engineers without borders australia

MULTIDISCIPLINARY TECHNOLOGY DEVELOPMENT

ATEC* Biodigesters Case Study

The biodigester turns animal manure and green waste into biogas for cooking and organic fertiliser that farmers can use on their crops. Source: Harvey

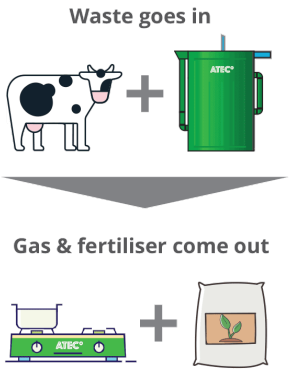
Technology development often requires many professionals with different areas of expertise to work together to develop a solution.

It's critical for these multidisciplinary teams to communicate with one another and develop a unified approach to the solution. This not only ensures that solutions are functional across all its different parts, but it ensures that the design as a whole strategically takes into account how it influences the user and the desired outcomes. This is called a systems thinking approach - where professionals seek to understand how each aspect of the design is interrelated with all other aspects, and how they will affect the people that it comes into contact with, in order to develop the most appropriate solution. See EWB Australia's *Human Centred Engineering Approach* to learn more about our guiding principles such as systems thinking and human-centred mindsets to ensure user perspectives are always kept in mind.

When developing a solution it's useful to ask yourself: who will engage with this part of the design? How will it affect them? Who else should be consulted that might have knowledge to share? How will this part of the design influence other aspects that other people are designing, and how can I collaborate with them?

Theavy (middle) and Pavi (right) of the ATEC Biodigesters team speaking with a customer in Cambodia. Source: Feed the Future Partnering for Innovation on Medium*

The ATEC* biodigester is a great example of this approach.



ATEC* Biodigesters (ATEC*) is an international social enterprise with its headquarters in Melbourne and business units in Cambodia and Bangladesh. It was founded in 2015 and evolved out of an EWB Challenge student project several years earlier. The ATEC* biodigester converts animal manure and green, kitchen and human waste into clean biogas that can be used for all daily cooking needs as well as high quality organic fertiliser for farming. Using a tank for each household, the biogas is naturally generated onsite and linked directly to a kitchen cookstove. This reduces the health risks from smoke released when cooking with firewood and charcoal, and improves livelihood resilience against the increasing scarcity of these fuels due to deforestation. The ATEC* biodigester avoids the continuous costs of purchasing these fuels including commercially available LPG, saving families an estimated US$521 each year[1]. The byproduct (known as bioslurry) can be used as organic fertiliser, with each biodigester able to produce up to 20 tons of bioslurry per year for crops[2]. ATEC*'s vision is to reach 1 million people in 5 countries by 2030, and so in pursuit of this vision they expanded operations to Bangladesh in 2020. Read more about their work *here*.

The biodigester is unique in several ways: the design is resilient (suitable for contexts prone to flooding, high groundwater and earthquakes, and is UV resistant); it uses ready-made materials (installation takes only 3-4 hours); and it utilises a PAYGO system. In 2019 ATEC* launched the integrated PAYGO ("pay as you go") system that expands the reach of biodigesters to thousands of Cambodian and Bangladeshi families and their smallholder farmers. It has turned a solution that is normally only affordable to mid-income customers into something also accessible to people in the low-income market. Such families would otherwise not be able to afford a biodigester up front as they can be costly but ATEC* allows them to repay the cost of the biodigester in monthly installments. This avoids families having to take out interest loans from microfinancing institutions (MFIs) which can then be used to threaten or seize their assets, including homes. Importantly, the use of a biodigester increases their financial independence and ensures they save money in the long term so they can invest in the things that matter most to them.

A woman in Bangladesh demonstrates how to add waste to the biodigester

These empowering outcomes required multidisciplinary collaboration to understand the user context and design the technology in an integrated way, all the way from product concept to installation to repayments.

Browse the skill sets below required to develop the ATEC* biodigester into a successful, scalable commercial product and understand how different technical skills along with a deep understanding of the user context are required to develop the most appropriate solution.

ICT, software engineering and electronics engineering

Users pay-off the cost of the biodigester in small monthly installments through mobile money providers such as *Wing*, which follows the PAYGO concept. Payment is regulated by ATEC* using the Angaza Hub system. The Angaza Hub tracks when customers make their payments to ATEC*'s account. When a payment is made the Angaza Hub will send an SMS activation code to the user which is entered into the PAYGO box using a numeric keypad that can be powered by a small solar panel. The activation code opens a solenoid valve which allows the biogas to continually flow. The days remaining of credit are shown on the LCD screen, and if the credit runs out before the user makes the payment the valve will switch closed until a new code is entered.

CommCare is used as the case management software that allows ATEC* staff to manage new and existing customers in one place. The Angaza Hub is integrated with Commcare so that when customers are late paying they are flagged in the database which triggers a phone call by ATEC* staff to support the customer in making payment or ascertaining if there are any other issues.

When setting up CommCare, the PAYGO box, and the integrations, ICT professionals considered human-centred design principles around the needs of staff and the customers to streamline the process, including improving the user experience and user interface. For example, this involved understanding what information construction staff need during installation and designing CommCare so staff can record and retrieve information quickly to make informed decisions. It's just one example of where professionals with ICT and software engineering skills actively collaborated with field engineers to develop the most appropriate solution.

Other design considerations included optimising aesthetic and visual communication of the PAYGO interface to improve the user experience. This required an in-depth understanding of how both the user and staff journey can be influenced by the design. For example, the idea of a simple count-down display on the PAYGO box gives users (including with minimal literacy) advance notice about when it will run out so they have time to make the repayment. This design has contributed to the fact that very few users are late in their repayments.

The PAYGO box can be powered by a small solar panel

Service design

A service design approach led to the integration of the Angaza Hub with mobile money payments and the use of SMS activation codes, in order to streamline the staff and user journey. This makes it easy for users to make almost instant repayments and biogas activation from their home or community centre cookstove, making the whole process entirely remote without relying on staff to travel to collect repayments.

Civil engineering

Civil engineering was used to design the biodigester tank itself to withstand soil pressure when half buried, as well as challenging environments faced in high groundwater, earthquake, and flood affected areas. It was originally designed to address the challenges experienced by disadvantaged communities living on and around the water in the Tonle Sap Lake and River region in Cambodia which are vulnerable to seasonal flooding.

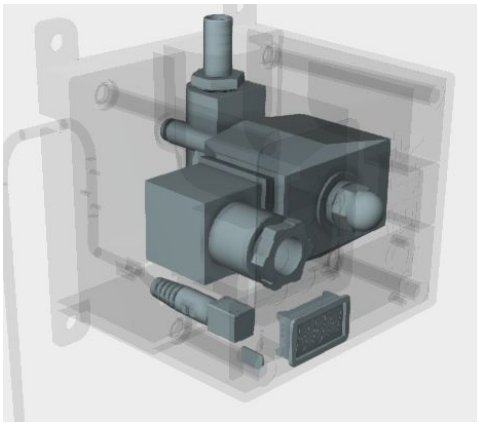
A 3D render of the biodigester tank

Mechanical engineering

Mechanical engineering was used alongside electronics engineering to allow the PAYGO unit (right) to execute the opening and closing of the biogas valve, and to facilitate the flow of gas through the piping system all the way to the cookstove, including regulating gas pressure at the cookstove.

Biochemical engineering

Biochemical engineering was used to optimise the biogas and bioslurry generation process to produce the highest quality output of gas, including calculating the waste-to-gas ratio of different types of waste and the byproducts they produce. It was found that cow and pig manure produced the best results for gas cooking.



A transparent view inside the PAYGO box (patented)

Further resources

- [1]ATEC* Biodigesters *website*
- EWB Australia *page* on ATEC* Biodigesters
- EWB Australia *blogs* on ATEC* Biodigesters
- [2]Engineering for Change Solutions Library *listing*
- EWB Australia and New Zealand *article* on ATEC* Biodigesters toilet trial
- Harvey *case study* on use of digital strategies to reach more families and boost sales
- **Watch:** Youtube *video* introducing ATEC* Biodigesters

A woman in Cambodia and her ATEC system*

A farmer poors bioslurry as organic fertiliser onto his crops

The ATEC team in Cambodia install a biodigester outside a house*

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