

CIRCULAR ECONOMY BUSINESS CASE STUDIES IN SOUTHEAST ASIA



African Clean Energy Solutions Cambodia (ACE)

-  Siem Reap, Cambodia
-  Renewable Energy (solar and biomass)
-  africancleanenergy.com/about/
-  Analysis period: 2016-2023

Revolutionising Clean Cooking in Cambodia

Business Spotlight

ACE is an international renewable energy firm that entered Cambodia's energy sector in 2016, building on its experiences in Africa. Their premier product, the ACE One, is an integrated solar-biomass hybrid household energy system that combines an advanced clean cooking stove and solar PV system for LED lights and mobile charging. The stove significantly cuts down smoke emissions and helps prevent deforestation by reducing consumption of firewood. Furthermore, ACE now provides eco-briquettes made from agricultural waste, further expanding its services and reducing environmental impact.

ACE has achieved notable growth. The adoption of an instalment plan for sales has improved customer affordability and boosted product uptake. Additionally, ACE draws upon usage data from its stoves to refine its offerings and bolster its carbon offset credits programme as a further source of revenue.

Looking to the future, ACE is focused on increasing sales, reinforcing its sustainable practices, reinvesting in initiatives like affordable sustainable fuel, and expanding its online business. While challenges exist, such as bringing about behavioural change and upscaling eco-briquette production, ACE's forward-thinking strategies reflect strong prospects for continued growth and influence in the sustainable energy sector.

Keywords

Sustainable Household Energy, Biomass Fuels, Circular Economy, Solar Power

Innovation

Product/service design, Manufacturing, Use and maintenance, Resource circularity, Resource efficiency, Resource substitution

Context and baseline

Approximately 2.3 billion people globally lack access to clean, modern energy for cooking. Traditional sources of energy generate substantial smoke, leading to indoor air pollution. Moreover, an estimated 21% of the world's black-carbon emissions are attributed to residential cooking with biomass fuel in traditional, inefficient stoves, primarily in developing countries. While advanced cookstoves have been recognised as a potential solution, implementation is hindered by the lack of specific, appropriate, and affordable models for different countries.

In Cambodia, about 80% of the rural population relies on traditional cooking methods using primarily wood and charcoal as fuel.

ACE, a global renewable energy company, has developed an advanced cookstove that employs a solar-powered fan to improve cooking and reduce air pollution. In its flagship product, the 'ACE One,' the company combined an advanced cooking stove with capability for charging mobile phones and using LED lights, thus providing a decentralised all-in-one energy and connectivity solution for rural households. After its initial introduction in Africa, ACE expanded its operations to Cambodia in 2016 and began production in 2020. The original cookstove design was acquired, significantly improved and modified by African Clean Energy (ACE) for the Cambodian Market. In doing so, ACE arrived at a comprehensive energy solution for off-grid households in developing countries that is currently being deployed in Cambodia as well as in Southern and Eastern Africa.

Innovation

The ACE One is built around a forced-air gasifier cookstove made from stainless steel, which requires a fan to assist the gasification process, for which ACE has incorporated a battery and a small PV system. The excess power generated when the cookstove is not in use is sufficient for charging mobile phones and running LED lights, eliminating the need for kerosine, candles or torches while also offering connectivity. The stove can run efficiently on diverse biomass materials such as animal waste, crop residues, and small sticks, some of which are unsuitable for traditional stoves, and still achieve high cooking temperatures.

According to the study by SNV Netherlands Development Agency¹, the ACE One achieves high cooking efficiency, reduces smoke emissions by 90% and cuts fuel costs by over 50%. It is also safe to handle and operate.

In 2019, smart features were introduced that enable users to charge and connect their smartphones at the stove. The updated ACE One stoves can also be switched off remotely. Tested in accordance with international ISO standards, the stove meets voluntary IWA-ISO performance at tier 4 level for emissions and efficiency, with a thermal efficiency of over 40%.

ACE is combining this product innovation with a fixed instalment plan model, allowing access to the clean energy system with low upfront costs and further system repayment from incremental costs savings on the users' fuel costs. The repayments activate the system for a corresponding period until the full investment is paid off, after which the stove belongs to the user. Payments are predominantly carried out on-line. However, selling the stove is just one part of the ACE approach. The remotely collected usage data are converted into energy and firewood savings that qualify as greenhouse gas emission reductions and can be traded on the Carbon Market. To encourage adoption and regular use of the stove, ACE focuses on delivering an enhanced customer experience.

ACE has developed fuel briquettes for use in their stove. These are made from compressed crushed sugar cane (from street sellers) and wood chips and are easier to use and more affordable for customers.

Circular Economy impact

The combined innovations in product design deliver a practical contribution to the key circular economy strategies. First and foremost, the cooking stove is more efficient and less polluting, which is pertinent for resource efficiency. Second, the PV electric system replaces batteries, kerosine and/or grid power for lighting and phone charging – which is a change from non-renewable to renewable energy that contributes to resource substitution. Thirdly, with the switch to eco-briquettes made from agricultural and other waste, the stove contributes to energy recovery from previously wasted products, which contributes to resource circularity.

The ACE cookstove significantly lowers CO₂ emissions in comparison with traditional cooking stoves, thanks to its efficiency in burning biomass. This efficiency is even further enhanced when using sustainable biomass, such as briquettes made from agricultural waste. Conservatively it has been estimated that each ACE One cookstove can prevent on average of 1.5 to 2 tonnes of carbon emissions per year when substituting for fuels like charcoal.

¹ <https://cleancooking.org/reports-and-tools/quantifying-the-health-impacts-of-ace-1-biomass-and-biogas-stoves-in-cambodia>

Thanks to the high burning efficiency of the ACE stove, the need for firewood is reduced, generating positive effects on local natural resources. Recently, ACE has developed sustainably sourced briquettes and pellets made from sugarcane biomass waste as an alternative to firewood, which also addresses the waste-management problem. This waste-to-energy initiative aims to reduce firewood consumption further as one of the drivers of deforestation underscoring ACE's commitment to preserving natural resources and promoting sustainable practices.

The ACE-1 stove drastically reduces smoke emissions to near negligible levels, as confirmed by The Berkeley Air Monitoring Group. Both laboratory and field tests have demonstrated that the stove possesses the cleanest, safest, and most efficient multi-fuel cooking capabilities on the market. It not only reduces exposure to cooking smoke but also lowers the incidence of cooking-related burns among children by 40%.

On a global scale, and with a total of 76,601 units sold by the end of 2022 worldwide, the company has estimate that 791,250 cumulative tonnes of CO₂ emissions were prevented using the ACE stove. Additionally, this technology has saved 474,750 cumulative tonnes of firewood, averaging 1.5 tonnes averted per cooking stove per year. By the end of 2022, ACE Cambodia had sold round 12,000 units in Cambodia, including both imported and locally manufactured stoves.

Business and market impact

Initially imported from Lesotho, the cookstoves have been locally manufactured since 2020, totaling 13,500 units. Of this production, 30% has been exported to Uganda. The company currently sells around 300 units per month and aims to increase this to 500 cookstoves. They also offer robust after-sales support, including warranties and referral fees.

ACE stoves are significantly more expensive than traditional woodstoves, priced at \$140 for a cash payment or \$150 with their fixed instalment plan. However, they offer greater energy efficiency, safer usage, and are healthier due to being largely smoke emission-free. The primary market for these stoves is low-income households. Energy savings can be considerable. For example, in Cambodia, there is a 50% reduction in energy costs for cooking compared to using wood (or LPG gas). Additionally, the solar panel that is included provides lighting and phone charging, contributing to further energy cost reductions and addressing energy poverty.

Continuous use of the stoves is crucial for ACE, because the level of use has an effect on the repayment of supplied units. The company collects

usage data from each stove and has shown a strong commitment to generating carbon offset credits that are supported by empirical data.

The initiative to commercialise eco-briquettes made from sugarcane pulp originated in the desire to improve value for the user. The eco-briquettes, priced at around USD 3 for 15 kg, are sold exclusively to ACE customers and are competitive with other cooking fuel sources. At this pilot stage of the project, the monthly sales range from 3–5 tonnes.

Part of the revenue generated from the data-backed carbon credits can be reinvested to make sustainable fuel even more affordable for ACE One users. It is hoped that this strategy will attract more households to adopt responsible energy solutions and reinforce the circularity of the business model.

ACE is also exploring further opportunities in e-commerce and enhancing its online presence.

Stakeholders

The Innovation Against Poverty programme of SNV Netherlands Development Agency supported the establishment of the manufacturing unit for ACE stoves in Siem Reap, Cambodia in 2020. SNV has also significantly contributed to behaviour change and demand creation, reaching 100 villages with its 'Smoke Free Villages' campaign and promoting the use of improved stoves. Additionally, SNV had commissioned research to quantify the health repercussions of the ACE-1 stove and have also been advocating for clean cooking at the ministry level.

For the sugarcane briquette project, ACE is collaborating with 15 to 20 sugarcane juice vendors, helping to reduce waste in Siem Reap where the company is based.

The impact of ACE on the health and well-being of their customers is substantial, extending beyond energy and electricity savings. With around 12,000 units sold in Cambodia, the stoves directly improve the lives of some 40,000 Cambodians by mitigating household air pollution and enabling significant savings on energy expenses.

Moreover, ACE is continuously engaging with various different stakeholders to further improve their products and their impact on the community and environment.

Implementation

In terms of incentives, it is noteworthy that ACE has secured a VAT exemption until the end of 2025 from the Ministry of Economy and Finance, as recognition for the company's high social relevance and innovative technology.

Regarding the challenges faced by ACE, the instalment plan system carries some financial risks, including a certain level of non-repayment. Additionally, procuring high quality components and raw materials presents additional challenges, particularly due to the high and fluctuating costs of international shipping and logistics.

However, the primary challenge for ACE in Cambodia is fostering behavioural change and ensuring the long-term adoption and use of their improved stove, which requires ongoing engagement with customers and maintaining strong relationships.

Another issue for ACE is scaling their waste-to-energy initiative for production of eco-briquettes. The current experimental phase has been successful; however, scaling up will require substantial investment in machinery, reorganisation of logistics, securing sufficient feedstock, and finding customers for the increased production capacity. While the potential for growth exists, it will require further development and strategic and business planning.

Takeaways

While technology may be top-notch, user experience is paramount. Driving behavioural change is essential to prevent families from reverting back to their old habits. There is considerable resistance to change, and selling the stove is not the most difficult part of the process. In this context, empowering the customer team in their engagements with the community is crucial.

Adapting to the local context and understanding customer needs are also key elements, and they guided the decision to start the production of eco-briquettes. Ideally, subsidising the cost of the briquettes for customers as much as possible would reduce their energy expenses significantly. By encouraging more customers to adopt responsible energy solutions, the model will continue to increase carbon revenues, fostering a cycle that would enhance the scalability and sustainability of ACE's business model and its overall impact.



Acknowledgements

This business case study was prepared within the framework of the Technical Advisory project: Mobilising Business Action for Circular Economy in the ASEAN countries under the EU SWITCH-Asia Policy Support Component for the sole purpose of documenting and analysing business experiences with the circular economy. The case study was produced by Ratana Phurik-Callebaut (national expert, Cambodia) and reviewed by Rene Van Berkel and Thomas Thomas (regional experts) on the basis of information provided and validated by ACE Energy Solutions Cambodia.

Disclaimer

The content of this publication is the joint responsibility of ACE Energy Solutions Cambodia and the expert team. This publication does not constitute an endorsement of ACE Energy Solutions Cambodia by the European Union nor any of the partners of the SWITCH-Asia Policy Support Component, nor necessarily reflects their views.

 www.switch-asia.eu

 **EU SWITCH-Asia Programme**
@EUSWITCHAsia

 **SWITCH-Asia**
@SWITCHAsia

 **SWITCH-Asia Official**
@switch-asia-official