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1 **Forest based biomass for energy in Uganda; stakeholder dynamics in**
2 **feedstock production**

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4 Highlights

- 1

Forest based biomass for energy in Uganda; stakeholder dynamics in feedstock production

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8 Abstract

Insufficient energy supply and low levels of development are closely linked. Both are major issues in Uganda where growing demand cannot be met by overstretched infrastructure and the majority still rely on traditional biomass use. Uganda's renewable energy policy focuses on decentralised sources including modern biomass. In this paper, stakeholder dynamics and potential socio-economic impacts of eight modern bioenergy feedstock production models in Uganda are considered, and key considerations for future planning provided. For these models the main distinctions were land ownership (communal or private) and feedstock type (by-product or plantation). Key social issues varied by value chain (corporate, government or farmer/NGO), and what production arrangement was in place (produced for own use or sale). Small, privately owned production models can be profitable but are unlikely to benefit landless poor and, if repeated without strategic planning, could result in resource depletion. Larger projects can have greater financial benefits, though may have longer term natural resource impacts felt by adjacent communities. Bioenergy initiatives which allow the rural poor to participate through having a collaborative stake, rather than receiving information, and provide opportunities for the landless are most likely to result in socio-economic rural development to meet policy goals. The structured approach to understanding stakeholder dynamics used was found to be robust and sufficiently adaptable to provide meaningful analysis. In conclusion; local, context-specific planning and assessment for bioenergy projects, where all stakeholders have the

opportunity to be collaborators in the process throughout its full lifecycle, is required to achieve rural development objectives.

1. Introduction

1.1 Energy and socio-economic development; the role of bioenergy

It is commonly agreed that sustainable development relies not only on a country or region's economic performance; in fact modern indicators of development incorporate the social features of the population at all levels and the divide between rich and poor [1,2]. In addition, it has long been appreciated that there is a direct link between insufficient energy supply and low levels of development [3,4]. As a result, policies, programmes and projects to improve the availability and accessibility of secure energy supplies for the poorest and most remote people have been central to development efforts [2]. Increasingly there is a drive towards decentralised, renewable provision of energy which relies on local resources [5] in order to reduce the negative effects of high dependency on imported fossil fuels. This is often preferred over trying to improve and extend existing national grid infrastructure, which in many developing countries is already struggling to cope with existing demand [2]. Bioenergy schemes are regularly reported to be motivated by socio-economic drivers such as employment and livelihood-generating opportunities in rural areas, localised multiplication of financial benefits in the community, and improvements to local energy supplies [6,7,8]. However, these benefits are not always adequately and equitably delivered, and in many cases do not have as profound an impact as might be anticipated due to poor planning and implementation [9,10]. Stakeholder participation throughout the project lifecycle and inclusion in project design is required to increase the likelihood of benefit capture and maximise social gains [6]. Achieving this requires a thorough understanding of stakeholders and social issues [11]. It is therefore suggested that a structured approach to understanding stakeholder roles, requirements, risks and relationships such as that proposed in Harrison *et al.* [12] should be used in planning and assessment of bioenergy projects [13,14] as part of a wider sustainability planning framework covering the entire life cycle [15].

1 The environmental impacts of different bioenergy systems, as investigated using the Life Cycle
2 Analysis (LCA) method, have been seen to be influenced by regional variation, particularly with
3 respect to land use, existing or proposed examples of bioenergy feedstock production (referred
4 to as production models) models and the reference energy system [16]. This context specification
5 also applies very much to social impact variables which are also affected by aspects such as scale,
6 social and political structures and resource availability and accessibility [11,17,18]. To
7 adequately capture context diversity, two separate case study areas have been considered:
8 Uganda and the State of Chhattisgarh in India. This paper uses the approach trialled in India [14]
9 to improve understanding of the stakeholder dynamics for several proposed bioenergy projects
10 in Uganda, in order to assess whether the methodology is meaningful in this very different
11 context.

12 ***1.2 Electricity and energy in Uganda***

13 From 1954, when the public electricity supply in Uganda began, until 2005, more than 98% of the
14 country's electricity was sourced from the Owen Falls dam [19]. At that time it was reported that
15 only 5% of Ugandan households had access to electricity, which was one of the lowest rates in
16 Africa [20]. To meet growing demands, and counter poor hydro performance due to drought and
17 the consequent low water levels in Lake Victoria, in 2005 the Government contracted an
18 independent power producer to supply 150MW capacity to the grid based on diesel [21]. This
19 has had the effect of dramatically raising tariffs, resulting in the need for substantial government
20 and donor subsidisation, as well as an increased energy import bill. This has led to an
21 accompanying rise in diesel and fuel prices in Uganda, which are already high as virtually all
22 petroleum products are imported (at the time of writing) [21]. Despite this, the most commonly
23 used alternative energy source in rural areas not connected to the grid comprises petrol- and
24 diesel-powered generators [22].

25 In addition to extremely low overall access, the distribution of electricity supply in Uganda has
26 historically been very inequitable. It has been recently reported that, despite 84% of Ugandans
27 living rurally, electricity supply is mostly centred around the major urban areas, leaving less than
28 1% of available electricity to supply rural communities [23]. The government initiated the Rural
29 Electrification Strategy and Plan (RESP) in 2001, with a target of 10% access by 2010, but it was

1 reported that less than half of this rate was achieved [24]. Even if rural areas had an electricity
2 supply the vast majority would not be able to afford to use it for cooking. The majority of
3 Ugandans rely on traditional fuelwood for energy; in fact Bingh reported in 2004 that around
4 90% of the total energy needs of Ugandans are supplied by fuelwood [25]. It is well accepted that
5 this fuelwood consumption is not only outstripping supply, but is generally an inefficient source
6 of energy which has knock-on social and environmental consequences [26]. The negative social
7 impacts from traditional biomass use include time taken to collect fuelwood, primarily by women
8 and children, and indoor air pollution with detrimental consequences for health; both of which
9 are perceived to be social barriers to development [4,27]. These social factors are often traded off
10 against economic factors, i.e. the opportunity cost of collecting firewood might be ranked less by
11 poor individuals than the financial cost of paying for energy [28].

12 There is clearly a need for alternative, off-grid electricity and energy solutions. This is
13 particularly the case for rural parts of northern Uganda which have been affected by more than
14 two decades of conflict and are now gradually being re-inhabited [29,30]. It is suggested that
15 investment in small scale electrification plants could help to secure domestic energy supplies, as
16 well as providing additional economic and social benefits to rural areas [23,31]. This is reflected
17 in one of the main aims of Uganda's energy policies; to eradicate poverty through increasing
18 access to modern, affordable and reliable energy services [26,32]. The objectives are to both
19 increase public access to electricity and modernise biomass conversion technologies, though with
20 existing financial and technological capacity it is unlikely that these objectives will be achieved in
21 the near future [21]. Rather than trying to meet energy needs through large-scale hydro, fossil
22 fuel and even nuclear power projects, which have reportedly faced difficulties and low success
23 rates due to lack of investors and international opposition [20], it has been suggested that small-
24 scale, decentralised, wood-based biopower systems could be more successful in meeting multiple
25 development objectives [23]. In 2007, the Government published its Renewable Energy Policy for
26 Uganda, for which the overall policy goal is to "*increase the use of modern renewable energy, from
27 the current 4% to 61% of the total energy consumption by the year 2017*" [32]. To achieve this, a
28 combination of biomass, peat, hydropower, geothermal, solar and wind sources will be targeted.
29 This paper evaluates the different models of biomass for bioenergy production being proposed to
30 identify what their potential social impacts are likely to be. Neither the impact of such models on

the level of biomass use nor the most sustainable means of providing the wood feedstock will be considered here. However, this is a critical aspect of these projects bearing in mind the current, rapidly degrading state of Uganda's biomass resource.

1.3 Opportunities for bioenergy investment and development in Uganda

The Government policy outlined above, along with donor development objectives for Uganda (particularly the northern region), focus on provision of decentralised, often renewable, energy sources through programmes, financial and other fiscal incentives [32,33]. In addition to local schemes, this opens up private investment opportunities. The ensuing risk is that this could result in feedstock being produced purely for export, which would be assumed to have less local socio-economic benefits. At the other end of the scale, the recent history of conflict and internal displacement, particularly in the north of the country, has resulted in the establishment of densely populated Internally Displaced Persons' (IDP) camps [30]. Since the declaration of peace there has been a movement for the camps to be systematically closed and for their inhabitants to return to their homelands [34]. In some cases, however, the local council authorities can decide to pursue the establishment of a trading centre around the remaining community; meaning a centrally situated focal point where communities can come together for trading and exchange. These are opportunities for entrepreneurship within these locations, and such prospects are essential for allowing people to move out of poverty [35]. Bioenergy feedstock production projects and related energy provision initiatives could help to provide such entrepreneurial opportunities. Donor funding is available for commercial forestry plantation and community or institutional woodlots, alongside other projects such as improved cook stoves [36,37]. There are numerous models that could be applied; some of the possibilities being proposed are discussed in this paper. Appropriate consideration will be given as to what the implications of such opportunities are for rural planning, for bioenergy projects in particular, and key issues that need to be taken into account will be identified.

There is a particular stakeholder group which is often overlooked in project development terms, but is often at the centre of both local and national concerns. These are the rural landless poor, colloquially described as "idlers", who are usually unskilled youths and young adults unable to find employment and not having land of their own to provide themselves a living [38]. Locally,

1 problems occur because these individuals can be driven to crime. Such incidents as crops and
2 tools being stolen have necessitated the hiring of security services by some to protect their land,
3 an increasing phenomenon particularly in the Mt Elgon region of Uganda [39]. Other groups
4 including NGOs, donors and even government are increasingly looking for ways to provide
5 vocational, entrepreneurship and other opportunities for these landless poor. Developmental
6 projects and policies need to consider their inclusion as well as mechanisms to provide
7 assistance such as micro finance to enable them in livelihood generating activities [40]. This will
8 be considered a specific goal of Uganda's energy policy within general poverty alleviation.
9 Achieving this goal may take more than just providing opportunities and encouraging
10 entrepreneurship, as some previous attempts at cooperatives and community based initiatives
11 have been unsuccessful at including the "destitute" [41]. It has been suggested that, in certain
12 cases, the idlers are passive individuals (predominately male) with a low level of initiative and
13 predisposition to alcoholism and that engaging them in developmental activities is not always an
14 easy task [42,43]. The potential role of this group in bioenergy feedstock production models will
15 be considered explicitly, since they have been identified as high priority.

16 The aim of this paper is to further the understanding of stakeholder roles, requirements and risks
17 (termed their dynamics, see [14]) in the case of a number of, predominately proposed, types of
18 bioenergy feedstock production in Uganda. This is achieved through the application of a novel
19 approach, developed in India under very different conditions [14], and the opportunity taken to
20 briefly evaluate its validity and robustness in a new context. An evaluation of whether the results
21 would contribute towards successful multi-stakeholder consultation (MSC) or participation as
22 part of a planning for sustainability framework [15], which is the intention for this approach, is
23 also presented.

24

25 **2. Using the structured approach to understanding stakeholder dynamics**

26 **in the Ugandan situation**

27 A structured approach to understanding stakeholder dynamics in bioenergy project is outlined in
28 Harrison *et al.* [14]. It consists of 5 steps (see Box 1) which require stakeholder collaboration to

1 complete the relatively simple exercises associated with each step. This method builds on Social
2 Impact Assessment (SIA) [44,45], Sustainability Assessment (SA) [46] and takes account of
3 developments in Environmental Impact Assessment (EIA) and Strategic Environmental
4 Assessment (SEA) [47]. Increased stakeholder participation in planning is demanded by donor
5 organisations, international NGOs and many government departments; but is regularly
6 ineffective and far too often does not result in the views or goals of individual stakeholder groups
7 being taken into account [12]. Gaining a more structured understanding of the roles,
8 requirements, risks and relationships between stakeholders (their dynamics) is intended help
9 planners, project developers and policy makers to incorporate stakeholder views at an early
10 stage in the planning process, paving the way for a more bottom-up, community centred
11 approach where participation is more collaborative and empowering rather than simply
12 involving one-way information sharing [48]. It is also hoped that the approach used here would
13 provide an informed enabling platform for the MSC required for effective stakeholder
14 participation. MSC is the process of informed participation by a full range of stakeholder
15 representatives throughout project design, implementation, and evaluation [49]

16 **[Box 1: the structured approach to understanding stakeholder dynamics in bioenergy projects [14]]**

17 Interactions with stakeholders were carried out as extensively as possible during the six weeks
18 of field research undertaken for this paper. It is vital that a full range of stakeholder groups are
19 consulted in the assessment of stakeholder dynamics, rather than just a random selection
20 [14,50,51]. The need to include a representative range of stakeholders in other social research
21 has been emphasised, and classifications or categories of stakeholders which should be covered
22 have been identified [48,52]. For the purposes of this study a representative number of
23 stakeholders covering all categories have been included in the analysis. The methods of
24 consultation and participation ranged from involvement in a teaching module with international
25 technical experts and students from Makerere University, which included daily interactive
26 sessions; to focus group discussions; a small workshop and many informal one-to-one
27 discussions. Table 1 shows the different stakeholders who were approached and the way in
28 which their interactions were conducted.

29 **[Table 1: Summary of the stakeholders and interaction methods.]**

Semi-structured or informal interviews were undertaken with key stakeholders involved in the implementation of the different bioenergy projects. These are discussions based around getting answers to pre-defined questions, see Box 2 for those used in this case, but through facilitated, two-way dialogue rather than a traditional question and answer formal interview format [53]. Semi-structured interviews are planned and set up formally, whereas informal interviews are opportunistic but nonetheless extremely informative and recorded in the same level of detail. Additional focus group discussions were also conducted with local communities using the same base questions. During the interviews and focus groups, English was spoken where everyone was a fluent speaker, but in many situations this was not the case, particularly with the villagers, farmers and NGO workers. In these situations, translation was provided. Throughout all of the interviews, group discussions and other stakeholder interactions, very detailed shorthand notes were taken which were written up into transcripts, then shared and verified amongst the group.

[Box 2: the questions forming the basis for the semi-structured and informal interviews, based on [14]]

3. Results

In this section the completion of the simple, collaborative exercises comprising the 5 steps of the structured approach for bioenergy feedstock production models in Uganda is documented. Preliminary understanding gained in each case will be presented within the sub-sections. The following section will then discuss and evaluate the results, with a particular focus on the typology of bioenergy feedstock production models for Uganda and the social mapping exercise.

3.1 Context analysis: Identification of stakeholders

The stakeholder identification table for bioenergy feedstock production projects, as piloted in India [14], has been completed for Uganda, see Table 2. This was populated following the stakeholder interactions outlined in Table 1, as well as the desk-based study described in section 2. Ideally, a full assessment of the social impacts, see [54], would have been completed in this situation prior to the employment of the structured approach, as is recommended. However, in this case it was not feasible due to constraints on time and repeated access to the relevant

stakeholders. Instead, aspects of the SIA methodology (Situation Analysis and identification of potential direct, indirect and cumulative impacts) were compiled informally and the results discussed at length with experts living locally in order to gain a basic level of understanding of the potential socio-economic impacts that would be expected from these projects.

[Table 2: Bioenergy stakeholder identification in Uganda]

3.2 Identification of production models

Following the classification of stakeholders and over six weeks of field research, seven biomass-for-bioenergy and one biofuel from oil seed production models were identified, mostly potential but two existing. These are: a) a large scale biomass power plant planned by an International Energy Company (Aldwych); b) waste biomass to energy in sawmills; c) communal (Gumtindo), d) private land (farm scale) and e) institutional (Bududa) woodlot cultivation for cooperative or personal consumption; f) a private company exporting biofuel feedstock (Human Energy); g) gasification of waste biomass for energy on a large, internationally owned tea estate (Muzizi); and h) gasification for electricity for a former IDP camp (Anaka). See Table 3 for the models and Figure 1 for their locations.

[Table 3: Eight potential models of biomass to bioenergy production in Uganda]

[Figure 1: Location of six of the eight production models in Uganda] [55]

Of the eight models, only Human Energy is currently operational. This private company, an Indian owned biofuel production company with subsidiaries in Uganda, interacts with stakeholders in Kampala and exports processed biofuel to India from *Jatropha curcas* L. plantations in northern Buganda. The Aldwych venture was a 50 MW biomass powered plant proposed in 2006/7 for which 35,000ha of *Eucalyptus grandis* would have been required in the Amuru and Gulu Districts. Localised field trials and problems with land tenure resulted in the company pulling out and no further plans have been put forward. The biomass for energy in sawmills is a business proposal being considered by entrepreneurs associated with the SPGS and UTGA, which have organised commercial timber growing clients into 'clusters' within which sawmills will be required once the plantations reach maturity [36]. The intention is that the

sawmills contain small gasifiers which can be used to run electricity generators. The sawmills would purchase trimmings and prunings from farmers within their clusters, as well as using chippings from their own activities to cheaply produce their own electricity [56]. Gumtindo Cooperative and Bududa Vocational Institute, both small and medium enterprises (SMEs), with NGO involvement, are considering the use of small scale woodlots for gasification (extracting energy, in the form of a gas fuel, from biomass) to serve their electricity and heating requirements. Similarly the farm scale woodlots have been suggested as a means for individual farmers to provide themselves with a more sustainable fuelwood source or even for micro gasifiers [23]. The Muzizi Tea Estate, owned by James Finlay (Uganda) Ltd., has a woodlot and gasification unit on site to provide internal electricity supplies [5]. Whilst the gasifier is still in place, there have been technical difficulties with its operation which are currently being addressed [57]. The Anaka trading centre was formerly an IDP camp (closed officially as a camp in January 2010 and designated as a trading centre) where the existing schools, hospital, shops and market rely on fossil fuel generators to provide electricity; here a gasification unit is suggested as an alternative, cheaper electricity generation source. A theoretical feasibility and multi criteria analysis study has been done for a similar example of a trading centre, Kasonga, in western Uganda [5], and the Anaka case forms the basis for a culmination of donor activities, private sector involvement and academic research directed towards reliable, renewable energy provision for sustainable rural development in northern Uganda [58].

3.3 Distinctions between production models

The simple matrices for comparison of the production models used in India [14] are not directly applicable in this case for two reasons. Firstly there are no government led feedstock production models in Uganda, secondly biomass for bioenergy is being almost exclusively considered for gasification for electricity, there is no local market for conversion into liquid fuels which is a costly and often inefficient process. To reflect these differences, minor modifications to the matrices (from (i) Government/Private to Communal/Private and (ii) Transport/Electrification to Waste/Woodlot) have been completed to make them relevant to this context, see [2.

[Figure 2: Ugandan feedstock production models mapped by (i) Land size (vertical axis) and land ownership (horizontal axis); (ii) Feedstock type (vertical axis) and market scale (horizontal axis).]

The straddling of the small/large distinction by the sawmills' model (b) in Figure 2(i) is due to the fact that each sawmill would in total be collecting fuelwood from a large area (within a cluster of forest plantations), however the scale of production from each plot directly for energy purposes would be small. The shaded area in Figure 2(i) shows that, from the production models identified, there is no large scale communal biomass for bioenergy production. In fact the majority of the models would be implemented on private land, with only the cooperative group Gumtindo and the Anaka trading centre proposing to use communal land for production. Land tenure in Uganda is a highly contentious issue [59]. Private land ownership can take different forms of tenure, either customary or statutory. Whether customary land is formally certified and a freehold title has been allocated will often influence people's inclination to invest in forestry plantations. Land rights and occupation have been strongly disputed, largely due to the country's history of conflict, poor land records and political instability [30]. A rapidly expanding population and increased demand for fuelwood, as discussed earlier, is resulting in growing pressure on protected or forested lands. Communal land holdings are not frequent, and private land can be leased from the Government (although this is by no means a straightforward or all-inclusive arrangement) [60]. Large scale land private holding or acquisition is more likely than in India because of the opportunity for all rights to the use of customarily held land in Uganda to be accorded to the land holder [61].

The interesting distinguishing factor for Figure 2(ii), as virtually all biomass for bioenergy is used for electrification, is whether feedstock is purposely cultivated or comes as a by-product or waste biomass from an existing operation. There is no national market for energy produced from biomass waste from the selected production models, as seen by the shaded area in Figure 2(ii), and only one local bioenergy from waste model proposed. This is largely because of constraints in terms of volumes produced per unit area and viability of the exercise where transport distances are high [31]. Bioenergy from waste is generally only economically viable where conversion is done on site or in the locality, so is unlikely to be a major national source of

feedstock; however it can be an excellent value adding activity for existing operations such as commercial timber production which produce significant quantities of waste [31,56].

3.4 Typology of production models

The differences observed between the distinguishing features identified in Figure 2 (communal versus private land ownership; by-product versus dedicated plantation feedstock type) and those used in the Indian case (Government versus private land ownership; electrification versus transport market end uses) suggest that the typology of production models produced in India will not be identical to that for Uganda (shown in Table 4). The great majority of land ownership type in this context is private, and so the distinction here simply between communal and private land was not seen to be sufficient to classify the full range of possible bioenergy production models. The size distinction used in Figure 2 maps directly onto the value chain classification (according to project proponent) of Altenburg *et al.* [62], i.e. all farmer/NGO led models would be small scale, whereas all corporate models would be large scale, so therefore using this distinction would not necessarily add anything to the typology either.

From observations made during field research the key distinguishing feature between the models on privately owned land was seen to be whether the land was: owned by the production company; owned by farmers and provided by contract to a production company; or owned and used on site by the producer, the distinction between which has been termed the 'production arrangement'. The classification of the eight Ugandan production models according to this, land ownership and value chain is shown in Figure 3.

[Figure 3: Models for biomass for energy production in Uganda classified by land owner, value chain and production arrangement.]

[Table 4: Typology of Ugandan bioenergy feedstock production models, potential benefits and key issues.]

Input from an expert in Ugandan land use arrangements [63] suggested that an additional option to those covered this far exists: government/donor centred models which aim at exporting feedstock. This was proposed as an additional possibility which is already being explored in the country, but did not emerge from the field research undertaken for this study. The higher level

typology of models which has been produced (Table 4) accommodates this example and is comparable to that produced in the India case study [14]. The potential socio-economic benefits and key issues for the different model types were identified from the field research, stakeholder interviews, workshops and the understanding from the earlier stages of the approach and the additional work completed to produce the necessary outputs of SIA (for example, Table 2). This typology forms the basis of the social mapping exercise in the next stage, where representative examples have been selected for further examination.

3.5 Social Mapping

For this next stage of the analysis, stakeholders have been mapped onto matrices according to (i) their power in terms of decision making involvement in implementation; and (ii) risks in terms of extent of impact of project failure and level of personal capital input required (see Figure 4). This is a qualitative, transparent and participatory method which adds a new layer of understanding to the earlier, simpler assessment of production models. The distinctions are important in gaining a better understanding of the roles, requirements, risks and relationships of and between the various stakeholders in the different models. The mapping allows robust comparison between the stakeholder dynamics of different production models. It could be revisited throughout the lifecycle of a particular model to see how the stakeholder dynamics change over time.

[Figure 4: Social Mapping matrices by (i) power and (ii) risks [14]]

Figure 5 shows the results of the social mapping for three of the models; (a) Aldwych, (b) sawmills and (c) Guntindo, which are representative of the full eight. These three have been chosen as being representative of the full eight in terms of their socio-economic opportunities and potential impacts (as shown in Table 4). This mapping exercise shows that the range of stakeholders and their levels of involvement in the different production models vary widely. This is consistent with Figure 3, from which the range of diversity in the classification of models is clear. Because the 'alternative' final type was not identified through the stakeholder interactions, the mapping has not been completed for this model type. From discussions with experts around

the topic it was determined that the results from carrying out this exercise would not have a significant influence on the discussion and conclusions that can be drawn in this case.

[Figure 5: Examples of the completed stakeholder mapping matrices for (a) Aldwych; (b) the Sawmills and (c) Gumtindo production models by (i) power and (ii) risks.]

4. Understanding stakeholder dynamics in the Uganda case study

In this section the Ugandan results are evaluated, with a particular focus on the typology of bioenergy feedstock production models for Uganda and the social mapping exercise.

4.1 Providing energy security and modern forms of bioenergy

Section 1.2 highlighted the need for increased energy supply security in Uganda, particularly the northern region, in providing a platform for sustainable development. The country's energy policies aim to increase public access to electricity, particularly in rural areas, and modernise biomass conversion technologies. Whether or not the energy produced from the different bioenergy feedstock production types is used in the country or exported (Figure 2) is therefore going to have a bearing on whether or not a particular model contributes to meeting this goal of improved rural electricity access. Production types where the feedstock is produced to provide energy for the producers (types (U-1), (U-4) and (U-5)) are going to be most likely to achieve increased local energy security and therefore realise the benefits expected to arise from that activity (Table 2). It is not necessarily the case that the alternative will be true – even if feedstock is being produced for sale there may still be local energy security benefits. Income generated through the trade of feedstock (or any product manufactured from it) is likely to be multiplied within the community and increase the potential of individuals or communities to pay for improved energy provision. Collective action and the ability to pay could even improve the leverage on government and energy firms to provide grid energy to areas previously unconnected. However, this possibility is thought to be a 'best case scenario' and not a guaranteed outcome. This is because in one area visited during the field work, there was a community with the ability to pay which had been campaigning for grid connection but been

1 unsuccessful. This was despite years of lobbying, promises of connection and a community
2 pledge to pay towards the infrastructure and maintenance costs [39].

3 Another mechanism whereby local energy security might be achieved through production
4 models producing feedstock for sale would be where the companies purchasing the feedstock
5 were doing so with a view to providing energy services within the area. This could be either as
6 part of their business plan, due to an agreement with the government or even as a corporate
7 social responsibility (CSR) exercise. With the creation of a large scale powerplant such as that
8 proposed in the Aldwych model, the construction of infrastructure required to transport the
9 electricity generated away from the plant could increase the likelihood of local grid connections
10 (particularly if this was stipulated in a planning agreement). In this situation there would need to
11 be controls in place to ensure that the services being provided were of sufficient quality, quantity
12 (of connections) and affordability. Alternatively, in cases such as the Human Energy or Aldwych
13 models, where feedstock is being produced entirely for export, if local energy needs are to be
14 sustainably met there needs to be some mechanisms in place whereby local benefits are assured
15 either from government or donor mandate. This is because of the government's driver to reduce
16 poverty through increasing access to modern, affordable and reliable energy services outlined in
17 section 1.3. Figure 4 shows that marginal farmers and landless poor do not feature in these
18 model types in terms of risks or responsibilities, and so are unlikely to directly benefit and
19 achieve the policy goal. If the government were to solely support this type of bioenergy model
20 then they would need to ensure that there was some local contribution to the availability and
21 affordability of modern energy services in order to meet their targets.

22 In terms of the use of more modern forms of bioenergy generation, proposed small scale
23 gasification units are perhaps not seen as the advanced technologies which many people would
24 prefer [5]. The size and potential output of a project such as the Aldwych powerplant would seem
25 to be more favourable in meeting this particular policy objective. However, it is important to note
26 that the concerns over negative impacts (see Table 4) would need to be adequately addressed
27 prior to anything being implemented on that scale. The decision on whether or not to promote a
28 particular model should be based on more than one objective. By contrast, a severe negative
29 impact on any one aspect could be enough to result in a block or complete redesign of a project

even if there are multiple other benefits expected, for example increased water resource availability.

4.2 Social mapping: assessing power and risk dynamics

The social mapping exercise was used to visualise and easily compare some aspects of the stakeholder dynamics (roles and risks) in three feedstock production models. The requirements of the stakeholders would usually be identified through SIA, which was not possible in this case. The Situation Analysis and stakeholder identification exercises were used to gather the necessary information on different stakeholder requirements, presented in Table 2. In the Aldwych case, representing type (U-2), the company itself takes decisions, and ultimately bears a substantial risk of failure (Figure 4(a)). There are landowners involved, from whom the land for plantation would be leased or purchased, however their role is ultimately limited as the company manages the whole product chain from feedstock to market. There is a degree of risk for those who would retain ownership of the land if the company pulled out and the land use proved unprofitable. The land managers and labourers would not be participants in decision-making and so be powerless in that respect but with a substantial role to play in ensuring the success of the venture through management activities. Their level of risk would be lower than the company and the landowners, but still relatively high because of their entire livelihood being potentially centred around employment at the plantation. The government and NEMA have a limited role to play in the stakeholder dynamics in this model except that they ought to be involved in the monitoring and assessment of the venture. The high level of corporate risk in this case could have been a contributing factor to the proposal not being implemented. In the case of the sawmills, which is a type (U-3) model, it is the operators of the mills who would have the highest input, role and ultimately risk (Figure 4(b)). The likelihood of failure could be minimised by pilot projects supported by donors, NGOs or government to demonstrate best practise and a viable business model. Compared to the previous model the level of risk is minimal because this is not the central income generating activity for either the feedstock producer or the end user. The plantation owners and managers incur minimal risk because they already need to thin and prune their stands in order to maximise timber yield, and so any revenue from this activity adds value. The additional stakeholders included in the mapping (Figure 4(b)) would perform supportive roles,

1 and it is unlikely that this model would provide any substantial socio-economic benefits outside
2 of those already engaged in the timber plantations or sawmill operation.

3 The cooperative members in the type (U-5) example of Gumtindo would have the greatest power
4 and risk (Figure 4(c)). The cooperative workers and local community members could benefit
5 from the electricity produced if there was surplus after the needs of the coffee processing were
6 met. This would offset the price of diesel purchased for power generation, and could provide
7 additional revenue if further connections could be established and paid for. Because, again, the
8 production of bioenergy feedstock is not the main income generating activity in this model, there
9 is overall less inherent risk of failure. There were reported to be specific targeted opportunities
10 for the “idlers” in this particular model driven by international NGO involvement (unlike in other
11 cases where excluding them was seen to be a priority). The intention was to support groups of
12 these landless poor in setting up and running parts of the product chain through entrepreneurial
13 training. If taught basic business skills and supported by the cooperative (as both a market and
14 potential financing source), it was expected that this group would be able to work their way out
15 of poverty and help to improve the security and cohesiveness of the whole community through
16 energy provision and poverty reduction. The importance of local education and research in the
17 success of such a scheme was seen to be paramount. Although using communal land does make it
18 more feasible, this is not the only model or type of model which could involve idlers in part of a
19 bioenergy product chain. In models where private land is used for feedstock plantation (e.g., type
20 (U-2), (U-3), (U-6)) it is more likely that the idlers would be employed as labourers, if at all. If an
21 entrepreneurial method of involving the landless poor were to be adopted, then NGO or donor
22 groups would need to play an active role, at least in the short term. The difficulties anticipated
23 with achieving the involvement of idlers, as discussed in section 1.3, mean that additional efforts
24 may be required to get their input and feedback. Safe technology and sound economics are
25 insufficient to ensure the success of a rural bioenergy project; involvement of the stakeholders in
26 planning, implementation and monitoring is vital. The Anaka model, type (U-4), is an example of
27 how the government and/or donors could be involved in setting up a model which potentially
28 contributes towards realising energy policy goals and development objectives as well as
29 providing opportunities for the landless poor.

1 **4.3 *Scale remains important***

2 Despite the fact that scale was not found to be distinctive in producing the typology of production
3 models, the issue remains significant in all of the different types. This holds true whether in
4 reference to the size of the plantation area or the destination of the end product. Generally the
5 small scale woodlots on privately owned land for internal use are unlikely to inflict negative
6 social impacts on the community because they will be managed in a relatively closed system
7 where effects (for instance on food supply through changed land use) would be immediately felt.
8 Whilst potentially providing indirect socio-economic benefits to rural areas, they are unlikely to
9 provide opportunities for idlers as no employment or other direct cash benefits would be
10 provided as a result. If the goals of the energy policies (in terms of poverty alleviation through
11 electrification) are to be met then those initiatives which serve to provide opportunities for
12 individuals at multiple levels of rural society, particularly the lowest, should also be pursued. If
13 there are financial constraints to the successful outcome of such projects then donor or
14 entrepreneur schemes could be employed to assist in their early piloting and development of
15 local capacity. The cases of the trading centres, such as Anaka and Kasonga, as well as the
16 Gumtindo example, are thought to be of strategic importance in this regard due to the possible
17 entrepreneurship opportunities for the landless poor. There are also likely contributions towards
18 agenda including energy security, livelihood diversity, renewable energy and rural development.
19 Further consideration of this type of model, and in fact any other small scale options that could
20 potentially be implemented in multiple locations, would need to be completed for a true
21 assessment of cumulative social and environmental consequences.

22 The larger scale projects on the whole provide economic opportunities to locals and therefore
23 socio-economic benefits, but may have other negative social and biophysical consequences which
24 should be considered (see Table 4). These could include impacts on the resource base of the area,
25 which would be felt more unevenly by the local population, and perhaps not immediately but
26 over the longer term. Initiatives which provide livelihood opportunities for the rural poor, for
27 example by allowing them to participate in feedstock production and value-adding activities
28 through having a stake in the process, are the most likely to provide the desired rural
29 development outcomes. In order to minimise the negative impacts of larger scale projects, careful

1 planning which takes into account potential social and environmental impacts should be
2 employed and, where possible, interventions designed to be socially beneficial and improve
3 livelihood options for local stakeholders through an iterative sustainability planning process.
4 There is a need to learn from international examples such as that of sugarcane production in
5 Brazil, where recent attempts to improve the sustainability of their product have included land
6 use zoning to reduce environmental impact and giving workers a personal piece of land for food
7 cultivation with time set aside to work on it [64]. Once projects are in place there is a need for
8 ongoing regulation, including monitoring of biophysical and socio-economic impacts by an
9 independent party to ensure that the identified goals of the intervention are being met. The
10 participation of stakeholders should continue through to the monitoring stage to ensure that
11 their criteria are used in the evaluation of projects.

12 **5. Conclusions and further work**

13 It has been found that the structured approach to understanding stakeholder dynamics in
14 bioenergy projects provides sufficient level of detail in such a way as the analysis is clear and
15 comparable, and would support the MSC process. As outlined in section 1.2, drivers behind
16 increasing bioenergy feedstock production in Uganda are predominantly socio-economic, so this
17 approach is very useful to aid decision and policy makers in identifying the most suitable types to
18 meet their goals. In order to more accurately define the criteria against which proposed projects
19 or plans might be assessed, this approach needs to be incorporated within a sustainability
20 planning framework - and ideally follow on from a full SIA. It is likely that additional criteria
21 would include national energy security, foreign exchange and investment and this will have a
22 bearing on the range of preferred types. If the benefits of small scale gasification do match up to
23 the expectations of their proponents (including [22] for example) then it is proposed that
24 education and activities to change the perceptions of individuals who are against the “simplicity”
25 of the technology are more important than just promoting larger scale, more technologically
26 advanced models. The method has been effective in terms of providing a thorough understanding
27 of both the existing production models in the Indian State of Chhattisgarh and the proposed
28 models in Uganda, with some flexibility. This demonstrates that it is adaptable enough be applied
29 in different contexts and on various types of bioenergy production models, but nonetheless

1 provides the sort of robust, comparable analysis which can and should be used in policy and
2 decision making. In addition, it presents a clear idea of the relevant scales for planning and
3 monitoring. A clear priority in both cases is for stakeholders from all representative groups to be
4 involved in the process. These should include donors and the landless poor, and consideration
5 needs to be given to their roles, risks and requirements (dynamics) from the proposed
6 intervention. Local, context-specific planning and assessment are essential and the participation
7 of stakeholders should last throughout the project lifecycle. There needs to be a focus on
8 collaboration rather than simply data or information sharing. Further testing of the method with
9 policy makers and project developers would be beneficial to streamline and optimise results.

10 Of the models discussed in this paper, the Gumtindo type (U-5) example appears to have the
11 potential to contribute most strongly towards meeting the country's energy policy and
12 development objectives. Providing energy security to individual areas using technology capable
13 of competing with current alternatives such as fossil fuel generators, whilst simultaneously
14 providing opportunities for the landless poor to generate livelihoods for themselves, presents a
15 potentially favourable socio-economic situation. There are, of course, additional reasons (socio-
16 economic and otherwise) why other models are likely to be pursued. For example, larger scale,
17 privately owned ventures would be expected to contribute towards foreign exchange, whilst
18 smaller scale value-adding models could provide localised benefits and support other industries
19 such as commercial timber production. In each individual case the positive outcomes expected
20 from implementing a project or policy should be assessed in context, weighed up against
21 potential negative impacts and a suitable monitoring strategy be put in place if and when they do
22 actually become operational. There are a number of useful outcomes from this exercise to
23 consider in relation to future planning in Uganda. The availability of secure and renewable wood
24 supplies for bioenergy production, as well as issues of existing land use and potential land use
25 competition, are not discussed at any length in this paper, however these aspects must be
26 considered for any form of land use planning in the country where current wood consumption is
27 dramatically outstripping re-growth.

28 It can be concluded that, where planned and implemented in a participatory and environmentally
29 aware manner, considerable scope exists for bioenergy projects to result in socio-economic

benefits; particularly for remote, rural areas. There need to be opportunities for the landless poor, or 'idlers', in order for real socio-economic development to take place, particularly in remote rural locations. The focus should not just be on the export of raw materials, although this can undoubtedly bring tangible national benefits, but also on projects where locals have ownership and there is a high probability of community value addition. The importance of donor agendas and NGO focus in Uganda has been touched upon, but is an important area for further research.

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6. References

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- [1] United Nations Development Programme (UNDP). Human Development Report. New York: Oxford University Press; 1990 May. 189 p. ISBN: 0-19-506481-X.
- [2] Goldemberg J, Lucon O. Energy, Environment and Development. 2nd ed. London: Earthscan, ISBN: HB 978-1-84407-749-6; 2010.
- [3] Goldemberg J, Johanssen TB (editors). World Energy Assessment Overview 2004 update. New York: UNDP; 2004 December. 85 p. ISBN: 92-1-126167-8.
- [4] Modi V, McDade S, Lallement D, Saghir J. Energy Services for the Millennium Development Goals. New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project, and World Bank; 2006. 98 p.
- [5] Buchholz T, Volk TA. Designing short-rotation coppice based BIOenergy Systems for Rural Communities in east Africa BIOSYRCA project: final report. New York: USAID/EGAT/I&E/E and AEAI/World Learning, Energy Sector Grants Program; 2007 September. 33 p. Report number D4.2.

-
- [6] Domac J, Segon V, Richards K, Madlener R, White B, Healion K et al. People and Bioenergy. Croatia: Energy Institute; 2005. 10 p. Final Report from IEA Bioenergy Task 29: 'Socio-economic Drivers in Implementing Bioenergy Projects'.
- [7] Faaij APC, Domac J. Emerging international bio-energy markets and opportunities for socio-economic development. *Energ Sustain Dev* 2006; 10(1): 7–19.
- [8] The Food and Agriculture Organisation of the United Nations (FAO). The State of Food and Agriculture, Biofuels: prospects, risks and opportunities. Rome: FAO; 2008. 128 p. ISSN 0081-4539.
- [9] Grunwald M. The Clean Energy Scam. *Time Magazine* 07.04.2008:28-33.
- [10] Gallagher E. The Gallagher review of the indirect effects of biofuels production. Sussex: Renewable Fuels Agency; 2008 July. 90 p.
- [11] Esteves AM, Vanclay F. Social Development Needs Analysis as a tool for SIA to guide corporate-community investment: Applications in the minerals industry. *Environ Impact Asses* 2009; 29(2):137–45.
- [12] Dalal-Clayton B, Dent D, Dubois O. Rural Planning in Developing Countries: supporting natural resource management and sustainable livelihoods. London: Earthscan, ISBN 1-85383-938-8; 2003.
- [13] Elghali L, Clift R, Sinclair P, Panoutsou C, Bauen A. Developing a sustainability framework for the assessment of bioenergy systems. *Energ Policy* 2007; 35(12): 6075–6083.
- [14] Harrison JA, Tiwari S, Amezaga JM. Stakeholder dynamics in bioenergy feedstock production; the case of *Jatropha curcas* for biodiesel in Chhattisgarh State, India. *This Issue*.
- [15] Haywood L, de Wet B, von Maltitz GP. Planning for Sustainability for Bioenergy Programmes, Plans and Projects. In: Amezaga JM, von Maltitz G, Boyes SL, editors. *Assessing the Sustainability of Bioenergy Projects in Developing Countries: A Framework for Policy Evaluation*. Newcastle upon Tyne: Newcastle University ISBN 978-9937-8219-1-9; 2010.
- [16] Cherubini F, Bird DN, Cowie A, Jungmeier G, Schlamadinger B, Woess-Gallasch S. Energy- and greenhouse gas-based LCA of biofuel and bioenergy systems: Key issues, ranges and recommendations. *Resour Conserv Recy* 2009; 53(8): 434–47.
- [17] Barrow CJ. Social Impact Assessment: An Introduction. London: Arnold; 2000.
- [18] Becker HA. Social impact assessment. *Eur J Oper Res* 2001; 128(2):311-21.
- [19] Keating MF. Global best practice(s) and electricity sector reform in Uganda. Coventry UK: University of Warwick; 2006 Jan. 27 p. CSGR Working Paper No. 192/06.
- [20] Clark A, Davis M, Eberhard A, Gratwick K, Wamukonya N. Power sector reform in Africa: Assessing the impact on poor people. Washington D. C. USA; 2005 Aug. 175 p. ESMAP/World Bank report No 306/05.
- [21] Kiza M. The role and potentials of bioenergy in Uganda's energy sector. In: Fritsche O, editor. *The World Bioenergy Conference and Exhibition on Biomass for Energy*; 30.05 – 01.06.06; Jönköping, Sweden. Jönköping: Liepziger Messe International; 2006. 6 p.
- [22] Buchholz T, da Silva IP. Potential of distributed wood-based biopower systems serving basic electricity needs in rural Uganda. *Energ for Sust Dev* 2010; 14(1):56–61.
- [23] Buchholz T, Volk TD. Considerations of project scale and sustainability of modern bioenergy systems in Uganda. *J Sustain Forestry* 2012; 31(1-2):154-73.
- [24] National Rural Electric Cooperative Association (NRECA). NRECA International [Internet]. Uganda: NRECA; 2010. Uganda [cited 2011 March 18]; [about 1 screen]. Available from <http://www.nrecainternational.coop/Projects/Uganda/Pages/default.aspx>
- [25] Bingh LP. Opportunities for utilizing waste biomass for energy in Uganda. Norway: Norwegian University of Science and Technology (Masters' Thesis); 2004. 97 p. Submission ETP-H-2004-06.

-
- [26] Ministry of Energy and Minerals Development (MEMD). Uganda National Energy Balance 2002. Kampala: Republic of Uganda; 2003. 15 p.
- [27] Bailis R, Ezzati M, Kammen DM. Mortality and greenhouse gas impacts of biomass and petroleum energy futures in Africa. *Science* 2005; 308(5718):98-103.
- [28] Kanagawa M, Nakata T. Analysis of the energy access improvement and its socio-economic impacts in rural areas of developing countries. *Ecol Econ* 2007; 62(2):319-29.
- [29] Syngellakis K, Arudo E. Uganda: Energy Sector Policy Overview Paper. Kampala: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ); 2006 May. 9 p. ENABLE project report, Intelligent Energy, Europe.
- [30] Rugadya M. Northern Uganda Land Study Analysis of Post Conflict Land Policy and Land Administration: a survey of IDP return and resettlement issues and lesson: Acholi and Lango Regions. Kampala: World Bank; 2008 February. 80 p.
- [31] Woods J, Tipper R, Brown G, Diaz-Chavez R, Lovell J, de Groot P. Evaluating the sustainability of co-firing in the UK. London: Department of Trade and Industry (DTI); 2006 September. 63 p. Report number URN 06/1960.
- [32] Uganda Ministry of Energy and Minerals Development (MEMD). The Renewable Energy Policy for Uganda. Kampala: Republic of Uganda. 2007.
- [33] German Technical Cooperation (GTZ) Kampala. Promotion of Renewable Energy and Energy Efficiency Programme [Internet]. Kampala: GTZ. Environmental and health benefits of German-Ugandan stove project [cited 2010 June 1]; [about 2 screens]. Available from http://www.southafrica.diplo.de/Vertretung/suedafrika/en/_pr/1_GIC/2010/11_Uganda_stoves.html
- [34] Russo R. UNHCR The UN Refugee Agency [Internet]. Kampala: NRECA. Uganda's IDP camps start to close as peace takes hold [cited 2010 July 22]; [about 2 screens]. Available from <http://www.unhcr.org/46e6a68013.html> [accessed 22.07.2010]
- [35] Alvord SH, Brown LD, Letts CW. Social Entrepreneurship and Societal Transformation: an Exploratory Study. *J Appl Behav Sci* 2004; 40(3):260-82.
- [36] Jacovelli P. Uganda's Sawlog Production Grant Scheme: a success story from Africa. *Int For Rev* 2009; 11(1):119-25.
- [37] Namaalwa J, Hofstad O, Sankhayan PL. Achieving Sustainable Charcoal Supply from Woodlands to Urban Consumers in Kampala, Uganda. *Int For Rev* 2009; 11(1):64-78.
- [38] Rugumayo A. Coordination Manager, Energy for Rural Transformation, Ministry of Energy and Mineral Development, Government of Uganda. Pers comms on 04.11.2009.
- [39] Wambembe N. School teacher, head of Gumtindo cooperative group and resident of Konokoyi village, Mt Elgon. Pers comms on 07.11.2009.
- [40] Harrington J. Welsh Assembly, Twin NGO and Gumtindo Cooperative. Pers comms on 08.11.2009.
- [41] Raabe K. Reforming the Agricultural Extension System in India: What Do We Know About What Works Where and Why? Washington DC: International Food Policy Research Institute (IFPRI); 2008 July. 43 p. IFPRI Discussion Paper 00775.
- [42] Tumwesigye MN, Kasirye R. Gender and the Major Consequences of Alcohol Consumption in Uganda. In: Obot IS, Room R. Alcohol, editors. *Gender and Drinking Problems: Perspectives from Low and Middle Income Countries*. Geneva: World Health Organisation. ISBN 92 4 156302 8; 2005.
- [43] da Silva I. Director, Centre for Research in Energy and Energy Conservation (CREEC), Makerere University, Uganda. Pers comms on 18.03.2011.
- [44] Burdige RJ. A Community Guide to Social Impact Assessment. Wisconsin: Social Ecology Press; 1995.

-
- [45] Centre for Good Governance (CGG). A comprehensive guide for social impact assessment. New Delhi: Centre for Good Governance; 2006. 28 p.
- [46] Gibson RB. Beyond the pillars: sustainability assessment as a framework for effective integration of social, economic and ecological considerations in significant decision-making. *J Environ Asses Policy Manage* 2006; 8(3):259-80.
- [47] Hacking T, Guthrie P. A framework for clarifying the meaning of Triple Bottom-Line, Integrated and Sustainability Assessment. *Environ Imp Asses Rev* 2008; 28(2-3):73-89.
- [48] Rogers PP, Jalal KF, Boyd JA. An Introduction to Sustainable Development. London: Earthscan; 2008.
- [49] Yin Y, Xu W, Zhou S. Linking carbon sequestration science with local sustainability: An integrated assessment approach. *J Environ Manage* 2007; 85(3): 711-21.
- [50] Reed MS. Stakeholder Participation for Environmental Management: A Literature Review. *Biol Conserv* 2008; 141(10):2417-31.
- [51] Reed MS, Graves A, Dandy N, Posthumus H, Hubacek K, Morris J et al. Who's in and why? A typology of stakeholder analysis methods for natural resource management. *J Environ Manage* 2009; 90(5):1933-49.
- [52] Bell S, Morse S. Sustainability Indicators: Measuring the Unmeasurable? 4th ed. London: Earthscan; 2008.
- [53] Case DAD. The community's toolbox: The idea, methods and tools for participatory assessment, monitoring and evaluation in community forestry. Bangkok: Food and Agriculture Organisation of the United Nations (FAO); 1990. Community Forestry Field Manual 2.
- [54] Tiwari S, Harrison JA, von Maltitz G. Assessing Social Impacts of Bioenergy Projects. In: Amezaga JM, von Maltitz G, Boyes SL, editors. *Assessing the Sustainability of Bioenergy Projects in Developing Countries: A Framework for Policy Evaluation*. Newcastle upon Tyne: Newcastle University ISBN 978-9937-8219-1-9; 2010.
- [55] Perry-Castañeda Library. Open Source Map Collection [Internet]. Texas: University of Texas at Austin; 2021. Uganda Political Map [adapted 2012 August 8]. Available from http://www.lib.utexas.edu/maps/africa/uganda_pol_2005.jpg
- [56] Harrison JA, Windhorst K. Markets for Thinnings and Prunings: could modern bioenergy be the key? *Sawlog Production Grant Scheme Newsletter* 2010; 28:20-21.
- [57] Hemsted S. Technical Services Executive, James Finlay (Uganda) Ltd. Pers comms on 24.07.2010.
- [58] Centre for Land Use and Water Resources Research (CLUWRR). Re-Impact [Internet]. Newcastle upon Tyne: Newcastle University. Strategic Assessment of Bioenergy from Forestry Projects in Northern Uganda: Minutes from a workshop held in Kampala on 19.05.2010 [cited 2012 July 27]; 4 p. Available from <http://research.ncl.ac.uk/reimpact/Related%20Documents/Reports/KampalaWorkshopMay10.pdf>
- [59] Himmelfarb D. Moving People, Moving Boundaries: The socio-economic effects of protectionist conservation, involuntary resettlement and tenure insecurity on the edge of Mt. Elgon National Park, Uganda. Athens USA: World Agroforestry Centre; 2006. 13 p. Agroforestry in Landscape Mosaics Working Paper Series Number 24.
- [60] Hunt D. Unintended Consequences of Land Rights Reform: The Case of the 1998 Uganda Land Act. *Dev Policy Rev* 2004; 22(2):173-91.
- [61] Government of Uganda. FAO Legal Office [Internet]. Kampala: Government of Uganda. The Land Act, 1998 [cited 2011 March 4]; 83 p. Available from <http://faolex.fao.org/docs/pdf/uga19682.pdf>
- [62] Altenburg T, Dietz H, Hahl M, Nikoladakis N, Rosendahl C, Seelige K. Biodiesel policies for rural development in India. Bonn: German Development Institute (DIE); 2008 May. 95 p.

[63] Schoneveld G. Associate Professional Officer, Forests and Governance Programme, Centre for International Forestry Research (CIFOR). Pers comm on 18.03.2011.

[64] Schaffel SB, La Rovere EL. The quest for eco-social efficiency in biofuels production in Brazil. *J Clean Prod* 2010; 18(16-17):1663–70.

Boxes: Forest based biomass for energy in Uganda; stakeholder dynamics in feedstock production

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- 1) Context analysis: identification of stakeholders, their role in biofuel production, their expectations from it, and any assumptions therein;
 - 2) Identification of different models of production in the country;
 - 3) Mapping of production models according to land size and ownership, and market end use and scale;
 - 4) Classification of production models to identify significant distinctions between them;
 - 5) Social mapping: identify stakeholders' varying power and risk between production models.

Box 1: the structured approach to understanding stakeholder dynamics in bioenergy projects [14]

Who owns the land?	Who has rights to purchase the produce?
What was the previous land use?	Who gets access to by-products?
Who funds establishment?	Who sets the purchase price?
Who makes plantation management decisions?	What livelihood benefits are available to poor/landless?
Who manages the trees/crops?	Who carries the risk if projected yields/prices are not realised?
Who funds management activities?	Is there possibility for vertical integration?
Who has feedstock harvesting rights?	What ecosystem services are gained or lost?

Box 2: the questions forming the basis for the semi-structured and informal interviews, based on [14]

Tables: Forest based biomass for energy in Uganda; stakeholder dynamics in feedstock production

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Stakeholder	Type of communication
National Level	
Students from Makerere University and international technical experts (teaching the course)	Daily interactive sessions over a two week module
Energy for Rural Transformation Department Coordination Manager, Ministry of Energy and Minerals Development (MEMD), Renewable Energy Policy coauthor	Semi-structured interviews on two occasions
Environmental Impact Assessment (EIA) Officer for the National Environmental Management Agency (NEMA)	Informally interviewed
The professor heading the Centre for Renewable Energy and Energy Conservation (CREEC), Makerere University	Met on three occasions, involved in a workshop along with other technical experts in the team
Academics from the Water Resources Department and the Institute for Adult and Continuing Education at Makerere University	Interviewed
Representatives from the EU Delegation to Uganda	Discussions were held on three occasions; they were also involved in the workshop
Researchers who have many years of experience living and working in Uganda in fields including forestry, rural development and climate change	Multiple discussions were held both during the field visits, and remotely via email/skype
Field officers for the UN High Commission for Refugees (UNHCR)	Written communications via email
Private Sector	
The Managing Director of the firm Human Energy, based in Kampala	Interviewed
The chairman of the Uganda Carbon Bureau	Interviewed
Multiple forestry consultants and an energy consultant	Multiple interactions ranging from semi-structured to informal interviews/remote group and individual discussions via email/skype
Head of the Uganda Timber Growers Association (UTGA)	Informally interviewed
Commercial timber plantation manager	Provided a plantation tour, answered questions
The Chief Technical Advisor to the Sawlog Production Grant Scheme (SPGS) project	Interviewed and involved in the workshop
A number of SPGS clients	Informal interviews, discussions at conference
Local level	
farmers, villagers, a land manager and cooperative workers	Informally interviewed
Representatives from the NGO Twin, the Welsh Assembly and Gumbindo Coffee Cooperative Enterprises (GCCE)	Two day site investigation in the Mount Elgon region
A field supervisor, an environmental officer, a certification officer (also a local Youth Group leader), a coffee quality promoter, the secretary and the chairperson of GCCE	Interviewed in an interactive group session
Head teacher (and founder), volunteers and pupils of the Bududa Vocational Institute, Konokoyi Village, Mt Elgon	Informally interviewed

Table 1: Summary of the stakeholders and interaction methods.

Stakeholder	(Potential) Role in bioenergy production	Motives for participation in bioenergy projects	Assumptions on which expected outcomes are based
National Level – Ministries and Commissions			
MEMD – Ministry of Energy and Minerals Development	National renewable energy / bioenergy policy development	Promoting renewable energy sources, sustainable (esp. rural) development, low-carbon energy, energy security, targets	Bioenergy is a viable renewable energy option
European Union Delegation to Uganda	Donor funding, research and development, market	Strengthen EU/Uganda ties, sustainable (esp. social, poverty eradication, & economic) development, applied research	Bioenergy will contribute towards social and economic development
GTZ / DfID / Developed country donors	Donor funding, research and development, market	Strengthen national ties, poverty alleviation, sustainable development, energy supply	Bioenergy will lead to sustainable development
Uganda Timber Growers Assoc. (UTGA)	Coordination of land holders & the private timber forestry sector, dissemination of ideas	Economic gains from a new and more profitable market for by-products	Markets for biomass waste are available
Uganda Carbon Bureau	Providing assistance for CDM projects	Low-carbon energy, suitable projects for CDM	Bioenergy cultivation qualifies for CDM
National Environmental Management Authority (NEMA)	Approval of bioenergy projects, ensuring environmental/social sustainability of projects	Sustainable (esp. environmental) development	Bioenergy will contribute towards environmental development
District Level			
Civil society organisations / NGOs	Social watchdogs – protect local communities' & marginalised rights, establish innovative methods of involving local communities in developing bioenergy plantations, R&D, outreach	Sustainable (esp. social [poverty eradication], and environmental) development, energy supply, potential negatives – biodiversity loss, water resource depletion	Bioenergy is a viable renewable energy option, monocultures would affect local biodiversity and use water extensively, bioenergy will contribute towards social and environmental development
Cooperative leaders and coordinators	Coordination of producers, market for feedstock	Profit, energy security, sustainable (esp. social) development	Bioenergy is a viable energy option and will contribute towards social development
Sawmill operators	Market for feedstock	Profit, energy security, feedstock supply	Bioenergy is a viable energy option
Private corporations	Production of or market for bioenergy feedstock, refining and sale to Oil Marketing Companies or for export	Feedstock supply, profits, rural development (if CSR activities)	Bioenergy plantation is a viable business proposition, predicted yields would be realised under field conditions, farmers / locals willing to enter into formal / informal joint ventures
Community Level			
Individual farmers	Cultivation of feedstock	Profit, livelihood diversity, assured markets	Food crops not displaced, minimal financial risks, access to relevant information & technical inputs
Poor / landless / "idlers"	Participate in plantation establishment & management	Employment	Bioenergy intervention strategy specifically involves landless
Local education and research institutions	Training farmers / landless in improved agronomy, perhaps have model production	Skills/livelihood opportunities to pass on to pupils, sustainable development	Bioenergy is a viable energy option and provides employment / livelihood opportunities
Land managers and owners	Cultivation of feedstock	Profit, livelihood diversity, assured market	Bioenergy is a viable energy option, food crops not displaced

Table 2: Bioenergy stakeholder identification in Uganda

Model	Status	Type of proponent	Business model
(a) Aldwych	Proposed	Private company	50MW biomass plant
(b) Sawmills	Proposed	Private company	Purchase waste biomass for gasification
(c) Gumtindo	Proposed	Private company (Cooperative)	Private woodlot for gasification
(d) Farm scale woodlots	Proposed	Farmer/NGO	Individual farm scale bioenergy woodlots
(e) Bududa, Konokoyi	Proposed	NGO (vocational institute)	Individual farm scale bioenergy woodlot
(f) Human Energy biofuels	Existing	Private company	Exporting Jatropha feedstock for biodiesel
(g) Muzizi Tea Estate	Existing, on hold	Private company	Private woodlot for gasification
(h) Anaka trading centre	Proposed	Locals/NGO	Multiple farm scale woodlots for gasification

Table 3: Eight potential models of biomass to bioenergy production in Uganda

Typology	Production models	Potential socio-economic benefits	Key issues identified
(U-1) Corporately led, feedstock is produced for their own use	Muzizi	Saving expenditure on electricity if feedstock can be produced easily alongside commercial activities; More control over energy expenditure and reliability.	Little inclusion of farmers or landless poor; Power generation for internal requirements is unlikely to have any benefit in terms of energy access for the rural poor; Questionable external regulation of company activities could lead to resource depletion and negative environmental impacts with knock on implications for locals.
(U-2) Corporately led, land is owned by the company processing feedstock and selling the final product	Aldwych; Human Energy	Employment opportunities on the plantations and in associated commercial activities; Foreign exchange generation, tax revenues for government; Possibility of CSR activities, e.g., improved energy infrastructure.	Large scale power production or export of energy feedstock is unlikely to result in improved energy access for the rural poor; Questionable external regulation of company activities could lead to resource depletion and negative environmental impacts; Possibility of plantation establishment on land without clear tenure arrangement, potentially impacting informal residents/users.
(U-3) Corporately led, farmers produce the feedstock but are contracted to sell to particular company	Human Energy; Sawmills	Value-addition for farmers diversifying their incomes; Assured markets for agricultural produce.	The breaking down of free market principles allowing company price fixing to be a possibility; Potential penalties if yields are low depending on contract arrangements; The locking in of current land use (although it has been verbally suggested this is unlikely to be a real problem in Uganda where contracts are not always honoured).
(U-4) Government/ donor led, feedstock produced on private land for own use	Anaka	Affordable local electricity; Local ownership of the process; Employment and entrepreneurship opportunities for landless poor; Income diversity for local farmers producing feedstock.	Technology may not be perceived as modern or advanced enough; Mechanisms to specifically address the needs of landless poor are still required; Availability of land for small scale farmers.
(U-5) Farmers/NGO led, feedstock produced for own use on private or communal land	Farm woodlots Bududa Gumtindo	Affordable local electricity; Local ownership of the process; Possibly employment and entrepreneurship opportunities for landless poor.	Technology may not be perceived as modern or advanced enough; Involvement of landless poor may be sporadic at best, mechanisms to specifically address their needs are required; Availability of land for small scale farmers.
(U-6) Farmers/ NGO/ Government/ Donor led, feedstock production, on private/ communal land,	Alternatives	Foreign exchange generation, tax revenues for government; Employment opportunities on the plantations and in associated commercial activities; Local ownership of the process.	Involvement of landless poor may be sporadic at best, mechanisms to specifically address their needs are required; Availability of land, concerns over equitable sharing of assets where communal land is used.

and processing for sale

Table 4: Typology of Ugandan bioenergy feedstock production models, potential benefits and key issues.

List of Figures: Forest based biomass for energy in Uganda; stakeholder dynamics in feedstock production

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Figure 1: Location of six of the eight production models in Uganda (a) Aldwych, (c) Gumtindo, (e) Bududa, Konokoyi, (f) Human Energy biofuels, (g) Muzizi Tea Estate, (h) Anaka trading centre; based on map sourced from Perry-Casteñeda Library Open Source Map Collection [55].

Figure 2: Ugandan feedstock production models mapped by (i) Land size (vertical axis) and land ownership (horizontal axis); (ii) Feedstock type (vertical axis) and market scale (horizontal axis).

Dashed lines distinguish individual routes of models (c), (g) and (h)

Figure 3: Models for biomass for energy production in Uganda classified by land owner, value chain and production arrangement.

Figure 4: Social Mapping matrices by (i) power and (ii) risks [14].

(a) (i)

(a) (ii)

(b) (i)

(b) (ii)

(c) (i)

(c) (ii)

Stakeholder Key

1. Production companies; Aldwych International	10. Local education and research institutions
2. National Government; "MEMD"	11. Uganda Timber Growers Association (UTGA)
3. Cooperative leaders	12. National Environmental Management Authority (NEMA)
4. NGO's	13. Land managers; Bruno Nyeko
5. Cooperative members	14. Land owners
6. Marginal farmers	15. Sawmill operators
7. Uganda Carbon Bureau	
8. Landless poor; "idlers"	
9. Aid funding bodies; EU, GTZ	

Figure 5: Examples of the completed stakeholder mapping matrices for a) Aldwych; b) the Sawmills and c) Gumtindo production models by i) power and ii) risks.