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Characterization of Energy Portability Tools to Implement in Colombia

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Abstract

Electricity is one of the fundamental components that drive the economy, i. e. the higher the economic growth, the higher the energy consumption and vice versa.

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Therefore, the energy market must be able to cover the increase in energy demand and establish strategies for efficient energy use. In the United Kingdom, the implementation of modern technologies in the electric system has been boosted with an automatic energy supplier switching process known as auto-switching. In this strategy, users are not exclusively bound to the local supplier and have the freedom to switch. On the other hand, Colombia could liberalize the energy market through an auto-switching pilot program to increase competition among energy suppliers by deregulating the tariffs. This would facilitate the supplier selection process for new clients by allowing them to choose the supplier with the lowest rate, best quality, and desired energy source, among others. This paper presents a characterization of the attributes and functionalities of the main auto-switching tools in the United Kingdom. Additionally, it proposes an adapted auto-switching tool for the Colombian energy market considering information from Enel Codensa related to the registration of new potential customers, affiliation with energy suppliers, offers views, and notifications for customers, among others. To liberalize the Colombian energy market, it is necessary to promote these types of tools that provide greater benefits to users and suppliers.

Keywords: auto-switching; characterization; energy portability; suppliers; tools; users.

Caracterización de herramientas de portabilidad energética para ser aplicados en Colombia

Resumen

La energía eléctrica o electricidad es uno de los componentes esenciales que impulsan la economía, es decir, a que mayor crecimiento económico mayor consumo energético y viceversa. En consecuencia, el mercado eléctrico debe estar en la capacidad de cubrir el incremento en la demanda de energía, y de la misma forma, establecer estrategias para el uso eficiente de la energía. En el Reino Unido se ha potencializado la inclusión de nuevas tecnologías en el sistema eléctrico, a través de un programa de cambio automático de comercializador de energía conocido como AutoSwitch, en el cual, los usuarios ya no están sujetos a un vínculo

exclusivo con su comercializador local y tienen la libertad de cambiar de comercializador de energía. En Colombia se abre la posibilidad de liberalizar el mercado de energía a través de un programa piloto de AutoSwitch, buscando inducir mayor competencia entre los comercializadores de energía por medio de la desregulación de las tarifas y facilitar a los clientes la selección del comercializador que le ofrezca un menor costo, mayor calidad en el servicio, la fuente de energía deseada, entre otros. En este artículo, se presenta una caracterización de los atributos y funcionalidades de las principales herramientas de AutoSwitch del Reino Unido. Además, la adecuación de esta caracterización a una herramienta de AutoSwitch para el mercado eléctrico colombiano, teniendo en cuenta información suministrada por la empresa Enel Codensa, relacionada con el registro de potenciales usuarios, vinculación con el comercializador de energía, visualización de ofertas, notificaciones a los usuarios, entre otros. Para llegar a la liberación del mercado eléctrico colombiano, se hace necesario promover este tipo de herramientas, con las cuales, usuarios y comercializadores puedan llegar a tener mayores beneficios.

Palabras clave: AutoSwitch; caracterización; comercializadores; herramientas; portabilidad energética; usuarios.

Caracterização das ferramentas de portabilidade energética a serem aplicadas na Colômbia

Resumo

A energia elétrica ou eletricidade é um dos componentes essenciais que impulsionam a economia, ou seja, quanto maior o crescimento econômico, maior o consumo de energia e vice-versa. Consequentemente, o mercado de eletricidade deve ser capaz de cobrir o aumento da demanda de energia e, da mesma forma, estabelecer estratégias para o uso eficiente da energia. No Reino Unido, a inclusão de novas tecnologias no sistema elétrico foi promovida por meio de um programa de troca automática de fornecedores de energia conhecido como AutoSwitch, em que os usuários não estão mais sujeitos a um vínculo exclusivo com seu fornecedor. mudar de fornecedor de energia. Na Colômbia, abre-se a possibilidade de

liberalização do mercado de energia por meio de um programa piloto AutoSwitch, buscando induzir maior concorrência entre os comercializadores de energia por meio da desregulamentação das tarifas e facilitar aos clientes a escolha do comercializador que oferece menor custo, maior qualidade de serviço, a fonte de energia desejada, entre outros. Este artigo apresenta uma caracterização dos atributos e funcionalidades das principais ferramentas AutoSwitch do Reino Unido. Além disso, a adaptação desta caracterização a uma ferramenta AutoSwitch para o mercado de eletricidade colombiano, levando em consideração informações fornecidas pela empresa Enel Codensa, relacionadas ao registro de usuários potenciais, links com o comerciante de energia, exibição de ofertas, notificações aos usuários, entre outros. Para alcançar a liberação do mercado de eletricidade colombiano, é necessário promover este tipo de ferramentas, com as quais usuários e comerciantes podem obter maiores benefícios.

Palavras-chave: AutoSwitch; caracterização; comerciantes; Ferramentas; portabilidade de energia; usuários.

I. INTRODUCTION

Electricity is one of the fundamental components that drive the economy and supports many of the services on which people depend. There are different energy sources, but they can be classified mainly into two categories, non-renewable and renewable [1]. Non-renewable sources include oil, natural gas, and coal. Renewable sources include hydroelectric, wind, and solar. These have the advantage of not emitting greenhouse gases [2-3]. Some of the challenges related to the energy system that any country faces (including Colombia) are finding low-cost, large-scale energy storage, slowly decreasing the use of non-renewable energy sources, integrating all the energy sources available in the national energy system, and making it easier for users to choose the energy source and supplier.

Energy and economy are directly related [4], i. e. the higher the economic growth, the higher the energy consumption and vice versa. Therefore, the national energy market must be prepared to cover the increase in energy demand and establish strategies for efficient energy use [5]. Concerning the last point, according to [6], in Colombia, the energy efficiency policy has been reassessed, focusing on the inclusion of new technologies in the energy system and the promotion of good consumer habits to optimize the management and use of the energy resources available and the active participation of the different stakeholders of the system (generators, shipping companies, distributors, suppliers, high-consumption customers, residential customers, among others). All of this is in the context of a more flexible market that enables the reduction of costs.

Similar to the United States [7], Europe [8], and other countries, Colombia is considering the liberalization of the energy market through a pilot program known in other places as auto-switching or automatic energy supplier switching. In this program, users (consumers or clients) are no longer subject to an exclusive affiliation with the local supplier (monopolistic) and have the freedom to switch the energy supplier. This new market aims at increasing competition among energy suppliers by deregulating the tariffs and facilitating the supplier selection process for new clients by allowing them to choose the supplier with the lowest rate, the best service quality, the energy source desired, among others. Currently, according to [9-11],

households in Europe can save a considerable amount of money per year by changing their energy supplier.

A market liberalization policy can be complemented with an energy efficiency policy, which can motivate users to make effective use of the energy while saving money due to its low price in the auto-switching market. Thus, the country makes better use of the energy produced and prepares to respond to economic growth or tolerate periods of crisis.

Digital tools have been built to support users in the automatic energy supplier switching process. These tools select the best tariff currently offered in the energy market based on an algorithm that finds the best option in the market for a contract with an energy supplier according to specific preferences [12]. These tools are immensely helpful since they reduce search costs and ensure users do not forget to change their contracts. Additionally, they scan the market regularly to benefit the users and inform them when and how much they can save by switching energy suppliers. Most tools can indicate at any moment which would be the best supplier switch for the user. If the user accepts the switch, all the details about the new energy plan are sent through email or the communication method selected by the user. Moreover, they guarantee the right of withdrawal; if the user does not want to switch for any reason, they have 14 days to withdraw. With these tools becoming increasingly available, the questions of when and under what circumstances users are willing to use them become extremely important.

Despite the relevance of the auto-switching tools, the literature on their impact on users and how to use this technology in a new energy market is scarce at the moment. On the other hand, there are studies related to the state of development of the electricity retail markets [13], alternative policies that can complement the electricity retail markets' liberalization [14], policies and strategies to make the electricity retail market more competitive with a continuous price regulation [14], the value of the switch in the electricity retail market and the effects of the users' choice [15], and how to regulate the electricity costs [16], among others.

This paper presents the attributes and functionalities of the main energy portability tools in the United Kingdom. This study seeks to serve as a basis for identifying and

defining the attributes and functionalities suitable for an energy portability tool in the Colombian electricity market. Moreover, we expect to contribute to the definition of critical aspects of the energy market liberalization process in the country.

While exploring the auto-switching tools, we found publications in portals such as *Forbes* [17] and *Energy Switching* [18], which allowed us to identify the top-rated tools by users and their major features. Subsequently, the top 20 tools were selected and studied, including 11 tools with OFGEM's Confidence Code⁶.

The paper is structured as follows: Section two describes the methodology implemented to study and analyze the selected tools. Section 3 presents the results in detail of the characteristics of the studied tools. Finally, section 4 presents the conclusions and future work the research group expects to develop in the field.

II. METHODOLOGY

This study is based on the adaptation of the documentary research method proposed [19], which intends to establish the conceptual basis of projects that seek to make scientific contributions. This method is divided into four stages: preparatory, descriptive, global theoretical construction, extension and publication.

A. Preparatory Stage

In this stage, the documents of the different tools available on the web (see Table 1) and the energy regulation websites in the United Kingdom were identified to extract their characteristics.

The most relevant concepts on the energy markets topic, which are directly related to the automatic energy switching tools, were extracted from the analyzed units.

➤ **General concepts** [20]

- *Energy supplier*: The company to which users pay for the energy used. The supplier buys energy in the wholesale market and sells it to the clients. These suppliers are classified into small, medium, and large.

⁶ OFGEM is an independent entity that works with the government, the industry, and the clients to regulate the energy market in Great Britain.

- *OFGEM's Confidence Code*: A code of good practice that the automatic energy switching tools can use voluntarily. Its objective is to help clients feel reassured about the advice they receive when they use one of these tools accredited to switch energy suppliers.
- *Annual bill*: Amount of money a client would have to pay for gas, electricity or both in one calendar year.
- *Annual summary*: A written document suppliers have to provide to each client each year with critical information on fees. It includes the name of the tariff, the consumption in the last 12 months, and the annual cost estimate for the next 12 months.
- *Automatic extension*: Per the contract's terms, a supplier would have the ability to extend the duration of an existing fixed-term tariff or apply a new fixed-term tariff without approval from the client.
- *Domestic user*: A client using energy for non-commercial purposes.
- *Energy consumption*: Using electricity as a source of heat and energy. The consumption is measured with an energy meter.
- *Energy meter*: The device used for registering the amount of electricity consumed.
- *Tariff or energy tariff*: The charges made by suppliers according to certain conditions for the energy used by the clients.
- *Green plans*: A scheme allowing owners to improve the energy efficiency of their homes and obtain refunds for the cost through the electricity bill.
- *Kilowatt-hour (kWh)*: The measurement unit used for the consumption of electricity.
- *Large energy suppliers (Big Six)*: The large energy suppliers (often called the Big Six) are the companies with supply licenses that provide most of the energy to the households in the British market.
- *Small supplier*: Suppliers operating in the national energy market that do not have a significant market share.
- *Meter point administration number (MPAN)*: An MPAN identifies the household where there is an electricity supply.

- *Payment method*: A method by which a customer pays for energy. They are classified into three main categories: direct debit, standard credit, and prepayment.
- *Switching*: The process of changing energy suppliers. It can be done automatically with the auto-switching tool or through direct contact between the client and the supplier.
- *Switching costs*: The costs a customer pays for finding and changing suppliers.
- *Switching window*: The time a customer has to change suppliers in response to an end-of-contract notification.
- *Typical domestic consumption values*: These are the industry's standard annual values for the electricity used by an average client.
- *Energy measurement units*: Usually indicated in kilowatts per hour. One kWh is equivalent to leaving a 40-watts light bulb on for 25 hours. It is also known as energy unit.
- *Warm home discount (WHD)*: It is a government scheme to tackle fuel poverty in Great Britain. With this scheme, the largest energy suppliers support the people in fuel poverty or at risk of being there.
- *Energy switch guarantee*: It is a promise to provide a fast and safe switch from one supplier to another.

➤ **Types of tariffs**

- *Default tariff*: The energy supplier's basic tariff. Usually, it is the most expensive contract and tariff change.
- *Standard variable tariff (SVT)*: The most common default tariff. This means the prices go up and down with the market. Usually, they do not have an end date, and they will not have a fixed term in the terms and conditions of the contract.
- *Fixed energy tariff*: A tariff with specific conditions applied to the terms of the contract. Usually, it is a fixed price for a fixed time.
- *Green tariff*: A tariff that is promoted primarily based on its association with renewable energy sources or climate change mitigation.

- *Standing charge*: A fixed monthly or daily amount paid to the energy supplier for maintenance and other costs, such as maintenance of the connection to the electrical network.
- *Exit fees*: When they are included in the contract, these are contractually agreed fees that are paid when the customer terminates the contract before the agreed termination date.

➤ **Payment methods**

- *Direct debit*: A fixed or variable fee is charged to a bank account each month, quarter or year.
- *Standard credit*: When the payment is made after receiving the bill instead of using direct debit or arranging for a prepayment meter. The payment can be made once a month or quarterly. Usually, payment is due within 28 days of the issuance of the bill.
- *Prepayment*: Customers pay in advance, and the value is registered as credit in their account. The supplier reduces the credit from the account (meter) according to the energy used by the client and the tariffs agreed with that client.
- *Payment upon bill reception*: The customers receive the paper bill and pay with their preferred payment method.

➤ **Types of meters**

- *Prepayment meter*: Electricity is paid in advance with this meter.
- *Economy 7 / Economy 10*: Different tariffs for day and night consumption. The number following the word “economy” is the number of hours for which the night rates are available.
- *Smart meter*: A new line of electricity meters that the government wants to install in every household and business in Britain. They can report the consumption through the electrical network in different time units (minutes, hours, days, months), which allows companies to study the customers’ consumption in detail and make them offers suited to their needs.
- *Dynamically teleswitched (DTS) meter*: With these meters, the tariffs have a control unit that allows the supplier to switch the supply remotely.

B. Descriptive Stage

In this stage, a review of the current state of knowledge of the energy switching process was conducted, emphasizing the conditions and considerations that clients need to meet to switch suppliers or meters.

➤ **Conditions**

- The client must be authorized to make a contract with the energy supplier for the current household, i. e. the client must be the property owner or have the owner's authorization.
- The client must know the postcode of the property, the name of the current supplier, the name of the tariff, and the annual energy consumption of the property. Generally, this information can be found in the bill. However, if the client does not have a bill, they have to create an account in a comparison application, which uses diverse ways to find information about the property or estimate the consumption.
- The client should use a rate comparison application that allows them to make an informed decision on the switch. Comparison applications (OFGEM accredits some) vary in their service abilities. Some of them can access the complete information of the user just with the postcode. Others request different data to make the comparison. Some of these tools only compare, and the user has to make the service switch by calling directly to the selected supplier. Others complete the process automatically, for which they request the user's bank information and other data.
- To make the switch, automatically (for example, with auto-switching) or by contacting the selected supplier directly, the client has to register the energy meter's reading on the day of the switch and send it to the new supplier. Additionally, it is worth remembering that the customer has 14 days to cancel the switch and the other user protection clauses regulated by OFGEM.

➤ **Considerations**

- The energy supplier switching process can be overwhelming. Therefore, it is usually convenient to use an auto-switching tool accredited by OFGEM if possible, making the process easier and more transparent for the user.
- There are different switching motives for each client. For example, maybe the users prefer an energy company with renewable sources, high-quality service ratings, or that allows them to save money. Switching suppliers or energy tariffs can have a significant financial impact on electricity bills.
- Most users can switch energy suppliers easily. Nonetheless, if the client has a debt with the current energy supplier, it will not be possible to make the switch. The debt has to be paid in full before agreeing to a new energy contract.
- The energy supplier usually pays the intermediary company a fee when the switch is completed. However, this fee is already included in the marketing budgets of the energy supplier. Thus, the user does not have to pay additional.
- If the energy supplier is part of the “energy switch guarantee,” the complete switch must be carried out in the 21 days following the switch request. The switch begins the first day after the 14-day withdrawal period, and it will not take more than 7 days after the end of this period. If an energy supplier is not part of the “energy switch guarantee,” the time necessary for making the switch depends on the supplier, and it must be reviewed in the terms and conditions of the energy switch.
- When switching suppliers, the energy runs through the same conduct. The only difference is to whom and how much the client pays. Therefore, the energy supply will not be affected by the switch. Moreover, no one will have to enter the household or change anything, and everything remains the same. Simply the payment is made to a different supplier.
- There is a 14-day withdrawal period where the clients can change their minds about the switch. This legally protected withdrawal does not have a cost for the user. This period starts the day after the contract is agreed upon and

applies regardless of whether the procedure was made in person, online or by telephone.

- If the landlord (owner) has a “preferred supplier” in the lease agreement, the tenant has to obtain their approval to request an energy supplier switch.
- The energy regulator (OFGEM) will intervene and name a new energy supplier if the current supplier of a group of users ceases operations. In this case, the energy supply will never cease, and OFGEM will designate a new supplier. The new supplier will manage the positive balances the clients have with the previous supplier.

C. Global Theoretical Construction Stage

In this stage, we present a balance of the results in this study; identify gaps, limitations, and trends; and analyze the tools, which were considered in this paper as the research units according to the documentary research method. We analyzed 20 tools, and 11 of them have OFGEM’s confidence code. The names and URLs of each tool are presented in Table 1.

Table 1. List of auto-switching tools

Tools	URL address
Switchd	https://switchd.co.uk/
Look After My Bills	https://lookaftermybills.com/
Flipper	https://flipper.community/ http://help.flipper.community/en/articles/374977-which-suppliers-can-flipper-flip-me-to http://help.flipper.community/en/articles/374999-what-meters-and-tariffs-does-flipper-support
WeFlip	Now part of the tool “Look After My Bills”
Switchcraft	https://www.switchcraft.co.uk/
Homebox	https://www.homebox.co.uk/ Energy comparison API: (https://api-docs.homebox.co.uk/#/)
Migrate	https://migrate.co.uk/ (not available at the moment) https://www.safeenergyswitch.co.uk/migrate-automatic-energy-switching.php
Labrador	https://www.thelabrador.co.uk/#/home
Switch Gas & Electric	https://switchgasandelectric.com/
Unravelit	https://www.unravelit.com/energy-switching
Cheap Energy Club	Cheap Energy Club – Compare Energy Deals – MSE (moneysavingexpert.com)
Runpath	https://www.runpathdigital.com/gas-electricity/
Uswitch	https://www.uswitch.com/
Quotezone	https://www.quotezone.co.uk/

Tools	URL address
SimplySwitch	https://www.simplyswitch.com/
EnergyLinx	https://www.energylinx.co.uk/energycalc.html
Energy Comparison	https://energycompare.citizensadvice.org.uk
Energy Helpline	https://www.energyhelpline.com/
Money Super Market	https://www.moneysupermarket.com/
My Utility Genius	https://www.myutilitygenius.co.uk/

The analysis evidenced that most tools do not charge the user for the energy supplier switch (see Table 2). However, they receive commissions from the supplier when a user switches. Only two tools charge the user, but only when they find a better offer. These do not receive commissions from the suppliers and state this gives the clients more freedom to choose the offer. A gap or limitation was that the tools do not provide information on their business model to remain competitive in the market, since some do not charge the user nor receive commissions from the suppliers.

Table 2. Number of tools that charge the user for the service

Charges user	Receives commissions from suppliers	Number of tools
No (It is free)	Yes	12
Yes (When there is a better tariff, they charge a fixed fee)	No	2
No (It is free)	No	4
No (It is free)	No (Although some suppliers pay a fee for the switch)	2
TOTAL		20

After analyzing the fees, the functionalities are divided into three study items for each tool: 1) Data entry, 2) Functionalities (processes), and 3) Best offer (output).

D. Data Entry

It includes the initial data the user submits to the tool to identify them and define the plans or offers that each supplier registered in the tool can make. The data are related to the country of operation, the residence information, the personal data of the potential user, and the current service (if there is one). Fig. 1 shows that most of the tools require an email (14 out of 20 tools, which becomes the main

communication channel), the name (9), the phone number (9), and the date of birth (7). This information from the user is considered basic or essential. Additionally, most tools require the postcode (17) or the address (14), leaving aside the phone number. It is worth mentioning that most tools require only the postcode or the address for the service as data entry. With this information, they automatically find the current supplier (tariff and payment method), type of meter, current discounts, and consumption. Moreover, these tools only work in the United Kingdom, and most houses, flats, factories, and others, have some type of smart meter.

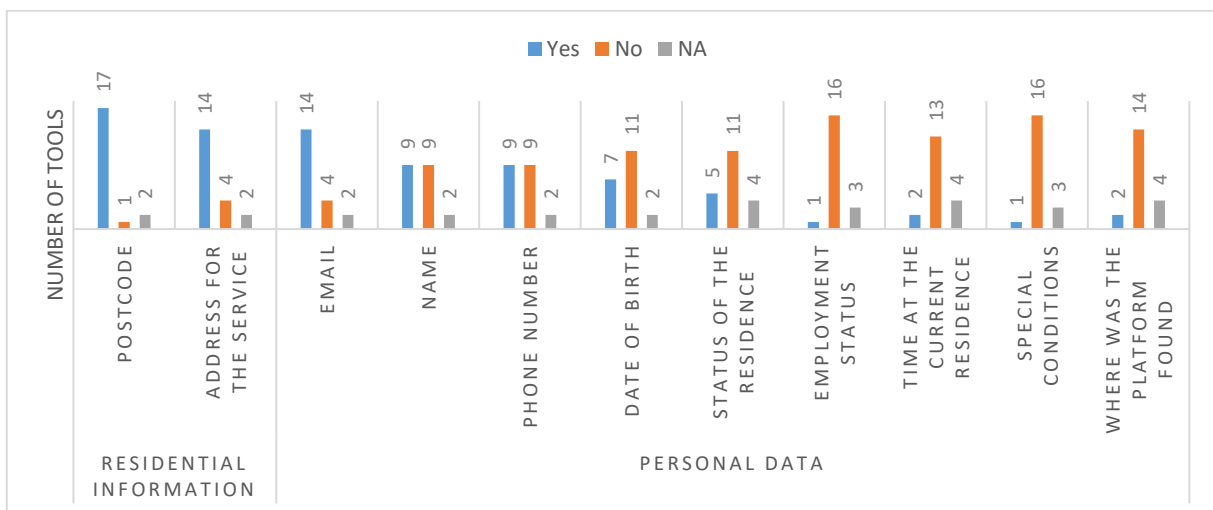


Fig. 1. Number of tools by data entry (residence, personal).

Regarding the data entry of the current service, Fig. 2 presents the data considered to define the plans or offers. The majority of the tools considered relevant the communication channel with the user (email, phone, SMS or mail), the type of service the user currently has (18), the supplier (18), and the current consumption, which is measured by some tools in money or kilowatts per period (year, quarter or month). If the user does not know the consumption, it can be expressed as Low, Medium, or High. The information on the current consumption (18) is a reference in the calculation of the new tariff. Likewise, the payment method is required by 17 tools. This information can be expressed as: monthly or quarterly direct debit, variable direct debit, payment upon receipt of the quarterly or monthly bill,

prepayment, and monthly payment in advance with direct debit. In addition, the type of meter (15) can be prepayment, economy 7 or smart.

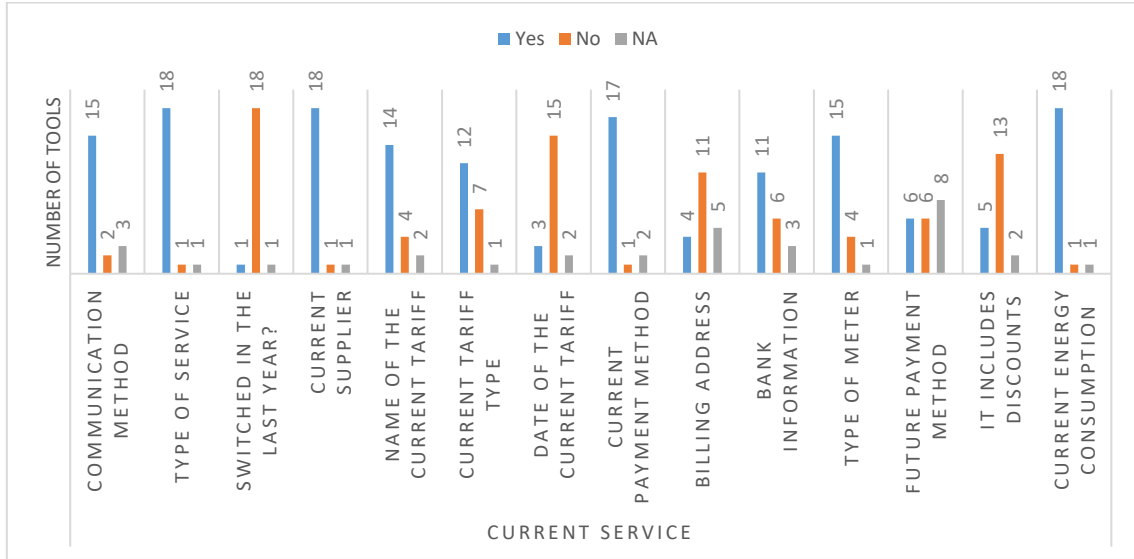


Fig. 2. Number of tools for the data entry of the current service.

E. Functionalities (Processes)

In the tools' functionality analysis (see Fig. 3), we found that most tools focus on the savings estimate functionality (15) since it is particularly interesting for the users. Moreover, many tools provide details regarding the new tariff (14). They show the tariff's name, the contract's cost, the payment methods available, the billing cycle, the amount of money the user can save by selecting the tariff, and they send an email with the contract's terms and conditions in detail. Ten tools inform the user about the time required to make the energy supplier switch, making this process transparent for the user. Some tools allow establishing a time frame for cancelling the switch, which can be from 21 to 35 days. Finally, eight tools allow to issue an online bill; the rest send the bill to the user's email.

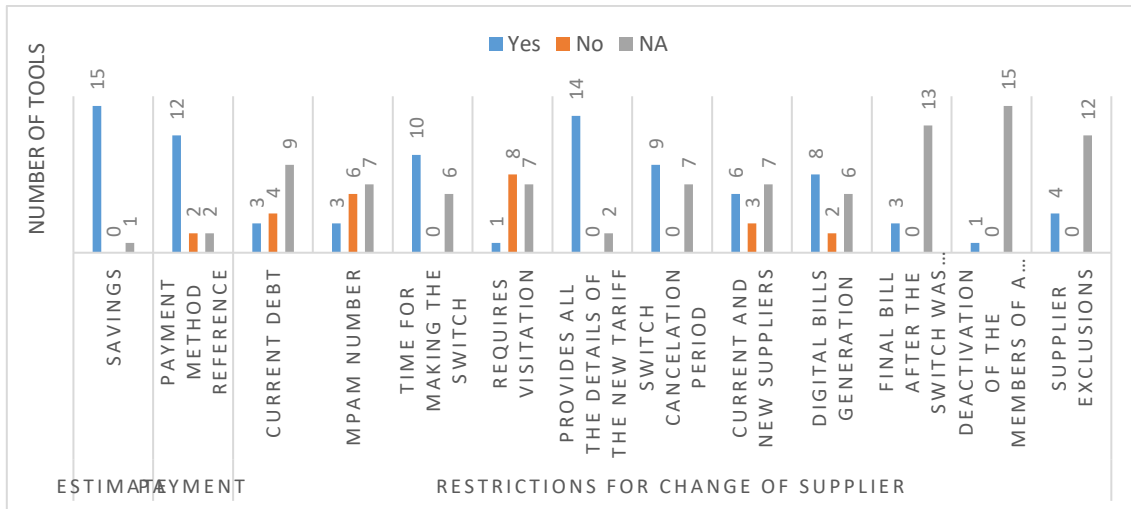


Fig. 3. Number of tools that have Estimate, Payment, and Restrictions functionalities for making the switch.

Fig. 4 presents the functionalities related to the transition to the new supplier. Some of them allow the user to set up an online account for the new supplier and display the bills. However, there is not a history of the payments made to the supplier, and only some tools allow downloading those bills. Usually, the tools do not specify if they have the bills stored in their systems or if they are linked to the suppliers' to display them.

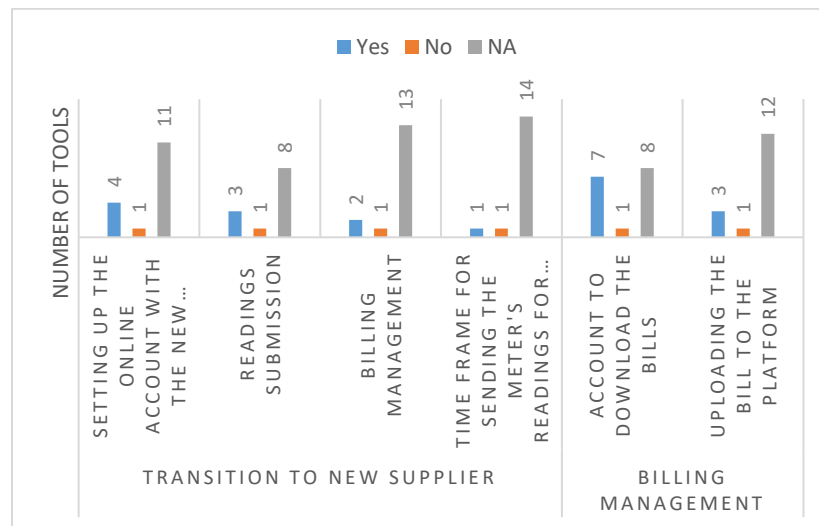


Fig. 4. Number of tools that have Transition to new supplier and Bill management functionalities.

F. Best Offer (Output)

It was found that the tools can look for an annual or monthly savings estimate or even a specific amount. To make the estimate, they use the data from the current supplier, the type of tariff, the current consumption, the type of meter and if there is a discount. However, most tools do not specify how they estimate the best offer. Table 3 presents some additional aspects considered by certain tools.

Table 3. Aspects considered by certain tools to estimate the best offer.

Tool	Aspects
Flipper	Current and estimated rate. Exit fee and time left to avoid the charge of this fee. Types of tariff (variable or fixed).
Switchcraft	Number of complaints to the supplier: Reported by the company monitoring the service. Customer reviews on the service: obtained from diverse sources. Long-term cost: The supplier's ability to maintain low rates. Commercial stability: Existence of the supplier in the business with success for 3 years or more.
Other	Differences between the annual costs estimated in the current plan and the plan the user might switch to.

Most of the tools offer a series of filters that allow users to calculate the best tariff according to their preferences. These filters can be changed dynamically to select the best option. Figure 5 shows that the most recurrent ones are the name of the tariff (17), the type of switch (17), the update on the type of tariff (16), the estimated savings per year (15), the billing or payment method (15), the personal projection per year (15), additional data on the tariff offered (15), and the comparison between the current cost and the cost of the offer.

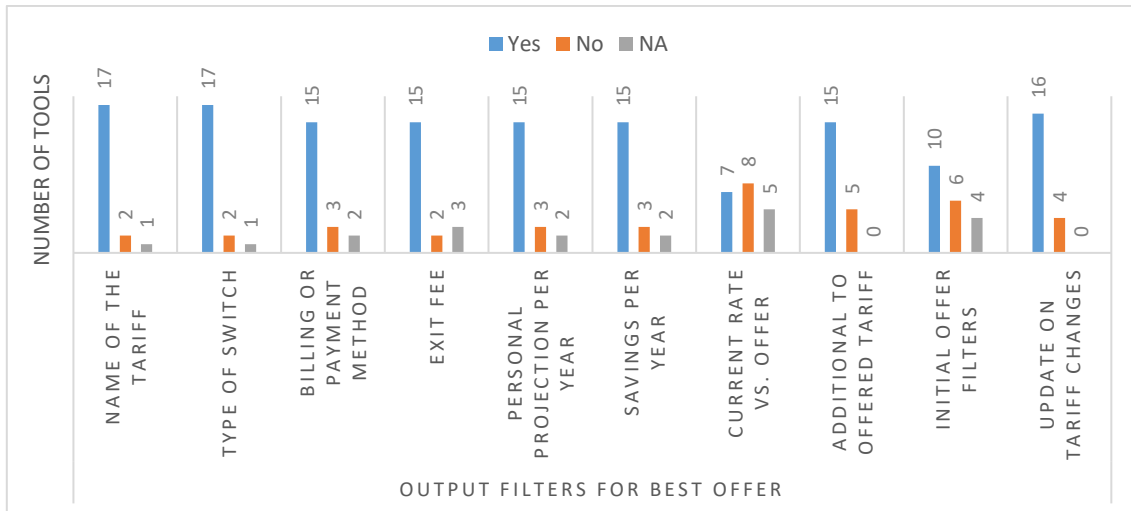


Fig. 5. Number of tools in output filters for best offer.

III. RESULTS

A. Extension and Publication Stage

In this stage, the results obtained in the study for the characterization of energy portability tools to use in the Colombian market are disseminated [19]. Thus, the information provided by the company Enel Codensa was analyzed, emphasizing how an energy supplier in Colombia should operate regarding registering potential users and creating offers, among others. The characterization focused on the attributes and functionalities an auto-switching tool has to have, considering the data entry from a potential customer, the creation and visualization of the offers, the client's affiliation to the new supplier (supplier switch) and the payment of the bills. The first step was the study of the electricity models in Colombia, which is divided primarily into: 1) *Non-regulated market*: Where natural and legal persons with high energy consumption (the regulating entity, CREG, defines a minimum and maximum) participate voluntarily and freely agree with their supplier the cost for the energy they consume. 2) *Regulated market*: It includes the rest of the industrial, commercial, and residential users with energy demands below a certain amount established by the regulating entity. The majority of the customers in the country are part of this market, and the tariff structure is established with a formula (based on

the generation, transmission, distribution, commercialization, loss, and restriction costs) defined by CREG.

B. Key concepts in the Colombian Energy Market [20],[21]

- *Average consumption*: Total energy consumption for a fixed period in households or businesses.
- *Tariff contribution*: Amount obtained by applying the subsidy or contribution factor legally authorized by CREG to the Unit Cost of Service Provision.
- *Stratum*: In Colombia, the residential properties that should have utilities are socioeconomically classified into stratum.
- *Voltage*: The electric tension or potential difference in physical magnitude that quantifies the electric potential difference between two connection points. It is the voltage at which electricity goes from one point to another.
- *Network operator*: The person in charge of planning the expansion, investment, operation, and maintenance of all or part of the regional transmission system (STR). The assets can be owned or from third parties.
- *Sector*: It comprises primary, secondary and tertiary activities related to the production, transportation, management, and sale of energy products to industrial, commercial, residential or official users.
- *Type of area*: In Colombia, the areas are classified into rural and urban. The urban areas are industrialized, while nature and low population density predominate in rural areas.
- *User*: Natural or legal person benefitting from the utilities as the owner of the property where the service is provided or direct recipient of the service.

Next, there is a description of the attributes and functionalities an auto-switching tool should have to operate in the Colombian market.

C. Potential User Registration

To register a potential user, it is necessary to enter the general information that allows identifying the type of user to request additional information later.

- **Basic data entry:** The information required in Table 4 applies to natural and legal persons in the regulated and non-regulated markets. On the right side of the table are possible values or examples of them if they are not controlled data. The distributors and suppliers the user can select depends on the address where the service is provided.

Table 4. Basic data entry.

Category	Attributes	Values
Personal	Types of person	Natural, legal
	Type of user	Regulated, non-regulated
	Email	juanperez@gmail.com
Installation	Department	Santander, Cauca, Valle del Cauca.
	City	Bucaramanga, Popayán, Cali.
	Address	Calle 4 # 6-40.
	Type of installation	House, building, other.
	Description of installation	Tower A, apartment 403; Block B, house 3.
	Type of area	Rural, urban.
	Sector	Industrial, commercial, residential, official.
Current energy service	Network operator:	Pre-filling (after entering the address)
	Supplier:	CODENSA, CEO, etc. (pre-filling with suppliers offering the service in the location of the user)
Service preferences	Preferred type of energy source	Based on hydrocarbons, solar, wind, hydraulic, biomass, tidal, geothermal.
Advertising of the tool	Where can I learn about the tool	Friends, social networks, internet search, newspapers, radio.

- **Consumption data entry:** The tool must request the entry data presented in Table 5. This table indicates if the attribute is required for natural (N) or legal (L) persons.

Table 5. Consumption data entry.

Category	Attributes	Type of Person		Values
		N	L	
Installation	Stratum	X	X	1, 2, ..., 6. It can be obtained with the address.
Current energy service	Voltage	X	X	1, 2, ..., 5.
	Average consumption	X	X	Monthly cost (kW)
	Consumption in the last 6 months	X	X	Month 1: Cost (kW);...; Month 6: Cost (kW).
	Type of tariff	X	X	Fixed, variable.
	Monthly rate	X	X	If it is regulated, it is the result of the formula (kW/month); if it is not, it depends on the supplier.

Category	Attributes	Type of Person		Values
		N	L	
	Type of meter	X	X	Standard, telemeter, smart, prepayment.
	Current type of energy source	X	X	Based on hydrocarbons, solar, wind, hydraulic, biomass, tidal, geothermal.
For the estimated consumption	Estimated average consumption	X	X	Estimated monthly cost (kW).
	People living at the service location	X		1-2, 3-5, more than 5 people.
	Is there natural gas service? [7]	X		Yes, no.
	Number of electronic devices.	X	X	1-4, 5-10, more than 10 devices.
	Is there a self-generation power system?	X	X	Yes, no.
	Electric vehicles	X	X	Automobile, motorcycle, automobile and motorcycle.

D. Offer generation

We propose two alternatives for this functionality: 1) Having an auto-switching tool with an integrated simulator based on artificial intelligence (machine learning algorithms) that allows predicting the consumption depending on the user, and the energy tariffs depending on the possible suppliers so it can generate the offers suitable for the user. 2) Having the tool send the consumption information to the suppliers so they can use their own simulators to generate the offers that will be received by the tool and displayed to the user.

The data sent by the tool to the suppliers or used for the simulation are those previously presented in Table 4 and Table 5, except for the *Email* and *Current supplier* fields.

Table 6 shows the data sent by the suppliers to the tool regarding the offer(s) for the regulated users. In the case of non-regulated users, the data are the same as in Table 6, except for *Type of tariff* and *Fixed rate*. Additionally, the name of the *Annual Projection* attribute is changed to *Cost of annual contract*. As the market liberalizes in Colombia, variable tariffs can be integrated. They can be based on the time of the day the energy is consumed (morning, afternoon, evening), the high-consumption periods (weeks or months) and the low-consumption periods, among others.

Table 6. Data of the offer generated for a regulated user.

Category	Attributes	Values
Information on the offer and tariff	Supplier	Name of the supplier
	Monthly cost	kW/month
	Type of tariff	Fixed, variable.
	Fixed rate	Fixed cost/monthly.
	Length of the contract	12 months, 18 months, 2 years, 3 years.
	Termination fee	Tariff cost, without charges.
	Type of energy source	Based on hydrocarbons, solar, wind, hydraulic, biomass, tidal, geothermal.
	Type of meter	Standard, telemeter, smart, prepayment.
	Subsidy rate	Without subsidy, with subsidy.
	Tariff contribution	Without contribution, with contribution.
	Annual projection	Annual cost (amount/year)
	Annual savings	Annual savings (amount/year)
	Billing cycle	Monthly, bimonthly, prepaid.
Payment method	Alliances (banks, supermarkets), automatic debit, prepayment.	

E. Visualization of the Tariffs Offered to the User

The information of the offers received by the tool from the suppliers, or the simulation is presented to the potential users ordered by the money saved (monthly, bimonthly, yearly) and with graphics.

- **Visualization:** If the potential users are regulated or non-regulated, they can visualize all the data regarding the offers from the suppliers presented in Table 6 in addition to the attribute of Table 7.

Table 7. Supplier rating attribute.

Category	Attributes	Values
Information on the offer and tariff	Rating of the supplier	1, 2, ..., 5 stars.

- **Comparison and filters in the visualization of offers:** When the potential users (regulated or non-regulated) are visualizing the list of offers, they can compare a specific offer from a selected supplier with the tariff of the current supplier. Additionally, the users can filter according to their interests. This information is in Table 8.

Table 8. Comparison and filters attribute.

Category	Attributes	Values
Comparison	Comparison of current vs. new offer	The attributes of "Information on the offer and tariff" for the current supplier and the offer selected by the user are displayed.
Filters	Market overview	Automatic switch suppliers, offers for direct switch with the supplier.
	Supplier	List of suppliers.
	Payment method	Alliances (banks, supermarkets), automatic debit, prepayment.
	Type of tariff	Fixed, variable.
	Rating of the supplier	1, 2, ..., 5 stars.
	Type of energy source	Based on hydrocarbons, solar, wind, hydraulic, biomass, tidal, geothermal.

F. Affiliation with the Supplier

When the user decides to accept one of the offers proposed by the suppliers in the tool, additional information will be requested to formalize the negotiation.

- **Regulated user data entry** Table 9 presents the attributes the tool will request to the regulated user to complete the affiliation with the supplier.

Table 9. Data entry attributes for the affiliation of a regulated user with the supplier.

Category	Attributes	Type of Person		Values
		N	L	
Basic	Identification	X	X	Identification number.
	Type of identification.	X	X	National ID, foreign national ID, TIN.
	Name		X	Juan Carlos Castro.
	Phone number	X	X	07987654321
	Date of birth	X		12-12-1981
	Sex	X		Male, female
	Civil status	X		Single, married, common-law marriage, divorced.
	Taxpayer ID	X		34343-4545.
	TIN		X	2323-54566.
	Commercial activity		X	Textiles sales, industrial support, restaurant.
	Chamber of commerce		X	Registration in the chamber of commerce
	Legal status		X	Legal status resolution
Legal representative		X	Full name, identification number.	
Commercial offer	Type of meter	X	X	Standard, telemeter, smart, prepayment.
	Billing cycle	X	X	Monthly.
	Payment method	X	X	Alliances (banks, supermarkets), automatic debit, prepayment.
	Billing address	X	X	Optional

Category	Attributes	Type of Person		Values
		N	L	
	Bank information (if automatic debit was selected)	X	X	Name of the bank, name of the account holder, type of account, account number.
	Letter of intent to switch	X		Proforma letter downloaded by the user that must be signed and uploaded again to the tool ¹ .
	Regulatory assurance mechanisms	X	X	Three types of guarantees are presented. Each must be explained in detail, and the user has to choose the proforma most suitable for their decision.
	Change of market		X	Change from non-regulated to regulated market. Dropdown list, Yes/No, if the answer is Yes, the field to download the form is activated, and after filling out and signing the form, it can be uploaded again.
	Tax exemptions	X	X	Depending on the economic activity, the document that must be uploaded activates ³ .
	Exemption request form	X	X	Pre-filled document that the user must download, fills out, sign, and upload.
	ISIC certifications	X	X	The user's certifications according to the ISIC

- **Non-regulated user data entry:** The non-regulated user data entry attributes are the same as in Table 9 with an additional attribute, *Commercial offer contract*. It is a document drafted by mutual agreement between the supplier and the non-regulated user to define the tariff to be paid for the service.

G. Change of Meter

This is an additional service contemplated when there is a contract between the supplier and the tool. Table 10 presents the entry attributes necessary to do a meter change process.

Table 10. Change of meter for regulated and non-regulated users.

Category	Attributes	Type of Person		Values
		N	L	
Change of meter	Meter identifier	X	X	Serial number of the meter to be installed (89-323-212)
	Type of meter	X	X	Standard, telemeter, smart, prepayment.
	Brand of the meter	X	X	
	Date and time	X	X	Date and time scheduled for the change of meter.
	Department	X	X	Santander, Cauca, Valle del Cauca.

Category	Attributes	Type of Person		Values
		N	L	
	City	X	X	Popayán, Cali.
	Address	X	X	Calle 4 # 6-40.
	Technician's identification	X	X	Identification of the technician making the change of meter.
	Name of the technician	X	X	Name of the technician making the change of meter.

H. Billing

The user can decide whether to receive a physical or digital bill. If the user wants a physical bill, the supplier sends it directly to the user at the registered address. Otherwise, the supplier sends the digital bill to the user's email and the auto-switching tool.

- **Information required from the supplier**

Article 42 of Resolution CREG 108, 1997 [8], establishes the minimum information that the bills for the energy and gas services must include. The modifications in the Resolutions CREG 015, 1999 [9], and CREG 058, 2000 [10], have to be considered as well.

Every time the user requires a bill, the tool will make a request to the API of the supplier, which will respond with the minimum information specified in Table 11 for a regulated and non-regulated user, in JSON or XML format, in addition to the bill in PDF format.

Table 11. Attributes of the bill.

Category	Attributes	Regular	Prepaid	Description
General information	Payment reference	X		Numerical value used for online payments
	Code	X		Integer value with the bill's identifier
Company's information	Prepayment identification for the supplier		X	Identification as prepayment service with the supplier.
	Name of the supplier	X	X	Name of the supplier
Basic information	Sector	X		Residential, commercial, industrial, official.
	Name of the user	X	X	Name of the subscriber
	Type of use	X	X	Type of use of the service.
	Stratum	X	X	Number of the stratum of the property.
	Address	X	X	Address of the residence.
Technical information	Meter's ID	X	X	Meter identifier.
	Operator	X		Name of the network operator.

Category	Attributes	Regular	Prepaid	Description
	Voltage	X		Network's voltage
	Average monthly consumption	X	X	Cost with the monthly consumption kWh. For prepaid electricity, it corresponds to the last six months.
Reading	Previous reading	X		Previous reading of the consumption meter, if there was one.
	Current reading	X		Current reading of the consumption meter, if there is one.
	Reasons if there was no reading	X		Motives behind a missing reading.
Consumption history (for each period)	Month-Period	X	X	Month or period of the consumption, or activation, if it is a prepayment service.
	Year	X	X	Year of the consumption, or activation, if it is a prepayment service.
	Consumption	X	X	Monthly consumption in kWh.
	Amount prepaid.		X	Amount of prepaid energy.
Dates	Initial period	X		The day when the consumption starts.
	Final period	X		The last day the consumption is measured.
	On-time payment	X		Final date to make the on-time payment.
	Disconnection	X		Date when the service will be disconnected if the payment is not made.
Cost components	Generation	X	X	Generation cost in the formula of the tariff.
	Transmission	X	X	Transmission cost in the formula of the tariff.
	Distribution	X	X	Distribution cost in the formula of the tariff.
	Sale	X	X	Sale cost in the formula of the tariff.
	Loss	X	X	Loss cost in the formula of the tariff.
	Restrictions	X	X	Restrictions cost in the formula of the tariff.
Other services (for each of them)	Name	X		Name of the additional service charged in the bill.
	Percentage	X		Percentage corresponding to the total cost of the bill.
	Cost	X	X	Cost in COP to be charged in the bill.
Default	Default interest	X		Amount of the default interest.
	Default interest rate	X		Rate applied to the default interest (%).
Other ⁴	Name	X	X	Name of the item.
	Cost	X	X	Cost in COP for the additional item.
Quality indicators	EDS	X		Equivalent Duration of Service Interruptions (EDS) by default or calculated.
	EFS	X		Equivalent Frequency of Service Interruptions (EFS) by default or calculated.
	Max. EDS	X		Maximum value accepted for EDS.
	Max. EFS	X		Maximum value accepted for EFS.

Category	Attributes	Regular	Prepaid	Description
	Compensation	X	X	Cost in COP of the compensation for the quality of the service (optional).
Costs to be paid	Debt	X	X	Amount of debt or pending debt for consumption if it is prepaid.
	Cost applied to the debt		X	Cost of the prepayment portion applied to the debt for consumption (optional).
	Consumption	X	X	Monthly consumption in kWh.
	Amount prepaid		X	Amount of prepaid energy.
	Contribution	X	X	Cost in COP of contribution.
	Applied percentage	X		Percentage applied to determine the contribution cost.
	Subsidy	X	X	Cost in COP of subsidy.
	Basis for payment	X		Basis for payment of the subsidy.
	Adjustment	X		Cost in COP of the adjustment to round up the bill.
	Total	X	X	Total amount to pay in COP

For the billing of non-regulated users, the same attributes of Table 11 are used, except for: *Prepayment identification for the supplier*, *Cost applied to the debt* and *Amount prepaid*. Additionally, the columns REGULAR and IDENTIFICATION are not considered.

I. Payment Gateway

After obtaining the information on the bill, the user can make the payment through the auto-switching tool if this option was selected in the contract. The basic information sent to the payment gateway is shown in Table 12. This information is based on the requirements to make payments by integrating the PSE API.

Table 12. Information sent to the payment gateway.

Name	Description
Code of the financial institution	It is the code of the financial institution or bank selected by the user.
Cost of the transaction	It includes the cost of the transaction (total cost of the bill)
VAT cost	It is the tax included in the transaction cost.
Redirecting URL	It is the URL sent by the tool to the selected bank so that it can redirect the user to the tool's website at the end of the transaction.
Type of user	To identify if the person making the payment is natural or legal. The information is sent to the bank to process the transaction in accordance with their internal guidelines.
Reference number	Type and number of the document used by the user in the first Reference. Example: CC7178211.

Name	Description
	IP address of the user making the payment. Example: 200.32.81.126. A distinctive value that identifies unequivocally the user making the payment through the PSE button of the company. Example: Subscriber number: 3101001001.
Date of request	The date of the transaction request.
Payment description	It is the description of the payment. This field must contain information that accurately informs the payment concept in progress.

In response to the PSE service, the values specified in Table 13 must be returned.

Table 13. Information received by the payment gateway.

Name	Description
Bank's processing date	The date the transaction was processed by the bank.
Transaction cycle	Transaction cycle
Status of the transaction	Status of the transaction Examples: OK, NOT_AUTHORIZED, PENDING, FAILED
Return code	Return code Examples: SUCCESS, FAIL_TIMEOUT.

J. Additional Services

These additional services aim at earning the user's loyalty and usage of an auto-switching tool with increasing value for its users.

- **Notifications:** The tool must include a module informing the user about the different events that take place during the energy acquisition process and in the tool and suppliers. Table 14 describes the notifications considered.

Table 14. Notifications of payments and services.

Event	Timeline and communication method	Transmission of information
When the tool finds an offer, and it generates savings in relation to the current cost.	Instantly/Email	An alert with the description of the offer published by the supplier.
If the supplier ceases operations, it will automatically switch to the best offer from another supplier.	Instantly/Email	An alert with the description of the event.
When a user makes a manual supplier switch.	Instantly	Notification/Description of the process.
When a user has been inactive for some time, a report with the savings obtained during the period the user	Instantly. 15-60 days after/Notification in the web application.	Report/Message describing the expiration date. Redirection to the offers page.

Event	Timeline and communication method	Transmission of information
had the services will be sent along with new available offers.		
When a user exceeds the established maximum consumption.	Instantly/Email	Alert/Message with a warning about consumption. Link redirecting to the space for education and interaction.
Notifications of billing and payments		
When the payment of the bill is completed successfully.	Instantly/Email	Notification/Description of the successful payment. Amount paid
When the next bill is about to be due.	N days set up before the bill is due/Text message/Web notification	Alert/Message with a payment reminder. Amount to be paid
When a new bill is generated.	Instantly/Text message/Web notification	Alert/Message with new bill generation. Link redirecting to the payment section in the web application.
When the contract is about to expire.	N days set up before the contract expires.	Alert/Message describing the expiration.
When the contract's expiration date has arrived.	Instantly/Text message	Alert/Message describing the expiration. Link to the offers published in the web application.

IV. CONCLUSIONS

This paper analyzed and characterized the auto-switching tools (automatic energy supplier switching) used in the United Kingdom. Eleven of them have OFGEM's confidence code, an independent energy regulator in Britain. After this analysis, and considering the contextualized information of the Colombian energy market (using as a basis Enel Codensa's data), we presented a proposal with the characteristics and functionalities necessary to implement an auto-switching tool in Colombia after adapting the current regulatory system, which is a work that the CREG should lead. By studying the auto-switching tools included in this paper, we found that most of them use the email as the main engagement, communication, and information management method. In addition, some of them provide REST API services that can be used by third parties to compare the rates between suppliers. Moreover, some tools only require the postcode to retrieve the complete information about the property and the current energy consumption. Others offer alert services for tariff

changes, and the user can allow the automatic switch. Finally, they include suppliers that offer renewable energy sources.

The attributes and functionalities proposed in this article for an auto-switching tool suitable for the Colombian energy market contribute to the user's freedom to change the energy supplier automatically. This aims at obtaining better rates and service, and having the possibility to choose renewable energy sources that have less impact on the planet. To estimate the offer, which includes a prediction of the user's consumption and the supplier's tariff, there are two options: an estimation done by the auto-switching tool or direct communication with the prediction system used by the supplier.

The functionalities proposed here allow having regulated and non-regulated users in the Colombian energy market. Additionally, they include automatic notification services when there is an offer that would generate savings compared to the current rate, the supplier ceases operation, the due date of the bill is getting closer, or the contract is about to expire.

An alternative to contribute to the liberalization of the Colombian energy market is to create and promote energy portability programs using auto-switching tools. These allow users to select the supplier most suitable for their needs and benefit economically.

Future work will describe in detail each step of the process (customer acquisition, offer comparison, billing management, payments, additional services) and support the consumption estimate and energy cost predictions to define possible tariffs based on smart applications (deep learning). Finally, it would include the integration of the internet of things based on smart objects such as domotic on/off controls for appliances to reduce energy consumption.

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