Photo: Roger Bymolt (KIT)

# Powering commodity value chains with **sustainable energy**

## Introduction

Energy powers the world's economic engine and is an essential element for sustainable development and poverty eradication. Poor access to energy in many developing countries stifles industry and business, and hampers the provision of basic services, such as health care and education. In commodity dependent developing countries, a lack of reliable energy is often a limiting factor in the development of a competitive commodity sector. Such is the importance of energy, former UN Secretary-General, Ban Ki-moon called it "the golden thread that connects economic growth, social equity, and environmental sustainability."[1]

In recent decades, access to energy has improved in many parts of the world. Between 1990 and 2010, for example, the number of people with access to electricity increased by 1.7 billion.[2] But as the global population continues to rise, so too does the demand for affordable energy. Worldwide, around 1.1 billion people still have no access to electricity, and a further 1 billion only have access to unreliable electricity networks. Meanwhile, 3 billion people continue to rely on traditional biomass, such as wood and charcoal, for cooking and heating.[3] The challenge is to reconcile the increased demand for modern and sustainable energy services with its impact on climate change and the environment.[4]

[1] United Nations Secretary-General. (2016). Secretary-General's remarks to the World Future Energy Summit. Available at https://www.un.org/sg/en/content/sg/statement/2016-01-18/secretary-generals-remarks-world-future-energy-summit

[2] UNDP. (2016). Sustainable Development Goals, Goal 7: Affordable and clean energy. Available from http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html

[3] The proportion of the global population with access to electricity has increased steadily from 79% in 2000 to 85% in 2012. Still, 1.1 billion people are without this valuable service. Recent global progress in this area has been driven largely by Asia, where access is expanding at more than twice the pace of demographic growth. Of those gaining access to electricity worldwide since 2010, 80% are urban dwellers. See GTF. (2017). Sustainable energy for all global tracking framework, progress toward sustainable energy 2017. International Bank for Reconstruction and Development/The World Bank and the International Energy Agency. Available at http://gtf.esmap.org/data/files/download-documents/eegp17-01_gtf_summary_final_for_web_posting_0331.pdf

[4] Energy is a major contributor to climate change, accounting for around 60% of total global greenhouse gas emissions. Reducing the carbon intensity of energy is a key objective in long-term climate goals. http://www.un.org/sustainabledevelopment/energy/; https://sustainabledevelopment.un.org/topics/energy

CFC common fund for commodities
KIT Royal Tropical Institute

Whilst energy was not explicitly included among the Millennium Development Goals, it has gained greater prominence on national and international agendas thereafter. The 9th session of the Commission on Sustainable Development (CSD-9) in 2001 and the Johannesburg Plan of Implementation (JPOI) in 2002 sought to address energy in the context of sustainable development.[5]

UN-Energy was then created in 2004 to coordinate and develop more coherent energy-related programmes across UN agencies. The 'Sustainable Energy for All' initiative was launched in 2011 by UN Secretary-General Ban Ki-moon and World Bank President Jim Kim. The initiative focused on three goals for 2030: ensuring universal access to modern energy services; doubling the global rate of improvement in energy efficiency; and doubling the share of renewable energy in global energy.[6] Access to energy was given further prioritisation in the 2012 Rio+20 Conference on Sustainable Development.[7] Most recently, energy was included in goal 7 of Sustainable Development Goals (SDGs), which calls on countries to "ensure access to affordable, reliable, sustainable and modern energy for all." Efforts to achieve the SDGs and corresponding targets are ongoing (Table 1).

Unfortunately, according to the latest Global Tracking Framework (GTF), progress on goals is not moving fast enough to meet 2030 targets. To meet the Sustainable Energy for All objectives, it is estimated that renewable energy investment would need to increase by a factor of 2 to 3, and energy efficiency investment by a factor of 3 to 6.[8]

> ***"Energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive. Development is not possible without energy, and sustainable development is not possible without sustainable energy."***
> Ban Ki-moon, former UN Secretary-General

The Common Fund for Commodities (CFC) is a committed supporter of global efforts to shift towards low-carbon energy systems and green economies in the drive for sustainable development. CFC advocates for much greater levels of investment in energy and a willingness to embrace new technologies on a wider scale. CFC has contributed through its own successful investments in energy, helping to demonstrate the viability of new technologies in commodity value chains.

**Table 1: Sustainable Development Goal 7 – Ensure universal access to affordable, reliable, sustainable and modern energy for all**

| Targets | Indicators |
|---|---|
| **7.1** By 2030, ensure universal access to affordable, reliable and modern energy services | **7.1.1** Proportion of population with access to electricity |
| | **7.1.2** Proportion of population with primary reliance on clean fuels and technology |
| **7.2** By 2030, increase substantially the share of renewable energy in the global energy mix | **7.2.1** Renewable energy share in the total final energy consumption |
| **7.3** By 2030, double the global rate of improvement in energy efficiency | **7.3.1** Energy intensity measured in terms of primary energy and GDP |
| **7.A** By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology | **7.A.1** Mobilised amount of United States dollars per year starting in 2020 accountable towards the $100 billion commitment |
| **7.B** By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support | **7.B.1** Investments in energy efficiency as a percentage of GDP and the amount of foreign direct investment in financial transfer to infrastructure and technology for sustainable development services |

*Source: UNDP (2016)*

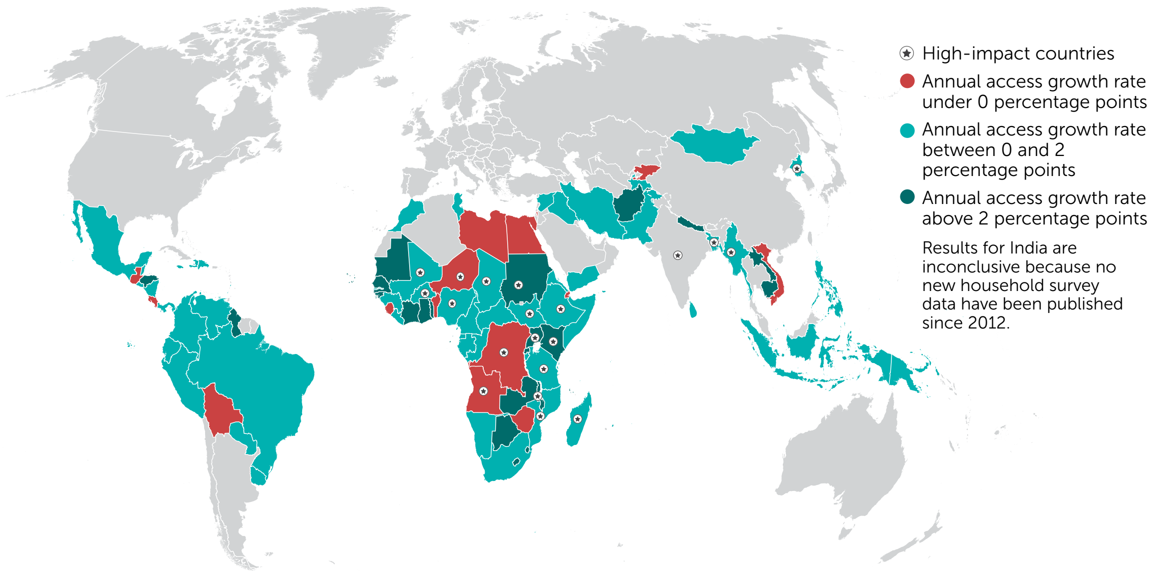
[5] At the CSD-9 countries agreed that stronger emphasis should be placed on the development, implementation, and transfer of cleaner, more efficient energy technologies and that urgent action was required to further develop and expand the role of alternative energy sources. The JPOI, adopted at the World Summit on Sustainable Development in 2002, addressed energy in the context of sustainable development. Among other things, the JPOI called for action to: (1) improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services; (2) recognise that energy services have positive impacts on poverty eradication and the improvement of standards of living; (3) develop and disseminate alternative energy technologies with the aim of giving a greater share of the energy mix to renewable energy and, with a sense of urgency, substantially increase the global share of renewable energy sources; (4) diversify energy supply by developing advanced, cleaner, more efficient and cost-effective energy technologies; (5) combine a range of energy technologies, including advanced and cleaner fossil fuel technologies, to meet the growing need for energy services; (6) accelerate the development, dissemination and deployment of affordable and cleaner energy efficiency and energy conservation technologies; (7) take action, where appropriate, to phase out subsidies in this area that inhibit sustainable development.

[6] See http://www.se4all.org/

[7] In 2012, the resolution by the UN General Assembly declaring 2012 as the 'International Year of Sustainable Energy for All' was successfully implemented with many activities and commitments promoting a sustainable energy future. In the outcome of the 2012 Rio+20 Conference on Sustainable Development (The Future We Want), member states: (1) recognised the critical role that energy plays in the development process; (2) emphasised the need to address the challenge of access to sustainable modern energy services for all; and (3) recognised that improving energy efficiency, increasing the share of renewable energy and cleaner energy-efficient technologies is important for sustainable development.

[8] The GTF 2017 aims to provide the international community with a global dashboard to register progress on energy access, energy efficiency and renewable energy. Released by the World Bank and the International Energy Agency as part of the Sustainable Energy for All Knowledge Hub, the GTF shows that the increase in people getting access to electricity is slowing down and, if this trend is not reversed, projections are that the world will only reach 92% electrification by 2030, still short of universal access. Progress is uneven, but some countries are succeeding, illustrating that universal access is possible with the right policies, robust investments (both public and private), and innovative technology. See GTF. (2017). Sustainable energy for all global tracking framework, progress toward sustainable energy 2017. International Bank for Reconstruction and Development/The World Bank and the International Energy Agency. Available at http://gtf.esmap.org/data/files/download-documents/eegp17-01_gtf_summary_final_for_web_posting_0331.pdf

Figure 1: Speed of progress toward electrification goal 2012-14




*Source: Global Tracking Framework (2017)*

## Case study - Katani Ltd. Biogas production from sisal waste in Tanzania

One such CFC energy investment is situated in Tanga, in north-eastern Tanzania. The innovative pilot project, established at Katani Ltd.'s Hale Estate and concluded in 2011, is the world's first sisal biogas plant. The project was co-financed by CFC, the UN Industrial Development Organization, the government of Tanzania and Katani Ltd., at a cost of around US$1.5 million.

A field visit was organised by the CFC together with representatives of the Tanzanian Ministry of Industry, Trade and Investment and the Ministry of Agriculture, Livestock and Fisheries to learn more about the biogas plant's current performance and sustainability.

### The sisal industry in Tanzania

Sisal is a robust plant with natural fibres that can be extracted and transformed into products, such as rope, carpets, mats, and sacks. In the 1960s, sisal was a major export earner for Tanzania, but due to competition from synthetics the size of the industry has declined considerably in recent decades. Nevertheless, the Tanzanian sisal industry continues to process more than 20,000 metric tonnes of sisal fibre annually, providing work for around 100,000 Tanzanians.[9]

Remarkably, the process of extracting long fibres from sisal leaves, known as decortication, has changed little over the past century. Sisal fibre constitutes only about 4% of the leaf, which means that the remaining 96% is typically discarded as waste biomass. The sisal waste biomass is usually left to decompose on nearby land, and the waste water within it flows, untreated, into nearby waterways. This causes a drop in the pH of nearby rivers and streams, leading to the biological oxygen demand rising far above acceptable levels.[10] The 25,000 metric tonnes of fibre produced in Tanzania in 2010 is estimated to have generated over half a million tonnes of biomass waste. The Tanzanian government has begun pressing the industry to address and overcome its pollution problem or face consequences, including possible closure.

The pilot project aimed to address the environmental problem of sisal waste and demonstrate the feasibility of producing biogas and clean electricity to run the factory. Additionally, the project explored whether by-products from the biogas production process could be converted into fertiliser.

### The biogas plant design and performance

The biogas plant consists of five tanks: a collection tank, hydrolysis tank, digester tank, biogas storage tank and an after-storage tank. The type of digester selected was a continuously stirred tank reactor (CSTR) to ensure that sisal waste is well mixed and does not remain floating on the surface of the tank.

[9] Figures include seasonal labourers. See Magoggo, J. (2011). Project Completion Report – Cleaner Integral Utilization of Sisal Waste for Biogas and Biofertilizers, CFC.
[10] Biological oxygen demand refers to the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample, at certain temperature over a specific time period.

Photo: Roger Bymolt (KIT)

*Katani Ltd sisal energy plant, Tanga, Tanzania*

Modifications were made to the plant's machinery by installing a system of conveyor belts to transport the biomass from the decorticator (used for fibre extraction) to a flume tow (short fibre) recovery plant. This replaced the old method of propelling untreated waste away down the land with large volumes of water. The pilot plant was designed to produce 300 kW of electricity – sufficient to power the factory and with excess potential to supply nearby villages that are not connected to the grid.

Katani Ltd. has since calculated that the estate produces enough waste biomass to supply a 700 kW rated plant. According to the Tanzanian sisal board, there are around 45-50 similar sisal estates in Tanzania, each estimated to have a leaf potential sufficient to supply a 500 kW installation, or above. 500 kW is an important threshold because at that scale it becomes viable to sell excess electricity supply back to the national grid.

The pilot project has clearly demonstrated the 'proof of concept' - quality biogas can be extracted from sisal waste at sufficient volumes to power typical sisal estates in Tanzania, such as Katani Ltd.'s Hale Farm, thereby reducing the cost and environmental impact of operations.

### Identifying and overcoming challenges

As a 'first in the world' pilot, the project encountered several challenges during implementation. Most challenges, such as technical issues related to plant modifications for the separation and removal of short fibres from residues, were fairly easy to overcome. However, other challenges have meant that replication of the technology has not taken off at other locations, despite wide interest.

The main challenge has been the use of steel tanks in the design of the plant. Whilst these make sense for other biogas projects, particularly those with limited land availability, Katani Ltd advises against their use for sisal waste. The acidic properties of the sisal waste have resulted in high rates of rusting. Since project completion, the steel tanks have already been sandblasted twice and repainted with protective enamel paint. Each operation halts operations for several weeks and the specialist maintenance costs around US$50,000.

To overcome the challenge of rusting steel tanks, the team have identified a lagoon system to hold the biogas. This has been investigated by looking at cases from China, Brazil and Thailand. The typical disadvantage of lagoons is that they use more land, however, space is not a problem for sisal estates. The advantages are that they overcome rusting issues, are cheaper, and the system is tried and tested for other biogas plants around the world, although not yet with sisal waste.

A further challenge involved an unsuitable generator installed for converting biofuel to electricity. The project's available funds necessitated the purchase of a lower grade generator and, recently, breakdowns and performance issues have hampered operations. With more resources, Katani Ltd would have preferred to purchase a more expensive and higher quality generator.

Considerable experience has been gained applying the technology. Katani Ltd wishes to develop another biogas plant and are currently looking for investment to finance their vision. The new plant would have a larger capacity – 500 kW or higher – making it financially viable to connect to the national grid. The estate has already registered 6,000 neighbouring households who wish to be connected to the grid, and the Tanzania Rural Energy Agency has offered a US$500 rebate for each household the estate connects. Such reimbursements should help the biogas plant to repay investors relatively quickly. Connecting villagers with piped biogas, or electricity, has an additional environmental benefit as it reduces the heavy reliance of most rural villages on wood and charcoal for fuel, which results in deforestation in the surrounding areas.

These proposals dovetail nicely with Tanzania's Integrated Industrial Development Strategy 2025, which aims to make Tanzania an industrial and logistical hub in East Africa, promote rural industrialisation through 'agricultural development-led industrialisation', and provide growth opportunities to growth-oriented micro, small and medium scale enterprises.[11]

***"We are aiming for a clean, zero emissions biogas plant, which supplies reliable energy to the factory, serves neighbouring villages and does away with the pollution. We don't want to throw anything away."***
Katani Ltd Plant Manager

However, Katani Ltd notes that investors are hesitant to commit to investing in a technology that is not yet widely established. Commercial banks typically offer interest rates of around 25% per annum with 24-36 month terms, which is not a good fit for infrastructure investments of this nature. Institutional investors, such as CFC, the World Bank, or the African Development Bank, seem to be a better fit and Katani is exploring these options.

*Representatives of Katani Ltd, the Tanzanian Sisal Board, the Ministry of Industry, Trade and Investment, and Ministry of Agriculture, Livestock and Fisheries outside the Katani Ltd sisal energy plant, Tanga, Tanzania*


Photo: Roger Bymolt (KIT)

[11] The target is for the manufacturing sector to grow by 15% per annum on average, amounting to a 23% share of GDP by 2025. See: Ministry of Industry and Trade. 2011. Integrated Industrial Development Strategy 2025. United Republic of Tanzania.

## Case study - SimGas. Powering rural households with biogas

It is not only medium and large scale biogas solutions that call out for greater investment. CFC have recently become acquainted with SimGas, who are delivering biogas solutions at the household level.

According to the World Health Organisation (WHO), smoke from polluting and inefficient cooking, lighting, and heating devices kills an estimated 4 million people a year and causes a range of chronic illnesses and other negative health impacts.[12] SimGas was established in 2009 by two brothers who were determined to address this problem, and in doing so provide clean energy and fertiliser to potentially millions of people in developing countries.

Headquartered in the Netherlands with production facilities in Tanzania, and subsidiaries in Kenya, Tanzania and Rwanda, SimGas has rapidly grown to become the largest supplier of domestic biogas systems in Africa. Director and Co-founder Sanne Castro met with the CFC to discuss how SimGas solutions generate energy whilst, at the same time, greatly reducing indoor air pollution, deforestation, and carbon emissions.

Mr Castro describes SimGas as a 'triple bottom line company' that takes social and environmental impact just as seriously as economic impact. His vision, and that of SimGas, is to make biogas accessible not just for the lucky few, but for the worthy many.

> ***"We want our customers to become more productive, independent, and healthy farmers. We want to make biogas accessible not just for the lucky few, but for the worthy many."***
> Sanne Castro, Director and Co-founder

In Africa, many households keep several cows as part of their livelihood strategy. SimGas has designed a system specifically for rural households who are not connected to the national grid and have three or more cows. The SimGas solution is easily scalable depending on the number of cattle that a household manages.

The system operates through the use of anaerobic digestion, the process by which biodegradable material is broken down by bacteria in the absence of oxygen. Farmers simply feed livestock manure into the digester on a daily basis to generate a sustainable supply of clean biogas. SimGas has calculated its biogas systems save on average US$250 per household per year on energy expenditure, and the investment pays for itself within two years.

> ***"Initially, we were thinking mostly about people's health. But we have seen that our system is a big deal for the dignity of women, who now cook on modern appliances rather than from the floor, and no longer have to spend hours collecting firewood. The biogas systems have given families a whole different outlook."***
> Sanne Castro, Director and Co-founder

When farmers invest in a SimGas system they receive all the necessary piping and a double burner stove setup – even rice cookers are available. Mr Castro explains that SimGas has had the most success with 'aspirational farmers' – those who aren't necessarily rich in local terms, but who are ambitious. "Initially, we were thinking mostly about people's health. But we have seen that our system is a big deal for the dignity of women, who now cook on modern appliances rather than from the floor, and no longer have to spend hours collecting firewood. The biogas systems have given families a whole different outlook."

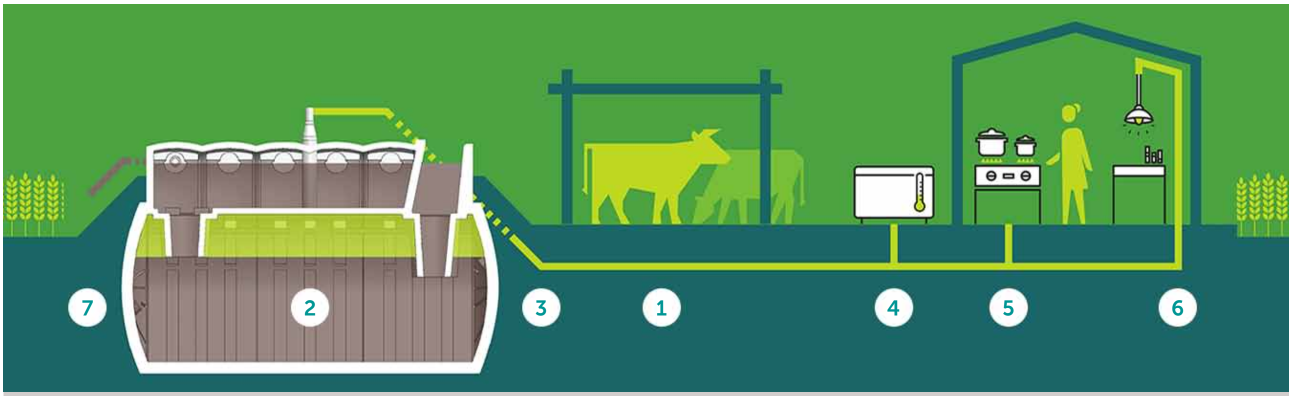
SimGas has also developed a milk chiller to provide an off-grid biogas powered milk cooling facility. It's a shocking fact that 30-50% of milk production in East Africa may go to waste because the lack of electricity and chilling facilities causes evening milk to go bad.[13] The system allows smallholder dairy farmers without access to electricity, to store, deliver and sell the highest possible quality of raw milk and increase their income.

*SimGas biogas system, first generation*

Photo: SimGas

[12] http://www.who.int/mediacentre/factsheets/fs292/en/
[13] http://simgas.org/projects/biogas-milk-chilling/

Figure 2: The SimGas biogas system




**1 Manure from livestock**
Each day a farmer feeds the digester with manure from livestock and water.

**2 Anaerobic digestion**
Inside the digester, micro- organisms work symbiotically to convert the manure into biogas and slurry through the process of anaerobic digestion.

**3 Piping**
Biogas flows through piping from the digester to the farmer's house, where the pipe is connected to a cookstove and other biogas auxiliaries.

**4 Milk chiller**
Biogas can be used to power off-grid milk chillers to keep milk fresh.

**5 Cook stove**
Biogas stoves allow farmers to cook their meals using a clean fuel.

**6 Biogas lamp**
Biogas can fuel gas lamps used for both task and ambient lighting.

**7 Organic fertilizer**
Slurry that has been fully digested exits the system onto to the farmer's land where it is used as an organic fertilizer.

*Source: SimGas*

As a further bonus, the biogas systems also produce a slurry by-product. This slurry is effectively a high-quality organic fertiliser, which owners can use to boost crop yields, whilst saving money on chemical fertilisers.

## Extending credit

Households typically need to borrow to pay for their SimGas system. Over time, SimGas has established its own microfinance institution to provide credit to its customers. Unfortunately, it is not uncommon for customers to be late in making repayments, and so the company's local presence is important for monitoring any problems customers may be having. SimGas doesn't ask for collateral because this is typically problematic and can create bad feelings in the community. Instead, SimGas relies on customers making an initial down payment, and requires other villagers to vouch that the customer is trustworthy. Only in rare cases will SimGas repossess the system.

## Secrets to success

Mr Castro believes the secret to SimGas' success is a combination of local presence, great partnerships and smart investments in research and development.

To enhance their local presence, the company works with a 'hub' concept. Each hub covers an area with a radius of around 10 km, and has a hub manager, sales people and technicians. Staff are hired and trained from the immediate area to strengthen the bond between the company and the local households. "It's important to convince civic and religious leaders that we are here to stay," Mr Castro explains, "They have seen others come and go, but our local presence gives them confidence."

Smart investments have enabled the company to iterate on its design so that there are fewer technical issues to maintain, and have allowed them to gradually add new products and features.

## A glimpse into the future with SimGas

Since its inception, SimGas has been focused on growth ahead of profitability, with plans to reach 1 million people within the next 5 years. The focus on growth means extending into new communities, investing in the product portfolio, resolving some technical issues, and improving production capacity. While this remains the strategy, SimGas' Kenya operations are expected to be profitable by the end of the year, hopefully providing investors with additional confidence in the business model.

This is important because risk aversion remains prominent throughout the sector, not only from private investors, but also in the donor community. "We welcome competition, there is enough space in the market for other companies too, and we can all grow together. If biogas wins SimGas wins, and local people win. We are opening new markets, and development partners need to embrace the risk that goes with that," says Castro.

## Believe in the future

The cases of Katani Ltd and SimGas are a hint of what is possible with bold investments in renewables in developing markets. CFC believes firmly that, with the right governance and greater levels of investment, sustainable energy for all is an achievable goal. Smart investments have the potential to improve social and economic well-being, whilst reducing the carbon intensity of energy and its effect on climate change.

**Author:** Roger Bymolt, r.bymolt@kit Royal Tropical Institute



*SimGas biogas system, second generation*

Photo: SimGas