UNDP United Nations Development Program

BRA/10/G31 - SUGARCANE RENEWABLE ELECTRICITY (SUCRE)

Evaluation of Implementation Arrangements and Substantive Revision Proposal

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Outline

1. The SUCRE project

Sugarcane is an important source of energy in Brazil; about 16% of the national energy supply (42.8 Mtoe) came from sugarcane fields in 2011 (EPE, 2012). Currently all Brazilian cars consume ethanol, either as anhydrous ethanol blended with gasoline (ethanol content 18 to 25% by volume) or as hydrous ethanol (ethanol with 6% water) pure, in vehicles with dedicated engines, or in any blend with gasoline in vehicles with flex fuel engines, which move nowadays almost 50% of the national fleet of light vehicles (ANFAVEA, 2012). In Brazilian mills there are today nearly 9 GW of generating capacity using bagasse, which produced about 25 GWh in 2011, 4% of the national demand, similar to the natural gas power plants output (EPE, 2012).

The sustainability indicators of the Brazilian sugarcane bioenergy program are well documented, in terms of economic competitiveness, social benefits and actual conditions to achieve significant reductions in greenhouse gas emissions relative to conventional fossil fuel use (Macedo et al., 2008). Nevertheless relevant additional improvements can be introduced, in the feedstock production and processing, as well as in logistics and management of the sugarcane agroindustry. In this context, the Sugarcane Renewable Electricity (SUCRE) project focused to increase the use of solid residues of this agroindustry (bagasse and sugarcane trash) to generate electricity. Cogeneration power schemes are largely adopted in the Brazilian sugar mills, but typically present limited energy surpluses to public grid, significantly below the potential defined by better design and operation (BNDES, 2008). As observed in the SUCRE project proposal, this subject is globally relevant because over 80 countries grow sugarcane, and Brazil is viewed internationally as a leader in technological innovation and competitiveness in the sugarcane processing industries. Thus, success in Brazil can induce similar efforts in other countries.

The overall objective of the SUCRE project is to foster the establishment of a commercial market for sugarcane-based electricity generation to the Brazilian grid, reducing the fossil-fuel use in power plants. Actually, although hydropower still represents the main source of primary energy for electricity production in Brazil, the generation of electricity in conventional thermal plants, using coal and natural gas, is expanding at a worrying pace. Thus, reinforcing the use of renewable energy is relevant, particularly with regards to the GHG emission in the power sector. The GEF has already helped lay the bases for a sustainable sugarcane power industry in Brazil by sponsoring an earlier project (Biomass Power Generation – GEF ID 338) (Hassuani et al., 2005) that was largely a technology development and capacity building effort. Following essentially the same track, the SUCRE project aims to push the transformation of the

sugarcane industry in Brazil, into one for which the supply of bioelectricity to the grid is a significant and core aspect of their business, alongside sugar and ethanol production.

In order to maximize the potential for electricity generation from sugarcane, the project proposed to expand the use of bagasse in efficient power plants and launch the widespread use of sugarcane "trash", the tops and leaves of the sugarcane plant that historically have been burned on the cane field as a waste product. As previously determined, the quantity of trash that is available in a typical cane field is similar to the amount of bagasse produced, thus increasing significantly the potential of electricity production in sugar mills. According Hassuani (2013), electricity export increases of 70% can be achieved if 50% of the available trash in unburned areas is used as fuel in thermal cycles with boilers at 67 bar and 490 °C.

In spite of SUCRE PRODOC signature on December 2010, the Implementing Partner, the Center for Sugarcane Technology (CTC), did not initiate this project. This institution, formerly a non-profit research institution and responsible for the development of the previous GEF project assessing the potential and conditions to use the sugarcane trash, changed its legal status on January 2011, becoming a private company and thus not allowed to implement GEF resources. Therefore, since then such project is frozen.

However, the global and domestic contexts remains attractive for promoting the rational use of bagasse and trash of sugarcane, motivating a revision of the initial plan and a new implementation arrangement, looking for a feasible alternative to resume the SUCRE project and reach its basic expected outcome; better use of sugarcane as source of energy, displacing fossil fuels and reducing carbon emissions. In fact, this project is still waiting to be effectively started and followed up in its advances and outcome. In accordance to the UNDP Monitoring and Evaluation policy and regarding the current situation of the SUCRE project, it is relevant "to provide a basis for decision making on necessary amendments and improvements". This is the aim of this report.

2. Diagnosis

As an initial activity of this consultancy, to assess the project design consistency in the current conditions, a diagnosis was developed, by a revision of the basic project document (PRODOC) and interviews with the main stakeholders and experts. Following, the objectives, budget and implementation arrangements are commented.

2.1 Comments on SUCRE PRODOC (page numbers refer to PIMS 5315)

Although in general the project document can be considered valid, since the main drivers are essentially the same and the potential for trash utilization and increase of power generation remains relatively untapped, the context has evolved during the last years. Thus, in the next paragraphs some remarks on relevant aspects of SUCRE PRODOC are presented, most of them suggested by Remi Rijs (Eologica), the international consultant in this study.

1. Brazil's Sugarcane Industry (pg. 8/43). For an update, particularly on the production data and cultivated area, see Nogueira and Capaz (2013). In a briefing, this industry is processing annually about 600 million ton of sugarcane, cultivated in 9.4 million ha, about half part of this amount is used to produce around 25 billion litres of ethanol. After a period of huge expansion (2003-2008) and some years of relative stagnation, this agroindustry seems to face now good perspectives of production.

2. Progress of green and mechanized harvesting (pg. 10/43). The introduction of green (no previous burning) mechanized harvesting in the sugarcane culture has presented a pace more accelerated than expected, mainly in the Centre-South region, as indicated in Figure 1. This fact means that an important amount of trash is available before than forecast.

3. Electricity Market in Brazil (pg. 12/43). Reinforcing the evaluation presented in the PRODOC, the situation of the Brazilian power system has evolved in favour of independent power producers, as sugarcane mills, since the share of hydro power is declining, the dependence on rain regime and the risk of deficit in the national interconnect power is increasing, imposing the operation of conventional (fossil fuels) thermal power plants during longer time. Considering economic aspects, as well as the national objectives of reducing GHG emissions, the opportunity for alternative sources of generation are widening.

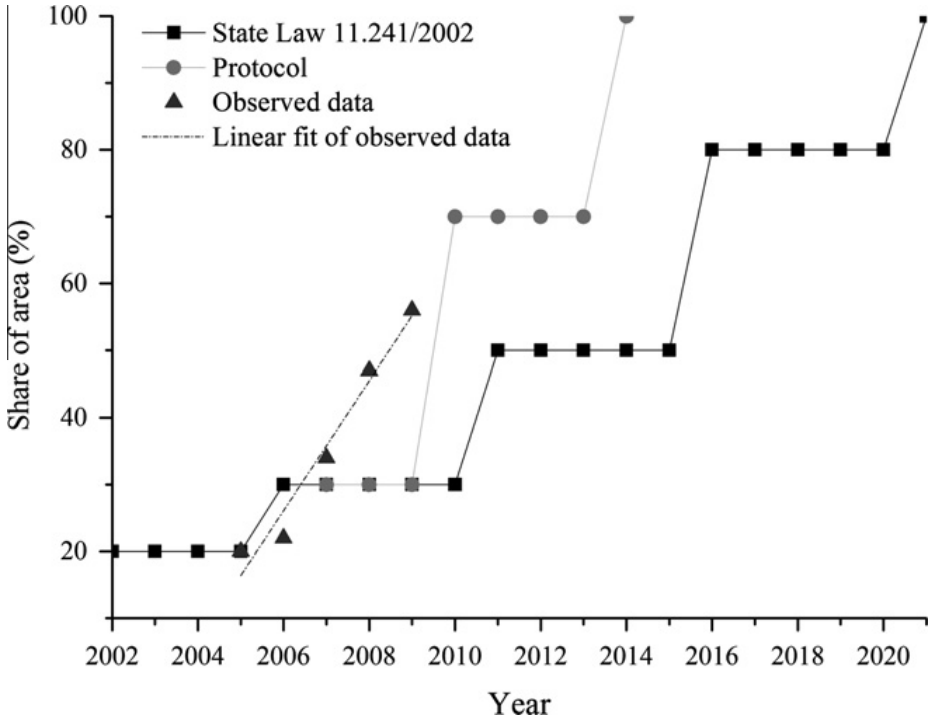

Figure 1. Reduction of previous burning projected by environmental laws and observed data in São Paulo State (Capaz et al., 2013)

4. Barriers for trash collecting and use (pg. 15/43, topics 34/35). It is interesting to note that the trash collection and use have been progressively introduced during the last years in some Brazilian mills, which are adopting different systems and routes, promoting a kind of learning-by-doing process, still with a limited economic performance. This aspect will be retaken further, when commenting the field visits, but certainly the current level of knowledge on trash collecting (process, equipment, costs, practices, etc.) is higher compared with some years ago, when the SUCRE PRODOC was prepared. Nowadays the difficulties and hurdles are better identified, but they are not effectively solved, with several doubts and questions remaining to answer. As a kind of signal of immatureness of the technology available for trash collecting, today two routes are adopted: baling and partial cleaning. In the first one, trash in the field is left to dry and then is baled, bales are loaded onto trucks and transported to the mill where some of the soil carried are removed and trash is shredded and fed to boilers. In the second route, harvester cleaning fan speed is reduced, letting more vegetal impurities go with the cane to the factory. Cane reaching the factory has the trash and mineral impurities separated by a dry cleaning system, with trash shredded before being sent to boilers. These two routes are essentially the same that the earlier GEF project on trash has pointed as potentially feasible. Some other questions have arisen, such as, the influence of soil type, humidity, variety, age,

topography, deserving effectively more studies and efforts to set the better conditions for trash collection. Finally and very important, those trials and experiments with trash collection and use have been developed in restricted areas, requiring more extensive evaluation in terms of area and time.

5. Barriers for trash collecting and use (pg. 15/43, topics 34/35). On the other hand, an additional and relevant aspect stimulating trash collecting is the negative impact of leaving large amounts of straw in field on the plant health and productivity. It has been observed an increase of pests and diseases when trash is not harvested, imposing to intensify the use of chemical and biological defensives. From this perspective, trash partial removal is a necessity.

6. Barriers for trash collecting and use (pg. 15/43, topics 34/35). An important last remark on this core issue of SUCRE PRODOC: the cost of collecting trash should be kept low and the current experience demonstrates the need of more attention to the reliability and maintainability indicators in the equipment, symptom of a young technology. Technical solutions have meaning just when economically feasible.

7. Financial barriers (pg. 15/43, topic 36). Although there were advances in the technical side, as observed above, there are challenges to face in regards to assure the economic feasibility. In this context financial support is important and possibly BNDES should be contacted to extend special financing programs as PAISS (for technology development) and Prorenova (to foster sugarcane production) to these context.

8. Regulatory barriers for trading electricity to the grid (pg. 15/43, topic 37). The regulatory framework is basically the same that was observed when the SUCRE PRODOC was prepared, but the number of mills interconnected was expanded significantly. According to ANEEL (2013), there are currently 370 mills certified to generate in parallel with the grid, summing 8.97 GW (with more 1.28 GW in construction). Even when just a fraction of these mills (around 130 mills) actually sell energy surpluses to the public utilities, due to low tariffs and lack of clear supporting policies towards independent electricity producers, the growth of interconnected mills is an advance and demonstrate the willingness of the sugarcane agroindustry in to be an active player in the power sector.

9. Relative value of trash (pg. 16/43, topic 39). It seems correct and worth to mention that, compared with sugarcane bagasse (which is carried and transported necessarily in the sugarcane stalks, thus produced in the sugar mill), the sugarcane trash always impose an additional cost to delivery, independently of the adopted route to collect, transport and use. On the upside, it should be mentioned that the trash moisture is typically bellow 15% (wet base), which

means that the available heating value of trash is around 1.8 times greater the heating value for bagasse with 50% moisture (wet base). Of course that trash has a cost (collecting, logistics, etc) that should be considered in the evaluation of the cost of electricity produced using this material.

10. Transmission lines to connect mills to the grid (pg. 16/43, topic 40). This problem remains unsolved, but it is more relevant for mills located far from the load centers of Center-South region. It is clearly a regulatory barrier, faced not only by cogeneration plants of sugarcane mills, but also by other decentralized generating plants (wind, for instance), solved for big hydro power plants in Amazonia, which transmission lines were not charged to the energy produced by these plants but shared with all consumers in Brazil.

11. Alternative schemes for trading energy (pg. 16/43, topic 41). Since 2004 energy produced by sugarcane mills can be commercialized within the Regulated Contracting Environment ('ACR', acronym in Portuguese), after auctions and under strict control of regulatory bodies, whilst in the Free Contracting Environment (the acronym is 'ACL' in Portuguese), bilateral contracts are undertaken with conditions, prices and quantities freely negotiated between generators, traders, importers and exporters of energy and free consumers, including different prices depending on the time of year and horary. This flexible scheme is positive and posed to stimulate the energy production in the sugarcane agroindustry, but typically not enough known by managers of mills.

12. “Wire fee” exemption (pg. 16/43, topic 42). This exemption on the transmission fee, applicable to the energy transmitted from power plants with less than 30 MW of capacity was created exactly to foster small power plants (the initial focus was just small hydro plants). Transmission fees are important economic locational indicator for generators (they take into account the distance effect between generators and consumers) and it seems incorrect to reduce these fees for larger power plants.

13. Overcoming barriers and diffusing results (pg. 16/43, topic 43). It is relevant to recognize that the solutions to look for and put forward should represent, as mentioned in (f), sound technical and economic alternatives, in a broad sense. The challenge to solve in this context is to balance properly technical performance (generally evaluated by efficiencies, productivities, yields, etc.) and economic performance (assessed by capital, operation and maintenance costs), in the actual scenarios. Thus, the SUCRE project concept seems correct, in a first phase to develop and consolidate solutions, then diffuse and promote them, in Brazil and abroad. To develop this work and solve consistently the several trade-offs that arise, the best approach is put to together actual users (mills) and institutions really involved with development and innovation.

14. Overcoming regulatory barriers (pg. 16/43, topic 45). The co-operation of UNICA makes sense, this institution have been playing an active role in proposing improvements in the regulatory framework towards an increase of power production by Brazilian sugarcane mills.

15. Stakeholders analysis (pg. 18/43). In a revision of this project is important to include in this analysis the CTBE, the Brazilian Bioethanol Science and Technology Laboratory, created in 2008. Today this center is probably the most important and active federal initiative in the field of innovation in the sugarcane agroindustry and to be presented in more detail further in this report.

16. Baseline scenario (pg. 17/43). It is interesting to observe that in the baseline condition was assumed that 20% of trash is used (lower limit of trash separation in harvesters), due to the lack of information and proper conditions to promote a higher use, assumed as 50% after the SUCRE project. Thus, the project impact is correctly evaluated as a differential change (more trash use) in the same green mechanized harvesting context.

17. Economic impact of power generation from trash (pg. 22/43). The expected contribution of selling electricity to the revenue of a typical mill, about 20%, has been confirmed in several actual units. Of course that this share depends on the tariff contracted for electricity as well as the market conditions of other products (sugar and ethanol), anyway it is becoming more and more clear that power can represent effectively a core product for sugarcane agroindustry, giving more flexibility for mills to face different market conditions. In this context, trash use is a relevant upside to be promoted.

18. SUCRE project outcome (Table 5, pg. 25/43). The first outcome (Technology for sugarcane trash collection and conversion to exported electricity at sugarcane mills is commercially launched) should be revised. In fact this technology is already available, offered by agricultural machinery suppliers, as New Holland and John Deere). However, this technology is still expensive and need improvements to reach more acceptable levels of performance and reliability, as recognized also by the equipment suppliers.

19. SUCRE project technical and economic risks (pg. 27/43). The technical risk on trash collecting seems to be manageable, but it should be seriously considered and affects directly the economic feasibility of full project. The performance of trash collecting and baling equipment (able to properly deal with sugarcane stalks, heavier and harder than wheat straw, for which they were generally formerly designed) (first route), as well as the impact of transporting trash with chopped sugarcane on logistic cost and the efficiency of separation in the dry cleaning

system (second route), specially on wet days, present major problems that should be effectively solved. This demands efforts, time and specialized applied knowledge.

20. SUCRE project environmental permitting risk (pg. 28/43). This risk was estimated as moderate but in the current level of information on the trash collecting and use implications it can be revised at a lower level. Regarding this aspect and although the impacts of trash left in soil are currently better known, it is worth to mention that there are relevant issues to be assessed and the concerns on the trash logistics can be properly elucidated. On the other hand, the Brazilian National Policy for Climate Change explicitly proposes to increase the use of sugarcane by-products (bagasse and trash) for electricity production.

21. SUCRE project soil fertility risk (pg. 28/43). This risk should be revaluated, since the accumulated experience during the last years with green harvesting; leaving trash on soil, is indicating an worrying increase of some pests and health problems with sugarcane plant, while there are benefits in terms of increase of carbon in soil. Today it seems more clear that, always depending on the soil, variety, terrain slope, yield, weather, rainfall regime, etc., trash removal should be considered as an important agricultural practice, independent of trash use as fuel or feedstock in other processes. Certainly to set a more consistent information base for defining the desirable and feasible level of trash removal is one of most relevant outcome of this kind of project.

22. SUCRE project co-financing (pg. 32/43). Considering a project revision, the access to complementary sources of financial support, including private and public institutions, is relevant and should be promoted, as did in the initial version. In this context and taking account the evident convergence of interests and synergies between activities, SUCRE project is well posed to leverage resources at government level, particularly from MCTI (Ministry of Science, Technology and Innovation and BNDES (National Development Bank) through programs as PAISS and Fundo Clima.

2.2 Technical visits and interviews

Aiming to verify in the field the actual conditions of trash collecting and use for power generation, two sugarcane mills were visited and some relevant professionals were interviewed. These activities were organized with CTC support and developed together Remi Rijs (Eologica), the international consultant in this study. A briefing of these visits and interviews and their main outcome are presented as follows.

Visit to Usina Alta Mogiana S.A. (24/06/2013)

Located in S. Joaquim da Barra (SP), this mill is one of biggest units in the Brazilian sugarcane agroindustry, processing annually about 6 million ton of sugarcane, cultivated in 48.000 ha, and producing 450,000 ton of sugar and 145 million liters of ethanol (data from last harvest season 2011/2012). Its cogeneration plant with 75 MW of installed capacity uses steam at 65 and 42 bar and 410 C, to produce 145 GWh/year.

In this mill the sugarcane trash is collected together sugarcane stalks chopped by harvesters and separated before feeding the sugarcane to one of two milling tandems. The separated trash is then cleaned, chipped and carried by conveying belts to be burned mixed with bagasse in the boilers. According to Eng. Ronildo Campos da Silva, responsible for this unit, its overall cost was R$8 million and the maximum capacity is 40 ton/hour, separating typically 60 kg of trash per ton of sugarcane. The moisture of trash is about 38% and the maximum soil content is 8%. For an average milling of 1200 ton/hour, about 300 ton/hour of bagasse are produced, which is blended with 5 to 10% trash to be used as fuel.

This cleaning unit has been operating in satisfactory conditions during the last three years and some improvements have been introduced, mainly in the straw and soil separation drums, adding baffles and changing the velocity of air streams. Nevertheless, according to the mill personnel, there is a large room for additional improvement, considering for instance the different trash conditions depending on the weather during harvest and the potential of introducing automatic control systems to optimize separation, evaluating moisture, density, straw fraction, etc. and adjusting properly parameters as belt velocity and fans rotation. The mill is aware about the risk of burning in the piles of sugarcane straw and adopts special attention to the storage of this material.

Always according to information given by the Usina Alta Mogiana personnel, the cleaning of sugarcane improves, mainly during wet and rainy periods, the quality of sugarcane juice and consequently of sugar (evaluated by its color), as well as to increase significantly the net processing capacity of milling tandem. These indirect advantages, as well as the cleaning efficiency and the solids balance since the harvesting is still to be better assessed.

Figures 2 and 3 present respectively the trash blower/separator (with two fans, separates trash from sugarcane chopped stalks) and the trash cleaning and preparation system (in the first plan is the rotating screen soil separator, followed by the straw chipper and belts to the boilers). The impurities resulting from this trash cleaning is shown in Figure 4.

Figure 2. Chopped cane trash separator, Usina Alta Mogiana (CAD photo, from Hassuani, 2013)

Figure 3. Trash cleaning system and chipper, Usina Alta Mogiana, 2013

Figure 4. Mineral and organic impurities separated in dry cleaning system, Usina Alta Mogiana, 2013

Visit to Usina da Pedra (25/06/2013)

Situated in Serrana (SP), this mill is the leading unit of Pedra Agroindustrial S.A., a holding company with other three mills. For the current harvest season (2012/2013) it is forecasted for Usina da Pedra to process about 4 million ton of sugarcane (about 22,000 ton/day), to produce 260,000 ton of sugar, 173 million liters of ethanol and 425 GWh of electric energy, in a cogeneration plant with 35 MW operating with live steam at 67 and 450 C. This mill has been implementing several technological improvements and innovations in the sugarcane agroindustry; among them one can mention the PHB Industrial S.A., a subsidiary operating a pilot plant using sugar as feedstock to produce PHB (polyhydroxybutyrate), a biodegradable polymer.

Usina da Pedra implemented during the last two years a scheme for collecting sugarcane trash left in the field after stalks harvesting. This trash is left some days to dry, then a sequence of operations is developed: 1) the trash is raked (forming a row), 2) the trash is baled (in this case as large rectangular bales, weighing about 300 kg, more compact and easier to transport compared with round bales), 3) the bales are carried to a loading area, using special tractors, 4) from this area, the bales are transported to the mill, and, 5) in mill, the bales are dismantled, the trash is cleaned of mineral impurities, shredded and finally conveyed to the boilers.

Figures 5 to 8 present some views of the equipment utilized for operations of trash raking, collecting, dismantling and shredding, taken during this visit to Usina da Pedra. These photos were taken in field to be replanted, with plants that will be removed. Usually these operations are conducted after harvesting and before sugarcane sprout.

Figure 5. Mechanical rake utilized for preparing rows of trash, Usina da Pedra, 2013

Figure 6. Baler collecting trash and downloading a bale, Usina da Pedra, 2013

Figure 7. Trash bales ready to be transported to the mill, Usina da Pedra, 2013

Figure 8. Bales dismantling and trash shredding system, Usina da Pedra, 2013

According to the personnel from Usina da Pedra that guided the consultants during this visit, Engs. Matheus Biagi Carvalho and Thiago Zampar Serra, the amount of trash collected depends essentially on the weather, and the operation is held when moisture is above 15% and/or the soil content is above 5%. The trash receiving system in this mill, able to open rectangular and round bales, can process daily up to 300 ton of trash, in its average operation means 2.5% more biomass and 4.5% more energy supplied for steam production in the boilers.

The selection of this system for trash collection in Usina da Pedra resulted from an analysis of constraints in sugarcane logistics, particularly with regards the impact of trash transport together sugarcane stalks, reducing the apparent density of truck load and consequently increasing costs. Since its start up, this system has received several improvements, aiming to increase the reliability of collecting equipment (mainly balers, which were originally models for hay and wheat straw baling, adapted to work with sugarcane trash, heavier and presenting tops and leaves as well as stalks and stumps, still deserving more development) and reduce the dust emission during the bales processing and trash moving in the mill, in this case with good results.

As a direct effect of the initial stage of this technology, the current final cost of trash at the mill is about twice the value initially expected, around 50-60 R$/ton. Synthetizing, the trash collection in the Usina da Pedra mill presents positive results and benefits, but still requires additional development and specific optimization.

Interviews with professionals from CTC, CTBE, IPT and UNICA (26-27/06/2013)

Due to the happening of the XXVIII Congress of International Society of Sugar Cane Technologists (ISSCT) and the III Ethanol Summit in São Paulo during the same week, both relevant meetings focusing sugarcane issues, it was relatively easy to coordinate meetings with professionals and representatives of institutions directly or potentially involved with the development and promotion of trash utilization and power generation, in sugarcane mills.

The list bellows present the people contacted and interviewed, essentially in order to evaluate new perspectives in terms of implementation arrangement and objectives consistence for the SUCRE project.

Professional	Institution	Field of activity
Bonomi, Antonio M.	CTBE	Sugarcane advanced process
Braunbeck, Oscar	CTBE	Sugarcane agricultural engineering
Hassuani, Suleiman	CTC	Sugarcane bioenergy
Landgraf, Fernando	IPT (President)	Thermochemical bioenergy processes
Leal, Regis L. V.	CTBE	Sugarcane bioenergy and sustainability
Rossel, Carlos E.	CTBE	Sugarcane industry chemical process
Souza, Zilmar*	UNICA	Sugarcane bioelectricity

*Interviewed by Remi Rijs

After a briefing by the consultants on SUCRE proposal, objectives and current situation, it was discussed the perspectives for project revision and continuity, considering new implementation conditions. The main conclusions from these talks are summarized as follows:

1. All professionals contacted consider relevant to resume the SUCRE project, taking into account the relevant potential for using trash rationally and promote power generation.
2. Trash is a biomass resource that can be available at attractive cost for power production and, in new scenarios, also as feedstock for biorefineries and advanced process. However, technology for trash collection is still in development, it should be improved and diffused.
3. The main challenges are in the field operations, the best route for green cane harvesting (carrying the trash together or separate of stalks) is still to be defined, maybe there is room for different approaches depending on the soil, logistics, variety, climate, etc.
4. IPT declined to participate directly in a leading role in the SUCRE project, considering that the main aspects to be explored and developed are mostly

associated to agricultural engineering. However, he offered the experience of IPT with materials and processes, probably required in some tasks of this project.

5. All professionals from CTBE presented an enthusiastic support to the idea of their institution to lead the SUCRE project in revised version. It is relevant to add that some of them (Braunbeck, Regis and Rossell) worked for years in CTC and have a good knowledge of this project and the previous one. Trash collection and use for power and other processes is a central subject to CTBE and their most active and senior experts affirmed that a project as SUCRE is absolutely fitted to be part of their regular program of activities.
6. UNICA representative endorsed the resuming of SUCRE project, commenting also that electricity is becoming an important product of the sugarcane agroindustry, reinforcing the need of trash rational utilization.

Visit to CTBE and CNPEM (10-11/07/2013)

Considering the profile and activities developed by Brazilian Bioethanol Science and Technology Laboratory (CTBE), a federal institution located in Campinas (SP) and focused on applied R&D in sugarcane agroindustry, and the interest shown by CTBE professionals in undertaking the SUCRE project, it was arranged a visit to this national laboratory and its Director, Prof. Carlos Alberto Labate (in 11/07). Since CTBE is a laboratory integrating the Brazilian Center of Research in Energy and Materials (CNPEM), it was arranged also an appointment with its General Director, Prof. Carlos Alberto Aragão de Carvalho Filho (in 10/07). Besides the CTBE, CNPEM currently houses the Brazilian Synchrotron Light Laboratory (LNLS), the Brazilian Biosciences National Laboratory (LNBio) and the National Laboratory of Nanotechnology (LNNano).

Figure 9. CTBE buildings in the CNPEM

In these visits Profs. Labate and Aragão indicated the clear interest of CTBE in assuming a project as SUCRE, pointing out the natural connection of their institutional objectives and activities with the SUCRE aims. CTBE is a major investment of the Brazilian federal government in science and technology related to sugarcane bioenergy, in line with the Brazilian efforts to produce sustainably energy and materials. Its buildings (offices and laboratories), inaugurated in 2009, occupy about 8,000 square meters, housing about 50 permanent researchers, a similar number of visitors (graduate students, PhD students, post-doctoral fellows and associated researchers) and 90 technical collaborators.

The main R&D programs of CTBE are: 1) industrial technologies for cellulosic ethanol production, 2) low impact mechanization of sugarcane agriculture, and 3) sustainability models for sugarcane agroindustry. Most activities are developed with governmental and private partners, such as sugarcane mills, equipment manufacturers, universities and other research institutions, from Brazil and abroad. The CTBE budget (from federal funds, excluding other complementary sources of financing) was about R$ 55 million in 2012 and a similar value is planned for 2013. The Director Plan 2010-2016 of CNPEM programed to CTBE for this period a total budget of R$ 371 million.

Prof. Labate guided a brief tour in the CTBE labs, stressing the relevance of trash utilization in the Pilot Plant for Process Development, and presenting the current stage of development of the Controlled Traffic Structure (ETC), an innovative machine designed to execute all the operations involved from the planting to the harvesting of the sugarcane, with a minimum contact between tires and plants. This equipment is expected to be useful for efficient and cost competitive sugarcane trash collecting, with reduced soil compaction.

An important feature stressed by Prof. Aragão with regards to a possible involvement in the SUCRE project and access to the GEF funds, is its legal and institutional character. CNPEM, which includes and administratively manages CTBE, is a Social Organization, in the framework of Law 9.637/1998. This law was issued aiming to improve the Federal Administration of qualified institutions, transferring to them the management of personnel, public resources and services, without the mandatory constraints of regular public institutions. The Social Organizations should be non-profit entities, developing social interest activities, related with education, scientific research, technological development, protection and preservation of environment, culture and health, and should have a Management Contract with the Federal Administration, setting targets and defining resources, to be regularly followed up by a board of independent auditors, indicated by the Federal government. Thus, CNPEM and therefore CTBE, are in formal and legal conditions to receive and manage extra-budgetary funds, conditioning that these funds must be dedicated to its regular activities. In fact, CTBE

has been developing partnerships and joint projects with several private companies, involving financing and resources for personal, equipment and services.

The relationship of the SUCRE project aims with the regular CTBE program of activities can be explicitly observed in the Director Plan of CNPEM, part of the Management Contract 2010-2016, signed with the Ministry of Science, Technology and Innovation (ABTLuS, 2010). Among the CTBE objectives in this document are clearly stated in the Agricultural Program (pg 52) to promote the partial removal of cane straw, with lower content of mineral impurities and lower shipping cost to be used as fuel in boilers, including adopting innovative equipment (such as the mentioned ETC equipment) and in the Industrial Program (pg 44) is included to develop studies in thermochemical process for using straw in boilers, looking for improvements in the energy balance and electricity production.

2.3 Research objectives revision and budget evaluation

The main objectives of the SUCRE project are still valid, justifiable and relevant: a) contribute to transforming the nature of electricity generation in the sugarcane industry in Brazil; b) promote the utilization of a new renewable fuel; c) contribute to an expansion in the sustainable use of biomass for energy; d) introduce new technology to the sugarcane industry; and e) lead to reduced greenhouse gas emissions from electricity supply in Brazil. These objectives, which mean in summary to promote increased sales of renewable energy to the grid by the sugarcane sector in Brazil, are well aligned with GEF Strategic Objective 4 (To Promote On-Grid Renewable Energy).

Nevertheless, as observed in the analysis of SUCRE PRODOC, some specific objectives should be revised, since in the last years some mills have been implementing trash collecting and use as fuel and the trade of electricity surpluses in sugarcane mills is already a reality in several plants. Anyway, it is difficult to affirm that the trash utilization was “commercially launched” or the use of bagasse and trash for electricity generation is largely adopted in Brazil. Actually there is a large room to increase significantly both trash collection and power production to the grid in the context of this agroindustry and a project as SUCRE has still strong and good reasons to be put forward, mainly focusing effectively to implement, consolidate and diffuse efficient, competitive and reliable technologies for trash collecting and transport.

It is worth to mention that, in a new phase of SUCRE project, under a new institutional arrangement, it should be opened the opportunity for the new leading institution revise and detail properly the expected project outcome (SUCRE PRODOC, Table 5, pg. 25/43), stressing aspects and objectives that today are more recognized as relevant, such as the harvesting machinery development, the fraction/amount of trash to be left on the field, and regulatory aspects of interconnecting independent power plants.

Naturally connected with such specific objectives revision, the budget should be also revised, because it was essentially prepared almost ten years ago and probably the former objectives will be revised. This revision should be done by a team of experts and discussed and approved timely by UNDP/GEF.

2.4 Implementation arrangements evaluated

Looking for to define a new and consistent implementation arrangement for resume the SUCRE project, some alternatives were explored. As main constraints, considering the current situation of this project, besides to be non-profit institution, it was required an effective experience with sugarcane bioenergy technology development, diffusion and implementation, good networking and visibility to the sugarcane agroindustry, and, last but not least, clear interest and strong commitment with the main project aim: to promote sustainable bioenergy from sugarcane.

Under these conditions, universities and research centers (such as IPT (SP) and INT (RJ)) were initially considered, but further discarded, mainly due the lack of effective experience in the whole field of the SUCRE project (sugarcane agriculture and industry issues) and due to limited links with productive sector.

In this context CTBE naturally aroused as a good alternative. This Brazilian Bioethanol Science and Technology Laboratory, heir of several senior experts from CTC and is developing a broad applied research program, which includes trash collecting and use for power generation, has consolidated his role and start to present solid contribution to the sustainable development of sugarcane agroindustry in Brazil and other similar countries.

In some sense, CTBE appears as the “only one” alternative institution to assume SUCRE project, accomplishing enough the above-mentioned requirements. But in fact CTBE represents an excellent alternative, with highly qualified team of professionals, modern infrastructure, good relationship with mills, non-profit and legally qualified to access GEF funds, in a few words, the best alternative possible.

3. Conclusions and recommendations

Considering the current situation of SUCRE project and the need of resuming or closing its activities, the analysis of project documents, the technical visits to two mills collecting (using different technologies) and using trash for power generation and the several interviews conducted with experts on different fields of sugarcane agroindustry, allowed to establish a set of clear and robust opinions, some of them already presented in the previous GEF study (Hassuani et al., 2005):

1. the use of trash presents relevant benefits, from the agronomic perspective until the increase of energy surpluses to the grid and GHG emission mitigation, making this project worthwhile, with effective potential to be implemented in competitive conditions and be replicated in other similar conditions abroad.
2. the technology currently available for trash collection, transport and use have been improved significantly and is somewhat already available, but still demand efforts to reach better levels of reliability, performance and cost, before to be largely diffused and adopted.
3. the trash removal impacts and benefits depends on many factors; sugarcane variety, terrain slope, weather, soil type, etc., and controlled studies will be important to define the correct amount to leave on soil, taking into account the impact on nutrients recycling, carbon dynamic in soil, erosion protection, ratoon sprouting, water balance, among other issues.
4. the electricity generation in sugarcane mills, using bagasse and trash, is enough known and partially adopted, presenting good potential for expansion, but lacks of clear public policies in the power sector.
5. a project as SUCRE is relevant to accelerate the development and diffusion of technology for trash collection and use, including the increase of electricity trading with public utilities.
6. CTBE presents qualified human resources, good infrastructure, links already established with productive sectors and proper legal base to undertake the SUCRE project, and more relevant than these points is the very positive response to the idea of assuming this project, as clearly expressed by its managers and leading professionals from CTBE, some of them directly involved in the earlier GEF project with CTC.

Defined the CTBE as a consistent alternative to retake SUCRE project, it is necessary to develop actions towards to officially confirm its goodwill and interest, and to obtain its clear commitment towards the objectives of this project. Of course that it depends on the usual procedures adopted by UNDP/GEF, but certainly a Memorandum

of Understanding could be a good starting point, outlining reciprocal compromises and agreements, which should include a revision of specific objectives and deadlines, adjusting the outcomes and products, as well as a preparation of a new budget, of course considering the expenses already executed and the overall availability of funds.

In a complementary line, it is interesting in this revision to consider additional sources of resources and co-financing, that can be obtained from the MCTI directly, and also from BNDES and FINEP. In this moment, when the Brazilian government start to redefine one set of public policies and measures towards to recover the sugarcane agroindustry, this kind of project presents, in addition to its environmental and sustainability positive aspects, good conditions to improve the profitability of this activity, reducing losses and adding value to a by-product still almost without use.

Finally, considering the SUCRE project outcomes, it is important to stress the importance of supply clear and accessible information designed and oriented to the decision makers in this agroindustry. The effective implementation of improved technologies for trash collection and use will happen as fast as such communication barrier will be eliminated.

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