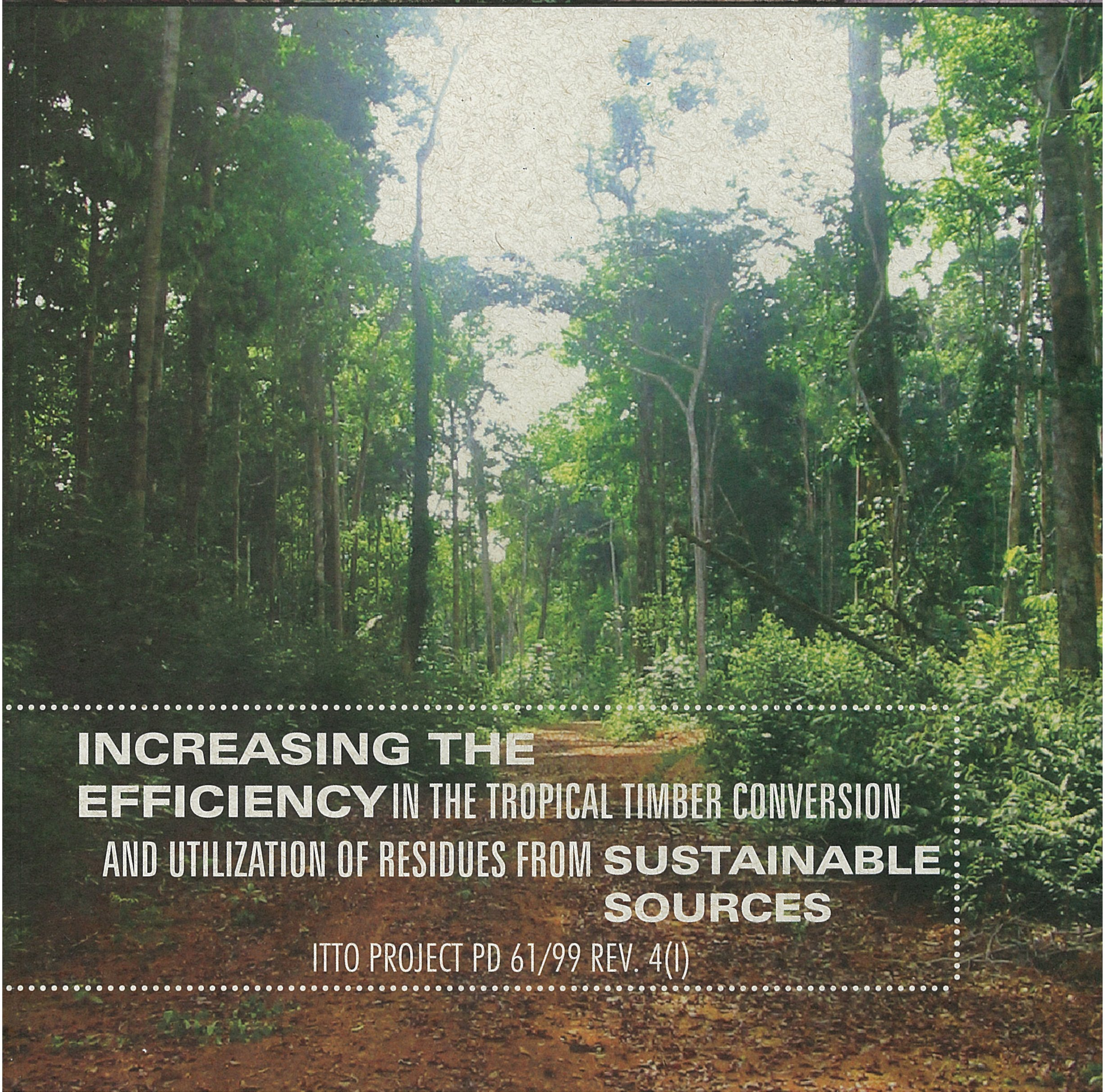

INCREASING THE EFFICIENCY IN THE TROPICAL TIMBER CONVERSION AND UTILIZATION OF RESIDUES FROM SUSTAINABLE SOURCES

ITTO PROJECT PD 61/99 REV. 4(I)

INTERNATIONAL TROPICAL TIMBER ORGANIZATION – ITTO
Federal University of Paraná Foundation for
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Siqueira, Joésio Deoclécio Pierin

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PREFACE

The transformation of tropical forest areas into other uses, especially agriculture and animal farming, is the largest threat to the production of timber and to make sustainable management plans feasible for this type of forest. In Brazil, an example of this situation is the growth of land clearing in the Brazilian Amazon Region over the last few years, which is resulting in a change of forest cover of more than 20 km^2 per year, with a loss of sustainable production potential of commercial timber logs in the order of 2 million m^3 per year.

The search for any alternative for making forest management feasible under a sustainable regime, whatever its economic, technical, social, environmental and other aspects, it is of fundamental importance to have a sustainable development process, one of the objectives of the International Tropical Timber Organization – ITTO, as well as fulfilling another of the Organization objective, which is the stimulation for the development of national policies that aim at sustainable use and conservation of tropical forests and their genetic resources, and the maintenance of ecological equilibrium in the region involved.

The study in question, financed by ITTO and carried out by FUNPAR tries to contribute to the sustainable development of the forest base in the Brazilian Amazon Forest, increasing the competitiveness of the timber productive chain through the aggregation of the value to its by-products, such as biomass from forest harvest and industrial transformation residues. The innovating factor of this initiative is the identification of external partners in the forest sector, for example, the generation of electric energy. Currently, the isolated Amazon communities use high cost diesel fuel (fuel from fossil origin) as a raw material for the production of energy, even with the availability of large quantities of biomass from a vegetable origin.

Another relevant factor, considered by the ITTO and the Brazilian Government for this study is the possibility of insertion of energy generation into local communities, creating a new productive activity, looking for a way of changing the picture for natural resource appropriation with an improved economic and social response, through sustainable forest use, while at the same time, providing a new form of increasing income and permanent job opportunities for these communities.

Thus, the project presented herein contributes to the fulfillment of ITTO objectives, by the fact of aggregating additional value to timber production chain, from the forest to industry, even contributing of making sustainable forest management more feasible, generating energy and improving the infrastructure for isolated communities, at the same time substituting a fossil origin fuel with a renewable source fuel, and most important permitting the use of natural resources in a way to make isolated communities of the Brazilian Amazon Region more dynamic.

Manoel Sobral Filho
Executive Director ITTO

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1 - INTRODUCTION

This document is the final report for ITTO Project PD 61/99, carried out by FUNPAR – Foundation of the Federal University of Paraná for the Development of Science, Technology and Culture, entitled "Increasing the Efficiency in the Tropical Timber Conversion and Utilization of Residues from Sustainable Sources".

The project execution timetable was the following:

- *Presentation of the Project to ITTO in 1999;*
- *ITTO Approval of the Project in 2001;*
- *Contract signing in August 2002;*
- *Contracting the main project team (coordinator and forest development specialist) and the ITTO non rejection in December 2002;*
- *Bidding for sub-contract for carrying out the surveys and evaluation of Forest/Forest Product Resources and feasibility study for energy generation, in 2003:*
- *Execution of surveys, evaluation and studies, in 2004;*
- *Holding of workshops for the discussion of the Project in 2005; and,*
- *Conclusion of Project, in 2005.*

THE PROBLEM

The tropical forest conversion expansion into other soil uses clearly demonstrates, amongst other things, that in many tropical areas the maintenance of the forest cover is not attractive and financially competitive. The largest restriction to the implementation of the forest management and the production of forest products in the largest part of the Amazon Region (that reduces the forest management competitiveness in relation to other economic activities) are:

- The restricted uses of species, because the timber consumer markets are far away from the production centers, absorbing only several selected species (less than 20% of the sustainable production), which coupled with the small local markets limits the use of a majority of the existing forest species in the areas under sustainable forest management;
- The absence of markets to absorb the set (variety) of species and forest harvest residues produced in the heterogeneous Amazon forest, when managed on a sustainable basis and conserving the biodiversity; and,
- The absence of a local market for the industrial residue.

Energy generation using the timber biomass is one of the alternatives to create and develop the local markets with a potential to absorb the non-marketable and low species use and the processing industry residues. Such that the two first (non-marketable species and forest harvesting residue) represent the largest part of the wood fiber material existing in the sustainable forest management areas in the Amazon.

OBJECTIVES

The overall objective is:
To contribute to the development of the sustainable forest base in the Amazon.
The specific objective is:

To demonstrate that the traditional forest product industry, together with a non-traditional timber consumer (energy generation industry) can contribute to the implementation of industrial operations, making the sustainable forest product industry a feasible operation in selected locations.

RESULTS

The expected results from the execution of the Project are the following:

- Data and information about the feasibility of sustainable forest management for the procurement of the traditional forest product industry and energy generation plants for the areas selected for case studies;
- To facilitate and stimulate the future development of demonstrative energy generation plants based on biomass with a forest origin (non-marketable species and forest harvest residues) and industrial residues, mainly by independent energy producers, as a means of increasing efficiency and reducing losses;
- Critical analysis and making information available about the potential to integrate sustainable forest management, the forest product industry and the energy generation industry in the Amazon;
- Amplification of the perspective for the development of demonstrative units linked to forest management, forest product industry and energy generation plants using forest biomass and industrial residues; and,
- Perspective for an increase in investments for the forest development in the Amazon.

TARGET PUBLIC

The target public for the project in question is made up of:

- Governments, timber and electricity consumers who will benefit from greater perspectives for sustainable forest development, based on sustainable biomass production to supply both the traditional forest product industry and the energy generation industry;
- Local communities that will benefit from increased employment perspectives and use of local resources;
- The local forest product industry and economy will have an alternative source of energy available, and in principle at a much lower cost; and,
- Environmental protection: generates benefits for the sustainable timber production, combined with the traditional use of forest products and energy generation, with a net carbon capture equivalent to the substitution of diesel currently consumed for electricity generation, as CO_2 emissions are reduced.

2 - METHODOLOGY

The study was carried out to meet the needs of the PD 61/99 Project presented to ITTO. Originally, two case studies were foreseen, with one in the Rio Branco Region in the State of Acre and the other in the Itacoatiara Region in the State of Amazonas. Between the presentation to ITTO and the field study in the Itacoatiara Region, the implementation of an energy generating plant was undertaken by the BK Group in conjunction with MIL (Precious Wood), which used all available combustible timber residues (biomass) in the Region.

As a function of this overwell situation, the Project team carried out negotiations with Jari Celulose S.A. (company in the Orsa Group in the State of Pará) and SDS – State of Amazonas Secretary of Sustainable Development, and proposed to ITTO and ABC the substitution of the case study in the Itacoatiara region by two others involving the Alto Solimões Region (State of Amazonas) and Jari/Orsa Region (State of Pará), such that both institutions agreed to the changes.

The methodology presented below contemplates the following aspects:

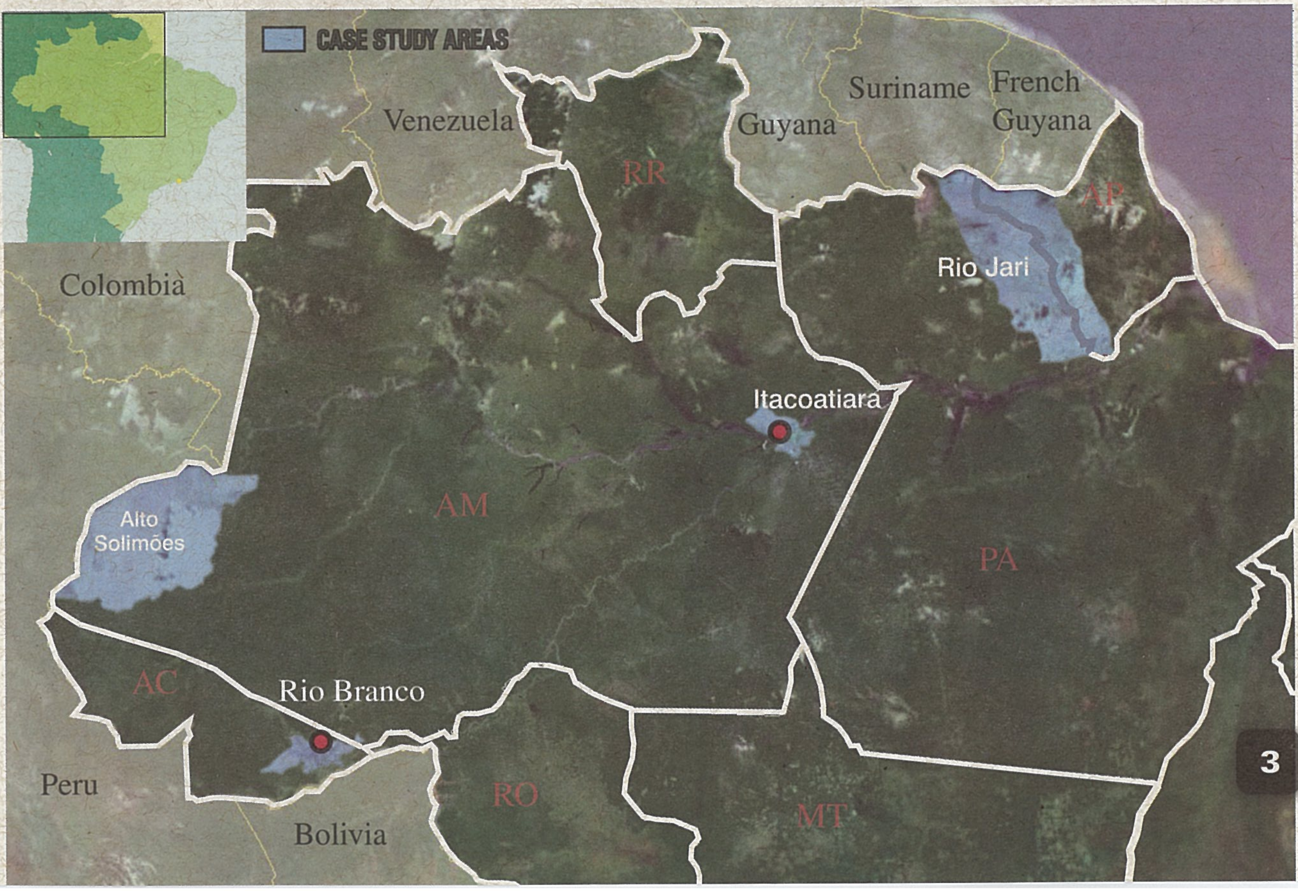
- Coverage of the study;
- Overall View of Biomass residues in the Amazon;
- Data collection;
- Estimate of available biomass;
- Energy plant design development; and,
- Feasibility study and risk analysis.

2.1 – STUDY COVERAGE

The project in question contemplates an information survey in four distinct regions (see Figure 01) with the purpose of energy generation based on biomass for 3 (three) of the four regions:

- Rio Branco (AC),
- Itacoatiara (AM);
- Rio Jari (PA); and,
- Alto Solimões.

Figure 01 – Location of the Study Areas



2.2 – BIOMASS TYPE

Energy generation is one of the options with a potential to create a local market, capable of absorbing the by-products (marginal biomass) generated in the timber productive chain (non-economic use) in the areas under sustainable forest management, from the forest to the industrial unit, contemplating the following products (Figure 02):

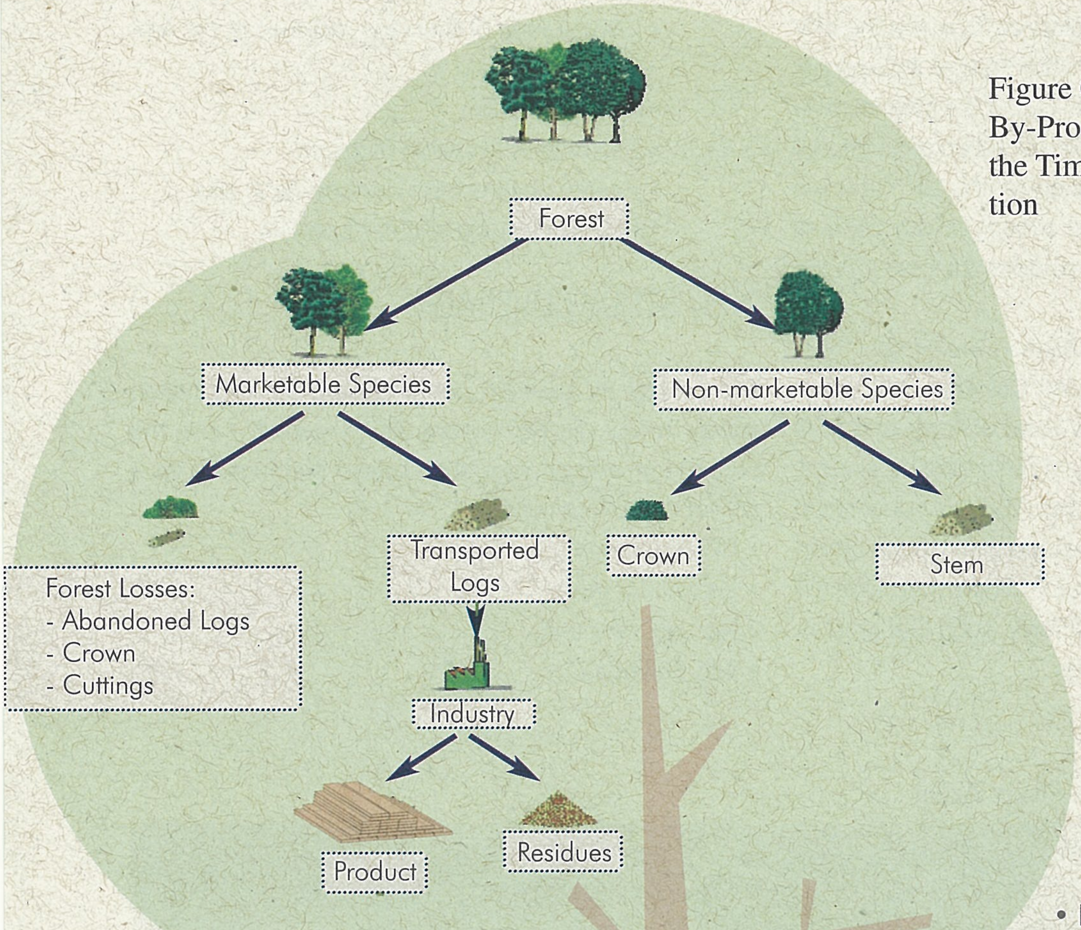


Figure 02 – Residues and By-Product Generation in the Timber Chain Production

• NON-MARKETABLE SPECIES

The non-marketable species correspond to mature trees existing in sustainable forest management areas (marginal biomass from forest management), ready to be sold, which make up part of forest species but are not saleable in the Region. The volume of this species group is made up of:

Stems; and,
Crown.

• FOREST HARVEST RESIDUES

The forest harvest residues is a by-product (marginal biomass) generated during the log production phase for marketable species, which are not transported to the industrial unit and remain in the forest, with no economic destination, including:

Crown,
Stumps, and,
Tree tops.

• INDUSTRIAL RESIDUES

Industrial residues correspond to by-products generated in the diverse phases of industrial transformation (marginal biomass), leftover from the productive process and in the majority of cases not sold, thus constituting an environmental liability for industry. The types of industrial residues are:

Saw dust,
Shavings,
Log ends,
Ends and wanes,
Bark,
Slabs, and,
Other losses from the industrial processing.

2.3 – DATA COLLECTION

Data collection includes the covered area for each case study and where information was surveyed at the various levels in the timber productive chain and feasibility studies made, including the energy generation unit and insertion of the energy in the distribution network, contemplating the following:

- BIOMASS:
    - Area with forest per Region
    - Area with potential for log production;
    - Mature (apt for harvest) timber volume (marketable and non-marketable);
    - Estimated crown volume; and,
    - Estimated Tree stem (log) residue generated by forest harvesting.

Data collection was carried out through the execution of the following activities:

- Review of existing studies:
    - Antimary State Forest;
    - IBAMA and others in Itacoatiara;
    - SDS and Forest Agency studies in the Alto Solimões Region; and,
    - Studies carried out by the Jari and Orsa Group in the Jari/Orsa Region.
- Interviews with institutions and researchers in each one of the Regions;
- Field data surveys, together with companies, NGO's and other institutions that carry out forest management;
- Data surveys of registered forest management areas:
    - IBAMA in the State of Acre,
    - IBAMA in the State of Amazonas (Itacoatiara);
    - Forest and Sustainable Business Agency and SDS in Amazonas; and,
    - Orsa Florestal.
- Data surveys for forest management areas registered in the state environmental agencies, IMAC, IPAAM and SECTAM.

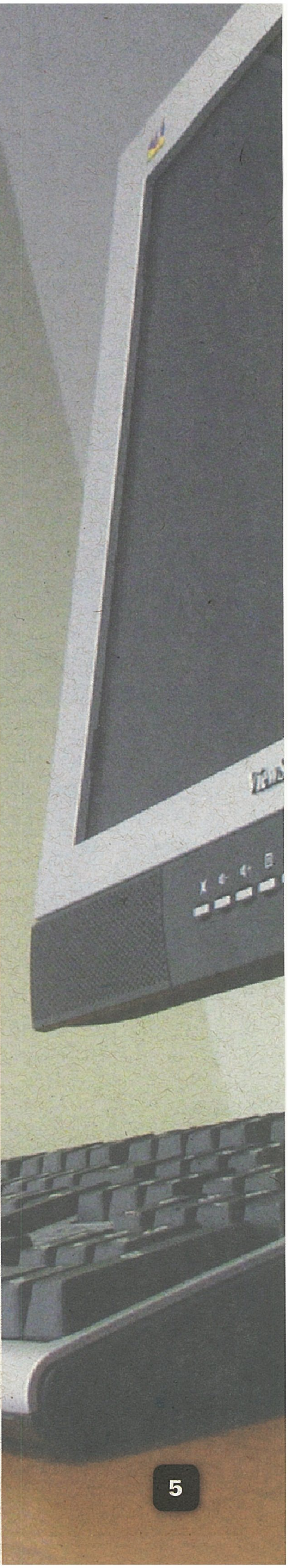
- ENERGY GENERATION:

Data collection for the information surveys about the energy generation involved:

- Energy generation and distribution companies in the 4 (four) Regions: and,
- Equipment manufacturers.

For the data surveys about energy generation, the following activities were carried out:

- Literature review of available information;
- Contacts and information surveys with energy generation equipment and machinery manufacturers;
- Contacts with energy distributors, ELETROACRE, CEAM and CELPA;



and,
- Contacts with energy generating companies.

- FEASIBILITY STUDY:

The following activities were carried out for data collection for the feasibility study:

- Literature review for forest product prices and costs in the States of Acre, Amazonas and Pará;
- Forest product prices and costs in the States of Acre, Amazonas and Pará;
- Price, equipment quality and technology information survey with energy generation machinery and equipment manufacturers;
- Contact with energy distributor, ELETROACRE, CEAM and CELPA; and,
- Contacts with energy generation companies.

2.4 – DETERMINATION OF BIOMASS VOLUME

The determination of the biomass volume available for energy generation was carried out for each type of residue generated in the timber productive chain:

- FOREST BIOMASS
  - Forest Harvest residue (marketable species):
    Stems; and,
    Crown.
  - Non-marketable species:
    Timber logs; and,
    Crowns.

- INDUSTRIAL RESIDUES

2.4.1 – FOREST BIOMASS

For the determination of the forest biomass volume, the crown and stem residue for harvested per tree volume was calculated:

- CROWN VOLUME PER TREE

The relationship between the crown volume and stem volume was studied by various authors, including JANKAUSKIS (1983) and HIGUCHI (1998), which will be used as a basis to estimate the crown volume in this study.

- STEM RESIDUES

The relationship between the log volume usable by industry and total stem volume in the Amazon Region was studied by various authors, such as JANKAUSKIS (1983) that obtained a relationship of 70.9% log and 29.1% residue, while IMAZON (1997) found a relationship of 78.7% log and 21.3% residue and more recently MANOA (2002) found a relationship of 69.4% for logs and 30.6% for residue. These studies will be used as a basis to estimate the stem residue volume for marketable species.

- DETERMINATION OF EXISTING TIMBER VOLUME

The existing timber volume in each Region was obtained through forest inventory information surveys and existing management plans registered with Ibama or State environmental agencies for each one of the areas object of the study.

- In the case of Rio Branco, the information from the forest inventory carried out in the Antimary State Forest for authorizations issued by Ibama and IMAC was used.
- In the case of Itacoatiara information contained in the management plans existing in Ibama was used.
- In the case of Jari/Orsa the information form the Orsa Florestal Management Plan approved by Ibama was used.
- In the case of Alto Solimões the management plans prepared by the Forest and Sustainable Business Agency in Amazonas in the Free Zone Green Program for the State of Amazonas was used as a basis.

- MARKETABLE SPECIES VOLUME

The marketable species volume was surveyed through an analysis of the forest harvest authorizations, previously indicated and studies with the timber consuming companies in each Region, contemplating:

- Determination of the average volume per hectare per species in each Region;
- Identification of species acquired by the market; and,
- Determination of the authorized marketable species volume for harvest and the remaining marketable species.

- NON-MARKETABLE SPECIES VOLUME

The non-marketable species volume (currently not sold) was obtained through management plan information, adopting the following procedures:

- Determination of the average volume per species for each Region;
- Identification of non-marketable species (not sold);
- Determination of total volume of non-marketable species; and,
- Determination of maximum harvest volume based on the relationship used for marketable species.

2.4.2 – INDUSTRIAL BIOMASS RESIDUE

Industrial residues are by-products generated during the timber transformation process, such as bark, slabs, wanes, ends, sawdust, shavings, rejected pieces and others.

The transformation factors used in this study to determine the industry residue quantities available were surveyed as follows:

- For the Rio Branco Region based on the forest sector assessment;
- For the Itacoatiara Region based on Ibama information;
- For the Alto Solimões Region based on information collected from companies; and,
- For the Jari (Monte Dourado) Region based on information provided by the company.

2.5 – ENERGY PLANT DESIGN

For the thermoelectric energy generation plant design, the following activities were carried out:

- Review and evaluation of the basic thermoelectric energy generation concepts;
- Evaluation of existing and available technolo-

gies for the energetic use of biomass;

- Analysis of the advantages and disadvantages of the existing thermal technology and machinery;
- Selection of the most appropriate thermal technology and machinery based on main product (electric energy or process steam) and the advantage and disadvantage balance for each one;
- Generating plant and equipment sizing to be used, adopting 2 (two) generation alternatives for each case study;
- Equipment and building technical specifications for each generating plant alternative;
- Plant macro location;
- Basic design preparation and preliminary physical plant layout;
- Identification and quantification of labor needs;
- Description of biomass procurement logistics to meet the energy generation plant needs; and,
- Specification of other plant needs.

The alternative generating plant designs were used as a basis to determine the investments necessary for their implementation, as well as operating costs, which will aid in feasibility study analysis.

2.6 – FEASIBILITY STUDY AND RISK ANALYSIS

The economic feasibility study and risk analysis were carried out with the objective of evaluating the profitability of the energy generating plants for the Regions being studied. For each alternative selected, two options were analyzed in the feasibility study:

- Energy generation for the market; and,
- Substitution of diesel by biomass.

For the energy generation for the market option, it was considered that the investor would receive benefits in the CCC account on the investment made.

For the substitution option, it was considered that the generation unit was consuming diesel and would begin to save on the cost of raw material, having a supposed revenue corresponding to the value saved.

For each proposed alternative by Region, the following economic indicators were analyzed:

i. IRR – The Internal Rate of Return is the remuneration rate for the undertaking over the capital invested.

ii. NPV – The Net Present Value is the net financial result at the present moment (date of investment) of a business for a given period, discounted based on a Discount Rate (DR), established by the investor (owner of the capital). For this study the DR was defined as 12% per year; and,

iii. PAYBACK - Payback is the time necessary to recover the investment made in the business.

For the economic/financial analysis, the feasibility study used the following information:

i. Plant size, in function of raw material availability, technology and generation capacity;

ii. Cash Flow preparation: cash inflow and outflow

a) Cash inflow:

- Electric energy sales revenue;
- Steam sale revenue (if applicable);
- Benefit from CCC account share (if applicable); and,
- Estimated diesel costs savings.

b) Cash outflow:

- Investment in fixed assets: machinery and equipment, buildings and installation and pre-operating expenses;
- Working capital investment;
- Production costs: fuel, labor, consumables, insurance and general expenses;
- Depreciation: machinery and equipment, buildings and installations;
- Amortization of deferred assets; and,
- Taxes.

iii. Horizon of analysis: 15 years.

The risk sensibility analysis included raw material price variations, the main operating cost component, and energy sales price, the main operating revenue component.

3 - BIOMASS

Biomass availability was determined for each of the case studies involved in the project in question, as shown below:

3.1 – OVERALL ASPECTS

As shown in the methodology, the biomass with a potential to meet the needs of the project in question is made up from:

- Biomass from the forest harvest residue (crown and stem);
- Biomass from non-marketable species (logs and crown); and,
- Biomass from industrial residues.

CROWN VOLUME

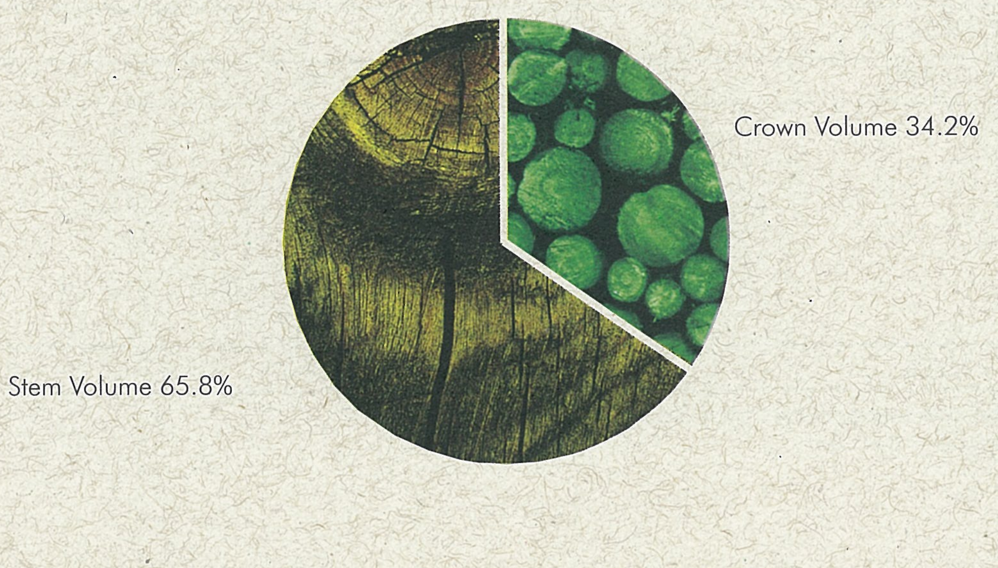
The relationship between the crown volume and the stem volume was subject of study by several authors including JANKAUSKIS (1983) and HIGUCHI (1998), such that HIGUCHI (op. cit.) found a relationship where the stem represents 65.8% of the total aerial part of the tree and the crown 34.2% (Table 01 and Figure 03).

Table 01 – Composition of Tree Volume

COMPONENT	%
STEM	65.8
CROWN (Residues)	34.2
TOTAL	100.0

Source: HIGUCHI et al., 1998 - Biomassa da Parte Aérea da Vegetação da Floresta Tropical Úmida de Terra Firme da Amazônia Brasileira (Biomass from the Aerial Part of the Tropical Rain Forest Vegetation in the Brazilian Amazon)

Figure 03 – Relationship between Crown Volume and Stem Volume



LOG (STEM) RESIDUES

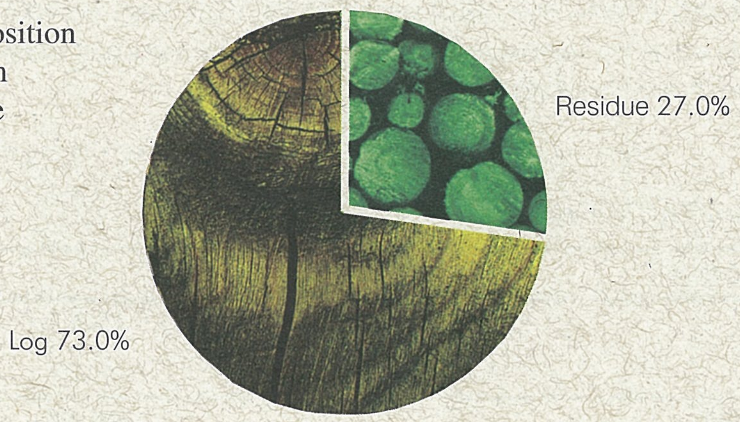
The relationship between the log volume used by industry and the total stem volume in the Amazon was subject of studies studied by several authors, such as JANKAUSKIS (1983) that obtained a relationship of 70.9% logs and 29.1% residue, while IMAZON (1997) found 78.7% logs and 21.3% residue and MANOA (2002) found 69.4% logs and 30.6% stem (Table 02 and Figure 04).

Table 02 – Log Residue (%)

COMPONENT	JANKAUSKIS (1983)	IMAZON (1997)	MANOA (2002)	AVERAGE
LOG	70.9	78.7	69.4	73.0
RESIDUE	29.1	21.3	30.6	27.0
- Hauling	22.0	5.6	13.2	13.6
- Abandoned Logs	7.1	15.7	17.4	13.4
TOTAL	100.0	100.0	100.0	100.0

Source: JANKAUSKIS, J. 1983. Avaliação de Resíduos Florestais da Exploração Mecanizada da Floresta de Terra Firme. (Forest Residues Evaluation for Mechanized Forest Harvest)
IMAZON; Vidal, E. et al., 1997. Redução de Desperdícios na Produção de Madeira na Amazônia. (Reduction of Losses from Timber Production in the Amazon)
MANOA, 2002. Análise da Viabilidade do Manejo Florestal em Fazenda Localizada no Município de Cujubim / RO. (Feasibility Analysis for Forest Management on a Farm Located in the Municipality of Cujubim / RO)

Figure 04 – Composition of Stem Volume



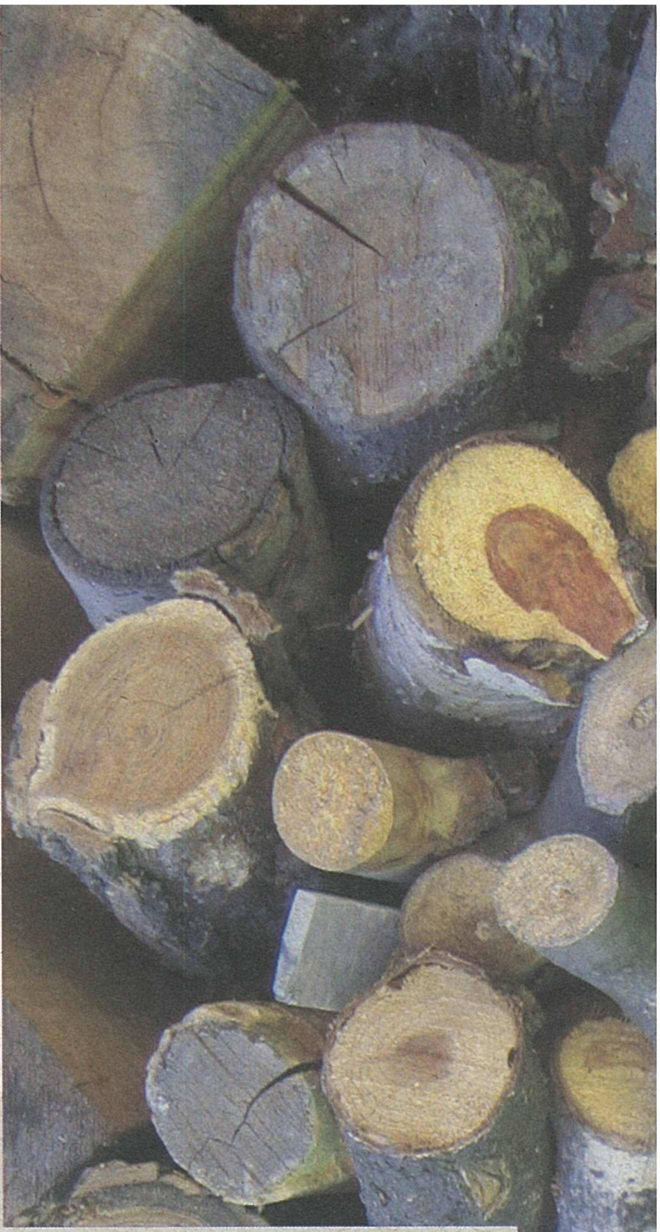
VOLUME RESIDUE PER TREE

The volume residue per tree was obtained by using indices obtained from the relationship between stem and crown and between the log volume and stem volume (Table 03).

Table 03 – Commercial and Residue Volume per Tree

COMPONENT	%
LOG (COMMERCIAL VOLUME)	48.1
RESIDUE	51.9
Stem Residue	17.7
Crown Residue	34.2
Ø < 35 cm	20.5
Ø ≥ 35 cm	13.7
TOTAL	100.0

Fonte: HIGUCHI et al., 1998, Biomassa da Parte Aérea da Vegetação da Floresta Tropical Úmida da Terra Firma da Amazônia Brasileira

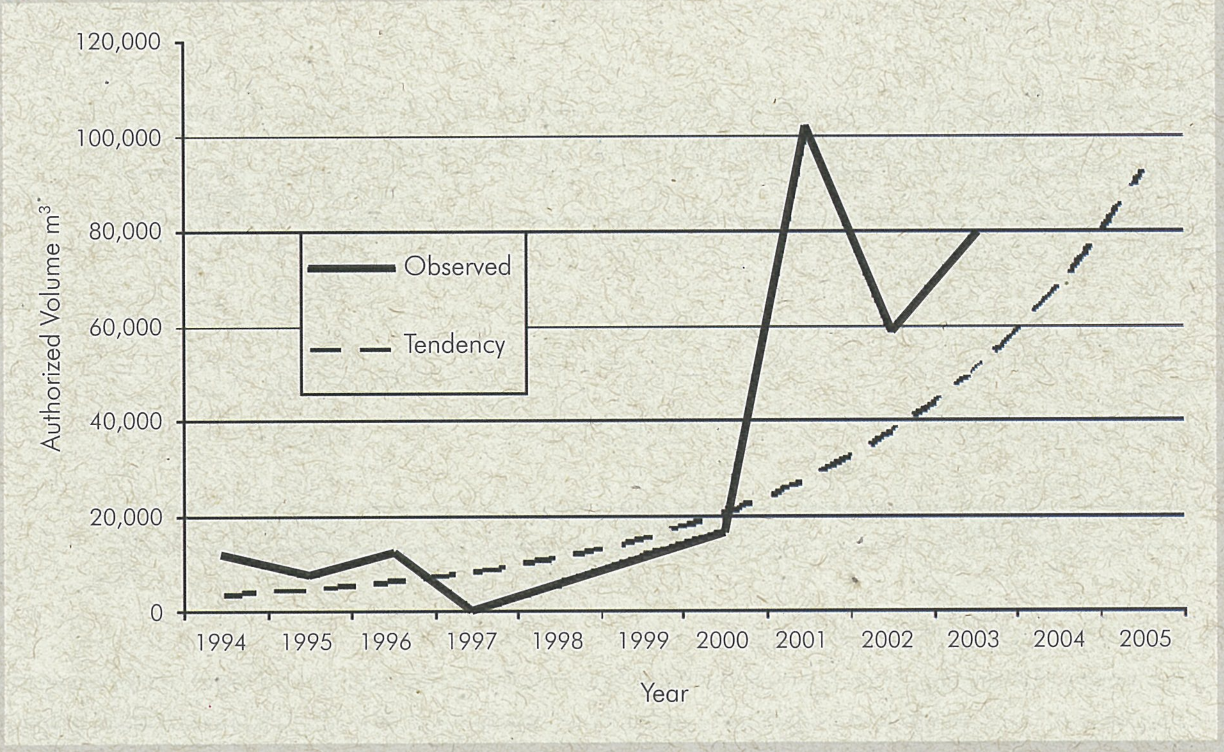


3.2 – RIO BRANCO

BIOMASS FROM FOREST HARVEST RESIDUES

The total volume authorized by IBAMA for harvest in the sustained forest management areas in the Rio Branco Region in the last three years (2001-2003) was 80 thousand m³/year (Figure 05).

Figure 05 – Volume Authorized for Harvest for the Management Plans in the Rio Branco Region



The average annual forest harvest residue volume generated from the management plans authorized by IBAMA in the Rio Branco Region is 86.3 thousand m³, of which 29.4 thousand correspond to stem volume and 56.9 thousand to crown volume (Table 04).

Table 04 – Estimate of Potential Biomass from Forest Harvest Residue Generated in the Region of Rio Branco

TYPE	AVERAGE VOLUME (m³ / year)		
	INDUSTRIAL USE	RESIDUE	TOTAL
STEM	79,970	29,428	109,398
Log	79,970	--	79,970
Residue	--	29,428	29,428
Crown	--	56,859	56,859
Ø < 35 cm	--	34,082	34,082
Ø ≥ 35 cm	--	22,777	22,777
TOTAL	79,970	86,287	166,257

BIOMASS FROM NON-MARKETABLE SPECIES

According to forest inventory and Antimary State Forest Management Plan information, the non-marketable species volume, with a DBH ≥ 50 cm is 35.84 m³/ha. For the study, it was established in a random manner that the maximum of 50% of this volume could be harvested for biomass for energy generation, whose potential average volume is 17.92 m³/ha of stem. The average authorized area for forest harvest was 4,125 hectares, which has the potential of supplying 73,920 m³ of logs per year of non-marketable species and a total biomass of 153,679 m³/year (Table 05).

Table 05 – Estimate of Biomass Production Potential for Non-Marketable Species from Forest Management Plans in the Rio Branco Region

TYPE	%	VOLUME (m³ / year)
STEM	65.8	101,121
Log	48.1	73,920
Residue	17.7	27,201
Crown	34.2	52,558
Ø < 35 cm	20.5	31,504
Ø ≥ 35 cm	13.7	21,054
TOTAL	100.0	153,679

BIOMASS FROM INDUSTRIAL RESIDUES

The forest-based industry log consumption in the Rio Branco Region, according to Acre forest sector assessment is 221 thousand m³/year, which has a capacity to generate a residue volume of 103 thousand m³/year, in function of the average yield for each type of industry (Table 06).

Table 06 – Estimated Industrial Residue Biomass Generated in the Rio Branco Region

INDUSTRY	TIMBER CONSUMPTION (m³/year)	AVERAGE YIELD (%)	RESIDUE VOLUME (¹) (m³/year)
Sawmill	144,613	50	72,307
Veneer	56,560	55	25,452
Processor	11,474	60	4,590
Carpentry	8,686	85	1,303
TOTAL	221,333	--	103,652

(1) Solid m³ (equivalent in m³ of logs)
Source: SEFE/AC (2002)

TOTAL AVAILABLE BIOMASS

The biomass available in the Rio Branco Region is 336.8 thousand m³, of which 28.8% corresponds to biomass from industrial residue, 25.6% to biomass from forest harvests and 45.6% to biomass from non-marketable species (Table 07).

Table 07 – Total Biomass Available for Energy - Rio Branco Region (m³ /year)

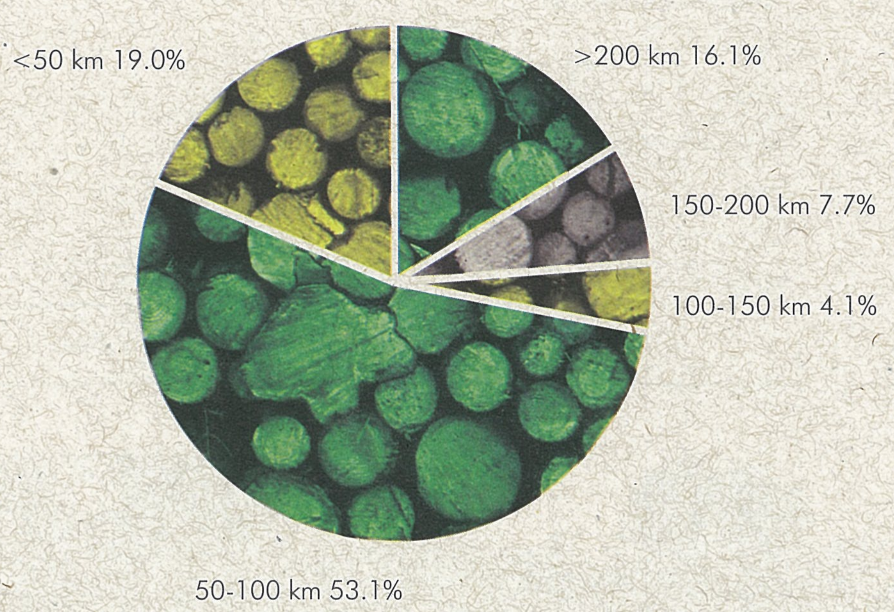
TYPE	EXISTING (m³ / year)	COMMITTED (m³ / year)	AVAILABLE (m³ / year)	%
Forest Harvest Residue	86,287	--	86,287	25.62
Stem	29,428	--	29,428	8.74
Crown	56,859	--	56,859	16.88
Non-Marketable Species	153,679	--	153,679	45.63
Stem	101,121	--	101,121	30.02
Crown	52,558	--	52,558	15.61
Industrial Residue	103,652	6,844	96,808	28.75
TOTAL	343,618	6,844	336,774	100.00

The largest part of the biomass in the Region (72.1%) is located within a distance by highway of 100 kilometers from the city of Rio Branco (Table 08 and Figure 06).

Table 08 – Biomass Distribution by Distance in the Rio Branco Region (m^3/year)

DISTANCE * (km)	HARVEST RESIDUE			NON-MARKETABLE SPECIES			INDUST. RESIDUE	TOTAL	%
	STEM	CROWN	TOTAL	STEM	CROWN	TOTAL			
< 50	--	--	--	--	--	--	63,971	**63,971**	19.0
50 - 100	20,549	39,704	60,253	72,058	37,460	109,518	8,940	**178,711**	53.1
100 - 150	--	--	--	--	--	--	13,704	**13,704**	4.1
150 - 200	3,242	6,264	9,506	10,898	5,656	16,554	--	**26,060**	7.7
> 200	5,637	10,891	16,528	18,165	9,442	27,607	10,193	**54,328**	16.1
TOTAL	**29,428**	**56,859**	**86,287**	**101,121**	**52,558**	**153,679**	**96,808**	**336,774**	**100.0**

Figure 06 – Biomass Distribution by Distance in Rio Branco Region

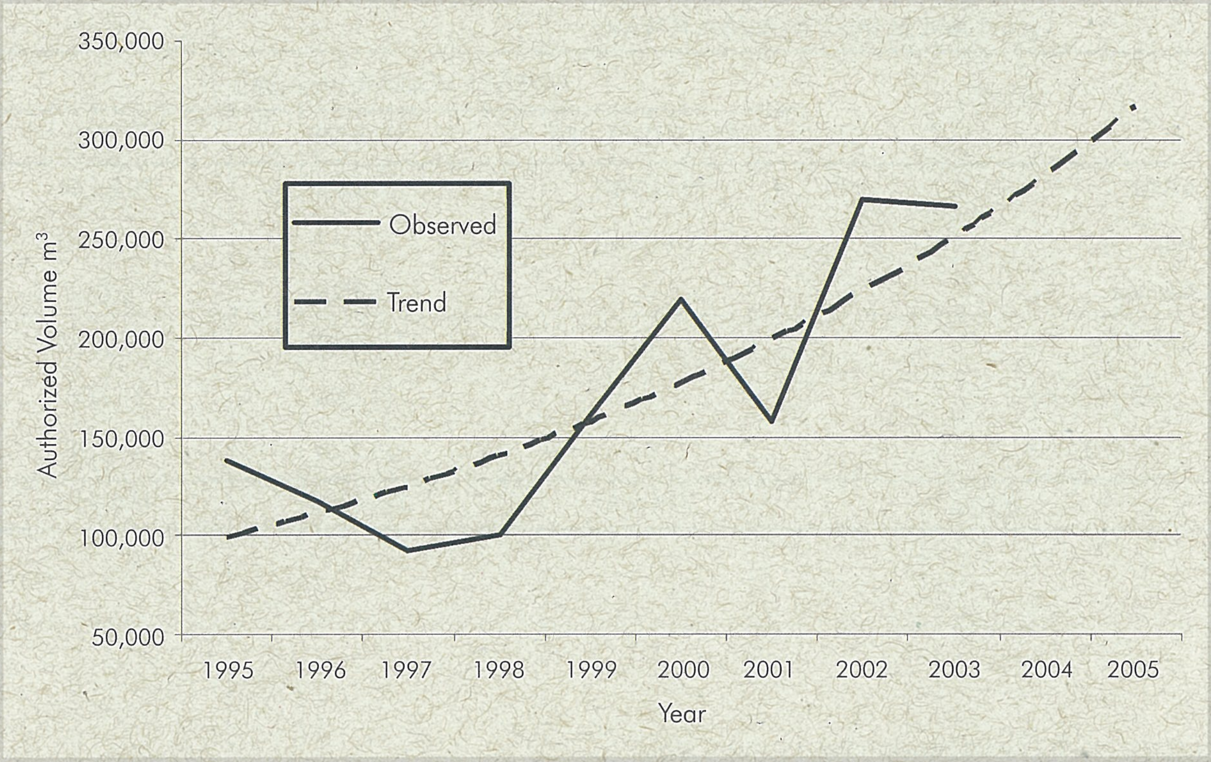


3.3 – ITACOATIARA

Itacoatiara is the major forest product producing center in the State of Amazonas, with large sized companies, which have their own forest management areas for raw material supplies, notably Precious Woods (ex Mil Madeira) and Gethal.

The timber volume authorized by IBAMA for harvest in the Itacoatiara region between 1999 and 2003 was 1.1 thousand m^3, with an average of 214.940 m^3/year (Figure 07), which will be used as sustainable timber production capacity of the managed forests in the Region.

Figure 07 – Volume Authorized by Ibama for Harvest in the Sustainable Management Plans in the Itacoatiara Region



BIOMASS FROM FOREST HARVEST RESIDUES

The potential for forest harvest residue generated in the Itacoatiara Region is 232 thousand m³ per year of which 153 thousand m³ are from crown residue and 79 thousand m³ from stem residue (Figure 08 and Table 09).

Figure 08 – Distribution of Forest Harvest Residues by Type–Itacoatiara Region

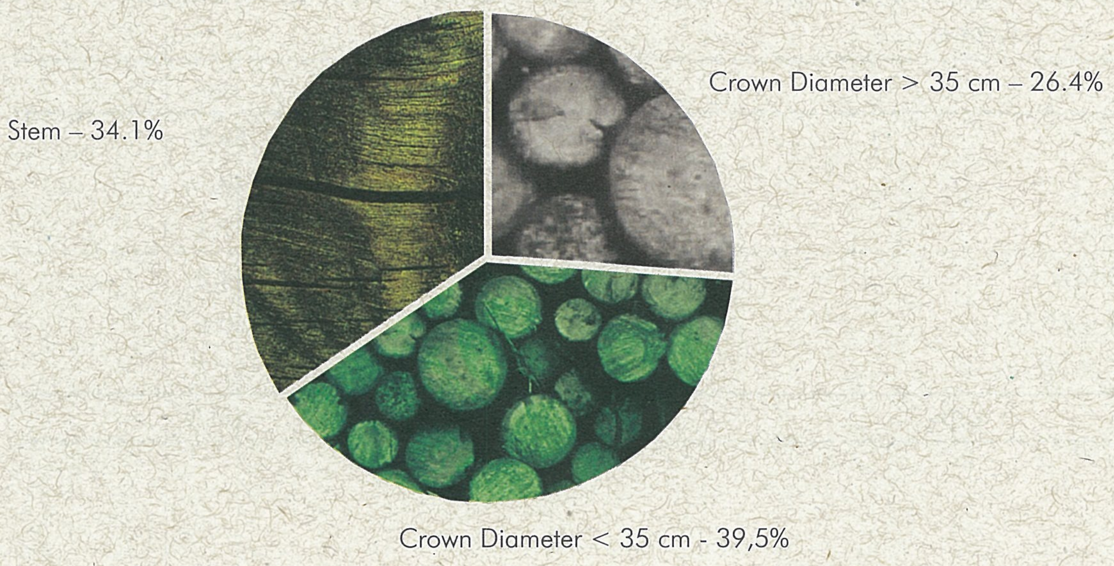


Table 09 – Estimate of Biomass Potential from Forest Harvest Residue Generated in the Itacoatiara Region

TYPE	AVERAGE VOLUME (m³/ year)		
	INDUSTRIAL USE	RESIDUE	TOTAL
STEM	214,940	79,094	294,034
Log	214,940	--	214,940
Residue	--	79,094	79,094
CROWN	--	152,826	152,826
Ø < 35 cm	--	91,606	91,606
Ø ≥ 35 cm	--	61,220	61,220
TOTAL	214,940	231,920	446,860

BIOMASS FROM NON-MARKETABLE SPECIES

For the Forest management Plans in the Itacoatiara, the volume of non-marketable species with a DBH > 50 cm is 28.10 m³/ha, which will be used as a basis for estimating this type of biomass. In the same manner as for the Rio Branco case, it is estimated that it is possible to harvest 50% of the volume, that is, generating an average stem volume of 14.05 m³/ha. The potential biomass for energy generation from non-marketable species under these conditions, in the authorized management plans, is 264.5 thousand m³ (7,917 ha/year) of which 174 thousand m³ correspond to the stem volume and 90.5 thousand m³ to the crown volume (Table 10).

Table 10 – Estimate of Biomass Volume for Non-Marketable Species - Itacoatiara Region

TYPE	VOLUME (m³/ year)	%
STEM	152,166	65.8
Log	111,233	48.1
Residue	40,933	17.7
CROWN	79,089	34.2
Ø < 35 cm	47,407	20.5
Ø ≥ 35 cm	31,682	13.7
TOTAL	231,255	100.0

BIOMASS FROM INDUSTRIAL RESIDUE

According to GONÇALVES (2001)[1], the State of Amazonas has 113 companies under the categories of Sawn Wood Industry and Timber Processing Industry. Of these 10 (ten) are medium/large-sized companies, which were responsible for more than 85% of timber log consumption between 1999 and 2000.

The major forest product companies in the Itacoatiara Region (municipalities of Itacoatiara, Silves and Itapiranga), used as a reference for this study are:

- Precious Woods Amazon / Mil Madeireira Itacoatiara Ltda. (sawn wood and processed timber);
- Carolina (veneer and plywood); and,
- Gethal Amazonas (veneer and plywood).

The biomass from industrial residue in Itacoatiara was estimated based on studies carried out by GONÇALVES (2001) and from field surveys, with a consumption of 220 thousand m³ of log timber, generating a residue volume of 102 thousand m³, (Table 11).

Table 11 – Industrial Residues Generated in the Itacoatiara Region

TYPE OF INDUSTRY	TIMBER CONSUMPTION (m³ / year)	RESIDUE QUANTITY	
		m³ / year (1)	%
Sawmill	70,000	35,000	50
Veneer/Plywood	150,000	67,500	45
TOTAL	220,000	102,500	--

Source:
(1) GONÇALVES (2001) - Subsídios para o estudo da cadeia produtiva da madeira no Estado do Amazonas: elementos de reflexão (Factors for the study of the timber product chain in the State of Amazonas: elements for thought);
(1) Solid m³ (equivalent in m³ of logs)

The industrial residue is used to feed the boilers for sawn wood drying, and part is sold to brick makers and for the generation of energy in the Region. The first energy co-generation unit using timber residue in the Amazon began to operate in Itacoatiara, Amazonas, with an installed capacity of 9 MWH of energy, destined to supply Precious Woods Amazon, and the City of Itacoatiara distribution network. Gethal has also manifested its intention of installing a steam and electric energy co-generation plant with a capacity of 6 MWH, using its own and third party productive process residues. Under this scenario, there is no availability of residue of industrial origin in Itacoatiara to meet the needs of the project in question.

TOTAL AVAILABLE BIOMASS

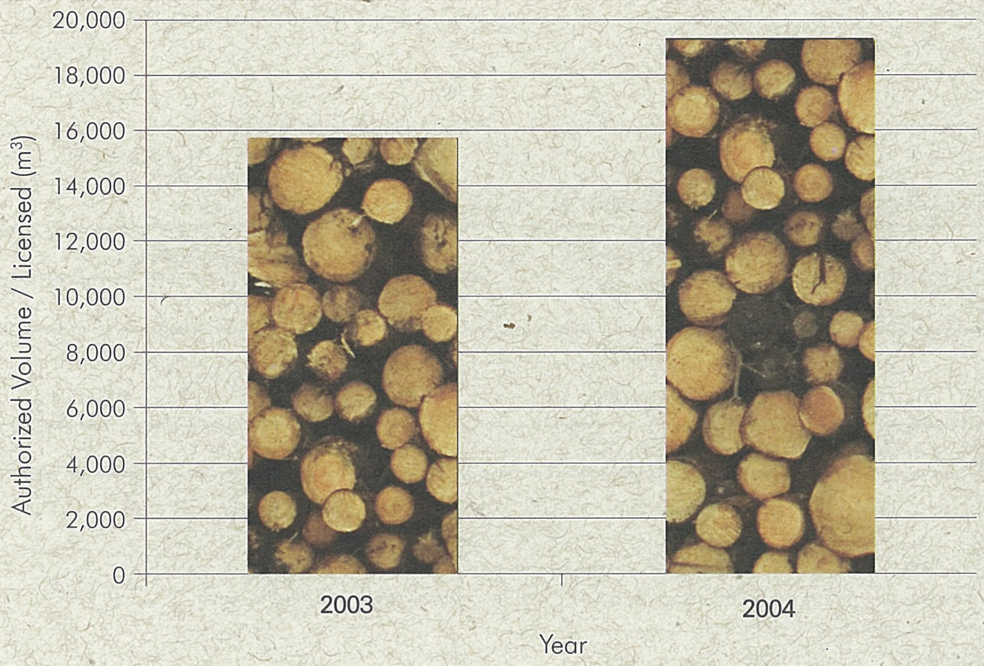
There is no availability of industrial residues in the Itacoatiara Region as the residues generated by Mil Madeireirá Itacoatiara / Precious Woods is already committed to an energy generation unit installed on its site. On the other hand, Gethal uses part of its residues for steam generation and intends to implement an energy generation unit with a capacity of 6.0 MWH, which should create a demand for residues in the order of 70 thousand tons per year.

3.4 – ALTO SOLIMÕES

BIOMASS FROM FOREST HARVEST RESIDUE

The total harvest volume authorized by IPAAM – State of Amazonas Environmental Protection for sustained management forests in the municipalities of Benjamin Constant and Atalaia do Norte was 15.7 thousand m³ for 2003, and the estimated volume to be licensed for 2004 is 19.3 thousand m³ (Figure 09).

Figure 09 – Harvest Authorization / Licensing for Management Plans in the Alto Solimões Region



The estimated annual forest harvest residue generated in the Alto Solimões Region is 20.8 thousand m³ (Table 12), in function of the volume licensed by IPAAM for harvest from managed forests in 2004 (19.319 m³ / year).

Table 12 – Estimate of Biomass Potential from Forest Harvest Residue Generated in the Alto Solimões Region

TYPE	%	AVERAGE VOLUME (m³/ year)		
		INDUSTRIAL USE	RESIDUE	TOTAL
STEM	65.8	19,319	7,109	26,428
Log	48.1	19,319	--	19,319
Residue	17.7	--	7,109	7,109
CROWN	34.2	--	13,736	13,736
Ø < 35 cm	20.5	--	8,233	8,233
Ø ≥ 35 cm	13.7	--	5,503	5,503
TOTAL	100.0	19,319	20,845	40,164

BIOMASS FROM NON-MARKETABLE SPECIES

The potential biomass volume from non-marketable species was estimated to be 50% of existing volume, that is 28.30 m³/ha of stem in the Alto Solimões Region, which could generate on the 740 ha authorized for harvest in the counties of Benjamin Constant and Atalaia do Norte 43.5 thousand m³, of which 28.6 thousand m³ correspond to stem volume and 14.9 thousand m³ to crown volume (Table 13).

Table 13 – Estimate of Total Biomass Production from Non-Marketable Species - Alto Solimões Region

TYPE	VOLUME (m³ / year)	%
STEM	28,648	65.8
Log	20,942	48.1
Residue	7,706	17.7
CROWN	14,890	34.2
Ø < 35 cm	8,925	20.5
Ø ≥ 35 cm	5,965	13.7
TOTAL	43,538	100.0

BIOMASS FROM INDUSTRIAL RESIDUE

The biomass potential from industrial residue to be generated in the Alto Solimões Region is 10.6 thousand m³ / year (Table 14), using as a basis the timber consumption for 2004 and the average local industry yield.

TOTAL AVAILABLE BIOMASS

The maximum biomass production capacity in the Alto Solimões Region under the conditions simulated in this case study is 75 thousand m³ per year, of which 14% corresponds to biomass from industrial residue, 28% from forest harvest residue and 58% from non-marketable species (Table 15).

Table 14 – Estimated Industrial Residue Biomass Generated in the Alto Solimões Region

TIMBER CONSUMPTION (m³ / year)	QUANTITY OF RESIDUE	
	%	m³/ year (1)
19,319	55	10,625

(1) Solid m³ (equivalent m logs)

Table 15 – Total Biomass available for Energy –Alto Solimões Region (m³/year)

TYPE	QUANTITY	
	m³ / year	%
Forest Harvest Residue	20,845	27.79
Stem	7,109	9.48
Crown	13,736	18.31
Biomass from Non-Marketable Species	43,538	58.04
Stem	28,648	38.19
Crown	14,890	19.85
Industrial Residue	10,625	14.17
TOTAL	75,008	100.00

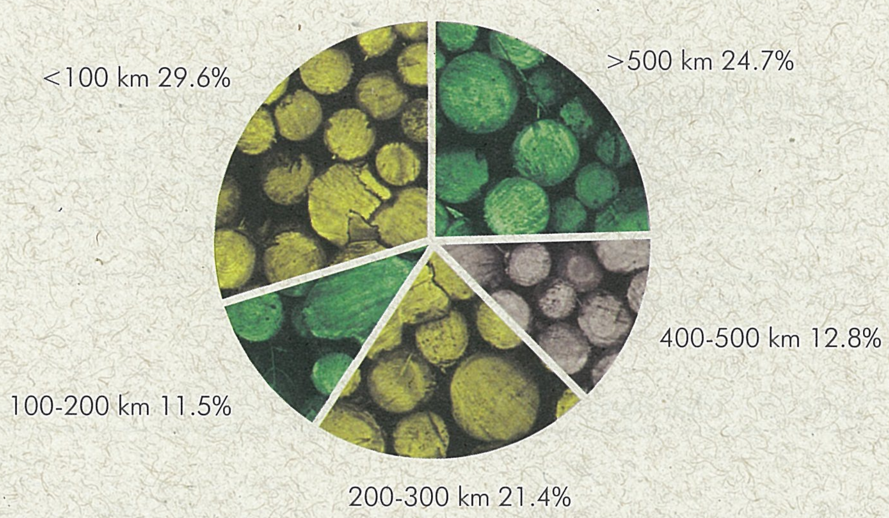
About 30% of the forest biomass existing in the Alto Solimões Region is located within 100 kilometers of Benjamin Constant, the major regional energy consuming center while 12% ranges between 100 and 200 kilometers and 21% ranges between 200 and 300 kilometers, the rest is from a distance of more than 400 kilometers (Table 16 and Figure 10).

Table 16 – Biomass Distribution by Distance in the Alto Solimões Region (m^3 /year)

DISTANCE * (km)	HARVEST RESIDUE			BIOMASS FROM NON-MARKETABLE SPECIES			INDUST. RESIDUE	TOTAL	%
	STEM	CROWN	TOTAL	STEM	CROWN	TOTAL			
< 100	1,280	2,474	3,754	5,159	2,682	7,841	10,625	22,220	29.6
100 - 200	953	1,840	2,793	3,839	1,995	5,834	--	8,627	11.5
200 - 300	1,773	3,426	5,199	7,145	3,713	10,858	--	16,057	21.4
300 - 400	--	--	--	--	--	--	--	--	--
400 - 500	1,059	2,047	3,106	4,269	2,219	6,488	--	9,594	12.8
> 500	2,044	3,949	5,993	8,236	4,281	12,517	--	18,510	24.7
TOTAL	7,109	13,736	20,845	28,648	14,890	43,538	10,625	75,008	100

* Waterway distance from management areas to Benjamin Constant

Figure 10 – Biomass Distribution by Distance in the Alto Solimões Region

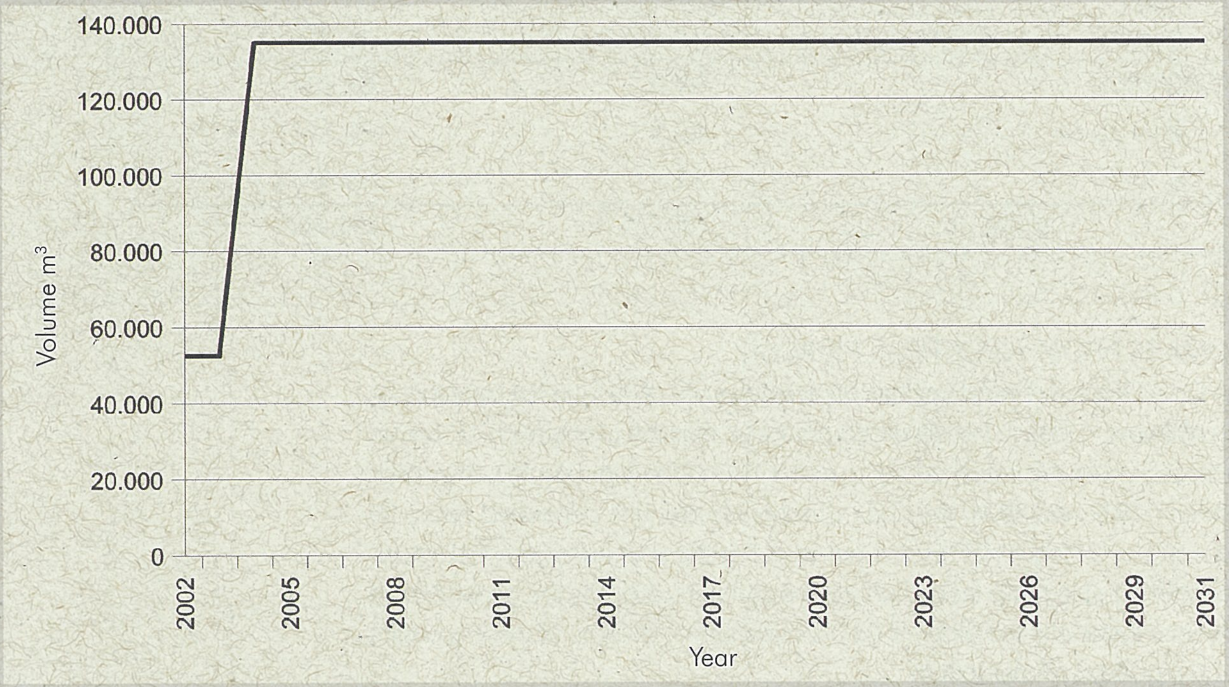


3.5 – JARI/ORSA

BIOMASS FROM FOREST HARVEST RESIDUE

The annual volume to be harvested in the Orsa Group management areas is 135,000 m³, which will generate by the end of the 30-year cycle a total volume in the order of 3.9 million m³. The growth forecast for the Orsa Group forest management areas is shown in Figure 11.

Figure 11 – Growth of the Orsa Group Sustainable Management Plans



The potential biomass from forest harvest residue generated by the Orsa Group management plan is 145.7 thousand m³, of which 96 thousand m³ correspond to crown residue and 49.7 thousand m³ to stem residue (Table 17).

Table 17 – Estimate of Biomass Potential from Forest Harvest Residue Generated in the Jari Region

TYPE	%	AVERAGE VOLUME (m³ / year)		
		INDUSTRIAL USE	RESIDUE	TOTAL
STEM	65.8	135,000	49,678	184,678
Log	48.1	135,000	--	135,000
Residue	17.7	--	49,678	49,678
CROWN	34.2	--	95,987	95,987
Ø < 35 cm	20.5	--	57,536	57,536
Ø ≥ 35 cm	13.7	--	38,451	38,451
TOTAL	100.0	135,000	145,665	280,665

BIOMASS FROM NON-MARKETABLE SPECIES

The potential non-marketable species volume to be harvested was estimated at 50% of existing volume, that is 13.69 m^3/ha of stem volume in the Jari Region. The average area to be managed in the Region of Jari is 9,000 ha, which has the potential of supplying 123 thousand m^3 of log volume per year and a total biomass of 256 thousand m^3 / year (Table 18).

Table 18 – Estimate of Total Biomass Production from Non-Marketable Species - Jari Region

TYPE	%	VOLUME (m^3 / year)
STEM	65.8	168,549
Log	48.1	123,210
Residue	17.7	45,339
CROWN	34.2	87,604
Ø < 35 cm	20.5	52,511
Ø ≥ 35 cm	13.7	35,093
TOTAL	100.0	256,153

BIOMASS FROM INDUSTRIAL RESIDUE

The Orsa Group industrial unit has an average yield of 30% for the transformation of timber in logs to industrialized products, thus the expectation of residue generation from the industrial unit is about 70% of the log volume consumed. Between 2002 and 2004, the Orsa Group industrial unit generated about 29 thousand m^3 of industrial residue per year. For the next few years, with an increase in the size of the industrial unit, the company projects the generation of industrial residue in the order of 94.5 thousand m^3 per year, or the equivalent of 7.9 thousand m^3 per month.

TOTAL AVAILABLE BIOMASS

Using as a basis the amount of existing biomass presented in the previous items, Table 19 shows the biomass available for energy generation in the Jari Region.

Table 19 – Biomass Available for Energy Generation in the Jari Region (m^3 /year)

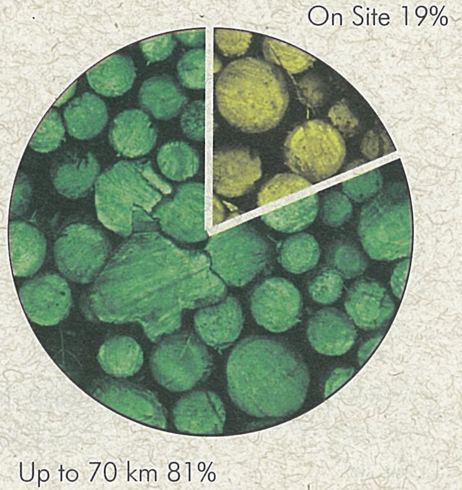
TYPE	BIOMASS E BIOMASS (m^3 / year)	%
Forest Harvest Residue	145,665	29.35
Stem	49,678	10.01
Crown	95,987	19.34
Non-Marketable Species	256,153	51.61
Stem	168,549	33.96
Crown	87,604	17.65
Industrial Residue	94,500	19.04
TOTAL	496,318	100.00

The largest part of the existing and available biomass in the Region (81.0%) is located at an average distance of 70 kilometers from Monte Dourado (Table 20 and Figure 12).

Table 20 – Biomass Distribution by Distance in the Jari Region (m^3 /year)

AVERAGE DISTANCE	HARVEST RESIDUE			NON-MARKETABLE SPECIES			INDUST. RESIDUE	TOTAL	%
	STEM	CROWN	TOTAL	STEM	CROWN	TOTAL			
At Site	--	--	--	--	--	--	94,500	94,500	19.0
70 km	49,678	95,987	145,665	168,549	87,604	256,153	--	401,818	81.0
TOTAL	49,678	95,987	145,665	168,549	87,604	256,153	94,500	496,318	100.0

Figure 12 – Biomass Distribution by Distance Range in the Jari/Orsa Region.



4 - CONCEPTUAL DESIGN

4.1 – TECHNOLOGY

4.1.1 – OVERALL ASPECTS

The technology for electric energy generation from biomass most available and used in Brazil is direct and indirect combustion.

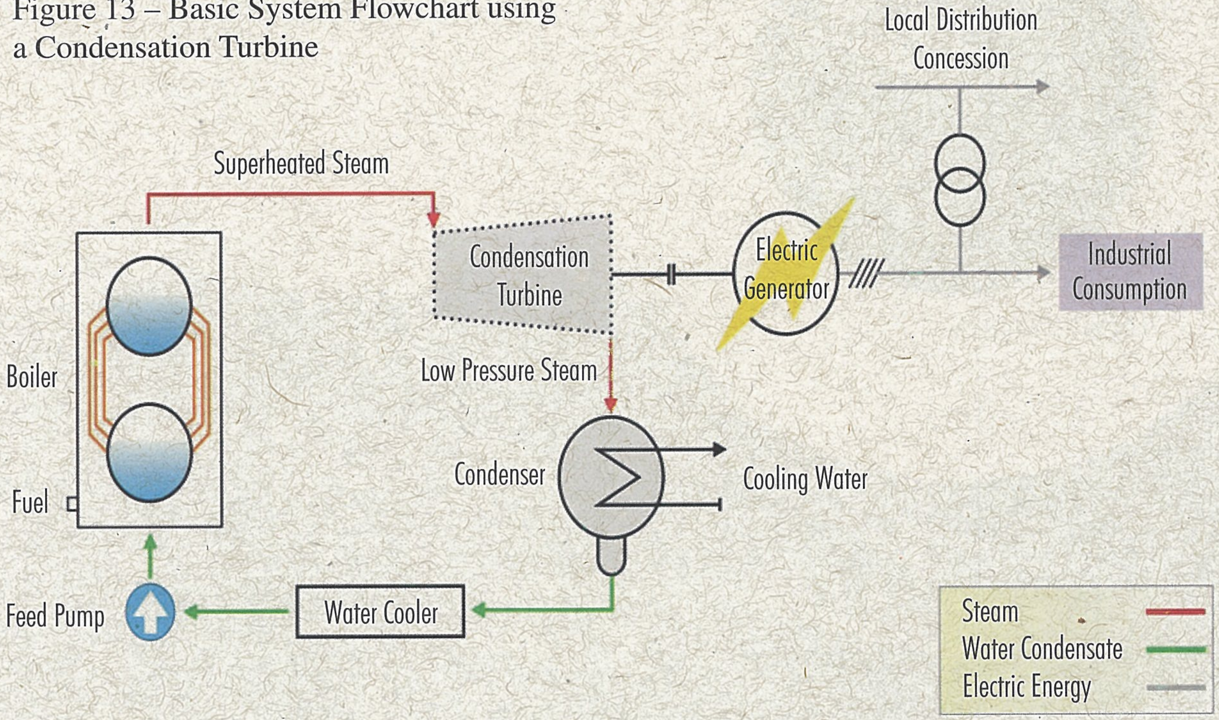
DIRECT COMBUSTION

The main thermal machines available in the market for the generation of electric energy from the direct combustion of biomass are steam turbines and alternating motors.

a) Condensation Turbine

Figure 13 shows the basic direct combustion system flowchart with a steam cycle considering a condensation turbine. This type of turbine is used mainly in thermoelectric plants where the only product is the generation of electric energy. By being more flexible and producing more electric energy, condensation turbines are very much more in use.

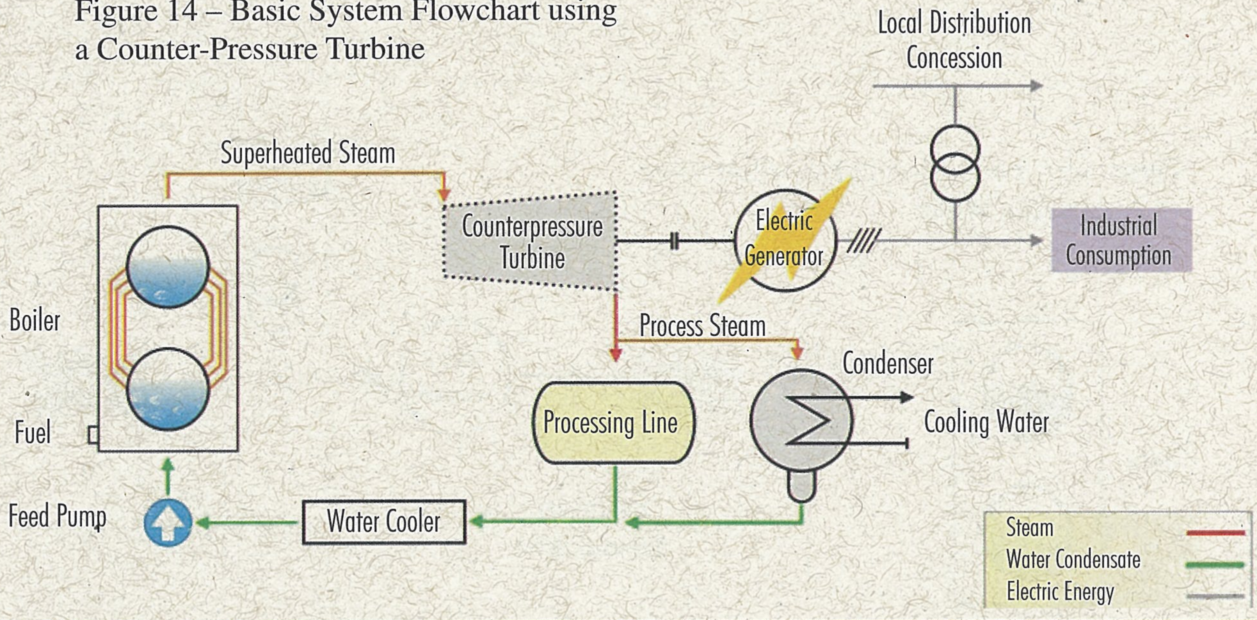
Figure 13 – Basic System Flowchart using a Condensation Turbine



b) Counter-Pressure Turbine

Figure 14 shows the basic steam generation system flowchart using a counter-pressure turbine. This type of turbine is used in co-generation plants that permit the production of electric energy and thermal energy (Steam).

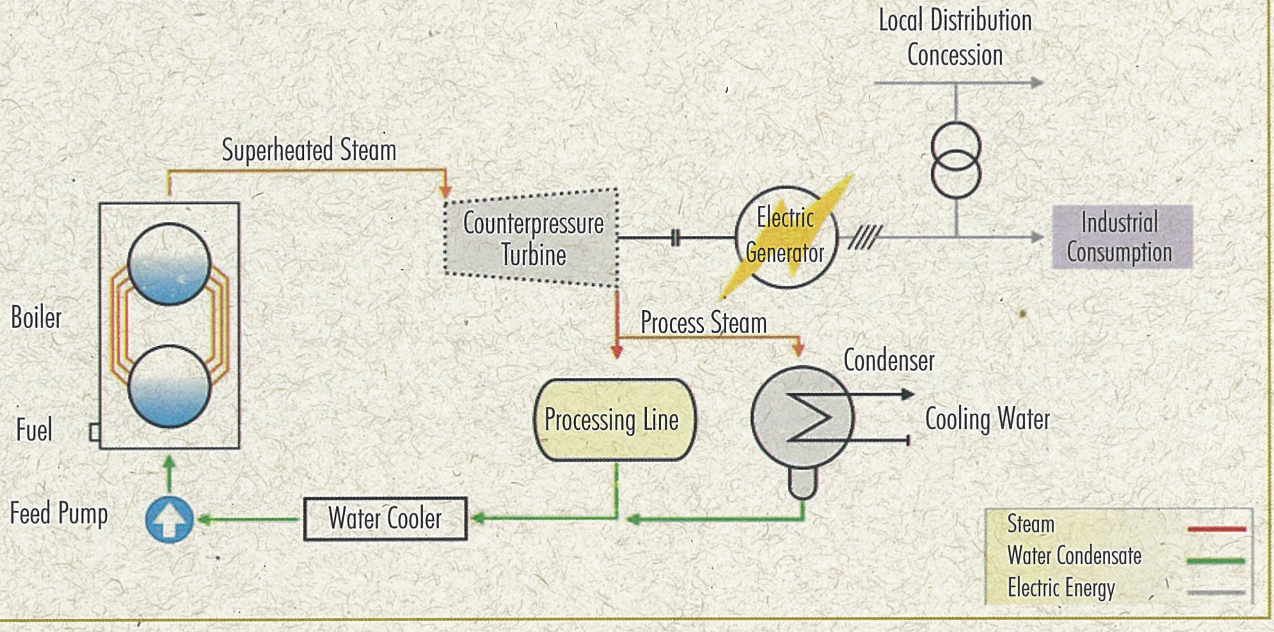
Figure 14 – Basic System Flowchart using a Counter-Pressure Turbine



c) Extraction Turbine

Figure 15 shows the basic steam generation system flowchart using an extraction turbine. The extraction turbine is used in installations that require the generation of energy as well as steam for the industrial process.

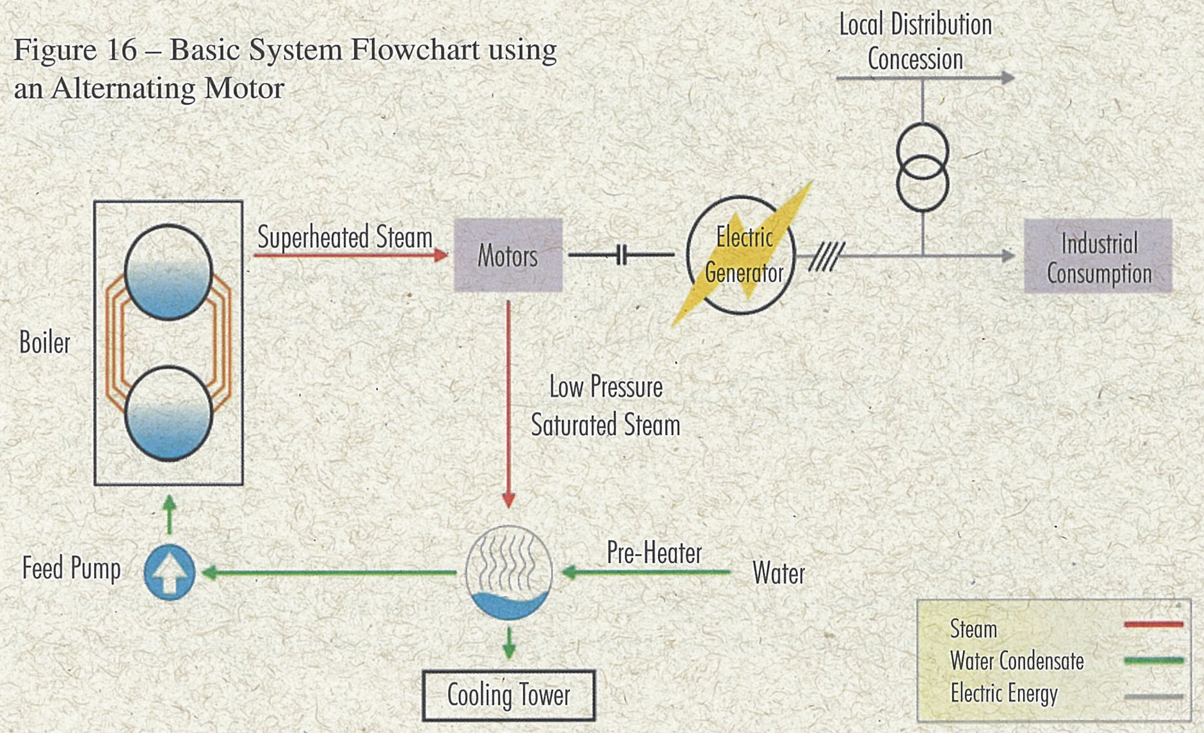
Figure 15 – Basic System Flowchart using an Extraction Turbine



d) Alternating Motor

Figure 16 shows the basic system flowchart using an alternating motor. The alternating motor mechanism is similar to an internal combustion engine. Through a generator, the mechanical energy is converted to electric energy. This system is used in small capacity plants.

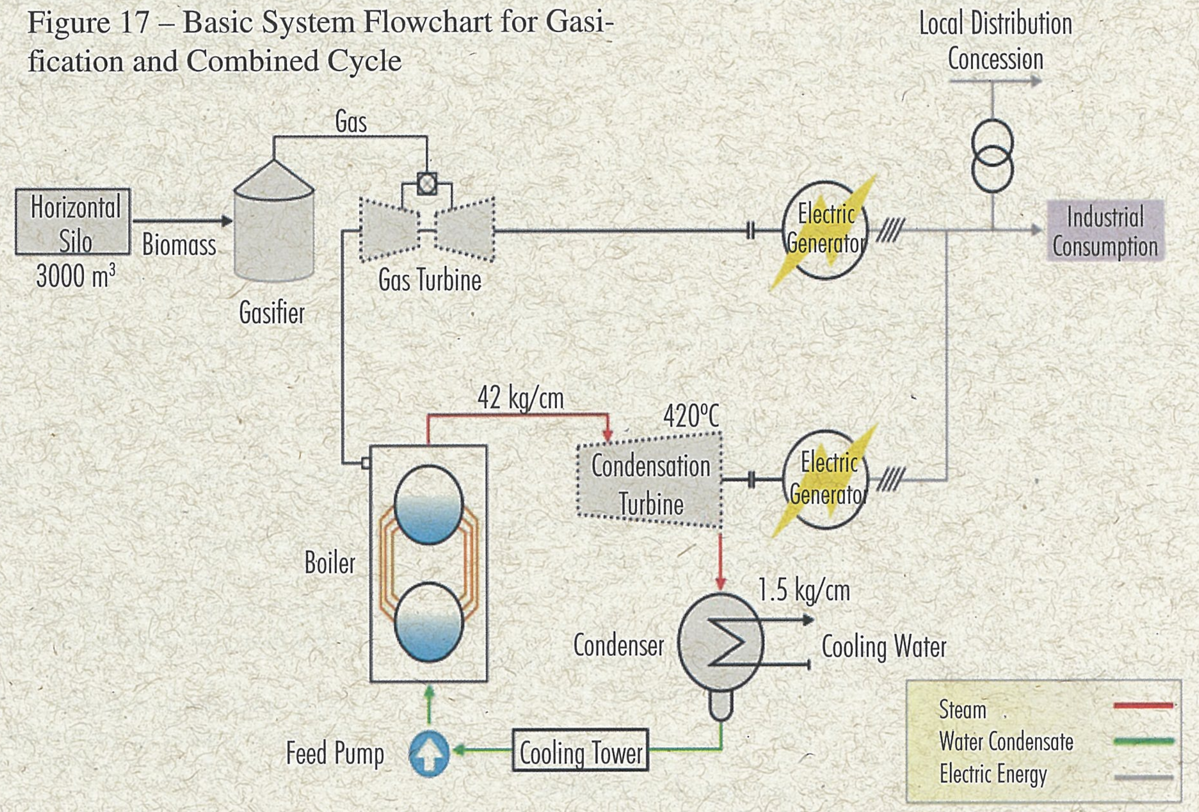
Figure 16 – Basic System Flowchart using an Alternating Motor



INDIRECT COMBUSTION - GASIFICATION

This cycle combines the simultaneous operation of steam turbines with gas turbines, where the gas is obtained through the gasification of the fuel. The production process of a combustible gas from biomass is done in three basic steps: drying, pyrolysis or carbonization and gasification, itself. The thermal energy contained in the hot exhaust gases by the gas turbine is used in a boiler to produce steam. This steam is used in a condensation turbine to generate additional energy. This technology has been tried for years, but the results have not been promising owing to various limitations. Figure 4.05 shows the basic system flowchart for biomass gasification and use of gas in a combined cycle.

Figure 17 – Basic System Flowchart for Gasification and Combined Cycle



4.1.2 – COMPARISON BETWEEN THE ALTERNATIVES

Table 21 shows the comparison between the existing technology alternatives, such that the criteria used for selection of the technology to be used in the energy generation plants, in function of the positive and negative points, highlights direct combustion and steam cycles.

Table 21 – Advantages and Disadvantages of the Technologies Using Biomass

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Direct combustion with steam cycles	• Market availability • Various technology options • Well used in Brazil	
Gasification with combined cycles	• High efficiency	• Not available (in study) • Combustion product problems - low product reliance • High gas cleaning system costs

The comparison between alternatives that use direct combustion is shown as follows in Table 22, which will be used to define which one of them will be used for each case under discussion.

For each region being studied, the type of business was selected taking into account the main product. In the Jari Region, the main products were defined as electric energy and thermal energy (steam for industrial processing), indicating the selection of a steam cycle thermal machine with an extraction turbine. Two alternative technologies were defined, with each one sized to the level of fuel consumption (biomass). The main technological characteristics of the central units are shown in Table 23.

Table 22 – Advantages and Disadvantages of Thermal Machine Options

DIRECT COMBUSTION AND STEAM CYCLES	ADVANTAGES	DISADVANTAGES
Condensation Turbine	• Uses all steam generated • Widely used • Lower investment in relation to counter-pressure turbine	• Does not supply steam to industrial processes – not able to be used for co-generation
Counter-pressure Turbine	• Supplies steam for industrial processes – can be used for co-generation	• Specific steam consumption is larger than condensation turbine • Larger level of investment in relation to condensation turbine
Extraction Turbine	• Largest operating flexibility; • Can make steam available for diverse industrial pressure processes – can be used for co-generation; • Can operate in a condensation regime when there is no demand for steam.	• Larger level of investment In relation to counter-pressure turbine
Alternating Motor		• Steam contamination by oil not allowing reuse of steam impossible • Available for energy generation on a small scale only • High specific steam consumption

Table 23 – Plant Technical Characteristics

CHARACTERISTIC	RIO BRANCO	ALTO SOLIMÕES	JARI/ORSA
Main Product	Electric Energy (independent producer)	Electric Energy (independent producer)	Electric energy and thermal energy (self producer under a co-generation regime)
Fuel used	Industrial and forest biomass	Industrial and forest biomass	Industrial and forest biomass
Thermal Machine	Steam cycle with condensation turbine	Steam cycle with condensation turbine	Steam cycle with extraction turbine
Boiler	Medium pressure for superheated steam	Medium pressure for superheated steam.	Medium pressure for superheated steam
Generating Scale	2.0 MWH 10.0 MWH	2.0 MWH 10.0 MWH	3.5 MWH 5.6 MWH

4.2 – PROCUREMENT LOGISTICS

The procurement logistics involves biomass preparation and transportation with delivery to the energy generation plant. The activities involved in this energy generation process step vary in function of the type of biomass used, that is, forest and industrial biomass.

4.2.1 – BIOMASS FROM FOREST

The procurement logistics for forest biomass is shown separately for each type of biomass: stem residue, crown residue and non-marketable species.

BIOMASS FROM LOGS RESIDUES IN A YARD

The stem residue generated from cutting and sizing marketable species logs will be in the log-loading yard, and for taking them to the energy generation plant yard they have to go through residue preparation, piling, loading, transport and unloading (Figure 18).

- Residue Preparation (split and/or slash)
  The splitting / slashing operation consists in segmenting the tree stem into logs with a length of 1.10 or 2.20 meters. For this case study, the sizing used was 2.20 meters, which corresponds to the width of the tree stem cargo used for transport. The tree log pieces that have a diameter greater than 35 cm have to be split to make smaller diameter pieces.
- Piling
  The pieces prepared with appropriate sizes (Ø < 35 cm and 2,20 m in length) are grouped in piles manually.
- Loading
  This operation consists in loading the biomass piled in the log-loading yard on to transport trucks.
  In the Alto Solimões Region, river transportation is used so that the biomass log barges are loaded manually.
- Transport
  The slash residue transportation is done in trucks, with the pieces laid transversally to the length of the trunk cargo space.
  In the Alto Solimões Region transportation is carried out by river log barges. In this case, there will always be a transfer operation to allow the crown or the stem biomass to be placed on larger sized river banks.

BIOMASS FROM LOG RESIDUE IN THE FOREST

For the preparation logistics for this material, there is an additional operation, that of taking the material out of the forest to the side of the road, which can be done by two distinct methods dragging or transfer (Figure 18, shown above):

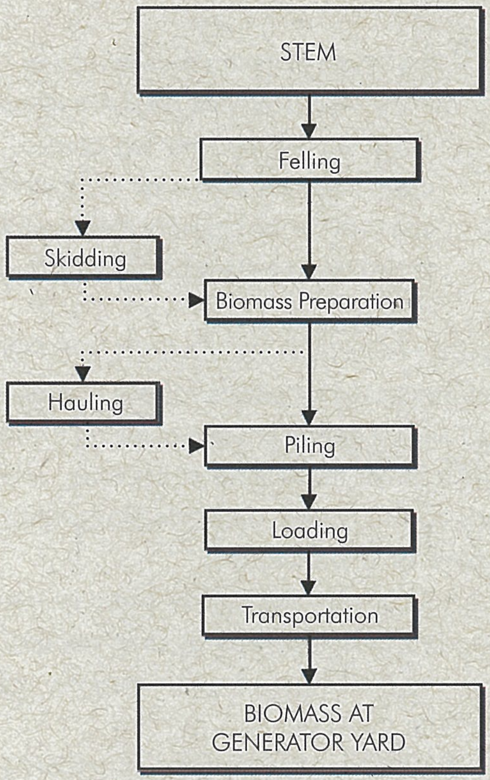
- Skidding – the logs or stem are transported by skidders or by drag tractors to the log-loading yard where they are prepared for transport.
- Hauling – the biomass is prepared in the forest and the material transported to the plants is pieces 2.20 meters long and with a 35 cm maximum diameter. The transfer can be manual, semi-mechanized or mechanized.
- Piling and Loading – the piling and loading operation should be mechanized using a farm tractor equipped with a forest loader.
- Transportation – is carried out in the same way as for cut residue.

BIOMASS FROM CROWN RESIDUE

The crown biomass was classified into two levels in function of piece size: diameter up to 35 cm and diameter above 35 cm.

- Diameter greater than 35 cm – similar treatment to logs and/or stem that remained in the forest (figure 18).
- Diameter less than 35 cm – the pieces are prepared through the following operations: slashing, transfer, piling, loading and transport in a similar way as used for stem biomass, excluding the operation for splitting the pieces.

Figure 18 – Procurement Logistics for Stem Residues – Felling Losses



STEM

The operations carried out for making the biomass from non-marketable species stems are felling, preparation, hauling or transfer, piling, loading and transport (Figure 19).

BIOMASS FROM NON-MARKETABLE SPECIES

The non-marketable species procurement logistics are carried out using similar operations as those used for marketable species, separating the crown and the stem.

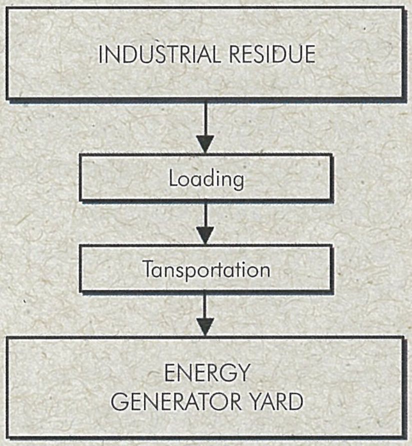
CROWN

The operations are the same as used for marketable species, described above.

4.2.2 – BIOMASS FROM INDUSTRIAL ORIGINS

The procurement logistics for industrial residue involve loading and transportation operations. These operations are mechanized with the use of a tractor equipped with a front loader and trucks.

Figure 19 – Procurement Logistics for Industrial Residue



4.2.3 – BIOMASS PREPARATION AND TRANSPORTATION COSTS

The average preparation and transportation costs for supplying raw material (biomass) to the energy generation plants, vary between R$ 10.00 and R$ 182.06 per metric ton in function of the raw material preparation cost and the transportation cost (Table 24).

The industrial residue has a lower raw material preparation cost, while non-market species logs and crown have a higher cost. On the other hand, the transportation costs vary in function of the distance between the procurement source and generating plant. Normally, biomass from industrial origin is located closer to the energy generation plant while biomass from forest origins is located at more distant points, increasing the transportation cost.

The procurement cost by raw material type in the case of the Jari/Orsa energy generating plant does not vary in function of distance but only in function of the type of raw material as it is located at a fixed distance, whether they be industrial biomass or forest biomass.

Table 24 – Biomass Generating Plant Procurement Cost Intervals (R$/t)

TYPE OF BIOMASS	RIO BRANCO		ALTO SOLIMÕES		JARI/ORSA
	MIN.	MAX.	MIN.	MAX.	
Forest Harvest Residue					
Logs	41.51	174.45	38.47	117.04	59.26
Crown	45.81	178.75	42.71	112.29	60.04
Biomass from Non-Marketable Species					
Stem	49.12	182.06	46.03	124.60	73.05
Crown	45.81	178.75	42.71	121.29	60.04
Industrial Residue	18.33	126.66	14.41	–	10.00

Source: Study data, prepared by author.
* Average

4.3 – DESIGN CONCEPTION

TECHNOLOGY USED

Table 25 shows the sizing and technology definition for each one of the alternatives used in the case studies in question, as well as the assumptions used for this definition.

Table 25 – Assumptions and Technology Used and Biomass Consumption for Generating Plants

REGION	RIO BRANCO	ALTO SOLIMÕES	JARI/ORSA
ASSUMPTIONS			
CATEGORY	Independent Producer	Independent Producer	Self-producer
RAW MATERIAL	Market purchases	Market purchases	Own procurement
TYPE	Energy Generation	Energy Generation	Co-generation (energy and steam)
REVENUE	Energy Sale	Energy Sale	Own consumption and sale of excess
CHARACTERIZATION			
TECHNOLOGY	Multistage condensation turbine, one of the more recommended as it has a larger thermal efficiency in relation to the others	Multistage condensation turbine, one of the more recommended as it has a larger thermal efficiency in relation to the others	Controlled extraction turbine, the most recommended for co-generation plants
POWER MWH	2.0 MWH 10.0 MWH	2.0 MWH 10.0 MWH	3.5 MWH 5.6 MWH
BIOMASS CONSUMPTION (t/year)	36,300 t/year 132,200 t/year	36,300 t/year 132,200 t/year	79,500 t/year 121,000 t/year
LOCATION	Rio Branco	Benjamim Constant	Monte Dourado

Table 26 shows the sizing of the energy generating plants used in the case studies, object of this work, as indicated previously.

Table 26 – Energy Generation Plant Sizing

ITEM	UNIT	2.0 MWH	3.5 MWH	5.6 MWH	10.0 MWH
Annual Biomass Consumption	t/year	36,300	79,500	121,000	132,200
Operational Availability	h/year	8,640	8,640	8,640	8,640
Chips per hour availability	t/h	4.2	9.2	14.0	15.3
Average chip humidity (basis dry)	%	43.00	43.00	43.00	43.00
Average chip humidity (basis humid)	%	30.00	30.00	30.00	30.00
Upper Calorific Power (UCP))	kcal/kg	4,320	4,320	4,320	4,320
Lower Calorific Power (LCP)	kcal/kg	4,000	4,000	4,000	4,000
Net Calorific Power (NPC)	kcal/kg	2,600	2,600	2,600	2,600
Superheated Steam Pressure	bar	21	42	42	42
Superheated Steam Temperature	°C	300	420	420	420
Boiler Efficiency	%	80,00	85,00	85,00	85,00
Generated Steam	kg/h	13,000	--	--	47,200
Turbine Steam Imput	kg/h	--	30,000	45,000	--
Nominal Boiler Capacity	kg/h	15,000	35,000	50,000	50,000
Turbine Output Steam Pressure	bar	0.12	1.05	1.03	0.16
Steam at Extraction	kg/h	--	10,000	10,000	--
Steam Pressure at Turbine Extraction	bar	--	10	10	--
Turbine Rotation	RPM	6,500	8,000	8,000	8,000
Driven Machine Rotation	RPM	1,800	1,800	1,800	1,800
Specific Turbine Steam Consumption	kg/kWh	6.5	8.6	8.0	4.7
Electric Energy Generation Capacity	kW	2,000	3,500	5,600	10,000
Average Plant Consumption	kW	180	300	500	900
Total Energy Generated	MWH/year	17,280	30,240	48,384	86,400
Energy Consumed	MWH/year	1,555	2,592	4,320	7,776
Net Energy Available	MWH/year	15,725	27,648	44,064	78,624

EQUIPMENT AND BUILDINGS

Table 27 lists the main machinery and equipment needed for the implementation of the generating plants.

Table 27 – Main Machinery and Equipment for the Energy Generating Plants

MACHINERY AND EQUIPMENT	BUILDINGS AND INSTALLATIONS
Roadway scale	Area cleaning and land preparation
Fixed crame	Land grading
Belt transporters	Building foundations
Chipper	Building infrastructure
Screener	Superstructure
Storage Silos	Building base and metal structure for equipment
Boiler and accessories	Electric, hydraulic and pneumatic installations
Turbine and reducer	Roadway layout
Generator	

LABOR

The labor necessary for the operation of the generating plants, according to the alternatives being considered, is shown in Table 28.

Table 28 – Quantity of Allocated Labor

TYPE	2.0 MWH	3.5 MWH	5.6 MWH	10.0 MWH
Manager	1	1	1	1
Administrative Assistant II	1	1	1	1
Administrative Assistant I	4	4	4	4
Operator III	5	5	5	5
Operator II	5	5	5	5
Operator I	5	10	10	10
TOTAL	21	26	26	26

5 - FEASIBILITY STUDY

The economic and financial feasibility of the alternatives for the proposed plants was carried out using the Internal Rate of Return – IRR, the Net Present Value - NPV and the Payback Period (the time to recover the investment). Lastly, a risk analysis was made in function of variations of biomass costs and revenues.

5.1 – INVESTMENTS

5.1.1 – FIXED ASSETS

The fixed asset investments used in this analysis (Table 29) were the following:

- Rio Branco: the 2.0 and 10.0 MWH alternatives have investments of R$ 7.5 and 28.6 million, respectively;
- Alto Solimões: the 2.0 MWH alternative has an investment of R$ 7.5 millions; and,
- Jari/Orsa: the 3.5 and 5.6 MWH alternatives have investments of R$ 13.3 and 23.2 million, respectively.

Table 29 – Summary of Fixed Asset Investments (R$)

ITEM	2.0 MWH	3.5 MWH	5.6 MWH	10.0 MWH
Machinery and equipment	3,210,270	7,457,625	14,422,149	14,436,849
Buildings and Installations	2,780,148	3,139,500	3,780,000	7,416,150
Pre-operating Expenses	1,191,778	2,043,051	3,929,326	5,400,869
Contingencies (5%)	359,110	632,009	1,106,574	1,362,693
TOTAL	7,541,306	13,272,185	23,238,049	28,616,561

5.1.2 – WORKING CAPITAL

The working capital investment was determined based on the turnover of current assets and liabilities, that vary in function of the selected production layout and generation capacity analyzed, (Table 30), taking into consideration the following values:

- Rio Branco: the 2.0 and 10.0 MWH alternatives with values of R$ 108.0 and 46.5 thousand, respectively;
- Alto Solimões: the 2.0 MWH alternative with the value of R$ 160.5 thousand; and,
- Jari/Orsa: the 3.5 and 5.6 MWH alternatives with values of R$ 184.0 and 369.5 thousand, respectively.

Table 30 – Working Capital Investment

ITEM	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
CURRENT ASSETS	**203,170**	**1,089,545**	**355,353**	**348,891**	**784,626**
Accounts Receivable	127,929	628,933	222,657	199,515	436,840
Inventory	61,775	394,409	109,258	128,374	301,803
Fuel	27,724	239,828	75,207	46,530	147,369
Consumables	1,948	10,213	1,948	7,268	10,213
Spare Parts	32,103	144,368	32,103	74,576	144,221
Cash	13,466	66,203	23,438	21,002	45,983
CURRENT LIABILITIES	**95,150**	**626,046**	**194,863**	**164,933**	**415,098**
Accounts Payable	95,150	626,046	194,863	164,933	415,098
WORKING CAPITAL	**108,020**	**463,499**	**160,490**	**183,958**	**369,528**

5.2 – PRODUCTION COSTS

The annual production costs for each of the alternatives analyzed in the regions included in the study is shown as follows, in Table 31.

Table 31 – Total Production Cost (R$/year)

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
TYPE	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Fuel	665,379	6,002,433	1,804,958	1,126,766	3,593,843
Labor	457,020	657,660	457,020	657,660	657,660
Consumables	46,740	245,100	46,740	174,420	245,100
Maintenance	184,014	725,797	184,014	361,095	652,486
Insurance	46,004	181,449	46,004	90,274	163,121
General Expenses	69,958	390,621	126,937	120,511	265,611
TOTAL	1,469,115	8,203,061	2,665,673	2,530,726	5,577,821

5.2.1 – FUEL

Fuel is the major raw material used in the energy generating process. In the case of biomass, the production cost, or the price of raw material, for the energy generating plant has the following composition: biomass price, biomass preparation cost (varies by type) and transportation costs (varies in function of distance).

- RIO BRANCO REGION

The average raw material procurement price in the Rio Branco Region for the 2.0 MWH alternative is R$ 18.33 per metric ton while the price for the 10.0 MWH alternative is R$ 45.40 per metric ton (Table 32). In this case priority is given to the lower cost procurement options.

Table 32 – Total Fuel Cost In the Rio Branco Region

TYPE/ DISTANCE (KM)	COST (R$/t)	CONSUMPTION (t/year)		COST (R$/year)	
		2.0 MWH	10.0 MWH	2.0 MWH	10.0 MWH
INDUSTRIAL BIOMASS					
0 – 50 km	18.33	36,300	49,258	665,379	902,899
50 – 100 km	35.00	--	6,884	--	240,940
100 – 150 km	51.66	--	10,552	--	545,116
STEM BIOMASS					
50 – 100 km	61.96	--	15,823	--	980,393
CROWN BIOMASS					
50 – 100 km	66.26	--	30,572	--	2,025,700
NON-MARKETABLE SPECIES					
Log/Crown 50 – 100 km	68.41	--	19,111	--	1,307,383
TOTAL	--	36,300	132,200	665,379	6,002,433

• ALTO SOLIMÕES REGION

The average price for raw material procurement in the Alto Solimões Region for the 2.0 MWH alternative is R$ 49.72 per metric ton, (Table 33), with priority given to the lower cost procurement options.

Table 33 – Total Fuel costs in the Alto Solimões Region - 2.0 MWH Alternative

TYPE	UNIT COST (R$/t)	CONSUMPTION (t/year)	TOTAL COST (R$/year)
INDUSTRIAL BIOMASS			
Up to 100 km	14.41	8,181	117,888
STEM BIOMASS			
Up to 100 km	38.47	986	37,931
100 – 200 km	52.75	734	38,719
200 – 300 km	67.04	1,365	91,510
400 – 500 km	95.61	184	17,592
CROWN BIOMASS			
Up to 100 km	42.71	1,905	81,363
100 – 200 km	57.00	1,417	80,769
200 – 300 km	71.29	2,638	188,063
NON-MARKETABLE CROWN			
Up to 100 km	42.71	2,065	88,196
100 – 200 km	57.00	1,536	87,552
200 – 300 km	71.29	2,859	203,818
NON-MARKETABLE STEM			
Up to 100 km	46.03	3,972	182,831
100 – 200 km	60.31	2,956	178,276
200 – 300 km	74.60	5,502	410,449
TOTAL	49.72	36,300	1,804,957

- JARI/ORSA REGION

The average raw material procurement price in the Jari/Orsa Region for the 3.5 MWH and 5.6 MWH alternatives is R$ 14.17 and 29.70 per metric ton, respectively, (Table 34). In this case, there is no industrial biomass transportation costs, while the forest biomass (stem and crown) is transported in an average distance of 70 km.

Table 34 – Fuel Cost in the Jari Region

TYPE	COST (R$/t)	TOTAL CONSUMPTION (t/year)		TOTAL COST (R$/year)	
		3.5 MWH	5.6 MWH	3.5 MWH	5.6 MWH
INDUSTRIAL BIOMASS	14.04	72,765	72,765	727,650	727,650
STEM BIOMASS	57.77	6,735	38,252	389,081	2,209,818
CROWN BIOMASS	60.04	--	9,983	--	599,379
TOTAL	--	79,500	121,000	1,116,731	3,536,847

5.2.2 – LABOR

The worker categories and annual labor cost for labor for the generation plant alternative considered are shown in Table 35.

Table 35 – Annual Labor Cost in Generation Plants (R$)

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
CATEGORY	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Manager	158,000	158,000	158,000	158,000	158,000
Assistant II	31,500	31,500	31,500	31,500	31,500
Assistant I	36,480	72,960	36,480	72,960	72,960
Operator III	109,440	182,400	109,440	182,400	182,400
Operator II	72,960	91,200	72,960	91,200	91,200
Operator I	48,640	121,600	48,640	121,600	121,600
TOTAL	457,020	657,660	457,020	657,660	657,660

5.2.3 – CONSUMABLES

The annual consumable costs for the proposed generating plants are shown in Table 36.

Table 36 – Estimated Annual Consumable Costs for the Generating Plants (R$)

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
TYPE	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Chemical Products	25,200	134,400	25,200	79,800	134,400
Lubricants	21,000	108,000	21,000	93,000	108,000
Others	540	2,700	540	1,620	2700
TOTAL	46,740	245,100	46,740	174,420	245,100

5.2.4 – MAINTENANCE

The annual machinery, equipment, building and installation maintenance costs for the proposed plant alternatives are shown in Table 37

Table 37 – Estimated Annual Maintenance Costs (R$)

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
TYPE	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Machinery and Equipment	128,411	577,474	128,411	298,305	576,886
Buildings and Installations	55,603	148,323	55,603	62,790	75,600
TOTAL	184,014	725,797	184,014	361,095	652,486

5.2.5 – INSURANCE

The estimated annual machinery, equipment, building and installations insurance expenses for the proposed alternative plants are shown in Table 38.

Table 38 – Estimated Annual Insurance Costs (R$)

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
TYPE	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Machinery and Equipment	32,103	144,368	32,103	74,576	144,221
Buildings and Installations	13,901	37,081	13,901	15,698	18,900
TOTAL	46,004	181,449	46,004	90,274	163,121

5.2.6 – GENERAL EXPENSES

The general expenses, involving several itens non covered in other cost components are shown in Table 39.

Table 39 – Estimated General Expenses

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
TYPE	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
General Expenses	69,958	390,621	126,937	120,009	262,761

5.3 – OTHER COSTS

5.3.1 – DEPRECIATION

The annual depreciation costs calculated by linear depreciation for each alternative being considered is shown in Table 40.

Table 40 – Estimated Annual Depreciation Costs (R$)

TYPE	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Machinery and Equipment	321,027	1,443,685	321,027	745,763	1,442,215
Buildings and Installations	111,206	296,646	111,206	125,580	151,200
TOTAL	432,233	1,740,331	432,233	871,343	1,593,415

5.3.2 – DEFERRED ASSET AMORTIZATION

The deferred asset amortization follows the same principle as depreciation. It consists of the accounting recuperation of capital invested in rights, costs, charges or expenses that will have an effect in subsequent years. For the purposes of this study, pre-operating expenses carried out during the implementation period are considered as deferred assets. Table 41 shows the estimated annual deferred asset amortization costs for the proposed generating plants alternatives.

Table 41 – Estimated Annual Amortization Costs

TYPE	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Amortization	155,089	676,356	155,089	267,506	503,590

5.4 – TAXES

The taxes considered for this feasibility analysis are:

- On Invoicing - PIS (0.65%), COFINS (3.00%) and CPMF (0.38%);
- ICMS (State Value Added Tax)- 17%; and,
- On Income – CSLL (Social Contribution on Net Income) (9.00%) and IR (Income Tax) (25.00%).

5.5 – CASH FLOW ENTRY

5.5.1 – SALE AND BENEFIT RECEIPTS

The cash inflows for each alternative considered are shown in Table 42, consider the following aspects:

i. Sales of energy at regional market prices;
ii. Sales of steam at production cost;
iii. CCC benefit up to 75% of invested value;
iv. Fuel economy, substitution corresponding to rice paid based on diesel fuel that is no longer being used (average price considered is R$ 0.80 per liter); and,
v. No taxes are considered on CCC receipts.

Table 42 – Annual Cash Inflows (R$)

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
TYPE	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
1. Energy Sales	1,729,750	8,648,640	1,729,750	3,041,280	4,847,040
2. Steam Sales	--	--	--	1,296,000	1,296,000
3. Subtotal Sales	1,729,750	8,648,640	1,729,750	4,337,280	6,143,040
4. CCC Benefits	5,655,980	21,462,421	5,655,980	9,954,139	17,428,537
5. Fuel Economy	4,147,200	20,736,000	4,147,200	6,635,520	10,575,360
6. Total Market (3+4)	7,385,730	30,110,061	7,385,730	14,291,419	23,571,577
7. Total Substitution (3+5)	5,876,950	29,384,640	5,876,950	10,972,800	16,718,400

5.5.2 - RESIDUAL VALUE

The residual value of the undertaking of the alternative plants considered is shown in Table 43, below.

Table 43 – Residual Value (R$)

	RIO BRANCO		ALTO SOLIMÕES	JARI/ORSA	
TYPE	2.0 MWH	10.0 MWH	2.0 MWH	3.5 MWH	5.6 MWH
Total Investment	7,541,306	28,616,561	7,541,306	13,272,185	23,238,049
Total Depreciated	4,878,360	18,886,540	4,878,360	9,341,330	16,690,150
Assets	1,550,890	6,763,560	1,550,890	2,675,060	5,035,900
Total Amortized Assets Residual Fixed Assets Investment	1,112,056	2,966,461	1,112,056	1,255,795	1,511,999
Working Capital	90,716	439,944	143,184	162,647	341,418
TOTAL	1,202,772	3,406,405	1,255,240	1,418,442	1,853,417

5.6 – CASH FLOW

Table 44 shows the cash for the two alternatives analyzed for the Rio Branco Region, under the hypothesis of energy market sales and fossil fuel (petroleum) substitution by biomass.

Table 44 – Energy Generation Cash Flow for Rio Branco Region (R$)

ITEM	2.0 MWH MARKET	2.0 MWH SUBSTITUTION	10.0 MWH MARKET	10.0 MWH SUBSTITUTION
CASH INFLOW	32,805,002	89,357,022	154,598,426	444,176,005
Energy Sales Revenue	25,946,250	25,926,250	129,729,600	129,729,600
CCC or Fuel Savings	5,655,980	62,208,000	21,462,421	311,040,000
Residual Value	1,202,772	1,202,772	3,406,405	3,406,405
CASH OUTFLOW	34,484,347	34,484,347	176,180,120	176,180,120
Fixed Asset Investment	7,541,306	7,541,306	28,616,561	28,616,561
Working Capital Investment	90,716	90,716	439,944	439,944
Production Costs	22,036,725	22,036,725	123,045,915	123,045,915
Revenues Taxes	4,815,600	4,815,600	24,077,700	24,077,700
Income Taxes	--	--	--	--
NET CASH FLOW	-1,679,345	54,872,675	-21,581,694	267,995,885

Table 45 shows the cash flow for the two alternatives analyzed for the Alto Solimões Region, considering the energy market sale and fossil fuel (petroleum) substitution by biomass.

Table 45 – Energy Generation Cash Flow for the Alto Solimões Region (R$)

ITEM	3.0 MWH MARKET	2.0 MWH SUBSTITUTION
CASH INFLOW	32,857,470	89,409,490
Energy and Steam Sales	25,946,250	25,946,250
CCC	5,655,980	62,208,000
Residual Value	1,255,240	1,255,240
CASH OUTFLOW	52,485,185	52,485,185
Fixed Asset Investment	7,541,306	7,541,306
Working Capital Investment	143,184	143,184
Production Costs	39,985,095	39,985,095
Revenues Taxes	4,815,600	4,815,600
Income Taxes	--	--
NET CASH FLOW	-19,627,715	36,924,305

Table 46 shows the cash flow for the two alternatives for the Orsa/Jari Region, under the hypothesis of energy market sale and fossil fuel (petroleum) substitution by biomass.

Table 46 – Energy Generation Cash Flow for the Orsa/Jari Region (R$)

ITEM	2.0 MWH MARKET	2.0 MWH SUBSTITUTION	10.0 MWH MARKET	10.0 MWH SUBSTITUTION
CASH INFLOW	**76,431,781**	**120,406,921**	**111,427,554**	**252,625,202**
Energy Sales	65,059,200	19,440,000	92,145,600	92,145,600
CCC	9,954,139	99,532,800	17,428,537	158,630,400
Residual Value	1,418,442	1,434,121	1,853,417	1,849,202
CASH OUTFLOW	**64,959,812**	**55,019,456**	**124,348,927**	**126,620,797**
Fixed Asset Investment	13,272,185	13,272,185	23,238,049	23,238,049
Working Capital Investment	162,647	178,326	341,418	337,203
Production Costs	37,960,890	37,960,890	83,667,315	83,667,315
Revenues Taxes	12,074,925	3,608,055	17,102,145	19,378,230
Income Taxes	1,489,165	--	--	--
NET CASH FLOW	**11,471,969**	**65,387,465**	**-12,921,373**	**126,004,405**

5.7 – ECONOMIC AND FINANCIAL INDICES

The economic and financial indices for the alternative plants considered are shown In Table 47. These indices were calculated based on projected net cash flow, shown above.

- The energy market sale options showed low internal rates of return (IRR), feasible only in the case of Orsa Group /Jari with a 3.5 MWH energy generating plant, selling energy and steam, (Table 47).
- All the fossil fuel substitution by biomass options were feasible, with the largest IRR obtained In the Rio Branco Region cases, followed by those in the Jari/Orsa region and lastly by those in the Alto Solimões Region.
- Net Present Value - NPV – also shows a behavior similar to the IRR.

Table 47 – Economic and Financial Indices for the Alternatives Analyzed

REGION/ ALTERNATIVE	POWER MWH	NPV (R$) (MDR 12%)	IRR %	INVESTMENT RECUPERATION (years)
RIO BRANCO				
Market	2.0	-2,840,301	--	8.6
	10.0	-17,550,577	--	15.0
Substitution	2.0	20,432,046	53.7	1.8
	10.0	104,945,170	67.8	1.4
ALTO SOLIMÕES				
Market	2.0	-11,167,087	--	--
Substitution	2.0	12,245,191	37.5	2.4
JARI/ORSA				
Market	3.5	1,824,220	16.6	1.9
	5.6	-12,315,574	--	10.9
Substitution	3.5	38,512,790	57.0	1.9
	5.6	43,876,860	41.7	2.3

• INFLUENCE OF TAXES ON THE ECONOMIC AND FINANCIAL INDICES.

Table 48 shows the influence of taxes on the economic and financial indices for the alternatives analyzed, where the following can be seen:

- The removal of taxes such as ICMS and other taxes collected on revenue, improve the IRR result, making the sale of energy alternative feasible in the Regions of Rio Branco and Jari.
- The IRR of the substitution of fossil fuel by biomass alternative also improves with the removal of taxes.
- The NPV also shows a behavior similar to the IRR with the removal of taxes.

Table 48 – The Economic and Financial Indices for the Alternatives Analyzed for no Tax Payments

REGION/ ALTERNATIVE	POWER MWH	WITHOUT ICMS		WITHOUT TAXES	
		NPV (R$)	IRR (%)	NPV (R$)	IRR (%)
RIO BRANCO					
Market	2.0	-1,304,868	5.5	-800,005	8.2
	10.0	-9,016,562	--	-6,649,578	2.1
Substitution	2.0	22,107,410	57.0	22,612,273	57.9
	10.0	113,479,185	72.1	115,542,699	73.3
ALTO SOLIMÕES					
Market	2.0	-9,460,264	--	-8,986,860	--
Substitution	2.0	13,952,014	40.9	14,425,418	41.8
JARI/ORSA					
Market	3.5	4,908,405	23.3	7,636,730	28.0
	5.6	-6,319,641	0.2	-4,572,706	4.2
Substitution	3.5	41,596,490	60.5	44,325,399	63.0
	5.6	50,903,274	46.2	52,650,209	47.3

5.8 – SENSITIVITY ANALYSIS

- RIO BRANCO REGION

Figures 20 and 21 show the sensitivity analysis as to biomass prices and the energy sale prices in the Rio Branco Region, where one can see:

- The energy market sale alternative supports maximum biomass price of up to R$ 30.00 per metric ton, (Figure 20);
- The fuel source substitution alternative supports a biomass price of up to R$ 180.00 per metric ton, (Figure 20); and,
- The minimum acceptable energy market sale price is R$ 120.00 per MWH, while for the substitution alternatives these prices can be as low as zero as the saving in fuel price justifies the operation for the substitution of petroleum by biomass. (Figure 21).

Figure 20 – IRR Sensitivity to Biomass Sales Price Variations in the Rio Branco Region

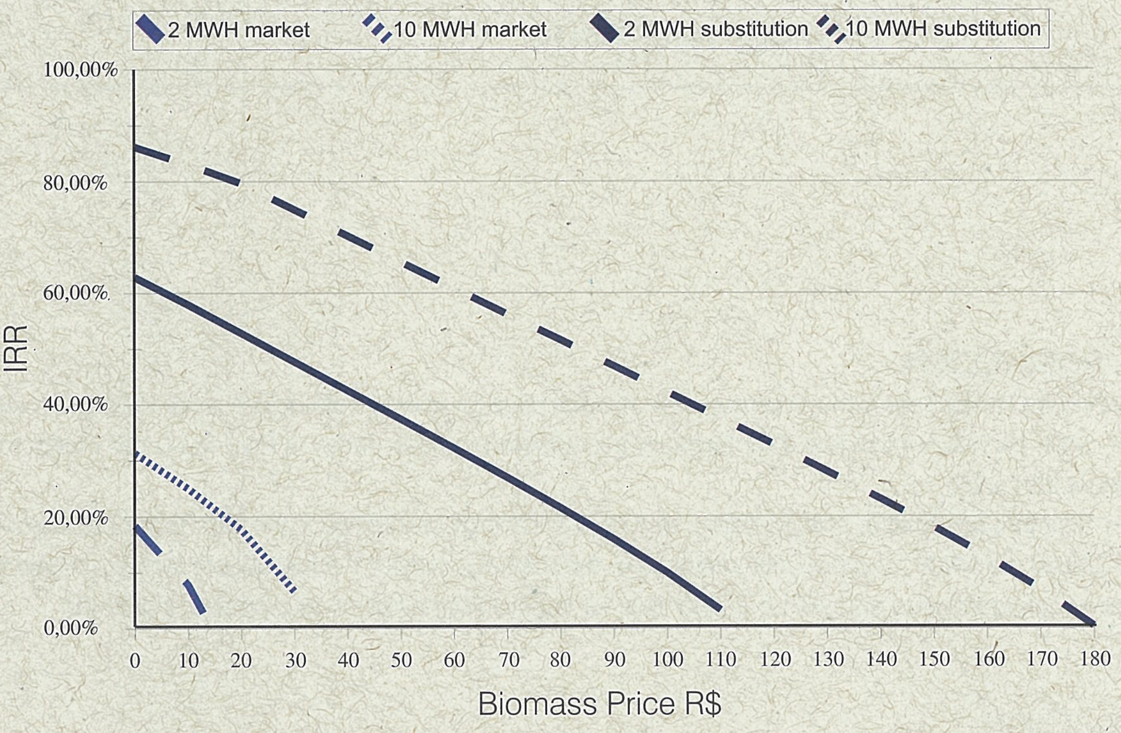
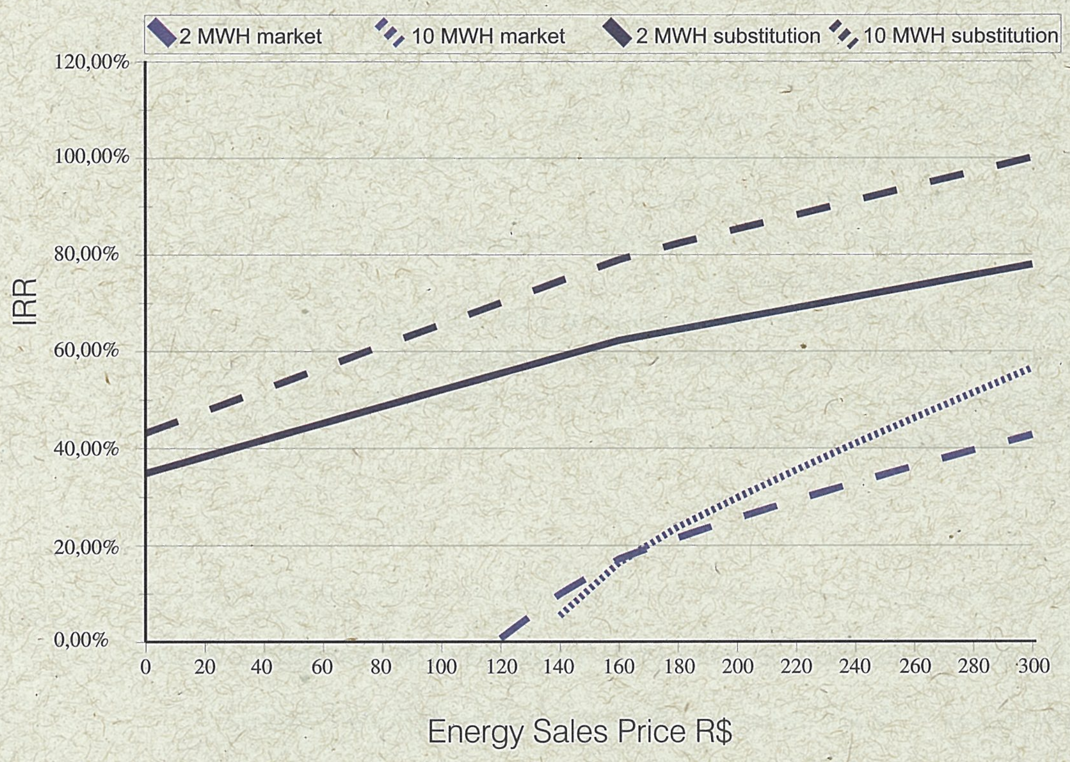


Figure 21 – IRR Sensitivity to Energy Sales Price Variations in the Rio Branco Region



- ALTO SOLIMÕES REGION
    - For Alto Solimões Region the maximum raw material price for energy market sale is R$ 15.00 per metric ton, while for fuel substitution the maximum acceptable biomass prices is R$ 118.00 per metric ton, (Figure 22); and
    - The minimum acceptable energy market sale price for energy production in the Alto Solimões Region is R$ 220.00 per MWH for production destined to the market, while for the fuel substitution price paid for energy can reach zero and still be economical for substitution of fuel oil by biomass. (figure 23)

- JARI/ORSA REGION
    - In the Jari/Orsa Region the raw material market sale price limits are at the maximum R$ 25.00 and 22.45 per metric ton, for the 3.5 and 5.6 MWH plant, respectively. While that for the maximum acceptable biomass substitution price is R$ 100.20 and 99.10 per ton for 3.5 and 5.6 MWH plant, respectively, (Figure 24);
    - The minimum acceptable energy market price to make energy generation to remain feasible in the Alto Solimões Region is R$ 71.60 and 134.50 for 3.5 and 5.6 MWH plant, respectively, while those for substitution only, is feasible for company consumption at any price due to the fuel savings (Figure 25);

Figure 22 – IRR Sensitivity to Biomass Sales Price Variations in the Alto Solimões Region

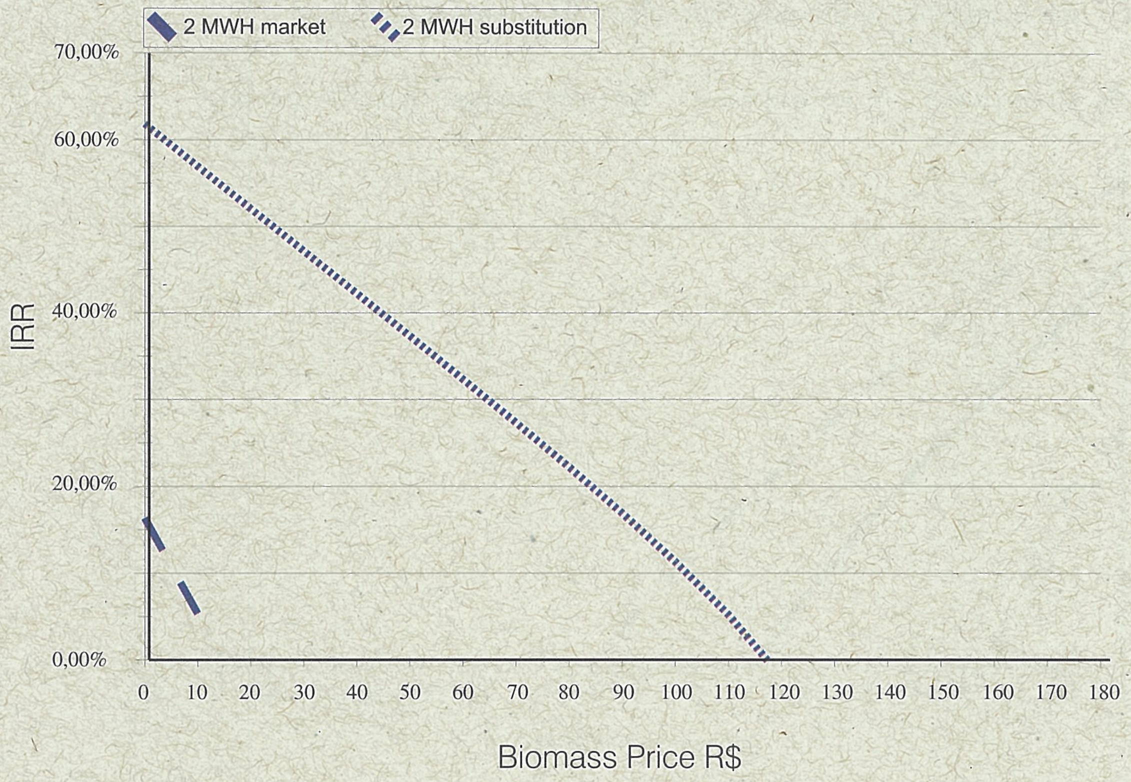


Figure 23 – IRR Sensitivity to Energy Sales Price Variations in the Alto Solimões Region

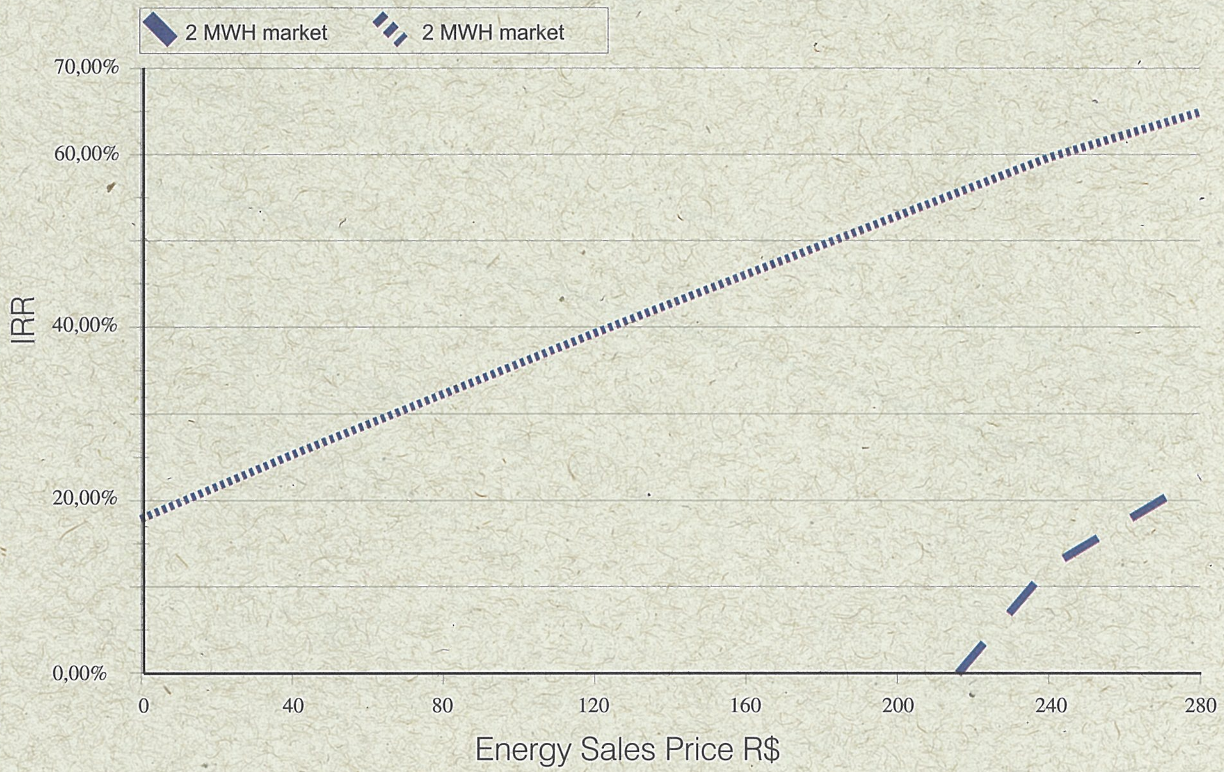


Figure 24 – IRR Sensitivity to Biomass Sales Price Variations at Jari/Orsa

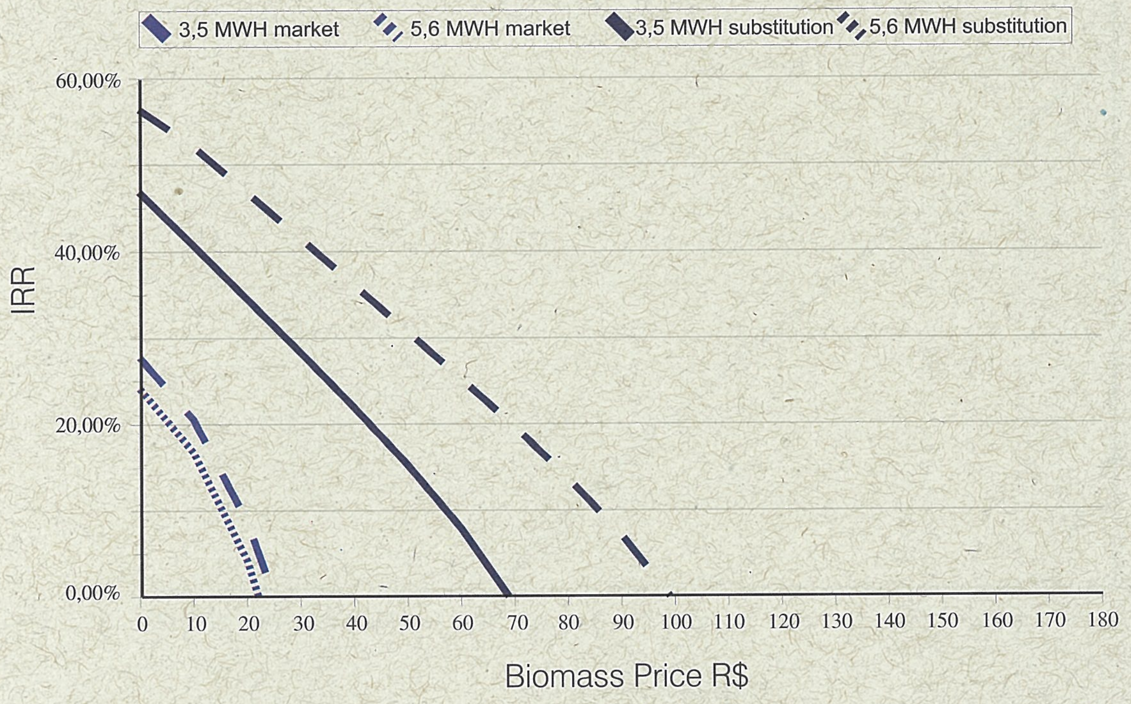
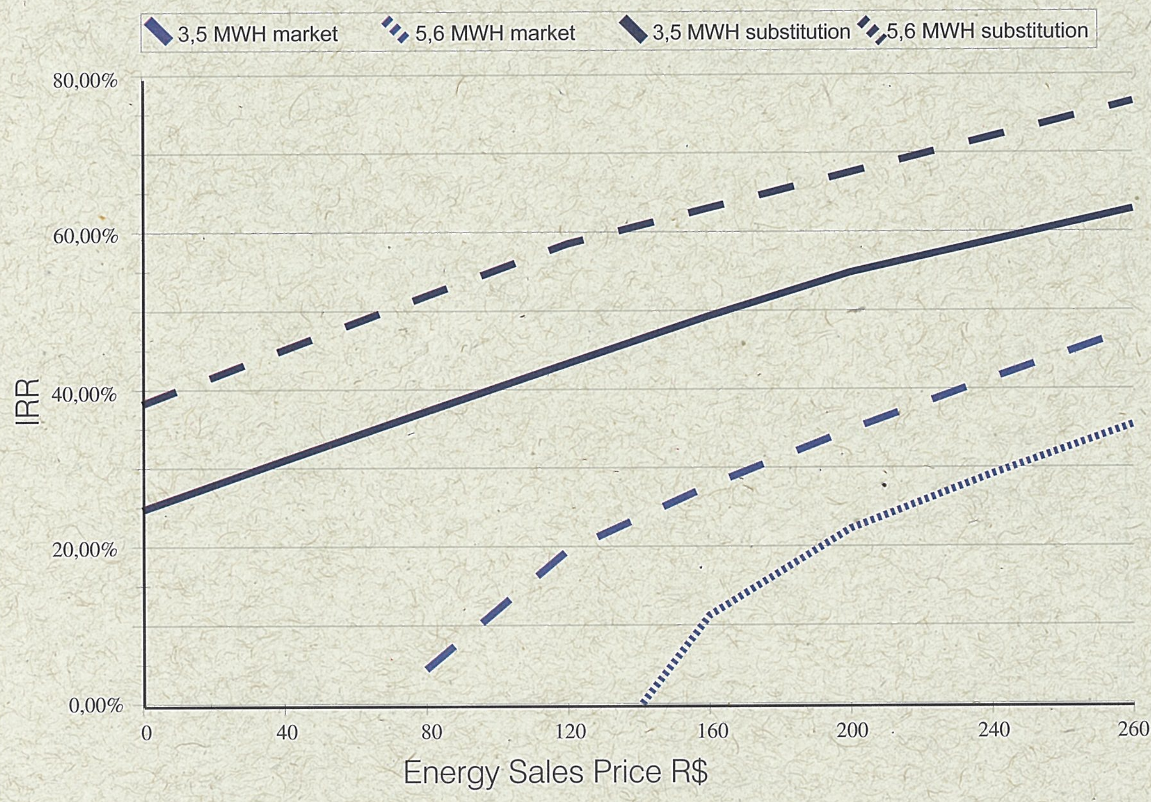


Figure 25 – IRR Sensitivity to Energy Sales Price Variations at Jari/Orsa



6 - PUBLIC POLICIES

The recommendations for public policies were obtained from round table discussions carried out during the 3 (three) workshops, in which representatives from Government (public), the private sector (forest product industry and energy generation and distribution industry businessmen), research institutions and other representatives from the local civil society participated.

The main objective of these round tables was: to obtain indications and proposals for actions and public policies aimed at the use of forest productive chain marginal residues and policy proposals for improving the conditions for energy generation.

6.1 – WORKSHOP RESULTS

The following presents a summary of the most relevant observations made during the debates carried out during the workshops.

6.1.1 – RIO BRANCO IN THE STATE OF ACRE

Major comments regarding public policies discussed at the Rio Branco Workshop were the following:

RAW MATERIAL (BIOMASS) PROCUREMENT

i. There is a legal impediment for the use of forest harvest residue since authorization is needed for the use of this product, as there is no legal standard defined by the authorities responsible for its control, making its use subject to individual criteria, as to quantity and type of material that can be removed from forest areas being harvested.

ii. Energy generation based on timber biomass has several limitations associated with the characteristics of the forest product industry, which are:

- Raw material procurement instability (due to the forest-based industry seasonality and instability), and the lack of a long-term sustainable procurement (a period superior to 15 years). In this case energy generation (strategic product) is a by-product of an industrial operation with limitations to long-term sustainability and short-term stability (seasonality during the year).

iii. In Acre, the workshop similar energy generation experiences biomass-based became unfeasible owing to raw material procurement instability, mainly as a result of increased biomass transportion and preparation costs. As a strategic issue, energy generation for meeting local population needs can not be subject to raw material availability oscillations.

FEASIBILITY AND CONTRIBUTION TO FOREST MANAGEMENT AND INDUSTRY COMPETITIVENESS (TIMBER PRODUCTIVE CHAIN)

i. The subsidies for energy generation in the State of Acre, to make procurement compatible to the tariffs practiced in other regions in Brazil are in excess of R$ 3 billion per year.

ii. The cost forest replacement requires for utilizing forest harvest residue is a limiting factor to the feasibility of using this as a fuel source for energy. This does not happen to industrial biomass, since forest replacement costs were already paid at harvesting.

iii. Lack of competitiveness with hydroelectric energy, the Brazilian energetic matrix base, limits biomass use as an energy alternative. The way of making market energy based on timber biomass feasible is to use partial maintenance of subsidies destined to petroleum fuel. However, this strategy does not make up part of Ministry of Mines and Energy policy.

iv. The use of forest harvest and industrial processing residue contributes to add value to forest management, in a way to increase the monetary value obtained by managed area unit, making sustainable forest management significantly more feasible in certified areas.

ENVIRONMENTAL IMPACT

i. The State of Acre Energy Regulating Agency, together with Asimanejo and FIEAC is preparing a proposal for energy generation from alternative sources with priority for the use of industrial residues as a way of providing a solution to environmental liability issues for companies installed in the Rio Branco Industrial District, which have problems is disposing industrial residue.

ii. According to the EMBRAPA/AC representative, the removal of the non-marketable species is not recommended due to the environmental impact caused to the existing natural resources in the forest.

iii. The timber biomass life cycle is shorter than the combustible fuel life cycle, representing a large advantage of this source of fuel as an effort of clean development, including its insertion as a CDM (Clean Development Mechanism).

iv. The use of biomass from forest harvest residue contributes for reduction forest fire risks in sustainable management areas, owing to the removal of material with a combustible potential.

6.1.2 – ALTO SOLIMÕES IN THE STATE OF AMAZONAS

The main comments in respect to public policies made at the Manaus Workshop (Alto Solimões case study) were the following:

RAW MATERIAL (BIOMASS) PROCUREMENT

i. The creation of sustainable forest production areas, which permits economically feasible management of areas in the State and National Forest Programs, will provide the availability of a forest origin biomass concentration, making forest origin raw material operation for energy generation feasible.

FEASIBILITY AND CONTRIBUTION TO FOREST MANAGEMENT AND INDUSTRY COMPETITIVENESS (TIMBER PRODUCTIVE CHAIN)

i. The use of forest harvest biomass residue to increase the productivity in forest management areas, currently between 1 and 2 m^3/ha/year, improves the economic results (forest remuneration) and will contribute to the success of forest management, making forest management operations as well as those activities linked to certification more feasible.

ii. Biomass transportation costs reduction through improvements to the infrastructure is essential for increasing competitiveness to support energy sales prices.

SOCIAL ECONOMIC IMPACT

i. The use of biomass with subsidies equivalent to those currently received for combustible fuel, as well making energy production feasible, injects up to R$ 4.87 million into the local economy per year, which could revolutionize the Benjamin Constant economy.

ii. The transfer of decision making to a local sphere, City and State Governments, makes the implementation of actions destined to the solution of local problems easier, when adapted to the specific conditions of each Region, giving priority the use of local raw material sources, and the accumulation of economic results to the timber chain. Currently, the economic results produced by the energy generation chain are accumulated in other locations, which are not the consumers of the energy, because the raw material and transport are from other areas.

iii. Initially, the use of biomass brings scientific and technological development to help manage and conserve the forest areas for industrial plant procurement.

iv. The direct benefits of the project are: the income generation, local employment, substitution of a non-renewable resource by a renewable one, improved conditions in rural areas in support to local populations, reducing migration, permanent settlement in the forest areas, improved technology events and increased competitiveness of the forest sector.

v. The project is an alternative for providing a solution to the absurdity of having a city in the middle of the Amazon forest throwing away industrial residue (biomass) that could be used as a fuel for energy generation instead of consuming diesel oil to generate energy.

vi. The project is an opportunity for the State to develop policies for the forest sector to face growing costs for diesel energy generation with biomass-based energy, such that the Government should repass the petroleum subsidies to biomass, furnishing better conditions for the use of biomass as an energy source.

vii. It is recommended that the project look at a partnership with the brick and tile making sector that has been working with bamboo and cassia that could be alternative energy sources. The preliminary results with cassia are three times larger that native brush.

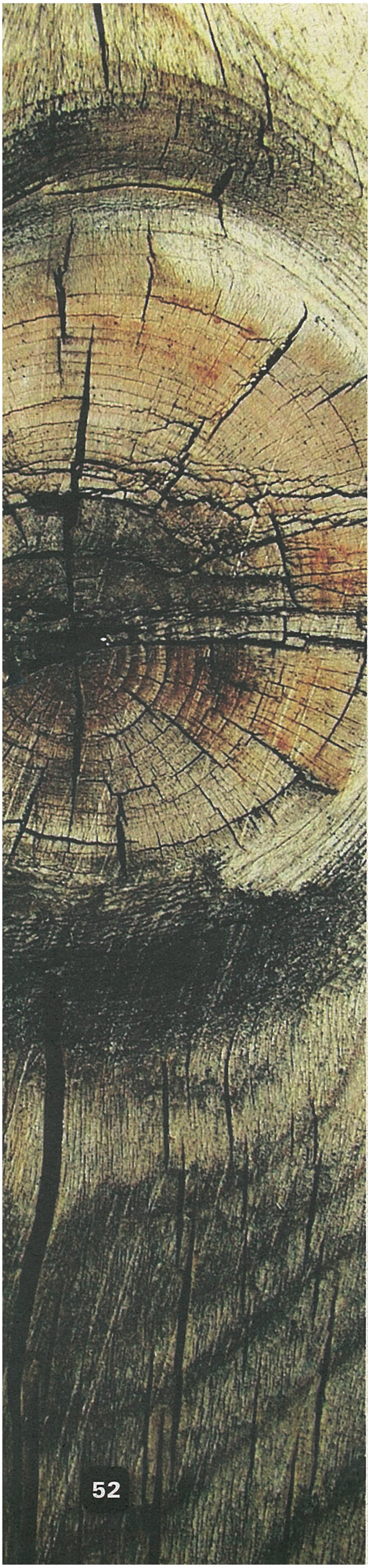
6.1.3 – JARI/ORSA IN THE STATE OF PARÁ

The main comments in respect to the public policies from the Belém Workshop (Jari/Orsa case study) were the following:

RAW MATERIAL (BIOMASS)

i. The Macro Zoning, through ZEE should be utilized as an land use planning instrument, which should help in the implementation of this type of project, mainly with the concentration of sustainable forest management areas, reducing the cost to the energy generating plants.

ii. The use of forest biomass residue, for any purpose, should be taken into account the



current use situation of the resource in the State, mainly in the eastern region, where wood is being produced from timber biomass (mainly residue) to sustain 7 (seven) pig iron plants and related foundries, using all the available residue in the this region.

iii. The use of timber biomass residue, whether from the forest or industry, should meet the conditions implemented by the State through SECTAM. This will be the big challenge for this type of project.

FEASIBILITY AND CONTRIBUTION TO FOREST MANAGEMENT AND INDUSTRY COMPETITIVENESS (FOREST PRODUCT PRODUCTIVE CHAIN)

i. The use of residues (secondary biomass) provides more value to the forest, allowing companies to generate more income. Nevertheless, it is recommended that nobler uses be given to biomass, other than energy, aggregating value to residue in general.

ii. Biomass is one important source of alternative fuel for energy production through firewood and others (cane, alcohol and others), although such sources may have large problems related to sustainability and procurement guarantee. Uncertainties surrounding the conditions of energy sources is one of the biggest problems for energy supply, and it is one of the reasons why many communities use energy based on petroleum in detriment to alternative sources such as biomass.

iii. The treatment given to payment for replacing forest harvest residue can become a decisive factor to the feasibility of energy generation based on timber biomass.

ENVIRONMENTAL IMPACT

i. The impact on the forest with harvest of non-marketable species can compromise future production capacity, with it being recommended that these species not be used for energy generation.

ii. It is necessary to avoid the export of existing nutrients in leaves and less than 5 cm diameter branches. In this case, it is recommended that this type of forest harvest residue not be used until more qualified studies are undertaken by EMBRAPA/CRATU.

iii. The volume of Forest harvest residue generated could be greater than that presented in the study, because it does not take into consideration the volume generated by other fallen trees, that are not marketable, knocked down or damaged during the timber harvest.

SOCIAL ECONOMIC IMPACT

i. The project also provides a contribution to the energetic infrastructure to support the agro-industry, generating energy at low prices in regions with limited energetic supply.

ii. The State of Pará has specific legislation for attracting investments considered strategic by the Government through fiscal incentives for equipment as a form of improving cost. The incentive is up to 95% of the ICMS for strategic companies, through FUNTEC. This can be a local contribution to making this type of project feasible.

iii. Pará has an abundance of energy in the eastern part, on the other hand there are regions such as the Northern trough along the Amazon River and Marajó Island where one could implement this type of project, as the energy supply is precarious. In these cases, biomass becomes a strategic energy source.

6.2 – PUBLIC POLICY SUGGESTION PROPOSALS

Based on discussions and suggestions presented at the workshops in Rio Branco, Manaus and Belém, it is suggested that the following Public Policy actions be taken to make the energy generation projects based on timber biomass more feasible.

RAW MATERIAL (BIOMASS) PROCUREMENT

i. Norms – prepare a standard at the national level to establish the quantity and type of industrial and forest harvest biomass that could be used for energy generation. The following is suggested:

Allow the integral use of industrial residue without any costs for forest replacement as it was already paid during the harvest phase for industrial processing.

The quantity of residue to meet this requirement should obey the same criteria as used to determine the quantity of product residue from the transformation process.

To allow the use of all the residue generated by forest harvest: crown and stem residue from trees removed and species damaged by forest harvest, payment for forest replacement should not be required.

ii. Zoning and Land Use – use the ZEE as a tool for territorial ordering, which is associated to the creation of forest production areas, through a cluster system, concentrating forest and industrial origin biomass production, reducing transportation costs and creating stability for raw material (biomass) procurement, facilitating energy production to meet the needs of the market and the forest producers themselves.

FEASIBILITY AND CONTRIBUTION TO FOREST MANAGEMENT AND INDUSTRY COMPETITIVENESS (FOREST PRODUCT PRODUCTIVE CHAIN)

i. Subsidies – to develop a policy for combustible fuel substitution for biomass for energy generation for the market, through providing part of the subsidies granted to combustible fuel to biomass to make energy generation meet market needs, and benefiting communities. The subsidy value could be equivalent to one-half the value granted to diesel oil for current generation.

ii. Pilot Model – Implement a pilot model on a small scale with priority for Rio Branco with a 2.0 MWH generation capacity as a basis for development of the proposed generation operating model.

iii. Sustainable Forest Management – the project implementation will make sustainable forest management feasible. In an area where one harvests 15 m³/ha of timber logs, there will be a R$ 125.00 per hectare (12.5 metric tons) increase in revenue, for the payment of currently non-used stem and crown, representing a growth of at least 10% in revenue.

ENVIRONMENTAL IMPACT

i. Industry Environmental Liabilities – the promotion of industrial residue (biomass) use should be implemented by forest production development and environment and control agencies, as a solution for environmental liabilities generated by industrial production. The development of a joint action is recommended together with these institutions, the Public Attorney's Office (environment) and business entities, mainly in the Municipality of Rio Branco where this problem is being discussed.

ii. Non-Marketable Species – the impact generated on the forest with non-marketable species harvest could compromise future production capacity and steps should be used to improve the use of these species.

iii. Nutrient Export – the use of forest harvest residue with a diameter of less than 5 cm and leaves should not be permitted, to avoid the export of existing nutrients.

iv. Clean Development Mechanism (CDM) – the timber biomass life cycle is less that the fossil fuel cycle, representing a great advantage of this source in efforts for clean development, including insertion as CDM.

OVERALL ASPECTS

i. Increased Local Decision Power – To promote the transfer of decision making to a local sphere, City and State Governments make easier the implementation of actions to solve local problems. These are to be adapted to the specific conditions of each Region, giving priority to the use of local raw material, and the accumulation of economic results within the timber chain.

ii. Science and Technology Development – to implement via official institutions and research organizations the necessary studies to promote biomass utilization as an alternative source of energy in the more distant regions of Amazon.

7 - CONCLUSIONS

In accordance with the studies carried out in the different locations in the Amazon region, it can be concluded that the use of forest biomass for the production of energy, has the following characteristics.

FEASIBILITY

In the Itacoatiara Region, there is no raw material available for new timber biomass-based energy generation on timber biomass, as existing residues are already committed to this type of unit.

Timber biomass is competitive for energy generation for sale to the market when compared to energy generation based on oil. Nevertheless, it is not feasible to meet the needs of the markets in the Regions under study, for prices currently paid by are less than production costs, owing to large subsidies received by thermoelectric producers (for oil based derivatives).

Thus, timber biomass competitiveness is reduced due to subsidies received for energy generation from fuel oil, such that only energy generated from industrial biomass is feasible for energy market sale at prices competitive with those currently being paid by the distributors, while energy generated from forest harvest biomass is not feasible, owing to high raw material transport and preparation costs.

Timber biomass is a highly feasible alternative as a substitute for fuel oil for energy generation, under the current public prices conditions and subsidies paid to energy companies and distributors. In this case, all biomass sources, industrial and forest become highly feasible and all the energy generation alternatives analyzed become feasible when subsidies are granted to fuel oil currently being used for generation in the locations under analysis.

The generation for self-consumption is feasible for all the alternatives analyzed. This includes industrial biomass and even forest biomass, in a way that combined with the substitution of fuel oil, it becames very attractive for industrial units, permitting the use of industrial and forest residues, within a transport distance of 200 kilometers.

The best economic and most feasible option for energy generation is the use of industrial transformation residues. Non-marketable species were found to be the worst economic option, being unfeasible in all cases.

CONTRIBUTION TO SUSTAINABLE MANAGEMENT:

Use of biomass for commercial purposes contributes to add value to sustainable forest management and increases the competitiveness of the activity. It was found that extra incomes up to R$ 125.00 could be provide per ha.

Energy generation as a non-traditional timber consumer can together with the forest-base industry contribute in a significant way to making sustainable forest management feasible.

Non-marketable species harvests are unfeasible in economic terms as well as representing an expressive increase in forest intervention. The use of these species is not very attractive in economic terms, owing to the high cost of raw material preparation, high transport cost and also to the large impact generated by the volume harvested on the management areas, and therefore, is not recommended as an alternative for the project in question.

IMPACTS ON FOREST-BASED INDUSTRY INCOME:

The use of industrial residue represents a solution for an environmental liability generated by the timber industry and a possibility, as well, of adding value to this material, and improving the company profitability.

Energy generation for self-consumption also represents savings for in the use of fuel oil (lower cost energy price) and aggregates value to an industrial transformation by-product.

Co-generation also represents a possibility for steam generation for drying, allowing an improvement in industrial processing, aggregating value to the main product, quality dried wood.

IMPACT ON REGIONAL SOCIAL ECONOMIC DEVELOPMENT

The energy generated through the use of biomass is a big employer of labor in comparison with the different ways of energy generation, whether thermoelectric or other. Jobs are generated in the production sites where the energy is consumed, injecting resources directly into the local and regional economy.

The income generated is aggregated to the local productive chain, through payment for raw material, its preparation, transportation and energy generation. The above benefits mentioned increase employment and income. Increases of tax collection at local and regional level, contributes to an improvement of social economic conditions.

The processes mentioned above insert the local population into the productive chain and the benefits generated by it, including the availability of electric energy to meet community needs.

There is the possibility of using the undertaking as a Clean Development Mechanism and Carbon Capture generating an additional incentive by substituting fuel oil by biomass.

Lastly, energy generation based on timber biomass to meet market needs is highly feasible and recommended for substitution of fuel oil as long as part of the subsidies tied to fossil fuel generation are granted to generation biomas-based processes.

Co-generation and generation for self-consumption are fundamental to make the forest-based industry more feasible in locations where fuel oil is used or limitations to energy supply are still experienced.

Injection of Resources into Local Economy – the benefits produced with energy generation, including any eventual subsidies will be accumulated in to the local productive chain, providing:

a. Income generation,
b. Local employment,
c. Substitution of a non-renewable source with a renewable source,
d. Less migration to urban areas,
e. Technological improvements,
f. Increased competitiveness of the forest sector,
g. Social inclusion.

For continuing the work, it is recommended that pilot projects are developed to meet specific characteristics of each Region, which are:

- Rio Branco: to implement a 2.0 MWH pilot model to provide a solution to an environmental liability created by timber companies in the Industrial District.
- Alto Solimões: implement a small-scale pilot model to meet isolated community needs, such that in function of the limited supply of raw material, a 0.5 MWH plant is recommended.
- Jari/Orsa: to implement a 5.0 to 10.0 MWH pilot model with co-generation to meet the large demand for energy in the local, which currently uses fuel oil. As It is an excellent option for immediate substitution of fossil fuel by timber biomass, with immediate feasibility, using forest harvest residue within a transportion radius of 100 kilometers.

Appendices

- LIST OF WORKSHOP PARTICIPANTS
- WORKSHOP PROGRAM
- LIST OF ABBREVIATIONS
- GLOSSARY OF TECHNICAL TERMS

Appendix I

List of Rio Branco Workshop Participants

NAME	INSTITUITION	FUNCTION
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2. Roberto Ferreira dos Santos	ABC/MRE	Cooperation Technician
3. Valéria Cristina Rigueira Losito	ABC/MRE	Cooperation Technician
4. Ivana Guerreiro Lima	Friends of the Earth	Collaborator Acre / Rondônia
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17. Elenice Nadvorny Nascimento	FUNPAR Consultants	Forestry Engineer
18. Mirian Albino de Oliveira	ACRESERV	Businesswoman
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21. Alberto Fernandes Rodrigues	MME	Light for Everyone Program
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38. Rosângela de Oliveira	SEMA / IMAC	Coordinator PGAI/AC
39. Rosana Cavalcante dos Santos	SEMA/IMAC	Solid Waste Coordinator
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5. Carlos Fernando Guedelha Leão	USIPAR/BAC.	Charcoal and Procurement Coordinator
6. Inês Graciette Leal	JURUÁ FLORESTAL	Administrative Manager
7. Luiz Carlos Fensterseifer	BORDEN QUÍMICA	Sales Representative
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10. Thais Yuri R. Nagaishi	UFRA	Student
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19. Vanise Barbosa de Almeida	UFRA	Forestry Engineer
20. Leonardo M. Sobral	CIKEL	Environmental Manager e
21. José Osvaldo O. de Barros	Sindicato Rural de Cametá	Secretary
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23. Aguimar Mendes Ferreira	FUNPAR	Consultant Project PD 61/99
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25. Crisomar Lobato	SECTAM/ZEE	Forestry Eng. – ZEE/SECTAM
26. Luiz Pinto Oliveira	SECTAM	Assistant Secretary
27. Margarida F. Azevedo	MCM Consult	Managing Partner
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29. Carlos Victor Pereira Leitão	UFRA	Student
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List of Manaus Workshop Participants

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10. Joésio D. P. Siqueira	FUNPAR	Project Coordinator
11. Malvino Salvador	Forest Agency	President
12. Morgana Aguiar	Forest Agency	Forestry Engineer
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15. Cintia R. Souza	EMBRAPA	Researcher
16. Fernando C. Lucas Filho	UFAM/CIDE	Researcher
17. Jardel A. A. Louzeiro	Forest Agency	Assistant I
18. Marcel da C. Hummel	Forest Agency	Trainee
19. Jorge Luis G. Teixeira	FIEAM/CIEAM	Director/Consultant
20. Elenice N. Nascimento	FUNPAR	Forestry Engineer
21. Hans Peter	Sustainable Forestry	Businessman
22. Cláudio P. Machado	SUFRAMA	Public Servant
23. Débora Delgado França	UP GRADE	Tourism
24. Sávio Mendonça	SDS	Secretary of Water Resources
25. Frank Lopes Pereira	ACERIM	Businessman
26. José Luiz Chielle	FUNPAR	Consultant
27. Moysés Israel	FIEAM	Businessman
28. Nabor da Silveira Pio	UFAM	Professor
29. Raimar Aguiar	FIEAM/SICLAM	Union President
30. Eduardo Coutinho da Cruz	UFAM	Professor
31. Aguimar Mendes Ferreira	Funpar	Consultant

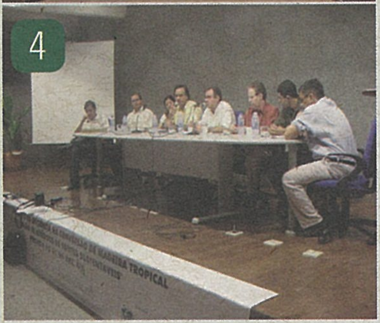
Appendix II

RIO BRANCO WORKSHOP
Date: July 22, 2005
Location: Federal Revenue Office Auditorium I, R. Marechal
Deodoro, 340, Ground Floor – Center
Rio Branco – Acre

HOUR	EVENT
09:00 – 9:40	Registration and reception
09:50 – 10:00	Opening: Aguimar Mendes Ferreira –Forest Development Consultant FUNPAR/ITTO Project PD 61/99
10:00 – 10:50	Technology for the generation of energy from the use of timber biomass Speaker: José Luiz Bauer Chielle – Consultant FUNPAR/ITTO Project PD 61/99
10:50 – 11:00	Coffee Break
11:00 - 12:00	Industrial Solid Timber Residue Inventory in Acre Speaker: Rosana Cavalcante dos Santos – SEMA/IMAC
12:00 - 14:30	Lunch
14:30 – 16:00	Presentation of FUNPAR/ITTO Project Executive Summary – Increasing the Efficiency in the Tropical Timber Conversion and Utilization of Residues from Sustainable Sources Speaker: Aguimar Mendes Ferreira – Consultant FUNPAR/ITTO Project PD 61/99
16:00 – 16:15	Coffee break
16:20 - 18:00	Round Table: Use of timber biomass for energy generation. Participants: Marcus Vinícius N. D'Oliveira - EMBRAPA/CPAFAC Moisés Silveira Lobão - UFAC – Forestry Engineer Adelaide Fátima de Oliveira - ASIMMANEJO Zenóbio Abel G. P. da Gama e Silva - FUNTAC Edson Freire - GUASCOR Francisco Eulálio Alves dos Santos - AGEAC Aguimar Mendes Ferreira - FUNPAR/ITTO Celso Santos Matheus - ELETROACRE
18:00	Closing

BELÉM WORKSHOP
Date: July 18, 2005
Location: State of Pará Industry Federation, Auditorium I, 7th Floor – A Block
Trav. Quintino Bocaiúva, 1588, Nazaré

HOUR	EVENT
09:00	Registration and reception
09:40	Opening Ceremonies: Dr. Luis Pinto de Oliveira – Assistant Secretary– SECTAM – State of Pará Executive Secretary of Science, Technology an Environment Dr. Justiniano Queiroz Neto – Executive Director AIMEX – State of Pará Timber Industry Exporter Association Prof. Dr. Sueo Numazawa – Federal Rural University of Amazons Aguimar Mendes Ferreira – Forest Development Consultant FUNPAR/ITTO Project PD 61/99
10:00	Ecological Economic Mapping for Pará – for the Prospecting of Areas for Sustainable Development Speaker: Crisomar Lobato – Pará ZEE Coordination - SECTAM
11:00 - 11:15	Coffee Break
11:15	Technology available for energy generation from the use of timber biomass Speaker: José Luiz Bauer Chielle – Consultant FUNPAR/ITTO Project PD 61/99
12:00 - 14:30	Lunch
14:30	Presentation of the Results from the Jari/Orsa Case Study FUNPAR/ITTO Project - Increasing the Efficiency in the Tropical Timber Conversion and Utilization of Residues from Sustainable Sources – Jari/Orsa Case Expositor: Aguimar Mendes Ferreira – Consultant FUNPAT/ITTO Project PD 61/99
16:00 – 16:20	Coffee Break
16:20 - 18:00	Round Table: Use of timber biomass for energy generation Participants: Justiniano Neto – Executive Director-AIMEX Sueo Numazawa – Vice Chancellor UFRA Augusto César Brasil – Assistant Professor UFPA Luiz Pinto Oliveira – Assistant Secretary - SECTAM Lúcia Porpino – Environmental Directorate - SECTAM Joésio D. Pierin Siqueira – Coordinator Project. PD 61/99 Rev. 4 (I) Aguimar Mendes Ferreira – Forest Development Consultant Project PD 61/99
18:00	Closing



PHOTOGRAPHS - RIO BRANCO

1 - Overall View of Rio Branco Workshop
2 - Opening of Rio Branco Workshop
3 - Talk by Dra. Rosana Cavalcante Santos SEMA/IMAC – Rio Branco
4 - Round Table – Rio Branco Workshop

MANAUS WORKSHOP
Date: July 20, 2005
Location: SESI/FIEAM Building, Directors Room, 3rd Floor, R. Joaquim Nabuco, 1919 – Center

HOUR	EVENT
09:00	Registration and reception
09:20	Opening: Jorge Garcez – Assistant Director FIEAM Sávio Mendonça – Executive Secretary Water Resources - SDS Malvino Salvador – President of Sustainable Forest and Resources Agency - SDS Joésio Deoclécio P. Siqueira – Coordinator Project FUNPAR, PD 61/99 Aguimar Mendes Ferreira – Forest Development Consultant FUNPAR, Project PD 61/99
09:30	Presentation of the Free Zone Green Program Speaker: Malvino Salvador – President of the Amazon Sustainable Forest and Business Agency
10:00	Use of the timber resources for electricity generation: Alto Solimões Speaker: Mariano Colini Cenamo – Consultant IGPLAN/FUNPAR/ITTO Project PD 61/99
10:30 - 10:50	Coffee Break
10:50	Technologies for energy generation using timber biomass Speaker: José Luiz Bauer Chielle – Consultant FUNPAR/ITTO Project PD 61/99
12:00 - 14:30	Lunch
14:30	Presentation of FUNPAR/ITTO Project Executive Summary – Increasing the Efficiency in the Tropical Timber Conversion and Utilization of Residues from Sustainable Sources – Alto Solimões Speaker: Aguimar Mendes Ferreira – Consultant FUNPAT/ITTO Project PD 61/99
16:00 - 18:00	Round Table: Use of timber biomass for energy generation Participants: All speakers
18:00	Closing

PHOTOGRAPHS – MANAUS

5 - Opening of Manaus Workshop
6 - Overall View of Manaus Workshop
7 - Final Manaus Workshop Session
8 - Talk by Forest and Sustainable Business Agency President Dr. Malvino Salvador
9 - Talk about Energy Generation from Biomass José Luís Bauer Chielle FUNPAR/ITTO
10-Talk about Alto Solimões case study Aguimar Mendes Ferreira – FUNPAR/ITTO – Project PD 61/99
11-Final Session to Debate Project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Appendix III

ABBREVIATIONS

% - Percent
°C - Degrees Celsius
ABC - Agência Brasileira de Cooperação (Brazilian Cooperation Agency)
AC - Acre (State of Acre)
AGEAC - Agência de Energia do Acre (Acre Energy Agency)
AIMEx - Ass. das Indústrias Exportadoras de Madeira do Pará (State of Pará Association of Timber Exporter Companies)
AM - Amazonas (State of Amazonas)
ANAC - Agência de Negócios do Acre (Acre Business Agency)
ASIMANEJO - Ass. das Indústrias de Manejo Florestal do Acre (State of Acre Association of Forest Management Companies)
bar - Bar (measure of pressure)
BK -BK Energética
CCC - Conta de Consumo de Combustível (Fuel Consumption Account)
DBH - Diameter at Breast Height
CEAM - Companhia de Eletricidade do Amazonas (Electric Company of Amazonas)
CELPA - Companhia de Eletricidade do Pará (Electric Company of Pará)
CEPEA - ESALQ/USP - Centro de Pesquisa em Economia Aplicada/Escola Superior de Agricultura Luiz de Queiroz/Universidade de São Paulo (Research Center for Applied Economics/ Luiz de Queiroz Agricultural School /University of São Paulo
CETEMM/SENAI-DR- Centro de Tecnologia de Madeira e Móveis/ Serviço Nacional de Aprendizagem Industrial (Timber and Furniture Technical Center/ National Industrial Training Service)
CDM – Clean Development Mechanism
CO_2 - Carbon dioxide
COFINS - Contribuição para Financiamento da Seguridade Social (Social Security Financing Contribution)
COSIPA - Companhia Siderúriga do Pará (Steel Company of Pará)
CPATU - Centro de Pesquisa Agrícola do Trópico úmido (Tropical Rain Forest Agriculture Research Center)
CPMF - Contribuição Provisória sobre Movimentação Financeira (Temporary Financial Movement Contribution)
CSLL - Contribuição Sobre o Lucro Líquido (Contribution on Net Income)
ELETROACRE - Companhia de Eletricidade do Acre (Electric Company of Acre)
EMBRAPA - Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Company)
FIEAC - Federação das Indústrias do Estado do Acre (State of Acre Industry Federation)
FIEAM - Federação das Indústrias do Estado do Amazonas (State of Amazonas Industry Federation)
FUNPAR - Fundação da Universidade Federal do Paraná para o Desenvolvimento da Ciência, da Tecnologia e da Cultura (Federal University of Paraná Foundation for the Development of Science, Technology and Culture))
GEMAF–Gerência de Manejo Florestal (Forest Management Administration)
h - hour
ha - Hectare
IBAMA - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environmental and Renewable Natural Resources)
ICMS - Imposto Sobre Circulação de Mercadorias (State Value Added Tax on Goods)
IMAC - Instituto de Meio Ambiente do Estado do Acre (State of Acre Environment Institute)
IMAZON - Instituto do Homem e Meio Ambiente da Amazônia (Amazon Environment and Human Institute)
IRR – Internal Rate of Return
IPAAM - Instituto de Proteção Ambiental do Estado do Amazonas (State of Amazonas Environmental Protection Institute)
IR - Imposto de Renda (Income Tax)
ITTO - International Tropical Timber Organization
kcal – kilocalorie
kg - kilogram
kgf - kilogram force
km - kilometer
LCP - Lower Calorific Power
m³ - cubic meter
MIL - Madeireira Itacoatiara Ltda
MME - Ministério das Minas e Energia (Ministry of Mines and Energy)
MW - Megawatt
MWH - Megawatt hour
NCP - Net Calorific Power
NGO – Non-Governmental Organization
NPV – Net Present Value
PA - Pará (State of Pará)
PIS - Porgrama de Integração Social (Social Integration Program)
PMB - Prefeitura Municipal de Belém (Municipal Government of Belém)
R$ - Reais
RPM – Rotation per minute
SDS - Secretaria de Desenvolvimento Sustentável do Estado do Amazonas (State of Amazonas Sustainable Development Secretary
SEBRAE - Serviço Brasileiro de Apoio a Pequena e Média Empresa (Brazilian Support Service for Small and Medium Companies)
SECTAM - Secretaria de Ciência Tecnologia e Meio Ambiente do Estado do Pará (State of Pará Secretary of Science Technology and Environment)
SEF - Secretaria de Florestas do Acre (State of Acre Secretary of Forests)
SEMA - Secretaria de Meio Ambiente do Acre (State of Acre Secretary of the Environment)
SEMULSP - Secretaria Municipal de Urbanização e Limpeza Pública de Manaus (Manuas Municipal Secretary of Urbanization and Public Health)
SEPLANDS - Secretaria de Estado de Planejamento e Desenvolvimento Sustentável do Acre (State of Acre State Secretary of Planning and Sustainable development)
SESE - Secretaria de Segurança (Secretary of Security)
SUFRAMA - Superintendência da Zona Franca de Manaus (Superintendent of Manuas Duty Free Zone)
t – metric ton (tonne)
UPC – Upper Calorific Power
UFAC - Universidade Federal do Acre (Federal University of Acre)
UFAM - Universidade Federal do Amazonas (Federal University of Amazonas)
UFPA - Universidade Federal do Pará (Federal University of Pará)
UFRA - Universidade Federal Rural da Amazônia (Federal Rural University of Amazonas)
UFV - Universidade Federal de Viçosa (Federal University of Viçosa)
USIPAR - Usina Siderúriga do Pará (Pará Steel Mill)
ZEE - Zoneamento Ecológico Econômico (Economic Ecological Zoning)

Appendix IV

GLOSSARY OF TECHNICAL TERMS

AMORTIZATION – Gradual payment. Consists of the accounting recovery, of the invested capital in rights, costs, expenses, or expenditures that will have effect in future years.

BARK – The exterior covering surrounding a tree.

BIOMASS – Biomass is all the organic material produced and accumulated in an ecosystem; however, not all primary production goes on to increase the ecosystem's vegetable biomass. Part of the accumulated energy is used by the ecosystem for its own maintenance.

BOILER – Equipment destined for the generation of steam for commercial, residential or industrial use.

CALORIFIC POWER – The amount of calories (in the form of heat), which results from the complete combustion (burning) of one unit volume of gas. The calorific power is expressed in Kcal/m3. Each fuel has its own calorific power that corresponds to its combustible capacity to generate heat.

CARBON SEQUESTRATION – The reversal of the accumulation of CO2 in the atmosphere, aiming at the reduction of the greenhouse effect, through the conservation of the carbon stocks in the soil, forest and other types of vegetation.

CARBONIZATION – The process by which wood is submitted to a thermal treatment in an environment where the temperature and pressure are controlled.

CASH FLOW – the receipt and disbursement of cash, including: receipts, benefits, investments, depreciation, costs, taxes and others.

CHIP – A wood splinter or fragment that can be used for burning.

COMBUSTION – Combination, generally rapid, of two combustible and burnable substances, which liberate a large amount of heat.

CROWN – Discarded industrial residue from the productive process and that in a majority of times is not sold and considered an environmental liability by industry.

DEFERRED ASSETS – Pre-operating expenses realized during the implementation period

FOREST INVENTORY – A qualitative and quantitative information survey about existing forest resources in a determined area or enterprise.

FOREST RESOURCES – Forest resources are understood to be timber or non-timber resources present in natural or replanted forests.

GASIFICATION – the conversion of coal, heavy oil, coke, biomass and other low-grade hydrocarbons into a clean gas that permits energy generation, fuel, and chemical or industrial products.

HAULING – Manual, semi mechanical or mechanical operation for the removing of small pieces up to 2.2 meters of material from the forest to the margins of the road.

INTERNAL RATE OF RETURN – IRR – This is the rate of remuneration that an enterprise provides on the invested capital.

LOGS - Felled stems.

MANAGEMENT – the application of a program for natural or artificial ecosystem use based on solid ecological theories in a way of maintaining it, in the best possible way, for the communities, as useful biological product sources for man, as well as a source of scientific knowledge and recreation.

MARGINAL BIOMASS – Sub-products generated in the timber productive chain, in the diverse industrial transformation phases (no marketable value) from the forest up to the industrial unit, such as forest harvest residue, non-marketable species and industrial residue.

MULTIPLE USE MANAGEMENT PLAN – This is a planning and management instrument for Conservation Units, prepared after a due analysis of all environmental factors and the resources to be managed.

NET PRESENT VALUE – NPV – this is the result of the discounted cash flow to the present at a Minimum Acceptable Discount Rate (MDR)

PAYBACK – Payback is the time necessary to recover the investment made in any business.

PYROLYSIS – The chemical decomposition by heat in the absence of oxygen.

SAW DUST - Discarded industrial residue from the productive process and that in most of the time is not sold, considered an environmental liability by industry

SHAVINGS – Discarded industrial residue from the productive process and that in most of the time is not sold, considered an environmental liability by industry.

SKIDING – the mechanical operation of removing large pieces of material from the forest to the margins of the road.

SLAB – Discarded industrial residue from the productive process and that in most of the time is not sold, considered an environmental liability by industry

SLASHING – Segmenting the stems into logs with a length of 1.10 or 2.20 meters.

SUSTAINABLE FOREST MANAGEMENT – Management of forest resources for obtaining products, services and economic or social benefits respecting the mechanism for its environmental subsistence.

SUSTAINABLE SOURCES – Resources that will be used over a long time and renewable in a sustainable way.

TOPPING - The complementary work of tree slash corresponding to the transversal cutting of the tree.

WANE – The material resulting from the timber processing operation

WORKING CAPITAL – A part of a company's total capital, which by the dynamics of its movement becomes important in its administration.

Support

ABC/MRE – Agência Brasiliera de Cooperação/Ministério das Relações Exteriores (Brazilian Cooperation Agency/Ministry of Foreign Affairs)

Agência de Floresta e Negócios Sustentáveis do Estado de Amazonas (State of Amazonas Sustainable Forest and Business Agency)

IBAMA – Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Enviornmaental and Renewable Natural Resources Institute)

AIMEX – Associação das Indústrias Exportadores de Madeira do Pará (State of Pará Timber Exporter Industry Association)

ASMANEJO – Associação das Indústrias de Manejo Florestal do Acre (State of Acre Forest Management Industry Association)

Associação das Indústrias Exportadores de Madeira do Alto Solimões (Alto Solimões Timber Exporter Industry Association)

EMBRAPA/AC – Empresa Brasileira de Pesquisa Agropecuária (Brazilian Animal and Agricultural Farming Research Company)

FIEC – Federação das Industrias do Estado do Acre (State of Acre Industry Federation)

FIEM – Federação das Industrias do Estado do Amazonas (State of Amazonas Industry Federation)

FIEPA – Federação das Industrias do Estado do Pará (State of Pará Industry Federation)

IMAC – Instituto de Meio Ambiente do Estado do Acre (State of Acre Enviromental Institute)

Jari Celulose S.A.

Orsa Florestal S.A.

Orsa Group

Precious Wood Amazon Group

SDS – Secretaria de Desenvolvimento Sustentável do Estado do Amazonas (State of Amazonas Secretary of Sustainable Development)

SECTAM – Secretaria de Ciência, Tecnologia e Meio Ambiente do Estado do Pará (State of Pará Secretary of Science, Technology and Emvironment)

SEF – Secretaria de Florestas Acre (State of Acre Secretary of Forests)

SEMA – Secretaria de Meio Ambiente do Acre (State of Acre Secretary of the Environment)

SEPLANDS – Secretaria de Estado de Planejamento e Desenvolvimento Sustentável do Acre (State of Acre State Secretary of Planning and Sustainable Development)

SESE – Secretaria de Segurança (Secretary of Welfare)

SUFRAMA – Superintendência de Zona Franca de Manaus (Manaus Duty Free Zone Superintendent)

UFAC – Universidade Federal do Acre (State of Acre Federal University)

UFAM – Universidade Federal do Amazonas (State of Amazonas Federal University)

UFPA – Universidade Federal do Pará (State of Pará Federal University)

UFRA – Universidade Federal Rural da Amazonia (Amazon Federal Rural University)

OCTOBER - 2005

ITTO

funpar