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# Energy poverty from a Oaxacan context: Towards an inclusive, pertinent and resilient characterization seen from the solidarity economy and the capabilities approach

# La pobreza energética desde el contexto oaxaqueño: Hacia una caracterización incluyente, pertinente y resiliente vista desde la economía solidaria y el enfoque de capacidades

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**Abstract**

This article aims to redesign the concept of energy poverty through an inclusive and relevant characterization of the biosocial context of the state of Oaxaca, Mexico, since none of the existing concepts in the literature understand its particularities. Based on solidarity economy and the capabilities approach, we discuss the relevance of reflecting on the areas of energy needs and their satisfiers by integrating quantitative and qualitative aspects, as well as the desired outcomes of the communities who suffer from this type of poverty. In addition, this article highlights the cultural methods and capacities that people have to intervene favorably in their energy satisfaction. The methodology for the research relies on a work breakdown structure, where students searched, selected and analyzed the so-called areas of energy needs in Oaxaca. In the final reflections, we define the concept of energy poverty as: lack self-management, access, and affordability of energetic resources impacting social development, collective growth, and health without compromising cultural values and worldview informing the right to personal decision making on what type of energy source is chosen to satisfy essential services in a household.

**Energy poverty, Energy development, Sustainability**

**Resumen**

El presente artículo busca rediseñar el concepto de pobreza energética mediante una caracterización incluyente y pertinente al contexto biosocial del estado de Oaxaca, México, debido a que ninguno de los conceptos existentes en la literatura comprende sus particularidades. Basados en la economía solidaria y el enfoque de las capacidades, discutimos la pertinencia de reflexionar sobre las áreas de necesidades energéticas y sus satisfactores desde una mirada que permita integrar aspectos cuantitativos y cualitativos, así como, la visión de las personas que padecen este tipo de pobreza, destacando las formas culturales y las capacidades que tienen las personas para intervenir favorablemente en su satisfacción energética. La metodología para la revisión de literatura fue la estructura de desglose de trabajo, donde acopiamos recursos humanos de estudiantes para buscar, seleccionar y analizar las denominadas áreas de necesidades energéticas de Oaxaca. En las reflexiones finales, exponemos el concepto de pobreza energética como: la incapacidad de autogestión, acceso y asequibilidad a los recursos energéticos, que repercuten en el desarrollo social, superación colectiva y salud de las personas, sin comprometer los parámetros de cultura y cosmovisión en el derecho de decisión-elección de la fuente de energía, así como, en la satisfacción de servicios esenciales del hogar.

**Pobreza energética, Desarrollo energético, Sostenibilidad**

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## 1. Introduction

### The Energy poverty and its transversal dimensions

In Mexico, 36.7% of the population live under energy poverty (from this point forward named as EP). The main appliances that this portion of the population lacks are "thermal comfort, efficient refrigerators, and gas or electric stoves" (García-Ochoa and Boris-Graizbord, 2016, p. 304). In addition, in 2019, Mexico was ranked eleventh place out of nineteen countries in Latin America with multidimensional poverty (Lagner, 2019).

The State of Oaxaca has a rich culture and many natural resources, but many of its communities live in poverty. In contrast to its wealth, Oaxaca is considered the state with the fourth largest amount of people living in poverty in Mexico. Poverty is defined as "when a person lacks at least one essential social need and not enough income to cover it" (CONEVAL, 2020: p.13) and under extreme poverty…. When a person lacks two or more essential social and has not enough income to cover basic groceries" (Ibid).

In reference to the previous paragraph, the concept used in Mexico to understand and measure the poverty levels and its effects is multidimensional poverty. This is not just a definition or a measure of poverty, but rather understood as an infringement on human rights through the goods and services that promote wellbeing and quality of life. There are eight indicators for this measure method, which are: Income, education level, access to health services, access to social security, access to nutrition, housing quality and size, access to housing utilities, and lastly, social cohesion (CONEVAL, 2015).

When analyzing the multidimensional poverty of Mexico/Oaxaca, it is important to consider the derivation of concept that allows one to go more in depth on EP, showing that it has a direct correlation with at least two of multidimensional poverty's indicators: quality and size of housing and access to housing utilities. EP is a social injustice issue (Sovacool and Dworkin, 2015) that exposes several inequalities and complex challenges for the human development.

Addressing the disparities of EP is a planned objective that will be discussed at the United Nations Organization's meeting in 2030. (Objective 7, Affordable and Non-Polluting Energy).

It could be said that it is excessive to develop another definition of EP given the fact that there are several publications that have defined and indicated the effects of EP. Nevertheless, the existence of various other indicators reflects a need to develop the concept of EP at a local level. The exiting definitions and indicators that tend to omit the cultural characteristics and idiosyncrasies of a community in their analysis generally have strong economic (based primarily in the income) or technological (based on the energy latter) components that do not consider the cultural practices of obtaining and consuming energy, communities' opinions on their own energy scarcity and needs, and the unique meanings ascribed to the concept of "energy" by each region. (Calvo, et al., 2019).

It is important to mention that the definitions of the traditional EP concept are based on an observer's perspective, whom has no direct experience in the mentioned living circumstances. Most of these publications focus on the economic aspects without considering the entire environment and its factors; consequently, this makes the definitions only an informative concept without giving the opportunity to its application to develop a better quality of life and consequently a better energy system.

Research conducted by Pellicer (2018) and Calvo, et al. (2019) considers that the applied EP concepts, used by researchers internationally, are inadequate and rely too heavily on quantitative indicators (economic and technological), while overlooking qualitative indicators such as sociocultural elements, structural and survival practices, and community abilities and skills.

A qualitative and multidimensional solution to counteract energy poverty is energy autonomy. Energy autonomy can be achieved if productive and economic approaches are developed that do not base their existence on individualism and resource utilitarianism.

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The practice of solidarity economy[1] contributes to a better understanding and distribution of energy resources, incorporating perspectives that consider the production, management, and common consumption of energy resources from the perspective of justice, cooperation, reciprocity, and mutual aid (Borge, 2015 quoting Pérez et al, 2008 p. 8). With an emphasis on solidarity economy, the definitions and implications of poverty and energy will be discussed from a perspective of collective support reinforcing community ties.

The community lifestyles have been practiced for hundreds of years in rural Oaxaca cannot be ignored. Combining the perspectives of the solidarity economy with the capabilities approach of the community and their ability to develop their own processes and goals will help to develop a better understanding of the relevant indicators of EP, including political, socio-cultural, environmental, technological and economic factors, creating the opportunity to create a more environmentally sustainable system.

Additionally, the current energy model for the economy of natural resources is having significant impacts in three different ways: energetic (consumption of fossils and non-renewable fuels), economic (based on accessibility and cost since most of the community live in poverty), and environmental (negative impact in the environment and community's health). These three factors contribute to a further widening of the gaps and impact of a global crisis (Regueiro and Doldán, 2014).

The relevance between poverty, energy, society, technology, and the environment should become more important lines of research (García, 2014), giving way to inclusive energy systems adapted to the situations of communities and people. The reconceptualization of EP based on qualitative information will create opportunities for possible intervention approaches that could improve the lives of communities.

The main goal of this research is to provide a new concept that will redesign the definition of EP from the perspective of the solidarity economy merged with the capabilities approach.

In this research, thermal comfort, water heating, food cooking, lighting, cooling, and water purification are key uses of energy used in the characterization of EP. In other words, since these components function with a specific purpose linked to a basic human need, they should be key aspects in redefining the EP.

Before redefining EP, the ways in which Oaxacans have satisfied their own energy needs must be identified. That way, we can characterize the needs of those living in EP in a multidimensional, inclusive and pertinent way.

## 2. Background

EP metrics publications have identified four conceptual perspectives: Multidimensional Energy Poverty Index (MEIP), Multi-tier Framework for Energy Access (MFEA), Three-Dimensional Territorialized Indicator of Energy Poverty (ITTPE), and the energy and human necessities approach. The first two approaches (MEPI and MFEA) are commonly used in less developed countries (Bhatia and Angelou, 2015, p.4), since they are based on an energetic hierarchy that correlates a residences' consumption of energy to its economic status. The other two approaches (ITTPE and energy and human necessities) are based on a Latin American context, specifically Chile and Mexico (Kroon, Brouwer and Beukering, 2011).

Although the criteria used in these approaches can be useful in the context of Oaxacan communities, the methodological approaches do not fully correspond with the context in which they are living in. The information they lack includes:

### 2.1 Difficulty obtaining data

The methods on which MFEA and ITTPE base their technical criteria are highly specific. This results in data being difficult and costly to obtain in a field study. For example, to measure the carbon monoxide levels in a house, specialized equipment and corresponding usage training is required.

[1] This publication will be based on the solidarity economy approach to better explain the social processes of the region of interest. This approach will unify the focuses of the social economy and the solidarity economy that can be applies depending on the region.

Additionally, ITTPE proposes a national standard of electric installations that corresponds with quality and security of access to energy (Calvo et al., 2019, p. 19).

In Mexico, compliance with this standard (NOM-001-SEDE-2018) can only be determined by the Unidad de Verificación de Instalaciones Eléctricas (UVIE), which is expensive and impractical to perform in a field study.

**2.2 Energy Hierarchy**

MEPI methodology is composed of five fundamental elements for essential energetic services that are then subcategorized into six criteria (electricity access, access to modern cooking fuel, indoor air pollution, ownership of household appliances, ownership of an entertainment and education and communication media) (Nussbaumer, Bazilian & Modi, 2012, as cited in Lin & Okyere, 2020). The focus on these criteria results in an inadequate analysis at a sub national level, classifying a family or residence as living in EP if the combination of deprivations they face exceeds a predefined limit (Mendoza & others, 2019).

Both the MEPI and the energy and human needs approach refers to the idea that the selection of certain fuels (particularly, firewood for heating and cooking food) implies a low economic status. The correlation between the use of certain fuels and income status has been criticized by authors such as Kroon, Brouwer, and Beukering (2011, p. 7) asserting that the correlation is not as significant as it was thought to be, especially in Latin America.

**2.3 Underestimation of renewable and passive technologies**

When variables such as thermal comfort are analyzed, the use of specific technologies such as fans and air conditioners are considered. However, this leaves out passive solar technologies such as housing designs. MEPI and the energy and human needs approach do not take into account technologies such as solar sanitary water heaters or solar stoves. According to MEPI and the energy and human needs approach, a home using a solar heating system or kitchen would be considered to be living in EP.

**2.4 Cost of living and income level**

ITTPE and MFEA utilize a scale of energy costs and income to determine EP. ITTPE utilizes the Low-Income High Cost to define its indicator (Calvo et al., 2019, p. 12) which has been criticized by Middleniss (2016) as well as Linares and Romero (2016). They argue that the method of the Low-Income High-Cost indicator is inefficient and tends to yield false positives and negatives when assessing the energetic efficiency of a residency.

On the other hand, MFEA establishes a spending limit of 10% of a families income for a 36.5 Kwh/year consumption package. Even though the limits are adaptable, the MFEA does not consider the varying rates based on consumption and how it is affected depending on the region’s climate. Furthermore, it considers the expenses in an autonomous system as excessive and consequently part of the EP spectrum.

**2.4 Discrepancies between the concept and its metrics**

Garcia’s (2020) energy and human needs approach based on Garcia (2014) and Garcia and Graizbord (2016) focuses its EP analysis on three categories: 1) basic human needs required to live, 2) benefits and state of well-being as a result of consuming energy though specific equipment and appliances, and 3) a residence, which is categorized by one or more people living in the same place. While the energy and human needs approach uses a quantitative-qualitative approach, it does not measure or evaluate poverty itself. Rather, it gives an general overview of the deprivation of technological resources by providing a conceptual relevance of the different facets of EP, but not in terms of its metrics.

This approach focuses on Mexico, but there are discrepancies on its praxis and episteme since the EP concept cannot be removed from the local and economic systems that are important according to Townsend (1962) and Sen (2000), who focus on people’s needs and their satisfaction factors from a relative perspective (Townsend) and an absolute perspective (Sen).

In conclusion, it is essential to present pertinent criteria that reflect both the absolute and relative scopes of EP. It is important to identify the needs of a community versus what their cultural practices are (the use of firewood does not necessarily indicate poverty, but rather the reflection of cultural traditions). Oaxaca has great potential in utilizing renewable energies and passive solar technologies.

## 3. Conceptual framework

### 3.1 Energy Poverty

When referring to energy poverty, there needs to be an understanding of the duality of the phrase derived from its metrics (indicators) and conceptualization (definition). Within the established definitions, one can find quantitative and qualitative approaches from only a third-person perspective. The characteristics of energy poverty depend on the region, income level, society, and technology available specifically to the region itself. Energy poverty should be defined by interconnected variables that determine what the root issue is. Next, the various definitions of EP that have been established in prior studies will be analyzed and serve as a reference to guide this study.

#### 3.1.1 Predominant Quantitative Concept

The quantitative conceptualization of energy poverty occurs when its components are more orientated to income level and when the acquisition of goods satisfies the common areas of the energetic workforce. According to Bordman (1991), a home under energy poverty is the one using more than 10% of its income on energy consumption costs, including any appliances needs to have a certain level of comfort. In a more recent study, Bordman and Culver (2017) concentrate on the scarcity and incapacity to obtain home energy services, making homes unsafe and inhabitable.

Mires (2014), Bhatia and Angeleon (2014) define energy poverty as experiencing energy inefficiency due to a lack of resources and energy services that would satisfy basic human needs in a healthy, convenient and efficient way. In this definition, there is a direct correlation between human needs and energy resources.

In the transition of conceptualizing EP with material and economic predominance to a concept focused on human needs, Middlemiss and Gillard (2015) propose to define EP by focusing on the lack of capacity in acquiring energy resources used to sustain a healthy life. The capacity or lack there of highlights the importance of managing energetic resources based on the communities that need them.

Masaud (2007) continues with the capabilities approach from Sen to confirm that EP is the lack of options and access to proper, reliable, and safe energy that is environmentally friendly and favors economic and human development.

The definition from Garcia (2014) and Garcia & Graizbord (2016) is foundational for this research since it was developed using a Mexican context and defines a home under energy poverty as:

*“The people who live there and do not satisfy their absolute energy needs, which are related to factors of satisfaction and essential economic goods based on their social and cultural values for a specific time and place” (García, 2014:17).*

Garcia (2014) asserts that his definition includes the absolute and relative needs described by Sen (1981) and Max-Neeh et al (1991). His definition titled “Necesidades Absolutas de Energía” (NAEs) presents a model based on needs and satisfaction factors in relation to the cultural and social practices that manifest a dimension of relative deprivation.

It’s important to note that although EP is a phenomenon that is generalized to a group of severe social and historical inequalities, the impacts are disproportionate, causing bigger harm to disadvantaged groups. According to Castelao y Mendez (2019), EP has a bigger impact on poor women’s health since it increases the time it takes to perform normal household activities, which are not compensated monetarily and therefore uphold the feminization of poverty.

Garcia’s (2014) concept of EP, while a strong concept, also has its weaknesses.

*“His definition has conceptual and methodological flaws, scarcely articulating concepts of poverty, survival strategies, vulnerability, and social exclusion. In addition, the existing bibliography does not explain how EP’s distinct factors interact and how this phenomenon factors into compensated and non-compensated labor, and the wellbeing of the people in a home” (Castlao y Mendez, 2019:148).*

After the analysis of the information, we can conclude that the capabilities to access energy resources of any kind is not necessarily related to its economic power. The real difficulty lies in the person’s ability to access and adopt practices and strategies.

**3.2 Solidarity economy**

For many decades, the management and distribution of energy resources has been conceptualized by the dominant economy; as Razeto (2001) says in his book “Los caminos de la economía de solidadidad", when people talk about economy, they spontaneously refer to scarcity, competition, profits and interests, among others, and although the concept often includes values, ethics and freedom of initiative, it does not give the value it deserves to gratitude, camaraderie or solidarity.

The main purpose of the economy should be a person’s well-being. The concept of EP results in many inequalities due to the close relationship between the economy and the energy sector, which it why it is necessary to approach this issue from the perspective of someone who is living this experience and has the ability to make personal and collective decisions for a better future.

*According to Reas (2011, pág. 1), “Solidarity economy is the approach in which economic activity prioritizes the community, environment, and sustainable development. In other words, it is a way of living that encompasses the integrity of people and designates the economy to provide the material bases for the personal, social, and environmental development of the human being in a sustainable way."*

Solidarity economy is a post neoliberal alternative based on values such equity, ethical consumption, and labor instead of wealth (Coraggio, 2011) and tries to converge autonomy with self-management (reas, 2011), in order to provide sufficiency over subsistence in relation to production and exchanges sustained by solidarity communities.

One of the most important arguments that outlines EP relates to solidarity economy sociocultural systems coexisting under capitalism. These systems operate under a collective use of resources and factors of satisfaction compared with other systems that operate from a private and utilitarian perspective.

Some countries have established a solidarity economy to reduce EP. In 2018, Greece implemented “Energetic Communities” through the adoption of judicial cooperatives that promote innovation in the energy sector, advocate against EP, and promote sustainable energy through various levels such as production, storage, self-consumption, and distribution (García y Frantzeskaki, 2021: 2).

Greece’s law 4450/2016 article 2.1 defines social economy as the economic activities that present different alternatives for production, distribution, consumption, and reinvestment mainly based on principles such democracy, equity, solidarity, cooperation, and respect for the human beings and the environment (García y Frantzeskaki, 2021: 2).

Considering the fact that the cost of energy was very high and many of the islands lack infrastructure and rely heavily on fossil fuels, Greece’s government was able to reduce territorial inequalities through their “Energetic Communities” by implementing solidarity economy principles.

By integrating this system into their economy, Greece is reducing the existing inequalities at a faster pace. In conjunction with politics, production and fiscal incentives, communities now can generate, manage, and even sell renewable energies at a local level (García y Frantzeskaki, 2021: 2).

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Implementing the solidarity economy as an alternative economy allows for holistic development both individually and collectively by promoting self-management, autonomy, cultural liberty, development of people's capabilities, environmental awareness, and community and economy solidarity based on local, national, and international relationships (Reas, 2011).

These intersections explain that multidimensionally improving one's quality of life requires the consideration of their liberty and capabilities as mentioned by Sen (1980). In other words, it should be considered that people will face a situation based on their personal knowledge and environments such as culture, technology, society, economy, and environment.

### 3.3 Capabilities Approach

The capabilities approach is based on the liberties and capabilities needed to obtain a desired living status (Sen, 2003). This approach is used when there are absolute provisions, thus poverty is discussed through the capabilities approach, focusing on its characteristics and utility.

The capabilities discussed are the liberties to choose a valued lifestyle. Therefore, not only goods and their benefits can be taken into account but characteristics take an important role when pursuing a desired lifestyle. The capability of a person is defined through the real-life applications of the various combinations of functions that can be achieved (Sen, 2000).

Capabilities are defined as one's ability to be effective/one's ability to achieve effectiveness (Colmenarejo, 2016, p. 123) in terms of functionality and capability through specific evaluations (León, 2018), by the real or effective opportunities available to the person to realize such functionalities (Colmenarejo citing Robeyns, 2005, p. 192), being a term of importance, the freedoms or opportunities that a person enjoys achieving such functionalities (León, 2018).

According to Pellicer (2018), the capabilities approach can be used to analyze the concept of EP from the perspective of the people who suffer this inequality by asking: what energetic capabilities are valued and undervalued and what are the problems that arise as a result of experiencing energy poverty? By asking these questions, the capabilities approach gives people the agency to analyze their own situation and can be applied to EP.

## 4. Methodology

In order to redefine EP, one must analyze the bibliographic context that identifies how Oaxaca's communities satisfy their energy needs based on their social and cultural values and the region's environment.

The research began by developing a focus group of 24 students within the Engineering in Renewable Energies program, specifically with the ER-1001 group of the Universidad Tecnológica de los Valles Centrales de Oaxaca, during the September-December 2020 term.

As part of its methodology, the study applied an EDT structure which made it more manageable to break down its phases or steps in order to achieve the desired result. The hierarchical breakdown is based on the work done within the team (Granillo, 2009). The EDT structure looks for the increase of detail and information as it moves through each phase (Díaz, 2006).

The students divided into subgroups and assigned deliverables and goals for the project. The first selection of sources included subjects related to energy and its interests from different fields of study such as Technology, Engineering, and Social Sciences.

The following stage consisted of reviewing the literature based on the development of analytic categories of energetic needs. This was followed by a group discussion on the categories pertaining to the energetic needs. The final phase consisted of the group synthesizing the information collected in the previous phases to focus on the factors of satisfaction related to energetic needs. The results and outcomes of these phases will be presented in the results section.

## 5. Results

### 5.1 Areas of energetic satisfaction as per Oaxaca's communities needs

After extensive analysis of research and previous studies, the following information of energetic needs were found:

#### 5.1.1 Thermal Comfort

Oaxaca is one of the states in Mexico with the highest indices for social underdevelopment (CONEVAL, 201) along with Chiapas and Guerrero, having a 73.4% deprivation rate in relation to living thermic comfort (García y Graizbord, 2016).

Although these communities seem to have precarious living situations based on the percentage of the population living without thermal comforts, it is important to mention that the climate of each region varies, thus and in-depth analysis is required to access if sustainable alternatives could meet the needs of each region.

According to CONCANACO SERV Y TUR (2018), the climate is warm sub humid and warm humid with 22 C median temperature and median precipitation of 1,550 mm, which is the reason why the population, do not have the need for a heating system in their homes, with the exception of those living in the highest areas of Sierra Norte, Sierra Sur, and Mixteca due to their colder temperatures.

The construction of a home should be an integral part of research considerations in addition to the environment and regional climate (Haramoto, 2002, citado por Ruiz, 2014).

The state of Oaxaca uses a variety of construction materials; approximately 60% of houses and buildings in Oaxaca's rural areas are built out of adobe or other mud-based materials. Just like many buildings in the different regions of Oaxaca, the buildings in the downtown historic center of Oaxaca were constructed based on the climate of the region (Instituto Politécnico Nacional, 2011).

The areas of Oaxaca with a semi-warm and mild sub-humid climate record an annual temperature between 12C to 18C (Barbosa, 2004). Taking this information into account, the evaluation of thermal comfort needs to take into account the materials used to build house.

For example, according to Sánchez (S.f.) Adobe as part of construction system preserves the cultural identity and authenticity of the person and contributes to environmental preservation. Because of its thermal mass, adobe is able to maintain warm temperatures during winter and consequently provide a comfortable temperature inside houses. Furthermore, adobe's composition and density makes it an ideal material for mild temperatures. It is also nontoxic, 100% environmentally friendly, recyclable and has acoustic properties. (Sánchez s.f.). Another optimal building material is wood because of its abundance throughout Oaxaca.

The burning of wood or charcoal is a great source of heat used in rural areas of Oaxaca. This energy source is also used to heat water, cook, and warm the living space. For example, a citizen, Toribia form Magdalena Jaltepc, stated using firewood to warm the house was enough because of the low temperatures of the area, "I used firewood regularly during the winter to keep warm the kitchen and the room" (Montes, 2020).

In summary, the material used as a heat source or to construct buildings depends on the climate of a specific region. The most common materials used are adobe, wood, and cantera.

#### 5.1.2 Water Heating

The characteristics and conditions of the climate in which one lives determines the necessity of the use of the water at boiling or room temperature. Access to clean water is unequal and limited. In 2015, only 45.3% of homes in Oaxaca had water (INEGI, 2015). More than half of the population does not have water in their houses and if they do have water, they do not have the resources to heat the water for their own use. There are different methods for water heating such microwaves, coffeemakers, electric or gas ranges. The heating methods that tend to be underestimated are ones based on natural resources such solar energy, charcoal, and wood.

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63% of a families total expenses is spent on the consumption of gas, with 54% being used to heat water. However, close to half of households used another source of energy other than gas to heat their water (SIE, 2018). It is important to understand the factors that determine the key impacts of energy consumption in regard to water heating.

The geo-climate factor: Oaxaca has a very bio-diverse climate because of its geographic location. This has a direct impact on the energy consumption, infrastructure and related services, throughout the year (CEPAL, 2018). With seven different climates, Oaxaca is ranked as having the most varying climates of any state in Mexico. It is important to consider the varying climates, regional differences, and how alternate heating methods used by the communities to meet their needs indicate how to obtain a more accurate analysis of energy consumption in Oaxaca. Geography and the climate indicate the needs of communities living in warm climate versus cold climate. Culture, gender, age, and purpose of a resource also play a big role when determining the needs of an individual or community (Garnica, 2020).

According to data from INEGI (2018), mild climate regions have the highest concentration of gas water heaters, about 11millions units, reflecting 70% of the population. Compare this to tropical climate regions such as Campeche, Chiapas, Guerrero, Oaxaca, Tabasco, and Yucatan using 510 thousand units. The data reflect that the methods used to heat water in the mild climate regions, including Oaxaca, are 81% gas, 6% solar energy, 12% electricity, and 1% wood. Rural areas in mild climate regions are more likely to use wood as a source of energy to heat water and cook (Contreras et al, 2003).

Solar energy is another method used in Oaxaca for water heating. The market from 2000 to 2015 reflected an increase from 0.7% to 3.7% for households showing interest in solar energy technology (CEPAL, 2018), but the cost of the equipment is high and the knowledge of its purpose and functionality is limited. Thus, the growth in demand in the market has been affected. Furthermore, the access to this technology is limited to certain populations because of its location. The goal of adopting this technology is to reduce the households' consumption of gas LP and and save energy.

In conclusion, urban areas in Oaxaca are more likely to use gas LP, solar energy, and occasionally electricity for water heating purposes.

### 5.1.3 Food Preparation

Oaxaca has a wide variety of traditional tools used to prepare food. According to Hinojosa (2003), wood is the main fuel used because of the availability of trees, mainly Mesquite and Encino. The use of wood also has a favorable economic impact on the food industry and can be used to produce other biofuels such a vegetable charcoal.

Wood has been used as a resource in Oaxaca for generations; although various types, sizes and byproduct are utilized, they all serve the purpose of preparing home cooked meals that communities need.

A Lorena stove is a type of technology that optimizes dendroenergy (wood energy) while preserving customs of rural families who use wood as a main source of food preparation (Vazquez et al, 2016). According to FAO-SAGARPA (2007), this type of stove lowers the risk of illnesses that can develop from inhaling smoke that show up mostly in women and children under 5 years old. Additionally, open ranges represent 80% of waste (FAO-SAGARPA, 2007). On the other hand, Mayorga (2017) shows that an earth oven is commonly utilized in the Isthmus region.

### 5.1.4 Lighting

Good lighting in a home extends the activities that one is able to accomplish in comparison to only using natural daylight. According to INEGI (2015) 3.2% of the population of Oaxaca has no access to electricity and instead uses fire, candles and fossil fuels as an alternate source of light, consequently having a negative impact on the environment and health. (SIFRA, 2018).

Mexico has a high presence of solar energy throughout most of the country. Half of the country has an average insolation of 5.5KWh/m2 a day, which is enough to cover 24 hours of the energy needed to illuminate the average household (SENER, 2012).

Throughout the year, Oaxaca experiences significant solar irradiation between 4.7 KWH/m2 and 5.8kwh/m2 per day, which facilitates the operation of photothermic systems used to generate electricity by heating fluids and photovoltaics (UNAM, 2011).

Due to the lack of electric services provided by the the federal commission of electricity, solar energy can be a viable alternate source of energy. Solar energy is a renewable energy that is free and, more importantly, there is plenty in Oaxaca as shown by the irradiation data previously mentioned. Unfortunately, there is little interest in transitioning to this technology because of the lack of understanding and political support, presence of myths, and the high cost due to low demand.

### 5.1.5 Refrigeration

The majority of food can quickly go bad according to Diaz (2005). The best way to conserve food is refrigeration to slow down food's decomposition. It contributes to factors like reducing biological activity (growth of bacteria) and water loss, and conserving nutrients (Inestroza, et al 2016). According to data from INEGI (2015), 64% of households have access to a refrigerator and freezer ((DIGEPO,2017). Those without access to refrigeration have to use alternative methods to preserve their food.

An example of an unconventional food preservation method is making brines using salt and vinegar, which limits the loss of water and therefore reduces decomposition and the growth of bacteria (Brito, 2019). Another method is the drying of the food outside to preserve its natural state for a longer period of time (UNESCO,2008). How food is packaged and stored also plays a critical role in food preservation by controlling content of humidity (Guevara y Cancino, 2008).

Another method is the adding of solutes such as salt or sugar. This method preserves food, although for a minimal period of time, since the bacteria's growth is restricted to the water availability (Guevara y Cancino, 2008).

Fermentation preserves food through the growth of microorganisms such as mold, fungus, or yeast (Infoalimentos, s.f.). Lastly, evaporation is used to conserve food by reducing the amount of water and augmenting the concentration of total solids (Guevara y Cancino, 2008). Similar to the drying method, the evaporation method of preserving food heats the food to reduce the amount of water. Rather than using natural heat outside, evaporation requires direct heat.

In conclusion, homes without access to refrigeration have implemented simple conservation methods that are as efficient as refrigeration (Langle y Jimenez, 2018).

### 5.1.6 Water Purification

The most common methods of water purification involve the following stages: capitation, filtration, sedimentation, decantation, coagulation, coloration, alkalization, and distribution (Samsa, 2008). These stages are processed and completed through specialized equipment that require electric energy to operate.

In 2015, according to CONAGUA 92018:103), 932 purification factories had a flow of 93.6 m3/s, and demonstrated the most significant lags in Oaxaca, Chiapas, and Guerrero.

The purification system in Oaxaca City consists of 58 water wells, with 23 of them being inactive because the equipment is broken (SENER, 2016). The estimated annual consumption of energy for these factories is 13,472,300kwh for an average consumption of 1.19 kwh/m3 of water extraction and 2.27 kwh/m3 for water admitted (SENER,2016). The lack of potable drinking water in Oaxaca is due to the energy poverty situation that the state is currently in.

The technology of social implementation to meet the vital need of potabilization fits perfectly within the type of projects described by Collin (2008). These types of projects emphasize autonomy and the need to diminish the dependency on the market by constructing networks that will guarantee safe drinking water.

Within this classification is ecotechnics, which guarantees safe drinking water for the household through solar disinfection.

From the viewpoint of the solidarity economy, the human right of access to clean drinking water is solidified, since its goal is to guarantee access to necessary resources used promote human development without dependence on current economic situations.

**Final Reflection**

In order to redesign the concept of EP, it was necessary to identity the concepts and approaches that guarantee a more inclusive and relevant definition. Solidarity economy's areas and dimensions were identified along with capability approaches pertinent to the aims of the study.

The following areas were most important to the comprehensive redesign of EP:

- Human rights
- Sustainable Development agenda 2030
- Decision Making Capabilities
- Quality of Life
- Ensuring health
- Energetic needs as per geolocation
- Culture
- Worldview
- Holistic analysis
- Energetic Natural Resources
- Affordability of current energy sources
- Access to existing energy sources
- Technological resources
- Knowledge of energy-providing technology
- Capacity for Individual development and achievement of goals

According to the information found, the cultural dimension plays an important role for the new redesign concept. By linking Oaxaca's biodiversity with the culture and traditions, the community will have more relevant alternatives to satisfy their energy needs than the ones offered by most economic systems.

Although not all people have access to electric networks or sufficient resources to support continuous consumption of gas, they can opt to use renewable fuels as an alternative to satisfy their needs.

Moreover, similar to the cultural dimension, environmental and technological dimensions are key in achieving autonomy and energy self-management in the regions. One benefit of renewable energies in any of the energetic areas discussed is that the use of ecotechnics and social technologies permits the attainment of energy resources in an accessible, affordable and inclusive way.

In contrast to Garcia's (2014) territorial characterization of EP, underlined by defining thermal comfort, refrigeration, lighting and water heating as "economic goods", we find that rather than possessing economic value, these energetic areas guarantee the realization of human rights. Therefore, they are more than a means to purchase and rather an end that should be guaranteed.

In conclusion, using the works of various authors, above all Garcia and Graizbold (2014), we have redefined the concept of EP as:

*The lack self-management, access, and affordability of energetic resources impacting social development, collective growth, and health without compromising cultural values and worldview informing the right to personal decision making on what type of energy source is chosen to satisfy essential services in a household.*

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