

Energy Service Company (ESCO) and Energy Efficiency in Buildings: Retrospective and Survey in Brazilian Context

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ABSTRACT: Energy Service Companies (ESCOs) are seen as expressive mechanisms for energy efficiency, and comprehend ESCO market developments, its limitations and how the market develops in other countries and Brazil is helpful for policy-makers. This article aims to draw an overview of the ESCOs in the world and in Brazil and make a quantitative characterization of local ESCO companies, especially those that work with energy retrofit of non-residential buildings. The method includes literature review and an extensive survey with the ESCOs. The results show the lack of documentation, articles and studies on the topic in Brazil, the characterization of the active ESCOs in the country, showing the main barriers, like little government support. The article is important to generate the basis for strengthen this market that can contribute a lot to reduce energy consumption.

KEYWORDS: Energy Efficiency, ESCO, Non residencial buildings

1. INTRODUCTION

Energy consumption in buildings represented in 2018 approximately 50% of total energy consumption in Brazil, with the residential sector representing 25.5%; commercial sector 17.1% and public sector 8.2% [1]. This show that the reduction of energy consumption is essential through the adoption of energy conservation measures in the construction sector [2]. In this sense, promoting the energy efficiency of buildings is an increasingly relevant strategy for mitigating global climate change, as the building sector currently accounts for approximately 50% of the total electricity consumed in Brazil.

Energy efficiency is generally the least cost-effective means of achieving new energy demand [3]. An effective business model can encourage energy retrofit of buildings based on market mechanisms and one of the most well-known business models of energy performance contracts is an energy service company (ESCO) [4]. An ESCO is a company that specializes in energy saving or an energy-saving service [5] and the EU Directive on the Energy Performance of buildings has been a driver for governments to encourage development of energy services and ESCO-contracts to retrofit existing public buildings is seen as an essential input for reaching international as well as national goals on energy savings.

However, there are not many studies on Brazilian ESCOs and how they have been operating in the market. There is a lack of information about this, which hinders the implementation of government policies that stimulate its action. The most recent information on the subject is from a 2005 paper that pointed out

that there were 60 ESCOs working in the country [6 - 7]. Currently, according to the Brazilian Association of Energy Conservation Companies (ABESCO), the country has an unknown total of companies that operate in the area due to the informality in the definition of ESCO by CNAE (Code of Economic Activity) of IBGE (Brazilian Institute Geography and Statistics).

This article is part of a master's research conducted in the Graduate Program of the University of Brasilia's Faculty of Architecture and Urbanism (PPG FAU UnB) that aims to draw an overview of the ESCOs in the world and in Brazil in addition to survey and characterize the ESCOs. This paper presents a survey that aims to make a quantitative characterization of ESCO companies that works with energy retrofit of buildings in Brazil.

2. METHODOLOGY

The method of this stage of the work is based on the analysis of Brazilian and international institutional documents, articles and dissertations related to ESCOs and study of sites of these companies and their associations. With the analysis of the cited documents, an international historical overview of the ESCOs is presented, exposing the evolution of the electric sector. The same will be done in the national context, from the nationalization period to the liberalization of the energy market. Briefly the history of the Brazilian Electricity Sector and the participation of Energy Service Companies (ESCOs) in this market. Highlighting the EE policies applied in Brazil, as well as the performance of ESCOs in Brazil.

In addition, after analysing and selecting ESCO companies that work with energy retrofit of buildings, a questionnaire was prepared to understand the profile of these companies, their customers and projects.

2.1 Steps for conducting the systematic review - databases

The research was based on an on-line survey and the databases used were: CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) thesis and dissertations catalog, Journal Portal of CAPES / MEC, Brazilian Institute of Information in Science and Technology (IBICT), Institutional Repositories of Brazilian Universities and Web Of Science. The search in the aforementioned databases was carried out with the keywords "energy efficiency" and "ESCO"; "Energy retrofit" and "ESCO"; "Energy Performance Contract" and "ESCO". A search was also carried out in English with the keywords "energy efficiency" and "ESCO"; "Energy retrofit" and "ESCO"; "Building environmental performance" and "ESCO". The search in all banks was limited over a period of 09 years, from 2010 to 2019.

About international works, 40 articles on the topic were found and 16 were selected and 4 government reports and 2 selected for the research. Following quality criteria [8]. Few national studies were found in the survey: 1 article, 4 dissertations, 2 monographs and 2 government reports. The article, 2 dissertations, 1 monograph and the 2 reports were selected.

2.2 Documentary survey

After contacting ABESCO's executive director, kno. From then on, work began identifying these companies and their main activities.

First, the work of organizing the ESCOs by region and identifying their main activities and quantifying them by state and region was done. As the study in question focuses on ESCOs with energy retrofit activities for non-residential buildings, companies that had retrofit in their scope of activities were highlighted for study.

From then on, these companies were organized by region and city. In addition, their website was accessed and their e-mails and contact phones updated. Companies that had no contact or website were dropped from the survey.

With the spreadsheet prepared and organized with information obtained from these ESCOs, a questionnaire was developed to be applied in each company in order to answer the points raised by the objectives of the research.

2.3 Method for developing and applying the questionnaire

In order to understand how ESCOs that operate with energy retrofit of buildings it is essential to first

investigate their profile. And so, to understand their size, types of professionals in the staff, in which regions they operate, how many energy retrofit projects for buildings are contracted per year. Consequently, the first topic defined was the "ESCO profile".

Then, in order to understand how contracting for projects takes place, it is necessary to know who the clients of these companies are. Whether they are mostly public or private institutions, which states they are from, and which contracts are the most recurring among these clients. Therefore, the second topic defined was "customer profile".

And finally, in order to survey the most common energy retrofit solutions, it is necessary to outline the profile of their projects. What are the main interventions adopted to achieve energy efficiency, what are the calculation parameters for a cost-benefit ratio and what are the main methods used and whether or not any computational simulation methods are used. Thus, the topics and subtopics were defined and the questionnaire questions were prepared on the online form "Google Forms".

With the questionnaire developed and the companies selected according to the spreadsheet elaborated, a work of contact with each of the companies and their project managers began. The contact was made initially by e-mail and then by telephone calls to establish a direct relationship with the respondents. Some questionnaires were answered via "WhatsApp" and others by e-mail and this varied according to the availability of each respondent.

3. RESULTS AND DISCUSSIONS

The results of the documentary research and the questionnaires applied to the selected ESCOs are presented below.

3.1 Results on documentary research

In September 2012, the European Commission (EC) approved a new proposal for an Energy Efficiency Directive (DEE), which repeals the old directive and points out new recommendations to overcome barriers to energy efficiency so that the potential for energy savings reaches the target 20% savings by 2030. The guidelines underline the importance of well-developed markets for energy services to reach the target. The DEE also states that small and medium-sized companies represent enormous potential for savings in the European Union and its member states must establish favorable structures to reinforce the ESCO market [9].

However, documentary research of international articles points precisely to the lack of government support in several countries. These papers, mainly from the United States, Italy, Sweden, China and Taiwan, address some common issues, including barriers to the ESCO market. The most cited financial

barrier is the lack of investor confidence in measures of economic viability, in addition to customers who are unaware of the “Energy Savings Performance Contracts” (ESPC) as a tool to share the risks of implementing energy retrofit projects for buildings.

“Energy Savings Performance Contracts” (ESPC) are often used to characterize models for energy services. Most common models are “Shared savings” and “Guaranteed savings” that concerns different distributions of investments and savings between the client and the ESCO-provider. In short, projects using the shared savings model (mainly used in developing countries where clients have limited access to capital) is based on full financing from the ESCO, who in return get a share of the savings—in the other hand, projects using the guaranteed savings model (in a European context, is predominant) are typically financed by the client [10].

Energy efficiency services are now a considerable market sector in the international context. In 2015, ESCOs, whose main business model is to provide energy efficiency solutions, had a total turnover of US \$ 24 billion. China is the largest market, with more than 600,000 people employed in ESCOs and revenue growth of 7% in 2015. ESCO revenue in the United States was \$ 6.4 billion in 2015, more than that doubled in the last ten years [11].

Countries such as Germany, France, Austria, the Czech Republic and the United Kingdom are recognized as the most active markets in the EU while Cyprus, Estonia and Malta remain without ESCO activity. The size of the EU market was estimated at € 2.4 billion in ESCO revenues in 2015. The ESCO market is driven both by market forces and specific policy measures, regulations and financial solutions [12].

In the United States, for example, these public incentive policies end up boosting the public/institutional market more in comparison with private sector and healthcare clients [13]. In China , however, despite very favorable political and market conditions shows up some issues which trust relationships between ESCOs and energy customers. Chinese ESCOs (which are predominantly small and private) perform poorly in terms of trust-building because they are disassociated from local policies and social networks [14].

If in developed countries these barriers can hinder the consolidation of the ESCO market, in developing countries they can be a potential impediment for this market to develop [15]. In particular, ESPC and ESCOs had a very limited role in the implementation of energy efficiency projects in the public sector. In Brazil, projects using "shared economy" ESPC are confirmed as the most used. However, it is more common in private building retrofits and not in public buildings and this is confirmed as a current contractual barrier [16].

Unlike the international scenario, as can be seen in the timeline of Figure 1, energy efficiency policies in Brazil have occurred very gradually and there are still many barriers (legal, financing) to their implementation happening more incisively [17].

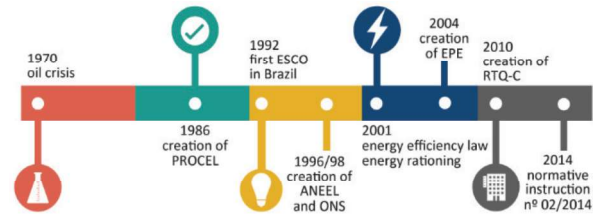


Figure 1 – Brazil's energy efficiency policy timeline (source: author).

Although the total number of ESCO companies operating in the country is still a somewhat uncertain number, it is important to investigate the number of companies associated with ABESCO precisely because they are companies registered by the association. The lack of an official definition of ESCO such as certification and standards are also seen as a legal barrier to the ESCO market [12].

Currently 140 ESCOs are registered with ABESCO with the most diverse areas of expertise. The number of ESCOs has grown since 2005 by 120% and is trying to grow even more, but of those 140 companies, 25 are ESCOs Equipment Suppliers and 95 are ESCOs companies. Only 51 of those work specifically with building energy retrofit [18].

In addition, the survey points out the main states with the most ESCOs in Brazil. From a total of 96 ESCOs, São Paulo (SP) has the largest number with 45 companies, followed by Minas Gerais (MG) with 10 companies and Rio Grande do Sul (RS) with 8. In addition to these 3 states, Rio de Janeiro (RJ), Santa Catarina (SC), Paraná (PR), Federal District (DF) and Bahia (BA) have a less significant number of ESCOs. As shown in the table in figure 2, the main areas of expertise are automation, cogeneration, energy retrofit and energy management.

STATES	NUMBERS	REGION	NUMBERS	MAIN ACTIVITIES BY REGION	NUMBERS BY REGION
Rio Grande do Sul	8	SUL	17	Automation	6
Santa Catarina	6			Electrical Management	5
Paraná	3			Energy Retrofit	10
São Paulo	45	SUDESTE	63	Automation	20
Rio de Janeiro	8			Electrical Management	22
Minas Gerais	10			Energy Retrofit	31
Distrito Federal	3	CENTRO-OESTE	6	Automation	3
Mato Grosso do Sul	2			Electrical Management	4
Mato Grosso	1			Energy Retrofit	5
Pará	1	NORTE	1	Automation	1
Bahia	3			Electrical Management	1
Pernambuco	4	NORDESTE	9	Automation	3
Rio Grande do Norte	1			Electrical Management	4
Ceará	1			Energy Retrofit	4
		TOTAL	96		

Figure 2 – Summary table of ESCOs associated with ABESCO

3.2 Questionnaire results

The questionnaires were applied to a total of 24 (twenty-four) valid companies (companies without contact - email, website and phone - were discarded

as well as those that changed the area of expertise) throughout Brazil and 12 (twelve) responses.

Of these 12 companies, 07 are from the Southeast region, 03 from the South region, and 02 from the Midwest region. No respondents from the North and Northeast regions.

Of the responding ESCO companies, in the Southeast region, 05 companies are from the state of São Paulo (SP), 01 from the state of Rio de Janeiro (RJ) and 01 from Minas Gerais (MG). In the South region, 01 company is from Rio Grande do Sul (RS) and 02 from Santa Catarina (SC). And from the Midwest region, 01 respondent is from Mato Grosso (MT) and the other, from Mato Grosso do Sul (MS).

According to corporate revenue, 58.3% are medium-sized companies, 25% are small companies and 16.7% are large companies.

Company Annual Gross Revenue
(CNAE definition for small, medium and large companies)

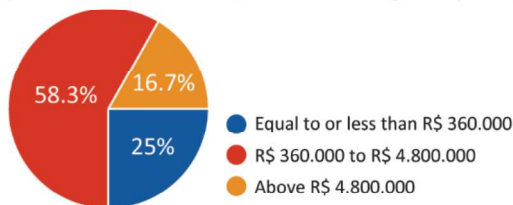


Figure 3 – Chart of the size of the companies interviewed (source: Google forms).

The main method of prospecting for new customers is making direct contact with potential customers, representing 92.3% of responding companies, 46.2% send emails to these potential customers, 15.4% make advertisements on social media. Other strategies such as advertising in specialized magazines, participation in congresses, forums and seminars, advertisements on google and the creation of profiles on social networks represent 7.7%.

About the staff of professionals working in the company: 100% is composed by engineers, 76.9% by administrators, 46.6% by other professionals with higher education and 30.8% by architects. The position of project manager is composed 100% by engineers and their level of education is 30.8% with only graduation, 46.2% with postgraduate, 15.4% with specialization and 7.7% with academic master's degree.

The number of energy retrofit projects in non-residential buildings that are carried out per year, the numbers showed to be quite variable, having a direct relationship with the size of the company. medium sized companies execute an average of 15 projects per year.

What level of training does the project manager have?

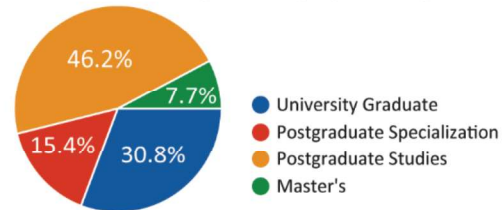


Figure 4 – Graph of the level of training of project managers (source: Google forms).

Regarding the location of client projects, 69.2% are from the state of São Paulo (SP), 23.1% are from Rio de Janeiro (RJ), Minas Gerais (MG), Mato Grosso (MT) and Santa Catarina (SC), 15.4% are from Rio Grande do Sul (RS) and 7.7% are from Alagoas (AL), Amazonas (AM), Goiás (GO), Mato Grosso do Sul (MS), Piauí (PI) and Tocantins (TO).

Of the most common typologies in retrofit projects, the hospital typology is the most common: 46.2% are hospitals, 23.1% are shopping centers and office buildings, 15.4% are supermarkets and 1% have hotel typologies, university campus, schools.

With regard to the main types of customers, 69.2% are national private companies, 53.8% are state / municipal public sector, 46.2% are local private companies, 30.8% are multinational private companies, 15.4% are private sector federal public. Non-profit entities and philanthropic institutions represent 1% of customers.

What are the main types of customers?

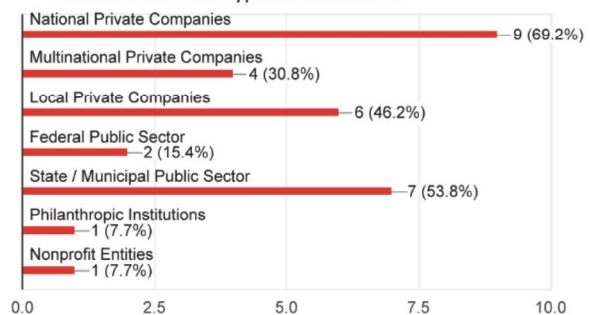


Figure 5 – Graph of the main types of customers (source: Google forms).

When asked about the main barriers for projects to be built, 46.2% say they have contractual and financing difficulties, 38.5% difficulty in attracting customers.

The most recurrent types of contract among the respondent companies, the Energy Saving Performance Contract (ESPC) is the most common, representing 53.8%. Other contracts, such as the Integrated Energy Contract (IEC), the Service Provision Contract, the Lost Fund (within the ANEEL Energy Efficiency Program), BOT model and direct contract for execution, represent 7.7% of the companies. Responding companies justify that the energy performance contract assures customers of risks and

it is easier to convince them to pay for the project with the savings obtained.

About energy retrofit projects in public buildings, companies were asked about the main interventions adopted to achieve energy efficiency. The replacement of lamps represents 91.7% of the solutions adopted by the companies, the replacement of appliances or the air conditioning system and the installation of photovoltaic modules, 75%. Building automation in the air conditioning system represents 33.3% and the exchange of glass or installation of films, 8.3%.

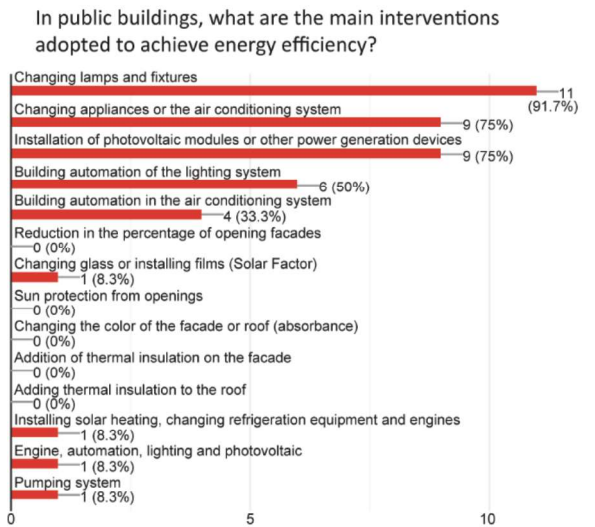


Figure 6 – Graph of the main interventions in public buildings (source: Google forms)

Regarding the justification for choosing interventions, 25% of the companies responded that it was more practical, 16.7% explained that the cost is lower and 8.3% are reduced to better cost-benefit ratios and lower payback.

Regarding energy retrofit projects in private buildings, the replacement of lamps and lighting represents 84.5% of the solutions adopted by companies, the replacement of appliances or the air conditioning system and the installation of photovoltaic modules, 76.9%. Building automation in the air conditioning system represents 38.5% and the replacement of glass or installation of films, installation of solar heating, 7.7%.

Regarding the justification for choosing interventions, 16.7% of the companies responded that it was more practical, 16.7% explained that the cost is lower and 8.3% are reduced to better cost-benefit ratios and higher return on investment.

In private buildings, what are the main interventions adopted to achieve energy efficiency?

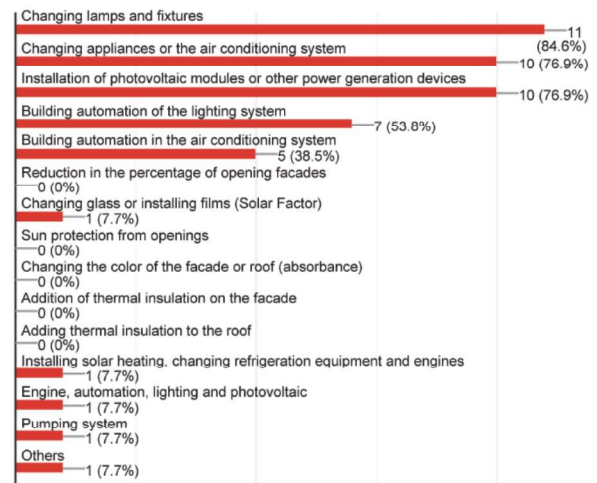


Figure 7 – Graph of the main interventions in private buildings (source: Google forms)

Of the companies interviewed, 53.8% of them follow the calculation parameters established by the National Electric Energy Agency (ANEEL) and 7.7% of them follow parameters based on international legislation.

The method for calculating the energy consumption of buildings most used to carry out the projects is Measurement and Verification representing 92.3% of the respondent companies, followed by computer simulation with 30.8% of the companies.

What methods of calculating the building's energy consumption are used to carry out the projects?

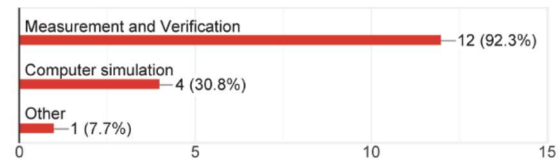


Figure 8 – Graph of the main methods of calculating energy consumption of the buildings used by the interviewed ESCOs (source: Google forms)

Companies that manage computer simulation method to calculate the energy consumption of buildings use “Dialux”, “HelioScope” and “PVsol” programs as the main work tool.

4. CONCLUSION

The main objectives of this article, that is to present an overview of ESCOs in Brazil, understand the main forms of contract (comparing with the international reality) and to research their quantity, main areas of action and types of project focusing mainly on ESCOs that work with retrofit energy in non-residential buildings, have been reached.

The research makes evident the lack of documentation, articles and studies on the topic in Brazil, leaving an information gap and hampering

government actions, as it is known that understanding the evolution of the ESCO market, its limitations and the success of relevant policies and programs is useful for policy makers. Therefore, the theme is extremely important to encourage discussions and actions to stimulate this market in Brazil.

Although there is no official definition of ESCO in the country and the number of companies that identify themselves as ESCO is not certain, 140 companies associated with ABESCO have been identified and, since 2005, their number has grown considerably, despite the many barriers that the market faces.

It is clear from the questionnaire that the largest concentration of companies with this specialty is found in the southeast region, especially the state of São Paulo, followed by the south region. The client's projects of these ESCOs are also concentrated in these two regions, but appear more heterogeneously, to a lesser extent, in the northeast, north and central-west regions.

They are mostly characterized by medium-sized companies that mostly have engineers as project managers and architects are the minority on the staff.

The most common type of retrofit projects is hospitals (a surprise in the survey), followed by shopping malls, business centers and supermarkets. The majority of ESCO's customers are national private companies, as has already been seen in documentary research, but the municipal and state public sector also appears with a large percentage, which was not expected according to the literature.

The main barrier encountered by Brazilian ESCOs for their projects to be built is the contractual and financing difficulty, which is quite comparable with international countries according to the literature. And the ESPC also seems to be the most recurrent form of contracting in both cases.

As can be seen with the questionnaires applied the main interventions adopted by these companies to achieve energy efficiency are practically the same both in public and private buildings. Apparently, the resources for retrofit works in public and private buildings do not seem to have much distinction and these companies seek practicality and a good cost-benefit ratio.

However, the main methods of buildings' calculating energy consumption do not appear to be very reliable. The most common method, Measurement and Verification is made with simplified tables and the energetic simulation is used in only 30.8% of the interviewed companies that also uses simpler programs.

Without reliable methods that prove energy savings, the level of distrust of banks and investors increases. Because of this and other barriers presented in the article, the Brazilian ESCO market grows with little government support. A work like this

that presents this overview is important to generate the basis for strengthen this market that can contribute a lot to reduce energy consumption.

ACKNOWLEDGEMENTS

We thank the University of Brasília (UnB) and Faculty of Architecture and Urbanism's Postgraduate Program (PPG FAU UnB) for all the support.

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