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Appendix 3b

Policy Brief
Biofuel production from lignocellulosic materials - 2GBIONRG

Introduction: Objectives of the project and giving an overview of the findings and conclusions.
Utilization of lignocellulosic feedstocks for bioenergy production in developing countries demands competitive but low-tech conversion routes and adapted technologies. The overall objective of the 2GBIONRG project has been to develop sustainable, competitive technologies for production of 2nd generation biofuels (notably biogas and bioethanol) from lignocellulosic waste material including household waste in developing countries in Africa, using Ghana as a model country. The overarching aim has been that the conversion technologies developed and demonstrated will make it possible to switch from a society depending on fossil energy to a modern biomass based society, with the added benefit that the increasing amounts of household waste (urbanization) are recycled for bioenergy. To ensure sustainability and responsible development the following findings and conclusion have been attained in the 2GBIONRG project in accord with the objectives of the project:
In Ghana, the available lignocellulosic materials and household wastes have been mapped, quantified, analytically characterised, and described. Notably the project has mapped the amounts of household waste nationally. Next, to enhance the conversion of the organic fraction of biomasses and waste streams to biofuels different pretreatment methods have been investigated and developed with focus in low tech methods that can be used in developing countries. In turn, production routes and assessment of 2nd generation biofuels, bioethanol and biogas were examined, and the energy potentials of different waste fractions were determined. In addition, the residuals from the 2nd generation biofuel production have been evaluated for possible soil applications. Sustainability assessment has been a huge part of the project: Mapping of energy supply and demand in Ghana, model for integrated energy, environmental and financial analysis of the 2nd generation biofuel production systems, analysis of economy of scale in relation to decentralized and centralized systems in relation to energy use. Possible recycling routes, energy demands and technology development opportunities have been described. For such an endeavour to succeed in real life, technology implementation involving participatory research is crucial, and in this project strategic technology transfer to end-users has been done, including notably technology transfer and knowledge transfer to Zoomlion, a large waste handling company in Ghana. Hands-on technology demonstration capacity has been developed at KNUST, Ghana, to ensure continued focus and options for further development of biofuel production processes.

Background, issue and context of the project and its approach and methodology, highlighting the value added.
Utilization of biomass residues for bioenergy is one potential route to decrease fossil fuel use, decrease greenhouse gas emissions, and secure the future energy supply. It has moreover been suggested that introduction of bioenergy production may enable development in developing countries e.g. in Africa.
A major tenet behind the project was that lignocellulosic materials like agricultural and industrial residuals in addition to organics in house hold waste can be converted to biofuels (biogas, bioethanol) in a way that support sustainable development in Ghana with minimum carbon foot print. In addition to environmental and climatic benefits, the value added by such processes would be provision of a sustainable energy supply. A critical prerequisite is local capacity building for creating such transition and the project has exactly targeted personnel training and education in addition to technology development locally in Ghana. The local empowerment attained is a significant value addition.

Results
The main objectives have been achieved through coordinated collaborative research work, with the main results spanning the following points: 1. Assessment and geographical and analytical mapping of waste and relevant industrial plant lignocellulose sidestream resources in Ghana. 2. Development of suitable low tech pretreatment technologies and processes for waste and biomass resources. 3. Production of 2nd generation biofuels: Bioethanol and biogas and determination of energy potentials of different waste fractions have been determined and suitable technologies developed for conversion of the wastes.
4. Assessment of the residues from 2nd generation biofuel production for new applications. 5. Sustainability assessment: Mapping of energy supply and demand in Ghana, model for integrated energy, environmental and financial analysis of the 2nd generation biofuel production systems, analysis of economy of scale. 5. Recycling, energy demands and technology opportunities have been assessed and described.
We learned that significant potential exists for sustainable bioenergy production in Ghana and local knowledge capacity and further capacity for continued research on the subject was developed in Ghana.

Conclusions
In conclusion, the results obtained show that lignocellulosic biofuels and biofuels produced from lignocellulosic resources and household waste streams can be a viable future alternative for energy production in Ghana. A number of alternative technologies developed are more relevant in Africa that high-tech methods, because the lower tech (some of them biology based, eg pretreatment), are applicable where decreased scale and low plant complexity is more important than treatment time. The results provide a foundation on which continued technological advancements can be made to promote implementation and use of lignocellulose and waste for renewable energy production in Africa.

Implications: What are the implications of your results and capacity building? Which policy changes do the results point to?
The production of bioenergy is subject to political decisions. At this point in time the political climate in e.g. Ghana is very focused on energy provision, but investments are needed both with respect to infrastructure and industrial reward programmes to apply the technologies in practice to an impact.

Recommendations: Call to action, which precise steps should be taken? (both flowing from conclusions, supported by evidence, and be feasible and "actionable").
It is very important to keep up the momemtum concerning development of biobased energy in Africe. In Ghana it is important to now support the integration of the project partners (mainly at universities) with companies that can implement the results and technologies in practice. Green growth is a crucial focus area that may enable improved livelihood development in developing countries e.g. in Africa. Continued political focus and investment in the area are recommended.