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A PRELIMINARY EVALUATION OF RENEWABLE ENERGY FROM THE BIOMASS OF THE SECONDARY FOREST OF COSTA RICA

THIS PAPER MAKES A PRELIMINARY COMPARATION OF THE ENERGY CAPTURED EVERY YEAR BY THE SECONDARY FORESTS IN COSTA RICA WITH THE NATIONAL CONSUMPTION OF ENERGY. IT ESTABLISHES THE AMOUNT OF PURCHASED ENERGY THAT COULD BE REPLACED BY THE BIOMASS ENERGY THAT COMES FROM THOSE FORESTS AND SUGGESTS THAT GIVEN THE HIGH BIOMASS POTENTIAL OF THESE FORESTS, THEY COULD BE USED TO REPLACE FOSSIL FUEL IMPORTS.

Since the consumption of fossil fuels has started to contribute significantly to global warming, foreign imports such as petroleum represent a major expenditure for developing economies especially as its price increases, and crude reserves start to become scarce; new energy alternatives will be required especially in developing countries. Secondary forest may represent an alternative for the endogenous development of tropical countries such as Costa Rica.

The amount of secondary forest in Central America has begun to increase since old pastures have started to be abandoned (REPPETO *et al.*, 1992). The energy potential of secondary forests can be studied from a biophysical perspective considering the concept of "energy return on investment" (EROI) (HALL *et al*., 1985). This concept can be applied to the amount of energy that is annually stored in the forests of Costa Rica that can be extracted and converted into "free energy". The EROI is defined as:

$$\text{EROI} = \frac{\text{extracted energy}}{\text{energy required to extract it}}$$

"Free energy" is defined as the total amount of energy that end consumers can use (HALL *et al.*, 1985). It can be calculated with the below formula based on the EROI:

$$\begin{pmatrix}\text{Free energy}\\ \text{from forests}\\ (\text{kcal} * \text{yr}^{-1})\end{pmatrix} = \underbrace{\begin{pmatrix}\text{Total hectares}\\ \text{of forest}\\ (\text{ha})\end{pmatrix} * \begin{pmatrix}\text{Mean annual}\\ \text{increment}\\ (\text{m}^{-3} * \text{ha}^{-1}\,\text{yr}^{-1})\end{pmatrix} * \begin{pmatrix}\text{Caloric}\\ \text{power}\\ (\text{kcal} * \text{kg}^{-1})\end{pmatrix} * \begin{pmatrix}\text{Density}\\ \text{of wood}\\ (\text{kg} * \text{m}^{-3})\end{pmatrix}}_{\text{Extracted energy}} * \frac{\text{EROI} - 1}{\text{EROI}}$$

Since:

$$\text{Free energy} = (\text{extracted energy}) - (\text{energy required to extract it})$$

There are 0.3 million hectares of secondary forest in Costa Rica and 1.5 million hectares that are at this moment used as pasturelands. However, a large part of these will soon become secondary forest given the de-

creasing price of meat and the overgrazing of many pastures. This paper compares free energy from the secondary forests with energy consumption in Costa Rica in order to suggest biomass management of these forests as a preliminary research hypothesis.

METHODOLOGY

The data of the area of secondary and primary forests between 1967 and 1987 comes from the book "Accounts overdue" edited by the World Watch Institute (REPPETO *et al*., 1992). REPPETO quotes BROWN *et al.* (1989) in order to give a value to the growth of secondary forest in Costa Rica: 27.5 to 33.8 m^3/hectare/year. CHAVES (1991) gave the value of 11 species of trees grown in Guanacaste (in northen Costa Rica). The highest growth was found in the following species: *Bombacopsis quinatum* and *Enterolobium ciclocarpum,* the first belonging to the family *Bombacaceae* and the second to the *Leguminoseae*. Those values were 24.5 m^3/hectare/year for the former and 15.5 m^3/hectare/year for the latter. The value used in this evaluation was the mean of 20 m^3/hectare/year. CHAVES´ values are given for trees with a diameter greater than 10 cm in reference to silvicultural values, and their total biomass is therefore much higher. In a personal communication Ortiz* proposed that those values should be multiplied by 1.8 taking into account not only the volume harvested for timber but the total biomass volume without green leaves. The energy value of the biomass of 3.897 kilocalories per dry kilogram comes from GOLLEY (1961). The density values for wood can vary in each species and BROWN (1997) compiled most of these values for tropical wood. He gave the value of 0.35 gram per cubic centimeter for *Enterolobium ciclocarpum* and three values for *Bombacopsis quinatum*: 0.38, 0.45 and 0.51 g/cm^3. Those for other secondary forest species are between 0.3-0.5 g/cm^3 and the mean of 0.4 g/cm^3 was used.

The energy return on investment (EROI) for a wood based energy farm producing liquid fuel was given by TILLMAN (1978). TILLMAN´s values assume hydrogenation and the introduction of liquid fuel into the national energy transportation system. For TILLMAN´s technology, more than 60% of the kcal used come from the conversion energy costs. Although other authors (HALL, 1985) suggest that preliminary calculations for the EROI of plantations (1.2:1) are much smaller than for naturally grown wood, this was the value used.

* Edgar Ortiz is Costa Rican Ph.D specialized in tropical biomass measurements.

RESULTS AND CONCLUSIONS

Figure 1 compares the values of the total energy coming from secondary forests corrected with EROI values of 1.2 and 2, with the total amount of energy and the consumption of fossil fuels used in Costa Rica over a period of 30 years.

The following results were obtained:

· These values show that in the 1980s the biomass energy corrected with an EROI value of 1.2 represented a third of the total energy used in Costa Rica.

· Nearly all the energy coming from imported fossil fuels could have been replaced in the same decade by the secondary forests biomass even without considering any improvement in the technology of biomasss energy production since 1978.

· The energy used in the country is always less than the amount of energy coming from non-corrected secondary forests.

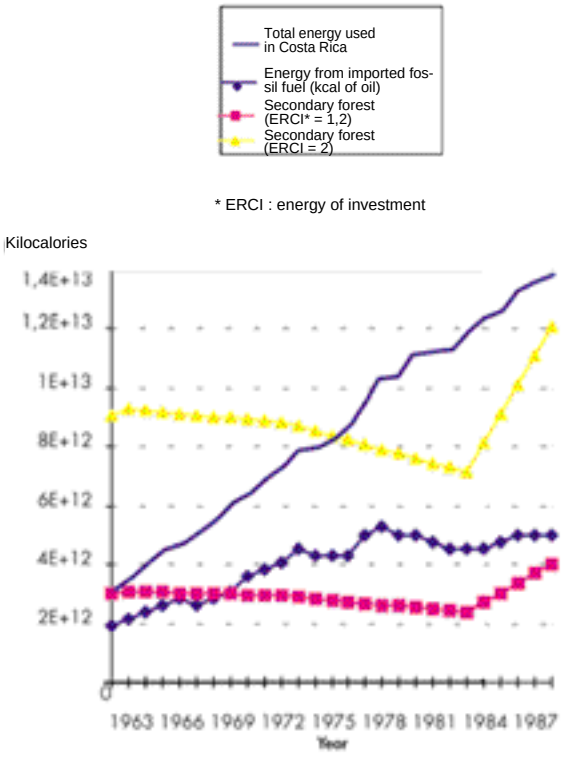

Figure 1. Energy from secondary forest vs total and fossil fuel consumption in Costa Rica.
Énergie emmagasinée par les forêts secondaires comparée à l'énergie totale consommée au Costa Rica et à l'énergie importée sous forme de pétrole.

This magnitude gives an idea of the potential used for biomass that secondary forests could have in Costa Rica in order to replace certain energy imports. If all the fossil fuel imports on the one hand, and Costa Rica's energy imports on the other are to be produced locally, technological improvements should attain EROI values of 1.2 and 2.

According to these values, a wood based energy farm system that could cover the main abandoned secondary forest areas of a tropical country and produce hydrogenated liquid fuel and put it into the national energy transportation could, from a biophysical perspective, represent a potential endogenous development alternative for tropical countries such as Costa Rica.

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