



# Report on solar PV installation/restoration of solar-based off-grid energy systems of health posts/centers in the Tigray region



**CESET**  
Community Energy and the  
Sustainable Energy Transition  
in Ethiopia, Malawi and Mozambique

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## Introduction

The Tigray regional state of Ethiopia faces significant challenges regarding energy access. Before the conflict that began in late 2020, the energy access rate in Tigray was already low, with a considerable portion of the rural population relying on traditional energy sources like firewood and charcoal for cooking and heating. Tigray Region is one of the eleven regional states of the Federal Democratic Republic of Ethiopia located in the northern part of the country. In line with Millennium Development Goals (MDGs), the Ethiopian government has been trying to introduce different programs and strategies for ensuring rapid regional economic development including improving the health services. To this end, the Tigray Regional Health Bureau envisions seeing healthy, productive, and prosperous people in every household of Tigray, through delivering a comprehensive package of promotive, preventive, curative, regulating, palliative, and rehabilitative health services within a decentralized health system that fosters the full ownership and empowerment of the community [1]. In 2015, the healthcare system in Tigray included 39 hospitals (2 referrals, 15 general and 22 primaries), 204 medium-sized health facilities/centers, and 712 small-sized clinics/health posts [2]. The Ethiopian Health system is categorized as small health clinics (posts), medium-sized health centers and hospitals. Key to improving the healthcare services of rural communities and to achieving health-related SDGs are improvements in the quality of health services.

However, there have been challenges to providing quality services in rural areas due to the lack of electricity access in the health centers and posts. Ensuring primary health care services to rural communities requires an improved and reliable energy supply. The lack of reliable energy provision to health centers and posts have been challenging particularly in the remote areas. In view of this, the Ethiopian ministry of health has initiated and fostered to introduce and deploy off-grid solar PV systems to the health centers and health posts to the remote areas, with the Tigray region as one of the beneficiaries of the programme. In the middle of such improvements in supplying electricity to the health services, a war breakout in November 2020 devastating all the service sectors in the Tigray region including the health services. According to the damage assessment team report 2022, nearly 514 health posts and 153 health centers were damaged and/or vandalized during the conflict [3]. This includes damaging and/or looting of the existing off-grid solar PVs by the invading forces. According to the rapid damage assessment report conducted by experts from the regional health bureau, about 60.9% of the health posts in Tigray had power from solar source prior to the start of the war. With the destruction and looting of the electricity supply equipment, the post war proportion of the health posts with power sources (solar/electricity) dropped to 11.0% according to the report.

In light of the challenges faced by health centers in Tigray, the CESET project has initiated efforts to install solar PV systems across health posts/centers in the region. The CESET project recognizes the importance of continued support for renewable energy initiatives in building a sustainable healthcare framework. This support will be crucial in addressing current challenges and preparing for future demands, ultimately contributing to the overall health and well-being of the Tigray region.

## Background of the CESET project

The CESET project has had a transformative impact on the health system in the Tigray region by promoting sustainable energy solutions. The introduction of solar photovoltaic

(PV) systems in health centers have not only addressed critical energy challenges but also contributed to broader community health and well-being. The implementation of solar PV systems has drastically improved the reliability of electricity access in health centers. This has allowed for uninterrupted medical services, including emergency procedures and vaccinations, which are crucial for both maternal and child health. With a stable power supply, health facilities can maintain essential services, leading to improved health outcomes. Access to consistent electricity reduces the risk of complications from power outages, ensuring timely medical interventions and enhanced quality of care. Improved energy access has led to increased trust in the health system, encouraging more community members to seek medical care. As health centers become more reliable and functional, utilization rates for services have risen, leading to better health outcomes for the entire community. The CESET project aligns with various Sustainable Development Goals, particularly Goal 3 (Good Health and Well-being). This report discusses the current state of the health center, the installation of the new solar PV system, and the anticipated impact on healthcare delivery in the specific health centers.

## Project Implementation

The researchers at Mekelle University reached out to the Health Bureau of the Tigray Regional State to identify health centers/posts that lack electric access that are affected by the devastating war. This collaboration was crucial to ensure that the most affected areas received attention. The team has discussed the aim of the project, and the criteria that need to be addressed while selecting the areas for electrification. Accordingly, the Health Bureau provided a list of health centers based on specific selection criteria, including proximity to the national grid, current electricity availability, and the overall need for reliable energy to improve healthcare delivery. After the identification of suitable health centres, the Mekelle University team have started to identify health centres/posts that are suffering much with electricity access by contacting the woreda level health office heads through the regional health bureau and receiving necessary approvals from the relevant authorities to proceed with the installation of solar PV systems. The selected health centers included locations known for their limited access to electricity. Figure 1 illustrates the logistics involved during the installation of the solar PV system. This includes the planning, transportation of materials, site preparation, and coordination among teams to ensure a successful installation process.







Figure 1: Logistics During Installation

## Procedure Followed to Install The Solar PV Systems

The successful installation of solar photovoltaic (PV) systems in the health centers of Tigray involved a series of coordinated steps to ensure effective deployment and operational sustainability. Below are the detailed procedures we followed during the project time:

**Acceptance of the solar PV Systems:** We received solar PV systems from the supplier, ensuring that they met with the necessary specifications and quality standards required for health center operations.

**Site Identification:** In consultation with the Health Bureau of Tigray, we identified suitable sites for installation within the region's health centers. This collaborative approach ensured alignment with local healthcare needs and priorities.

**Assessment of Energy Demand:** We conducted a comprehensive assessment of the energy demand for each health center. This involved evaluating the specific power requirements necessary to operate essential medical equipment, lighting, and other facilities, ensuring that the solar PV systems would adequately meet these needs.

**Transport Arrangements:** We arranged transportation facilities to deliver the solar PV systems and installation equipment to the selected health centers. This logistical planning was crucial for ensuring that all materials arrived on site in a timely manner.

**Installation of Equipment:** A skilled installation team was deployed to each health center, where they then installed the solar PV systems according to established guidelines. This process included setting up panels, inverters, and storage batteries, ensuring all systems were correctly configured and operational.

**Impact assessment interviews:** Following installation, we conducted interviews with health administrators at specific sites to assess the impact of the solar PV systems. These

discussions provided valuable insights into the improvements in service delivery, reliability of power supply, and overall satisfaction with the system.

**User training:** We provided training for health center staff on the use and safety issues associated with solar PV systems. This training included operational procedures, emergency protocols, preventive maintenance and best practices for energy management. Figure 2 demonstrates the solar PV cleaning procedure as a part of preventive maintenance. This process is essential for ensuring the efficiency and longevity of the solar panels by removing dust, debris, and other contaminants that can obstruct sunlight absorption.



Figure 2: Solar PV Cleaning procedure as preventive maintenance

## Health Centers With Installed Solar PV

Here below are the areas where the solar PV systems are installed

### ***Agazi Health Center***

Solar photovoltaic (PV) system was successfully installed at the Agazi Health Center located in Hadinet Tabia of Tsaeda Emba Woreda. This health centre is situated approximately 20 kilometers from the nearest national grid, emphasizing the need for an independent power source to ensure reliable healthcare services. Agazi Health Center has been operational since 2020 and plays a critical role in serving the woreda and its neighboring communities, totaling around 25,000 residents. On average, the health centre facilitates approximately 5 deliveries each month, highlighting its importance in maternal and child health services.



Before the installation of the solar PV system, the health centre relied on lanterns and mobile flashlights to provide essential services, which was inadequate, particularly for critical healthcare operations. After the Pretoria Peace Agreement, the centre attempted to enhance its power supply by purchasing a diesel generator. Unfortunately, the generator was not functional due to consistent shortages of fuel and budget constraints.

Despite having basic medical equipment, the lack of sufficient lighting severely limited the health centre's ability to provide services effectively. The installation of the solar PV system has now enabled Agazi Health Center to operate fully, ensuring that essential healthcare services can be delivered without interruption.

This initiative not only improves the functionality of the health centre but also enhances the overall quality of care provided to the community. The successful implementation of the solar PV system marks a significant step towards sustainable healthcare in rural areas facing energy challenges.

The figures provided below illustrate the progress made at Agazi Health Center, showcasing the preassembly phase and the complete installation of the solar photovoltaic (PV) system. This stage includes the preparation and assembly of solar panel components before installation.



Figure 3: Pre-assembly of Solar PV at Agazi Health Center

The second set of images captures the fully operational solar PV system in place at Agazi Health Center, highlighting the significant enhancement in energy supply and infrastructure.



Figure 4: During installation at Agazi Health Center



Figure 5: Installed Solar PV at Agazi Health Center

These visuals not only demonstrate the technical aspects of the installation but also reflect the project's impact on improving healthcare delivery in the community.



Figure 6: Infrastructure at the health center (Delivery bed)

### ***Daerere Health Center***

Daerere Health Center, located in the south-Eastern zone of Degua Temben, specifically in Tabia Walta. The health center serves a population of approximately 10,349 residents, along with an additional 2,352 individuals from nearby Tabias. Despite previously benefiting from both a solar PV system and a connection to the national grid, the health centre's power supply has been severely compromised due to war damage and ongoing infrastructure challenges.

Prior to the conflict, Daerere Health Center utilized a solar PV system that contributed significantly to its power needs, especially during the frequent blackouts experienced from the national grid. However, the system became nonfunctional due to war damage,



thereby eliminating a crucial source of power and exacerbating the challenges posed by the unreliable national grid.

The Daerere Health Center has traditionally provided critical healthcare services, including deliveries, laboratory services, and general healthcare. However, the recent conflict has devastated infrastructure, leading to the failure of the existing solar PV system and instability in the national grid. During and after the war, the health centre's reliance on mobile flashes and lanterns during critical times has significantly hampered its capacity to deliver essential services, particularly during nighttime deliveries.

We learned from this project that, to address the power supply challenges at Daerere Health Center, the installation of a new solar PV system is essential. The installation of a solar PV system would ensure a consistent power supply for health centre operations, mitigating the risks associated with power outages. With a reliable energy source, the health centre can maintain uninterrupted service delivery, including emergency health services, laboratory tests, and maternal healthcare during childbirth. The successful implementation of a solar PV system would not only support the health centre's operations but also contribute to the broader community's resilience, offering a model for energy independence in an area with historical energy challenges.



Figure 7: Installed Solar PV at Daerere Health Center

### ***KeretsMay Health Center***

KeretsMay Health Center, located in the Central Zone of Wereda Hahaile serves a population of approximately 21,000 people across three sub-districts (Tabias) and provides essential medical services to neighboring woredas like Woreda Endabatsahma, and Nebelet. Maikerets Health Center has historically played a crucial role in the healthcare system of its locality. It is equipped with basic laboratory equipment, including microscopes, critical for diagnosing and treating various health conditions. However, due to the absence of a reliable power source, essential services have been severely hampered. During power outages, they were using mobile flashlights and lanterns at night, which were insufficient for performing necessary medical procedures, including deliveries.

Before the outbreak of the war, KeretsMay Health Center operated a 2.4 kW solar PV system that provided sufficient electricity for its daily operations. This system allowed the health center to maintain necessary services, including laboratory tests and patient care, enhancing access to health services for the local population. However, the conflict led to significant damage to the solar equipment, leaving the health center without a functional power supply and greatly affecting its ability to serve the community.

In response to the critical need for reliable electricity, a new solar PV system has been installed at KeretsMay Health Center. This installation was part of the broader CESET project aimed at improving energy access for health facilities affected by the war. With the new solar PV system, KeretsMay Health Center can now operate essential medical equipment, including microscopes, allowing for proper diagnoses and treatment. The ability to provide reliable services will encourage more community members to seek healthcare at the center rather than relying on less reliable alternatives. With consistent electricity, the health center can perform critical functions such as emergency deliveries, thus improving maternal and child health in the area. The enhanced capacity of KeretsMay Health Center will benefit not only the local population but also residents of neighboring woredas, enhancing regional healthcare access and delivery.



Figure 8: Installed Solar PV at KeretsMay Health Center

### ***Mitslal Afras Health Post***

The Mitslal Afras Health Post is situated in the southeastern zone of Wereda Enderta, approximately 15 kilometers from the nearest main road. The route to the health post is characterized by rough, unpaved terrain, including hilly and uneven stretches, which pose significant challenges to accessibility. Despite these logistical difficulties, the health post serves as a crucial provider of primary healthcare services for an estimated population of 4,266 residents in the Mittslal Afras sub-districts (Tabias).

In addition to its primary service area, the health post extends its support to five nearby sub-districts located up to 25 kilometers away from the main road. This makes the health post a critical healthcare hub for wider sub-districts, addressing the needs of remote and underserved communities who have limited access to larger health facilities. Its strategic role in delivering essential health services underscores its importance in the overall healthcare infrastructure of the region.

The Mitslal Afras Health Post has been a vital pillar of the healthcare system in its isolated and remote community. Despite the challenging terrain and poorly developed road infrastructure that make access to the area difficult, this health post has consistently served as a lifeline for the local population.

The facility is modestly equipped with essential laboratory tools designed to support basic medical care and first aid services. Among its key equipment is a refrigerator, crucial for storing temperature-sensitive medical supplies like vaccines. The health post is staffed by

two highly committed health professionals who work tirelessly to meet the community's healthcare needs.

These dedicated workers provide a range of critical healthcare services, including administering life-saving vaccinations, treating illnesses in children under the age of five, managing malaria cases, and offering emergency first aid for a variety of urgent medical situations. Notably, their responsibilities extend to providing initial emergency assistance during childbirth, stabilizing mothers and newborns until an ambulance can arrive to transport them to larger Woreda health institutions for more comprehensive care.

This health post's role is indispensable in safeguarding the well-being of its community, bridging gaps in healthcare access created by the region's geographical and infrastructural challenges.

Despite its critical role in the community, the health post has encountered major operational challenges due to the absence of a reliable power supply. Situated far from the national power grid, the health post frequently experienced prolonged power outages, which severely hindered its ability to provide essential medical services effectively. This lack of electricity disrupted a range of activities that are fundamental to healthcare delivery, including the proper storage of temperature-sensitive medical supplies like vaccines and ensuring adequate lighting for medical procedures.

During nighttime emergencies, the health workers were forced to rely on mobile phone flashlights and lanterns to illuminate their workspaces. However, these makeshift solutions were inadequate, particularly during critical situations that required precision and proper lighting, such as assisting with safe deliveries or administering urgent medical care. The absence of reliable lighting not only compromised the quality of care but also placed both patients and healthcare providers at considerable risk during emergency interventions.

Additionally, the health workers use the ODKE application to collect and report health data monthly to the Woreda Health Office. Without electricity, they struggled to keep their devices charged, forcing them to walk 15 kilometers to the Woreda office simply to charge their mobile phones and upload the necessary data.

Fortunately, this significant obstacle has now been resolved, enabling the health post to operate more efficiently and consistently provide essential healthcare services to the community.

Prior to the outbreak of the war, the Mitslal Afras Health Post relied on a standalone solar PV system designed exclusively to power its DC refrigeration unit. This system was critical for maintaining the cold chain required to store essential medicines, particularly vaccines. However, the conflict caused extensive damage to the solar equipment as no maintenance and replacement has been taken, rendering it nonfunctional. As a result, the health post was left without a reliable power source, severely impacting its capacity to deliver basic healthcare services to the community.

In response to the critical need for reliable electricity, a new solar PV system has been installed at Mitslal Afras health post. This installation was part of the broader CESET project aimed at improving energy access for health facilities affected by the war and or remotely located health institutions. With the new solar PV system, Mitslal Afras health post can now operate essential medical equipment, including microscopes, allowing for proper diagnoses and treatment provided that if the it is equipped with those essential and basic medical equipment as per the witness provided by the health professionals. The



ability to provide reliable services will encourage more community members to seek healthcare at the center rather than relying on less reliable alternatives. With consistent electricity, the health post can perform critical functions such as emergency activities, first aid support for deliveries, thus improving maternal and child health in the area. The enhanced capacity of Mitslal Afras health post will benefit not only the local population but also residents of neighboring woredas, enhancing regional healthcare access and delivery



Figure 9: PV Components for Installation-Mitslal Afras Health Post



Figure 10: Installed Solar PV at Mitslal Afras Health Post

## Commissioning the System

### *Testing*

The Mekelle University team has successfully conducted testing and commissioning of the solar photovoltaic (PV) systems installed in the health centres across each of the targeted woredas. Following the installation of all components, comprehensive tests were carried out to ensure that each system was functioning optimally. The testing process included verifying the output of the solar panels, checking electrical connections, and confirming the performance of inverters and battery storage systems. After commissioning, ownership of the solar system is transferred to the health center administration for operation and maintenance. The commissioning phase was essential in ensuring that the solar PV systems were fully operational and capable of providing reliable electricity to the health centers. This achievement will significantly enhance healthcare delivery and improve access to essential services in the region.

The new solar PV system is designed to provide a reliable and sufficient energy supply to meet the health center's operational needs. The installation includes solar panels, inverters, batteries for energy storage, and necessary structural support. Training for health center staff on the operation and maintenance of the solar PV system has been provided to ensure long-term sustainability.

**Initial Testing:** Use a multimeter to check voltage and current outputs at various points of the system to ensure everything is functioning correctly.

**Performance Verification:** Monitor system performance to confirm it meets design specifications and local electricity needs.

## Impact on the health Centers

Solar PV systems provide a consistent and dependable source of energy, which is critical for the operation of medical equipment, lighting, and other essential services. This reliability ensures that health centers can function effectively, especially during nighttime hours and in the absence of grid power. With a stable energy supply, health centers can maintain important services, including emergency care, childbirth assistance, vaccinations,

and laboratory testing. This capability can directly improve health outcomes, particularly for maternal and child health services. Access to reliable electricity allows healthcare providers to perform medical procedures without interruption, reducing the risk of complications that may arise due to power outages. Furthermore, the ability to store vaccines at the required temperatures and solar PV systems enable health centers to maintain refrigeration units, which is vital for vaccination programs and other temperature-sensitive medications.







Figure 11: Lighting Service after Installation of Mitslsl Afras health post

## Challenges

The installation of solar photovoltaic (PV) systems in the health centres of the Tigray region encountered several significant challenges that impacted the project's progress and timely completion. Below are the key challenges faced by the installation team:

***Delays in importation of the solar systems:*** - Due to the absence of local solar system manufacturing, all components are imported from foreign countries. For this small project, importing the systems has taken over 8 months due to challenges with bureaucratic import clearance and obtaining foreign currency permission. Consequently, these delays have significantly affected the project timeline and the shelf life of the batteries, which were stored in Dubai during the clearance process.

***Initial Installation Failure:*** - During the first trial of the installation, the team travelled a considerable distance from Mekelle with all the necessary materials to set up the solar PV system. After completing the installation, the system failed to provide any light. This unexpected outcome led to disappointment and frustration as the team had invested time and resources into the project. Upon returning to Mekelle, the team investigated the issue

and discovered that the battery had been dead before installation. After recharging all the batteries, the team resolved the issue and are currently completing the remaining two solar systems.

***Travel inaccessibility during the rainy season:-*** The installation process faced significant logistical challenges during the summer months, which coincide with the rainy season in Ethiopia. The heavy rains made many rural roads impassable, making it extremely difficult for the team to travel to the designated health centers for installation and maintenance. This inaccessibility delayed the systems' installation and contributed to the delay of the project implementation.

## Conclusion

The CESET project has proactively addressed the pressing power challenges faced by health centers in the Tigray regional state by allocating a dedicated budget for the installation of solar photovoltaic (PV) systems. This initiative has been instrumental in transforming the energy landscape into health facilities throughout the region. Working collaboratively with the team from Mekelle University, solar PV systems have been successfully installed in various health centres. Feedback from health center administrators has been overwhelmingly positive, highlighting the vital role these systems play in ensuring an uninterrupted power supply. The implementation of solar energy has effectively eliminated the critical obstacles that previously hindered the delivery of essential health services.

With the installation of solar PV systems, health centres are now able to function efficiently, providing a wide range of services without disruptions caused by unreliable grid power or dependence on alternative fuel sources. This enhancement not only improves the standard of care but also fosters greater confidence among healthcare providers and patients alike.

The CESET project has made significant strides in resolving the power issues affecting health centers in Tigray, facilitating a more reliable and sustainable approach to healthcare delivery. The successful integration of solar PV technology stands as a testament to the CESETs project commitment to improving health outcomes and the overall well-being of the communities served in the region.

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