Final Report

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Creating Green Local Economy through Commercial Production of Biomass Briquettes from Agro-Industrial Residues in Kenya – Green Economy Partnership (GEP), Kenya

Grantee: Royal Norwegian Society for Development (Norges Vel)

Local Partner(s): Kenya Forestry Research Institute (KEFRI) and Gum Arabic and Resins Association (GARA)

Project start date: 01/05/2015
Project end date: 30/11/2017


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1 This is the version 2 of the Nordic Climate Facility’s Final (summary) report template. The template is subject to continuous revisions, and NCF/NEFCO welcomes any comments for the template. NCF reporting shall substantially be based on this template. Please delete all explanations, instructions, template words (in italics) etc. from the actual report.
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1. EXECUTIVE SUMMARY

This is the final report of the Project “Creating Green Local Economy through Commercial Production of Biomass Briquettes from Agro-Industrial Residues – Green Economy Partnership (GEP)”, a 30-month joint initiative implemented by Royal Norwegian Society for Development (Norges Vel) in partnership with Kenya Forestry Research Institute (KEFRI) and Gum Arabic and Resins Association (GARA) as local partners in Kenya. The project was financed by the Nordic Climate Facility (NCF) of Nordic Development Fund (NDF) administered by Nordic Environment Finance Corporation (NEFCO). The overall objective of the project was to develop the capacity of local enterprises in production and supply of carbonized briquettes from sugarcane bagasse in Kenya. The project was designed to establish five bio-enterprises in the briquettes value chain in Ndhiwa Sub-County, Homa-Bay County, in the sugarbelt, an area faced with a number of challenges including poverty, unemployment and deforestation. The production of high quality briquettes aimed at replacing wood fuel, reducing methane emissions from unutilized bagasse, creating job opportunities and contributing to poverty reduction. In addition, the project aimed to test and promote biochar as soil improver in smallholder farms.

The project was implemented to achieve results under three milestones: sustainable briquette production; market analysis and development; and business development, job creation, lobbying and development of associations. The achievements over the period have been the establishment of 3 briquette production units in 3 locations, establishment of 5 bio-enterprise cooperative societies and capacity building of the cooperatives in technical skills, business aspects and technology and knowledge transfer. One site has established a tree nursery and 2 more are planned. In regard to climate change mitigation, a total of 7.7 tCO₂ in a period of 17 months have been reduced as a real result of the production of Bio briquettes with potential reduction of 109 tCO₂ over 20 years. In addition comes a total of 3 360 tCO₂ from 28 000 trees planted over a period of 24 months with a potential of 33 600 tCO₂ over 20 years. The overall reduction over 20 years is then calculated to be 33 709 tCO₂. Although the project target of establishing 5 production units has not been fully realized due to unforeseen challenges, the concept has demonstrated opportunities for addressing multiple challenges facing that target communities. The potential for sustainability in the pilot production units is subject to a number of recommendations including legal confirmation of sufficient supply of and access to sugarcane bagasse or alternative biomass feedstock, stability of power supply in the region and optimisation of production processes to achieve commercial operations.

2. ASSESSMENT OF IMPLEMENTATION OF THE PROJECT

2.1 Implementation of Activities

The project consisted of three interlinked main activities: 1) Sustainable briquette production; 2) Market analysis and development; and 3) Business development and policy making and associations.

Activity 1: Sustainable briquette production

Confirmation of production locations and establishing cooperation with private sugar milling companies: This activity involved a baseline socio-economic survey, consultation and dialogue meetings with key stakeholders and businesses and environmental assessments. Key results were baseline socio-economic data and knowledge on green economy concept and climate change among
other parameters, confirmation of project locations and the establishment of 5 bio-enterprise cooperatives.

**Securing the supply of a good quality bagasse raw material**: This activity involved pilot-test of sugarcane bagasse for optimum qualities of carbonised briquettes, feedstock survey and dialogue meetings with Sukari Sugar Mills. As a result, a total of 78,199 kg of bagasse has been made available by Sukari Industries for pilot briquette production units during the project period. In addition, a feedstock supply plan was developed including bagasse from local jaggeries as an alternative and sustainable sources.

**Mapping and assessing available carbonization kilns**: This study involved a review of the existing carbonization and briquetting machines in Kenya by: i) documenting existing carbonizing kilns and briquetting machines and their efficiencies; and ii) comparing and contrasting various designs. As a result, suitable models were selected and designed for fabrication and installation.

**Improving production technology**: A series of community sensitization meetings and joint design of production sites were conducted. As a result, on-site designs and layouts for all 5 sites were made and validated for fabrication. A complete production line included stores for bagasse and binder, waste management systems, cook stove production, briquette production area, offices and stores.

**Testing optimal briquette designs**: To ensure the bagasse material being used is suitable as fuel material, samples of the material were tested based on international thermal standards to determine optimal thermal parameters. As a result, an improved briquetting machine design was made and production parameters were developed for use by briquette production units.

**Evaluation of production facilities alternatives and purchase/building of facilities**: This activity involved fabrication of equipment and establishment of production and operational of units. Key results were a model design of briquette line and establishment of 3 production units in 3 locations.

**Implementation of environmental health and safety (EHS) procedures**: Detailed reviewing and analysis of environmental regulations and other relevant policies for safety provisions was undertaken to determine their significance to the bio-enterprises. As a result, procedures and a policy in line with the Kenya’s Occupational Safety and Health Act (OSHA) were developed for clean and safe working conditions of the production units in regard to general health provision and machinery safety.

**Activity 2: Market analysis and development**

**Study on adaptable consumer practices**: Study was conducted to analyse and understand briquette market situation in the project area, perception of consumers on biomass briquettes and to capture consumer willingness to shift to biomass briquettes as source of energy. As a result, there has been an increased awareness of carbonized briquettes, and opportunities of turning the large amount of bagasse from sugar mills and jaggeries into economic value.

**Briquette product testing**: This activity involved using Kenya Ceramic Jiko (KCJ) cookstove to tests thermal characteristics of carbonized briquettes against charcoal from acacia wood. The results, which exhibit similarities, were complemented with laboratory tests done at KEFRI laboratories.

**Promote use of briquettes**: This activity involved participation in 4 marketplace events and trade exhibitions in Ligodho Market, Kendu-Bay, Eldoret and Kisumu. Apart from increased awareness, the
events provided opportunity for partnerships and linkages as well as a platform to showcase the products and services including policy issues on renewable energy sector.

**Pilot energy efficiency audits for households and institutions:** A detailed energy efficiency audit was undertaken at 100 households, 10 schools and 10 eateries to determine the amount of energy used per household/institution; its contribution to budget bills and outline potential strategies to reduce energy consumption. Results of the audit indicated that the traditional three stones stove (64%) and the Kenya Ceramic Jico stove (32%) were the most common types of stoves. 85% of the respondents indicated biomass energy as the main source of energy for cooking and heating. A simple guide was developed and piloted at 50 households for adoption. The guide also included options and suggestions on best practices for reducing biomass energy consumption by consumers.

**Evaluate use of briquettes in traditional and efficient cooking appliances:** Thermal and emission laboratory tests were conducted using efficient cook stoves (KCI) and briquettes. Test results showed that the calorific values of the briquettes had similarities with the quality of charcoal from acacia wood with 5.46Kcal/g, though the ash content level was still as high as 20% and should be a base for further studies and adjustments in the future.

**Pilot use of biochar from bagasse as soil improver:** Field studies on use of fertilizer and biochar from carbonized sugarcane bagasse for soil improvement were undertaken in three different sites with contrasting soil characteristics (sandy, clay and loamy soils). Results of the study indicated that use of biochar led to improved soil fertility with increased water retention; and increased crop production of maize by mean value 64% for the two fields. Tests at the sandy field failed due to drought.

**Activity 3: Business development, job creation, policy making and associations**

**Development and piloting of green growth business model:** Through rapid mapping, the model focused on processes within the carbonized briquettes value chain; potential market opportunities; actors; supply chains and demand. A green business model was developed through a consultative process and validated for adoption by bio-enterprises to develop their business plans.

**Engagement of local entrepreneurs of both genders in briquette production and distribution:** This activity involved establishment of local distributors. As a result of training and mentorship, 30 local distributors were identified and supported to set up distribution outlets and conduct sales.

**Development of green energy business plans:** Mentorship and coaching sessions were conducted for officials and managers of the bio-enterprises and focused on covering business plan preparation, how to prepare contractual agreements and techniques in customer services and negotiations. As a result, business plans for all the 5 briquette bio-enterprises were developed.

**Establishment of briquette enterprises and associations:** The process of forming cooperatives involved community sensitisation and consultations, and engagement with government authorities including Ministry of Cooperatives and NEMA, basic training in leadership, policies, business and financial management skills. As a result, 5 bio-enterprise cooperative societies have been established and are formally registered to sustainably manage the briquette production units and participate in market systems of the briquette value chain and improve livelihood of their members.

**Skills upgrading and capacity building for green growth in briquette production and marketing:** Training was provided for operators of the production units. A training guide was developed on the entire process including bagasse carbonization, briquette production and use, business management,
marketing and distribution and business advocacy. A total of 30 local enterprises were identified and trained in briquette distribution, while 9 operators from 3 production units trained in carbonisation and briquette production.

**Advocacy towards mainstreaming inclusive green growth in policy processes.** Key advocacy actions undertaken aimed at influencing inclusion of green growth strategies in policy and planning processes in Kenya. This involved dialogue meetings with Sukari Industries, consultative meetings with owners of jaggerys and key stakeholders, media engagement, policy advocacy and awareness creation events, as well as advocacy skills training on green economy and community meetings. As a result, awareness and visibility of the GEP project and partners has been enhanced. Enquiries on both the products and services have been made by consumers, public and civil society.

**Technology and knowledge transfer between briquettes enterprises in East Africa and internationally.** This activity involved knowledge and technology transfer through technical and skills training for adoption of biomass briquette technology to local community, media engagement and publications. Results and events of the project were highlighted in the mainstream media in Kenya, which disseminated the results achieved so far.

**Problems faced and how they were addressed**

A key problem noted from the establishment of pilot production units has been related to lack of sufficient infrastructure such as roads, water and electricity. It has taken longer time than planned to have electricity in place and the connection is still not in place in Sinoka and Kanyakira. This has led to delayed operations of production units. In addition, frequent power outages in the region have led to instability of production in Ligodho and the cooperative have not been able to meet their production targets.

During the implementation period technical challenges compounded by operational and logistical issues have been noted. The project has experienced a lack of commitment for legal confirmation of availability of feedstock supply by Sukari Industries, the nearby sugar mill. Although several meetings were held and follow-ups made, legal confirmation has not been made. Follow ups in collaboration with the Sugar Directorate are still being made to ensure that an agreement is reached. Further, an alternative source of feedstock from Sony Sugar Industries is being explored.

In regard to implementation, operational and administrative challenges, there was a delay in funds transmission to the cooperatives for completion of the planned work. To address this, early planning and procurement of local materials by cooperatives was adapted. In addition, cost variations from the original budget were noted particularly for the construction of the production facilities and electricity/power supply.

### 2.2 Deviations from the Planned Activities

#### 2.2.1 Activities that have not taken place

Out of 5 briquette production units planned, 3 units have been established. Although commitments were made by the Homa-Bay County Government to provide the necessary infrastructure (roads, electricity and water), the delays in having electricity and infrastructure in place made it impossible to establish 2 more units within the planned period. Discussions with the county government have confirmed that this was planned for the financial year 2017/2018 that started in July 2017. However, the political instability as a result of prolonged electioneering period in Kenya has further delayed this process and therefore establishment of the 2 units could not be achieved by November 2017. In
addition, standard-setting and patenting of the technology and products has not been fully accomplished but will be followed up by KEFRI and GARA beyond the project period. However, recommendations based on the experiences from the pilot project are set to inform standard-setting.

### 2.2.2 Unforeseen activities that have taken place

**Baseline survey:** As part of planning process a survey that aimed at collecting baseline socio-economic data and knowledge on green economy concept and climate change among other parameters, formed a benchmark for setting project targets and indicators of success. Although mentioned under section 4.4 in the application, it was not included in the matrix and budget. After project consultations, a baseline survey was conducted based on 200 households which formed the basis for monitoring and subsequent reporting and updating of the logical framework matrix.

**Improvement of production efficiency of briquetting machine:** Although the design of briquetting machine was based on report of technology assessment and prototype at KEFRI, modifications were undertaken for the first machine. This was identified as critical despite no budget provision was made for prototype development and modifications.

**Establishment of tree seedlings production:** Based on recommendations from the Homa-Bay County government, establishment of tree nurseries was integrated in the bio-enterprises to make certified tree seedlings locally available with the aim of enhancing tree planting drive in the targeted communities for environmental conservation.

**Organisation capacity assessment (OCA):** As part of the exit strategy, the need to conduct an OCA was identified during the review process. The main purpose of this activity was to provide opportunity for the 5 Bio-Enterprise Cooperative Societies to assess their organizational capacities, identify and prioritize key gaps, and develop action plans for addressing the identified capacity gaps. As part of the evaluation process, the assessment also aimed to provide the cooperatives with a critical opportunity to reflect and chart out their individual and collective sustainability plans.

**Capacity building for cooperatives:** The initial plan was to target business entrepreneurs and farmers established as self-help groups or community-based organisations. However, this model was identified during the assessment as not appropriate for briquette production and distribution. A better model was identified as the one of cooperatives which required more capacity building to be established and become operational.

### 2.3 Achievement of Outputs and Objectives

<table>
<thead>
<tr>
<th>Planned Objectives and Outputs</th>
<th>Indicator(s):</th>
<th>Achievement of the objectives and outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective 1:</strong> Reduced deforestation by substituting the use of charcoal produced from wood with biomass briquettes from agricultural waste; direct emission reduction of roughly 40,000 tCO₂e over a 20 years’ lifetime.</td>
<td>• GHG emissions reduction, by source (direct and indirect) per year (t-CO₂e/y).</td>
<td>• 3,360 tCO₂ indirect reduction as tree planting + 7.7 tCO₂ reduction from biochar briquettes substituting wood reached over approximately 1.5 years.</td>
</tr>
<tr>
<td>Output 1.1: Large sugar millers integrate supply of bagasse to local biomass briquette enterprises.</td>
<td>• Adoption of framework for agreement. • # of sugar millers confirming supplying of quality bagasse.</td>
<td>• Feedstock supply plan developed including other biomass than sugarcane bagasse;</td>
</tr>
</tbody>
</table>
### Planned Objectives and Outputs

<table>
<thead>
<tr>
<th>Objective 1: Planned Objectives and Outputs</th>
<th>Indicator(s):</th>
<th>Achievement of the objectives and outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output 1.2: Improved energy efficient kilns for carbonizing of biomass promoted.</td>
<td>% increase in efficiency in biomass carbonization kilns.</td>
<td>No binding agreement by the end of the project but engagement with other sugar millers and Sugar Directorate for policy intervention.</td>
</tr>
<tr>
<td>Output 1.3: Technology for briquetting carbonized bagasse is tested and implemented in 5 locations.</td>
<td># of demonstration facilities established and functioning; Amount of briquettes consumed.</td>
<td>3 briquette production enterprises established with 1 fully operational; 4,259 kg of briquettes consumed; 11,711 kg of briquettes produced</td>
</tr>
<tr>
<td>Output 1.4: Optimal design of briquettes is chosen, based on technical parameters and market studies.</td>
<td># of demonstration facilities established and functioning.</td>
<td>1st prototype improved with improved technical parameters.</td>
</tr>
<tr>
<td>Output 1.5: Documentation of briquette production and GHG reduction from 5 demonstration briquette enterprises</td>
<td># of policy briefs produced and disseminated; # of journals; Media articles</td>
<td>1 policy brief produced and disseminated; non 2 media articles in Kenya &amp; 2 in Norway.</td>
</tr>
</tbody>
</table>

### Objective 2: Strengthen technical and business capacity of rural enterprises for sustainable production and supply of green briquettes from agricultural wastes.

<table>
<thead>
<tr>
<th>Indicator(s):</th>
<th>Achievement of the objectives and outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 2.1: Adaptable consumer practices are studied in households, institutions and industry.</td>
<td>Level of consumer awareness raised; Quality of study report.</td>
</tr>
<tr>
<td>Objective 2.2: Briquette products are tested by target groups in energy efficient cooking appliances.</td>
<td># of consumers reached; Consumer acceptance of the briquettes.</td>
</tr>
<tr>
<td>Objective 2.3: Use of briquettes is promoted in ~5 local communities.</td>
<td># of events conducted; # of market linkages and partnerships formed.</td>
</tr>
<tr>
<td>Objective 2.4: Energy efficiency audits are done in ~20 households and ~5 institutions.</td>
<td>Adoption rate of guides for energy audits; # of consumers taking voluntary energy audits.</td>
</tr>
<tr>
<td>Objective 2.5: Evaluate use of briquettes in traditional and efficient cooking appliances.</td>
<td># and type of traditional &amp; efficient cooking appliances evaluated.</td>
</tr>
<tr>
<td>Planned Objectives and Outputs</td>
<td>Indicator(s):</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Output 2.6: Biochar from bagasse as a soil improvement agent is piloted in 3 locations. | • % increase in crops yields and water retention capacity                                                                 | • 3 field trials conducted in 3 soil types in 3 locations with positive effects of 64% increase in mean yields. 1 field failed by drought.  
• 1,530 kg of biochar sold to farmers. |
| Objective 3: Create new opportunities for rural private sector development in green enterprises | • # of green enterprises established;  
• # of green jobs created.                                                                                                     | • 5 cooperatives formed and trained;  
• 15 green jobs created in biochar production |
| Output 3.1: Business model for piloting green growth is developed, demonstrated and adopted. | • Adoption rate of business models;  
• # of new green enterprises created;                                                                                           | • A business model developed;  
• 5 cooperatives adopted business model to develop business plans;  
• 30 distributors established but in connection with already existing businesses. |
| Output 3.2: ~30 local entrepreneurs are identified and trained, in briquette production and distribution. | • # of individual trained & applying skills gained;  
• Quality of briquettes in the markets.                                                                                          | • 30 trained in briquette distribution.  
• 5 + 4 trained in carbonisation and briquette production,  
• 3 trained in fabrication of equipment.  
• Thermal values showed similarity with wood charcoal (5.46 Kcal/g). |
| Output 3.3: ~5 briquette enterprises and 5 entrepreneurs associations established. | • # of enterprises established and operating;  
• #of associations established.                                                                                                  | • 3 briquette enterprises established where 1 is fully operational while 2 are partly;  
• 5 cooperatives established. |
| Output 3.4: Enhanced participation and influence of green entrepreneurs in policy making processes. | • Capacity of entrepreneurs associations built;  
• Inclusion of green growth agenda in policies.                                                                                   | • Capacity of 5 cooperatives built in governance, financial and business management & advocacy;  
• Leaders of 5 cooperatives engage with policy makers (County government, Constituency Development Fund (CDF). |
| Output 3.5: Enhanced ethical business practices that guide green growth in biomass briquette enterprises sector through mentorship and standard-setting. | • #of coaching & mentorship sessions held;  
• # of enterprises registered;  
• # of enterprises conducting ethical business practices.                                                                         | • 5 mentorship sessions held on business plan development.  
• 5 cooperatives registered  
• 3 cooperatives conducting ethical business practices (Tools of trade – vouchers, delivery books, guidelines for procurement, financial policies HR manual). |
3. CLIMATE CHANGE

The climate change components in this project rely on the technical development of two pillars, namely: 1) carbonization of bagasse with kilns, and 2) briquetting machine. However, key energy assumptions such as materials and transport were beyond the project and therefore were not considered. After a short improvement of the kilns and the briquetting machine and lab tests of the composition of the briquettes, a complete value chain of briquette production was established at Ligodho in June 2016 while carbonisation of bagasse in Sinoka and Kanyakira started in spring 2017 and autumn 2017.

The main climate change mitigation impact of the project is the reduction of CO₂ emissions by substituting charcoal from non-sustainable wood with 4,259 kg of charcoal-briquettes from bagasse sold, resulting in a reduction of 7.7 tCO₂ during the project period of 17 months which is less than the expected.

### Summary of CO₂ effect of bagasse and biochar prosessed

**Assumption:** 1 tonne briquette is estimated to replace 1.2 tonnes non-sustainable wood (1.5 t CO₂/tonne wood)

<table>
<thead>
<tr>
<th>Site</th>
<th>Bagasse received from Sukari</th>
<th>Biochar produced (after drying)</th>
<th>CO₂ subst. effect</th>
<th>Calculated Biochar on stock</th>
<th>CO₂ subst. effect</th>
<th>Briquettes produced and sold in bags</th>
<th>CO₂ subst. effect</th>
<th>Biochar sold to farmers</th>
<th>CO₂ subst. effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kgs</td>
<td>kgs</td>
<td>kgs</td>
<td>kgs</td>
<td>kgs</td>
<td>kgs</td>
<td>kgs</td>
<td>kgs</td>
<td>kgs</td>
</tr>
<tr>
<td>1 Ligodho</td>
<td>54 759</td>
<td>8 994</td>
<td>16 189</td>
<td>3 985</td>
<td>7 173</td>
<td>4 259</td>
<td>7 666</td>
<td>750</td>
<td>none</td>
</tr>
<tr>
<td>2 Sinoka</td>
<td>20 040</td>
<td>2 300</td>
<td>4 140</td>
<td>1 800</td>
<td>3 240</td>
<td>0</td>
<td>0</td>
<td>500</td>
<td>none</td>
</tr>
<tr>
<td>5 Kanyakira</td>
<td>3 400</td>
<td>417</td>
<td>751</td>
<td>137</td>
<td>247</td>
<td>0</td>
<td>0</td>
<td>280</td>
<td>none</td>
</tr>
<tr>
<td>Total</td>
<td>78 199</td>
<td>11 711</td>
<td>21 080</td>
<td>5 922</td>
<td>10 660</td>
<td>4 259</td>
<td>7 666</td>
<td>1 530</td>
<td>none</td>
</tr>
</tbody>
</table>

However, looking at the installed capacity in all the three sites, the CO₂ reduction in one year with three fully operational enterprises (250 working days) will be 123,75 tCO₂:

<table>
<thead>
<tr>
<th>Site</th>
<th>No of kilns by Nov. 2017</th>
<th>Daily capacity bagasse when fully operational Kg (according to installed capacity)</th>
<th>Carbonized bagasse processed to briquettes/day Kg</th>
<th>Daily CO₂ reduction effect substituting wood tCO₂</th>
<th>Yearly CO₂ reduction, 250 working days tCO₂</th>
<th>CO₂ reduction over 20 years, 3 plants fully operational tCO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ligodho</td>
<td>2</td>
<td>275 + 300</td>
<td>50 + 75</td>
<td>0,225</td>
<td>123,75 tCO₂</td>
<td>2,475 tCO₂</td>
</tr>
<tr>
<td>Sinoka</td>
<td>1</td>
<td>300</td>
<td>75</td>
<td>0,135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kanyakira</td>
<td>1</td>
<td>300</td>
<td>75</td>
<td>0,135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>1175</td>
<td>275</td>
<td>0,495</td>
<td>123,75 tCO₂</td>
<td>2,475 tCO₂</td>
</tr>
</tbody>
</table>

Over a period of 20 years the CO₂ reductions from three operational plants will be 2,475 tCO₂. The limiting capacity in all three plants today are the kilns, while the briquetting machine has a large capacity. It’s interesting to see that the CO₂ mitigation effect from tree planting over just two years is calculated to be 3,360 tCO₂.

With regards to changing of behaviour and to a more climate friendly consumption, 200 households have been reached and confirmed of having switched from wood fuel to briquettes. The stock of...
biochar for processing of briquettes is 5,922 kg which will either be used in briquette production or as soil improvement. The improvement of the kilns and changing of people’s attitudes is promising for the continued production and development of marked for this energy.

In three demo fields, biochar as a soil improver and CO₂ sequestration, proved to have a positive effect on the yield (maize) with 64 % increases, mostly in black cotton soils and clay-loamy soil. Tests at the sandy field failed because of drought. This is promising for the food production and poverty reduction. The climate effect of the application of 1,530 kg biochar sold to farmers utilized on 6.12 acres of land is however insignificant. Besides, as a carbon negative sequestration measure, the first unit has produced 28,000 tree seedlings for reforestation on farm level. After expected 2 years of growth, this can be calculated to result in 3,360 tCO₂ captured. That means that in addition to some biochar in stock, the project has saved at least 3,367.7 tCO₂ during the project period. In other words, planting trees has been more efficient in terms of CO₂ reductions in the context of this project. Substituting biochar from wood with briquettes from bagasse, is though saving virgin forests and has a great potential of creating jobs and utilizing agricultural waste which otherwise would be left to decay in deposits.

The calculated annual emission reduction including indirect CO₂ capturing through tree planting is 2,376.7 tCO₂/y. With increased interest of the project by both national and county governments, the project has contributed to increased awareness at county planning processes.

4. DEVELOPMENT IMPACTS AND CROSS-CUTTING ISSUES

This project has focused on utilisation of sugarcane bagasse taken from decaying piles at Sukari factory as raw material for production of carbonized briquettes and biochar for soil improvement. However, the model can also be relevant for other biomass as alternative raw materials. The project has also pilot-tested production and application of biochar to soil in small farms to increase farmers’ land productivity and food security in areas where intense sugarcane growing. The production units intended to contribute to increased income from sale of briquettes and for higher yield from the farmers who had applied biochar as soil improvement. Improved access to biomass briquettes would also limit the need for collecting firewood, especially for women.

During the project period 5 green enterprises have been established and registered as cooperatives: Ligodho, Sinoka, Ariri-Kanyikela, Ober and Kanyakira. The enterprises provide 15 green jobs as compared to the planned 20. However, out of the 5 enterprises, 2 sites have not been equipped with production equipment and have not been in a position to create new jobs. In addition, 30 sales outlets have been established, providing 30 jobs.

In regard to household savings on energy, 200 households have been introduced to biomass briquettes. With an average household of 6 family members, 1,200 people have been directly exposed to and have gained energy from the briquettes. In addition to this, 4.3 tonnes of carbonised briquettes have been sold to households, contributing to the saving of 5,110 tons of wood.

After testing the application of charcoal to soil for soil improvement, the results from the test fields gives an average improvement of the yield measured as increased yield in kilo, as 64% compared to the fields without biochar added. Increase in yields will enhance the farmers’ livelihoods and food security. The direct beneficiaries are the 200 consumers of biomass briquettes and farmers using
biochar in rural households in the sugarbelt region. In total the project has benefited 2,496 persons as summarized in the table below.

<table>
<thead>
<tr>
<th>GEP Project Beneficiaries</th>
<th>18.12.2017</th>
<th>A. Cooperative members (Temporary)</th>
<th>Total</th>
<th>Men</th>
<th>Women</th>
<th>assumed fam size 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ligodho</td>
<td>49</td>
<td>29</td>
<td>20</td>
<td>294</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinoka</td>
<td>30</td>
<td>10</td>
<td>20</td>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kanyakira</td>
<td>44</td>
<td>24</td>
<td>20</td>
<td>264</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ariri-Kanyikela</td>
<td>28</td>
<td>16</td>
<td>12</td>
<td>168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ober</td>
<td>34</td>
<td>20</td>
<td>14</td>
<td>204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>99</td>
<td>86</td>
<td>1 110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Given estimated family members of 6</td>
<td>1 110</td>
<td>555</td>
<td>555</td>
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</table>

<table>
<thead>
<tr>
<th>B. Operators (Full-time Jobs)</th>
<th>Total</th>
<th>Men</th>
<th>Women</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Ligodho</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>42</td>
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<tr>
<td>Sinoka</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>30</td>
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<tr>
<td>Kanyakira</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>Ariri-Kanyikela</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ober</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Total</td>
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<td>11</td>
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<table>
<thead>
<tr>
<th>C. additional beneficiaries</th>
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<tr>
<td>Migori, service provider, trained in briquestting and carbonization kilns, fabrication and installation and maintainance</td>
<td>5</td>
</tr>
<tr>
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<td>30</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>D: farmers using biochar. The number and gender of fam members are estimated.</th>
<th>Total family members</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>test plots 3 families of 6</td>
<td>18</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>8 farmers bought carb bagasse of 6</td>
<td>48</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>total</td>
<td>66</td>
<td>33</td>
<td>33</td>
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</table>

<table>
<thead>
<tr>
<th>E: number of people with improves livelihood/incom generated possibilities,</th>
<th>Total family</th>
<th>Men</th>
<th>Women</th>
<th>assumed fam size 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>persons in product distribution centers</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Given estimated family members of 6</td>
<td>180</td>
<td>90</td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F: increased recilent to climate change</th>
<th>Total family</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>households trained in using carbonized briquettis.</td>
<td>200</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Given estimated family members of 6</td>
<td>1 200</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Total Beneficiaries</td>
<td>2 496</td>
<td>1 248</td>
<td>1 248</td>
</tr>
</tbody>
</table>
5. ASSESSMENT OF RESULTS AND IMPACTS OF THE PROJECT

5.1 Relevance

The project has been implemented in cooperation and involvement of both national and county governments and is in line with Kenya’s Vision 2030, National Climate Change Response Strategy (NCCRS), National Climate Change Action Plan (NCAP), National Energy Policy (Act) and other relevant documents. At the national level, the involvement of the National Government by the Ministry of Environment and Natural Resources and public agencies including National Environmental Authority (NEMA), Sugar Directorate and Kenya Forest Service throughout implementation including the launch and commissioning of the first production unit has demonstrated that the project is in line with national priorities and policies.

At county level, the commitment was demonstrated by signing of the Memorandum of Understanding (MoU) between KEFRI and Homa-Bay County Government for implementation of GEP project and for other similar initiatives in the future thus in line with county government policy on bio-energy and afforestation. The county government has also committed itself to provide the necessary infrastructure such as roads, electricity and water to the briquette production units, provision of loans to cooperatives and market support. This policy support demonstrates potential for scaling-up and replication of the concept. In addition, the project has political support and has been implemented in close cooperation with the Member of County Assembly (MCA), Member of Parliament (MP), and County Government departments (Agriculture, Energy and Natural Resources).

At community level, establishment of briquette enterprises using sugarcane bagasse has created opportunities for local community involvement in the green energy value chain. Cooperation of the community members and registration of cooperatives to manage production facilities, product distribution and business advocacy has demonstrated local support and priorities. The project has demonstrated opportunities to improve access to sustainable renewable energy, improve rural livelihoods, create jobs directly and mitigate deforestation and climate change mitigation through direct reduction of GHG emissions associated with sugarcane bagasse from sugar mills in the region.

5.2 Effectiveness

The overall objective of the project has been to reduce greenhouse gas emissions by promoting local enterprises in production and supply of carbonized biomass briquettes from sugar cane bagasse. By the end of the project 11,711 kg biochar has been produced. Of this, 4,259 kg have been produced and sold as carbonized briquettes while 1,530 kg has been used as soil improver. The unused biochar as of today will be converted into briquettes. In addition to the biochar production, the project has produced 28,000 tree seedlings which are estimated to have captured 3,360 tCO2 over a period of 24 months. Over a 20 years’ period this is expected to sequester an estimated of 33,600 tCO2.

The carbonisation production has been conducted through 3 units where one has been fully equipped with kilns and briquette production line, producing carbonised briquettes for sale (Ligodho). This cooperative is also selling biochar for soil improvement together with production and sale of tree seedlings. The second production, Sinoka unit is producing biochar for sale to farmers and has finalised test production of carbonised briquettes, but is awaiting electricity connection to be in place (power connection was promised in week 47). The third site (Kanyakira) has produced biochar and is also waiting for the electricity to be in place so that briquette production for sale can start Briquetting machine is ordered, but a water tank is not in place. In the last two sites of the five originally planned sites, the cooperatives have been established and trained, but have not been equipped with
production equipment and investments for necessary buildings. With production of biochar and briquettes from 3 out of 5 units, the climate effect is less than planned. This shortfall is related to problems with infrastructure (road, electricity and water), some political challenges and too ambitious plans for implementation in a period of 30 month.

The cooperatives have been trained in technical and business related topics. The positive and constructive engagement both in the cooperatives and the local communities has proven to be strong elements in the project and are important in the continued development of the production units and the cooperatives. The trainings and the cooperatives have enhanced the entrepreneurial thinking where new ideas for small businesses have started to come forward. In these less developed areas, strengthening and providing opportunities for entrepreneurial thinking is an important part of what has been achieved.

Originally it was not planned to include production and sale of tree seedlings. This was though started in Ligodho as a source of income for the cooperative as well as a contribution to the tCO2 reduction which is in line with national and international climate policy. This idea has been taken forward to the third production site (Kanyakira) but solely on the cooperatives own initiative which is an indication of local initiative and also the ability of learning from each other.

Application of biochar in agriculture has proven to increase the yield by at a mean of 64%. It is then likely that this increase could have a positive effect and contributed to improved economic situation for small scale farmers though the tests have been conducted in smaller plots. Adding biochar to the soil is though a long term carbon negative measure for storing carbon in the soil with no fossil substitution effect. Nevertheless, it is an important effort as a mitigation measure and which also helps in increasing the soil fertility.

The effectiveness of the project would have been stronger/higher if the selected sites would have had full access to relevant infrastructure. On the other hand, these areas are indeed in need for new opportunities and climate friendly development. By starting up businesses in such areas, local politicians could be encouraged to pay more attention to the potential for business development in these areas and also be in position to support and push for improvement of most needed infrastructures.

A notable risk is political, and perception of sites not established. For example, there is a general feeling by members of Kanyikela-Ariri of being left out and this perception is likely to be politicised which can jeopardise investments already made including networks built and training given to the cooperative. It is therefore critical that a way of supporting the two remaining sites through a scaling up programme should be considered.

5.3 Efficiency

During the project planning and implementation, the efforts taken and the preliminary results have been object for discussions and for potential modifications. The first kiln that was constructed in Ligodho was a pilot and where the next kilns were improved according to lessons learnt from the first construction. Also the third kiln have been improved based on experiences from the second one.

The first briquetting machine was also a pilot which during the project period have been modified, improved and also strengthened when it comes to the production capacity. After testing and applying the technology, the mixer that was in use in the first site, has not been copied into the second site.
due to experiences that it was not making the process more efficient than what could be done with a more manual operation.

The project has been planned in such a way that lessons from one site have been taken further when the next site are to be established and implemented. This seems to be a good way for this kind of project which consists of similar concepts, but where each unit can learn from the previous one. In that way we have been in position to cumulate experiences and lessons learnt not only at the end of the project, but during the implementation process and with the opportunity to apply these experiences in the next site in line.

The long process of getting a binding agreement for supply of raw material (bagasse) from Sukari factory, have been very time consuming. Though the access to the needed material has been in place during the project period, the predictability has not been secured, a situation which will affect the plan for upscaling of the briquette production.

The areas identified and selected for the location of the five production sites did not have the sufficient infrastructure for getting in place the planned production in the five sites inside of the timeframe for the project. With another selection of the locations, it is believed that the implementation would have been easier and also more efficient than what has been the case in this project.

Delay in the establishment of the production sites and getting the production units in operations have influenced on the planned CO$_2$ reduction. The efforts of starting with tree planting has proven to be more efficient when it comes to the CO$_2$ reduction than what has been achieved so far through the briquette production and reduced use of charcoal from trees.

The use of charcoal for soil improvement has been quite encouraging with a measured increased yield for maize (which has been cultivated on the 3 testfields) with a mean value of 64%.

Though only one production site is in full operation and two others are producing carbonised bagasse at the end of the project period, it is believed that the capacity building conducted when establishing the 5 cooperatives, and also a promised continued follow up by KEFRI/GARE in the coming year, has provided these local communities with skills and knowledge which will help them in developing their businesses and also encourage them to initiate and bring forward new plans and ideas. It is hard to estimate the value of such soft measures, but societies with high score on human resources and organisation capacities, have bigger potential than others to join forces, to develop their societies, attract investors, cooperate around new ideas and businesses and also make their voices heard in front of local and regional authorities.

When it comes to the cost efficiency aspect, this has been in focus throughout the project period. In the communication between Norway and Kenya, we have consequently been using either e-mails or meetings on skype. When we have organised follow up visits these have been coordinated with other follow up visits in the region (ref Tanzanian) and in that way reduced the number and costs of flights and internal travel expenses in addition to reduced carbon footprint. For the implementation of the project in Kenya, it was invested in two motorbikes which have been helping out in moving more easily around on bad roads, but also when it comes to reduced petrol consumption compared to using a car. The situation with a field office with field staff has also contributed in reduced needs for longer distant travels from Nairobi. The existence of a field office has also provided office space and a car when needed. Training of trainers in technical operations of briquette production has also reduced travel distance in the project since the trained local trainers are in position to take the
training further. Due to local regulations when using official cars like the one that is under KEFRIs authority and which requires the use of a driver has made us plan and organise for the use of taxi both for transportation related to the audit both for the midterm audit and for the planned audit of the last project period.

5.4 Impact

Beneficiaries - 2,469
Looking at the total number of beneficiaries whom the project has reached out to, we have a number of 2469 people. The figure is based the assumption that one household has an average of 6 members. When we have one person directly affected by/ involved in the project, this has been calculated as giving an indirect effect to a total of 6 persons. One person is then directly affected and the other 5 are indirect beneficiaries. Based on an estimation of 50/50 % on gender balance, the number of beneficiaries based on gender is calculated to be 1248 males and 1248 females.

Increased resilience to climate change - 2,376
Based on the number of people trained in using briquettes like cooperative members with their families (1,110), 200 households with their families (1,200) in addition to 11 families trained in the use of charcoal in soil (total 66) gives a number of 2,376 persons with an increased resilience to climate change.

CO₂ emission reduction
The calculated CO₂ emission reduction at the time of the completion of the project is adding up to 3,367.7 tCO₂. This is based on the reduction effect of briquettes produced in a 17 months period to be 7,7 tCO₂. In addition comes cultivation of 28,000 tree seedlings over a two years period calculated to have a CO₂ mitigation effect 3,360 tCO₂.

Calculating the CO₂ emission reduction for the theoretical installed capacity in the 3 production sites at the time when they are all up and running for full capacity, the the CO₂ reduction in one year (250 working days) would be 123.75 tCO₂. For 20 years this is 2,475 tCO₂.

Reflecting the CO₂ emission reduction during the lifetime of 20 years of the project, including the CO₂ reduction effect of substituting wood with briquettes (2,475 tCO₂) and the calculated CO₂ mitigation effect from the trees from the tree seedings initiative (33,600 tCO₂), this will add up to a CO₂ emission reduction of 36,075 tCO₂.

During the project period 5 cooperatives have been established with a total of 185 members (99 men and 86 women). In addition to be cooperative members, they have also been directly beneficntiated through temporary jobs during establishment of the production centres, training, use of clean briquettes and proceeds from income.

The total number of new jobs created are 15 (11 men and 4 women) in the 3 established production units. In addition to the jobs comes also that they have received training in technical aspects of briquette production and tree nursery management.

Other beneficiaries are 5 persons (4 men and 1 woman) from Migori Juakali Cooperative Union, an engineering service provider, trained in briquetting and carbonization kilns, fabrication and installation and maintenance.

A total of 11 farmer households (66 persons) have benefited from biochar application in the soil.
Also 30 persons have been engaged in distribution outlets of briquettes which comes as an additional activity to their regular work and sales activity.

A total of 200 households have been trained and exposed to the use of carbonized briquettes and with an estimated household of 6 persons, 1,200 persons have been given an increased resilience to climate change.

There was also disappointment from the 2 sites that didn’t succeed due to too optimistic plan for a 2.5 years period. The involved politicians whom have been informed about the project, have seen the potential and possibilities this concept represents for local development. For the project partners involved, the project has been a positive experience showing that development is obtainable though it takes time.

The project partners succeeded under the NCF6 call with an application targeting the same group, but were the project was not implemented due to some observed risks which were seen as too high for a successful implementation. The NCF4 project was also the baseline for our NCF 6 project. Other partnerships built as a result of the project with potential for financing include Norwegian Institute for Bioeconomy (NIBIO).

5.5 Innovativeness and learning

The innovativeness of this project has been both on the briquette production side and the marketing side. Briquette production focused on turning sugarcane bagasse, available in large quantities and regarded as waste in sugar mills into carbonised briquettes to replace charcoal for cooking and heating. Local manufacture of complete briquette line including highly efficient carbonisation kiln has been innovative in regard to technology adoption by local engineering enterprises through skills training and mentorship.

The cooperative model has been an innovative market-led approach to creating awareness for carbonised briquettes, a new energy product in the region and in engaging local communities of both genders in product distribution. This had made it possible for biomass consumers to switch to carbonised briquettes from wood-charcoal for their daily cooking and heating purposes.

The use of biochar for soil application as soil improver is not only an emerging product in the region, but also in Kenya. Biochar tests in different soil types, which recorded 64% increase in crop yields with maize probably due to increased water retention, has created awareness and elicited interest among smallholder farmers.

The concept of green economy partnership has demonstrated opportunity to solve identified challenges in community, country and global contexts. Even though all the targets were not achieved, the project is an eye-opener on new ways of solving challenges connected to climate change. The project has been implemented with strong human resource element, strong networks and team work, which is a cornerstone for change. It also emerged that the cooperatives established have demonstrated energy and openness with solid support from the communities, county and national governments, critical for scaling-up and replication of the concept.

Trials conducted on various aspects of the technology and processes in briquettes value chain are important for improving the system (kiln and briquetting machine) and logistical processes of feedstock acquisition (biomass raw material and binders) is therefore possible. In addition, challenges and opportunities emerged are important for further research and development, capacity building...
and innovations for alternatives and solutions. Although legal confirmation of availability of sugarcane bagasse for briquette production by a private sugar miller has not be realized, engagement with actors in public and private sector including the Sugar Directorate has confirmed the need for policy intervention in the agro-industry in Kenya. This challenge has though resulted in mapping of alternative feedstock resources including local jaggery mills, maize cobs and groundnut shells.

People need time to change and build networks. The project has been well-designed, anchored on Kenya’s Vision 2030 and local priorities and opportunities. The project plan was though too optimistic with regard to time, volume and value and where we also should change people’s attitude and habits.

6. SUSTAINABILITY AND POTENTIAL FOR SCALING UP AND FOLLOW-UP INVESTMENTS

The business model of cooperatives has potential for sustainability of the NCF-supported pilot phase. Within 17 months, a total of 4.3 tonnes of carbonized briquettes, 1,530 tons of biochar as soil improver and 18,840 tree seedlings have been sold by first production unit generating an income of KES. 203,756 (Euro. 1,749). As a result of product promotion during the project launch and marketplace events, apart from demand from local communities for household application, several inquiries have been made by commercial consumers including hotels and boarding schools in the region. However, the pilot plants are still in their early stages and cannot be able to meet customer demand. Scaling up to commercial operations of 1 ton/day of briquettes is possible through optimisation of production capacity/ more kilns and logistical processes of feedstock acquisition and drying. Potential partnerships with county government, sugar directorate, other NGOs and private investors, provide possibility for scaling up of the concept. Plan for scaling up include construction of at least 5 carbonisation kilns and 2 briquette lines per each facility, building greenhouse installed with fans to enhance drying and dry storage of both bagasse and wet briquettes. In addition, there is possibility of leveraging private sector financing for investment through development of marketable business plans by the cooperatives. However, there will be need for grant financing to bridge the financing gap to enable the bio-enterprises transition from pilot phase to commercial operations.

Although the pilot project has demonstrated economic potential, sustainability will be dependent on: i) policies that ensure legal binding for confirmation of availability of sugarcane bagasse by sugar millers to the briquette enterprises; ii) sustainable supply of relevant raw materials including alternative biomass and binders; iii) stability of power supply to the production plants; iv) implementation of charcoal rules (regulations) in order to streamline biomass energy markets; and v) provision of electricity connection, accessible roads and sustainable water supply.

The direct revenue recorded by 1 briquette enterprise from sales of briquettes, biochar and tree seedlings is Euro 1,008. At full capacity utilisation, the potential is promising. From market analysis, for carbonized briquettes, consumers are willing to pay KES. 800 pack of 35Kg, a competitive price with charcoal from wood in the marketplace. In addition, biochar, a new product in the region sold at KES. 20 per Kg has attracted many farmers for soil improvement and has potential for increasing revenue streams for the briquette enterprises. Overall, financial projections for one briquette enterprise based on business model developed during the project show steady income flow with a profit of Euro. 20,000 over one year. Therefore, there is potential for economic and financial sustainability of the briquette enterprises subject to optimisation of their operations.
The cooperative model of management of the enterprises provides organizational sustainability. The institutional arrangement is regulated by the Kenya Cooperatives Societies Act of 1998. Sustainability is also expected from mentorship provided by the project in cooperation with the sub-county cooperative officer in the areas of organisational management, financial management, procurement and human resource management. Tools of trade developed during the project period including management guidelines and internal policies and systems enable the cooperatives to conduct ethical business practices and sustainability of their operations.

The implementation of this project involved active participation of both men and women. The gender mix demonstrated that both men and women have different but complementary roles within briquette value chain. Both men and women will play roles during the establishment of the facilities and in the production, distribution, promotion and utilization of briquettes.

Results of an Environmental Impact Assessment (EIA) conducted at the start of the project provided basis for environmental sustainability. Based on recommendations of EIA, annual environmental audits should be conducted to ensure compliance including reduction of emissions from the carbonisation kilns. Optimisation of briquette production will reduce amount of sugarcane bagasse into the region’s waste stream thereby clean environment. Further, planting of more trees by farmers as a result of establishment of tree nurseries will lead to sustainable forest development ensuring environmental sustainability.

7. FINANCIAL REPORTING

The original project budget was a total of 625,000€ including 500,000 financed by NCF in addition to 60,000€ in own contribution from Norges Vel and 65,000€ in own contribution from KEFRI (48,000€) and GARA (17,000€).

During the project period a total of 564,884€ have been reported as expenditures in the project and where 451,907€ have been reimbursed by the donor. Out of the total reported expenditures, 54,308€ have been reported as own contribution from Norges Vel and 58,440€ as own contribution from the project partners respectively KEFRI and GARA. The total of own contribution reported adds up to 20% of the total reported costs.

In the reported costs under 1. Human resources we have an underspending on the technical area and overspending on administration. Work related to reporting have been more time-consuming and have generated more time but the division between the two areas of work are not clear cut. Underspending on travel for Norges Vel is due to 8 rather than 9 trips together with combining follow up of more project on the same flight. KEFRI has recorded some overspending on travel expenses due to more follow up and travels than planned for.

Under section 2 in the budget: Equipment for the enterprises, supplies/ Local, shows some overspending due to more expenses for operational costs, computers and not planned motorbikes.

Under section 3. Office Costs/Local: office costs are in line with budget. Expenses under Other costs have been higher than in the budget on some lines like financial service which is mainly due to the cost of having a bank guarantee. The lab tests conducted as part of the project was more costly than budgeted and also the training in green economy and consultative/dialog meetings have requested more funds than planned for.
Table 1. Costs and financing.

<table>
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<th>Organization</th>
<th>Costs, EUR</th>
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<th>Grantee</th>
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<th>Local Partner 2</th>
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<td>451,907</td>
<td>27,154</td>
<td>28,273</td>
<td>7,000</td>
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</table>

8. CONCLUSIONS AND RECOMMENDATIONS

The GEP project has achieved, to a large extent, its overall objective of developing the capacity of local enterprises in Homa-Bay County in production and supply of carbonized briquettes from sugarcane bagasse. Though the project was designed to establish five bio-enterprises in the briquettes value chain in Ndhiwa Sub-County, it was possible to establish three bio-enterprises. It was not possible to establish the last two remaining enterprises due to the delays in the installation of power resulting from the protracted unforeseen electioneering period in Kenya. However, the project has built the capacity of all the 5 cooperative societies established in technical skills, business aspects and technology and knowledge transfer. The project has also demonstrated that production of charcoal briquettes can contribute to climate change mitigation by reduction of 7.7 tCO₂ from biochar briquettes produced / sold over 1.5 years’ time. In addition the cultivation of tree seedlings have contributed with 3,360 tCO₂ in 24 months with potential of 33,709 tCO₂ over 20 years.

In regard to delivery, although some specific results were not realized in regard to establishment of production units, the project has contributed to achievement of main deliverables and has demonstrated technologies and processes to showcase opportunities. The project has also demonstrated models of linking technology and industry including communities and local private sector. From the 3 pilot briquette production units, and strong networks and public support, the project has laid ground for scaling-up to commercial operations with potential for replication to two remaining sites and in other new areas.

Based on the process and results of the implementation for the 30-months period, some recommendations have been made. These include:

**Recommendation 1:** From the pilot production and thermal tests in target groups and laboratories, there is need for improvement on efficiencies of production processes, quality assurance of ash content and quantity for commercial operations to meet consumer demand in volatile biomass energy markets in Kenya.

**Recommendation 2:** Recognising that the bio enterprises are still in their early stages of development, there is need for follow-up and mentorship. Local partners (KEFRI and GARA) should
continue with the GEP project for at least 1 year for continuation of incomplete activities and enable smooth phasing out of the bioenterprises and transition from pilot phase to commercial operations including resource mobilisation to bridge financing gap. The production capacity should be well thought through in relation with financial and investment cost. Profitability of the business model is therefore very dependent on full production capacity and the availability of feedstock.

**Recommendation 3:** Key results of the project including briquette tests at both consumer and laboratory levels provide opportunity for further technical and policy research in the value chain as well as standard-setting and patenting of the developed technology. Standardisation and certification of briquette production should be promoted and implemented.

**Recommendation 4:** The GEP project has demonstrated potential for leveraging other financing mechanisms. By succeeding with this model other investors and funding facilities will be more motivated to support expansion and scaling up according to the original project plans.

**Recommendation 5:** Tree seedlings have proven to be a very efficient tool for capturing CO2 and should be developed further both as a tool to fight deforestation, but also as a source of income for the cooperatives and others. The increment of the trees and the follow up of the tree planting ought to be further observed.

**Recommendation 6:** More attention should be given to the EHS (environmental, health and safety) conditions for the operators being in contact with carcinogens emission from the kilns.

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**ANNEXES**

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### Narrative Summary

**Overall Objective**
To reduce greenhouse gas emissions by promoting green local enterprises in production and supply of carbonized biomass briquettes from bagasse.

**Purpose**
To promote development of green energy enterprises in production and supply of biomass briquettes from bagasse generated by sugar mills in five rural locations in the sugarbelt region of western Kenya.

**Output (Results)**

1. **Sustainable briquette production**

   **Output 1.1:** Large sugar millers integrate supply of bagasse to local biomass briquette enterprises.
   - # of green enterprises established;
   - Amount of briquettes produced & consumed;
   - Households' savings on energy consumption and expenditure.
   - Adoption of framework for agreement.
   - Study report;
   - Progress reports;
   - Study report;
   - Progress reports.
   - Sugar millers willing to supply bagasse to local entrepreneurs;
   - There is adequate supply of bagasse.

   **Output 1.2:** Improved energy efficient kilns for carbonizing of biomass promoted.
   - % increase in efficiency in biomass carbonisation kilns.
   - Study report;
   - Progress reports;
   - Measure emissions.
   - Sugar millers willing to supply bagasse to local entrepreneurs;
   - There is adequate supply bagasse.

   **Output 1.3:** Technology for briquetting carbonized bagasse is tested and implemented in 5 locations.
   - # of demonstration facilities established and functioning.
   - Amount of briquettes consumed.
   - Study report;
   - Progress reports.
   - There is conducive environment for local private sector investment.
   - There is adequate supply bagasse.

   **Output 1.4:** Optimal design of briquetting machine and quality of briquettes is chosen, based on technical parameters and market studies.
   - # of demonstration facilities established and functioning.
   - Study report;
   - Progress reports.
   - Consumers are willing to participate;
   - Consumers are able to pay for appliances.

   **Output 1.5:** Documentation of briquette production and GHG reduction from 5 demonstration briquette enterprises.
   - # of policy briefs produced and disseminated;
   - # of journals.
   - Study report;
   - Progress reports.
   - Sugar millers willing to supply bagasse to briquette entrepreneurs.

2. **Market analysis and development**

   **Output 2.1:** Adaptable consumer practices are studied in households, institutions and industry
   - Level of consumer awareness raised;
   - Quality of study report.
   - Study report;
   - Progress reports.
   - Biomass energy consumers are willing to switch to briquettes;
   - Consumers are cooperative in the study.

   **Output 2.2:** Briquette products are tested by target groups in energy efficient cooking appliances.
   - # of consumers reached;
   - Consumer acceptance of the briquettes.
   - Test report
   - Progress reports.
   - Consumers are able to pay for appliances.

   **Output 2.3:** Briquettes are promoted in ~5 local communities.
   - # of events conducted;
   - # market linkages and partnerships formed.
   - Events reports;
   - Progress reports.
   - Consumers are willing to switch to biomass briquettes.

   **Output 2.4:** Energy efficiency audits are done in ~20 households and ~5 institutions.
   - Adoption rate of guides for energy audits;
   - Pilot report;
   - Consumers are willing to undertake voluntary energy audits.
| Output 2.5 Evaluate use of briquettes in traditional and efficient cooking appliances | • # of consumers taking voluntary energy audits. | • Progress reports. | • The processing of the briquettes can be adjusted to produce an optimal briquette structure with burning properties that the market will be willing to pay for. |
| Output 2.6: Biochar from bagasse as a soil improvement agent is piloted in 3 locations. | • # and type of traditional and efficient cooking appliances evaluated. | • Evaluation report | • There is favourable weather conditions; Farmers are willing to participate. |

### 3. Business development, job creation, policy making and associations

#### Output 3.1: Business model for piloting green growth is developed, demonstrated and adopted.
- Adoption rate of business models;
- # of new green enterprises created;
- Pilot report;
- Progress reports.
- There is conducive environment for local private sector investment.

#### Output 3.2: ~30 local entrepreneurs are identified and trained, in briquette production, distribution and sale.
- # of individual trained & applying skills gained;
- Quality of briquettes in the markets;
- Sales records;
- Progress reports.
- There is ready market for briquettes.

#### Output 3.3: ~5 briquette enterprises and 5 entrepreneurs associations established.
- # of enterprises established and operating;
- # of associations established.
- Pilot report;
- Progress reports.
- Communities are willing to cooperate.

#### Output 3.4: Enhanced participation and influence of green entrepreneurs in policy making processes.
- Capacity of entrepreneurs associations built;
- Inclusion of green growth agenda in policies;
- Pilot report;
- Progress reports.
- There is favourable political and policy environment.

#### Output 3.5: Enhanced ethical business practices that guide green growth in biomass briquette enterprises sector through mentorship and standard-setting.
- # of coaching and mentorship sessions held;
- # of enterprises registered;
- # of enterprises conducting ethical business practices;
- Pilot report;
- Progress reports.
- Local charcoal burners and traders are willing to switch to briquette enterprises.

### Activities

1. Sustainable briquette production.
- # of sugar millers and feedstock suppliers engaged;
- Amount of bagasse supplied to briquette enterprises.
- Activity reports;
- Progress reports.
- No competing use of bagasse;
- Communities willing to participate.

2. Market analysis and development.
- Quality of market study;
- # of promotion events conducted;
- # of consumers conducting energy audits.
- Activity reports;
- Progress reports.
- Consumers are willing to use briquettes;
- There is ready market for briquettes.

3. Business development, job creation, policy making and associations.
- # of value chain businesses value chain created;
- # of green jobs created;
- # of associations formed and strengthened;
- # Association representatives participating in policy, planning and budgetary processes.
- Activity reports;
- Progress reports.
- There is favourable political environment;
- There is ready market for briquettes

### Inputs

1. Human resource technical and admin personnel;
2. Project and office equipment and materials;
3. Program implementation costs;
4. Operating and administration logistics/costs.
- Effectiveness of staff in delivering results;
- Adequate facilities (labs);
- Quality of and timeliness of deliverables (reports, project and policy briefs).
- Personnel files;
- Audit reports;
- Progress reports;
- Evaluation reports.
- Staff will remain in the entire implementation period;
- Adequate facilities are available;
- Funds available in time.;
- Project partners willing to contribute.
Annex 2  Photos

Pictures GEP PROJECT PHOTOS

(i) Establishment of production units

Operators at Bagasse drying yard at Ligodho Bioenterprise – 1st Briquette Production Facility

From Left: Hon. Pharsh Ratego, CEC-Ministry of Energy and Natural Resources, Homa Bay County; HE. Hamilton O. Orata, Deputy Governor, Homa Bay County; Dr. Ben Chikamai, Director KEFRI; Prof. Judi W. Wakhungu (CBS), Cabinet Secretary Ministry of Environment & Natural Resources and Dr. Margaret W. Mwakima Principal Secretary, State Department of Natural Resources, during official unveiling of the Ligodho facility

Photo 3: An improved carbonisation kiln produced by MJCU for 2nd Briquette Production Facility at Sikwadhi

Photo 8: Construction work at Kanyakira Centre

Complete Briquette Facility at Kanyakira Centre
(ii) Production of briquettes

A modified dual outlet briquetting machine produced by MJCU and installed at Ligodho Briquette Production Facility

Carbonization kiln

Briquette production at the 1st Briquette Production Facility (Ligodho)

Drying of briquettes

Briquettes packed in 1kg bags

(iii) Training sessions

Participants during the training session

Participants during the group discussion session
(iv) Market events

Display of briquettes packed in 1kg bags by LIKABICS during the official aunching of the facility

County Executive Committee (CEC) member for Energy and Natural Resources, Homa Bay Couty, Mr. Pharesh Ratego at GEP Stand during Kendu Show(Market Event), July 2017

(v) Community Consultation meetings

Community consultative and planning meeting at the 2nd Briquette Production Facility at Sikwadi

Community consultative meeting at Ober site during Environmental Impact Assessment

(vi) Tree seedling production and biochar application

Tree seedling production at Ligodho

Biochar application in banana