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A proposal of electrical power supply to Brazilian Amazon remote communities

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ABSTRACT

This paper focuses on supplying electrical power for remote communities of the Brazilian Amazon using regional biomass, specifically palm oil biomass, as a primary energy source. The use of Straight Vegetable Oil (SVO) as fuel, is indicated for isolated communities, where the hydro plants or the installation of transmissions line are impracticable. The use of vegetable oils produced in the communities, is a solution when an adequate infrastructure to extracting the oil is available. Brazil is able to use an enormous diversity of vegetable oils, due to a great variety of plants, and the favorable climatic conditions. Technical, economic, environmental and social aspects are analyzed in order to provide a basis for electrical power supply viability in these communities. A case study is presented focused on a typical Brazilian Amazon community located in the State of Pará in order to demonstrate the applicability of the proposed viability strategy.

1. Introduction

The objective of this paper is to present an alternative of electric power supply to Brazilian Amazon remote communities, by the use of straight vegetable oil, from palm oil plantation, in a mixture with diesel oil in a proportion not to cause damage to the operation of the diesel generator. The main difference between this proposed supply alternative as compared to the conventional one that is based exclusively in using the diesel oil alone, is that the community will be involved in the process of planting the palm and extracting the oil, which is beneficial for economically dynamising the community through job creation and improvement in income by commercializing the surplus production of palm in the regional market.

Besides these commented aspects the proposal presented in this work constitutes an intermediate solution in the sense of maintaining the existing generation model, which is mainly based on using diesel oil, making it economically viable by the mixture of straight vegetable palm oil, obtaining, this way, lower tariffs for the generated energy. Another strong motivation to using this proposal is that the diesel motor technology is frequently useful by the population, once this technology has a wide use in generating electrical power as well as in driving thousands of small boats used for the transportation of people and goods in the many small rivers existing in the region.

Although other alternatives as wind and photovoltaic energies may also be possible and viable, they involve more

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advanced technologies which frequently demand an expert to operate and maintain these generating systems. This technological aspect has demonstrated to be a complication factor in small remote communities.

2. Regional contextualization

In Brazil the Amazon Region is the one which presents the largest amount of communities living in remote areas. These isolated Brazilian Amazon communities are generally small scattered population groups, typically ranging from 100 to 500 inhabitants (about twenty to one hundred families) with poor or nonexistent work conditions. These communities, totaling approximately 6,300,000 Brazilians, live on islands and other remote locations that are usually separated by wide rivers [1]. They make up around 30% of the population of the region and have no formal occupation. Their survival depends on hunting, fishing, family agriculture, and forest exploitation and their homes lack electric power, which cannot be economically and technically supplied by conventional systems or by the National Interconnected System. Fig. 1 shows typical homes in isolated Amazon communities.

3. Electric energy supply

Among the existing alternatives to electrical energy supply to small remote communities in the Amazon Region, small diesel oil generation systems are the ones mostly employed, which exhibit serious restrictions on operating conditions, with frequent energy interruptions, presenting also a poor power quality performance with respect to frequency and voltage regulations. Additionally these generation systems are supposed to operate only few hours a day, usually 4–6 h during the night period, besides also presenting high maintenance costs. However, most of these isolated communities are located in areas which present some renewable resources, as biomass for example, with good potential to generate sufficient electrical power to supply the communities.

Therefore, the search for more specific mechanisms based on regional resources to make power generation available, is a vital step in adding and offering other benefits besides energy itself to the communities served. Such new mechanisms may be quantified and customized in an innovative manner by defining a few viability indicators that will be calculated and analyzed in the case study that follows, which is focused in the use of a mixture of straight vegetable oil, from palm oil plantation, with diesel oil with the objective of obtaining an alternative for the diesel generation system largely employed in the region. This case study will be carried out in a typical rural community in the State of Pará-Brazil, which already presents a good infrastructure for commercialization of palm oil. Initially some technical aspects on the palm agriculture will be introduced, as well as some information about palm plantation in the State of Pará.

Fig. 1 – Sample picture of homes located in remote communities.

3.1. *Palm oil characteristics*

The use of palm oil is justified as it offers the highest productivity of oil per land unit. One hectare of this oleaginous palm can produce between 3 and 5 t ha^{-1} y^{-1} of oil [2] compared to soy (0.4–0.6 t ha^{-1}), rapeseed (0.8–1.1 t ha^{-1}), and sunflower (0.6–1 t ha^{-1}). It is also a crop that requires low mechanization and low use of agricultural pesticides.

African oil palm (*Elaeis guineensis*), is a perennial plant, of tree size (a palm of African origin), that has been cultivated in Brazil since the XVII century, initially in the State of Bahia and later in the State of Pará, with an economic life of 25 years for agro-industrial use, with production well distributed during every month of the year.

The palm develops well in the humid tropics, in bands of land extending 10° to the north and also to the south of the equator. In order to grow satisfactorily, the palms demand specific climatic conditions, with abundant light, a hot climate with temperature averages never less than 25 °C, besides a high rainfall rate (≅2000 mm of rain) well distributed throughout the year [3]. The favorable climatic conditions for this crop in the Brazilian Amazon have motivated the installation of commercial plantations, transforming this region into the largest oil palm production center in the country.

With an agro-industrial park made up of ten companies, Pará is the largest Brazilian producer, being responsible for approximately 85% of the total of palm oil produced [4].

4. Case study

Igarapé-Açu community, at municipality of Mojú – State of Pará, is far 10 h by boat, from the Moju city downtown, and is located on the right side of the Moju River, tributary of the Tocantins River, with Geographic Coordinates 02° 34′ 47.5″ S e 49° 09′ 29.7″ W, and is composed by three population groups: the first one at the riverside, with about 20 residencies, the second one, 1 km far from the riverside, with about 40 residencies, the third one around 5 km far from the riverside, with about 20 residencies, totalizing 400 inhabitants.

The community has a school, a public telephone that functions by a photovoltaic panel, an evangelic church and a catholic church. It also possesses a generator group, bought by the inhabitants that supply electrical energy to some residencies located on the riverside, for some hours a day. But due