Rice Straw to Biogas (R2B)

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Background

Unlike rice husks which cover the grain, rice straw (stems and leaves) is left in the field after harvest and few major uses have been identified, so more than 300 million tonnes of it are simply burned each year as waste. To date, attempts to profitably collect and use this vast resource for clean energy have almost all failed. In this concept note, a consortium of leading experts outline their bold plan to be leaders in this emerging field and provide a route to clean, affordable, reliable energy for the world's 200 million small-scale rice farmers.
Innovation: The novel approaches outlined here are designed systematically to overcome the four key barriers identified in the 3 year, UK-funded 'Rice Straw Energy project', which is now ending (September 2016). The barriers are: logistics of straw collection; rice straw fuel characteristics; lack of proven business models and policy support. The respective innovations to overcome them are: a simplified, village-scale supply chain that minimises collection costs and storage; a low-cost 'dry' anaerobic digestion technology appropriate for developing countries; packaged in an innovative business model with support from public funding to reduce the risks.

R2B team at the kick-off meeting

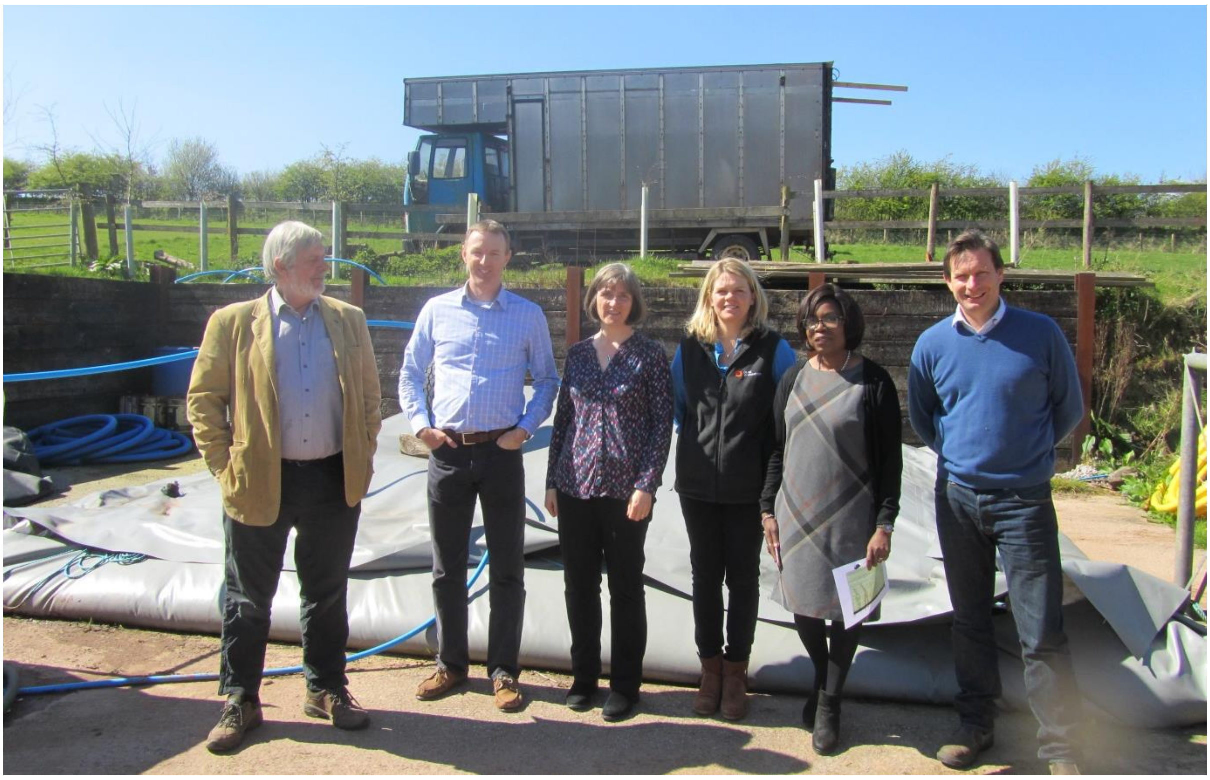
Project description

The project seeks to develop a route to making affordable, clean fuel from rice straw in developing countries. The technology to be used is anaerobic digestion, which is an established technology but using rice straw as the main feedstock is still an underdeveloped application for it. The focus is on industrial research to develop and test innovative new systems, sub-systems and components for producing biogas from rice straw in a more cost-effective way. This project addresses the energy trilemma as follows:

ENERGY ACCESS / SECURITY OF SUPPLY. Rice straw is one of the most abundant biomass resources in developing countries and small-scale rice farmers are among the poorest of the poor. Hence, being able to turn rice straw into clean fuel would significantly increase their access to clean energy. Rice is the world's number one food crop, and for every kilo of grain eaten, a kilo or more of straw is produced, so there is secure of supply of potential fuel, most of which is currently being burned as waste. As a storable fuel, biogas can provide reliable backup power for other renewables, including on calm days without wind power or at night when there is no sunshine for solar PV. However, the main target use in this proposal is as cooking fuel, because almost 50% of the population of SE Asia still relies on solid fuel for cooking, often involving collection risks for women.

AFFORDABILITY. Aims to greatly reduce the cost of rice straw biogas production through: a) A streamlined, one-step collection and transport supply chain; b) Localised 'village-scale' production to minimise transport costs but still allow economies and specialisation; c) A novel, low-cost 'dry' anaerobic digestion technology; and c) 'Cascading' use of biomass to maximise value from the straw and the digestate as fertiliser. It will also trial a business model that could benefit small-scale rice farmers in remote areas where fuel costs are especially high but rice straw is abundant.

CLEAN. As a cooking fuel, biogas offers attractive GHG emissions savings compared to LPG, and local emissions savings compared to wood or charcoal. Indeed, cooking with solid fuels is one of the five biggest killers in developing countries, causing 4.3 million premature deaths per year. In addition, producing biogas from rice straw can help reduce pollution from inefficiently burning straw as waste, giving a double saving in environmental emissions and health benefits.



Team on site at QUBE Renewables

Work plan

The work at Southampton involves laboratory trials providing data to support the techno-economic elements of the project, and allow science-based optimisation of digestion performance in field trials in the Philippines. Compositional analysis of the straw will allow assessment of the theoretical methane potential and of nutrient imbalances or deficiencies. Advanced microscopy and Raman spectroscopy will elucidate the effects of mechanical pre-treatments, which prior research suggests are of value, and batch methane potential tests will show changes in reaction kinetics. Semi-continuous digestion trials at a range of loadings will establish gas productivity and operational stability in both mesophilic and thermophilic conditions. The kinetic data will be used as a baseline for optimising design and operation of the larger-scale plant in the Philippines. Rice straw may be deficient in natural buffering, and co-digestion trials will be carried out using spent mushroom compost or duck and chicken manure as readily available co-substrates. As both shredding and co-substrate addition will affect rheology, permeability tests will be conducted in small-scale 'dry' digesters, and the use of bulking material to reduce hydraulic short circuiting will be tested. Any propensity for acidification will be addressed by recycling liquor from low-tech second-stage methanogenic reactors. Changes in microbial population structures will be monitored using gene techniques. Batch sequencing of dry digesters will be evaluated as a strategy to match harvesting schedules and minimise storage needs. Results will be fed into existing energy balance models to provide output for sustainability assessments.

Partners

Straw Innovations Ltd – Project Coordinator Dr Craig Jamieson
QUBE Renewables Ltd – www.quberenewables.co.uk
University of Southampton – www.bioenergy.soton.ac.uk
University of Manchester – Prof Patricia Thornley's team was also involved in the IIRI-SUPERGEN Rice Straw Energy Project.

http://www.eee.manchester.ac.uk/our-research/research-themes/e-agri/people/profpatriciathornley/