVID-19 cases, the under-equipped facility began referring patients with acute respiratory symptoms to Rohilkhand Medical College, Rajshree Medical College, and Sri Ram Murti Medical College in the adjoining Bareilly district.

Patients were also referred to hospitals in Lucknow which had better oxygen infrastructure to manage large number of COVID-19 cases requiring oxygen therapy.

### PATH's technical assistance

PATH and its funding partner in Uttar Pradesh for medical oxygen systems strengthening, the Bill and Melinda Gates Foundation (BMGF), approached the Department of Health and Family Welfare, Government of Uttar Pradesh to offer technical expertise in medical oxygen management for augmenting the state government's plans for oxygen sufficiency. After consultations between PATH, BMGF, and senior state health officials, including the Additional Mission Director, National Health Mission (NHM), Uttar Pradesh, Executive Director, Uttar Pradesh Technical Support Unit, and Joint Director and Nodal Officer for Oxygen, Government of Uttar Pradesh, the officials accepted the offer of technical assistance and developed a joint work plan for PATH and the Department of Health and Family Welfare, NHM. As part of the plan, the department earmarked the Mother and Child Healthcare (MCH)/L2 wing of the DCH for installation and commissioning of the PSA plant.

### One plant, two claimants

As a preparatory step to support the hospital, PATH's team of public health specialists and biomedical engineers conducted a site assessment at the DCH. PATH determined the PSA plant capacity for the facility by using a checklist that considered several factors such as bed availability, human resources, peak oxygen demand, oxygen sources, patient admission, space availability, and infrastructure, etc.

Issues started emerging as soon as PATH initiated the site assessment process. The DCH has two sub-hospitals. There is a District Hospital and there is a MCH unit within the same premises. Both the units are supervised by a different Chief Medical Superintendent. That is why, it is called District Combined Hospital. Both the Chief Medical Superintendents wanted the PSA plant to be installed close to their facility.

While both the facilities wanted the PSA plant, it was the newly constructed MCH unit which was identified by the state government as L2 facility, where the COVID-19 patients were being treated.

The issue was brought to the attention of the District Committee consisting of the Chief Medical Officer, Chief Medical Superintendents, District Nodal Officer for oxygen, and the City Magistrate. The District Committee, in consultation with PATH, decided to install the 500 liters per minute (LPM) PSA plant procured with the assistance of BMGF, near the MCH unit. Thereafter, based on PATH's site assessment report, a space was allotted by the District Committee to initiate civil work for the PSA plant installation.

### State allocates, district reallocates

PATH started the civil work for building a structure to house the PSA plant. Around June 2021, when the construction of the structure was in full swing, the Government of Uttar Pradesh began receiving the PSA oxygen plants allocated under PM CARES fund phase III for installation across the state. As a result, the state government initiated shifting of sites allocated to nongovernmental organizations and other organizations for PSA plant installation to other locations.

The Chief Medical Officer of Pilibhit district also asked PATH to install the PSA plant at a different site to accommodate the two PSA plants provided under PM CARES. Reflecting on the turn of events, Anil Mishra, State Lead, Uttar Pradesh, PATH, shared,

*“Under PM CARES, two PSA plants had been sanctioned for the DCH. The district authorities were asked to immediately install the two plants. We were instructed to shift our allocated site for PSA plant to a remote location. Since we had already initiated the civil work with donor funding for the installation of PSA oxygen plant, it was difficult to shift to another site without additional funding. The team was in a very tough situation and under tremendous pressure.”*

When PATH shared the issue with the Chief Medical Officer and the Chief Medical Superintendent of the MCH unit, they offered to install one of the two PM CARES-funded PSA plants on the platform. PATH strongly opposed this idea and took it up in several discussions with various district officials including the District Magistrate. Recalling the arguments presented by PATH for not shifting the site allocated to PATH for the PSA plant, Vinay Kuma Mishra, Public Health Coordinator, PATH says,

*“Selection of the health facilities for installation of PSA plant under PM CARES was based on the facility's caseload. Those health facilities which were left out of PM CARES coverage either did not have sufficient caseload or didn't have space to install PSA oxygen plant. When we were asked by the district authorities to relocate to a different site, we denied because the new site option allocate to us for the installation didn't have sufficient caseload. The facility wouldn't have sustained a plant.”*



Unloading the PSA plant

After consultations with the district authorities and acknowledgment of PATH's determination to retain the site for the PSA plant it was funding, the district health officials relented and decided not to shift the PSA plant site.

### Tryst with the Murphy's Law

Murphy's law is an adage or epigram that states that "if anything can go wrong, it will."

PATH provided the site preparation team with technical resources including architectural designs and layouts, charts, gas pipeline diagrams, etc. PATH representatives frequently visited the plant site and regularly engaged with the vendors to ensure that the site was constructed to meet the desired standards. Despite some delay in laying the medical gas pipeline system, the PATH Public Health Coordinator (PHC), who was supervising the site readiness, along with the team, completed the civil work well within time.

With the site ready, the installation and commissioning of the PSA oxygen plant was the next major step. It required the presence of the PSA plant engineers and the vendor. Despite repeated follow ups by PATH, the commissioning could not be done on time. The facility had not received an electrical connection. The PHC tried to persuade the senior officials and contacted the engineers in the district, but the engineering team delayed their arrival at the site further. This led to unexpected delays in commissioning of the PSA plant.

The district administration held a meeting to discuss the issue with PATH and the government engineer. Annoyed and anxious of the risk of missing the deadline that the district had committed to the state to commission the PSA plant, the district administration detained PATH's PHC for a whole day till the engineers didn't reach Pilibhit for the installation and commissioning of the plant. PATH leveraged its contacts and resources in the state and national offices to get the engineers to Pilibhit and get the PSA plant installed and commissioned.



Inauguration of the PSA plant

### All is well that ends well

Finally, Pilibhit district's first PSA oxygen generation plant of 500 LPM capacity was installed and successfully commissioned in September 2021. Additionally, the other

two facilities within the DCH, i.e., District Hospital and District Female Hospital have separate PSA plants of 500-LPM capacity each, installed under PM CARES. The PSA plant was handed over to the facility authorities after oxygen sample testing and training of the plant operators in the hospital.

Acknowledging the contribution that the PSA oxygen generation plants will make to building a sustainable oxygen ecosystem in the district, Dr. Rajesh, Nodal Officer, Mother and Child Care, DCH, Pilibhit, observed,

*"In the district hospital of Pilibhit, the dependency for oxygen was majorly on oxygen concentrators and cylinders. Even though the district didn't see high caseload but due to lack of oxygen supply, the critical patients had to be referred to hospitals and medical colleges in Bareilly. We indeed require continuous flow of oxygen, especially during COVID-19, as it will enable us to be more prepared. There was indeed a delay of four to five days in installation of PSA oxygen plant instead of being installed in one day, but it was worth it. This happens to be the first PSA oxygen plant in the district. Now we have two more plants installed under PM CARES. We now must invest in the maintenance and operations of the plants, which have been handed over to us."*

### Lessons learnt

- ▶ **A consultative conflict resolution system is necessary in a multi-stakeholder initiative.** PATH encountered conflicts at two points. Firstly, while deciding the location of the plant, and secondly, when the district authorities wanted to relocate the site of the PATH-supported PSA plant. In both the cases, a multi-stakeholder District Committee that was open to evidence-based and rational decision-making played a crucial role in resolving disputes and addressing grievances. Such a structure is necessary to capacitate various stakeholders involved in the oxygen ecosystem in the state.
- ▶ **It is important that one is prepared for all eventualities, and actions are put in place well in time to avoid any inconvenience.** PATH had completed the site preparation well in time. The PSA plant was also at site for installation. Yet, the installation got delayed because the biomedical engineers who were to install the plant were busy because many PSA plants were getting installed around the country at the same time. The vendors and their pool of engineers were limited.

### Way forward

The COVID-19 pandemic has highlighted and exacerbated the deficiencies in the hospital oxygen systems. However, an opportunity has also emerged to "build back better." Building robust oxygen systems across the state has been a high-priority of the Department of Health and Family Welfare, Uttar Pradesh. In the future, practical actions that hospitals can take to immediately expand oxygen access are (1) improving

pulse oximetry and oxygen use, (2) supporting biomedical engineers to optimize existing oxygen supplies, and (3) expanding the existing oxygen systems with robust equipment.

The priority of oxygen support is shifting from establishing PSA plants to its operations and maintenance. This shift

will require onboarding of biomedical engineers or an agency, which the government has to initiate. PATH will continue to provide technical support and lead the capacity-building initiatives on the oxygen ecosystem in the state.

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