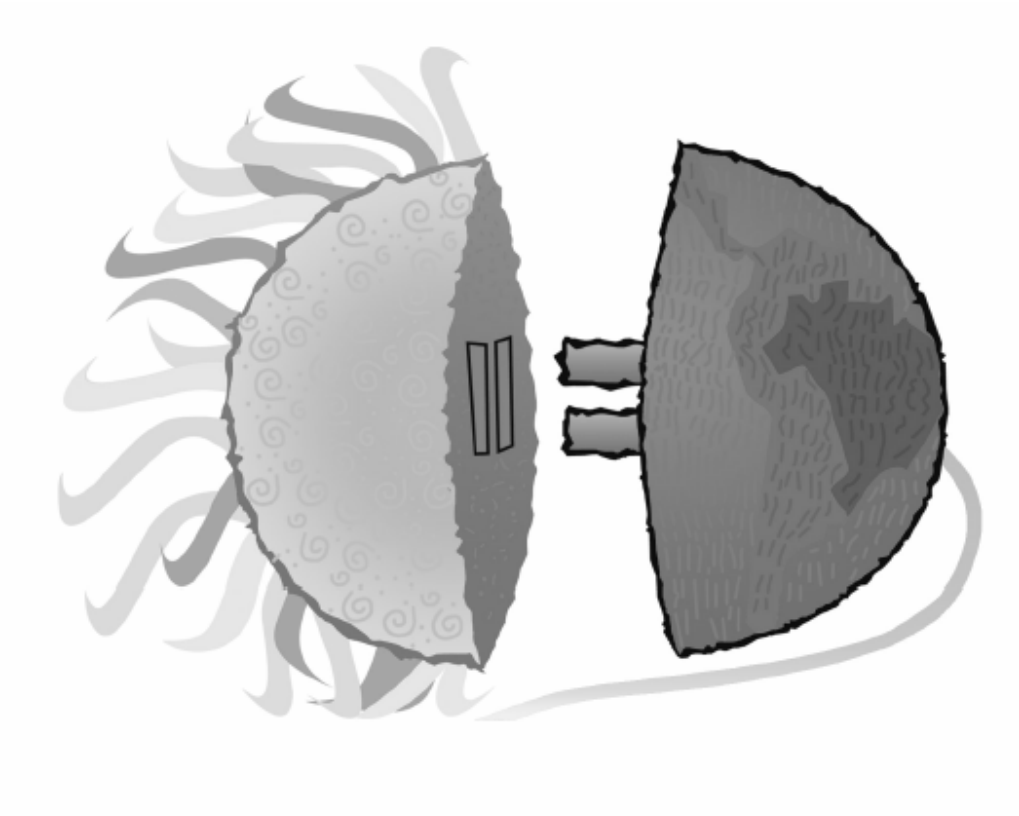

Business Prospects for Solar Water Heating Fee-for-Service Operations in Brazil

Vitae Civilis
Desenvolvimento, Meio Ambiente e Paz

March, 2006

Study conducted by
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INTRODUCTION

This text is a summary of a report called *"Business Prospects for Solar Water Heating Fee-for-Service Operations in Brazil*", originally published in Portuguese.

Solar Water Heating (SWH) contributes substantially to climate protection and development, displacing CO_2, creating skilled jobs, and producing local environmental and economic benefits. SWH are often cost-effective and can be locally made in many countries, but levels of market development vary greatly and are generally far lower than what is achievable. Brazil's market penetration, at 1.2 square meters of collector per 100 habitants, is far below many other countries, including Austria, Germany, and Denmark, which have less insolation and must use more complicated and expensive systems to protect against damage from freezing conditions. Innovative business and financial mechanisms can help to boost SWH markets, including fee-for-service operations, carbon finance, renewable energy certificate trading, and performance contracting. Stakeholders in some parts of the world are becoming experienced with these mechanisms, but additional work is required to introduce and adapt them in Brazil and many other developing nations that are experiencing rapid growth in energy demand.

This project aims to contribute to and build on activities underway to establish models and facilitate innovative financing for solar water heating in the Latin American region and beyond. In Brazil, team member Vitae Civilis is working with SWH stakeholders to identify and remove barriers to broader SWH dissemination.

This work was commissioned by Vitae Civilis in view of its Climatic Change and Energy Program. By investing in renewable energy, the program seeks to contribute to the solution of global challenges associated with climatic changes.

The concept of this study was developed by Délcio Rodrigues, a researcher associated with Vitae Civilis, and Steven Kaufman, Executive Director of Green Markets International. The study was conducted by Lucina Engenharia e Consultoria and financed by the *Renewable Energy and Energy Efficiency Partnership,* through a project called *Innovative financing to accelerate solar water heating*, co-developed by Vitae Civilis, *Green Markets International* and William Guiney, a Caribbean consultant in solar energy.

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SUMMARY

This study analyzes a hypothetical energy services company (ESCO), which supplies hot water heated by solar systems and complementary energy provided by heat pumps. The company operates in the commercial and residential markets and their prices compete against the tariffs and prices currently practiced by electricity and gas companies. The analysis focuses on the development of the business and draws encouraging conclusions: the solar systems assessed in the Case Studies offer a reasonable investment return. The research has confirmed that, for the applications studied, it is feasible to use solar energy for water heating. The return rates are higher than 30 percent, not computing investments in business development, and higher than 20 percent when all the costs are included.

An analysis of the market potential for solar thermal energy pointed that, when it comes to hot water, residential condominiums, apartment buildings, hotels and swimming pools are some of the end users to be first targeted. The figures shown in the case studies were defined with the support of DaSol ABRAVA (Solar Division of the Brazilian Association of Refrigeration, Air Conditioning, Ventilation and Heating), through the application of the latest calculation model. The economic feasibility of each case was evaluated based on credit lines already available or currently under study. The cases in which the competitiveness analysis of the solar water heating and the company's feasibility are based upon are:

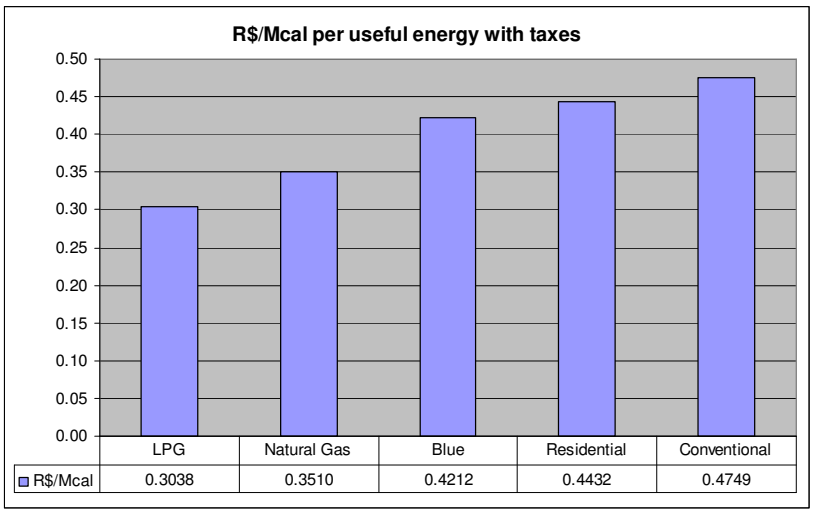
- Apartment Building: collector area 240 m^2
- Hotel: collector area 280 m^2
- Swimming Pool: collector area 375 m^2

Each case has a base alternative. Nonetheless, we analyzed three alternative options (Heat pump, Gas Heater — LPG and NG) for each of the cases, as follows:

- LPG Heating for the Apartment Building
- NG Heating for Hotels
- Electric Heating with Heat Pumps for Pools

We have deliberately left out the comparison 'solar heating versus conventional electric heating' due to the extremely high costs of the latter.

The real prices charged by the main competitors per useful energy are represented in the graph bellow. There we show the prices of the main energy sources and electricity tariffs in the categories A4 Blue (time-of-use electricity rate for consumers receiving Voltages between 2.3 and 13.8 kV), Residential and A4 Conventional (flat electricity retail price for consumers receiving Voltages between 2.3 and 13.8 kV).



The following table shows a summary of the main financial information of each Case Study. IRR means internal return rate with 100 percent of equity capital and ROE (Return on Equity) with 90 percent financing.

	Case Studies						
	Collector Area	Investment	Revenue	Financing	Results	IRR	ROE
	m2	R$	R$	R$	R$	%	%
Apartment Building	240	69,740	51,091	62,766	20,923	30%	63%
Hotel	280	61,920	40,608	55,728	19,526	31%	74%
Pool	375	100,313	66,396	90,281	45,240	45%	191%

Considering the methodology analysis applied, the results are strongly connected to the alternative being replaced and how much financing is available. Obviously, Heat Pumps are the most efficient way of using electricity to heat water, and represent the least advantageous alternative to be replaced by solar energy. Of course, the return rates increase when the alternative replaced is the conventional electric heating.

ESCO's evaluation included a detailed study of its objectives, mission, administrative and management structure, as well as its marketing and business development plan. ESCO could be set up by members of DaSol ABRAVA with the support of a specialized consultant, as mentioned herein below.

Finally, we sought to define ESCO's size by establishing the minimum gross revenue required to make the investment attractive. As it can be seen in the table below, the minimum gross revenue is achieved with 20 or 30 systems, in full operation, which yield an IRR higher than 20 percent — low, considering the risk factor inherent to the area.

	Case Studies						
	Number	Area	Investment	Revenue	Financing	Results	IRR
		m2	R$	R$	R$	R$	
Apartment Building	10	2,800	697,400	510,912	627,660	209,234	
Hotel	10	2,400	619,200	406,079	557,280	195,264	
Swimming Pool	20	7,500	2,006,250	1,327,927	1,805,625	904,806	
Total	40	12,700	3,322,850	2,244,917	2,990,565	1,309,304	35%

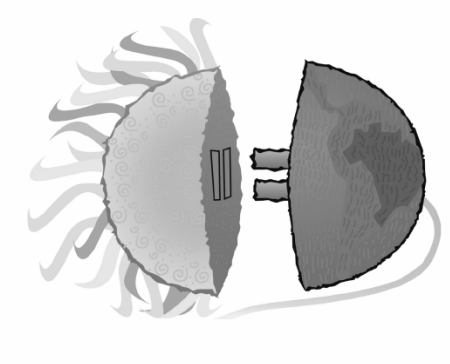
The return rate was calculated based on the premise that the development of the business will require an investment of about R$800,000. Also, ESCO will have to bear 10 percent of the cost of the systems to be implemented, as BNDES finances only 90 percent of the total investment amount. In Addition, we assumed that 40 systems will be in full operation within 12 months. Although these assumptions lack in complexity, they are realistic and can be implemented.

Among the most relevant recommendations, the following should be emphasized:

Services Company: The size of a company depends on several variables, especially whether it will be a new and completely independent initiative, in the sense that its main purpose will be the business that is now proposed; or if it will be a new business area of an existing company. Our recommendation is that DaSol ABRAVA, or a group of manufacturers, interested in the proposal, hire a services company in order to conduct the business development plan explained in this report;

Market Study: Exhibit III of the Portuguese full version of this document brings a market potential assessment in which is indicated the great number of clients that could and should be approached in order to determine, more accurately, how they heat their water and what their consumption levels are. The number of large hotels and swimming clubs mentioned therein is very significant and may be used as a preliminary data for a market research, as it lists the addresses and telephone numbers of each client;

Partnering Efforts: Solar Energy's marketing could have some national advertising, with local emphasis. At the national level, it could be jointly paid by the interested parties.



WHICH WOULD BE THE MARKET OF ESCO SOLAR?

In Brazil, more than 82 percent of the installed capacity for electricity generation comes from hydroelectric power plants. The remainder 18 percent is generated by thermoelectric plants — 15.1 percent from fossil fuels and a tiny addition of biomass and 2.9 percent from thermonuclear fuel. The new model for the Brazilian electric sector, approved in 2004 by the National Congress, established that the greatest source of electricity will continue to be the hydric alternative, despite the prediction that the participation of thermal sources will grow, especially those deriving from natural gas.

Nonetheless, the Sun is a renewable source of energy and one of the most promising options to increase the use of renewable sources. Solar energy is abundant, permanent and renewable; it doesn't emit any pollutants and nor has any negative impact on the ecosystems. Solar water heaters are a real and competitive possibility, capable of replacing part of the electricity used for heating therefore decreasing the environmental concern regarding that source of energy. This study is aimed at presenting an analysis of technical and financial alternatives that may enable new business models, allowing solar thermal energy to penetrate in residential condominiums, apartment buildings and in the commercial and services sectors, by taking advantage of the Brazilian solar potential.

Despite the efforts already undertaken, such as the attainment of some fiscal benefits — IPI and ICMS tax exemption — the domestic market of solar collectors, currently estimated in 350,000 m^2 per year, is still small, compared to its American and Canadian counterparts, and is still very far from the Israeli market, where the use of solar energy is mandatory and incorporated in construction projects.

Studies conducted on the electricity market during these last years, have provided information on energy consumption per social class, and sector. However, information on the end use of this energy is extremely rare or virtually nonexistent. The same is true for information involving useful energy. In this sense, the market analysis on hot water (up to 100ºC) outlined below should be seen as just an indicator. In order to cover this information gap, studies focused on determining consumer habits, kinds of installations, energy sources, and other information need to be carried out.

However, it is known that in the State of São Paulo, the main sources of energy used to heat water depend on the market sector. Despite the lack of data, it can be verified that in the residential sector the main source of energy — covering almost all households — is electricity, followed by piped gas and LPG. In the commercial and public sectors, the choices are the same as in the residential sector, plus fuel oil and wood, with some changes in the participation of each source. In the industrial sector, the priorities change, and fuel oil and diesel oil appear as the main inputs for water heating, followed by electricity and the other sources mentioned above.

RESIDENTIAL SECTOR

A preliminary analysis shows that, in the residential sector, water heating is predominantly done by electricity. Among other reasons, this predominance is due to the low availability of other energy sources in the State of São Paulo. However, an expansion in the piped gas network should change this scenario considerably, as this gas, from the technical and economic perspectives makes an excellent fuel for water heating. In this sense, the analysis below is highly significant — despite the lack of data — because, as it will be seen, the role of water heating in the residential sector is of great relevance; in

fact, there is a repressed demand of considerable proportions.

Influence of Water Heating in Electricity Consumption in the Residential Sector

The 2004 Brazilian Energy Balance shows that the residential sector was responsible for 22 percent of all the electricity consumed in Brazil, in that year, that is, 85TWh, which leaves no doubts about the importance of this sector, whether for its social aspects or for the great source of revenue it represents to the power industry. Electricity represents 32 percent of all the energy consumed by the residential sector; liquefied petroleum gas —LPG represents 27 percent and wood, 38 percent.

Among the uses of electricity in Brazil, the energy required for water heating answers, undoubtly, for the greatest portion. A study conducted in the State of São Paulo showed that up to 30 percent of the residential consumption of electricity goes to water heating, which represents a consumption of 7.5 TWh per year. In the Brazilian residential sector, the electricity used for water heating purposes is equal to 8 percent of the total consumption, that is, 24TWh per year.

These markets are responsible for a significant portion of the Peak Demand. Due to the low load factor required for electric water heating, the associated demand is about 3,000 MW in São Paulo and over 9,000 MW in the interconnected system.

The State of São Paulo represents a significant portion of the residential hot water market, in Brazil. In the City of São Paulo, capital of the state, there is a big concentration of apartment buildings, which increases the percentage of showers and central heaters, in relation to other regions of the State. The climate also contributes to the use of the existing equipment — central or individual — for longer periods.

Based on what has been presented, there is a market niche to which heated water could be sold — in the residential sector — especially when it comes to new buildings or those with central heating systems that allow adaptations for solar energy. One of our case studies simulates a scenario with an 84-unit apartment building.

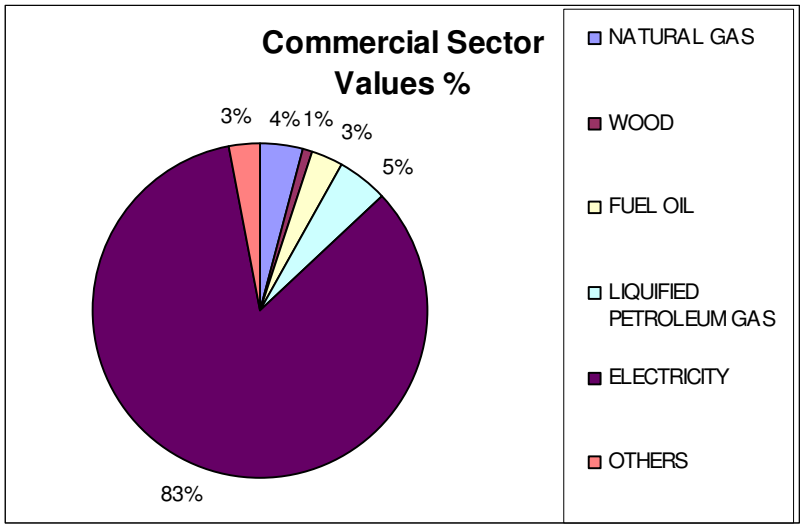
COMMERCIAL AND SERVICES SECTORS

For the purposes of this study, the commercial and services sectors comprise commerce, services and other activities, services and public bodies. Then, there is a brief analysis of the consumption and, the curve load of the sector, designed for the purpose of identifying the main end uses of water in this market segment.

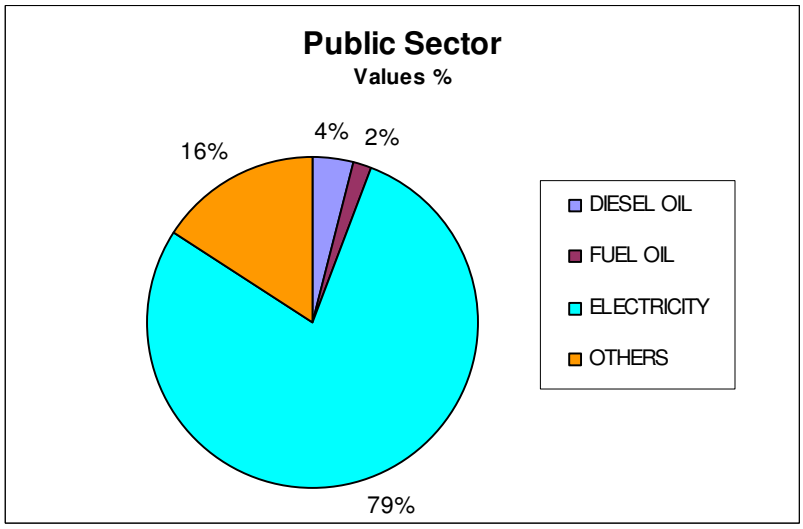
Consumption in the Commercial and Public Sectors

The commercial and public sectors, together, consume 22.3 percent of all the energy consumed in Brazil. The 2004 Brazilian Energy Balance also shows that 83 percent and 79 percent of the energy consumed by the commercial sector and the public sector, respectively, is the electricity.

The commercial sector consumes 14 percent of the electricity consumed in Brazil, or 50.1 TWh per year; 20 percent of this consumption goes for water heating.



Source: 2005 Brazilian Energy Balance – Year Base 2004



Source: 2005 Brazilian Energy Balance – Base Year: 2004

End Uses of Hot Water in the Commercial Sector

The hot water demand for sanitary purposes, heating and cooking appears in almost all segments of this sector. In order to supply this need, the energy sources most commonly used are electricity, piped gas and LPG. Nevertheless, there are segments in which the energy used for water heating represents a significant portion of the total energy consumption — such as hotels, hospitals, laundries and clubs, where the business activity requires the use of large volumes of hot water. It is also known that most of their electricity goes for water heating. However, due to the lack of data, it is not possible to accurately determine how much energy is spent with it.

This sector consumes much more electricity from 6a.m. to 8 p.m., but without showing peaks of consumption. Hotels, hospitals, laundries and clubs are among the segments, in the commercial sector, with the highest consumption of hot water; their consumption rate is flat throughout the day, which is vitally important for a company whose purpose is to sell hot water to this sector.

Concentrating the operations of the company in the City of São Paulo is a wise strategy, once the area answers for 17 percent of the electricity consumed in the State of São Paulo and 4 percent of the electricity consumed in Brazil – 15 TWh per year.

Field Research in Hotels: On research carried out with the hotel chain *Meliá* — only in the City of São Paulo — we counted 15 branches, totaling 2,900 rooms. During the research, we verified that the average volume of natural gas applied in water heating was 55,000 m^3, considering a calorific power of 8,700 kcal/ m^3. The table below shows the potential for hot water consumption to be exploited by this Services Company under study.

Hotel	Natural Gas Consumption	Calorific Power	Energy	Average temperature water	Temperature hot water	Delta Temperature	Potential Hot Water
Units	m^3/month	kcal/m^3	Mcal	^oC	^oC	^oC	m^3/month
15	58.000	8700	504.600	20	50	30	16.820
Hotel Case	1.937	8700	16.852	20	50	30	562

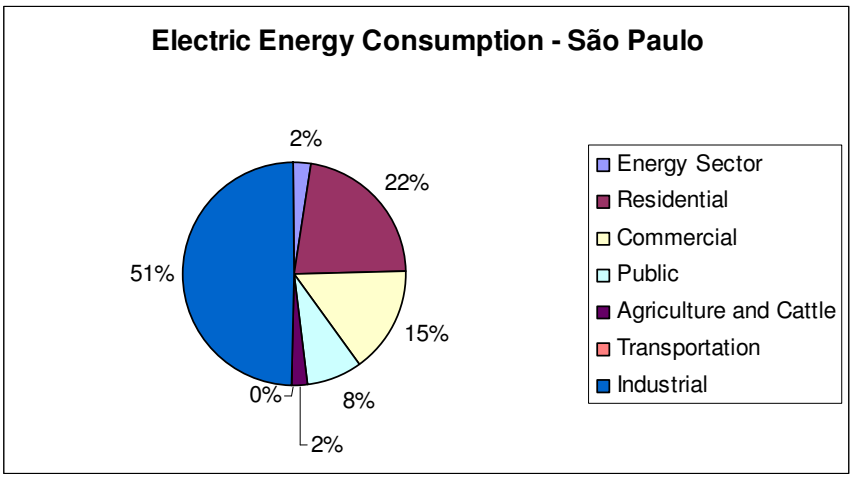
The potential for hot water consumption, in this chain alone, is 30 times bigger than the one used as base case in this study. Exhibit II of the Portuguese version of this work shows the study conducted in some of the main hotels operating in the City of São Paulo.

Field Research in Pools: *Runner*, a fitness club chain has 12 branches with semi-Olympic pools — all with the same characteristics of the model we studied. *Unique Fitness,* another chain, has 25 branches in the city of São Paulo. Together, these two chains have 37 branches with pools presenting the same size as the one studied herein. Exhibit II of the Portuguese version of this work shows a study conducted in some of the main swimming and fitness clubs operating in the City of São Paulo.

Pools	**Area**	**Volume**	**Energy w/out solar**	**Energia w/ solar**	**Energy Saved**	**Carbon Avoided**
units	m^2	m^3	kg/month	kg/month	kg/month	ton/year
Base Case	312.50	22.20	4,.653.21	438.54	4,214.67	28.00
37	11,562.50	22,200.00	172,168.88	16,226.06	155,942.83	1,048.00

INDUSTRIAL SECTOR

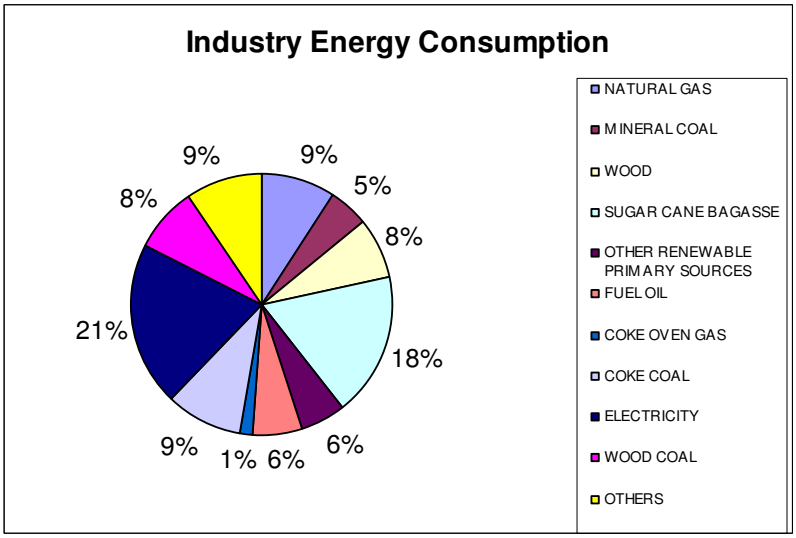
To evaluate the potential market for solar energy in the industrial sector, we analyzed the end use for energy in this industry. The industrial sector answers for most of the energy consumption, both in the State of São Paulo and in Brazil. Data from the Energy Balance of the State of São Paulo shows that the industrial sector answers for 51 and 48 percent of the electricity consumption in that State and in Brazil, respectively.



Source: 2005 Energy Balance of the State of São Paulo – Year Base: 2004

In the energy matrix of the State of São Paulo, the consumption of electricity represents 21 percent of all the energy consumed in the state. From the energy consumed by the industrial sector, 86 percent goes to heat production. From this, 44 percent is consumed at a low temperature, notably from 50 to 300ºC. The energy sources are used for water or thermal fluid heating, steam generation and production of process heat.

The chart below shows the distribution of the energy consumed by the industrial sector, separated by source, according to the 2004 Energy Balance of the State of São Paulo.



Source: 2005 Energy Balance of the State of São Paulo – Base Year: 2004

The energy consumed for thermal purposes in the industrial sector, separated according to the type of industry and temperature levels, is shown in the following table.

Temperature	Industrial Sector (% of Consumption)							
Levels (^{o} C)	textile	food	chemical and petrochemical	ceramic	glass	celullose and paper	metallurgy	cement
% thermal use	78,0	90,5	86,0	93,6	91,8	83,0	88,0	90,0
50 - 100 ^{o} C	46,2	22,1	-	-	-	-	-	-
100 - 150 ^{o} C	44,9	58,0	57	8,7	2,8	47	4,5	1,3
150 - 300 ^{o} C	8,9		18			44	-	
300 a 500 ^{o} C	-	19,9	-	-	14,5	-	-	19,1
500 - 700 ^{o} C	-	-	-	-	-	-	-	79,6
> 700 ^{o} C	-	-	25	91,3	82,7	9	95,5	
Total	100,0	100,0	100	100	100	100	100	100

Source: Agency for the Application of Energy (Agência para Aplicação de Energia)

General Aspects of the Industrial Use of Solar Energy

In the food and beverage sectors, one example of the possible applications could be to wash cans and bottles. However, due to the temperature it requires (90ºC), heating systems based on solar collectors could only contribute to pre-heat the water to a temperature between 50 and 60ºC. To increase the temperature to 90ºC another energy source would have to be used. A system bearing these characteristics was installed by a beverage manufacturer in the State of São Paulo.

There are possible applications in other industrial segments such as the tanning, candle and photographic films industries, etc, where solar systems have already been installed. The chemical industry is another segment where there may be possible applications.

However, the following factors should be considered when assessing the market potential for the industrial application of solar energy:

1. Solar systems take large surface areas when great volumes of hot water at a low temperature are required;
2. In many industries, hot water is the end use of the thermal energy produced by a single piece of equipment;
3. Absence of another application that could prove the technical and economic feasibility of solar energy;
4. Possibility of using or not using the residual heat.

ESCO SOLAR AS A BUSINESS OPORTUNITY

The recent deregulation of the Brazilian electric sector and increases of electricity tariffs at rates above the inflation have motivated companies to look for new energy products and services in order to decrease their costs. This new reality in the energy market created opportunities for retail sale of new products and services.

The idea of using solar thermal energy to heat water in pools of swimming schools and clubs, hospitals, hotels and residences, was rejected for a long time. However, it's being considered now, due to increases in electricity costs as well as in the prices of petroleum based products – the latter caused by a scarcity of sources and the need of preserving the environment.

This document seeks to explain how and why to set up a company in order to sell hot water, and presents a strategy, a commercial and financial balance sheet of a company entirely dedicated to this business.

Structured as a business plan, the *"Business Prospects for Solar Water Heating Fee-for-Service Operations in Brazil"* project explains how this solar water heating service will meet the real needs of residential and commercial clients, provide the expected efficiency and improve the processes and the profitability of the companies. The expectation is that the Solar Water Heating service will yield attractive profits for companies that invest in this kind of service almost anywhere in the country.

Everywhere and given the choice, intelligent consumers will choose an alternative that allows them to spend a little less with energy — for water heating purposes — than what they spend on their electricity bills, once the cost of electricity is increasing above inflation rates. And this is what modern solar technology, aimed at meeting most of the end uses of residential and commercial consumers of this country can provide: water heated by solar systems for a lower price and certainly much cleaner — environmentally speaking — than the water heated by any other source of energy.

Why hasn't it been done before? First of all because although this technology has undergone continuous improvement during these last few years, no one had yet conducted a deep analysis on the fundamental savings a company could have, as a result of solar thermal water heating. Throughout the time, most of the R&D budget has been invested in improving and analyzing the efficiency of the use of electricity. This is now changing, as companies have begun to study the potential of new products or services, classifying them in terms of business expansion opportunities.

Another reason why Solar Water Heating only recently began to be seen as economically attractive is the absence of experiences involving the deployment of solar systems in large business scale, which could convince services and utilities companies that operate in the residential and commercial markets to switch their business towards selling solar heated water, instead of selling or leasing equipment for water heating.

Agreements involving the sale of solar heated water may be long-lasting provided the client is satisfied with the services, that is, provided they cost a little less than the electric heating alternative or any other energy alternative, such as LPG or Natural Gas while still delivering adequate value.

The cash flow for a long-term services agreement is considerably more attractive than the profit margins resulting from the sale or leasing of solar equipment. Solar water heating is easier to sell, considering the end use, because it eliminates objections related to high equipment costs and investment risks, which were some of the main barriers to the commercialization of solar equipment, in the past.

In truth, it will drive a greater penetration of solar systems in the market. On the manufacturer end, this will increase the production and his profits due to a decrease in production costs. This will also reduce the prices to the entrepreneur or consumer, farther increasing their savings connected to the use of solar water heating.

DESCRIPTION OF THE ESCO SOLAR

In the last few years, the Solar Water Heating business in Brazil has developed at a slow pace — slower than it would be desirable — mostly due to the initial financial investment it requires. However, some factors, such as quality improvement and regulation and homologation by INMETRO allowed the industry of solar systems to grow, despite the relatively high investments these systems require. The establishment of companies in the Brazilian market aimed at providing water heating services will help the industry by creating standards to guarantee and certify the quality and the development of the product.

ESCO solar has the opportunity of creating a new and profitable business, offering solar heated water to commercial and residential consumers in a fee-for-service system, connected to the "end use". This service will be offered directly to the client, no matter the kind of commercial business — swimming clubs, hotels and others — for a period of 10 to 20 years. There is potential for great returns resulting from an increase in the number of clients and from continuous improvement in operations and other techniques highlighted in this business plan.

This business will operate on a market niche directly related to the solar water heating business. It will provide a new "green" set of products and services, more environmentally correct, to clients who are interested in cutting their energy costs while being environmentally concerned. The positive effects on users' brand image will be felt at state and national levels. And, finally, the permanence of this business in the mass market will provide valuable experience for the commercialization of future products and services with "advanced technology" in the commercial and residential sectors.

Mission and Objectives of the Company

The new company, ESCO, will supply water heating — heated by Solar Collectors — to commercial and residential consumers, according to a fee-for-service billing system. The company will acquire, install and maintain the solar heating equipment at the commercial or residential client premises.

In exchange for this, ESCO will charge the client a monthly fee for these water heating services, which should be slightly lower – we estimate it to be 15 percent lower – than his monthly expenditure with his traditional energy source — electricity, LPG or Natural Gas. In other words, the user will have a slight improvement in his monthly cash flow.

The equipment to be installed by ESCO will be designed to supply about 60 to 70 percent of a client's annual demand for commercial or domestic hot water. Clients won't notice any differences regarding the quality of the hot water or the way it is supplied. Whenever the solar energy is not enough to supply the demand for hot water, the existing gas heater or hot pump will supply the extra energy, as an auxiliary source.

Goals of ESCO Solar

ESCO Solar will achieve some important goals:

- It will enhance a company's leadership image and help it build an "environmental brand" image, which could be highly valued by its potential clients. This edge may be a powerful ingredient of success, in the future, once clients and consumers are becoming more and more

concerned about the importance of a cleaner environment — free from gases that cause the greenhouse effect.

- The deployment of solar systems, in scale, will create an important resource of renewable energy, offering tangible environmental and economic benefits to clients and society, as a whole. A conservative analysis of environmental benefits deriving from solar water heating shows that the long-term social benefits, resulting from a reduction in SO_2 and CO_2 levels are approximately the same as the installed cost of each system.
- It will satisfy an important demand by a significant part of the consumer base for an environment friendly and economical source of energy, as it begins to remove economic barriers (and other barriers) associated to the use of this technology.

Unique Opportunity

While manufacturers simply sell solar heating systems, ESCO Solar will be one of the first utility companies to offer solar heated water based on a fee-for-service billing system. The cost per end use will eclipse clients' first objections connected to the value of initial investments and the fear of adopting a new and unknown technology.

There isn't a significant competition in this market today, in Brazil. However, ESCO solar will seek to maximize the competitive advantages of an early market entry, offering discounts based on the volume of equipment purchases as well as the advantages of the learning curve in marketing, installation and maintenance techniques. The strategy, terms and scale of operations of ESCO solar support the argument above regarding the advantages of an early market entry.

MARKETING

The support of the solar systems industry may determine the advancement in the Brazilian market. The commercial model should demonstrate the reliability of solar systems, as well as of their complements, such as hot pumps and traditional heaters. ESCO solar will have to prove, to its clients, the advantages of its contractual system, compared to the acquisition of their own solar systems, such as:

- Elimination of initial investments involved in the purchase of the equipment, which is a barrier and,
- Elimination of concerns of property owners about bearing the responsibility of acquiring equipment with sophisticated and little known technology.

In this work, the residential client base for ESCO solar will be the upper-medium class families. Our ideal residential client will probably have the following profile:

- At least 4 members per family;
- Families with kids or teenagers;
- Homeowners environmentally concerned. Ideally, people related to an environmental organization.

The commercial client base will focus mainly on hotels and swimming clubs and schools.

The services company that will be established to provide solar heating system will have to satisfy some basic requirements in order to be successful. One of the important requirements is the absence, in the

same neighborhood, of another services company with the same business objectives. Another requirement is the existence of a water supply service, by a distribution company, as well the volume of water to be delivered to the services purchasers and their seasonality. Temperature and local climatic conditions will require different systems performance, which should be taken into account at the implementation time.

There are several technical aspects that should be evaluated based on the region where ESCO solar will operate, such as the style of the constructions and the population density in the property. The population density will influence the amount of hot water that needs to be produced and will have a direct impact in the installation, service and profitability of the project.

Upon the definition of the marketing program, the plan will increase marketing efforts and develop a market strategy. This part of the plan will determine the general guidelines of the company regarding what it wishes to accomplish, at a market level, and how it will be done.

Probably the best strategy for ESCO solar is to focus on a neighborhood and then successfully apply this experience in the expansion of this area.

The services company to be created has several options to reach the desired profitability and growth goals:

- If the target market is big, the services company's growth could be greater that what has been initially predicted. Consequently, it will improve the financial results beyond the expected.
- Offering related products and services, within the business area of the services company may result in greater growth.
- Partnerships with other commercial companies (generators, distributors, etc.) and other utilities may offer great opportunities to accelerate the development of the solar services business.

The main idea for ESCO solar's communication strategy is to send two main messages to its potential clients:

- Cost reductions and,
- Helpful steps towards the preservation of the environment for future generations (it's particularly appealing to families).

The communication materials should focus on the benefits the service brings to clients. This should be emphasized in all communications, presentations, written materials and electronic medium used by the company.

COMPARATIVE STUDY OF ENERGY SOURCES

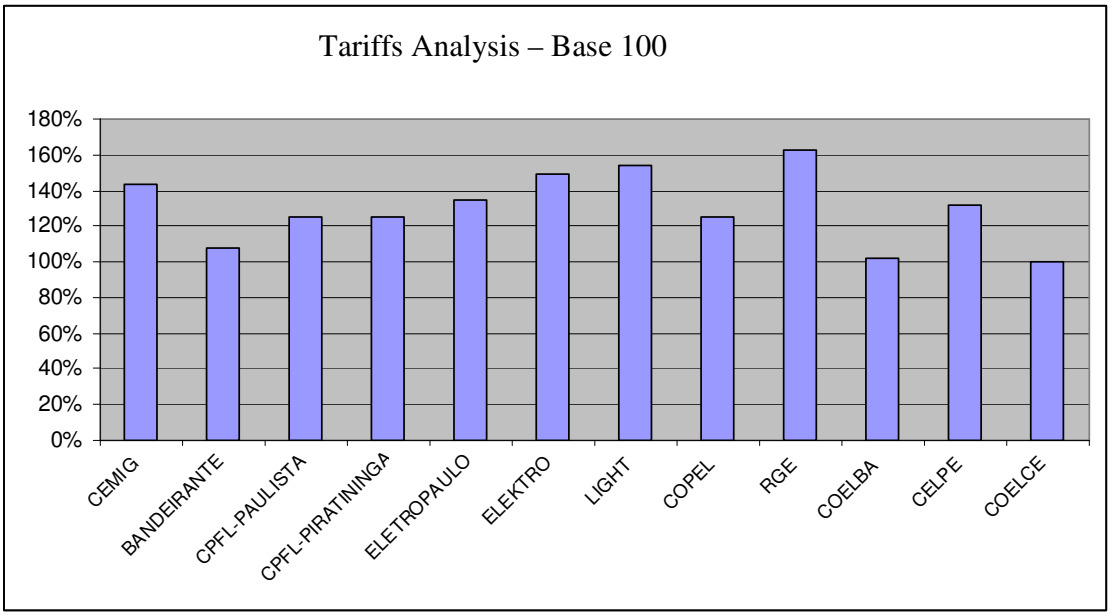
Comparative of the Electricity Tariffs Practiced in Brazil

Before the privatizations, the tariffs of the electricity sector were unified, in all Brazilian regions and states. After the beginning of the privatizations, in 1998, ANEEL (Brazilian Electricity Regulatory Agency) has authorized and published new electricity tariffs for each privatized company, based on the energy acquisition costs and operational expenses of each energy distribution company.

Studies conducted by the authors of this study show that there is great variation in the tariffs practiced by each utility company. Below, we show the tariffs paid by consumers within a voltage class of 2.3 to 25 kV, to the main distributors in the South and Southeast Regions. This is a recent snapshot of the industry. Comparing the figures, we have an average cost of R$257/MWh. The maximum cost is R$322/MWh and the minimum is R$197/MWh.

It's possible to notice that, in the State of São Paulo, which has distribution areas under the control of Eletropaulo (265 R$/MWh), CPFL Piratininga (247 R$/MWh), Paulista (247 R$/MWh), Elektro (295 R$/MWh) and Bandeirante (213 R$/MWh), there is great variation in the average tariffs, considering a typical consumer, with an average load factor of 70% with the same peak and off peak demands contracted with the utility companies.

Compared to other Brazilian states, we can see that in the State of Rio de Janeiro – Light (304 R$/MWh) and part of Rio Grande do Sul State - RGE (322 R$/MWh), consumers served by these distributors pay even higher average tariffs.



Making a comparative analysis of these tariffs, having as base 100 the tariff charged by COELCE, we can observe a great cost disparity in several Brazilian states, where some distributors charge almost 60 percent more than the base price.

We can see that the feasibility and return of this project will be greater or smaller depending on the area of concession it is located.

In this case study we will evaluate a services company that provides hot water based on 3 situations: a pool of a swimming school, a hotel and an apartment building located in an area under the control of Eletropaulo — in the City of São Paulo — and whose tariffs were used in the economic analysis contained in this study.

Comparison of Energy Costs

To elaborate the comparative analysis we had to take into account that several traditional energy sources — such as Liquefied Petroleum Gas (LPG), Natural Gas (NG), Electricity as well as heaters and heat pumps — can be used to heat the pool water in a swimming school, hotel or apartment building.

In order to be feasible, ESCO solar needs to look more economically attractive to clients. Therefore, the new company's revenue will depend on the prices practiced by the competition and the kind of discount the company will offer to the consumer.

To establish the comparative parameters, we will consider the costs of LPG supplied by *ULTRAGAZ*, of NG supplied by *COMGAS* and of electricity supplied by *ELETROPAULO.* We chose *ULTRAGAZ* and *COMGÁS* because they are the largest distributors of LGP and NG in Brazil. *ELETROPAULO* was chosen due to the fact that this work will focus in the city of São Paulo.

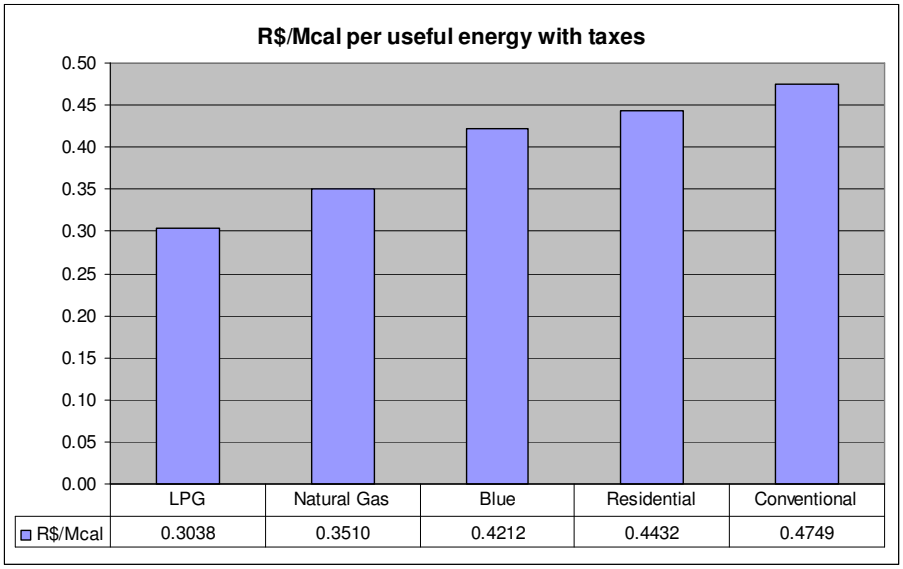
The feasibility of ESCO solar depends greatly on the real cost of useful energy supplied by the competitors and the kind of water heating technology the client uses. In the table below, there is a comparison of the relative costs of the energy sources analyzed in this study, considering their average commercial prices (including taxes) in case of fuels with inferior calorific power for water heating purposes. The costs correspond to useful energy in hot water.

Cost Comparison of Energy (Mcal) used for Water Heating

Source	Price			ICP	Cost Mcal
	Unit	Average		kcal/H.U.	R$/Mcal
Natural Gas	R$/m^3	2.418		8,400	0.3510
LPG	R$/kg	3.34	-	11,000	0.3038
Electricity					
Blue	R$/MWh	362.19	-	860	0.421
Conventional	R$/MWh	408.41	-	860	0.475
Residential	R$/MWh	381.16	-	860	0.443

Source: Lumina Energia

The main competitors' actual costs per useful energy are shown in the chart below. In the chart, we show the costs of the main energy sources and the costs of electricity in the A4 Blue (Blue), Residential and A4 Conventional categories.



Source: Lumina Energia

We can see that the costs of NG and LPG resulted in a lower cost in R$/MCal-equivalent for water heating.

CASE STUDIES

Hotel

ESCO solar will sell hot water. This water will be heated through a solar heating system, with panels; complementary energy will be provided by heat pumps.

A second alternative will be supplying hot water to hotels already equipped with an NG heater. In this case, the company will install the necessary solar panels and the gas heater will be used to provide the complementary energy, reducing the initial investment.

The base-client will be a 160-room hotel in the City of São Paulo, with an average occupancy rate of 50 percent and a hot water storage tank with a 15,000-liter capacity. The water will be heated to a temperature of 50ºC.

Apartment Building

ESCO solar will sell hot water. This water will be heated through a solar heating system, with panels; complementary energy will be provided by heat pumps.

Another business opportunity will be supplying hot water to apartment buildings already equipped with LPG heaters. In this case, the company will install the necessary solar panels and the gas heaters will provide the complementary energy, reducing the initial investment.

The client will be an 84-unit apartment building, in São Paulo, with an average of 3 people per household, and a hot water storage tank with a 20,000-liter capacity. The water will be heated by the company to a temperature of 50 ºC.

Pool

For the purposes of our case study we'll consider that the pool will operate at an average temperature of 30ºC throughout the year. It will be an outdoor pool; during the night the pool will be covered in order to reduce heat loss. The study will be conducted so as to achieve a heating system that yields a return rate (IRR) compatible to the return rates offered by the Brazilian financial market.

This project contains a sensibility analysis in which the collector area, formed by plates of $2m^2$ each, varies from 60 to 120 percent of the size of the pool area. Therefore, the collector area will vary from 187.50 to 375 m^2 and will receive complementary energy from 1 to 4 heat pumps, depending on the collector area. When a gas heater is already in operation, it will be used to provide the complementary energy. The tilt angle of the collector will be at 23º and it will face the true north.

The table below shows the energy produced by a solar collector as a result of the absorption of solar energy:

Solar Collector			
	Production		
Month	Daily	Monthly	Energy
	kWh/m2	kWh/m2	kcal/m2xday
jan	3,93	121,8	3.380
feb	4,37	122,4	3.758
mar	4,07	126,2	3.500
apr	3,39	101,7	2.915
mai	3,01	93,2	2.589
jun	2,73	82,0	2.348
jul	3,17	98,2	2.726
aug	3,50	108,6	3.010
sep	3,34	100,3	2.872
oct	3,58	110,8	3.079
nov	3,54	106,2	3.044
dec	3,45	106,9	2.967
Aveage	3,51	106,5	3.016

Source: ABRAVA - Brazilian Association of Refrigeration, Air Conditioning, Ventilation and Heating

These are the specifications of the Heat Pumps used in this study:

- Installed capacity per pump: 6 kW
- Connecting voltage: 220/380 V
- Gross weight per unit:160 Kg
- Maximum volume of water to be heated per pump: 140 m^3
- Maximum pool area per pump: 110 m^2
- Gross weight per pump: 157 kg

Hotel

This project brings a sensibility analysis varying the number of collector plates from 80 to 140, each plate measuring 2 m^2, resulting in a collector area that will vary from 160 to 280 m^2. The solar collector will be installed at the rooftop of the building, facing the true north and at tilt angle of 23º.

Complementary energy will be supplied by a heat pump or by the gas heaters already in use at the hotel. This last alternative will reduce the amount of investment, yielding a faster investment return, and at a higher rate.

Residential Apartment Building

This project brings a sensibility analysis varying the number of collector plates from 60 to 120, each plate measuring 2 m^2, resulting in a collector area that varies from 120 to 240 m^2. The solar collector will be installed at the rooftop of the construction, facing the true north and at tilt angle of 23º.

Complementary energy will be supplied by two heat pumps or by gas heaters already in use at the condominium. This last alternative will reduce the amount of investment, yielding a faster return and at a higher return rate.

RESOURCES FOR BUSINESS DEVELOPMENT

The services company's project for selling hot water to an end user assumes that the client will provide the area where the solar panels and solar pumps will be installed, without any charges.

Business Investment

Solar Collector:

Upon a market research we arrived at the value to be invested in solar collectors. The average price was R$195.00 per m^2 of solar collector.

This value will be applied to the collector area, in square meters, described in the sensibility analysis, and to each of the case studies, in order to calculate the total investment.

Heat Pump:

In the sensibility analysis conducted in relation to the collector area there is also a variation in the number of heat pumps.

When complementary energy is provided by heat pumps we will adopt the average price of R$12,000.00 per unit.

Civil Constructions

For the installation and adaptation of the existing conditions, in the three case studies, and considering the six-month period required for the conclusion of the work, plus the costs of labor and materials, the approximate investment will be R$15,000.00.

Available Financing

Nowadays, the Brazilian market offers two sources of financial resources aimed at financing services companies that supply water heated through some kind of alternative energy — in our case, solar heating and heat pump.

A new credit line is about to be approved by the board of BNDES, an initiative of its Environment Department. This new credit line, designed for ESCO's, is called ProEsco's and will finance projects by companies that use equipment powered by alternative sources of energy, such as solar energy, in its several forms, and wind energy.

Conditions of the financing:

- 90% financing
- 10% equity
- Annual rates %:
    - TJLP – currently 8,15%;
    - Spread – 1%
    - Risk rate – 3%
    - Commercial bank's commission – 2%.
- Amortization period — up to 72 months;
- Grace period — up to 24 months
- No guarantees will be required as they have been included in the risk rate

The project will have to be submitted to a technical analysis by an agency appointed by BNDES, which will perform the technical and economic analysis of the project before releasing the financial resources.

This company is an arm of the American company E+CO, established in 1994 as a non-profit organization. The idea for this organization came from the experience acquired with some programs from the Rockefeller Foundation. Nowadays, the company is an independent body, comprised by businessmen, investors and strategists focused on a mission: helping and supporting the establishment of domestic companies with good potential, that use clean and reliable energy at reasonable prices, facilitating the link between human capital, financial resources and different technologies.

E+CO finances up to US$500,000 which is handed to the end entrepreneur in Reais; the debt should be paid in Reais.
The financed amount can reach up to 100 percent of the total investment.
Guarantees to be offered may be: the financed equipment, vehicles in general, houses, apartments and others to be analyzed.
Low interest rate, about 12 percent per year — defined upon the analysis of the project.
Grace period can be as long as 24 months.
The debt can be amortized in up to 7 years, or 84 months.

The project will have to be submitted to a technical analysis by an agency appointed by E+CO, which will perform a technical and economic analysis of the project before the release of the financial resources.

Organization of the Company

The organization of a company is usually defined by the purposes and goals of this company, focusing on the specific set of competencies that will be required to make the company grow and prosper. The management team of a company that renders solar services will have to decide about the best organization structure, considering the challenges of its local market and the specific skills of each of its members. A practical rule is to form a harmonious and highly motivated team, keeping hew hirings to a minimum. Critical positions may be filled, according to the principle "just in time". Above all, it's crucial for the success of this solar services company that its team members have an entrepreneurial vision and a strong desire to serve and satisfy their clients.

This solar services company will have expenses with the management of the business, as well as with its operations and maintenance. As we still don't have the necessary information regarding its organizational structure nor the growth rates of the company, table 8.3.1 will show an hypothetical scenario. We considered that expenses with the management and maintenance of the company will represent 3 and 5 percent of its total annual revenue, respectively.

Management Team

The management team will be crucial for the success of the solar services company. Its members should be business-oriented professionals from the technical and marketing/sales areas. This team will start with two key members – the General Manager and the Sales and Market Manager — supported by a sales team, telemarketing representatives and administrative assistant.

This solar services company will resort to third party suppliers for installation services and customer service. In this manner, it will benefit from the information and management capabilities of its suppliers, as the company begins to grow. The solar services company will act as a connector, bringing together the talents and resources of third-party workers. This will enable the solar services company to leverage its management resources and conduct a lean and efficient operation.

<u>General Manager</u>

The General Manager will be in charge of all the management issues of the solar services company, and responsible for its general success. The GM will wear several "hats", especially while the company is in its first stages of development. The functional responsibilities of the GM will include:

- General Management
- Sales and Market Management
- Engineering and Operations Management

The most important quality the General Manager should possess is entrepreneurial skills. As the driving force of this new business, the General Manager needs to provide clear vision and energy to his team and outsourced workers. In summary, the General Manager should show great enthusiasm for the

construction of the business, be open-minded and have the tenacity that the building of such business requires.

The General Manager position is a salaried job. The professional should receive a significant performance-based bonus, dependent upon the achievement and the surpassing of business development objectives and sales and profits goals of the solar services company.

Sales and Market Manager

The Sales and Market Manager is the second most important person in the solar services company, after the General Manager. The solar services company needs to be a market and sales-oriented business and the Sales and Market Manager will be in charge of setting the company in the right direction. He is also responsible for accomplishing company's sales forecast, which will determine the profitability of the business.

The Sales and Market Manager should be a talented sales professional, with enough technical background to provide him/her the ability to work with solar heating technology. He or she should be a competent sales manager, as well as an apt salesperson. Upon the opening and during the first stage of business development, the Sales and Market Manager will be responsible for managing the sales activities performed by the Sales Engineers and telemarketing representatives, as well as for achieving, personally, part of the projected sales.

A final responsibility of the Sales and Market Manager will be to coordinate the marketing actions of this solar services company. This work will take part of his/her time and will consist in the development of detailed plans for the commercialization of the product plus a continuous follow-up of these plans. He or she will also oversee the implementation of some selected communication tactics. In this sense, the Sales and Market Manager should keep a good balance between his/her "marketing" and "sales" professional role.

This is a salaried job. Should there be significant responsibility for sales the base salary could be a reduced, and a performance bonus added.

Sales Engineers

In this solar services company, Sales Engineers wears a technical and a sales hat. However, their primary responsibility will be to the salesperson role. They will close contracts in a manner that enables the solar services company to reach its sales forecast, by making sure the systems are installed accordingly.

The technical role will begin during the assessment of the site, considering the sales objectives and the cost of installation. The Sales Engineer should have enough technical background to enable him/her to adequately evaluate a site, analyze the applicability of solar heating and calculate the installation costs. Besides being able to qualify an installation site and elaborate cost estimates, the Sales Engineer should be able to conduct an evaluation and certification of the system, after its installation. Finally, the professional should be able to provide technical support to the contractors during the installation of the system, as needed.

The Sales Engineer professional doesn't need to be an "engineer", but must be very knowledgeable on solar heating technology and be familiar with some common problems that may arise during the operations.

This is a salaried job, compensated according to the base salary + performance bonus formula.

Telemarketing

Telemarketing will be a very important tool for contacting and qualifying prospective clients for the solar services company. The telemarketing team will be responsible for identifying and qualifying sales opportunities, and will have an active and passive role.

Professionals will be paid on an hourly-basis.

Engineering and Operations Manager

The Engineering and Operations Manager professional will deal with technical and management issues and will take over some of the responsibilities initially fulfilled by the General Manager.

This is a salaried job.

Administrative Assistant

The Administrative Assistant will provide highly competent support to the management and the teams. The position will be occupied by a person capable of managing an office, able to meet challenges and to execute tasks without much supervision. This person should be able to deal effectively with outsourced workers, as he/she will be the first contact point between the solar services company and the clients or contractors.

This position may be remunerated on a salary or hourly basis.

FINANCIAL AND ECONOMIC ANALYSIS

Case Study: Pool water heating

In the table below we show some basic data and investment values resulting from a market research conducted in the City of São Paulo with companies that sell heating equipment for pools, including solar collectors.

Location	
FU	São Paulo
Latitude	-23.53
Longitude	-46.63
Altitude	792 meters

Data

Area	312.5 m^2
Depth	2 m
Volume	625 m^3
Temperature	30 C
Operation Hours	12 h
Coverage	100%
Collector Angle	30º

Total Investment

Collector Area	Collector	Pump	Hot Pump	Labour	Total	Total w/out Hot Pump
m^2	R$	unit	R$	R$	R$	R$
187.50	36,656	4.00	48,000	15,000	99,656	51,656
250.00	48,875	3.00	36,000	15,000	99,875	63,875
312.50	61,094	2.00	24,000	15,000	100,094	76,094
375.00	73,313	1.00	12,000	15,000	100,313	88,313

The table below shows the consumption of electricity in kWh/month and of LPG in kg/month as well as the monthly cost to heat the pool water without solar heating.

	unit	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat Pump	kWh/month	11,055	9,983	11,956	15,449	20,142	21,492	22,737	20,745	17,087	15,380	13,233	12,006
LPG	kg/month	3,227	2,914	3,491	4,510	5,880	6,274	6,638	6,056	4,988	4,490	3,863	3,505

	unit	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat Pump	R$/month	4,289	3,873	4,639	5,994	7,815	8,339	8,822	8,049	6,629	5,967	5,134	4,658
LPG	R$/month	8,068	7,286	8,727	11,275	14,701	15,686	16,595	15,141	12,471	11,225	9,659	8,763

The total annual expenditure, in Reais, is R$ 74,207.67 when using a heat pump and R$ 139.596.39 when using an LPG heater.

In the analysis conducted to determine the company's revenue, we established that the client would receive a 15 percent discount, based on his expenditure with pool water heating, considering that his heating alternative would be a heat pump, in case of new enterprises or LPG gas, supplied by *Ultragaz,* as they are the least expensive energy alternatives, among those we have studied.

The table below shows the consumption of electricity in kWh/month, when complementary energy is supplied by heat pumps and the consumption of LPG in kg/month when complementary energy is supplied by gas heaters.

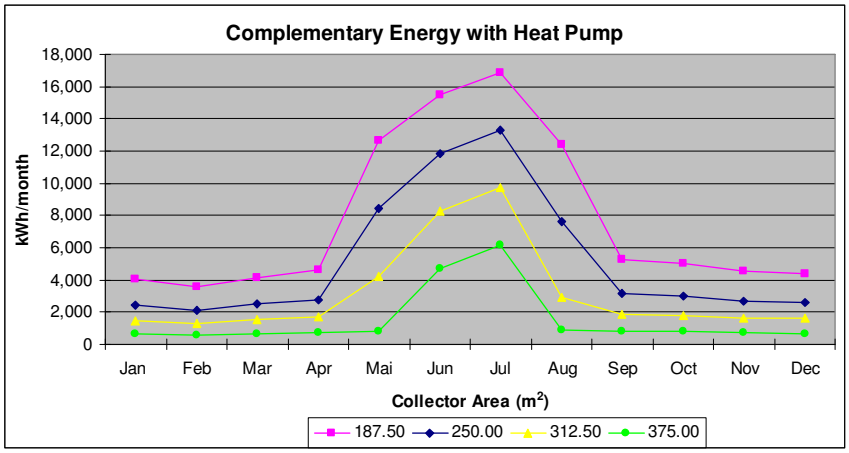
Complementary Energy provided by Heat Pumps (kWh/month)

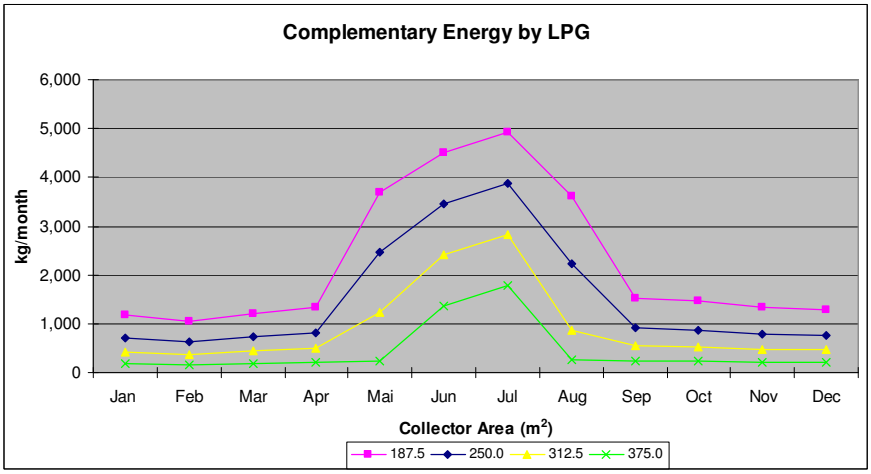
Relation Area	Collector m^2	Heat Pump	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
60%	187.50	187.50	4,045	3,574	4,143	4,621	12,639	15,457	16,901	12,380	5,236	5,008	4,536	4,370
80%	250.00	250.00	2,420	2,139	2,479	2,765	8,410	11,866	13,312	7,661	3,134	2,997	2,714	2,615
100%	312.50	312.50	1,468	1,298	1,504	1,678	4,182	8,275	9,723	2,943	1,901	1,818	1,647	1,586
120%	375.00	375.00	623	551	639	712	845	4,685	6,134	885	807	772	699	673

Complementary Energy provided by LPG (kg/month)

Relation Area	Collector m^2	LPG	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
60%	187.50	187.5	1,181	1,043	1,210	1,349	3,690	4,513	4,934	3,614	1,529	1,462	1,324	1,276
80%	250.00	250.0	707	624	724	807	2,455	3,464	3,886	2,237	915	875	792	763
100%	312.50	312.5	429	379	439	490	1,221	2,416	2,839	859	555	531	481	463
120%	375.00	375.0	182	161	186	208	247	1,368	1,791	258	236	225	204	197

The graphs below show the amount of electricity in kWh/month, and the amount of LPG in kg/month consumed to generate complementary energy to heat the pool water, in relation to the solar collector area.





In practice, it's important to consider that *COMGÁS* doesn't supply NG to all cities in the State of São Paulo. Also there are cases in which the product is available, but the neighborhood does not count with a gas distribution piping system.

We have also worked from the premise that the investment will be 100 percent financed, with a 12-month grace period and interest at the rate of 12 percent per year.

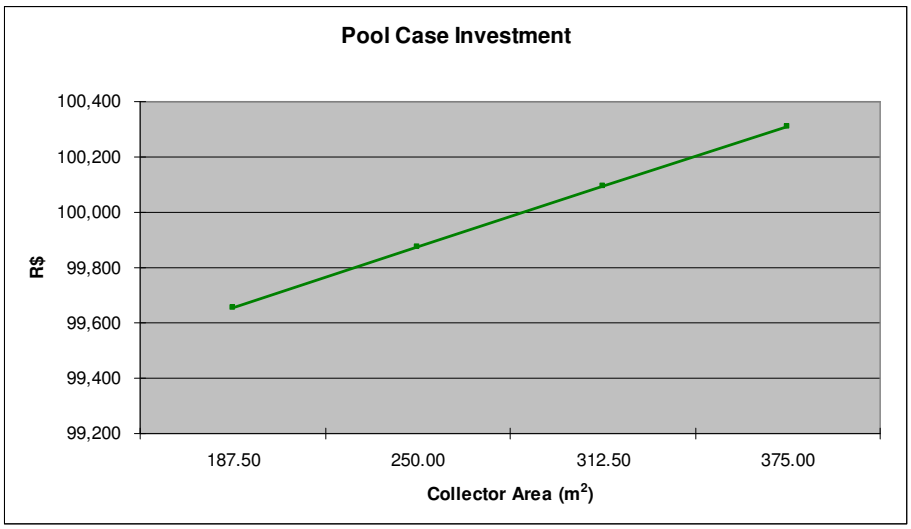
These are the main taxes to be considered, for a services company:

- ISS: 2% of gross revenue
- PIS: 0.65% of gross revenue
- Cofins: 3% of gross revenue
- IRPJ: 4.8% of gross revenue
- CSSL: 2.9% of gross revenue

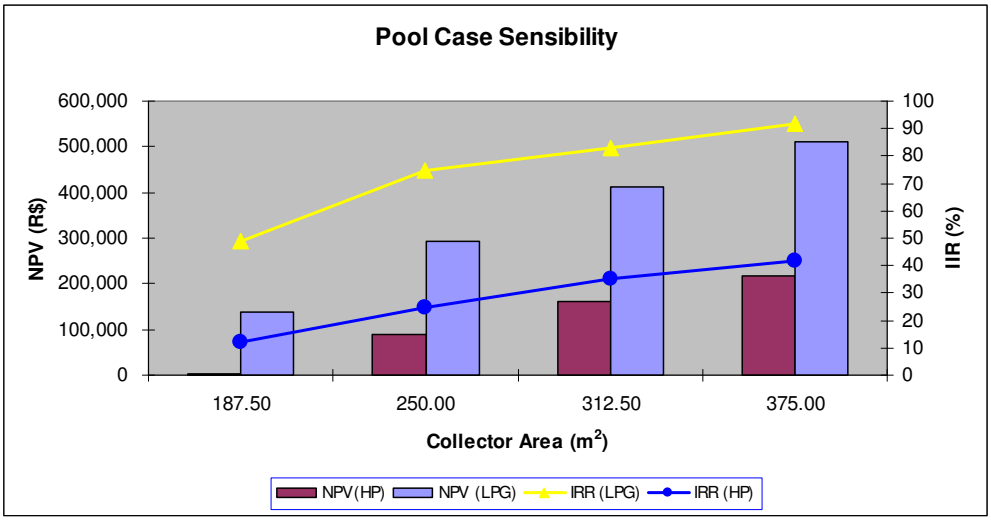
Should the quarterly revenue be greater than R$60,000, a 10 percent income tax will be paid on the result between this quarterly revenue minus R$60,000.

The graph below shows the investment variation in relation to the collector area when complementary energy is supplied by heat pumps and the investment variation when complementary energy is supplied by LPG heaters.

The investment is lower when complementary energy derives from LPG, once the client already owns a gas heater.



The graph below shows a sensibility analysis, comparing the investment and energy consumption when complementary energy is supplied by a Heat Pump (HP) and an LPG heater (LPG)



The graph above shows that the greater the solar collector area, the higher the internal return rate and the net present value of the enterprise, once the complementary energy represents a highly significant expense in the annual cost of the project.

Below, we present the project's cash flow.

- Revenue resulting from the sale of hot water is equal to client's monthly expenditure with water heating minus a 15 percent discount if this heating is performed by a hot pump or LPG heaters.
- Amortization is the value of the investment divided by the term stipulated by the financing bodies.
- Interest is calculated at a yearly rate of 12 percent applied on the outstanding balance.
- Expenses comprise the total disbursement with complementary energy, O&M, Management and Taxes.

The sensibility analysis showed that the best case is the one that requires less complementary energy that is, the collector should measure 375 m^2 and be supported by a heat pump, or a LPG heater, as shown next.

Collector Area 375 m2							Cash Flow Heat Pump Heater														
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amounts in R$																					
Revenue		63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077
Amortizacion		16,719	16,719	16,719	16,719	16,719	16,719	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interests		12,038	10,031	8,025	6,019	4,013	2,006	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		28,756	26,750	24,744	22,738	20,731	18,725	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost of Complementary Energy		6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994
O&M	5%	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154
Management	3%	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892
Taxes																					
ISS	2%	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262
PIS	0.65%	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410
COFINS	3%	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892
IRPJ	5%	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028
CSSL	3%	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Subtotal		20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448
Total		13,872	15,879	17,885	19,891	21,897	23,904	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629
NPV 12% a.a.	**218,099**																				
Depreciation		5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016

								Cash Flow Heat Pump Heater													
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenue		63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077	63,077
Cost of Complementary Energy		6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994	6,994
O&M	5%	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154	3,154
Management	3%	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892
Taxes																					
ISS	2%	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262	1,262
PIS	0.65%	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410	410
COFINS	3%	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892
IRPJ	5%	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028	3,028
CSSL	3%	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Subtotal		20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448	20,448
Total	(100,313)	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629	42,629
IRR	**42%**																				
Depreciation		5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016	5,016

Cash Flow LPG Heater																					
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amounts in R$																					
Revenue		118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657
Amortizacion		14,719	14,719	14,719	14,719	14,719	14,719	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interests		10,598	8,831	7,065	5,299	3,533	1,766	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		25,316	23,550	21,784	20,018	18,251	16,485	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost of Complementary Energy		13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156
O&M	5%	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933
Management	3%	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560
Taxes		771																			
ISS	2%	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373
PIS	0.65%	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771
COFINS	3%	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560
IRPJ	5%	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696
CSSL	3%	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417
Subtotal		39,237	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466
Total		54,104	56,641	58,407	60,174	61,940	63,706	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191
NPV 12% a.a.	**509,982**																				
Depreciation		4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416

Cash Flow LPG Heater																					
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenue		118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657	118,657
Cost of Complementary Energy		13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156	13,156
O&M	5%	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933	5,933
Management	3%	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560
Taxes																					
ISS	2%	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373	2,373
PIS	0.65%	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771	771
COFINS	3%	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560	3,560
IRPJ	5%	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696	5,696
CSSL	3%	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417	3,417
Subtotal		38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466	38,466
Total	(88,313)	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191	80,191
IRR	**91%**																				
Depreciation		4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416	4,416

Hotel Case Study

In the table below we show some basic data and investment values resulting from a market research conducted in the City of São Paulo with companies that sell water heating and solar heating equipment.

Location		
FU	São Paulo	
Latitude		-23.53
Longitude		-46.63
Altitude	792 meters	

Data	
Storage	15 m^3
Apartments	160
Temperature	50° C
Average Occupancy	40%
Collector Angle	30°
Gas Consumption	2,000 m^3/month

Total Investment

Collector Area	Collector	Pump	Hot Pump	Labour	Total	Total w/out Hot Pump
m2	R$	unit	R$	R$	R$	R$
120.00	23,460	1.00	12,000	15,000	50,460	38,460
160.00	31,280	1.00	12,000	15,000	58,280	46,280
200.00	39,100	1.00	12,000	15,000	66,100	54,100
240.00	46,920	1.00	12,000	15,000	73,920	61,920

The table below shows the consumption of electricity in kWh/month and the consumption of NG in m^3/month as well as the monthly cost to heat the pool water without solar heating.

Energy Consumption without solar heating

	unit	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat Pump	kWh/month	3,644	3,243	3,685	3,827	4,265	4,298	4,488	4,323	4,062	4,043	3,755	3,779
NG	m^3/month	1,787	1,590	1,807	1,877	2,092	2,107	2,201	2,115	1,992	1,982	1,842	1,853

Energy Expenses without solar heating

	unit	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat Pump	R$/month	1,414	1,258	1,430	1,485	1,655	1,668	1,741	1,677	1,576	1,569	1,457	1,466
NG	R$/month	3,541	3,150	3,580	3,719	4,145	4,175	4,361	4,190	3,947	3,927	3,650	3,671

The total annual expenditure, in Reais, is R$ 18,395.22 when using a heat pump and R$ 46,055.85 when using a Natural Gas (NG) heater.

In the analysis conducted to determine the company's revenue we established that the client would receive a 15 percent discount, based on his expenditure with water heating, considering that his heating

alternative would be a heat pump, in case of new enterprises or Natural Gas supplied by *Comgas,* as they are the least expensive energy alternatives, among those we have studied.

In practice, it's important to consider that *COMGÁS* doesn't supply NG to all cities in the State of São Paulo. Also there are cases in which the product is available, but the neighborhood does not count with a gas distribution piping system.

However, all the hotels from the Meliá chain, located in the City of São Paulo receive natural gas. Therefore, in this case study, the fuel used to supply complementary energy is natural gas.

The table below shows the consumption of electricity in kWh/month, when complementary energy is supplied by heat pumps and the consumption of NG in m3/month when complementary energy is supplied by gas heaters.

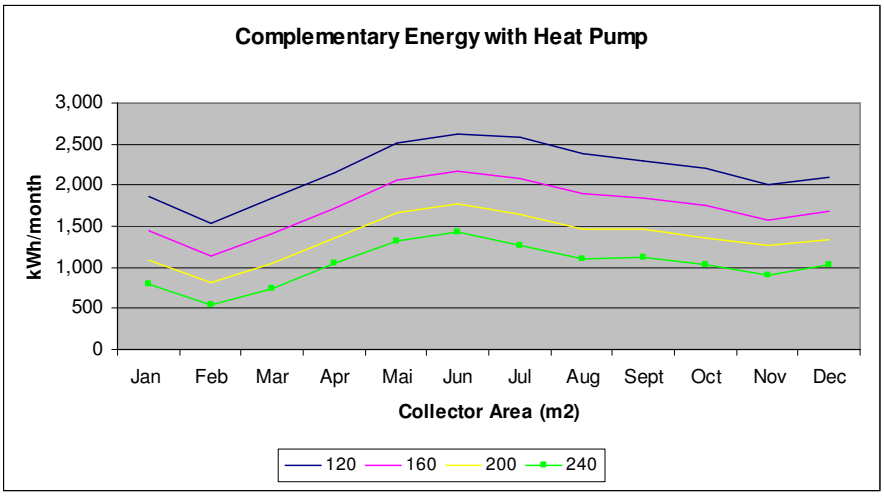
Complementary Energy provided by Heat Pumps (kWh/month)

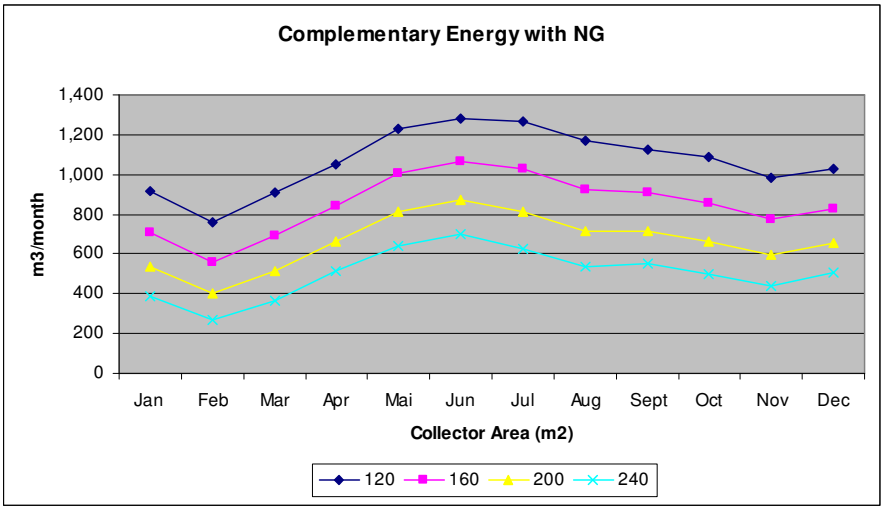
Collector's Number Unities	Collector m^2	Heat Pump units	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sept	Oct	Nov	Dec
60	120	1.00	1,869	1,542	1,849	2,142	2,510	2,614	2,582	2,382	2,299	2,211	2,008	2,103
80	160	1.00	1,446	1,146	1,412	1,722	2,058	2,177	2,087	1,890	1,851	1,753	1,577	1,688
100	200	1.00	1,088	818	1,046	1,356	1,659	1,780	1,651	1,464	1,459	1,359	1,264	1,335
120	240	1.00	794	549	741	1,046	1,314	1,433	1,270	1,094	1,122	1,023	904	1,036

Complementary Energy provided by NG (m^3/month)

Collector's Number Unities	Collector m^2	NG	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sept	Oct	Nov	Dec
60	120		916	756	907	1050	1231	1282	1266	1168	1128	1084	985	1031
80	160		709	561	692	844	1009	1065	1024	927	908	860	774	829
100	200		534	401	512	666	814	873	810	717	716	666	594	655
120	240		389	270	364	513	644	703	623	536	550	501	442	508

The graphs below show the amount of electricity in kWh/month, and the amount of NG in m3/month consumed to generate complementary energy to heat the pool water, in relation to the solar collector area.





Other premises we have adopted are that the investment will 100 percent financed, with a 12-month grace period and interest at the rate of 12% per year.

These are the main taxes to be considered, for a services company:

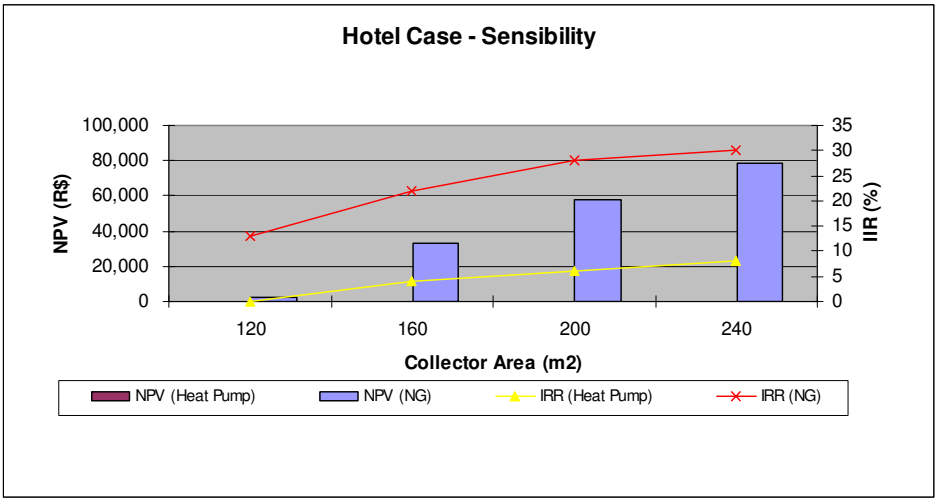
- ISS: 2% of gross revenue
- PIS: 0.65% of gross revenue
- Cofins: 3% of gross revenue
- IRPJ: 4.8% of gross revenue
- CSSL: 2.9% of gross revenue

Should the quarterly revenue be greater than R$60,000.00, a 10 percent income tax will be paid on the result between the quarterly revenue, minus R$60,000.00.

The graph below shows the investment variation in relation to the collector area, when complementary energy is provided by heat pumps and by NG heaters.

The investment is lower when NG is used because the client owns the heater that supplies the complementary energy.

The graph below shows a sensibility analysis, in relation to the investment and energy consumption when complementary energy is provided by a Heat Pump (HP) and a LPG heater (LPG).



In the graph above we see that the greater the solar collector area, the higher the internal return rate and the net present value of the enterprise, once the thermal complement represents a highly significant expense for the annual cost of the project.

Below, we present the project's cash flow.

- Revenue resulting from the sale of hot water is equal to client's monthly expenditure with water heating, minus a 15 percent discount if this heating is performed by a hot pump or LPG heaters.
- Amortization is the value of the investment divided by the term stipulated by the financing bodies.
- Interest is calculated at a yearly rate of 12 percent applied on the outstanding balance.
- Expenses comprise the total disbursement with complementary energy, O&M, Management and Taxes.

The sensibility analysis showed that the best case is the one that requires less complementary energy that is, the collector should measure 240 m^2 and be supported by a heat pump, or an NG heater, as shown below.

Collector Area 240 m^2																					
		Cash Flow Heat Pump Heater																			
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Amount in R$																					
Revenue		15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636
Amortization		12,320	12,320	12,320	12,320	12,320	12,320	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interests		8,870	7,392	5,914	4,435	2,957	1,478	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		21,190	19,712	18,234	16,755	15,277	13,798	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complementary Energy Costs		4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782
O&M	5%	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782
Management	3%	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469
Taxes																					
ISS	2%	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313
PIS	1%	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
COFINS	3%	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469
IRPJ	5%	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751
CSSL	3%	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
Subtotal		8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118
Total		-13,672	-12,194	-10,715	-9,237	-7,758	-6,280	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518
NPV 12% in a year	-17,762																				
Depreciation		3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696

		Cash Flow Heat Pump Heater																			
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Revenue		15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636	15,636
Complementary Energy Costs		4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782	4,782
O&M	5%	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782	782
Management	3%	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469
Taxes																					
ISS	2%	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313
PIS	1%	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
COFINS	3%	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469	469
IRPJ	5%	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751	751
CSSL	3%	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
Subtotal		8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118	8,118
Total	-73920	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518	7,518
IRR	8%																				
Depreciation		3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696	3696

Cash Flow GN Heater																					
Ano		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Amount in R$																					
Revenue		39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147	39,147
Amortization		10,320	10,320	10,320	10,320	10,320	10,320	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interests		7,430	6,192	4,954	3,715	2,477	1,238	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		17,750	16,512	15,274	14,035	12,797	11,558	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complementary Energy Costs		11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973
O&M	5%	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957
Management	3%	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174
Taxes																					
ISS	2%	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783
PIS	1%	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254
COFINS	3%	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174
IRPJ	5%	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879
CSSL	3%	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127
Subtotal		20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323
Total		1,074	2,312	3,551	4,789	6,027	7,266	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824
NPV 12% in a year	78,686																				
Depreciation		3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096

Cash Flow GN Heater																					
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Revenue		39147.5	39147.5	39147.5	39147.5	39147.5	39147.5	39147.47	39147.47	39147.5	39147.47	39147.47	39147.5	39147.47051	39147.47	39147.5	39147.5	39147.5	39147.5	39147.5	39147.5
Complementary Energy Costs		11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973	11,973
O&M	5%	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957	1,957
Management	3%	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174
Taxes																					
ISS	2%	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783	783
PIS	1%	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254	254
COFINS	3%	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174	1,174
IRPJ	5%	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879	1,879
CSSL	3%	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127
Subtotal		20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323
Total	(61,920)	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824	18,824
IRR	30%																				
Depreciation		3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096	3096

Case Study Apartment Building

In the table below we show some basic data and investment values resulting from a market research conducted in the City of São Paulo with companies that sell heating equipment for pools, including solar collectors.

Location

FU	São Paulo
Latitude	-23.53
Longitude	-46.63
Altitude	792 meters

Data

Storage	20 m^3
Apartments	84
Temperature	50° C
Average Occupancy	3 person per unit
Collector Angle	30°

Total Investment

Collector Area	Collector	Pump	Hot Pump	Labour	Total	Total w/out Hot Pump
m2	R$	Quant.	R$	R$	R$	R$
160.00	31,280	2.00	24,000	15,000	70,280	46,280
200.00	39,100	2.00	24,000	15,000	78,100	54,100
240.00	46,920	2.00	24,000	15,000	85,920	61,920
280.00	54,740	2.00	24,000	15,000	93,740	69,740

The table below shows the consumption of electricity in kWh/month and of LPG in kg/month as well as the monthly cost to heat the water consumed by the building.

Energy Consumption without solar heating

	unity	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat Pump	kWh/month	4,859	4,324	4,913	5,103	5,687	5,730	5,984	5,750	5,417	5,390	5,007	5,039
LPG	kg/month	1,848	1,645	1,869	1,941	2,163	2,180	2,276	2,187	2,061	2,050	1,905	1,917

Energy Expenses without solar heating

	unity	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heat Pump	R$/month	1,885	1,678	1,906	1,980	2,206	2,223	2,322	2,231	2,102	2,091	1,943	1,955
LPG	R$/month	4,621	4,112	4,672	4,853	5,408	5,449	5,691	5,468	5,152	5,126	4,762	4,792

The total annual expenditure, in Reais, is R$ 24.522,00 when using a heat pump and R$ 60.107,00 when using an LPG heater.

In the analysis conducted to determine the company's revenue, we established that the client would receive a 15 percent discount, based on his expenditure with water heating, considering that his heating

alternative would be a heat pump, in case of new enterprises or LPG gas, supplied by *Ultragaz,* as they are the least expensive energy alternatives, among those we have studied.

In practice, it's important to consider that *COMGÁS* doesn't supply NG to all cities in the State of São Paulo. Also there are cases in which the product is available, but the neighborhood does not count with a gas distribution piping system.

The table below shows the consumption of electricity in kWh/month, when complementary energy is supplied by heat pumps and the consumption of LPG in kg/month when complementary energy is supplied by gas heaters.

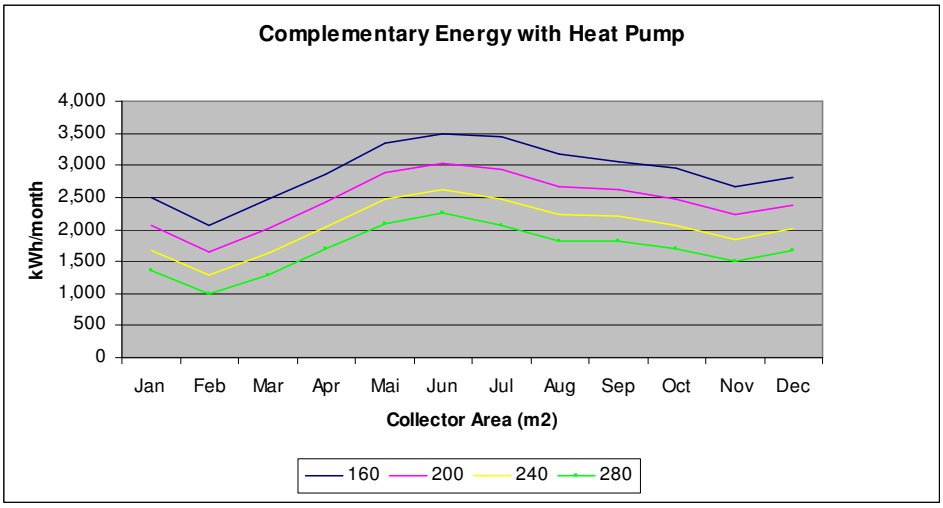
Complementary Energy provided by Heat Pumps (kWh/month)

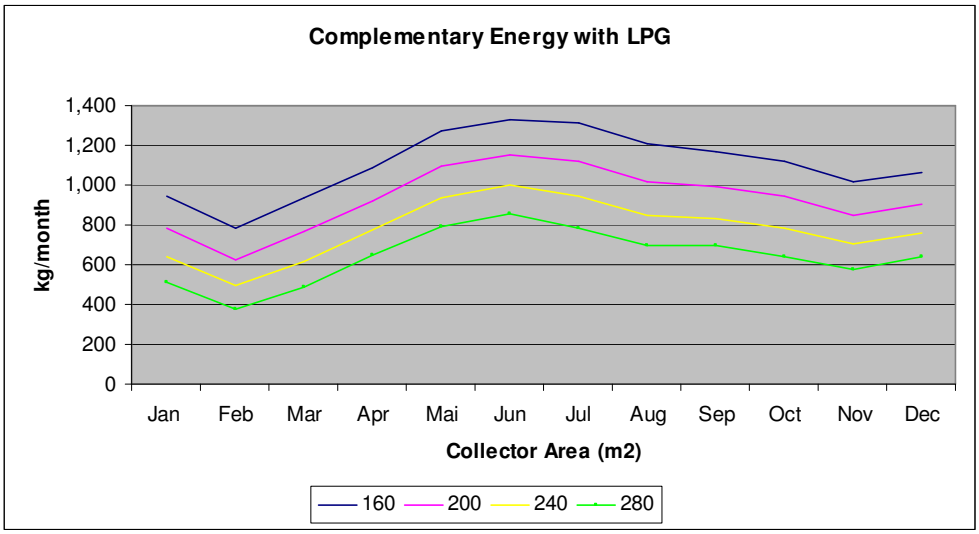
Collector's Numeber quant.	Collector m^2	Heat Pump quant	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80	160	2	2492	2056	2466	2855	3346	3486	3444	3176	3065	2947	2676	2802
100	200	2	2058	1651	2019	2426	2886	3036	2939	2671	2610	2482	2240	2382
120	240	2	1677	1296	1627	2043	2468	2626	2482	2227	2198	2064	1851	2008
140	280	2	1346	994	1285	1701	2092	2253	2069	1822	1827	1693	1506	1675

Complementary Energy provided by LPG (kg/month)

Collector's Numeber quant.	Collector m^2	LPG	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80	160		948	782	938	1086	1273	1326	1310	1208	1166	1121	1018	1066
100	200		783	628	768	923	1098	1155	1118	1016	993	944	852	906
120	240		638	493	619	777	939	999	944	847	836	785	704	764
140	280		512	378	489	647	796	857	787	693	695	644	573	637

The graphs below show the amount of electricity in kWh/month, and the amount of LPG in kg/month consumed to generate complementary energy to heat the pool water, in relation to the solar collector area.





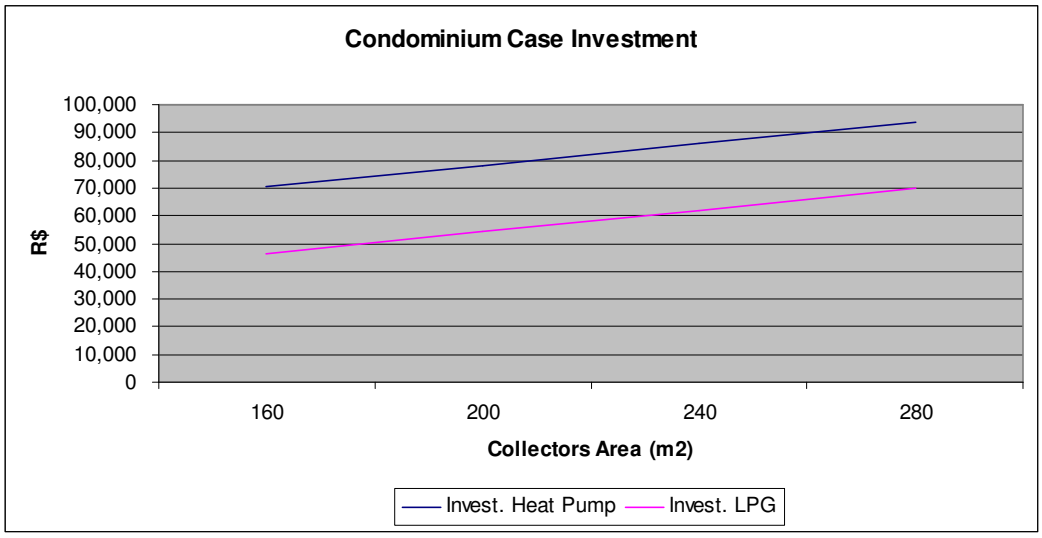
We have also worked from the premise that the investment will be 100 percent financed, with a 12-month grace period and interest at the rate of 12 percent per year.

These are the main taxes to be considered, for a services company:

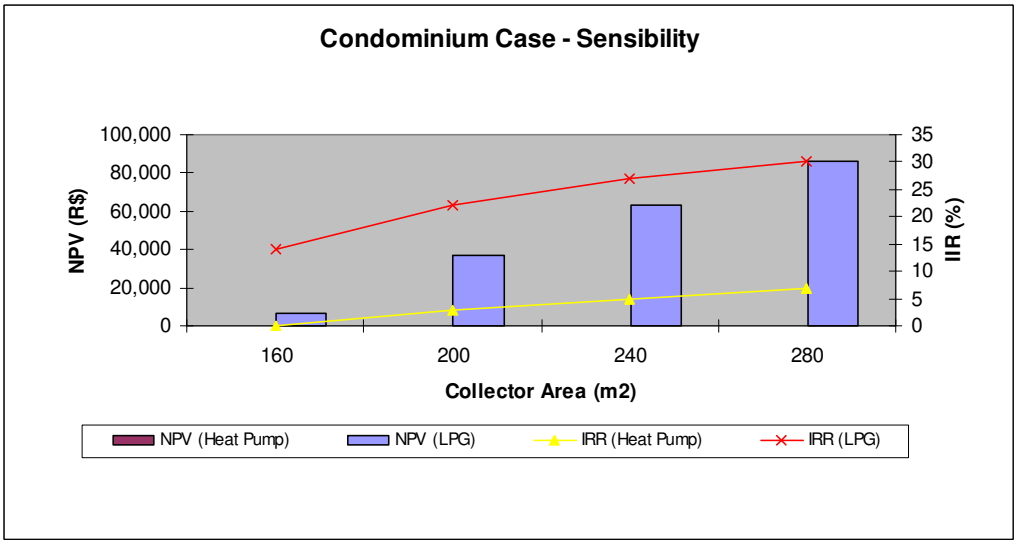
- ISS: 2% of gross revenue
- PIS: 0.65% of gross revenue
- Cofins: 3% of gross revenue
- IRPJ: 4.8% of gross revenue
- CSSL: 2.9% of gross revenue

Should the quarterly revenue be greater than R$60,000.00, a 10 percent income tax will be paid on the result between this quarterly revenue minus R$60,000.00.

The graph below shows the investment variation in relation to the collector area when complementary energy is supplied by heat pumps and the investment variation when complementary energy is supplied by LPG heaters. The investment is lower when complementary energy comes from LPG, once the client already owns a gas heater.



The graph below shows a sensibility analysis, comparing the investment and energy consumption when complementary energy is supplied by a Heat Pump (HP) and by an LPG heater (LPG).



The graph above shows that the greater the solar collector area, the higher the internal return rate and the net present value of the enterprise, once the complementary energy represents a highly significant expense for the annual cost of the project.

Below, we present the project's cash flow.

- Revenue resulting from the sale of hot water is equal to client's monthly expenditure with water heating minus a 15 percent discount if this heating is performed by a hot pump or LPG heaters.
- Amortization is the value of the investment divided by the term stipulated by the financing bodies.
- Interest is calculated at a yearly rate of 12 percent applied on the outstanding balance.
- Expenses comprise the total disbursement with complementary energy, O&M, Management and Taxes.

The sensibility analysis showed that the best case is the one that requires less complementary energy that is, the collector should measure 280 m^2 and be supported by two heat pumps, as shown next.

Collector Area 280 m^2		Cash Flow Heat Pump Heater																			
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amount in R$																					
Revenue		20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844
Amortization		15,623	15,623	15,623	15,623	15,623	15,623	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interests		11,249	9,374	7,499	5,624	3,750	1,875	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		26,872	24,997	23,123	21,248	19,373	17,498	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complementary Energy Cost		7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862
O&M	5%	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042
Management	3%	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
Taxes																					
ISS	2%	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417
PIS	0.65%	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
COFINS	3%	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
IRPJ	5%	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
CSSL	3%	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Subtotal		12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308
Total		-18,336	-16,461	-14,586	-12,712	-10,837	-8,962	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536
NPV 12% in a year.	**(29,980.01)**																				
Depreciation		4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687

		Cash Flow Heat Pump Heater																			
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenue		20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844	20,844
Complementary Energy Cost		7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862	7,862
O&M	5%	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042	1,042
Management	3%	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
Taxes																					
ISS	2%	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417
PIS	0.65%	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
COFINS	3%	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
IRPJ	5%	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
CSSL	3%	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
Subtotal		12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308	12,308
Total	(93,740.00)	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536	8,536
IRR	**7%**																				
Depreciation		4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687	4,687

Cash Flow LPG Heater																					
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amount in R$																					
Revenue		51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091
Amortization		11,623	11,623	11,623	11,623	11,623	11,623	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interests		8,369	6,974	5,579	4,184	2,790	1,395	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		19,992	18,597	17,203	15,808	14,413	13,018	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Complementary Energy Cost		19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270
O&M	5%	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555
Management	3%	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533
Taxes		332																			
ISS	2%	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022
PIS	0.65%	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332
COFINS	3%	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533
IRPJ	5%	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452
CSSL	3%	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471
Subtotal		30,500	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168
Total		599	2,326	3,721	5,116	6,510	7,905	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923
NPV 12% in a year.	**86,250**																				
Depreciation		3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487

Cash Flow LPG Heater																					
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Revenue		51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091	51,091
Complementary Energy Cost		19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270	19,270
O&M	5%	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555	2,555
Management	3%	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533
Taxes																					
ISS	2%	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022
PIS	0.65%	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332	332
COFINS	3%	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533	1,533
IRPJ	5%	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452	2,452
CSSL	3%	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471	1,471
Subtotal		30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168	30,168
Total	(69,740)	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923	20,923
IRR	**30%**																				
Depreciation		3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487	3,487

CONCLUSIONS

The conclusions for each of the cases studied are shown below.

Case Study — Pool

In this case study, we analyzed a semi-Olympic pool, measuring 12.5 by 25 meters and an area of 312.5 square meters in relation to two typical heating processes — a heat pump and a gas heater.

The study used, as an alternative for water heating, solar collectors with areas that varied from 60, 80, 100 and 120 percent of the pool's area, that is, from 187.5 to 375 square meters of collector plates. Complementary energy will be provided by hot pumps — varying from 4 to 1, in direct proportion to the area covered by the collector plates — or by the heater already in use at the swimming schools or clubs.

When solar collector and heat pumps are used, the project is economically and financially feasible if the collector area is equal or greater than 100 percent of the pool area. It requires and investment of R$100,100.00, Internal Return Rate – IRR of 35% and Present Net Value – PNV of R$160,000.00. When the collector area is equal to 120 percent of the pool area and the investment is equal to R$ 100,300.00, we'll have a PNV of R$ 218,100.00 and an IRR of 42 percent.

When solar collectors and a heat pump are used, the project is economically and financially feasible if the collector area is equal or greater than 60 percent of the pool area. It requires an investment of R$51,656.00, an Internal Return Rate – IRR of 49 percent and a Present Net Value – PNV of R$138,300.00. When the collector area is equal to 120 percent of the pool area and the investment is equal to R$ 88,312.00, we'll have a PNV of R$ 510,000.00 and an IRR of 92 percent.

Case Study— Hotel

This case study was based on a 160-room hotel with an average occupancy rate of 50 percent, average consumption of natural gas of 2,000 m3 per month, and a storage tank with capacity for 15,000 liters of hot water.

The study used, as an alternative for water heating, solar collectors with areas that varied from 120, 160, 200 and 240 square meters of collector plates Complementary energy will be provided by a hot pump and a heater, already in operation at the hotel.

When a solar collector and a heat pump are used, the project is not economically and financially feasible if it involves only one hotel. We should study carefully how an increase in the number of hotels can make the services company viable. In cases when a solar collector and a gas heater are used, the economic and financial feasibility of the project is as shown next page.

NGHeater			
Collector quant	Invest. NG R$	NPV (GN) R$	IRR(NG) %
60	38,460	2,081	13
80	46,280	32,776	22
100	54,100	58,165	28
120	61,920	78,686	30

The enterprise can only be feasible when the collector area is greater than 200m^2.

Case Study – Apartment Building

This case study was based on an 84-unit apartment building, with an average occupancy of 3 people per household, average consumption of 2,000 m3 of natural gas, and a storage tank with capacity for 20,000 liters of hot water.

The study used, as an alternative for water heating, solar collectors with areas that varied from 160, 200, 240 and 280 square meters of collector plates. Complementary energy will be provided by a hot pump and a heater, already in operation at the building.

When a solar collector and a heat pump are used, the project is not economically and financially viable if there is only one apartment building. We should study carefully how an increase in the number of buildings can make the services company viable.

In cases when a solar collector and a gas heater are used, the economic and financial feasibility of the project is as shown.

NGHeater			
Collector quant	Invest. NG R$	NPV (GN) R$	IRR(NG) %
80	46,280	6,370	14
100	54,100	36,980	22
120	61,920	63,500	27
140	69,740	86,250	30

The enterprise can only be feasible when the collector area is greater than 240m^2.

Size of the Company

A company exclusively dedicated to the development of the business described herein would need a minimum scale in order to be worth all the investments it requires.

Considering the minimum company structure below, we can estimate that R$800,000.00 would have to invested within 12 months, in order to reach the minimum volume of 30 to 40 contracts.

Investment Item		R$
Development		50.000
Managers	2	6.000
Salespeople/Engineers	5	2.000
Payroll Charges		7.200
Total		35.200
Structure		5.000
Expenses		10.000
Taxes	20%	10.040
Total		60.240

Under these conditions, the company would present, from the 2nd year of operations on, the following figures.

Case Studies

	Number	Area m2	Investment R$	Revenue R$	Financing R$	Results R$	IRR
Apartment Building	10	2,800	697,400	510,912	627,660	209,234	
Hotel	10	2,400	619,200	406,079	557,280	195,264	
Pool	20	7,500	2,006,250	1,327,927	1,805,625	904,806	
Total	40	12,700	3,322,850	2,244,917	2,990,565	1,309,304	35%

To arrive at an IRR rate of 35 percent, we considered an investment of R$800,000.00. Also, equity capital would make up for 10 percent of the total investment. The financing adopted was the one that is currently under study by BNDES, with a contractual term of 10 years. Clients will receive a 15 percent discount in price, in relation to the energy source that's being replaced.

In the Portuguese version of this work there is a model contract for cases with the above characteristics, provided by ABESCO.

RECOMMENDATIONS

This work has confirmed the feasibility of using solar energy for solar heating in the applications we studied, and showed return rates higher than 30 percent, not computing investments in business development.

The size of a company depends on several variables, especially whether it will be a new and completely independent initiative, in the sense that its main purpose will be the business that is now proposed; or if it will be a new business area of an existing company. Our recommendation is that DaSol ABRAVA, or a group of manufacturers, interested in the proposal, hire a services company in order to conduct the business development plan explained in this report;

Exhibit III of this document brings a market potential assessment, indicating the number of clients that could and should be approached in order to establish, more accurately, how they heat their water and what their consumption levels are.

The number of large hotels and swimming clubs mentioned therein is very significant and may be used as a preliminary data for a market research, as it lists the addresses and telephone numbers of each client.

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