

ENERGY AND ENVIRONMENTAL ANALYSIS OF A MUNICIPAL DISTRICT STARTING FROM QUESTIONNAIRE (SURVEY) ELECTRONICALLY TABULATED BY COMMERCIAL SOFTWARE

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Abstract. *This work aims at determining the power matrix of the Sentinela do Sul (RS - Brazil) as well as analysing its physical, territorial and socio-economic features in such a way that some proposals regarding energy and environment, among other areas, may be formulated and later implemented either by the public authorities or private enterprise.*

An exhaustive survey has been conducted to obtain a diagnosis that includes the area of energy in order to create a data bank of the rural properties in town and, from this bank, to be able to devise action strategies along with the community or an individual identifiable farm owner.

The survey was electronically tabulated through commercial software that allows for speedy upgrading and analysis of data under several different aspects.

The work has been developed in such way that both the community and the town administration interacted in a resolute manner so that the data could be obtained and made accessible to them. They have contributed for the analysis of the material bearing in mind specific needs of the community.

A number of proposals have been formulated from the tabulated data, in order to solve the matter of rural properties that don't have electrical energy, it has been concluded that the software used was quite suitable, and the town is auto-sufficient in biomass.

Keywords. *Energy, environment, planning.*

1. Introduction

This work bases on the consummate research between 1995 and 1997 in the Sentinela do Sul municipal district (RS - Brazil), developed through the PLAMUDES Project (*Planejamento Municipal Integrado Visando ao Desenvolvimento Sustentável* - Integrated Municipal Planning Seeking to the Maintainable Development), whose objective was to make possible to the low budget municipal districts the development and sustainability, through the acknowledgement of each person's opinion on several themes and of each one's reality. With this information permit then create strategies to assist the population in a differentiated way and to maximize the available resources.

The great differences between this type of gathering information and the one now accomplished are the width of the research and the fact it is not based in samples, but in the total of researched properties. People linked to the municipal district that received small subsidy applied an exhausting questionnaire in all municipal district rural properties. The questionnaire was electronically tabulated in the commercial software Le Sphix® Plus. As for the survey width, all of the municipal administration interest aspects were approached from social aspects to energy.

The research objective was the database development to be accessed by the municipal administration and to municipal district energy matrix assembly, using a simplified and agile process so that the community can use the information immediately at a low cost.

2. Methodology

This job becomes separated in five different stages which parts are possible to point out aspects that differentiate this process from the other now used. The five items are: the questionnaire itself, the electronic tabulation, the interaction among the community and the information, the possible extract and the energy matrix assembly of the municipal district.

2.1. The questionnaire

The questionnaire was developed by the team of the PLAMUDES Project collectively with leaderships of several Rio Grande do Sul state interior municipal districts.

The objective of the questionnaire is to provide a complete evaluation of each rural property of the municipal district. For future crossing of information seeking the area optimization of the energy, production and humans' resources.

The questionnaire consist of the following items: the producer or owner's data; the property general data; the technical support and agricultural practices; commercialization or industrialization; water supply and environmental protection; community infrastructure, health and life quality; and still: specific questionnaire for property assisted by electric power originating from public net; specific questionnaire for the property no assisted by electric power originating from public net.

The questionnaire was idealized to be answered in one hour at the most in each property. With a team of ten researchers it was possible to accomplish eight hundred interviews in ten useful days. Besides, the time of new surveys was reduced, because some information didn't have significant alterations along the time.

2.2. The electronic tabulation

The electronic tabulation was made through a commercial software called Le Sphix® Plus, with the intention of showing that it is possible to accomplish the tabulation of checked data with the use of the available computer science tools, without the specific software creation need. Besides, the cost of acquisition of this tool is very low. In Brazil the cost of a questionnaire as this to the city halls of low budget cities oscillates in the range of US\$ 5000,00, with all of the expenses, including the software acquired through a university.

The software version used was very simple, compatible with computers pc and with Windows. It was capable to operate with 1024 subjects of thirty options each and with the possibility of open answers being processed through the lexical tabulation. Easily the questionnaire could be inserted in the program and the dates typed by the single person.

The program-updated versions are available now, and still other programs can be used.

2.3. The community and information interaction

When the research stages and tabulation can be made by people of the municipal district whose interests are the same, and the agility in the process is assured. The research process generates a mass of information that can be worked according to the municipal district needs. Whenever they come, new problems and this solutions can be detected observing the information conforms the instant optics.

Lopes (1990) says that planning is also understood as coherent and understanding method of formation and implementation of guidelines, through a vast nets central control of organs and interdependent institutions, made possible by scientific knowledge and research.

This work presents an important tool for the planners of municipal districts with low budgets. The big differential is exactly the information needs and no merely statistics and the use of the computer science directly without a program done under request.

2.4. The extract and possible crossings

A number of 672 subjects being 233 closed, 275 numeric, 5 climb and 159 texts understand the applied questionnaire in Sentinela do Sul. This number of variables allows an extremely big number of combinations for crossing and extracting.

The software allows the crossing of up to 200 variables and the creation of extracts with up to twenty filters. A great number of crossing examples and extracts are possible. It permits to an administrator the priorities and specific needs determination.

In tab. (1) relevant social aspect is presented, like the diverse ranges of age see the changes in the health of the municipal district.

It is perceptible that the owners of less than 21 years of age see a worsening in the system of health. And in the other age strips an idea of very defined improvement exists, except for the strip above 81 years that considers that the service is the same.

Table 1. Crossing between the owner's age and vision concerning the health in the municipal district in the last ten years with exclusion of the no-answers. (Source Pierobon, 1998).

Age x vision about the health	It was better (%)	It was the same (%)	It was worse (%)
Less than 21years	25,0	0,0	50,0
From 21 to 35	40,9	25,5	24,5
From 36 to 50	41,0	29,8	20,8
From 51 to 65	37,4	33,7	19,5
From 66 to 80	38,6	24,8	20,8
Above 81	25,0	37,5	12,5

In the crossing proceeded the priorities most mentioned for the public authority can be observed with extract for proprietors with and without electricity in tab. (2).

It is possible to notice that in the properties without electric power there are a larger percentage of people that worry about the energy democratization. In the properties with electricity, it is noticed that the concern with access to the telephony is larger.

Table 2. People that have electricity or not: priorities and supply of. (Source Pierobon, 1998).

Priorities	Total sample		Extract with electrical energy.		Extract without electrical energy.	
	Qt. cit.	Freq.	Qt. cit.	Freq.	Qt. cit.	Freq.
Health improvements	673	82%	458	86%	215	82%
Improvements in the highways	374	46%	248	47%	126	48%
Access to public transportation	226	28%	144	27%	82	31%
Electric power for all	171	21%	17	3%	154	59%
Access the telephony	390	48%	299	56%	91	35%
Education area improvements	248	30%	183	35%	65	25%
TOTAL [OBS].	821		530		261	

Other extracts examples obtained starting from the database are:

How many (and which) producers are 50 years old or plus, they don't possess car or van and have problems with high pressure or intoxication for pesticides: 31 producers (perfectly identifiable).

The producers that are not assisted by electric net and have less than 1 km from their homes waterfalls or fast-moving water with some hydroelectric potential they are in number of 2.

The producers that are not assisted by electric net and they notice that the area where they live has moderate winds or abundant ones are of number of 96.

The producers that have wood stove, don't possess alternative shower, they are not supplied with electric power and have interest in receiving information on coils for wood stoves are in number of 38.

The producers that are not assisted by electric power and they have interest in receiving information regarding fotovoltaic energy generation are in number of 78.

The producers that capture water below the level of their houses and below the level of the destiny of the human or animal dejections, or have vegetable gardens below the level of the stable, or of the pigsty, are in number of 335.

The largest index of cessation of activity agricultural or cattle is in the age group between 36 and 51 years.

The most common diseases are: cold or influenza that happen mainly in the families of the producers between 21 and 36 years, pains in the back that attack the producers of more than 81 years.

Through extracts it is possible to determine the number and to identify in the register the properties where the producers have life risk potential for chronic diseases and depend on fast transport, the properties with potential for energizer through local sources and to define where the problems sanitariums are worse.

2.5. The municipal district energy matrix

The energy matrix of the municipal district was set up starting from the applied questionnaire to the countryside, from the available data in the city hall, from sample questionnaires in the urban way, of consultation to the area fuel distributors and local enterprises. The energy matrix is divided in petroleum derived, biomass derived and electric energy consumptions. Like the definitions in the work of Mossmann (1995) and Müller (1997),

2.5.1. Petroleum Derived Consumption

Municipal district of Sentinela do Sul energy petroleum derived monthly consumption in the 1995-year is presented in tab. (3). This is divided in gasoline, diesel oil and PLG (Petroleum Liquefied Gas) consumptions with respective values in PET (Petroleum Equivalent Tons). The urban consumption of PLG was extrapolated through the questionnaire by sampling with the municipal district residences portion of 3,2%.

Table 3. The petroleum derived energy monthly consumption in the 1995-year. (Source: questionnaires and the municipal district companies).

Energy	Consumption / month (liters)	Consumption / month (m ³)	Consumption / month (PET)
Gasoline	25100	25.1	19,348
Diesel oil	43700	43.7	37,060
PLG	17600	17.6	10,570

The machines and existent vehicles that consume petroleum derived energy were registered in the countryside of Sentinela do Sul. Table (4) demonstrates the number, the types and these machines and vehicles consumption in the 1995-year. Comparing tab. (3) data with tab. (4) it can be noticed that the gasoline consumption in the municipal district rural way corresponds to approximately 80% of that energy one total consumption. And the diesel oil consumption corresponds to approximately 53% of this fuel total consumption in the municipal district.

Table 4. The machines and vehicles energy consumption in the countryside in 1995-year. (Source questionnaires)

Energy	Machines and transport Means	Number	Consumption / month (liters)	Consumption / month (m ³)	Consumption / month PET
Gasoline	Cars, motorcycles and motor-saws	609	20116	20,116	15,506
Diesel oil	Personal minitractors and tractors	295	23236	23,236	19,705

2.5.2. Biomass Derived Consumption

Table (5) demonstrates the biomass derived energy monthly medium consumption, in the 1995-year. The residential firewood and vegetable coal consumption according to PROMEC (Mechanical Post graduation Program of UFRGS - Federal University of Rio Grande do Sul) energy nucleus studies was valued as being of 1 m³/month firewood for property that possesses wood stove and 3 kg/month of vegetable coal for each family. The urban way wood stoves number was valued for extrapolation. The municipal district brickworks firewood consumption was obtained starting from segment entrepreneurs' consultation.

Table 5. The biomass derived energy monthly medium consumption, in the year of 1995. (Source questionnaires and municipal district companies)

Energy	Unit	Consumption / month	Consumption/month (PET)
Alcohol	m ³	4,254	2,119
Firewood	m ³	905	100,555
Vegetable coal	t	3,213	2,023

The rural properties are almost self-sufficient in firewood for wood stove because 94% of the properties that possess them collect it in their properties.

It was registered 255ha of acacia that can produce 7650 m³/year firewood or 1912t of vegetable coal, 538,8ha of eucalyptus that can produce 26940 m³/year firewood, sum a total of 34590 m³/year. The firewood consumption besides in the form of vegetable coal doesn't surpass 11026 m³/year same considering that the municipal district wood stove used the firewood originating from reforestation, which doesn't happen nowadays. Therefore, the municipal district has a firewood *superavit* of at least 23564 m³/year.

The municipal district produces rice (7500 t/year) that has as by-product the peel (proximally 20%, 1500 t/year) that can be used as energy source.

2.5.3. Consumption of Electricity

Sentinela do Sul has, according to the accomplished register, 261 rural properties without electric power provisioning, from a universe of 821 properties.

The properties that possess service for electric power net are in number of 530, and only 3 possess alternative system for heating of water. Not forgetting that the electric shower consumption corresponds approximately to 30% of residence consumption. And the monthly consumption in the rural way of Sentinela do Sul was of 58,1 MWh, therefore, the conceited electric showers consumption reached 17,4 MWh, approximately 6,2% of the total municipal district consumption. Table (6) shows the electric power monthly consumption in the 1995-year.

Table 6. The electric power monthly consumption, for class in the 1995-year (source CEEE - *Companhia Estadual de Energia Elétrica do Rio Grande do Sul* - Electric Power Company of Rio Grande do Sul State).

Class of electric power consumption	Consumption / month MWh	Consumption / month PET
Residential	40,2	3,216
Industrial	162,6	13,008
Commercial	6	0,480
Public section	14	1,120
Rural	58,1	4,648
Other	0,2	0,016
Total	281,1	22,448

2.5.4. Sentinela do Sul energy balance to the 1995 year

Converting all the energy sources consumed for PET (Petroleum Equivalent Tons), it means the amount of energy contained in a ton of a petroleum type with energy of 45208,80 kJ/kg, it is possible, in the tab. (7), to compare the different types of energy and to set up the energy head office of the municipal district of Sentinela do Sul.

Table 7. Conversion factors of the energy ones. (Source: National Energy Balance /1994 – Brazil Minas and Energy Ministry.)

Energy	Specific mass (kg/m ³)	Calorific power (kJ/kg)
Diesel oil	852	44999,50
Gasoline	742	46966,92
Alcohol	809	27836,90
PLG	552	49185,50
Vegetable coal	250	28464,80
Firewood	400	12558,00

Table (8) demonstrates the consumption of energy for year in their usual units and in PET and contribution in percentile. The consumption annual total energy was 2331,241 PET. It is possible to observe that the municipal district consumption is based on biomass. The groups of energy are represented in bold for better identification and its values corresponds the sum of its energy ones, except for the electricity whose value is total.

Table 8. Sentinela do Sul energy matrix summarize. (Source: Questionnaires; CEEE; gas station and municipal district companies.)

Energy	Unit	Consumption / year	Consumption / year (PET)	%
PLG	m ³	211,2	126,837	5,441
Gasoline	m ³	301,2	232,182	9,959
Diesel oil	m ³	524,4	444,720	19,076
Petroleum Derived	-	-	803,739	34,477
Vegetable coal	t	38,5	24,241	1,040
Firewood	m ³	10872,0	1208,000	51,818
Alcohol	m ³	51,0	25,405	1,090
Biomass Derived	-	-	1257,646	53,947
Electricity	MWh	3373,2	269,856	11,576
TOTAL	-	-	2331,241	100

For the best visualization fig. (1) represents the Sentinela do Sul summarized power matrix in a sections graph. Where is possible to notice with clarity the contribution of each energy group. Exists a prevalence biomass derived use that appears in distinction as the largest section in the graph.

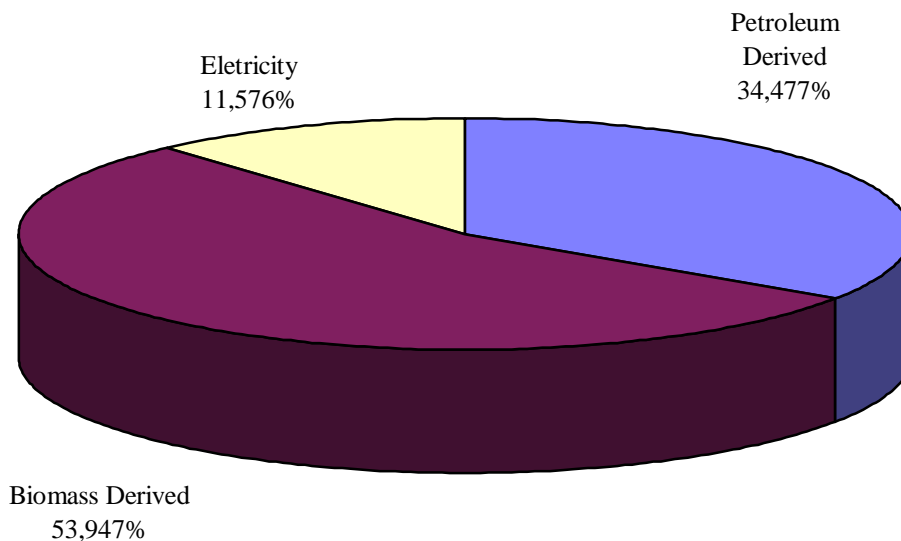


Figure 1. The Sentinela do Sul Summarized Energy matrix. (Source: Questionnaires; CEEE; gas station and municipal district companies.)

For a more specific visualization the Sentinela do Sul energy matrix is also presented completed in the fig. (2). The firewood consumption is the most significant, overcoming the all other energy ones added. Is important to point out that the others derived of biomass, as the alcohol and the vegetable coal are inexpensive in relation to the other energy ones.

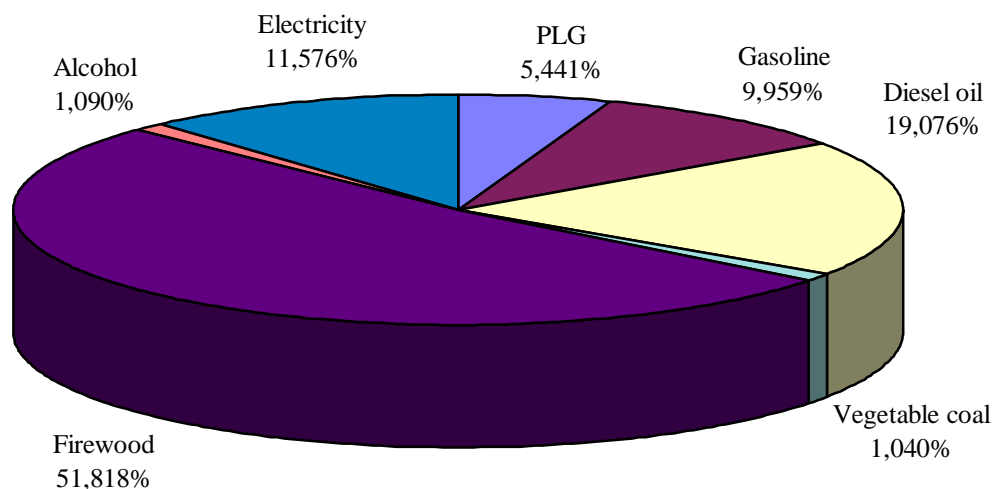


Figure 2. The Sentinela do Sul Completes Energy matrix. (Source: Questionnaires; CEEE; gas station and municipal district companies.)

3. The conclusions

Starting from the questionnaire for rural properties applied in PLAMUDES Project made possible to set up a computerized register of all Sentinela do Sul rural properties. This database was used immediately by the municipal administration and it allowed the preparation of a rural way profile of the municipal district, the determination of the energy balance of Sentinela do Sul and elaboration of some conclusions. Here will be mentioned some conclusions and possibilities of several sections included by the questionnaire, taking into account the impossibility of draining the conclusions and possibilities obtained starting from the data simplified tabulation. Therefore an analysis more deepened and detailed allowed several verifications and proposeds.

- The used software Le Sphinx[®] Plus was perfectly adapted to the questionnaire proposal (although it has been projected for accomplishment of samples) that is exhausting in the sense of forming a database on the municipal district.

- It was verified that, in the rural way, the properties tend to resemble to the city more and more, in terms of energy consumption, once they are gradually substituting the firewood stoves for gas stoves. In the rural properties with electric power provisioning, the number of gas stoves already overcame firewood stoves.

- There are, in the municipal district, properties with energizer possibility through LCH (little central hydroelectric), for that, the visit to those places for determination of the potentialities of the uses is suggested.

- There is, in the municipal district, a great amount of firewood stove, which could be implemented to the use of coils for heating of water that could cause an economy in the rural way of up to 17,4 MWh/month. The implement of the first units in the properties that demonstrated interest (38 properties) can be done, as a pilot project. Starting from the success of the equipment in those, to enlarge for the other ones.

- The municipal district is self-sufficient in firewood, with possibility to produce the equivalent to 3843 PET/year, enough to cover all consumption of energy, still presenting a superavit of approximately 65%.

- It could be done in the municipal district a use peel of rice as energy source study, once this by-product is abundant.

- It should be done in the municipal district a detailed research of the area eolic potential, once an expressive number of residents (36%) observed that in the area exist moderate to abundant winds.

Finally, in this work a more useful and smaller price tool was developed to be used by the public power for to control energy conditions and sustainability.

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