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Article

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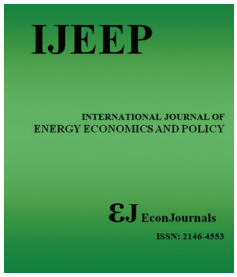

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Review on Rural Energy Access Policies

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ABSTRACT

Rural energy in all their dimensions, not only access, but also sources, supply, consumption, program management, project maintenance, control and evaluation has been a neglected area in national energy planning in developing countries. As a result, nearly two billion people all around the world lack access to commercial energy, particularly to electricity and clean cooking appliances. Poor people still depend on traditional sources of energy that are used inefficiently. The unplanned exploitation of local biomass resources, mainly for basic needs such as cooking, generates serious environmental problems. In this sense, women face hardship in the collection of biomass and exposure to smoke that adversely affect their health. Therefore, this study aims to explore rural energy policies through a systematic literature review about rural energy access as a problem to be solved by means of an adequate rural energy policy. The study tries to raise the general settings of rural energy access, their challenges, barriers, and alternatives for solution, especially through the consideration of rural energy policy as an alternative to achieve a sustainable solution for rural poverty. Besides, by organizing and collecting concepts, this review contributes to a better understanding of these topics and their general issues, particularly in Latin America. Considering the general context as an initial condition, and the universal energy access as the perfect condition, rural energy policy becomes the central strategy to ensure universal energy access in all rural areas, trying to transit from an initial to a perfect condition.

Keywords: Rural Energy Policy, Rural Energy Access, Rural Energy Poverty, Rural Electrification, Clean Cooking Alternatives
JEL Classifications: Q40, Q43, Q48, Q49, R10, R58

1. INTRODUCTION

The link between energy and development moved into the international agenda during the World Summit for Sustainable Development held in 2002, highlighting the need for new efforts and policies to promote electrification in developing regions (Gómez and Silveira, 2010). The decade of sustainable energy declared by the United Nations Organization, between 2014 and 2024 (Martínez-Gómez, Guerrón and Riofrio, 2017) has as the main purpose, closing the rural areas gap for efficient, sustainable and affordable energy resources for all. In this sense, the design of effective policies is necessary and the recovery of information through exploratory and descriptive works, e.g., literature reviews, is helpful to achieve this purpose.

Goldemberg and Prado (2013) pointed out that increases in electrification benefit more than increases in income because electricity induces social and individual development. In 2016, the Secretary-General of United Nations and the president of the World Bank called to all countries to commit themselves to universal modern energy access by 2030. Several international agencies such as the International Energy Agency, the European Union, and the Energy Management Assistance Program (ESMAP) are building scenarios about how to accomplish these purposes (Van der Vleuten, Stam and Van der Plas, 2013).

This manuscript intends to offer a holistic insight into the evolution of rural energy access and rural energy policies, covering the transition from a planned economy to a market economy through

structural reforms in Latin America[1]. Broadly, a comprehensive rural energy policy is lacking, and most policies focus on techno-economic aspects. Commonly, techno-economic rural energy policies are concentrated in a single aspect of one or multiple energy sources[2].

Rural energy policies are problem-oriented, deficient in predictability, and are often designed to solve specific energy issues (He, Hou and Liao, 2018; Nygaard, 2010). Only when these issues require an urgent solution, governments attend and promulgate related policies (Pinheiro, Rendeiro, Pinho, and Macedo, 2012; Panos, Densing and Volkart, 2016; Jimenez, 2017; Gacitua, et. al., 2018). However, due to a lack of planning, the formulation and implementation of these policies are uncertain and policy makers are unsure to what extent rural energy issues can be addressed by these policies (Wu, 2019; Ciller and Lumbreras, 2020; Qurat-ul-Ann and Mirza, 2020). Then, here a conceptual analysis for energy access, providing insights about electrification and clean cooking alternatives in the regional rural energy policy context. We also make a proposal for a problem-solving oriented approach that includes a revision of transcendental issues related to rural energy poverty.

2. INSTRUMENTATION OF THE STUDY

This study aims to address rural energy access through a policy perspective, i.e., making emphasis on the need to employ specific rural energy policies to increase energy access. The manuscript has been configured by a systematic literature review about general aspects, challenges and issues to solve through the adoption of policy strategies. In this regard, a systematic literature review is a type of data analysis that represents a transparent and reproducible methodology "that locates existing works, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in such a way that allows reasonably clean conclusions to be reached" (Denyer and Tranfield, 2009).

Several works address only electrification from a techno-economic perspective, while other literature reviews address only clean cooking[3]. Despite the importance of these contributions, there is a need to provide a more comprehensive analysis of the elements affecting rural energy access and the distinctive traits of energy for rural areas that pose the need for a specific energy policy. Specifically, adopting a systematic approach, this study addresses the following research questions:

1. What are the drivers and barriers that influence rural energy access, considering the resources to cover all household needs?
2. How the problem of rural energy access, considering electrification and clean cooking access, is related to the need for a rural energy policy?

1 To the best of the authors´ knowledge, this manuscript is pioneer in approaching a specific regional context.

2 However, rural energy policies evolve according to the change in rural energy issues, e.g., consumption paths.

3 Lewis and Pattanayak (2012) analyzed 32 manuscripts to identify the determinants of fuel and stove choice, while Puzzolo et al. (2016) reviewed 44 articles focusing on the adoption of clean fuels. Bonan et al. (2017) conducted a review to identify barriers and drivers of the adoption of different clean fuels and their impact on development and poverty reduction.

In this sense, it is necessary to point out that almost all works about rural energy access are approached in a singular specific-project, technical or economic perspective, but not from a policy perspective. Taking these assumptions as our starting point, the purpose of this manuscript is to develop a systematic literature review that helps to understand the general settings to approach the rural energy access problem better. From a methodological perspective, a systematic literature review involves several steps that have been applied to this study, these steps are (Denyer and Tranfield, 2009):

1. Formulate and define questions to be investigated, establishing the focus of the literature review
2. Locate documents as the materials for review
3. Evaluate and apply selection criteria to identify the documents relevant to the scope of the study
4. Proceed to apply analysis and synthesis methods that involve the evaluation and comparison of selected articles. This process allows associations and recognizing knowledge that is not apparent from reading the individual manuscripts in isolation.

3. ANALYSIS OF THE RESEARCH THEME

Rural energy access can be modeled as a multifactorial task connected to large number of social, economic, and environmental aspects. It is necessary to consider not only techno-economic competitiveness, but also socio-cultural dynamics and environmental consequences, making rural energy a complex challenge. Many electrification, and clean cooking access projects have failed due to lack of attention in issues beyond financial and technical dimensions (Rahman et al., 2013). Thereby, this research aims to address the problem from a policy perspective. Despite increasing attention towards this topic, few works have explored the factors influencing energy access in rural areas and the adoption of a specific rural energy policy. Then, this review aims to identify the main drivers and barriers to achieve rural energy access – electrification and clean cooking – from a political perspective. Also, it contributes to explain the general problematic.

A thematic analysis revealed the elements that may act as drivers and barriers to rural energy access, and which need to be addressed by a rural energy policy. In a broader classification, the elements are grouped in economic aspects; socio-demographics; fuel availability; attitude toward technology; awareness of the risks of traditional manners and the benefits of energy services; location; and social and cultural influences. Previous findings suggest that the availability and affordability of technology are not enough to cause energy adoption. Rather, policymakers and governments should approach energy access and customer needs with a less technical and a more social and personalized approach that considers the local context and its social and cultural dynamics (Vigolo et al., 2018).

4. BASIC CONCEPTUAL ASPECTS: FROM ENERGY POVERTY TO ENERGY ACCESS

Energy poverty refers to people that do not have regular, reliable, confident, and accurate access to electricity (Nagothu, 2016; Yadoo and Cruickshank, 2017; Ozughalu and Ogwumike, 2019). Pachauri

and Spreng (2003) defined energy poverty according to the access to energy services, since access to more efficient energy sources enhance the quality of human development and social prosperity (Pereira et al., 2013)[4].

On the other hand, according to the World Energy Outlook 2011 (OECD/IEA, 2011), energy access is defined "as a household having reliable and affordable access to clean cooking facilities, connection to electricity and an accessibility to increase their electricity consumption across time to reach the national average". The definition of energy access usually includes both electricity access and access to modern fuels for cooking to replace traditional biomass (Sarr, Dafrallah, Ndour, and Fall, 2008; Hou, et. al., 2017), because only electricity for basic needs is not enough for poverty alleviation and economic development.

Energy is essential to economic development, poverty alleviation, and social progress, necessary to achieve the Millennium Development Goals (Yadoo and Cruickshank, 2012; Van Ruijven, Schers, and Van Vuuren, 2012; Rosenthal, Quinn, Grieshop, Pillarisetti, and Glass, 2018). Energy services are necessary for the successful implementation of all development programs, productive activities, health, education, water, food security and agricultural development (Coelho and Goldemberg, 2013; Detchon and Van Leeuwen, 2014). Energy access envisages two ambits for a rural household: the electric perspective, enough connection that solves the basic lighting needs, the use of radio, TV, and electric appliances; besides, a more ambitious step is electricity for productive uses like education and telecommunications (Zuluaga and Dyner, 2007; Bazilian, et. al., 2012). Moreover, a clean cooking approach that allows transiting to a sustainable solution[5].

5. INSIGHTS ON POLITICAL ISSUES AND ENERGY ACCESS IN A LATIN AMERICA REGIONAL CONTEXT

Electricity coverage in Latin America has increased substantially in recent decades, rising from 50% of the population in 1970 to more than 95% in 2015 (Sheinbaum-Pardo and Ruiz, 2012). Growth, however, slowed in the 1990s as many countries had trouble in extending their networks further, in particular to serve those living in isolated and rural areas (Krauter and Kissel, 2005). In spite of this, the process of electrification continued and at the beginning of the 2010s decade, most countries in the region achieved access to electricity for almost all their populations. A combination of policy efforts has made it possible to achieve the current situation of universal electrification in the region (Banal-Estañol et al., 2017). However, the per-capita consumption levels remain beneath the suggested rates and the access to clean cooking are still limited. This situation is a consequence of the restricted political perspective.

Since the 1980s, governments, international donors, and cooperation agencies have actively worked to boost the region electrification. Most of the resulting coverage increase in countries such as Bolivia, Peru, and Honduras, has been generated in urban areas, where per capita income is high, and the costs of expanding the grid are relatively cheap. Nevertheless, electrification rates in rural areas have remained beneath the country averages, especially in Central America and the Andes. This situation is still affecting the great economies in the region such as Brazil and Mexico (Gómez-Hernández, et. al., 2019).

Another salient feature of the Latin America electricity markets is the significant differences in consumption levels across countries, which suggests that access to electricity alone does not mean that all consumers can reap all the service benefits. While per capita consumption is quite high in Argentina, Uruguay and Venezuela, it is significantly low in countries like Haiti, Guatemala, Nicaragua, Honduras, Bolivia, and El Salvador (Banal-Estañol et al., 2017).

Wolfram et al. (2012) examined the patterns of electrification across the developing world and found that electrification is consistently correlated with GDP per capita. Brown and Mobarak (2009) analyzed a group of 57 countries in the period 1973–1997 and showed that in poor countries democratization has meant an increase in the proportion of residential electricity above the industrial consumption, suggesting that democratic governments reflect better the preferences of the population and dedicate more resources and efforts to electrification.

Part of the increase in access and electricity consumption in Latin America can be attributed to the reform of the electricity markets that took place in the region during the last century. Until the 1990s, power sectors in the region were mostly managed by vertically integrated state-owned firms; based on the rationale that public monopolies could harness scale economies, make efficient use of scarce managerial skills and offer the service at an affordable price, even generating social tariffs to attend the poor people. However, by the mid-1990s, the economic situation of the region together with the inefficiencies and managerial problems of these firms led many governments to reform the sector, introducing several changes mostly oriented to the economic aperture of the industry. Many countries privatized their public monopolies and liberalized the energy market intending to attract investors and promote free-market competition (Victor, 2005; Calzada and Sanz, 2009).

The macroeconomic fluctuations of the 1970s and 1980s in most Latin American countries had a strong negative impact on public investment in the power sector. As the global economy slowed down, many countries simply could not afford to invest in their power sectors, leading to a decline in the quality of public services and multiple lack of enough capacity in their provision. Simultaneously, consumer demand steadily rose due to the development of the region and the urbanization process, resulting in considerable supply gaps and dissatisfaction with public supply. Consumer prices in the state-owned power sectors were heavily subsidized, which meant state-owned power firms ran continual losses. Against this backdrop, energy sector reforms became a means for governments to gain much-needed capital through the

4 Some countries has reached universal electrification. However, remains a lack in clean cooking access, exacerbating rural energy poverty, because electricity is irrelevant to cook, main activity in rural households (He, Hou, & Liao, 2018).

5 In this sense, a more sustainable solution considers reliable and affordable at household income levels, clean in the source and friendly with the environment, and healthy and equitable for people.

sale of public infrastructure, and to reduce public spending on subsidized tariffs (Wamukonya, 2003). International institutions were also a large driving force behind the power sector reform. In 1993, the World Bank made power sector loans conditional on commitments to private sector participation and liberalization (World Bank, 1993). Many other institutions, including the Inter-American Development Bank, began similar practices shortly afterward. Liberalization and privatization are often presented in the literature as attempts not only to improve efficiency in the power sector but also to bring about a wholesale change in ideology, with electricity going from a public service to a market commodity. Initially, power sector liberalization brought in the needed private sector investment to all Latin America.

By the 1990s, the region had the largest share of private electricity projects among all developing regions worldwide. More than 38% of total investment in the developing world's power sector was concentrated in Latin America (Henisz et al.). Although the promised investment arrived, it was largely concentrated in the more profitable areas with cheap costs and large demands. There is evidence that the power sector reforms brought loss reductions while extending coverage, increasing consumption, and reducing prices in several countries (Henisz et al, 2005 and Balza et al., 2013).

The privatization process in the region took place in conjunction with the vertical unbundling of the sector into its three basic business units - generation, transmission, and distribution. Most governments transferred generation, and to a lesser extent distribution and transmission, to the private sector. Simultaneously, they established new regulatory frameworks and market mechanisms to encourage competition. These transformations changed the institutional framework and the regulatory instruments available to supervise the sector, opening the door to new scenarios that favored the mix of public and private intervention to solve policy problems (Banal-Estañol et al., 2017)[6].

However, some countries in Latin America have partially reversed their policies due to changes in their governments´ ideology and a certain disenchantment with the results of the reforms. This is the case of Bolivia, which in 2010 initiated a nationalization process that reversed the changes introduced in the 1990s. Similarly, in Venezuela several industries have been nationalized in the last few years. In spite of this, most Latin American countries have consolidated a regulated competition system and have tried to equilibrate the undesirable effects of liberalization by implementing electrification policies. A common effect of privatization is that private investors tend to focus their efforts on urban areas, where they have more high-income consumers and benefit from scale economies. In rural and remote areas, by contrast, the service is usually non profitable for private investors. To compensate this lack of attention, since the 1990s, national governments have implemented specific electrification programs by investing part of the profits derived from the energy industry structural changes. Chile has been a pioneer launching such an electrification program. Other countries, like Colombia and Peru, have implemented specific rural electrification policies, and many others have created funds for rural electrification (e.g., Mexico and Argentina). The Brazilian program "Luz para Todos" is considered the biggest rural electrification program in the world. Most Latin American countries use social (subsidized) tariffs to boost affordability of the service (Slough, Urpelainen and Yang, 2015).

The regional heterogeneity of rural residents' willingness and interests are not adequately considered in the process of rural energy policy design and implementation. The current rural energy strategy and policies emphasize the nationwide use of renewable energy and clean biomass energy to achieve sustainable development in the new era, while the roles of commercial energy, such as liquefied petroleum gas (LPG) and electricity, are frequently neglected (Wu, 2019). While there are very few countries where, apart from traditional biomass, renewable energies have been able to provide a solution to energy access for the poor, Governments has abandoned its "menu of alternatives approach" and replaced this with a "renewable energy approach" (Vleuten et al., 2013), complicating the coverage of energy needs and reducing the effective solutions.

In many countries, a significant percentage of the population still uses biomass for cooking and heating, rather than clean energies. For example, this is the case of 12.5 million people in Brazil, 10.7 in Peru, 9.6 in Guatemala, and 7.1 in Colombia (IEA, 2014). There is a broad consensus in the literature that households tend to replace traditional cookstoves with modern ones when their socio-economic situation improves (Hosier and Kipondya, 1993; Masera et al., 2000; Heltberg, 2004; Pachauri and Spreng, 2004 as cited in Banal-Estañol et al., 2017). However, the challenges faced are rather more complex because poor-income households usually consume a fuel portfolio composed by a mix of resources to satisfy their different needs (Ruiz-Mercado et al., 2011; Hanna and Oliva, 2015).

At regional level, Brazil is the most representative case for success in rural electrification through a massive and specific program. The country has translated the electrification policy into the own institutional and legal framework. This implies a clear transfer of responsibility to the concessionaires to implement the policy in their concession areas according to well-defined guidelines. This responsibility went from information provision to implementation of connections and cost allocation within their specific concession areas (Gómez and Silveira, 2010). However, there is a program gap measuring the programs´ success and identifying the drivers for rural electrification.

In this sense, a key aspect is the development of indicators to know the transcendence of programs, for instance, some authors have developed indicators clustered into four sustainability dimensions: institutional, economic, environmental, and social (Feron and Cordero, 2018). In this sense, more comprehensive energy poverty measurement frameworks such as the Multidimensional Energy

6 Balza et al. (2013) show that in LA the intensity of private investment in power sector didn´t significantly affected the increase in coverage. By contrast, liberalization and creation of independent agencies had a positive effect on the expansion of service. During the 1990s, new regulatory models were established to introduce competition in the supply chain, especially in generation, but also in transmission and distribution. Moreover, price regulations and subsidy schemes were established to allow fair conditions for consumption, regulated users, and set the financial sustainability of firms.

Poverty Index (MEPI), and more recently the Multi-tier Framework (MTF), have been introduced to encourage decision makers to generate long-term and holistic energy policies. These tools might help encouraging better policies for rural energy access.

Some of the main drivers of electrification in Latin America have been related to economic growth and democratization. The reforms, characterized by privatization and regulated market competition, have also attracted investment for key issues, but more significantly, the establishment of independent regulatory agencies has provided policy stability and transparency. However, the implementation of rural electricity policies is often ineffectual, resulting in policy failures.

6. RURAL ENERGY ACCESS

The seventh goal of the Millennium Development Goals suggests that universal access to affordable, reliable, and modern energy services is central to energy poverty alleviation. To measure and promote access to modern energy services, the International Energy Agency (IEA) created an Energy Development Index (EDI), which was designed as a composite measure of a country's progress in the access and transition to modern energy services. The index (EDI-2004) contained three dimensions: per capita commercial energy consumption; share of commercial energy in the total final energy use; and the share of the population with access to electricity. The United Nation Development Program (UNDP) has recreated the Energy Development Index (EDI) and its use as an energy indicator has helped to approximate the state of energy access and consumption all around the world. However, this index cannot be applied in the rural context due to the lack of information.

Energy poverty usually roots in rural areas and the quality and cleanliness of energy services are not considered. Thus, a more appropriate indicator for rural energy development and renewable energy development is required to indicate the status of the energy poverty problem (Wang et al., 2017). National energy policies have been urban-biased and industry-biased, i.e., priority has been given to the energy demand of urban areas and industrial sectors. Moreover, rural energy policies need to serve or be subject to national policies (Bhanot and Jha, 2012). For instance, some rural energy policies are embodied in national socioeconomic policies (e.g., Rural Reform and Accelerating Agricultural Modernization in Brazil), (Ehnberg, Ahlborg and Hartvigsson, 2020).

Experience gained in several developing countries has demonstrated that renewable energy can be harnessed in cost-effective ways for decentralized energy applications in rural areas. These energy resources are abundant and locally available (Palit and Chaurey, 2011; Brass, Carley, MacLean, and Baldwin, 2012). However, supply issues of conventional energy projects make a sustainable market difficult to realize because in some cases technology transfer limits the renewable energies spread.

Although no clear consensus has been established on the definition of minimum energy consumptions, the minimum threshold proposed by the IEA is 100 kWh of electricity and 100 kg oil equivalent of modern fuels (equivalent to 1200 kWh) per person per year for fulfilling basic human needs (AGECC, 2010). A figure of 50 kWh, of electricity consumption for rural households, per person per year, which progressively increases to 160 kWh by 2030, has been used by the IEA (IEA, 2011). The Indian government has stipulated an electricity supply of 1 kWh/day/household, which equates to 365 kWh per household annually. For a general and relative comparison, the residential consumption of electricity varies from 1500 kWh/capita in Europe, around 2000 kW h/capita in OECD Asia and Pacific, and around 4500 kW h/capita in North America (Narula et al., 2012).

There are currently around 2.7 billion people in developing countries who rely primarily on traditional biomass for cooking and heating and about 82% of them live in rural areas (IEA, 2019). The income level is the principal aspect that determines the rural households´ energy consumption (Cheng and Chen, 2004; Wang et al., 1998; Wang and Song, 1993; Yao et al., 2012). The principal aspects affecting residential energy consumption can be described using the conceptual framework of the energy ladder (Smith et al., 1993; Yao et al., 2012). This approach argues that the economic development allows people to go up in an energy ladder. As people tend to have better income, they can spend more money in energy and then move up the ladder and use cleaner, more efficient, and more convenient fuels, replacing traditional biomass and coal gradually.

7. REGIONAL ELECTRIFICATION PROCESS

Kruckenberg and Loubere (2016) identifies three evolutionary stages for developing countries electrification programs. The initial stage, the "donor paradigm", occurred between 1970 and 1990, when international donors and cooperation agencies intervened in rural areas through the diffusion and transfer of Renewable Energy Technologies (RET´s). These programs were based on the transmission of small-scale RET´s such as biogas, stoves, wind turbines, and solar heaters, which were barely self-sustainable (Martinot et al., 2002). Development agencies sought to demonstrate to local authorities and communities how these technologies could solve energy needs. However, many of these projects had several problems and stopped working. The projects often lacked resources to maintain and operate the equipment that was delivered to the communities. Moreover, the beneficiaries were not trained to use or repair the systems, and there were no specific regulations or institutions available to guarantee the continued sustainability of projects (Martinot et al., 2002; Kruckenberg, 2015).

The second stage, the "market-oriented paradigm", was initiated after the 1992 United Nations Conference on Environment and Development (The Rio Earth Summit), where new forms of multilateral assistance were adopted for RET´s transfer, including solar home systems, biogas for lighting and cooking and small-scale mini-grids (Martinot et al., 2002). The development of these progressive programs, designed by development agencies, aimed to promoting these technologies by creating business models for firms and cooperation agencies in which funding programs shouldered part of the costs and risks. These interventions were based on the expectation that renewable energies would be economically profitable and technologically competitive in rural areas, but their adoption would require some institutional and financial support to local firms.

Many of these initiatives were adopted in Argentina, Brazil, and Chile rural areas. However, usually, they were only successful in economically able communities that were already undergoing development and that had access to other public services such as water, telecommunications, health, and education; and for urban and rural communities allocated close to cities and grid connections[7]. This suggests that effective instruments for targeting poor communities still required government involvement and participation being complemented with more active private participation, under the light of public measures. Here, it should be recalled that in many Latin American countries the pro-market period coincided with a process of administrative and political decentralization that transformed public policymaking in many different areas (Falleti 2010 as mentioned in Banal-Estañol et al., 2017). At the regional level, Faguet (2004) reports that a major decentralization process in countries such as Bolivia, Ecuador, Paraguay, Colombia, Peru and Chile led to greater investment in human capital and social services, and the poorest regions were able to choose projects according to their needs.

The third stage in electrification identified by Kruckenberg and Loubere (2016), the "participation paradigm," was introduced in the early years of the 2000s. Many rural electrification programs in developing countries have found that the projects impact and sustainability are usually constrained by persistent resource, capacity, and participation barriers. Hence, contrary to traditional electricity technologies, the introduction of RET´s in the form of off-grid and hybrid systems in rural areas requires the creation of new development pathways related to a rural systemic perspective[8].

Most countries in Latin America complement their electrification policies with universal service policies that seek to make the service more affordable for households that have already been electrified. This practice contrasts with the trend in OECD countries to eliminate social tariffs, where they are believed to create inefficiencies and to have little impact on the energy poor[9]. In Latin America, social tariffs are an essential part of social policies, having an important redistribution effect among poor people (Pantanali and Benavides, 2006 as cited in Banal-Estañol et al., 2017). In many cases, social tariffs have been created to moderate the increase in energy prices following to the introduction of renewable energies and as a plan to increase market efficiency or to protect the vulnerable population in periods of economic difficulties, e.g., in Argentina social tariffs were introduced after the 2001 crisis.

In most countries, social tariffs are tied to energy consumption, although several countries also link them to other indicators such as the geographical household location or household income. For example, in Argentina, Brazil, Chile, Colombia, and Peru the beneficiaries of social tariffs have been included in the census as beneath poverty income consumers. In these countries, it is believed that electricity consumption is determined by household income; but the size and location of households are used to determine their energy needs. The main challenge in rural areas is to tie energy consumption and energy needs, but the more complex communities are the most poor too. Initially, the key aspect is the information, for instance in Peru, SISFOH (Sistema de Focalización de Hogares) is a system that collects information about household socioeconomic characteristics, and which calculates a poverty index that allows households being classified into seven categories. This information is used by national agencies to determine the beneficiaries of social programs (Banal-Estañol et al., 2017). OLADE (2013) has analyzed the use of social tariffs in the region and shows that in most countries, the percentage of beneficiaries of these tariffs is higher than the percentage of people living below the poverty line.

Rural electrification initially allows access to a low electricity consumption, and after some years this initial consumption increases to higher consumption levels, causing immediate social benefits for households through major uses of electricity. Then, the results of this revision emphasize the need for government and other actors to integrate rural electrification into a broader rural energy policy to enable long-term welfare increases through electricity use (Obermaier et al., 2012). In developing countries rural areas, the main use of electricity is for light and watching television, given that most households are too poor to pay and being able to afford other appliances, such as fridges or heating (Khandker et al., 2013 as cited in Banal-Estañol et al., 2017).

8. ACCESS TO CLEAN COOKING ALTERNATIVES

Regionally, there are more than 85 million people that remain without access to clean cooking facilities. LPG and biogas are the alternatives adopted by governments and development agencies in the region to reduce health risks and environmental impacts of traditional firewood burning. Electricity, as an alternative for cooking in poor rural communities, is hardly a complex choice for clean cooking due to the limited electricity availability and the lack of electric cook appliances (Banerjee et al., 2016). In the 1980s, dissemination strategies mainly focused on support approaches or distribution of free stoves. Experience shows that these approaches were not always supportive of the construction of high-quality stoves thus evoking a negative image of stoves that break easily are not worth spending money on them, and in consequence, are not used. Commercialization[10] is considered a more successful approach for sustainable stove dissemination.

7 Both, peri-urban and, isolated and remote rural areas have been forgotten in this process of electrification.

8 In this context, partnerships between organizations can help obtain the complementary resources, skills and knowledge that are necessary to promote sustainable off-grid solutions, and promote the participation of local communities.

9 The World Summit for Sustainable Development in 2002 called for partnerships between governments, international organizations, companies, NGOs, and scientific institutions, as a way to accelerate development (Forsyth, 2010). Within this paradigm, electrification projects are recognized as multi-level, cross-sector nature and socio-technical issues. So investment, cost-sharing models, foster knowledge transfer and capacity building, and enhance the involvement of policy initiatives and donor organizations with local communities are necessary to promote access (Banal-Estañol et al, 2017).

10 Stove producers have more routine in building stoves according to certain design standards, and because they earn money running stove businesses, they have a strong interest in selling stoves (Kees & Feldmann, 2011).

In Latin America, Peru and Argentina have developed specific programs for dissemination of local clean stoves; Brazil and Colombia have received guide and support from the Global Alliance for Clean Cookstoves. However, developing countries' governments have not dedicated efforts to introduce electricity as a fuel option for cooking in their programs and projects of access to clean cooking alternatives, neither universal access to electricity (Berrueta, Edwards and Masera, 2008, Martínez-Gómez et al., 2017). According to estimations from the International Energy Agency (IEA), the number of people relying on biomass worldwide will increase rather than decrease in the future.

Furthermore, even many grid-connected households still use traditional cooking devices because they are familiar with them or because cannot afford an electrical stove nor can pay for the electricity bill. The main advantage of biomass fuels is that they are available in almost everywhere and can be burnt directly. They are cheaper than other fuels and when collected from ground there are no monetary costs. Biomass is a renewable and clean energy source, but the maintenance of this condition depends on the level of sustainability in the production and use of biomass: In the production side by bioenergy crops and in the use side by clean and efficient appliances. Biomass is commonly burnt inefficiently in traditional cookstoves, which causes severe health problems in women and children and affects the environment (Kees and Feldmann, 2011), being unsustainable.

Increase access to modern, affordable, and clean energy services is central for sustainable poverty reduction. This situation is more relevant in the rural context because economic and energy poverty are common conditions. For this, the UN Millennium Project (2005) calls to reduce the number of people without effective access to modern cooking fuels by 50% and make improved, efficient and clean cookstoves widely available. The efficient use of biomass or the switch to other fuels reduces the pressure on forest resources and contributes to decrease land degradation (GTZ, 2007).

Induction stoves will be considered cleaner cooking options if the electricity is produced from a renewable energy source such as solar, wind, or hydro. However, even if renewable resources are available in rural areas, in some cases covering the energy needs must stay above the condition of renewable energy, or at least never miss the main target of alleviating energy poverty. However, even at enough and sustainable levels of electricity coverage, the shift from firewood to electricity as a primary cooking fuel was observed in only 7% of the households (Banerjee et al., 2016).

At the current level of rural electrification and consumption patterns, induction stoves are not suitable for addressing the access to clean cooking challenges. Induction stoves spread depends on a massive access to electricity, a consolidation of a basic per capita consumption, and a consistent electricity access maintenance process is necessary to be taken up before initiating any policy introducing electricity as clean cooking fuel. Areas in developing countries with high levels of household electrification and low tariff rates provide an ideal location to implement induction stoves pilot projects. Induction stove technology is efficient in all cases, but can be truly clean, only if the electricity generation is also renewable based.

In areas where power supply is available, specialized electrical appliances such as electric kettles, rice cookers, and microwaves are used for specific purposes only. However, not all the electric alternatives are sustainable; for instance, the electric coil stoves have been considered a bad option due to their low efficiency and high-power consumption (Smith and Sager, 2014). Induction stoves beats the above-mentioned limitations, can be used for all cooking, and are considered 73% more efficient than electric coil stove (Smith and Sager, 2014).

Industrial production of efficient stoves has started in the last years. However, in many cases, these products are far too expensive for poor people. Little experience exists with the export to other countries where sales structures for large quantities of stoves still have to be set up, being indicative that efficient stoves must run in a local production approach. However, two main technical principles are always the same: improved combustion and improved heat transfer to the pot. The best stoves have improved heat transfer and combustion efficiency, simultaneously. Increased heat transfer reduces fuel requirements, whereas increased combustion efficiency decreases harmful emissions (Bryden et al., 2006 as mentioned in Kees and Feldmann, 2011).

Experience has shown that the best technological solution is not necessarily the most attractive one for the customer. Even very efficient stoves will fail in the market if they are not affordable for the poor, if they do not allow to prepare the most common dishes or if they are not considered to be "modern" and thus attractive in the opinion of the target group (Kees and Feldmann, 2011)[11]. Then, the general policy framework should be supportive. It is the role of national governments to formulate complete and specific policies, to integrate cooking energy into a social and environmental perspective, to promote awareness-raising campaigns, and to provide required public funds. According to the points argued by Kees and Feldmann (2011), Table 1 shows the main aspects to enhance clean cooking access through the role of rural energy policy in different ambits. Technology access is often inadequate in the region, especially in rural areas, reducing the ability to move from traditional methods and sources to more sustainable options[12].

The location has a significant effect on the type of cooking fuel adopted and differences are evident between urban and rural areas. Households from rural areas are less interested in adopting clean fuels because of the easy access to cheap biomass sources. Efficient cookstoves could represent a step on the energy ladder towards cleaner and more sustainable solutions, e.g., electric cookstoves. Improved cookstoves (ICS) are devices that burn biomass, designed "to maximize thermal and fuel efficiency, operate safely and minimize emissions harmful to human health", thus improving the cooking sustainability processes.

11 Despite the advantages, improved stoves do not sell as easy as cell phones or similar gadgets. Changing cooking habits is not an easy task. Behavioral changes take many efforts and thus needs a long-term investment.

12 The effect of variables on ICS adoption may differ according the context. Each variable plays a role as a driver or a barrier to ICS depending on the studies considered in the literature review (Vigolo et al, 2018).

Table 1: Role of rural energy policy to enhance clean cooking access[18]

Technical	Economical	Social[19]	Political[20]
The technology is convenient, modern, and affordable for consumers	The system acknowledges the relevance of efficient and modern cookstoves and supports a massive scaling-up by setting clear targets[21]	The dissemination approach–local producers employing local materials and providers, and NGOs training and promoting campaigns-strengthens local chains	Attach cooking energy into the public sector agenda of countries. As well as into the activities of NGOs, and other implementing agencies
Support research and testing centers	A system for the beginning guarantees of stoves quality	Promote stoves and awareness in the population	Support partner countries in launching biomass strategies
Develop capacities in trainers and producers			Raise awareness among organizations/international agenda
Support development of technologies			Create awareness in governments and Ministries

The term "improved cookstove" refers to a range of different cooking technologies that may have different performance and cost degrees[13].

Researchers have shown that social and cultural variables affect customers' decisions bout cooking systems. Urmee and Gyamfi (2014) reviewed clean cooking programs around the world and highlighted that the reason for the failure of many projects might be that none have considered local culture and social background in the target areas (Vleuten, Stam, & Plas, 2013)[14]. Poor income, together with a perception of high price for efficient cookstoves in rural locations, causes resistance towards the adoption of efficient cookstoves (Vigolo et al., 2018)[15]. The lack of electricity and cook patterns in households do not support the use of induction stoves for cooking.

9. PROPOSAL TO ADDRESS RURAL ENERGY ACCESS PROBLEMATICS

The analysis of the above situation suggests addressing rural energy access issues in a more systematic perspective, and a process that considers all the necessary elements to attack the lack of energy access should be developed. The proposed process, based in the Ackoff´s theoretical approach (1978) to attend problems (Peters, 2018), starts by pointing the initial position towards the ideal route, indicating the gap to surmount the difference. After this initial step, the key elements are enlisted, i.e., barriers, strategies, and resources, to achieve the rural coverage of energy needs at a household level. This process might be the basis to planning a rural energy policy that considers each necessary issue.

The policy design must include as a part of the solution, the reconfiguration of the system that reverberates in all the system and removes the problematic causes, keeping the "solution condition" as a permanent condition in the reconfigured system. This reconfigured condition must allow the system to work efficiently and dissolve any clue of the previous problematic condition[16]. For this, it is necessary to launch a problem-solving approach which considers all the elements from a systemic perspective, giving the necessary aspects to structure a holistic and exhaustive policy (Jackson, 1982; Moosavi, 2017). This suggested approach is outlined in Table 2.

Rural energy access needs policy innovation that would achieve a "perfect system"[17] (Moosavi, 2017). In this redesigned system, the previous problem condition should be dissolved (Ackoff, 1978). The creation of the "perfect system" starts identifying the difference between the current position and the perfect position to reach in the system. And to consider barriers, strategies, and necessary resources required to get the so called perfect position (Peters, 2018). In Table 2, this approach is applied for solving the rural energy access problem.

Each aspect marks the route for accurate energy access in rural areas. All of them must integrate the rural energy policy, as a core strategy to attend this issue in the order given in Table 2.

13 The design of stoves varies according to location and type of fuel available (Vigolo et al, 2018).

14 In addition, while younger age is mostly associated with a higher propensity to purchase efficient cookstoves, some works found that older age increases the probability of efficient cookstoves adoption.

15 For example, a higher level of education positively influences the intention to purchase more sustainable cooking systems, although other scholars have found that an open mind rather than education as such may affect consumers' choices.

16 The contributions of this work are the holistic perspective to analyze the rural energy access from the political context, and the systematic approach to propose the solution through an exhaustive policy design.

17 According to Ackoff, the alternatives to solve a problem are absolution that means policy inaction, considering as solution the migration from rural to urban areas due to the lack of conditions in rural areas. Resolution that is the policy extension of previous and current policies from urban to rural areas. Solution that means the policy adaptation of policies for cover each problem as "BAU" perspective, i.e., specific and isolated solutions for certain communities beneficiated by some technologies; and dissolution that is the policy innovation by redesign the system in absence of problem conditions.

18 In the context of this research, the prevalence of brushwood as a primary resource for cooking is due to their condition of more common and more employed resources in rural areas. However, sustainably considering their exploitation through efficient stoves. The assumption of this study is to push for clean and sustainable exploitation of brushwood through clean and efficient stoves that take advantage of the more abundant and profitable resource in rural regions.

19 To increase the diffusion of more sustainable cooking behavior among households in developing countries, there is a need to improve understanding of consumers' cooking choices, in particular concerning to the factors affecting the use of electric cookstoves.

20 Biomass strategies has shown that politicians are away from the problem and their solutions, or deny its relevance, considering biomass as an old-fashioned habit of poor people they do not have to attend (GTZ, 2009).

21 Access programs need enhance being evaluated to improve them and keep them in line with these changes.

Table 2: Assumptions to approach rural energy access

Situational position: initial position **Electricity consumption: For developing countries, access to electricity is lower than access to safe water and sewerage. So is the most transcendent problem in developing countries, although some countries have made progress due to energy reforms (Davidson and Sokona, 2002 & Mwakasonda, 2008). Access to electricity is associated with access to roads, street lighting, and paving** **Cooking resources: cooking firewood is the main alternative in developing countries as it is generated and processed on-site. In rural areas is the cheapest resource and emits less carbon dioxide than fossil fuels per unit of mass (Broadhead et al., 2001); heating and cooking wood will be the main resource for the next 25 years (IEA, 2004 & Broadhead et al., 2001)**		
Position to reach: ideal position: Having constant and quality electricity, and intradomiciliary contamination-free cooking schemes, friendly to the environment and more efficient and sustainable than traditional ones (IEA, 2016); according to the IEA Energy Model the position is:		
2030 Access	**Rural coverage**	**Alternatives to achieve the goal**
Electricity	100%	37% connected to the grid. 63% not in the grid: 70% mini grids and 30% autonomous generation
Clean cooking	100%	37% by LPG stoves. 38% by clean cookstoves and 25% by biogas
Space to achieve=Ideal position—initial position **Affordability, social local perspective, and community connection; and counteract inaccessibility, dispersed households, low density, unavailability of generating and distribution companies, maintenance, lack of qualified resources, dependence on support**		
Barriers: Geographical difficulties, remoteness, and dispersion of households, climate, reduce demands, losses, high investment, tariffs and costs limit grid extension[22]. Also, some causes affecting programs are political instability, poor market structure, lack of regulatory frameworks and tariff transparency, corruption and weak institutional configuration; also the costs inhibit investment and multilateral support, limit technical capacity and evaluation tools, affecting the execution of projects **Context: Rural characteristics:** Ample dispersion, the remoteness of generation points, low consumption, and low density, high supply and maintenance costs, and limited capacity to pay. This increases the unit cost of energy (ECLAC, GTZ, 2000). By 2035 from 100% of the population without access, 90% will live in developing countries[23] and much in rural areas[24] **Actions to remove barriers:** laws are necessary to manage renewable energies; policies should encourage private investment, regulate them, and the stakeholder linkage. Integrating the community is necessary to create transparent, effective, coordinated, and efficient schemes to provide training, promote development, and empower communities[25] Productive uses of electricity will be encouraged by increasing complementary infrastructure, access to services, and the market. It is important to consider that because resources are scarce, policies should drive cost-effective technologies, and projects should consider the availability and characteristics of resources to choose technologies. Supports must focus on renewable energy technologies to make them competitive[26] **Institutional support: National level:** generate the legal and regulatory framework, plans, and programs. It covers tariff regulation, generation control, coverage targets, investment, access maps, technological development, incentives, and community support. This level is responsible for planning and regulatory control **Regional and state-level:** Provide the link between the national and local levels. At this level are state and municipal governments, rural electrification agencies. Besides, levels are being responsible for strategies and tactical control. **County or local level:** At this level, communities must engage, coordinate management, be connected to higher levels, and check compliance with quality standards. In this range are executed the projects **Management:** property and management must be adapted to the needs and context of the community[27]. At high demands, companies would own and manage. At low demands and little productive activity, communities would exercise property but being management granted, and maintaining the property of government to ensure energy supply and create bases for tenders and concessions, and to sponsor competitiveness **Actions:** rural areas are moving to depend on energy products and not from natural resources[28]. When evaluating policies it is necessary to consider information, location, and legitimation (Derlien, 2012). There is great emphasis on proposing projects, but no longer in their review and evaluation, characterized by disinterest and lack of mechanisms of action. (Pereira, 2013)		
Requirement resources		
Investment: Problems in electrification programs are attributable to tariff structure (Elias and Victor, 2005; Almeshqab and Ustun, 2019), as it is designed without adapting to the characteristics of communities and without considering the ability to pay at increasing tariffs, and do not incentivize the increase in demand according to staggered schemes to increase per capita consumption **Technologies:** creating tools to assess local characteristics and resources by region and choose technologies and strategies according to the region. These practices need formalization being institutionalized, being regulated, and being replicated (Pereira, 2010) **Rural energy agency**: creating institutions with national competence would make it easier to formalize and strengthen the institutional framework and make investing and creating markets more attractive; it also institutionalizes and standardizes access[29] **Available resources:** Renewables energies are available and helps to generate enough energy, although being intermittent it is necessary to create hybrid systems in micro-networks. Besides, distributed generation is a sustainable alternative in remote and dispersed regions **Necessary resources (constrains)** **Integration in communities:** It takes 7 years for households to use electricity and after these 7 years, still the process of adoption is slow (Cook, 2011). That is why it is important to distinguish between policies for coverage and policies to enhance consumption[30]. In electrified regions, the marginal cost[31] of electrifying additional households is beneath because costs are falling down scales.[32] **Technology:** users have problems using technology because is complex (Bazilian, Nussbaumer, Eibs-Singer and Brew-Hammond, 2012; Espinoza, Muñoz-Cerón, Aguilera and De La Casa, 2019) . Already working, technology thunder, creating flashing, breakdowns, dissatisfaction, disuse, replacement problems, misuse, and abandonment by non-friendly design **Investment:** is necessary to increase resources towards rural areas, managing them based in a congruent policy to accurate access **Rural energy agency** is necessary a specific agency to attend coverage quality, per capita consumption and all issues of rural energy		

According to this approach, a key aspect is the identification of barriers, because once the barriers are identified, the definition of strategies and resources to achieve the ideal position is more accurate. In Table 3, the entire barriers are enlisted according to their category. Each stage can integrate parts of the policy to consolidate a complete, efficient, and general set of instruments to increase electricity access and consumption and to introduce clean and affordable cooking alternatives for all, in rural areas. This activity can help in planning and developing general guidelines for a rural energy policy.[22223242526272829303132]

10. FINAL GENERAL DISCUSSION

Until now, rural energy policies mainly have involved the extension of existing electric systems in densely populated areas to rural areas that cannot benefit from scale economies, promoting renewable energies, such as solar and mini-grids. They also have tried to attain universal policies for electrification, making electricity affordable and promoting its use in poor households (Banal-Estañol et al., 2017). However, rural energy problems are not limited to electrification only, since the more critical issue is associated to the absence of clean cooking alternatives, which has forced a large majority of rural populations to use biomass in primitive and unsustainable cookstoves (Balachandra, 2011). National energy policies and poverty reduction strategies very often focus only or mainly on electrification and do not reflect adequately the energy–poverty nexus (UNDP, 2006) and the relevance of sustainable cooking access in the energy equation for the coverage of rural household needs. On the international agenda, sustainable energy access started to become important, especially under the framework of the carbon market initiatives (Kees and Feldmann, 2011).

In the case of cooking by electric appliances, like electric induction stoves, the consideration of these alternatives keeps the approach of clean cooking alternatives, but the evaluation runs in the context of electrification, due to the dependence on electricity as a primary resource of these appliances. However, in a long term, and as a part of a continuous energy policy for rural areas, the transition towards electric appliances like induction stoves is a suitable goal to target, but the key is to increase coverage and consumption of electricity in a complete, constant, and continuous manner, to ensure the total energy coverage.

Therefore, this situation is part of the issues that push the need for specific policies in the context rural areas because issues like coverage, consumption, and appliance transition of are transcendental for rural regions regions (Gómez and Silveira 2011)[33]. There is a need to enhance the insertion of policies and configure them as a part of an energy policy, in which local institutions and communities are better placed to share their knowledge[34]. These local institutions will be useful for designing, implementing, and operating effective off-grid rural energy policies.

In order to attend rural energy, our central proposition is to adopt a rural energy policy which encompass all multidimensional aspects related to energy in rural areas in a holistic perspective. Some frameworks emerge as alternatives to evaluate rural energy issues. The Multi-tier Framework developed by ESMAP, and the Multidimensional Energy Poverty Index (MEPI) (Nussbaumer et al., 2011) could serve as instruments to evaluate the evolution and relevance of rural energy access but using only rural areas information and adapting each variable to this context.

The MEPI is a composite index that measures energy poverty through a set of quantities related to energy access, consumption, services and impacts for people. Compared to the Multi-tier Framework, the MEPI is more feasible to be used in the rural context due to a simpler process and availability of local information. At a regional level, a study conducted by Santillán et al. (2020) analyzed energy poverty in 7 countries of the Latin

22 Decentralized Distributed Generation alternatives that include small, dispersed sources of generation from Renewable Energy Technologies are emerging as a viable alternative to grid supply. These technologies are particularly suited for areas that have low demand for electricity and have low load factors (Kapil Narula, 2012).

23 Resource pressure will remain constant, depletion will advance; energy demand will increase 95% by 2035.

24 Much of the efforts of developing countries will address access in cities (IEA, 2015). By 2035, developing countries would have full access in cities, but not in rural areas where the changes will not be as significant.

25 The World Bank suggests as conditions to take advantage of the benefits of energy: infrastructure and markets with productive activities, agricultural growth and alternatives to improve income and social development.

26 The level and approach of supports is basic, as their indiscriminate use makes competition and market creation irrelevant; few supports cannibalize the market and over stimulate indiscriminate competition, affecting RETs, and devaluing those with potential. By directing support to a certain technology, it grows, limiting others.

27 In order for users being interested and involved, they can assume ownership of the schemes, paying with government support. This will help to appropriate and learn how to use technologies. When generation schemes are far away, there is no economic strength, households' lack of sufficient income, and costs are high, government must maintain ownership of facilities and equipment renting to companies and charge fees to users, making a difference to maintain the social approach. The service must be permanent, adaptable to demand, generate alternating and non-direct current, manage the load, reduce losses, efficient, and control discharges.

28 The use of electricity and gas arises from the expansion of cities and the industrial revolution; demand for these energy products and their economic efficiency, generates economies of scale, centralizing production in large generation plants with extensive distribution networks and complex logistics structures of delivery.

29 In developing countries, rural projects are un-regulated and support lack to extend to consumers.

30 It is necessary to increase coverage and incentivize demand. World Bank studies showed that in rural areas poor with electricity, connections remain low from high connection costs for income level.

31 To the extent that tariffs cover execution and maintenance costs, the costs of new connections, based on cost reduction due to a beneath marginal cost in comparison to the initial connections, generating a positive effect in energy dissemination through these communities.

32 As the basic input electricity is its demand and cross elasticity are inelastic, in addition to some fuels tend to behave as substitutes for others (Cook, 2011).

33 These motivate collaborative efforts and agreements among agents with different interests, and activates synergies.

34 In Brazil, the national government has launched a digital universalization initiative that aims to provide universal access to information technologies. The initiative pursues social inclusion and has electricity access as a prerequisite.

Table 3: General barriers for rural energy access

Barriers	Characteristics	Affects to
Economics[16]	Absence of economic supports	Inattention in remote areas by high costs
	High initial costs of capital	Incorrect management of rates
	High transactional costs	Use of candles, waste, and wood
Market attractiveness[17]	Unknown business	No creation of technician jobs
	High volatility of investments	Does not improve access in regions
	High associated expenses	Migration to cities
Insufficient technical knowledge	No resource assessments available	Lack of technical standards
	No economic information	No increase access in rural areas
	Reduced economic support	Lack of replacement of parts and specific tools
		Absence of qualified human resources
Geographical environment	Natural Barriers	The economic gap for high supply costs
	Climate Barriers	Companies don't accept to participate
Design of advice programs	Inefficient management	Lack of technical standards
	No complete information on maintenance and post-acquisition service	Does not improve access in regions
		Delay to provide technical tools
		Lack of trained human resources
Legal gaps and lack of political involvement[18]	Regulatory Framework	Loss of consumer confidence
	Specific laws	Communities not involved
		Economic problems
Technological barriers	Misuse and complexity of technologies	
	Bad approach to technology and conception on users	
	Corruption, conflict of interest, reduced credits and manipulation	
Barriers associated with managing the generation systems	Configuration of the distribution network: is necessary not to build too many nearby networks to successfully configure them	
	Rates: electric meters to prevent equal rates from being at different consumptions and, to prevent rates from changing at equal consumption	
	Interconnection: is necessary enough infrastructure to support hybrid systems	
Barriers associated with supply system management	Energy inconsistency: renewable energies are intermittent. It is recommended to have hybrid systems	
	Equipment: By not serving generators in distant areas, their arrangement and replacement are complex. It is necessary to have a substitute generator	
	Capacity: micro-networks are demand-adaptive and autonomous schemes are not; must be integrated to complement	

America region. The authors determined a high correlation between MEPI and HDI indices in countries like Guatemala, Peru, México and Colombia. This study has applied the MEPI, as a practical tool, in a comparative form at a regional level, but it considers only national averages and does not attend specifically the rural energy situation.[35][36][37]

11. RECOMMENDATIONS AND CONSIDERATIONS FOR FURTHER RESEARCH

Comprehensive rural energy policies should be promulgated to guide rural energy aspects. The fact that rural energy is an aggregated concept determines that the rural energy policy system consists of single policies for specific energy sources, while different government administrations promulgate these policies[38].

The promulgation of a comprehensive rural energy policy can help to define the functions of different departments, different importance of energy sources, and allocation of resources for rural energy development. Rural energy policy makers should be aware that energy transition often takes decades, and this implies that the design and implementation of policies should focus not only on current issues, technologies, and conditions, but also on long-term planning. The government should formulate rural energy policies according to the different energy demands. Also, the government should communicate policies to make rural residents aware of policy content, which can improve policy awareness and support[39]. The emphasis should be on innovative policies, institutional mechanisms, and financial support[40]. Some recommendations to design a rural energy policy are:

- Creation of rural energy authorities
- Establishment of funds to enable delivery of energy resources
- Integration of business principles to make energy affordable and equitable for households
- Treatment of entrepreneurs as strategic targets.

35 Economic barriers stem from high costs of technologies, capital, and investment, decentralized structures, lack of pricing policies, and support for renewables.

36 Centralizing on a small-scale increase efficiency, profitability, durability, economies of scale, low losses, and costs, offsetting low demands from low-income scattered households.

37 Technical standards, infrastructure costs, tariffs, losses, regional structure, and city priority, raise the cost of distribution to rural areas; private companies do not invest in rural electrification out of fear and because workers do not want to work in rural areas; benefits and incentives are necessary in this regard.

38 The government should investigate rural residents demand and attitudes towards new rural energy policies and combine them with local conditions before the design and implementation of rural energy policies.

39 Governments' functions relating to rural energy should be centralized. It is unavoidable that the design and implementation of rural energy policies involve many government departments.

40 Government should support market-oriented approaches that make the energy market equally accessible and attractive to local investors, communities, and consumers (Barnes and Floor, 1996 & Balachandra, 2011).

Rural energy policies should pay attention to introducing market mechanisms to support the development of rural energy markets. Although some rural energy projects are effective with support from the government, they are unsustainable in the long-term. Gollwitzer highlights the importance of the organizational set-up, which includes adopting and enforcing norms and regulations because once the government eliminates subsidies or ends preferential policies, rural residents discontinue using energy technologies or equipment intended to alleviate climate change or achieve sustainable development. Consequently, governments should establish an encompass rural energy market frameworks, encourage private investment, and provide some incentivizing policies (Wu, 2019).

This research has systematically reviewed the literature about rural energy access in relation to electrification and clean cooking from a policy perspective. By identifying the main barriers, resources, and drivers affecting rural access, this review contributes to better understanding the theme, especially remarking the need to launch a core, complete and specified rural energy policy based on the rural energy needs and not as a part of another development programs.

Some key findings at regional level (GNESD, 2008)[41] to go from energy poverty to energy access in rural areas of Latin America are: (i) Lack of strategic planning and long-term vision. (ii) Inaccessibility of clean fuels due to the nature of rural settlements (rural slums). (iii) Inability to afford clean fuels because of upfront connection costs. (iv) A lack of formal monitoring mechanisms. (v) Mistargeted supports. (vi) A lack of awareness regarding the use of clean fuels and clean cooking appliances.

12. CONCLUSION

Compared to rural electrification, the situation for clean cooking access is even worst. On many occasions, the problems are accentuated by fuel insufficiency, biomass overexploitation, and poor reliability and services quality available to the rural households, despite numerous initiatives by the local governments (Neudoerffer et al., 2001). Also there are difficulties for poor households financing for lighting and cooking fuels (Rao et al., 2009 and Balachandra, 2011). The current situation for rural energy access is characterized by

- A lack of effective policies and programs
- A lack of an institutional framework
- Inefficient and ineffective governance
- Misdirected focus and targets
- Ineffective delivery mechanisms
- A lack of private incentives.

According to this revision, cooking access is still behind in the race for energy access because it is a complex issue. In many countries, it is not clear which Ministry (Energy, Environment, or Economy) would be involved, e.g., in setting up a stove program or firewood energy. The same applies to donor organizations and their different departments. Many stove programs failed due to their approach or the technology involved[42]. Moreover, cooking energy is not considered a central topic among many politicians in developing countries nor donor organizations.

Policies related to clean cooking usually focus either on the demand side, e.g., promoting the production and use of clean stoves, or on the supply side, e.g., in reforestation and forest management programs (Kees and Feldmann, 2011). However, a complete intervention must pay attention to both aspects simultaneously. Policymakers should use the HDI more systematically to make sure that rural electrification efforts reach the poorest communities. We agree with Gómez and Silveira (2010) that the HDI can be a useful planning tool, but it should be used considering other factors[43].

Subsidized electricity tariffs are the typical instruments used by Latin America governments to foster consumption, but it has been economic growth experimented in recent years that has enabled millions of people to leave poverty, beginning the purchase of electrical equipment, such as fridges and heating systems. Increased consumption levels in rural and isolated areas is a much more difficult goal and will require a different set of policy instruments. Many communities in these areas live below the poverty line and lack access to other basic services, such as roads, safe water, and telecommunications. This means that electrification strategies cannot rely on market solutions. Besides, the electrification of these regions has been based on off-grid renewable energies that are enough only to use basic services such as light and television, but not to other appliances that consume more energy, such as fridges, clean stoves, and agricultural machinery. This is a central point because in some cases electricity supply is enough to consider access and statistically account a community as electrified, but not enough for a sustainable consumption covering all the needs of the rural house. In the coming years, the Latin American countries will have to define the quality of the electricity service that they want to offer to their rural communities and they will need to verify whether the technological solutions that they currently offer are appropriate for meeting this goal (Banal-Estañol et al., 2017) in a sustainable manner, i.e., economically affordable, socially inclusive and enough, and environmentally clean and efficient. Also, the appropriate and multifactorial decision choices are an integral part of long-term project sustainability to ensure rural energy access consistently. The multidimensional nature of rural energy access request complete attention at all levels, but it is necessary to start at the normative level to approach and attend access correctly.

Based on our revision, it is concluded that (1) a comprehensive rural energy policy is lacking, and most policies focus on techno-economic aspects; (2) most rural energy policies are problem-oriented and deficient in predictability; (3) the regional heterogeneity of rural residents' willingness and interests are not

41 GNESD is the Global Network on Energy for Sustainable Development, an UNEP network to energy issues.

42 While biomass is used widely as an energy source and is of high economic importance in many economies, political frameworks often do not reflect this situation. Biomass is and will remain the most important fuel for one-third of the world's population and considering its negative impacts on people and environment, the challenge is how to make its use sustainable.

43 A relevant area for further research would be an examination of the community-based projects implemented in the region.

adequately considered in rural energy policies; (4) the current energy administrative systems restricts the implementation of rural energy policies; (5) the role of the energy market system has been overlooked and (6) there are no responsible institutions for rural energy.

The respective policy implications at regional level are (1) designing and implementing a comprehensive rural energy policy; (2) establishing a rural energy management system; (3) taking into consideration the regional heterogeneity of rural residents toward rural energy policy elaboration; (4) centralizing functions relating to rural energy; (5) introducing market mechanisms and strengths to develop rural energy and (6) creating a specific agency to coordinate rural energy access.

Rural energy access is a topic lacking a correct perspective. The problem is approaches from a general perspective and at the micro-level, but solving the problem needs a specific perspective exclusively for rural regions and a macro level approach at normative and policy levels. The different aspects of rural energy access are not complicated concepts to understand and many of them are intuitive. The issue is the consideration of all these aspects in a systemic and integrated manner that accurately accomplish the exhaustive condition of complexity in the study of rural energy access and the need to develop a complete rural energy policy. This is the core contribution of this study. The structuration of a complete and systematic approach will help to better understanding the general aspects of rural energy policy as a solution of the related rural energy poverty problem.

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