



Analysis of the Ecuadorian energy audit practices: A review of energy efficiency promotion



Diego Moya, Roberto Torres, Sascha Stegen*

School of Engineering, Griffith University, 170 Kessels Road, Nathan, QLD 4111, Australia

ARTICLE INFO

Article history:

Received 21 January 2015
Received in revised form
9 January 2016
Accepted 26 April 2016

Keywords:

Ecuador
Energy audit
Energy efficiency
Electrical energy consumption

ABSTRACT

This study combines an analysis of Ecuador's national policies and programs on energy audit practices with information collected from a variety of local institutions involved in energy auditing activities. Despite Ecuador is addressing a cleaner energy matrix by the construction of eight new hydroelectric power plants by 2017, the sustainable use of energy does not only require increasing renewable energy production, but also using it efficiently. At first, the institutional framework concentrating on the regulatory gap to promote energy audits in the country is assessed. Furthermore, the international energy audit practice with a focus on government policies, energy audit standards, tools, and techniques applied on heat, ventilation and air conditioning (HVAC) systems, lighting and insulation is discussed. A gap analysis of Ecuador's energy auditing programs compared to international practice is also addressed. Finally, policy recommendations, based on international experienced, for facilitating effective energy practice in the country are highlighted.

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* Corresponding author.

E-mail addresses: diego.moyapinta@griffithuni.edu.au (D. Moya), robertomauricio.torrescedeno@griffithuni.edu.au (R. Torres), s.stegen@griffith.edu.au (S. Stegen).

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1. Introduction

In October 2015, the monthly National Balance of Electricity reported by the Ecuadorian Agency for Regulation and Control of Electricity (ARCONEL) reported that 25,409.03 GWh of electricity were consumed being produced in a 5542.39 MW installed capacity nationwide [1], with an annual growth rate of 4.91% and 5.94% respectively [2]. From the total power consumption, the industry sector used 28.2% of energy generation whereas the residential sector consumed 35.47%. Additionally, 20.66% was consumed by the commercial sector and 15.85% of the energy was consumed by the public street lighting and electric losses [1,3]. The scope of this research review is to conduct an analysis in energy audit practice in the residential and non-residential (industry and commercial) sectors with focus on the highest consumers. This review includes the study of Ecuador's national policy regarding energy audits and the analysis of documented and relevant case studies of energy auditing practice in the country in order to compare the local methods with international practices in energy auditing.

The Ecuadorian government has ratified and is signatory of four specific international agreements: United Nations Framework Convention on Climate Change, Conference of the Parties, COP21-Paris outcomes [4], The Kyoto Protocol [5], The Millennium Development Goals [6] and the Sustainable Development Goals at the Rio+20 Conference [5]. In Article 2, The Kyoto Protocol clearly recommends to achieve a reduction of greenhouse emissions commitments and that the Kyoto countries have to promote sustainable development by the enhancement of energy efficiency technologies in relevant sector of the country economy [7]. Although the millennium development goals do not include any targets regarding energy efficiency [8], in the Rio+20 Conference, one specific sustainable development goal is about energy efficiency [9], which deals with the use of the energy as well as energy services for communities and industries in order to have full access to affordable energy services [9]. Therefore, according to these international agreements, Ecuador is required to reduce greenhouse gas emissions not only increasing renewable energy production, but also using it efficiently.

Ecuador's Master Plan of Electrification, which covers 2013–2022, includes a goal to increase hydraulic energy production to 3420.81 MW by 2017, becoming 89% of the total demand of the country [2] by that time. However, the Ecuadorian Government will install three million electric induction cooktops by the end of 2017 requiring 3878 MW [10]. As an incentive to increase the use of energy efficiency appliances in the residential sector, 330,000 new high efficient refrigerators will be installed in this sector by 2017 [11]. This policy will save up to 50 MW of power, up to 216 MWh per year of energy consumption and 26 million dollars of saving in public generation of energy [12]. Overall, new incentives and hydroelectric power plants will not be enough to cover energy demand so it is necessary to increase energy efficiency by promoting energy audit techniques, for example.

2. Energy auditing practices in Ecuador

Many efforts have been made in order to implement energy audits in Ecuador. Some isolated programs were developed for Ecuador's main energy consumers, which consist of approximately 115 companies in textiles, chemical, mining, and oil refinement

[13]. These projects operated with foreign investment together with local incentives. The aim of these efforts was to reduce the amount of energy consumption in the large electricity consumers of the country. These steps opened the door to new policies and standards locally. As a second stage, a national framework was developed in order to promote energy efficient implementation around the country [14]. Stage three saw the development of new standards and laws to implement energy audits [15–17]. This section provides details of the institutional framework with a focus on the regulatory gap to promote energy audits in the country, followed by a description of the institutions involved in those activities.

2.1. Institutional framework to promote energy audits

International investments with local collaboration were the first steps to implement energy audits in Ecuador. In 2001, the World Bank, the Global Environmental Facility (GEF) and the Ecuadorian government funded the project PROMEC (Power and communications sectors modernization and rural services project) [18]. Energy audits were one component of this project, which were developed in public buildings, hotels, hospitals and industries, with the aim to identify opportunities for savings. Also, 100 representatives of private firms and educational institutions were trained in energy audits. At the end, a reduction of 80,000 t of carbon dioxide emissions was reported [18]. However, government instability and the constant change of Ecuadorian authorities caused many delays and reduced the effects of the project [19].

Another important initiative in the field is an energy audit project carried out between 2005 and 2006 in 30 of the biggest companies in Ecuador. This project was mainly developed by EGRANCONEL (Association of large electricity consumers of Ecuador – Spanish translation), CAF (Andean Development Corporation) and sponsored by the Ecuadorian Ministry of Energy. Savings of 35 MW in power through the implementation of short and long time improvements in these companies was reported [13]. Therefore, international initiatives with national support introduced energy audits in Ecuadorian industry.

Since 2007, new policies to promote energy efficiency technologies (EET), such as energy audits, in Ecuador have been added to the institutional framework. The New 2008 National Constitution, the National Plan of Well Living (NPWL) and ministerial decrees from the Minister of Electricity and Renewable Energy (MEER) and the Minister of Productivity are the principal executive instruments and incentives to encourage the use of EET in residential and non-residential sector [14].

According to the National Constitution, the Ecuadorian State will promote, in the public and private sector, the use of clean and environmental technologies, renewable energies and energy efficiency [20]. Additionally, Policy 4.3 and a strategic goal of NPWL states that the energy matrix will be diversified by the use of green and efficient energy technologies [21]. These policies are considered in the strategic plan of the MEER [22]. In general, therefore, it seems that promotion of energy efficiency technologies is a national priority, which implies that public institutions and ministries are committed. However, energy audit techniques as a method to seek energy efficiency needs to be discussed.

A key aspect of energy audits is the institution and standards that create and control its successful implementation. After the creation of MEER in 2007, the president decree No. 1048, in 2012,

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