

Development for large and small alike

By 2030, Senegal's national biogas programme has pledged to supply around 50,000 households with biogas plants. However, the country is still a long way short of this target. Local start-ups and Ziguinchor University scientists hope to change this for the better.

By Klaus Sieg

There is little visible sign of the biogas plants in the villages around Richard Toll, a town in the north of Senegal on the bank of the River Senegal. On the other side of the mighty river is the desert state of Mauritania. But even around Richard Toll, the countryside beyond the irrigated fields is dry and barren. The brick-built feed inlets of the mainly underground biogas plants are barely noticeable between the pale colours of the dusty soil and the simple stone houses. Yet unobtrusive as they are, they have brought considerable change to people's lives. "In the past, if we didn't have money for propane, we always had to cut firewood for cooking. It took several hours every day," says Maimouna Nwian, tweaking her colourful headscarf. "Sometimes I even had to go out twice a day." It only takes a glance at the environs of her village, Ariwele, to see why searching for firewood took so long. A herd of gaunt zebu cattle cluster around the sturdy, grey trunk of a gnarled baobab, one of the few shade-giving trees in the landscape. "There used to be more trees, but so many were chopped down for firewood," explains Maimouna Nwian. Most people in her village kept having to fall back on the already scarce resource, even after it was banned a few years ago. And a further drawback is that smoke from the fires is a health hazard. "I always had bad coughs and my eyes stung." But once they secured financing for a biogas plant through the national biogas programme PNB-SN four years ago, things fundamentally changed. Maimouna Nwian and her husband Mahmoudou Bathouly haven't needed to buy propane gas nor cook over a wood fire ever since.

Biogas secures family incomes

In the 18-cubic-metre digester beneath the dusty soil beside their house, the dung of their 22 cattle is now fermenting, mixed with rice straw, water, and sometimes kitchen waste. The plant produces at least five cubic metres of methane a day, and that's enough, even on the regular occasions when people other than their own five children show up at mealtimes. "We have lots of relatives; the group swells to fifteen hungry mouths in next to no time," says Mah-



Cow manure is the main substrate used in the biogas plants around Richard Toll.

madou Bathouly. After just five years the family had paid off the plant, which cost the equivalent of 1,400 euros. Now not only do they save around 10 euros per month on propane gas, but the fermentation residues they remove from the plant are also selling well. "They earn us the equivalent of around 200 euros a month," explains Mahmoudou Bathouly on his way to the trader's collection point, where he himself tips the fertiliser into a filling plant and packs it into sacks. Even more than rice and vegetable production on his three hectares of fields, selling the fertiliser has become an important source of income. The buyer is the *Compagnie Sucrière Sénégalaise* sugar factory in Richard Toll. It wants to convert ever more of its 11,200 hectares of sugarcane fields to this organic fertiliser. So there appears to be guaranteed demand. "Another thing is that our village has become really clean, because people collect the droppings of their mostly free-ranging animals to use in their own biogas plants or to sell to other plant operators," Mahmoudou Bathouly explains on our way back along the dusty tracks.

The masonry-built biogas plant is robust and easy to operate. Now, with a few years' expe-

rience, Maimouna Nwian and Mahmoudou Bathouly know how much rice straw and water they can add, and also that they need to check the salt content. They have even trained their cattle to deposit their manure as close to the plant as possible. Funny as that sounds, it makes a vital difference, especially in the dry season. Others in the village complain about the lack of substrate because, due to the drought, the cattle herds need an ever larger radius to find enough fodder. This makes it all the more difficult to collect their manure. One more reason why there are biogas plants using alternative feedstocks, like that of the Thilene Women's Association on the road to the coastal city of Saint Louis. In the yard, a machine is shredding bundles of reed grass into knots of fine, light green fibres. "We mix them half-and-half with cow manure. It works very well in the biogas plant," explains Khoudia Diop, the woman in charge. Since two dams were built between the sea and the Senegal River to stop the salinisation of the fields, reed grass has been overgrowing the riverbanks and fields in the region. That poses a threat to flora, fauna and agriculture. Work crews equipped with sickles are dispatched to keep the reed grass at bay. "We pay one of them out of the revenues from

selling fertiliser from the biogas plant,” explains Khoudia Diop. The women use the biogas to cook, dry and roast rice, millet and vegetables. There is also a biogas electricity generator which can power a packaging machine. “There would be enough biogas to produce 50 kilograms of our products every day, only we don’t have a market for them yet, unfortunately.” So far there are just two shops in nearby Saint Louis which the women have been supplying. Hence, the gas meter next to the tiled production room shows just 314 cubic metres. The ten-cubic-metre plant installed in December 2020 could have generated four times that volume. Today once again, the women in their pristine white aprons are filling the plant for demonstration purposes only.

Research to find the optimal substrate

Although the use of alternative substrates to cow manure, as the example in Saint Louis shows, will not get things going by itself, it is important nevertheless. It is therefore the subject of Omar Kata Faye’s research at Ziguinchor University. In a small building on the edge of the university grounds, the PhD student demonstrates his experimental set-up, consisting of water-filled PET bottles, plastic tubes and a small plastic barrel that serves as a digester. He uses the water levels to measure the quantity of biogas, and a gas analyser to measure its methane, carbon dioxide and hydrogen sulphide content. He is experimenting with mango waste, residues from cashew juice production, rice husks, and cow and donkey manure in various mixing ratios. Cashew fruit pulp is delivering very promising results. Every year, 25,000 tonnes of cashew fruit are processed into juice in Senegal, generating 18,000 tonnes of pulp. “This could potentially yield 360,000 cubic metres of biogas,” explains Omar Kata Faye as he walks across campus, passing a seminar room where some 20 students in blue overalls are poring over their final exams. The practical exams will take place that afternoon. With support from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Ziguinchor University is training an annual cohort of renewable energies technicians. The majority find work in the solar sector, but biogas would also give them plenty to do. “Many plants in Senegal are not working all that well, especially many of the ones that were installed through the national programme,” says Professor Lat Grand Ndiaye, the head of the university department. “The smallholders with micro biogas plants need better training, as do the tradespeople who install them.”



Mahmadou Bathouly next to his fertiliser filling plant.



Transport sacks for biogas.



Omar Katar Faye in his laboratory.

Plants need to be smaller and more flexible

Madiara Diop takes the same view. He also welcomes the research being done at Ziguinchor University on different substrates. “In Senegal, we focus far too much on cow manure without factoring in the potential of kitchen waste from households and restaurants, waste from market stalls, slaughterhouses and fish processors, and other organic residues.” Dressed in his boubou, the traditional male robe, Madiara Diop sits in his house in a suburb of the capital, Dakar. With his laptop on a plastic chair in front of him, he is surrounded by a bustling family life. He cannot yet afford an office for his young company, Afrique Biogaz Environment Dakar. An economics graduate, until

very recently he lived in Paris but now wants to realise biogas projects in Senegal. He has just concluded a contract with a municipality in the south of the country. Spread across several villages, it involves installing 500 small domestic plants and four 20-cubic-metre plants supplied by the German manufacturer (B)-Energy on central sites in the villages, to be fed with the municipality’s organic waste. Financing will be provided by the national biogas programme – at least, Madiara Diop has filed an application. But there are some things he wants to do differently. Instead of permanent masonry-built systems, which are relatively large, he favours small, flexible plants from (B)-Energy and a Chinese manufacturer. “A family can cook for two hours a day with just two cubic metres of biogas so there’s no need for plants of ten cubic metres or more.” Added to that, he finds that permanent plants are often badly built and allow biogas to leak into the atmosphere. Flexible systems made from robust membranes are considerably lower in cost, suitable for all kinds of substrates and easier to operate and maintain, he says. “And the small models can simply be placed in the sun to kick-start fermentation.” Even (B)-Energy’s 20-cubic-metre plants are fabricated from membranes and plastic components. And who are the intended consumers of their output? “Using lightweight one-cubic-metre sacks that can be strapped on like backpacks, households, restaurants or bakeries can pick up biogas themselves or have it delivered,” Madiara Diop explains.

Papa Assane has already realised one such plant to the south of Dakar, in the picturesque coastal town of Popenguine. It supplies gas for the kitchen of a children’s education centre. There are days when the kitchen is quiet. On other days, meals must be cooked for 100 children. But almost every day, the long plastic bag measuring 2 x 8 x 1.5 metres in the courtyard of the former hotel is filled to bulging with around four cubic metres of biogas. So it’s just as well that the transport sacks are on hand. A restaurant in the town buys up the biogas. “Alongside self-sufficiency, this creates a business model,” says Papa Assane. Part of the revenue might then be used to fund the purchase of substrate – for example, to collect organic waste from market stalls or fishermen. This in turn would benefit the environment. Organised waste disposal is the exception in Senegal. Most of it ends up untreated in the natural environment, polluting roads, fields and beaches. And it releases methane.

Assane’s company Methanizer, which has eight employees, has already realised over 200 projects in Mali, Niger, Benin, Cameroon and

Côte d'Ivoire, ranging from a 200-cubic-metre installation that works on a dairy farm with its own cheese dairy in Tunisia to small domestic plants from the Israeli supplier Home-biogas. Woulinnata Tamedu, who lives in a house on the outskirts of Yenne, operates one of the latter. Full to the brim and covered with a layer of dust, it occupies a sunny spot beside the entrance door. Sandbags on the inflated biogas plant exert the necessary pressure on the pipe that runs indoors into the kitchen. The installed plant cost the equivalent of approx. 1,050 euros. "We recouped that money after about six years, because we no longer have to buy propane gas even though I cook for my husband and our five children every day," says Woulinnata Tamedu. The family will also go on to save a lot of money in future, the equivalent of nearly 160 euros per year, for based on the quality workmanship of the flexible plant, Papa Assane expects it to have a 20-year service life.

An electrical engineer by training, he has installed only 50 plants in Senegal altogether. The 37-year-old entrepreneur sees the national biogas programme as rather an impediment to his work. Applicants are required to work with contracted firms whose unduly low prices undermine the free market. Insisting on masonry-built systems – which are often excessively large, to boot – is another mistake in his view. "How are we supposed to wall them up underground on rocky terrain, for example?"

Ramping up the support programme

The national biogas programme launched in 2009 was actually supposed to have installed 10,000 plants by 2020. Currently there are 2,300 in Senegal. It is not exactly a success story. "There is still a lot to be done," admits Malick Gaye, the programme's coordinator, from his darkened office in Dakar. On the wall behind him is a portrait of the president. "This year alone we want to build 2,000 plants, rising to 4,000 next year." This holds out the only hope that the newly adopted target of 50,000 installations by 2030 might be achieved. What went wrong in the past? "Initially we supplied the plants for free, but they didn't work because people didn't take care of them. That was enormously damaging for the technology's image." Now the operators have to pay off the plants in instalments, but by selling fertiliser they can earn money, too. "Things have got better ever since." The strategy will be opened up with regard to technologies as well, meaning that the programme could also be used to finance flexible systems. And the coordinator



Members of Thilene women's association crushing reed into fibre material.

Photos: Martin Egbert

expects a further boost from cooperation with the Swiss Foundation for Climate Protection and Carbon Offset, KliK.

And what about industrial biogas plants? Senegal is regarded as a stable state that aspires to the status of a newly industrialised country, where agriculture, fishing, food production, wastewater and organic waste would offer potential enough. Adjacent to the slaughterhouse of the capital city, there was once a very promising plant with a capacity of 4,000 cubic metres, the largest in the country. It had been funded by the United Nations Industrial Development Organisation (Unido), among other sources, and constructed by the Senegalese company Thecogaz. Methane derived from slaughterhouse waste and wastewater was passed through a combined heat and power (CHP) plant to generate electricity and heat. The latter ensured that the digester was kept at high enough temperatures, while the electricity powered the cold storage rooms, the offices and the lighting in the slaughterhouse. Unfortunately the plant had to make way for the extension of a railway line. Today, Thecogaz's successor company SB2-4ALL predominantly builds small plants but hopes to win the contract for a larger one from *Compagnie Sucrière Sénégalaise* in Richard Toll. Its tender for a pilot project to ferment molasses and other organic residues from sugar production is currently being reviewed by the refinery. Initially the plant is intended to supply the company's works canteen with cooking gas, which would be a good start.

Meanwhile, the state-owned water authority L'Office National de l'Assainissement du

Sénégal (O.N.A.S.) is thinking big. O.N.A.S. is currently building a vast wastewater biogas plant – a contender for the largest in Africa, no less – in Dakar. The facility will be able to clean 92,000 cubic metres of wastewater to a quality suitable for irrigating productive farmland. "It will be 37,000 cubic metres per day to begin with, but we expect to need more than double that capacity by 2035," says Abdoulaye Gueye, head of technical development at O.N.A.S. The Dakar metropolitan region is growing apace. Three 610-kilowatt CHP units will produce 90 per cent of the electrical energy needed by the wastewater treatment plant itself. That will save O.N.A.S. the equivalent of around 900,000 euros per year in electricity costs. But even more importantly, "by using the biogas, we avoid the emission of 3,000 cubic metres of methane per day," enthuses Abdoulaye Gueye, pushing his white construction helmet back off his forehead. In the future, O.N.A.S. wants to build biogas plants at all five of Dakar's sewage works.

The plant at the wrestling stadium is due to start operating in December 2022, and is already impossible to overlook – unlike the domestic plants belonging to Maimouna Nwian and Mahmadou Bathouly in Ariwele village, in the arid north of the country. For the development of Senegal and its people, however, both types are important.

Klaus Sieg is a freelance journalist. He writes about agriculture and food, the environment, energy, the economy and social issues. He is based in Hamburg, Germany.
Contact: klaus@siegtext.de