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Analysis of Factors that Interfere with the Regulatory Energy Process with Emphasis on the Energy Cloud

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ABSTRACT

The energy cloud (EC) is an emerging theme that has emerged as an option to the issues of managing energy supply and demand, since it makes use of tools that streamline this process, such as cloud computing, data processing, and smart devices. Efforts need to be focused on the regulation of this energy management model and understanding what affects or delays this process which is essential for the diffusion of EC. Thus, the objective of this paper is to present and discuss, through a systematic literature review, the factors that interfere in the energy regulatory process with emphasis on EC. This research resulted in 29 critical success factors (CSF), which, according to similar characteristics, were grouped into 7 fundamental points of view (FPV): Economic, personal or socio-cultural, availability, institutional and market, regulatory infrastructure, external and information factors, and ideology. The CSFs and FPVs were cited 183 times in the selected articles. The analysis of these factors contributed to the identification of barriers that affect the energy regulatory process, delaying the development towards an EC environment, and discussed the main regulatory challenges and opportunities in this area.

Keywords: Energy Cloud, Energy Management, Energy Cloud Regulation, Energy Regulation Process, Critical Success Factors, Fundamental Points of View
JEL Classifications: Q42, K32, P28, P48

1. INTRODUCTION

Due to the increasing energy demand, management measures must be taken to deal with the scarcity of limited resources (Schaefer et al., 2020). In this sense, energy management comprises the procedures to improve energy efficiency from energy use (Lawrence et al., 2019). Therefore, renewable energy sources make energy systems more cost-efficient (Osorio-Aravena et al., 2020), also contributing as an option to increasing energy efficiency. Thus, traditional energy models face new economic, environmental, and social challenges (Ben Abdeljawed and El Amraoui, 2021), as the installed capacity of renewable energy resources is continuously growing (Haidar et al., 2019). The smart grid manages the increase in demand and the complexity of the electricity grid (Sivapragash et al., 2012).

Smart grids monitor and manage the information flow of a city or community (Wang et al., 2019) and thus households can participate in the energy market by making smart use of their resources through devices (Radenković et al., 2020). Therefore, considering this evolution of energy systems, the adoption of new computing technologies to manage this increasingly dynamic market becomes necessary (Schaefer et al., 2021). These smart grid services can be accessed through cloud services (Kumar and Sivapragash, 2016), since this data will be collected in real-time by smart meters placed at the user's site or industrial scale, and this will require huge data processing (Renugadevi et al., 2021).

Cloud computing can be used in the context of smart grids to solve the problem of managing large amounts of information (Ma et al., 2018) once this technology remotely stores, monitors, and remotely controls any region's data (Kulkarni et al., 2019). Thus, with the support of computational processing techniques, cloud computing manages this information through pattern discovery (de Moraes et al., 2019). Bringing this technology to the energy scenario it will be possible to control and monitor energy systems. However, there is still no integrated power grid control that can monitor, evaluate, operate, control, and manage these systems in real-time (Talaat et al., 2020).

In this sense, cloud-based energy management systems, or energy cloud (EC), emerges as an option to this issue. The EC can be considered as a platform with technical and economic conditions to integrate distributed renewable energy (RE) systems with new eco-friendly and smart technologies, such as microgrids, IoT technologies, smart meters, and storage facilities (Giordano et al., 2019). Here, stakeholders can interact directly, without centralized supervision or third-party intervention, where sellers and buyers trade freely through a platform (Ben Abdeljawed and El Amraoui, 2021). In EC, the cloud server helps connect the central controller to manage the energy produced and is responsible for providing real-time analysis and satisfying the energy needs of consumer (Renugadevi et al., 2021).

Research encompassing the topic of the EC has been conducted worldwide. In the research by Schaefer et al. (2020), the basic elements and requirements for EC and its management were presented. Giordano et al. (2019) proposed a management model and an EC platform with a practical application at the University of Calabria. In Carvalho et al. (2021) research, technical, economic, and environmental regulations that can influence the development and diffusion of EC were suggested. All the technology and information about the EC has been growing and gaining more space. Therefore, there is a debate about the impact of policies supporting investment in renewable energy capacities (Bento et al., 2020). Then, it is important to identify negative policy interactions and look for opportunities to resolve or mitigate them, through a critical assessment of the limits that exist in governance processes and structures (Cox et al., 2019).

It is important to clarify the difference between non-cloud-based energy management and EC. In the first case, there is the traditional form of energy management in a centralized environment without an internet connection, characterized by large electricity production plants, this process increases the cost of electricity that reaches the final consumer. With the insertion of distributed generation, bidirectional energy flows were created, starting to generate the technological possibility of connecting to the internet via IoT and thus enabling EC. In the cloud-based management environment, or EC, electricity generation is carried out close to or close to the consumer, who has more autonomy to manage their own energy through cloud computing resources, in addition to lower environmental impact, stability of power lines. transmission and capture of different forms of renewable energy. Therefore, there is a need to analyze the factors that interfere in the regulation process of traditional energy management, and from there, analyze how they can influence the path towards cloud-based energy management.

Considering this context, the need for research that studies the regulatory aspects related to EC management and how to consolidate the implementation of this model becomes evident. The objective of this study is to present and discuss, based on a systematic literature review, the factors that interfere in the energy regulation process, and how these factors can influence in EC regulation. To guide this objective, it was necessary to identify and organize these factors into a hierarchical structure composed of fundamental points of view (FPV) and critical success factors (CSF). An analysis was then made of how these factors affect the development and implementation of energy trading in cloud-based energy environments and also how these factors affect the energy regulatory environments in general. The novelty of the study lies in the investigation of these factors by analyzing and bringing them into the EC context.

This research seeks to bring important contributions such as:

- By identifying and discussing what are the factors that interfere in the regulatory process of EC, this research contributes to the understanding of this environment, helping companies and researchers working in the energy regulatory area
- By identifying the factors that prevent or delay the implementation of EC, it contributes to structuring the decision process for the regulation of this energy management model
- The paper also contributes by discussing what are the main regulatory challenges and opportunities about the EC topic, presenting and discussing how these requirements should be implemented for the development and implementation of this promising energy management environment, serving as a starting point for researchers and companies
- This research provides a clear insight into the regulatory aspects related to the EC and thus contributing to the propagation and advancement of the topic.

The article comprises 7 sections: the next section presents a theoretical reference about the EC scenario and how this theme has been built and debated through research, and section 3 discusses the fundamental points of view (FPV) and critical success factors (CSF) concepts. Section 4 contemplates the methodological procedure used. Section 5 addresses the results and discussions about the factors listed. Section 6 presents some practical implications of the work. Section 7 shows the conclusions, limitations, and future research.

2. ENERGY CLOUD

EC is a platform that manages energy in real time through the cloud, and integrates energy and information infrastructures (Govindarajan et al., 2019), where energy follows a bidirectional, flexible and cleaner flow, connecting users to manage their energy through digital platforms (Carvalho et al., 2021), and dynamically integrates different technologies in a smart grid environment (Schaefer et al., 2020).

Moreover, EC provides technical and economic conditions to support distributed energy generation contributing to meet energy demand (Giordano et al., 2019). Cloud computing used in EC has flexible and scalable characteristics (Dileep, 2020) and the application of cloud technologies generates cost and energy savings opportunities (Basak et al., 2010) (Sequeira et al., 2014). With these technologies, EC connects different users and coordinates energy use according to consumption and generation, and adjusts the optimal storage capacity (Li et al., 2019).

From this EC system, governments will be able to conduct scientific analysis of the potential for energy savings, predict the consumption profile of consumers and advance the behavioral change of electricity conservation (Carvalho et al., 2021). The study by Schaefer et al. (2020) presented a layout composed of seven layers and four support blocks for EC management, and Carvalho et al. (2021) proposed the Regulation layer. In this sense, understanding how the factors that interfere in the implementation of this last layer becomes necessary, considering that these factors can delay the development and implementation of EC environments.

3. FUNDAMENTAL POINTS OF VIEW (FPV) AND CRITICAL SUCCESS FACTORS (CSF)

The FPV can be characterized as strategic performance objectives that organizations use to satisfactorily reflect industry needs (Slack et al., 2002). Thus, the FPVs are the main variables to be considered by decision-makers to assist in the evaluation of business actions to be performed (Ishizaka and Nemery, 2013). FPVs can be considered as groups of variables, and within each one, concepts of the same nature are grouped (da Silva et al., 2016). Each FPV groups sub-levels of variables, which can be measured through metrics such as Key Performance Indicators (Bai and Sarkis, 2012). Schaefer et al. (2021) identified FPV related to the challenges for the diffusion of EC and structured a management model for the implementation and development of these environments.

The sub-levels of variables of the FPV can be composed of CSF. A CSF can be considered the performance to accomplish the mission, vision, and goals, which an organization, institution, department, or project should achieve, and can be derived from a literature review and organizational documents (Donastorg et al., 2020). For the authors, a CSF provides a strong instrument for measuring performance goals. Much researches around the CSF are elaborated, mainly related to the energetic context, as follows: (Maqbool and Sudong, 2018) identified significant CSF for RE projects, for energy companies and governments to use, balancing cost issues and environmental benefits; (Rigo et al., 2019) through CSF, discussed whether the success of small-scale solar energy is feasible in Brazil.

4. METHODOLOGICAL PROCEDURES

This section covers the methodological procedure used in the research. The following subsection presents the protocol of the Systematic Literature Review used to retrieve the articles that contemplate the factors that interfere in the process in question.

4.1. Systematic Literature Review

The objective of this study was to research the factors that interfere in the energy regulation process and how these factors can influence in EC regulation. Therefore, a systematic literature review (SLR) was applied, as recommended by (Dresch et al., 2015), to raise the fundamental points of view (FPV) and the critical success factors (CSF) related to this process. Table 1 composes the filters used in the Scopus, Web of Science, and IEEE databases, in the period from 2010 to the present moment. This period was chosen since energy regulation is constantly changing and, in addition, the EC concept is very recent.

Figure 1 shows the protocol followed in the survey data collection.

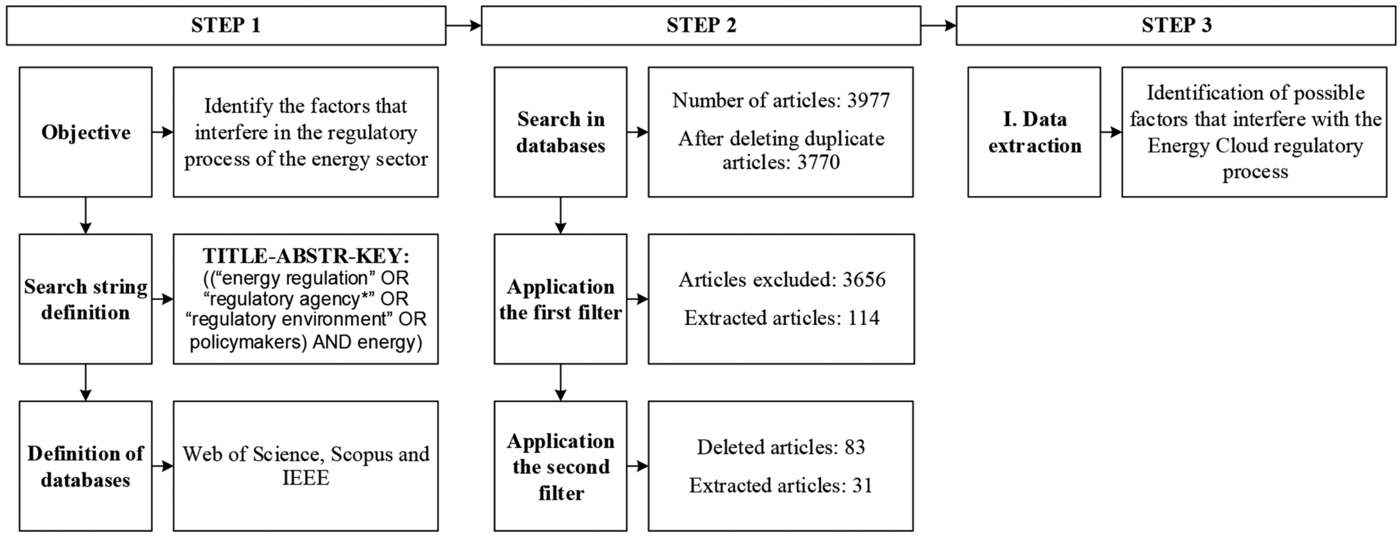
The SLR had the objective of "Identify the factors that interfere in the regulatory process of the "energy sector." This way, the following keywords were defined to contemplate this search: "energy regulation," "regulatory agency," "regulatory environment," "policymakers" and "energy," which resulted in the following search string: (("energy regulation" OR "regulatory agency *" OR "regulatory environment" OR policymakers) AND energy). This string was submitted to different scientific article databases to verify which databases cover the studies in the area. With this, it was defined that Scopus, Web of Science, and IEEE are the most appropriate databases to retrieve research on the subject since these databases cover a large number of high-quality published articles.

The researched articles were saved in the Mendeley bibliographic reference manager and the first search resulted in 3977 articles. After deleting the duplicate articles, 3770 articles remained. The first filter, consisting of the inclusion and exclusion criteria, applied when reading the title, abstract, and keywords, was performed on the articles. The inclusion criterion was to select articles that contained the keywords searched in the title, abstract, or keywords, and the exclusion criterion was to exclude articles that did not cover the searched terms. This step resulted in the extraction of 114 articles.

Table 1: Search filters used in the databases

Filter	Scopus	Web of Science	IEEE
Document type	Article or Review	Article or Review	Journal
Search in	Title, abstract or keywords	Topic	All Metadata
Subject areas	Energy; Engineering; Business; Management and Accounting; Computer Science	Engineering Multidisciplinary; Engineering Environmental; Engineering Electrical Electronic; Management; Construction Building Technology; Business; Law; Political Science; Computer Science Information Systems	Power Grids; Power Generation Control; Distributed Power Generation; Load Regulation; Renewable Energy Sources; Power Distribution Control; Smart Power Grids
Years	2010 – Present	2010 – Present	2010 – Present

Figure 1: Protocol of the systematic literature review



The application of the second filter consisted of a complete reading of the articles extracted in the previous step. When reading these articles in full, attention was given to those who brought information about the factors or barriers that interfere in the regulatory process in the energy sector. Attention was also given to articles that addressed questions about factors influencing decision-making by energy regulators and how this can affect consumers. The second filter resulted in 31 articles that brought these raised points. The last step of the SLR protocol was data extraction, which in this case consisted of listing the factors identified in the 31 selected articles.

These factors were classified as FPV, representing the first level of factors that interfere in the energy regulatory process, and each one is composed of different CSFs, which were grouped based on their affinity with the first FPV level. The results and discussion section is organized in subsections, one for each FPV. The discussion was given through the analysis of these factors, where it was verified how they interfere in the energy regulatory process and how they can influence the development of EC regulation.

5. RESULTS AND DISCUSSION

This section presents and discusses the results obtained in the SLR, where 31 articles were selected for the study. From these articles, 7 FPVs were extracted, considered here as the grouping of CSF with similar characteristics and leading to a common objective and performance, and 29 CSFs that interfere in the energy regulatory process, and these factors were cited 183 times by the articles. The listed factors refer to the energy regulation process in general, and in the results and discussion, these factors were also contextualized considering the EC scope. Thus, how they can influence the development of regulation to a cloud-based energy management scenario were discussed. Figure 2 shows an overview of the results obtained, presenting a hierarchical structure of factors, where the first column includes the FPVs and the second column the CSFs.

The following subsections discuss the factors under each FPV perspective and present each of these factors in detail.

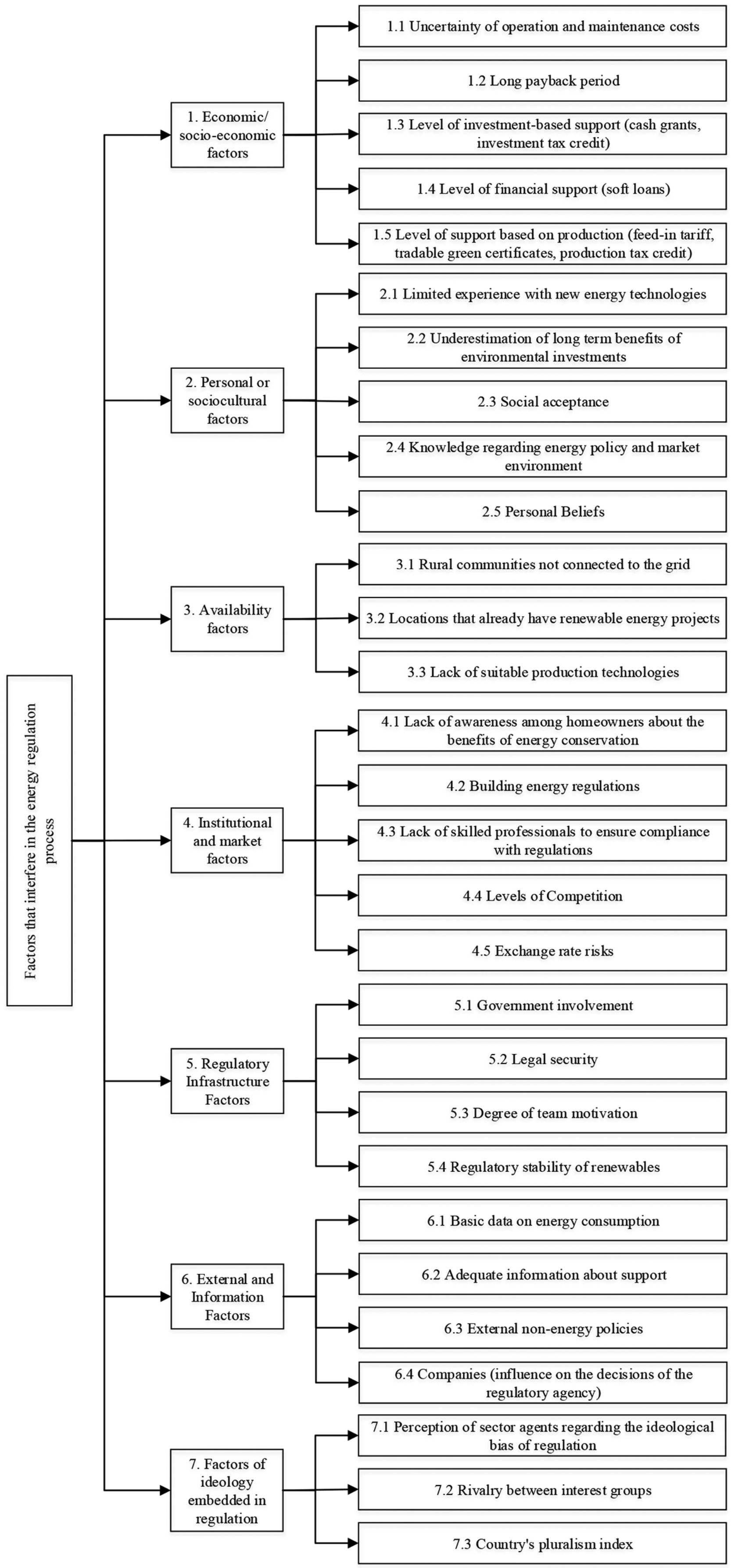
5.1. Economic/Socio-economic Factors

The first FPV listed and most cited was the economic or socioeconomic one, from which five other CSF are derived. This FPV directly influences the development of public policies to favor the consolidation of the EC, since the lack of financial support from the government and subsidy policies regarding investments in self-generation affect the adoption of this scenario. In this sense, a strong change in incentive schemes is necessary to increase the use of renewable energy (Bento et al., 2020). because in addition to the use of cloud technologies, the focus of EC is also cleaner energy sources.

Regarding the CSF “1.1 Uncertainty of operation and maintenance costs,” many users prefer the use of solar energy as an alternative to their current energy sources, however, these users feel limited by the installation and maintenance costs of solar energy systems (Okwanya et al., 2020). For the authors, the use of renewable energy would increase if policy incentives covered some of the maintenance and installation costs for renewable energy users. There may be ongoing operation and maintenance costs associated with control and automation technology that should also be considered as a barrier to purchasing this type of energy (Cappers et al., 2013). This uncertainty of operation and maintenance costs is an obstacle to the development of EC, as it has a lot of technology involved that involves uncertainties. This factor should be considered by policy makers and companies in the area. The factor “1.2 Long payback period” is cited by (Cappers et al., 2013), (Frate et al., 2017), (Blazquez et al., 2018), (Al-Sumaiti et al., 2019), among other authors, and it is known that investment in solar renewable energy projects is managed by incentive policies (Al-Sumaiti et al., 2019).

Local investment policies in the area of green energy resources are needed, and so factor “1.3 Level of investment-based support” encompasses this question. Renewable energy investment falls under the broadest category of infrastructure investment, as it is related to the characteristics of infrastructure projects, such as high initial capital requirements, long asset lives, inelastic demand for services, and the prevalence of fixed costs (Bento

Figure 2: Hierarchical structure of the FPV and CSF



et al., 2020). Incentives that help expand investments in renewable energy projects would guarantee investors reasonable profits in the long run, where the government would provide a discount for investments in clean energy projects, and thus meeting the demand for electricity by reforming current government policy (Al-Sumaiti et al., 2019). In 2018 in Norway, for example, 837 rooftop solar energy installations were made through an investment support scheme for residential installation costs, however, the general population showed little interest in investing in such installations, and prosuming remained of interest only to certain groups that are motivated by other factors than economic ones (Inderberg et al., 2020). Since the basis of the EC is this sharing of energy information and data (Giordano et al., 2019) and there is no interest in the population in becoming a prosumer, the transaction costs involved in this process should be reduced, and all stakeholders should develop competencies to manage their energy transaction processes.

CSF "1.4 Level of financial support" (Al-Sumaiti et al., 2019), (Bilich et al., 2019) is one of the main barriers faced by developing countries as a result of lack of funding. These financial subsidies can be important in facilitating the introduction of new technologies and enabling poorer households to become involved in the implementation of energy regulation and energy efficiency investments (Iwaro and Mwasha, 2010). Therefore, financial subsidies are useful in developing countries where financial constraints are a major barrier to energy regulation practices (Iwaro and Mwasha, 2010). In the northwestern European scenario, for example, the renewable energy market is very attractive and could be significantly enhanced by greater financial support (Lüthi and Prässler, 2011). The lack of financial support also interferes with the low number of prosumption for the general population to start prosuming (Inderberg et al., 2020).

The low financial support may be linked to the government's lack of interest due to the strong lobby of large companies, considering that there may be pressure from companies in the electricity sector, which may have a drop in sales and a drop in tax collection. On the other hand, in Brazil, there is the Incentive Program for Alternative Sources of Electric Energy, which aims to increase the participation of renewable sources in the production of electric energy, privileging entrepreneurs who do not have corporate links with transmission concessionaires or distribution (ANEEL, 2020). In addition, there are also Research, Development, and Innovation (RD&I) projects on energy alternatives conducted by universities or energy companies, from the regulatory investments. Bringing this CSF into the EC context, a portion of financial support could be allocated to knowledge propagation to understand the vast amount of information and technologies that the EC contemplates. In addition, existing subsidies could be transferred to the acquisition of EC technologies, such as smart meters, sensors, computational processing equipment, among others.

CSF "1.5 Level of support based on production" contemplates feed-in tariffs, tradable green certificates, and production tax credit (Al-Sumaiti et al., 2019). Here, bonus issues for the adoption of clean energy sources come in. Local governments need to develop climate policies and regulations of greenhouse gas emissions, increasing their role in controlling alternative sources of energy production (Armstrong, 2019). In the United States, production-based support is a widely used instrument (Lüthi and Prässler, 2011). The implementation of incentive mechanisms can stimulate investment in renewable energy. These incentives, such as feed-in tariffs, carbon taxes, quantitative-based instruments (such as renewable portfolio standards), tradable renewable energy certificates (RECs), cap-and-trade schemes, and auction- or bid-based policies, are important for accelerating the growth of emerging technologies (Bento et al., 2020).

Therefore, regulations that focus on economic and socioeconomic factors are of utmost importance for the spread of the EC, since it will be an energy management model that will involve a large amount of information and computing technology.

5.2. Personal or Sociocultural Factors

The level of awareness of the population also interferes with the use of renewable energy (Okwanya et al., 2020). About "2.1 Limited experience with new energy technologies," it is known that policies focusing on boosting technologies, such as government-funded R&D, are deployed to increase supply, where innovation is a key to provide and make existing technologies more marketable since often these technologies cannot compete in the market without policy support (Bento et al., 2020). For the regulatory issue of EC, there must be first wide dissemination of knowledge about the topic, where market agents who have an interest in the development can assist. Still, considering that more and more energy generation is becoming closer to the consumer, policies that guarantee or collaborate in the access to technologies that the EC contemplates have great importance, given the lack of knowledge on the subject and the high cost of access to these devices.

Regarding the CSF "2.2 Underestimation of long term benefits of environmental investments," there is a disconnect among most consumers regarding access to renewable energy contracts, where there is often no knowledge about the origin of the energy that is consumed. This suggests that policymakers be strategic in adopting and disseminating policies to maximize population participation, however in many cases, it may be impossible to enact a regulation across the state or country due to political constraints or because the majority of the population would not support it (Armstrong, 2019). The direct negative impact that these conditions provide is to slow down the implementation of the EC, which is why policies focused on propagating the real long-term environmental and financial benefit must be formulated and put into practice.

Factor "2.3 Social acceptance" deals with the conformism of energy users to current forms of consumption. Information about new energy technologies is accessible to a large part of the population, but there is a lack of understanding about their benefits. Social acceptance plays an important role (Bento et al., 2020) in the process of formulating regulations. This is because socio-cultural barriers can arise from inadequate attention to the issue of climate change or the social consequences of some projects (Sen and Ganguly, 2017), which leads to a lack of understanding of the positive impacts that these changes bring.

Populations with higher levels of education and income are more likely to adopt climate policies (Armstrong, 2019). CSF "2.4 Knowledge regarding energy policy and market environment" is a barrier to EC diffusion, considering that for its practical adoption, energy policies focusing on climate issues need to be changed or implemented. Therefore, it is necessary to improve communication, especially with the less enlightened or poorer population, so that people can better understand the benefits of EC. The CSF "2.5 Personal Beliefs," can provide important information about the choice of policy instrument, being a factor that shapes the policy process (Kammermann and Angst, 2021). (Parsad et al., 2020) define personal belief as a barrier to renewable energy acquisition and point for example to the aesthetic belief that solar panels can cause residences to look ugly. Therefore, social and political institutions can act as facilitators on this path.

People have an aversion to change, however, the EC is a future demand for greater consumer participation in the energy market independently. Therefore, without dissemination and engagement of society to accept the new technologies and forms of relationship with energy companies, there may be resistance to change by consumers. Therefore, personal or sociocultural factors are an obstacle to the propagation of regulations that encourage the transition of users to the EC, since without the correct understanding of the use and advantages of this management model, consumers will not see the benefits.

5.3. Availability Factors

Issues such as difficulty in connecting to the grid, locations that already have renewable energy projects, and lack of appropriate technologies are the CSF under the FPV "Availability." The current incentive policy of governments limits the rural sector's response to switching from traditional energy to modern, clean energy sources, as many rural residents prefer the use of traditional energy sources, such as firewood, due to the reliability of supply (Okwanya et al., 2020). This weak patronage of renewable energy technology among most rural communities can be explained by people's lack of skills and the cost of maintenance due to the low level of people living in these areas (Okwanya et al., 2020). In this context, the CSF "3.1 Rural communities not connected to the grid" interferes in the process of creating public policies for energy, since the lack of connection to the transmission and/or distribution grid of these areas, makes it impossible to consume renewable energy that most often are in locations far from the load center. In addition, studies on the response to policy incentives in rural areas are few (Okwanya et al., 2020).

As for CSF "3.2 Locations that already have renewable energy projects," it is known that the lack of basic infrastructure and local skills can interfere with investments in the area (Bento et al., 2020). Policies should be adequate to regulate the need for financing new projects to use renewable energy and expand existing projects (Al-Sumaiti et al., 2019). The electricity grid has a certain distance that brings limitations, this is a barrier to the creation of energy policies. That is why, the CSF "3.3 Lack of suitable production technologies," appears as another barrier. The cost of these technologies is the main challenge and has hindered the use of energy regulation of buildings for example, because the technical level of most developing countries lags behind some developed countries, forcing developers to import equipment and new technologies from abroad at a higher cost (Iwaro and Mwasha, 2010). This lack of technologies requires investments, but the reality in many countries is that they lack basics, such as sanitation and education.

Therefore, the creation of policies that contribute to the diffusion of EC is hindered, considering the technological bias of this energy management model where the main challenge for technological propagation is the cultural and economic differences between regions.

5.4. Institutional and Market Factors

"4.1 Lack of awareness among homeowners about the benefits of energy conservation" and "4.3 Lack of skilled professionals to ensure compliance with regulations" are two factors that affect the creation of renewable energy policies as well as the propagation of existing ones, since the lack of awareness about the use of RE and the lack of professionals make any public policy impossible. Without the involvement and information of the communities about the possible benefits that renewable energy can promote, then little importance will be given to the socio-environmental sustainability benefits (Frate et al., 2017). Okwanya et al., 2020 noted that the high cost of renewable technology is not the only factor inhibiting the implementation of renewable energy projects, with more compelling being the lack of qualified personnel to put this into practice. In addition, there is poor technology patronage in low-population communities (Okwanya et al., 2020), and therefore greater regulatory attention should be paid to this sample of energy consumers.

The building sector also interferes in the creation of energy policies and the development of regulations focusing on energy efficiency for buildings should be considered. CSF "4.2 Building energy regulations," addresses this issue. To develop a building energy regulation, incentives such as tax reduction, gross floor area grant, and certificate of merit, can be offered by the government to promote the newly released energy-efficient building regulation (Chan, 2019). Policymakers are advised to incorporate an evaluation phase of building energy regulation development, and thus it is possible to examine the environmental effects of regulatory requirements in energy-efficient building projects (Chan, 2019).

As for the CSF "4.4 Levels of Competition," it is known that a broad and competitive energy market will lead to increased demand, high consumer competence and expectations, greater homogeneity of product offerings, high market transparency, absence of trade barriers, among others. With this, the increase in the number of firms, such as installers, intermediaries, and producers, leads to the decentralization of firms and increased competition (Strupeit, 2017), which is beneficial to promote technological development and dissemination of renewable energies and consequently EC.

"4.5 Exchange rate risks" is another factor affecting the creation of energy policies (Bento et al., 2020). Regulatory measures related to the abolition of exchange rates, stimulate competition in the retail market since much energy equipment is imported and this measure stimulates the purchase of them (Nepal et al., 2014). Exchange rate risks negatively impact any technological development when the national currency loses value and imported products become more expensive. This makes the development of public policies unfeasible and therefore, regulatory measures capable of identifying, standardizing, and managing these risks need to be identified and considered when formulating energy regulations. The exemption or reduction of import taxes on renewable energy installation and maintenance equipment, as well as consumption monitoring devices, is one step towards greater access to these largely imported technologies.

5.5. Regulatory Infrastructure Factors

The regulatory infrastructure itself can be a barrier to energy policymaking and was therefore listed as an FPV composed of four CSFs. The first factor is "5.1 Government involvement." The government's role in this process is clear, such as reducing bureaucratic burdens and regulating rights and obligations, however, some of this work could also be done by other players and stakeholders (Inderberg et al., 2020). Many of the local governments are using money associated with the purchase and sale of energy to implement and expand a variety of energy efficiency, renewable energy development, electrification, and emissions-related programs in their communities (Armstrong, 2019). The government's involvement in the regulatory process can be advantageous because it favors the public interest, being neutral and transparent in decisions, but on the other hand, there is the slowness in the process, and also the possibility of the government benefiting itself during the decisions of this process, either by lobbying companies or individual interests. Therefore, it would be interesting if the responsibility were shared between public and private, where the government could play a supervisory role and there would be a regulatory agency acting independently from changes in government. In any case, the regulatory process needs to consider the balance of relations between investors and energy users.

"5.2 Legal security" is another factor that interferes with energy policy development, as it creates confidence in contract enforcement and predictability of legal decisions. Legal certainty includes general legal stability, a country's history of legal conduct, levels of corruption, the enforceability of contracts and, trust between business partners (Lüthi and Prässler, 2011). The lack of legal security makes every investment a high risk, which reduces the attractive interest of domestic and foreign investors, causes uncertainties, inhibits the operation of the market, delays receipts and payments of agents who operate in the electricity market. These factors, reduce investments in the energy sector and consequently generate delays in the creation of policies for the EC.

The degree of motivation of the whole team and the regulatory area in particular is another factor that can interfere during decision making for energy regulation (Bastos et al., 2011), and therefore, the CSF "5.3 Degree of team motivation" was listed. Therefore, performance measurement systems that map the competencies of the team as a whole, in addition to dynamic regulatory competencies to internalize the changes and demands of the legal and regulatory environment, can be incentive measures for the team (Bastos et al., 2011). There needs to be interest from all parties involved in this process, such as investors, regulatory bodies, and consumers, and also a verification agency to track and audit energy regulatory departments during this policy development process, also including public participation.

"5.4 Regulatory stability of renewables" is another one that interferes with the energy regulatory process (Armstrong, 2019). The insertion of smart grids into an already consolidated energy model presents regulatory challenges, considering the existence of lagging regulations in terms of renewable energy. Therefore, efforts to overcome regulatory challenges and address technical deficiencies must be made, since there is a need for automation and deployment of data communication systems (Martins et al., 2020).

5.6. External and Information Factors

There are also factors external to regulation that interfere with the energy regulatory process, and among them, the SLR listed four CSFs. The first, "6.1 Basic data on energy consumption," concerns information regarding data such as consumption and forecasts for correct energy sizing. In many developing countries, basic data on energy consumption is lacking. This is a problem because policy instruments require knowledge of energy consumption to measure the success of regulations (Iwaro and Mwasha, 2010). Energy procurement data and forecasts serve to assess the effects of policy in terms of renewable energy, showing the energy needed to meet users' electricity demands each year, in addition to the amount of renewable energy available (Armstrong, 2019). This consumption and production information needs to exist and be known by regulators to establish strategies for the economic sustainability of energy as a whole.

Energy systems are not only impacted by energy-focused policies but are shaped by a wide range of other policies, being affected by a wide range of policies coming from other sectors (Cox et al., 2019). As examples of external policies that influence energy policies can be cited internet technologies, such as information and communication technologies (ICT) that are drivers of increased electricity demand, also the increased electricity load from computers, mainly for cooling servers and at peak times of ICT use (Cox et al., 2019). Here also the CSFs "6.2 Adequate information about support" and "6.3 External non-energy policies." These informational barriers are important factors that can make renewable energy projects more expensive or even economically unfeasible (Bento et al., 2020).

Another external factor of strong influence on energy regulatory decisions are the companies, so it was listed the CSF "6.4 Companies (influence on the decisions of the regulatory agency)" (Bastos et al., 2011). The energy chain has a wide range of interactions with various stakeholders, such as businesses, consumers, authorities, and other organizations. Policymakers need to consider the importance of interested companies in this process since this factor interferes with the spread of renewable energy and consequently the interconnection of users (Strupeit, 2017), which is the basis of EC.

In the case of EC, regulations should not be focused only on generation, transmission and distribution, but rather on all the layers that this energy management model comprises, such as infrastructure in general, communication networks for long-distance data transmission, brokerage for buying and selling, data security and privacy, data processing and storage, and platform services for interaction with consumers. Therefore, the EC will have strong influence from policies in other sectors and not only those focused on energy, where the question will be how to integrate all these policies in a way that they talk to each other and support the EC model.

5.7. Factors of the Ideology Embedded in Regulation

Ideological factors are also present in energy regulation. Here, three CSFs were listed, being: "7.1 Perception of sector agents regarding the ideological bias of regulation," "7.2 Rivalry between interest groups" and "7.3 Country's pluralism index" (Bastos et al., 2011). For example, a more liberal government's ideological orientation increases the likelihood of such policy adoption, ideological factors also predict governments that are more susceptible to adopt climate change policies (Armstrong, 2019).

The rivalry between interest groups affects the regulatory process as the difference in economic interests, for example, can affect the decision-making of that process. In addition, there may be pressure for regulatory aspects to be set according to certain technologies of certain companies. Therefore, the autonomy of regulatory agencies is necessary, since this does not benefit a specific sector of the energy market.

6. PRACTICAL IMPLICATIONS FOR POLICY-MAKING AND REGULATION

Based on the discussions in the previous sections, this paper brings a series of practical implications that contribute to the formulation of energy policies and regulations, especially regarding aspects related to the EC. Thus, some strategies can be suggested:

- The structure presented in Figure 2 with the definition of the 7 FPVs and their subdivision into CSFs aims to help policymakers to direct efforts, concentrating and categorizing the factors according to the scope of the desired impacts
- From the findings of the SLR, one can see clear shortcomings related to the regulatory infrastructure directed to the development and implementation of EC. Even though there is a technological evolution towards energy management in a cloud environment, there is little discussion about increasing regulatory robustness by anticipating this evolution and saying how these new technologies will be incorporated to assist in the management of energy systems
- The greater concentration of economic and socioeconomic factors and institutional and market factors suggest that adopting corporate governance practices that focus on these factors may be one of the key balancing points of developing cloud-based energy management environments
- The research also suggests that the personal or socio-cultural factors need a strong practical approach, which can reverse the current frameworks and add knowledge by improving the social acceptance of the use of new energy-related practices for the well-being of the population in the future
- The previous point added to ideological factors has a significant impact on the formulation of policies related to energy management. Thus, one might suggest the adoption of policy-making and regulatory practices that automatically evolve into a system of triggers over time, and that this trigger system be technically constructed by independent agencies based on international standards. In this way, whenever a certain technological, energy consumption or generation, or even social milestone is reached, there can be a step-change in the regulatory requirements of the sector.

7. CONCLUSIONS

The energy regulatory environment is composed of factors that interfere in this process, either positively or negatively. Understanding what these factors are and how decision-making is influenced during this process is the beginning of identifying gaps and improvements to satisfy all stakeholders in the energy chain. Furthermore, identifying and understanding these factors contributes to the propagation of a regulatory environment for the EC. Therefore, the objective of this study was to present and discuss, through a systematic literature review, the factors that interfere in the energy regulation process, and how these factors can influence in EC regulation. Considering this objective, the SLR made it possible to list these factors and relate them to the EC context, verifying how they interfere in the energy regulatory process and how these factors could be improved.

By considering the opinions of different researchers, this article demonstrates several practical contributions by describing the factors listed and can help energy regulators on the path to policy reform with an emphasis on EC. Moreover, this study will contribute to the development of future research, leaving as a suggestion the analysis of the relationships between the factors through a mathematical model, thus verifying which points should be attacked first in an energy policy reform, paying attention to the most influential factors in this process.

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