Centre of Excellence for Mining, Environmental Engineering and Resource Management (CEMEREM)

Pilot Projects

TAITA TAVETA UNIVERSITY

A Premier Institution in Education, Training, Research, Innovation
And Community Outreach

Centre of Excellence for Mining, Environmental Engineering and Resource Management

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CEMEREM Smart Biogas Project

Background:

In most rural and urban areas in Kenya, wood fuels constitute the primary energy source for cooking and heating. It is estimated that more than 90 percent of rural households depend on firewood and 80 percent of urban households depend on charcoal (Ndegwa et al. 2011). Due to the increase in population, demand for wood fuels is steadily increasing. However, the use of wood fuels leads to deforestation, land degradation, and sicknesses of women and children. Bioenergy, which is obtained from biomass and biowastes, can be an alternative option and it can play an increasing role in meeting future energy demands in rural and urban areas in Kenya. In Ngerenyi, two biogas plants are already in use. One of them is installed at Taita Taveta University's School of Agricultural, Earth and Environmental Sciences (SAEES) Campus and the second plant is operated by St. Mary's High School. Both plants have a traditional design, which allows for a reliable yield of biogas but at a low level of effectiveness. Modern, innovative biogas technologies with much higher yields have now become available for application.

In the framework of the CEMEREM project, a specific technology transfer project is started to install and operate the so-called Smart Biogas Plant (SBP), developed by Freiberg experts Niazi Khan and Erik Ferchau, researcher on biogas at Institute of Heat Technology and Thermodynamics of TU Bergakademie Freiberg. The main purpose is to increase energy efficiency through the use of biogas generated from local natural resources.

About SBP:

The Smart Biogas Plants are based upon an innovative and completely novel application of the well-known anaerobic digestion principle. The SBP technology allows for the processing of a large variety of many types of organic wastes, which currently have no use and are therefore available at zero cost. Such wastes come from kitchens in households and other establishments, cattle breeding and livestock farming, agricultural plant production, horticulture and toilets. In contrast to traditional underground dome structures found in many parts of the world, they stand above ground, they are lightweight, portable in an empty condition and without any need for preparatory civil engineering works. Moreover, biogas production is highly effective in comparison with underground domes and outgoing digested sludge constitute an important bio-fertilizer.

Main benefits of the application of SBP:

- utilization of organic wastes for the generation of biogas as a clean fuel,
- generation of a digested organic effluent with good fertilizer properties,
- high efficiency in terms of biogas generation,
- uncomplicated transport to any suitable site,
- easy installation and operation,
- applicability in small decentralized energy systems and
- flexibility, since several SBP units can be combined into larger production facilities.

Azim Niazi Khan and Erik Ferchau showing theirs Smart Biogas Plant in front of a "big brother"

Objectives of the project:

The main objectives of the pilot project are:

- Installation of the Smart Biogas Plants at TTU as test and demonstration plants
- Establishment of a biogas laboratory at TTU
- Teaching and training of teaching staffs, students at TTU and selected members of the local community about utilisation of biogas
- Completion of a sustainability analysis consisting an environmental and social benefits analysis and analysis of the acceptance of the local community
- Completion of a feasibility study of the application of SBP in Taita Taveta Region including a cost-benefit analysis of the application
- Development of a business plan for the application of SBP in Taita Taveta Region

Status of the project:

As a part of the CEMEREM Smart Biogas Project, Joshua Holland, an IMRE student of TU Bergakademie Freiberg has done his master thesis in the topic "Investigating into the development potential of biogas technologies for small-scale farmers in Taita Taveta, Kenya". He did a survey about potentials for introducing the smart biogas plant. He developed a questionnaire for administration to the local population around TTU's agricultural campus in the Taita Taveta regions.

In 2018, four plants have been installed at the TTU main campus and at the campus of the School of Agricultural, Earth and Environmental Science s (SAEES) in nearby Ngerenyi. In a first stage, they will produce biogas for TTU's Catering Department with kitchen waste and other biomass as preferred feedstocks and be used for the research about the quantity and qualities of biogas. More importantly, these biogas plants can be used as a demonstration plant for local farmers and would-be entrepreneurs who intend to disseminate the technology around the SAEES campus and beyond.

Installation of the Smart Biogas Plants at TTU

Tasks in 2019:

The following tasks need to be done:

- Report of the using four biogas plants at TTU
- Cost-benefit analysis of the application of the SBP
- Development of a business plan for the application of SBP
- Further providing training courses for the SBP technology for TTU staff, students and selected members of the local community
- Providing workshops for the local communities to demonstrate the biogas plants

Responsible Person:

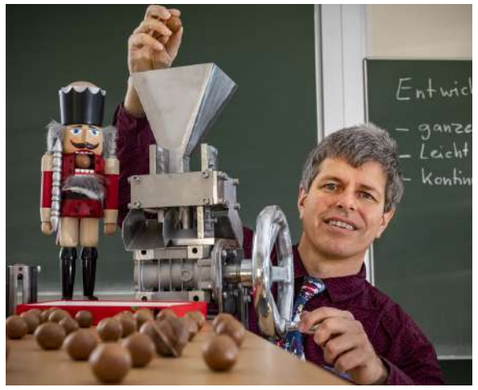
TU Bergakademie Freiberg: Khan Azim Niazi, Erik Ferchau, Prof. Bongaerts, Dr. Jiangxue Liu
TTU: Samuel Mjomba, Dr. Nelima Ondiaka

Efficient Macadamia Nuts Cracking Project

Background:

In 2016, during a visit of the SAEES Campus of Taita Taveta University (School of Agricultural, Earth and Environmental Sciences), the “problem of nuts cracking” was identified. SAEES, in their plantation, cultivate macadamia trees. Macadamia nuts range at the top end of all nuts in terms of quality, except that they are extremely difficult to open. Current technologies often result in shells being cracked and nuts being pulverized. This makes them almost worthless for sale. Moreover, the lack of an efficient nutcracker technology significantly reduces their price for the farmers. In essence, the value added is much higher for cracked nuts. As a result, an attempt was made to draft a profile of requirements to be fulfilled by a better, benign, technology cracking the shells and leaving at least 80 percent of the nuts intact. Another, important, objective consisted in a minimum capacity of production expressed as the number of nuts opened per unit of time. Needless to say that this machine should also be robust, and eventually manufactured in Kenya.

As a result of that initiative, TU Bergakademie Freiberg’s Professor Mathias Kröger and his student Johannes Gebel investigated various physical principles serving the purpose and developed a machine as a prototype which meets the set requirements. The prototype is in December 2018 patented. The main purpose of this pilot project is now to develop a nuts cracking machine for practical use in Kenya.



Left: Prof Kröger and the Macadamia Cracking Prototype, Right: The Macadamia Cracking Prototype

Objectives of the project:

In order to bring the machine in practical use in Kenya, it is important to have an overview of the supply chain of macadamia and complete a suitable business plan for the utilization of the new efficient nuts cracking machine. The main objectives of the pilot project are:

- Development of an efficient nuts cracking machine for practical using
- Completion of an analysis of the supply chain of macadamia nuts consisting an analyses of nuts production, processing, and market analyses
- Completion of a benefits analysis and a feasibility study of manufacturing and using the new efficient nuts cracking machine in Kenya
- Development of a business plan for the using of the new efficient nuts cracking machine in Kenya
- Establishing an network with macadamia nuts farmers and processors

Status of the project:

In 2018, the prototype of the cracking machine is already developed and patented. Johannes Gebel has done his master thesis in the topic “Development of a macadamia cracking machine”. He travelled to TTU to test the prototype and to investigate the possibility to produce a machine at TTU. He initiates the first contact with few processors in Nairobi.

Johannes Gebel demostrate the Macadamia Prototype at TTU

Tasks in 2019:

The following tasks need to be done in the future:

- Further improving the prototype of the nuts cracking machine
- Visit of processors in Nairobi
- Analysis of the supply chain of macadamia nuts in Kenya
- Development of a business plan for the application of SBP

Responsible Person:

TU Bergakademie Freiberg: Prof. Kröger, Prof. Bongaerts, Dr. Jiangxue Liu
TTU: To be identified

Gemstone Project

Background:

The history of the discovery and the mining of green garnets (Grüne Rubine) in Tanzania and Kenya are well-known and documented. Tsavorite is a mineral containing silica and, unlike the usual garnets, its green colour is caused by the presence of vanadium and chromium oxide. Tsavorites only occur in Tanzania and Kenya and, due to their rarity and their small sizes, they are among the most expensive of all garnets. The following very general statements can be made:

è prices of up to $8,000 per carat
è most pieces are less than 3 carats
è a piece above 5 carats is large and rare
è pieces above 20 carats are world-class

Mining these gemstones is the business of small-scale miners with limited mining equipment. Underground galleries are blasted and or drilled and the material is transported in bags to above ground whilst hanging onto a cable lift operated by an engine. Sorting and – hopefully – not missing the rare discoveries are performed above ground. Working conditions are commonly poor with little or no appropriate health and safety measures in place.

Current sales process

Miners sell their produce to middlemen, who, like the miners themselves, have little knowledge about the aptitudes of each individual gemstone with respect to its cutting and polishing opportunities, and, hence, with respect to its ultimate value as a polished piece of jewellery. These middlemen sell to other middlemen with better knowledge and expertise and, from there, the potentially best pieces are moved on to other layers of traders, who, ultimately, deliver to cutters and polishers. Obviously, within this largely inefficient process, a lot of material and, unavoidably, a lot of value is lost.

New innovative sales process

In a near future, this process can be replaced by a an alternative, disruptive and innovative trading process which enables miners to entre in direct contact with their ultimate clients, i.e., cutters and polishers anywhere in the world. The new process is embedded in a virtual sales platform. It operates with a cloud and a blockchain technology.

1. Every individual mined raw gemstone can be documented in the cloud. Visual (photos) and other information can be stored. Such information includes weight in carats, crystallography, hardness (in Mohs), specific gravity, refractive index, optical character, transparency etc. Initially, much of that information will not be available to the miners, but, with time and improvement of the process, this may change.
2. Interested buyers can place bids in the cloud. They are individualized and uniquely documented and traceable with the blockchain technology. They can be anonymous or identifiable to the owner (miner) of the gemstone(s) for which the bid is placed.
3. Agreements on sales are equally are individualized and uniquely documented and traceable with the blockchain technology. They can be anonymous or identifiable to the owner (miner) of the gemstone(s) which are purchased.

In comparison to the existing sales process, the following advantages can be expected:

- Continuous sales opportunities (“open day and night” and “worldwide”)
- Affordable costs of arrangement of the platform itself
- No more middlemen
- (Very likely) higher prices for the miners
- Transparency in the process
- “polishers” directly address “rough” producers
- Avoidance of unnecessary sorting
- Quality assurance in the process
- No inventories with middlemen
- “Value for money”

Objectives of the project:

The main objectives of the project consist in the following:

- Development of the platform
- Securing and development of the required software
- Testing the platform at plot level and for practical application
- Launching the platform

Status of the project:

Initial statuts

Tasks in 2019:

- Securing funding (around 10 000 Euro equivalent)
- Networking with stakeholders in the region
- Development and administration of a questionnaire to stakeholders
- Design of the requirements and characteristics of a software
- Testing the software

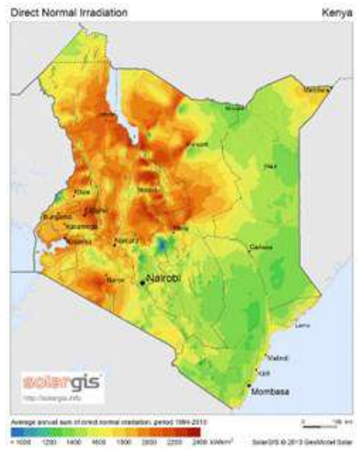
Responsible Person:

TU Bergakademie Freiberg: Prof. Bongaerts
TTU: Dr. Maurice Ogada

Compatible Solar Panel Project

Background:

Kenya has very high potential of utilization of solar energy with an average insolation rate of 5-7 peak sunshine hours and average daily insolation of 4-6 kWh/m^2. Solar power is largely seen as a solution rural electricity supply, since the majority of the population doesn't have electricity assess. The Kenyan government is aiming to install an additional 500 MW solar system by 2030. It is expected that the installation of solar panels will be expanded in the near future. However, the installation of solar panels requires large quantities of space and land. It can lead to the conflict between energy production and plants cultivation. A compatible land use for energy production and agriculture should be explored. For this purpose, a joint research project within the framework of the CEMEREM started in 2018 to maximize the land use efficiency at TTU.



Objectives of the project:

For investigation of different climatic and soil conditions for plant cultivation under solar panels, a solar test area is set up at the campus of the School of Agricultural, Earth and Environmental Sciences (SAEES). The main objectives of the research project are:

- Installation of a solar plant with 24 modules and soil measure equipment
- Conducting soil moisture measurements and experiments on plants cultivation
- Analyse the impact of the solar panel installation on the soil water balance
- Optimization of the land use for both solar energy production and plants cultivation
- Teaching and training staffs and students at TTU about the utilization of solar panel
- Promoting students to develop research ideas
- Support power supply at SAEES during the power failure

Status of the project:

In February 2019, 12 solar modules have been installed at SAEES. The plant is 2 m high in order to grow crops and carry out soil measurements underneath. Under solar modules, two Soil Moisture Probes Delta-T PR2 and four Soil Moisture Sensors Delta-T SM150 have been installed for the measurement of soil moisture up to 1 m depth. The same probes have been installed in a reference area for comparison the results of the measurements. In addition, a weather station has been built for the measurement of the air temperature and humidity, the radiation intensity and the precipitation. Three Bachelor students and a Postdoc of the SAEES were trained to maintain the measurement system and set up a database of the measurement.

Left: Soil Moisture Measurement System , Right: Installation of Solar Panels

Tasks in the future:

The following tasks need to be done in the future:

- Conducting soil moisture measurements including gradation analysis, estimation of soil permeability and density within the scope of student work / internships
- Conducting experiments on different plants cultivation
- Analysis of the results of the measurement and modelling of the soil moisture
- Comparison of results with the data from reference surface

Responsible Person:

HTWD: Susanna Kettner

TTU: Dr. Marianne Wughanga Maghenda, Dr.Nelima Ondiaka

Business Incubation & Development Centre (BIDC)

Background:

One of the major goal of CEMEREM is to build the network with partners from Government and Industry for contributing to a sustainable growth of academic education at TTU. For that purpose, TTU has established the Friends and Supporters Association (FSA) and the Business Incubation and Development Centre (BIDC).

The main objectives of the BIDC:

- Identification of continuous education and training needs
- Identification of needs of industry
- Design of appropriate education and training formats
- Design of contents of education and training packages
- Networking with industry partners
- Involvement of industry partners in teaching at CEMEREM
- Design of appropriate CEMEREM services
- Training of engineers and resource managers
- Providing short courses for practitioners in the extractive sector
- Networking with industry and training
- Support for young entrepreneurs

Activities in the past:

After the establishment of the BIDC. Several workshops have already took place:

- November 2017: Young Entrepreneurs Workshop gave by staffs of SAXEED, the Entrepreneurial Centres of TU Bergakademie Freiberg
- May 2018: Short Course for Gemstone Artisanal Miners “Mining and Entrepreneurship”
- November 2018: CEMEREM Entrepreneurship Workshop – TOOLKIT for Micro, Small and Medium Enterprises (MSMEs)
- February 2019: Jiamini Youth Challenge Entrepreneurial kit

Event in 2019:

Biennial CEMEREM International Conference from September 17 – 18, 2019 at the Voi Wildlife Lodge in Voi, Taita Taveta County, Kenya.

Main Theme: Sustainable development in the extractives industry in Africa

Conference papers and posters are invited in the following sub-themes:

- Environmental Engineering for Sustainable Mining
- Women empowerment in mining
- Social licence in extractive industry
- Mining 4.0
- Mine Economics and Financial Evaluation
- Entrepreneurship in mining
- Resource governance

CEMEREM TEAM

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