



EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

BRIDGING THE GAP FOR THE FISH COLD CHAIN IN LAKE TURKANA



Lake Turkana, in Northern Kenya, is the world's largest permanent desert lake. The lake is abundant in fish and fishing is critical to the local economy, but this is threatened by falling water levels. Climate change has plunged the communities into extreme poverty, with prolonged droughts decimating the livestock and triggering hunger crises. Farmers have therefore turned to commercial fishing, relying upon the lake's aquatic wildlife.

Historically, salting and sun-drying fish is the main method that fishers used to preserve fish. However, compared to the market price of fresh fish this preservation method significantly lowers the value of the fish by an average of 40%. The value of fresh fish in markets surrounding the lake is also much lower than the selling price in urban areas of Kenya.

The gap in the urban fish price and the source (Lake Turkana) is caused by the lack of an efficient cold chain in the area, compared to urban areas. A shortage of affordable electricity, expensive cold chain equipment, and existing systems for the hygienic handling of fish, are some of the reasons for these inefficiencies. A solution to this problem was to develop a suitable business model and an end-to-end cold chain management company to efficiently and affordably bring chilled fish from Lake Turkana to urban markets. Fishers sell their fish to the company who aggregate from multiple fishers and manage transportation and storage via cold chain, including ice, before taking it to market.

Water from Lake Turkana and borehole water around the region is outside the World Health Organisation limits for potable water and is unsafe for ice processing. The production of ice for fish chilling is an important component, but water also first needs to be treated before the freezing process.

DID YOU KNOW?

Despite living on the shores of the world's largest desert lake, approximately 60% of the population is acutely food insecure.

FUND INNOVATOR SERIES

ADILI SOLAR HUBS

Adili Solar Hubs (Adili) is a social enterprise that develops clean and productive energy use commercial solutions for marginalised communities. Adili is based in Kenya with headquarters in Nairobi, and operational in Turkana Central, Turkana County, and Takawiri Island, Homa Bay County.

ADILI SOLAR HUBS

"The Efficiency for Access Research and Development Fund enabled Adili to procure, operate, and model the key equipment for an efficient fish cold chain."

Kimani Gichuche, Executive Director







A worker from Adili moving ice generated by the solar-powered ice maker

End-to-end off grid cold chain system

For the project, Adili developed a cold-chain system incorporating an ice making machine, water treatment, a cold room, chest freezers and an energy monitoring system. This was powered by a third party solar minigrid and a small back-up diesel generator. From the monitoring system, Adili was able to log data and production parameters.

It used the data to simulate the most effective way to produce ice, run the fish processing plant on 100% renewable energy and at a lower levelised cost of energy (LCOE) than the electricity grid, all in a remote off-grid setting.

During the project, Adili studied the individual equipment energy consumption needs using the installed monitoring equipment. It generated load profiles for each component of its system and found that the rate of ice production is dependent on the ambient temperature and the feed water temperature. The cold room has three set points on its profile: on, defrost and off. It automatically switches processes off when the target temperature has been acquired. The data has enabled Adili to design and simulate multiple systems and optimise the load profile to achieve the lowest LCOE, capital cost, carbon emissions and the highest system efficiency and solar fraction, whilst maintaining the production output.

WHAT DID THE PROJECT ACHIEVE?

Piloting the system in the right conditions

For the success of the project, a suitable location first had to be identified and obtained. The solar powered mini-grid in the heart of a fishing village offered the optimum location to establish the pilot and utilise its solar energy. Adili set up a semi-permanent building to house the equipment and operate the hub from. Cooperation from the community was instrumental for this. Ice flake machinery, coldroom and water treatment units were installed.

Adili piloted the system for three months, followed by an additional one month to verify the operation. From the pilot, it was able to produce up to 500kg of ice in a day and process up to 3.5T of fish in a week. Adili installed a 1.6kW solar water pumping system, enabling it to treat 6,000L of water per day for internal use. They also supplied clean drinking water to a school, which significantly lowered cases of waterborne diseases among both students and the village community.

In efforts to promote sustainable fishing practices, Adili collaborated closely with local fishers. They made a commitment not to purchase juvenile fish to protect the fish population. They also actively engaged with the local government to establish and implement sustainable fishing regulations at their aggregation facility.



Local fishers supplying fish

Development and optimisation of the system

During the project, Adili made a number of changes to the system to optimise its performance. They explored the global warming potential (GWP) of various refrigerant gases, and acquired refrigerants with a low GWP for new appliances. It also optimised the power supply for the system. Prior to the establishment of the hub, the utilisation of the mini-grid was 40%. However, once the system was introduced, it achieved full utilisation, with 100% of the generated power being effectively used. As such, the Adili Hub also acted as an anchor load for the mini-grid which enabled it to dramatically improve its commercial viability.

Increased income for Lake Turkana's fishing community

As a result of the operation, fresh fish prices for the fishers in the Kalokol region doubled. Before Adili's intervention, most of the fish was sold dried to the Democratic Republic of the Congo market, where the selling price of dried fish was less than fresh fish, and incurred additional costs including salting and labour for sun drying. Fishers who chose to sell their fish through the Adili Solar Hubs business experienced a remarkable sixfold increase in income in contrast to those who previously sold their catch dried. The system also created permanent employment for six people in the community.

The perception of fish from the region also changed during the project. Before Adili's intervention, most urban markets in Kenya had some misconceptions about fish from Lake Turkana. The fish was believed to be too slim, contaminated with sand, and not as sweet as fish from Lake Victoria. After Adili started supplying the market, the narrative changed, and their produce has since been embraced by all local markets. Adili learnt that most of the initial claims in the market were attributable to unhygienic processing and packaging of the fish.



Fish arriving at Eldoret market, packed with ice in cooler boxes.

WHAT DID WE LEARN?

The biggest market for fish is in commercial wholesale

Adili initially encountered a smaller market than expected for the commercial cold storage of fish. A change of direction supplying fish mostly to wholesalers has resulted in a pool of regular customers.

The fish must meet a high-quality standard to ensure that wholesalers purchase it at a profitable price. Due to the high perishability of the fish and a lack of storage, Adili focused on quickly moving the fish on to retailers. They found that retailers were also willing to buy if they can be provided with a consistent supply of quality fish.

The energy requirement for ice machines, cold rooms and water treatment units was higher than expected.

Adili found that the daily energy requirement was over 100kWh, which could not be fully sustained by the mini-grid at night. As a result, it intends to expand its current pilot facility into a commercial fish processing plant, with the intention of selling any excess ice produced to fishers and traders.

The need for refrigerated vehicles to transport fresh fish

During the project, Adili used cooler boxes to transport fish to the market, arranging alternating layers of fish and ice, and using public couriers overnight. In the cooler season this worked well, and the product arrived to the Eldoret market still fresh and the fish remaining solid. However, if there was a delay in the transportation, fish would arrive in a pool of melted ice with the fish starting to deteriorate. To address the problem of fish spoilage due to inadequate cold chain during transport, Adili trialled the use of refrigerated vehicles. However, the cost of outsourcing temperature controlled logistics was too high, and the trucks lacked proper maintenance leading to breakdowns on the road and breaking of the cold chain during transport.

With a clear need for efficient, affordable cold storage transportation solutions, Adili acquired a refrigerated van to transport fish from the lake to the markets. This van features an electrical plug-in system, allowing it to be powered by the grid or solar energy when stationary, reducing reliance on the diesel engine.

NEXT STEPS

With support from the Efficiency for Access Research and Development Fund, Adili has successfully implemented decentralised cold chain facilities at fish landing sites and conducted essential research to explore commercially sustainable strategies for scaling up their operations in remote locations. By gathering comprehensive financial data, Adili has been able to refine its business models and ensure the economic feasibility of these facilities. Currently, Adili is actively exploring various financial avenues to support the establishment of five commercial facilities at remote fish landing sites along the shores of Lake Turkana.

GET IN TOUCH

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