# Energy Recovery with Faecal Sludge Fuels in Kampala, Uganda

Fuels from dried faecal sludge could generate larger revenues than soil conditioner. Market demand exists for crushed fuel and char briquettes; fuel pellets provide benefits for faecal sludge drying. M. Gold[1], D. Turyasiima[2], M. Cunningham[1], F. Studer[3], S. Tukahirwa[4], S. Nantambi[4], R. Arnheiter[5], M. Bleuler[5], W. Getkate[4], A. Schönborn[5], Ch. Niwagaba[2], M. Babu[6], Ch. Kanyesigye[6], L. Strande[1]

## Introduction

Faecal sludge (FS) treatment and its sustainable operation is often limited by available financial resources. Yet, the sale of FS treatment endproducts could offset these costs. With sufficient market demand, fuels and other treatment endproducts could generate revenue to pay for FS treatment [1, 2].

## Pellets

Our research shows that dewatered FS can be turned into fuel pellets (Photo 1), which are homogenous in size and easy to transport, store and dry (see www.sandec.ch/seek). Passive drying of FS pellets from a moisture content of 40–60 % to 10 % required one week, much faster than the time required on drying beds. There is, however, no existing market currently for this product, but the potential to develop such a market in Uganda and elsewhere exists.

## Char briquettes

FS char briquettes are made through carbonisation and briquetting with a binder. They can be produced with locally available equipment and skills, and look like other briquettes. CNN and the Daily Monitor recently reported that several businesses in Kampala are trying to tap into the existing charcoal market with FS briquettes and that FS briquettes could significantly reduce deforestation [3, 4]. The latter, however, is disputable. If all faeces produced in Kampala were used for carbonisation, this would only offset around 2 % of the current charcoal consumption.

FS char also has several disadvantages, i.e. a high ash and low energy content. Char from dried FS from drying beds had an ash content as high as 70 % and a calorific value of 7 MJ/kg, while charcoal is less than 5 % ash and has 22–30 MJ/kg. However, FS briquettes made from material that comes from source separation toilets could be more suitable as they would have a lower ash content. And high ash briquettes can still be used by industries with less sensitive fuel quality needs, unlike households, although the emissions would have to be controlled to provide environmental benefits. Ongoing research is evaluating the fuel performance of FS briquettes compared to wood based charcoal and briquettes produced from agricultural waste, as well as the optimal operating conditions for FS pyrolysis.

## Crushed fuel

Dried FS can be crushed and used as a fuel without pelletising, carbonisation or briquetting; this has been demonstrated in pilot-scale experiments and industrial trials [2]. The advantages of crushed FS include an existing market and competitive energy content compared to solid biofuels [5]. Cement and clay companies in Uganda are interested in using dried FS as a crushed fuel, especially since it is compatible with their combustion technology and currently used fuels. The disadvantage is, however, that FS treatment capacities cannot yet meet industry demand (i.e. several tons per day).

## Conclusion

Pilot tests by researchers and businesses have demonstrated that FS fuel pellets, briquettes and crushed fuel have a market and/or are technically feasible. Up-scaling is also possible if local FS characteristics (e.g. ash content) and quantities (i.e. amount of fuel produced per day) match market needs. Meeting market demand could benefit FS management because the revenue generated from the sale of FS endproducts could offset treatment costs.

[1] Diener, S., Semiyaga, S., Niwagaba, C.B., Muspratt, A.M., Gning, J.B., Mbéguéré, M., Ennin, J.E., Zurbrugg, C., Strande, L. (2014): A value proposition: Resource recovery from faecal sludge – Can it be the driver for improved sanitation? Resources, Conservation & Recycling *88(0)*, 32–38.

[2] Gold, M., Niang, S., Niwagaba, C.B., Eder, G., Murray Muspratt, A., Diop, P.S., Strande, L. (2014): Results from FaME (Faecal Management Enterprises) – Can dried faecal sludge fuel the sanitation service chain?, 37th WEDC International Conference, Hanoi, Vietnam.

[3] CNN, (2016): Fighting Poor Sanitation in Uganda, African Start-Up Program, Atlanta, GA.

[4] Namagembe, L. (24 February 2016): How Lubigi women have found gold in human waste. Daily Monitor.

[5] Muspratt, A.M. et al. (2014): Fuel potential of faecal sludge: Calorific value results from Uganda, Ghana and Senegal. Journal of Water, Sanitation and Hygiene for Development *4(2)*, 223–230.


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Photo 1: Pellets (top), briquettes (bottom) and crushed fuel produced from FS (right).

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