OPTIMIZATION MODEL FOR ENERGY PLANNING OF CITIES

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Abstract. *In the energetic planning of cities, taking into account the availability of natural resources and the respective environmental impacts, the public managers generally do not have analytical tools for comparing options to be considered for attending regional needs. Nowadays a growing concern is observed to energy and environmental management aspects, and such fact is due mainly to a larger conscience to the involved costs and their legal implications. However, the decisions concerning the investment in energy generation alternatives which are environmentally favorable are generally restricted to the federal and state spheres, but it is in municipal extent that the knowledge of the available and existent constraints is adequately perceived, being this certainly the appropriate forum for the decisions makers. Renewable energy sources have been proposed in several occasions as feasible options in technical and economic terms, for the increase of the reliability of energy supply, for the improvement of equipments energy conversion efficiency, and also for the global reduction of pollutant emissions. In this article it is identified, for medium size cities, the energetic alternatives that have been potentially incorporated to the electric system for attending the electric system expansion, as well as present an optimization model for the energetic planning of cities, taking into account technical, economic and environmental aspects as constraints and considering the energy needs and available energy alternatives for the definition of a ranking of options for the expansion of electricity demand in the medium and long terms.*

Keywords*: Planning, energy, environment, sustainable development.*

1. INTRODUCTION

The energy affects the social and economic development of the populations. As the regional sub-systems are interlinked and they are interdependent in several segments, quantifying the available energy resources and the pattern of energy consumption in small scale is an important step in the planning process because it determinates the dynamics changes in the supply patterns and demand of energy. The planning of micro-regions should consider the local reality, starting from the establishment of the needs of the population and discrimination of the available energy resources, in way to allow appropriate exploitation policy of those resources to be driven.

The energy questions have been occupying prominence amongst the relevant subjects at present time since the 1970’s, with the petroleum’s world crisis, that established changes of individual and collective behavior relative to the energy use, but also and mainly it altered in a significant way the discussion of the natural resources use, the forms of generation of energy and the impacts of its consequences, besides the concern with the final deposition of the equipments after its useful life.

The proposed solutions are frequently partial in real problems, or in other words, they don't contemplate all of the aspects of the problem and, then, they need to be accompanied by measures of technical, organizational and legal nature (Georgopoulou *et al*, 1997). However, partial actions and with local performance can constitute alternative strategies, as for instance implantation of small central hydroelectric, programs of reduction, new utilization and recycling of products, among others. Brazil, as other developing countries, gathers conditions to motivate the use of the renewable sources of energy in substitution to the fossil fuels.

The country could stimulate and implement in a more effective way, systems of solar generation, wind energy and biomass, or even hybrid systems of those sources, in the implantation of new enterprises or in the eventual substitution of the existent ones, such as use of the solar energy, especially for located ends, in the domestic use for heating of water in substitution to the electric shower, one of the equipments that has more intense use of electricity, and in the rural way for pumping water and as complementary system of generation of electricity. Some projects with support of the Program of Incentive to Alternative Sources of Electric Power (PROINFA) work with the simultaneous use of the solar light and the winds which are also being developed to act as systems of distributed generation, through small located plants in the proximities of the consuming centers.

The energy planning process, when initiated in a micro-regional scale, can represent advantages to the country; the centralized generation not always gets to assist to the energy needs regarding the new implantation of enterprises, particularly the implantation of industrial or commercial poles in the cities, although in those same places could exist potentially interesting points of distributed generation, which could help in urban problems, as the garbage disposition and sewer.

2. ENERGY NEEDS OF CITIES

The concentration of people during the last decades resulted of an intense process of urbanization; as a consequence, a lot of micro-regions have experienced severe economic recession, increase of the poverty, unemployment and other social problems. The social and environmental problems consequent to the urbanization can be expressed by the high production of solid wastes and liquid effluent discarding that occupies large areas and represents significant impacts for the environment. The cities present high concentration of energy demand in services, residential section or transport, which results in high indexes of emissions of direct and indirect pollutants. For the evaluation of the environmental impact of measures that affect the use of the energy, environmental externalities should be necessarily considered.

In spite of the great number of existent regulations, the cities still need methodological structures and more specific statistics bases which enable the public managers a support in the process of decision with regard to the regional mechanisms that should be induced, that they are capable to serve to the interests of the population in terms of the service of their basic needs, be attractive for the enterprising groups, as well as they are rendered to allow financing mechanisms for the social development.

The formal impediments can be reverted through administrations of the public power in terms of induction of the use of energy alternatives in new urban enterprises, that should be foreseen in the master plan of the cities; for the diffusion of new technology, campaigns of understanding of the population, the training and the spread of information to the technical body are forms of overcoming such difficulties.

For Nascimento (2002), a study supported by the English government foresees that the number of plants of wind energy and of some other renewable sources up to 2020 will be six time the current one; in the same period, it is estimated that about 20% of the energy head office of the country it will be obliged to be generated by renewable sources. However, that effort for use of energy in balance with the environment presents a cost that should be absorbed by the society, and the domestic consumers of electricity will have an increase of up to 6% in the energy bill, while the commercial customers will have increases of 12% to finance an environmentally correct energy option.

In Germany, there is a forecast up to the year of 2010 for the duplication of the participation of the renewable sources in the consumption of primary energy and in the generation of electricity. In 2050, 50% of the demands of primary energy and of electricity should be obtained starting from renewable sources of energy (Altmann, 2002). Another support of the new German energetic politic is the rational use of the energy, whose studies point that the increase of the efficiency creates new jobs in almost all of the cities, especially in the areas of small and medium companies.

From this information it is possible to notice that a narrow link exists among the participation of the alternative sources of energy, the rational use of the natural resources and the social action addressed to the acceptance of new technologies. The conscious participation of the communities by the structuring of programs that provide the perception of the real needs and the possible forms of energy supply, has the potential of resulting in the invigoration of the initiatives of rational use of the involved resources and, consequently, to favor the insertion of new technologies, as, for instance, hybrid systems of conversion of energy.

The quantitative impact of possible changes suggested in sceneries of short, medium and long terms should be investigated by forecasting models. Conventional methods of forecast use econometric techniques or time series analysis to project the future, though, a considerable part of the places needs to review its structure of acquisition of information, once they are commonly incomplete data of the temporary series for local evaluations (Devadas, 2001).

An energy politics has the objective to favor the socioeconomic development in maintainable conditions, providing the social rescue of the less favored populations through the integrated planning of resources. It is possible to reach a reorganization of the activities with views to a new dynamics of the social structure by positive actions, as the reduction of the consumption, the new use and the recycling of products associated to the integration with the system of health and social attendance.

Another question to be considered are the conditions that should be established when there is a statement of the sustainability of the positive actions to be proposed; in several way to what happens in the deprived initiative, the period of return of the investment can be more extensive, once the return is diversified and it considers a lot of times situations didn't measure, but of great social interest and even environmental.

In this context, the existent politics of energy include the following aspects (Dermibas, 2001):

- Research of energy planning and development of activities to find the applications above mentioned;
- Evaluation of the demand of the needs of long period of public, private and domestic order;
- Use of the existent sources of energy and incentive to the research for new sources;

- Evaluation of the transformation costs and supply of energy;
- To assist to the demand of energy, if possible, through internal sources (local);
- Implementation of measures of energy efficiency, avoiding expenses and minimizing losses in production, transmission, distribution and in the consumption of energy;
- Protection to the environment in the process of obtaining the energy needs.

A city, analyzed in the urban point of view, can be classified in terms of energy consumption starting from the sections residential, commercial, industrial and of municipal services. By those considerations, independent of its size, the characterization of a city possesses some structures that are common, however differentiated in the accommodation of their needs. Such structures make possible the manipulation of sceneries for the establishment of criteria for searching the balance between the supply and the demand of the energy resources.

3. AVAILABLE ENERGY ALTERNATIVES

One of the limiting factors for the Brazilian electric system is the electrical transmission process, which is expensive. In this way, the decentralized generation may be seen as a feasible option for the cities that are far from the energy generation centers, such as hydroelectric power stations.

For the same capacity, thermal power plants, if compared to hydroelectric plants, may be built in a shorter time and may be sited near the consumption centers, with no additional investment costs in transmission lines. A disadvantage is the electric operational cost of such energy that is higher than the hydroelectric–based electricity: for a combined cycle, electricity operational costs may range from 38 to 42 US$/MWh. This price structure is accordance to the international mean price for thermal power generation, but is higher than the hydroelectric–based costs, that are in the range of 14 to 17 US$/MWh. For a single thermal cycle, electricity operational cost may achieve 60 US$/MWh.

Natural gas participation in the Brazilian electric system could be of up to 4.14% in an external constraint scenario, or 4.82% in a high development scenario, or 5.24% for a sustainable development scenario (Fernandes *et al*, 2005). According to the projections of Mine and Energy Ministry (1992), natural gas participation in the Brazilian energetic matrix would be of 12% until 2010. In countries as Canada, United States, Italy and the Netherlands, natural gas is a reality for over 50 years, and nowadays it represents a large parcel of their energetic matrix. In the case of United States, 1,700 million Nm^3 per day is consumed, that represents 616 billions m^3 per year that is equivalent to the natural gas reserves of Bolivia or Argentina. The projection for Brazil is that the maximum consumption for the next 10 years will be of 100 millions of m3 per day (Fernandes *et al*, 2005). It is also important to note that natural gas demand presents a quick response to the growing of economic indexes, and both are related to the growing demand of electricity, that favors the industrial demand and the electric generation by gas turbines.

Landfill gas (LFG) recovery projects are one possible option to be considered. Landfills produce biogas by anaerobic decomposition of organic materials and are composed of approximately equal parts of methane and carbon dioxide, with trace concentrations of other gases, including non-methane organic compounds (Coneg, 1994). Energy generation technologies, such as internal combustion engines, gas turbine systems and steam cycles (high pressure steam generators and steam turbines), may be used for producing only electricity, or even combined heat and electricity, in cogeneration systems.

Biogas is produced from the organic fraction of municipal solid wastes (MSW) and incineration or gasification applied to the non-organic, non-recyclable fraction. Biogas needs to be adequately cleaned before burning. Murphy and McKeogh (2004) investigated technologies which produce energy from municipal solid waste (MSW): incineration, gasification, generation of biogas and utilization in a combined heat and power (CHP) plant, generation of biogas and conversion to transport fuel. The authors concluded that the last option is up to vehicles which return to base each day, local authority cars, taxis, company cars, or buses; although all the technologies save greenhouse gas, MSW gasification is not yet a proven technology at commercial scale, and a thermal market is essential to improve the sustainability.

Biomass are the wastes from agriculture (and also called vegetable biomass), municipal solid wastes and “modern biomass”, i.e., biomass produced in a sustainable way (Goldemberg and Coelho, 2004). The best argument for using biomass is that it is an available and relatively low priced energy source; it has a strong environmental meaning and a reasonable heating value[1]. Municipal solid wastes constitute a serious problem in cities, for which the landfilling and incineration are solutions commonly proposed. Countries as Japan, that presents high density cities, are the ones in which residues treatment are more advanced (Holanda and Balestieri, 1999; Miranda and Hale, 1997).

Based on Dermibas (2001) and the Protocol of Kyoto suggestions, the inclusion of new sources of energy in the service structure energy of the cities should be assessed in justifiable criteria of the environmental point of view. In this way, the sanitary embankments, for instance, that potentially they could mean problem in terms of allocation of physical space, in a new context they become models of integrated use of resources in the way that allow the separation of recyclable products (minimizing the exhaustion of natural resources) and incineration of solids no-recycled and use of embankment gases for generation of energy, with that reducing the use of the physical space due to the covered volume.

[1] According to Larson (1993), lower heating values ranges from 15000 kJ/kg (industrial residues) to 20000 kJ/kg (several vegetal species) (p. 570).

The alternatives in micro planning should consider factors as population growth and agricultural, residential, commercial and industrial operations, verifying the difference among the energy demand and supply, among recommendations based on the processes and studies in such a way to reduce such difference. This includes an effective introduction of the technology of the biogas use, generation of electricity starting from the biomass and biogas, expansion of the consumption of electricity for illumination, introduction of more efficient kerosene oil stoves. The minimization of all the costs of energy, minimization of the uses of the resources no-local and maximization of the efficiency of all the means of use is advisable (Mallikarjuna and Subramanian, 1988), however it should be contemplated the involved social aspects.

In the modern conception of administration of residues, the embankments are actually a palliative, and not a definitive solution. They are graves of true raw matters, which could be being valued. The disposition in embankments for dangerous residues (Class 1) costs, on average[2], in Brazil, US$ 200.00/t. In opposition, the incineration costs are in the range of US$480.00 to US$600.00/t. In France, the relationship is the reverse - the treatment is privileged, and it is punished the stockpiling. In many cases, the treatment is subsidized (Campos, 1998).

For Alshuwaikhat and Nkwenti (2002), the uses of the renewable energies should be suitable with their vocations, in other words, the solar energy would be advisable for residential and similar use, the biomass for industrial and similar use, the wind energy for agriculture and similar, as well as the geothermic energy for the water culture and similar. In the case of the water, the authors propose that the recycling of the served water renders to the irrigation and the desalination from seawater, as well as the underground waters be used in the industrial and domestic provision.

4. INVESTMENTS IN ENERGY SOURCES

The alternatives in regional planning should consider factors as population growth and agricultural, residential, commercial and industrial operations, as well as the difference between the demand and the supply of energy. This includes an effective introduction of the biogas technology and use, generation of electricity from biomass, among others. It is advisable the minimization of all of the costs of energy and the uses of non local resources, and the maximization of the efficiency of all of the production means, contemplating the social aspects involved (Mallikarjuna and Subramanian, 1988).

The uses of renewable energies should be suitable to their nature, in other words, the solar energy would be advisable for residential and similar use, the biomass for industrial and similar use, the wind energy for agriculture and similar. In the case of the water, it has been proposed that the recycling of served water should be used to the irrigation and the desalinated water for the industrial and domestic provision (Alshuwaikhat and Nkwentl, 2002).

Table 1 presents the installation cost values and capacity factor for electricity generation of several alternative sources of energy. The costs of installation of the biomass plants using Brazilian technology can vary between US$ 700/kW and US$ 1000/kW and Mini Hidro Power (MHP) can reach values between US$ 700/kW and US$ 1200/kW (Salles, 2004).

Table 1: Range of values for installed cost and capacity factor

Source	Installed cost (US$/kW)	Capacity factor (%)
Biomass	1000 – 2000	45 – 85
Wind	900 – 1400	25 – 40
MHP	1000 – 3000	40 – 70
Solar PV	6000 – 10000	18 – 22

The unitary costs of the alternative sources in the world are still high compared at the marginal cost of expansion of the system, calculated in US$ 34/MWh (IEA, 2004). These costs are reduced considering several externalities that are not introduced in the traditional analyses of costs and benefits, as the environmental and social subjects. The operation costs and maintenance (O&M) used for biomass, wind energy and small hydroelectric (MHP) are 7, 10 and 10 US$/MWh, respectively (Salles, 2004).

The alternative sources of energy contribute to the reduction of the global warming and, with the ratification of the Kyoto Protocol, it is perceived an accentuated growth of investments in alternative sources of energy aiming to the reduction of gases emissions which causes the greenhouse gas effects. Therefore, the Certificates of Reduced Emissions emitted in function of those investments can contribute to the objectives of the Protocol, besides they increase the financial return of the projects in renewable sources. The Tables 2 and 3, and Figure 1 shows power generation costs of alternatives sources of energy.

[2] Converted from original data considering 1US$ = R$2.20

Table 2: Range of generation costs and life time of the systems

Source	Unitary cost of generation (payback tax of 15% and payback time of 20 years) (US$/MWh)[a]	Medium life time of system and equipaments (years)
Biomass	45 – 105	20[b]
Wind energy	50 – 95	30[c]
MHP	35 – 145	30[d]
Photovoltaic	500 – 1160	20[e]

Source: (IEA, 2004)[a]; (Mendes, 2005)[b]; (Salles, 2004)[c]; (Castro, 2004)[d]; (CRESESB, 2005)[e].

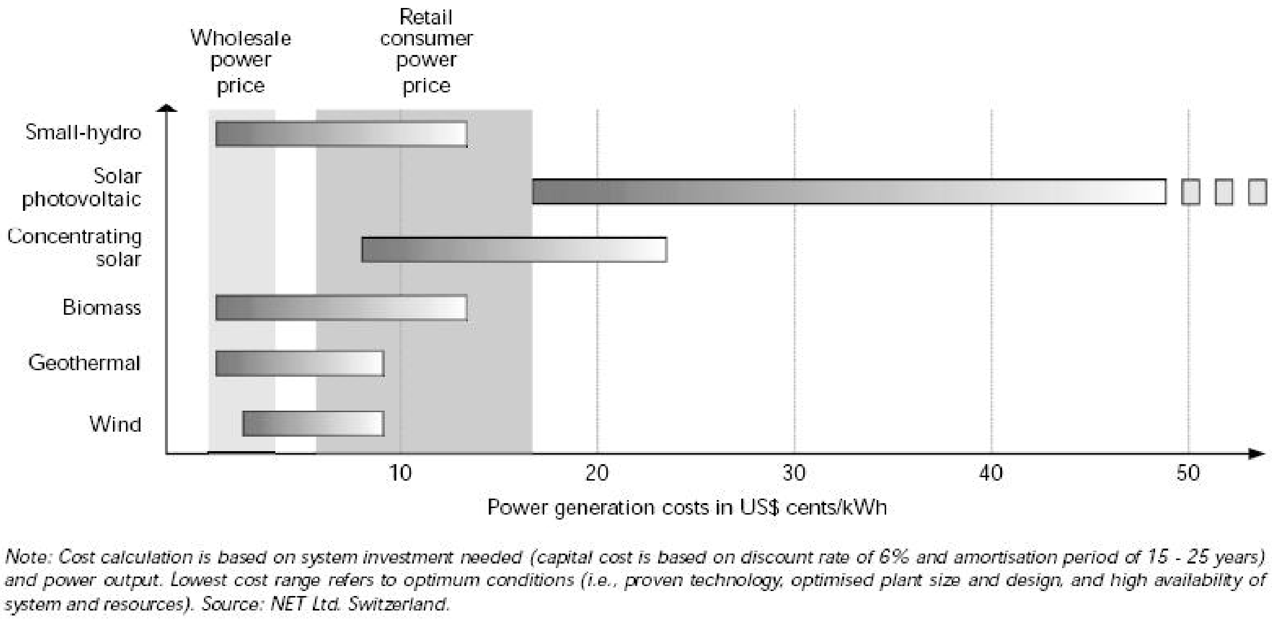


Figure 1. Cost Competitiveness of Selected Renewable Power Technologies (IEA, 2004)

In the first and second column of Table 3 shows a comparison between lower and higher costs of energy sources (Ministério das Minas e Energia, 2005). The following columns presents the considered values for this paper e the conversions, considering 1 US$ = R$ 2.20 (BRASIL, 2006).

Table 3: Cost of alternative sources of energy (Ministério das Minas e Energia, 2005)

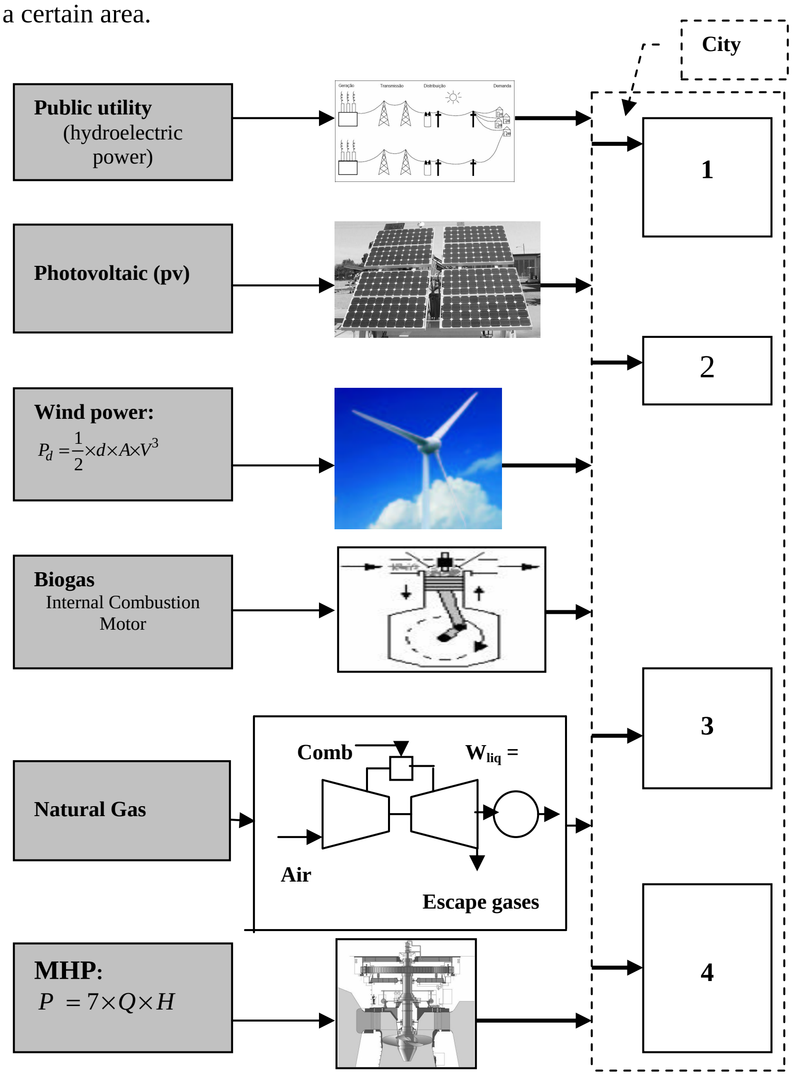
Energetic system	(R$/MWh)	Considered value (R$/MWh)	Considered value (US$/MWh)	(US$/kWh)
Biogas	67 to 190	130	60	0.060
Photovoltaic	200 to 400	300	140	0.140
Wind energy	50 to 80	70	30	0.030
Biomass	40 to 70	60	25	0.025
MHP	20 to 40	30	15	0.015
Diesel engine	100 to 300	200	100	0.100

5. ENERGETIC OPTMIZATION MODEL

The formulation of an energy model allows the accomplishment of the appropriate allocation of energy renewable sources available considering the electric generation alternatives associated to the consumption forms to assist an energy demand, as presented in the Figure 2.

In general, the economic development directs the problem to maximize the return, on one side, and to minimize the cost on the other hand, to reach the wanted objectives. In these circumstances, it is desirable to use optimization techniques to apply in feasible plans, which can solve multi-dimensional problems on one side, and to accelerate the economic growth on the other side.

The planning of regional areas can consider the essential needs of the population and to reach the locally available resources exploration policies. A regional appropriate planning can be based in many planning tools, as system analysis, operational researches, statistics and economic and environmental evaluations. The proposed model is based in the emissions of pollutant of the main alternative sources of energy, contemplating the technological restrictions in each generation way for a certain area.



Note: 1 – Residential sector. 2 – Rural area. 3 – Commerce and service sectors. 4 – Industrial sector.

Figure 2: Structure of the allocated sources of energy

5.1 Identification of objective functions

The model considers the objectives setting out the energy-economic relationship:

- Minimization of energy: refers to the demand supply and costs for generated energy, according to the alternatives of the energy source for electricity generation and expressed in US$/year of energy from the sources.

Objective function:

$$\text{Min} \sum_{j=1}^{n} p_j . q_j = \text{Min} \sum_{j=1}^{n} e_j$$

where

e_j = costs of energy generated in the year [US$/year].
p_j = amount of energy generated [kWh/year]
q_j = cost of kWh generated of each source [US$/kWh]

5.2 Identification of energetic functions

MIN = (yel*(el*(0.136 + 0.016)))+ (ypv*((1.02*a2)+(pv*0.140))) + (ywind*(a3 + (wind*(0.010+0.030))) + (ybio*(a4 + ((0.025+0.007)*bio))+ 50000)) + (ygn*(a5 + C_{gn} + (gn*0.055))) + (ypch*(a6 + (pch*(0.015+0.010))));

- Constraints

pv > E_{pvmin}*N; (for minimum insolation) [kWh/ano];
pv < E_{pvmax}*N (maximum insolation) [kWh/ano];
el + pv + wind + bio + gn + pch > 700*hab; (energy supply) [kWh/ano];
hab = P_{fut} - P_a ; (inhabitants = future population – actual population)
V_{wind} < 28; (cutoff speed generator) [m/s];
V_{wind} > 3; (initial speed for generation);

- Photovoltaic

a2 = ypv*(P2*pv/2190) / ((((1+i2)^n2)-1)/(((1+i2)^n2)*i2));
$A_{placapv}$ = $L_{placapv}$ * $C_{placapv}$; (colector área = lenght * width)
$A_{totalpv}$ = N * $A_{placapv}$; (total área)
E_{pvmed} = ($A_{placapv}$ * h_{mod} * P_f * h_{pc} * I_{med}) * 365;
pv = ypv * N * E_{pvmed} * FC_{pv} (generated energy per year) [kWh/ano];

- Wind system:

a3 = ywind*(P3*P_{wind})/((((1+i3)^n3)-1) / (((1+i3)^n3) * i3));
P_{wind} = (0.5*d_{ar}*A_{pa}*V_{wind}^3)/1000;
V_{wind} = V_o * (H/H_o)^0.3;
A_{pa} = (3.1415/4)*d_{rotor}^2; (m²);
P_{eolica} = 0.30 * P_{wind}; (Potency of the wind converted in electric);
wind = ywind * P_{eolica} * 8760 * FC_{wind}; (generated energy per year) [kWh/ano];

- Biogas

a4 = ybio*(P4*P_{bio})/((((1+i4)^n4)-1) / (((1+i4)^n4) * i4));
P_{bio} = (Q_{metano} * PCI_{metano} * E)/31536000;
Q_{metano} = L_o* tx_{rsd} * P_a ;
P_{fut} = P_a * (1 + j)^(f - a);
bio = ybio * η_{mci} * P_{bio} * 8760 * FC_{bio} (generated energy per year) [kWh/ano];

- Natural gas

a5 = ygn*(P5*P_{gn})/((((1+i5)^n5)-1) / (((1+i5)^n5) * i5));
m_c = (HR * P_{gn})/ (3600 * PCI_{gn}) (massic flow of natural gas);
V_{gn} = (m_c * 8760 * 3600) / 0.61 (annual volume of natural gas);
C_{gn} = V_{gn} * 0.05588 (annual cost of gás natural consume) [US$/ano];
gn = ygn * P_{gn} * 8760 (generated energy per year) [kWh/ano];

- MHP (PCH):

a6 = ypch*(P6*P_{pch})/((((1+i6)^n6)-1) / (((1+i6)^n6) * i6));

P_{pch} = 7 * Q * H_{queda};

pch = ypch * P_{pch} * 8760 * FC_{pch};

Demand side:

(el.yel)+(pv.ypv)+(wind.ywind) + (bio.ybio) + (gn.ygn) + (pch.ypch) = 700.hab

Calculation of the total power:

Potgertotal = el+pv+wind+bio+gn+pch

In which:

E_{pv} = photovoltaic energy supply of 1 colector (kWh/year).
pv = photovoltaic energy supply through the whole system with N collectors [kWh/year].
el = energy supply through electric net - concessionary [kWh/year].
wind = energy supply through wind power [kWh/year].
bio = energy supply through biomass [kWh/year].
N = number of photovoltaic panels.
yel, ypv, ywin, ybio = boolean variables, that can assume the values 0 or 1.
a = investiment value (US$)
n = period (20 years)
i = interests (10 % per year)
hab = inhabitants
P_f = future population
P_a = actual population
j = growing coefficient
P_f = packaging factor (0,9)
h_{pc} = efficiency of conditioning of energy (0,86)
FC = capacity factor
Vwind =
Vo = wind speed at known height (Ho)(m/s)
H = height of the wind generator (m)
Ho = known height (m)
Apa = shovel area (m²)
Q_{metano} = methane flow [$m^3 CH_4$/ano]
E = gas collecting efficiency (%)
L_o = potential of methane generation (m^3 CH_4/t of RSD)
tx_{rsd} = municipal solid waste coefficient (kg/hab.ano)
η_{mci} = internal combustion motor efficiency (%)
HR = Heat Rate
Q = massic flow of water (m³/s)
H_{queda} = falling height (m)

Each inhabitant (hab) consumes 700 kWh/year on average, assuming for each 10.000 inhabitants it is necessary 800 kW, value verified by the data of cities (SEADE, 2006), therefore the number of assisted inhabitants will be the difference between the current (P_a) and future population (P_{fut}):

hab = $P_{fut} - P_a$

Using the software LINGO, the results shows that the optimal value is using the hydropower matrix of Brazil, supplying the demand side and specially for an isolated system, the optimum value is obtained for the small hidro power energy.

Scenery: considering the structure presented in Figure 2.

YEL 1.000000
EL 1702400. [kWh/year]

YPCH 1.000000
PCH 3372600. [kWh/year]

6. CONCLUSIONS

The concern about environmental impacts of the energy has been enlarging the group of political goals significantly in the energy sector. In the past, the choices among the energy politics in regional levels were only based on cost minimization and reproduction of applications of characteristic concepts of developed areas. The regional energy planning takes into account multi-criteria problems and multi-actions, mainly in the case of generation of energy in areas that presents high taxes of growth of demand of energy, with a significant potential of renewable sources of energy; however several and frequent conflicting point of view should be considered, such as social, economic, environmental, technical and political aspects.

Technical and political criteria of use demands and one based technical decision should be provided to balance the arrangement of energy readiness and environmental preservation to provide a better solution selection of the generation capacity and distribution for the expansion of electricity in areas with high growth of the electric power demand, as well as a significant potential of renewable sources of energy with environmental restrictions, where the environmental dimension is added to the usual economy and social factors.

These conflicting factors not only indicate the multi-criteria character of the problem, as well as they reflect the involvement of a number of agents in the process of decision. These agents and their values should be taken into account during the formulation and evaluation of alternative strategies in generation of electricity, in a way to reduce conflicts and to guarantee the efficient implementation of the selected solutions.

The decision-makers should be provided with technology and resources to implement intensive programs of conservation aimed to supply energy and to sustain the economical growth, but the public opinion still ignores the inclusion of the energy subject and their social, economical and environmental implications. Although the energy is considered indispensable, most people ignores the state of the resources and the energy production, including the way in which the energy is generated, transmitted and distributed, or even discusses the inherent problems to the abrupt growth of the consumption.

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