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ENERGY
PROGRAM

ENERGY POVERTY: NEGATIVE EFFECTS OF TARIFF SUBSIDIES

POLICY PAPER

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Executive Summary

Access to energy is a key aspect of sustainable development, addressed by the United Nations Sustainable Development Goal (SDG) 7, which aims to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. According to the International Energy Agency (IEA), around 745 million people still lack access to electric energy. However, measuring only access to electricity does not capture the full scope of energy poverty.

An adequate assessment in this regard includes the lack of access to essential energy services like heating, cooling, lighting, and cooking. In this sense, effective policies should consider both the availability of energy and its affordability to fully understand and address energy poverty. Energy poverty is linked to various socioeconomic issues, making it a complex problem. Key causes include poor infrastructure, low income, high-energy costs, lack of energy efficiency, and urban exclusion. The impacts of energy poverty are extensive, affecting health, education, and overall living standards, perpetuating systemic inequalities.

To address these challenges, policies must integrate improvements in energy infrastructure, efficiency programs, and regulatory innovations, avoiding, at the same time, high-energy costs that can make it unaffordable to the lower income population. To reach the goal, it is crucial to reduce onerous and unnecessary costs usually carried out by energy tariffs, such as subsidies to specific energy sources that are already competitive. On the other hand, it is important to strengthen those subsidies with the objective to reduce energy costs to lower-income populations, which can, in fact, give a response to energy poverty. Thereby, the path to ensure reliable and affordable energy access for all becomes effective and efficient.

In this context, it is crucial to analyze how subsidies can impact energy poverty, positively or negatively. Subsidies are government actions, by tax incentives or financial assistance, designed to modify the rights and responsibilities of specific groups to promote their development or improve social welfare and purchasing power. They can be classified based on the economic agents involved, the source of funding, and the focus of the service provided, including direct subsidies for identified users, indirect subsidies for service providers, tariff-based subsidies, fiscal subsidies from budgetary allocations, access subsidies for user connection costs, and consumption subsidies for continuous service usage. These subsidies aim to reduce costs or increase payment capacity, ultimately promoting development, correcting market price externalities, inducing technological learning, reducing dependency on imports, and creating economic activities and jobs.

In the power sector, subsidies often play a crucial role in promoting renewable energy and stimulating distributed generation, for example. These subsidies have evolved to support decarbonization and the adoption of renewable sources. They are essential in enhancing energy access and reliability, reducing emissions, and fostering technological innovation. However, their implementation also brings huge challenges, including economic distortions and the need for continuous review and adjustment to ensure that resources effectively reach those in need while minimizing negative externalities, costs that the entire society ends up paying. Properly designed subsidies can balance the goals of economic development, environmental sustainability, and social welfare if they are designed with rationality.

In this paper, we analyze international experiences regarding energy poverty and subsidies policies, highlighting case studies from Brazil, Colombia, India and Nigeria. In Brazil, the focus is on the experience of Light Serviços de Eletricidade, Rio de Janeiro's main power distributor, which has implemented several efforts to address energy poverty and manage the unwholesome issue of energy theft in its concession. Colombia's analysis involves innovative policies aimed at improving energy access and efficiency. India's case study examines large-scale programs to enhance these goals, contributing to overall development and poverty reduction, while Nigeria faces significant challenges related to infrastructure and affordability.

The table below summarizes, for each country, the intricacies involving subsidies, the key aspects of energy poverty, challenges, socioeconomic impacts and outcomes, as well as policy recommendations to address specific issues faced by each nation.

Country	Subsidies	Energy Poverty Context	Main challenges	Outcomes	Recommendations
Brazil	- Social Tariff - Fossil fuel for thermal plants in the isolated systems (CCC Account) - Coal - Renewable power generation incentives (mainly solar and wind, utility scale and distributed generation)	- 99.8% access to electricity - Significant electricity theft	- High tariffs - Economic and social distortions - Barriers to power sector modernization	- Renewable power generation is competitive, even without incentives - High tariffs leading to increased energy theft - Challenges in reducing emissions in isolated systems	- Reduce unnecessary subsidies - Strengthen regulatory agencies - Promote competition on fair basis
Colombia	- Subsidized tariff system based on socioeconomic strata	- 18.5% in energy poverty - High reliance on fossil fuels in non-interconnected zones (ZNI)	- Misclassification of households - High costs in remote areas - Limited renewable energy implementation	- Social equity through stratified tariffs - Financial burden on high-income households subsidizing lower strata	- Enhance energy efficiency - Modernize tariff structures - Foster energy efficiency projects

India	- Fossil fuel subsidies - Renewable energy incentives - Biofuel programs	- High energy demand due to socioeconomic growth - Challenges in balancing energy transition with developmental priorities	- Subsidy inefficiencies - High costs of renewable energy with storage	- Increased access to electricity - High renewable energy capacity	- Design effective social tariffs - Tailor policies for socioeconomic problems - Rationalize tariff subsidies
Nigeria	- Fossil fuel subsidies - Cash transfers and social programs	- 40% lack reliable electricity - 85% rely on traditional biomass for cooking	- Inefficient subsidy targeting - Low electricity reliability - High reliance on traditional biomass	- Fiscal strain from subsidies - High health and environmental risks from biomass use	- Provide adequate economic signals for network usage - Foster energy efficiency - Strengthen regulatory agencies

Table 1 – Comparative table: Brazil, Colombia, India and Nigeria

Given the complex relationship between energy poverty and subsidies, we can draw valuable lessons from these international experiences to support the achievement of SDG7.

STRENGTHENING REGULATORY AGENCIES

It should be noted that regulatory agencies play a central role in the search for reasonable tariffs, in guaranteeing the economic-financial balance of utilities providing network services, in ensuring equal competition between agents and in promoting innovation.

However, in recent years, there has been a tendency towards decreasing the role of regulatory agencies in several countries' power sectors around the world, even the ones with more advanced regulatory frameworks, such as Brazil. This weakening of regulatory activity potentially brings notable damage to companies and consumers in terms of efficiency and, at the same time, the correct allocation of costs and risks between power sector agents.

On these bases, it is extremely important to pursue policies that strengthen regulatory agencies, enforcing their independence and autonomy. In addition, it is necessary to attract and retain qualified technical staff, compatible with the high complexity and impact of the regulatory decisions taken by the agencies.

This strengthening of regulatory agencies creates conditions for regulatory rules to be designed based on a technical and economical basis, fostering competition and favoring final consumers.

GUARANTEEING COMPETITION ON ISONOMIC AND FAIR BASIS

The implementation of measures to unbundle the power industry from the end of the 1980s onwards sought for competition in the generation segment as a fundamental goal. At the time, there was great concern about guaranteeing access to the network on an isonomic basis, which in many cases was implemented by the correct regulatory framework.

However, the diffusion of variable renewable sources, which at first came with once necessary tariff subsidies, has brought new challenges in the search for efficient power trading markets, in addition to inflated tariffs in the countries where subsidies lasted much more than needed.

As a way to deal with this problem, it is recommended that competition between sources tries to focus on attributes that meet the requirements of the power systems, such as energy, capacity and flexibility. The focus on attributes is better fitted to the promotion of competition between different power generation sources, compatible with the required security of supply at the lowest possible cost. At the same time, the formation of market reserves for specific power generation sources should be avoided, due to the negative implications in terms of inefficiencies brought by these market reserves.

Finally, as the issue of environmental sustainability is a growing concern, it is important to define environmental attributes. For example, limits on greenhouse gas emissions can be defined.

REDUCING POWER CONTRACT PRICES FOR REGULATED CONSUMERS

Another item with a significant weight in final tariffs is related to the energy the utility purchases to supply its captive market. Depending on the country, the power market design is such that buyers of power in the free market typically purchase electricity exclusively from the least-cost options available (typically solar and wind), whereas distribution utilities in the regulated market purchase a costlier (and often more polluting) mix of technologies. Because of this practice, the average cost of contracts in the regulated market (which usually serves low voltage consumers, including those in social complex regions) is much higher than contracts in the deregulated market.

Therefore, it is crucial to seek measures that change regulatory rules for power purchases in the regulated market, seeking reduction in its contract prices.

PROVIDING ADEQUATE ECONOMIC SIGNALS FOR NETWORK USAGE

The neutrality of network usage tariffs must be reinforced as a basic premise in promoting competition in power markets. Furthermore, economic signals must be given that induce projects to be installed in locations of greatest value for power systems in order to minimize systemic costs.

Therefore, it is advised that there are no subsidies in network usage tariffs for specific sources and/or technologies, nor for specific consumers. Furthermore, it is recommended the presence of locational signals that are effective in allocating costs to agents depending on the costs that each agent imputes to the electrical grid.

MODERNIZING TARIFF STRUCTURES

Considering the emergence of new technologies, the trend towards decentralization of power systems and the new consumption patterns of increasingly active and engaged consumers, there is a clear need to design tariffs compatible with this new reality. In this sense, it is recommended that measures be adopted to modernize tariff structures.

Issues such as the presence of time signals in tariffs, demand charging in tariffs and implementation of specific tariffs for consumers with distributed generation systems tend to assume relevance. In the specific case of low-income consumers, an alternative to be debated is the implementation of prepayment mechanisms.

Finally, in order to test new tariff modalities before large-scale implementation, it is important to carry out tariff sandboxes that make it possible to assess consumer responses to new tariff structures and the real gains.

RATIONALIZING TARIFF SUBSIDIES

It is important to recognize that there will continue to be situations in which the granting of subsidies will be necessary. However, those cases should be exclusively based on studies that attest that their expected gains are greater than expected extra costs to consumers and/or taxpayers in general.

Furthermore, all subsidies should be temporary in nature, settling its duration in advance.

However, this is not the case of many countries' tariffs, such as Brazil. It is very common to find situations in which subsidies for renewable sources, for example, are perpetuated, even after they become the most competitive sources. In addition, it is not rare to find subsidies to fossil fuel sources (such as coal and natural gas) perpetuated, unnecessarily increasing tariffs and gas emissions.

Under these circumstances, other strategies involve ending existing subsidies (as much as possible) and removing remaining subsidies from consumer tariffs, funding them through general national or regional revenue sources such as taxation. This approach would alleviate the financial burden on low-income households, contributing to keeping energy affordable and accessible. It would also allow better transparency, shedding light to the budget impacts of such incentives, which can strengthen the debate about their legitimacy and adequacy. By reallocating subsidy costs to public funds, the regressive impact of high energy tariffs can be mitigated, in order to promote social equity while supporting only essential public policies.

Finally, it is important that consumers in the electricity sector only pay for subsidies whose objectives are natural to the electricity sector. In this sense, subsidies with objectives in other spheres must be funded in other instances. For example, although subsidies for social purposes are worthy, this type of incentive should be funded with treasury resources instead of being financed through electricity bills.

DESIGNING EFFECTIVE SOCIAL TARIFFS

Social tariffs are a powerful instrument to address energy poverty when well structured and designed. To make social tariffs more effective, it is crucial to consider the specific needs of vulnerable communities, accounting for regional disparities, climate and geographical particularities, as well as seasonal variations. For this purpose, it is important to guarantee that social tariffs specifically address the needs of the most vulnerable populations, with precise criteria of eligibility, ensuring equitable access to energy for those who truly need it and at a satisfactory level to promote dignity.

The policy should recognize and look into regional differences, such as the distinct challenges faced by low-income families in different states or areas, which can be heterogeneous. Also, it should reflect the unique climate and geographical conditions of each region, acknowledging that energy needs and purchasing power can vary significantly across the same legal and regulatory jurisdiction. Finally, social tariffs should account for seasonal fluctuations in energy demand, providing additional support during unusual or extreme weather periods to ensure continuous and affordable energy access.

In fact, previous experience in developing countries indicates that “social tariffs” can be a powerful tool to mitigate energy poverty, increasing affordability, decreasing electricity waste, decreasing electricity theft and enhancing quality.

TAILORING POLICIES FOR SOCIOECONOMIC PROBLEMS

Another worthy implementation is tailoring public policies to address complex socioeconomic issues such as electricity theft and fraud. Adopting advanced technologies and control tools can help prevent these illicit activities, thereby mitigating their impact on tariff rates and ensuring the efficient operation of energy distributors, which normally leads to better quality, breaking the cycle involving electricity theft and poverty. Moreover, establishing a trust bond between utilities and households is crucial. This can be achieved by means of social projects that empower community leaders and foster collaboration, addressing socioeconomic needs beyond power consumption. By integrating technological solutions with community engagement initiatives, there is room to create a sustainable framework that not only protects the financial health of public power, but also promotes social cohesion and collaboration within vulnerable communities.

FOSTERING ENERGY EFFICIENCY

Energy efficiency projects offer substantial benefits, particularly in vulnerable communities. By introducing more efficient appliances, these projects can significantly reduce power usage costs for households, providing financial relief to low-income families who often face high-energy expenses compared to their income. Moreover, the adoption of cleaner, energy-efficient cooking methods can greatly enhance indoor air quality, reducing health risks associated with toxic emissions from traditional cooking fuels, which are common in extremely poor communities. These initiatives not only promote economic savings but also contribute to healthier living environments, fostering a better quality of life for these households.

1 Energy Poverty

1.1. DEFINITIONS AND *ÉTAT DE LIEUX*

Energy poverty can be defined through various lenses, reflecting its complex nature. Broadly, it refers to the lack of access to essential energy services, such as heating, cooling, lighting, and cooking, which are necessary for maintaining a basic standard of living. In this context, two key factors in assessing this access are availability and affordability, with the former being a prerequisite for the latter. This means that the lack of access can arise from either the unavailability of energy infrastructure (availability) or the inability to afford energy services (affordability). Differentiating between these factors can enhance the design of efficient indicators that address them. Understanding energy poverty through these indicators can help build public consensus on the issue, facilitate its contextual description and guide the creation of policies aimed at alleviating them (World Resources Institute, 2008).

For this purpose, the share of the population with access to electricity (availability), which was, worldwide on average, 90% in 2022 (IEA, 2022), must be complemented with other indicators related to energy expenditure (affordability). For instance, one common indicator refers to the proportion of household income spent on energy. A household is considered energy-poor if it spends more than a certain percentage of its income on energy services, often set at 10% (Boardman, 1991). This approach provides a straightforward and easy-to-understand measure that can be used worldwide but may not capture the full scope of energy poverty, since it overlooks other important dimensions such as the quality and adequacy of energy services.

Multidimensional indicators, on the other hand, incorporate various aspects of energy poverty, providing a more comprehensive assessment. These indicators may include access to different types of energy services, the efficiency of energy use, and the adequacy of energy supply. For example, the Multidimensional Energy Poverty Index (MEPI), proposed by Nussbaumer in 2013, considers factors such as cooking, lighting, heating, and the ability to use appliances. This approach recognizes that energy poverty is not just about the cost but also about the adequacy and reliability of energy services. Such an approach aligns with Reddy's (2000) definition of energy poverty as the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development.

Considering “poverty” as “a condition characterized by a severe deprivation of human needs” (UN, 1995), the energy basic needs of households support the claim that energy plays a supportive role in human development. These needs include:

Electricity: Electric access is crucial for powering household appliances, lighting, and electronic devices;
Lighting: Adequate lighting is necessary for various activities, including studying, working, and general household tasks;
Heating: Maintaining a comfortable indoor temperature is vital for health and well-being, particularly in extreme weather conditions;
Food conservation: Properly storing and preserving food is key to avoiding spoilage;
Cooking: Access to modern cooking facilities is essential for preparing food safely and efficiently;
Productive Activities: Reliable energy access enables households to engage in productive activities, enhancing income and improving living standards.

Recent events, such as the COVID-19 pandemic and the war in Ukraine, have significantly impacted the world's progress in ensuring energy availability for all, as proposed by SDG 7. In 2022, the International Energy Agency (IEA) reported an increase in the number of people lacking access to energy, reaching 760 million. Although projections for 2023 suggest a slight improvement, with the number decreasing to 745 million, this progress remains insufficient to eliminate energy poverty by 2030. Under current state policies, the Agency estimates that 660 million people will still lack access to energy by that time (IEA, 2022 and 2023), which affects overall world development goals.

1.2. CAUSES AND DETERMINANTS

Energy poverty is embedded in a context of multiple vulnerabilities, with fundamentally multidirectional causal links that create challenges in addressing isolated factors. In fact, understanding energy poverty, its extent, and its relationship with other socioeconomic vulnerability indicators is a prerequisite for public policies (IDB, 2023).

As previously noted, energy poverty encompasses both the lack of affordability and the lack of (physical) access to energy infrastructure, such as electricity grids and gas networks. The latter is particularly critical in developing countries. For instance, Africa has the lowest rates of electrification, with around 600 million people lacking access to electricity, hindering economic development and educational opportunities (IEA, 2023). Furthermore, households without access to modern energy services are forced to rely on polluting and inefficient fuels, which negatively impacts their health, safety, and ability to participate fully in society.

In addition to infrastructure deficits, research indicates that there are four major elements considered crucial to explain energy poverty, from an affordability perspective: low income, high cost of energy, lack of energy efficiency, and urban exclusion. These factors interact in complex ways, making it difficult to address energy poverty through isolated policy interventions.

One of the primary causes of energy poverty is low income. Households with insufficient income are often unable to afford basic energy services. This lack of resources forces them to make difficult choices

between energy and other essential needs, such as food and housing, perpetuating a cycle of deprivation and poverty. This vector reinforces the belonging of energy poverty in a broad framework of dignity and the effort to end global extreme poverty (García Ochoa, 2014), which has decreased in the last 25 years (World Bank, 2024).

The high cost of energy is also a critical factor contributing to energy poverty. Elevated energy tariffs driven by incentives, excessive taxation, or poor production can make energy unaffordable for many households. This economic distortion disproportionately affects low-income families, since their bills represent a relatively higher part of their income (Robinson et al., 2018), forcing them to limit their energy use below their needs, fall into debt to cover their energy expenses, face default, or resort to electricity theft.

Another significant factor is the lack of energy efficiency, which strongly correlates with poor housing conditions (Chen et al., 2022). Many households, especially those in low-income brackets, use outdated and inefficient appliances that consume more energy and cost more to operate. Additionally, older, poorly insulated homes lacking basic energy services exacerbate the problem, leading to relatively higher energy consumption to maintain the same comfortable living conditions. The combination of these issues results in higher energy bills and greater financial strain on already vulnerable households.

Also, under low-income and high energy costs, less costly but less efficient and safe technologies are commonly employed. For example, one-third of the population cooks using polluting sources, such as kerosene, wood, and coal. This number has been stable for the last two decades[1], contributing to environmental pollution, and being responsible for the premature death of 3,2 million people annually (WHO, 2023).

Finally, urban exclusion, and the consequent precarious living conditions, plays a significant role in energy poverty. In many metropolitan areas, the absence of effective public authority and the presence of parallel power structures contribute to poor and unsafe living conditions, combined with the lack of sanitation, inefficient urban waste treatment, and low-quality housing. This poor infrastructure coupled with marginalization can influence consumption patterns. Issues such as theft, fraud, and wasteful consumption further complicate the situation, deteriorating the relationship between utilities and consumers and reinforcing the cycle of energy poverty, which in its most severe form is related to other factors of socioeconomic vulnerability (IDB, 2023).

1.3. HARMFUL IMPACTS

The impacts of energy poverty justify understanding this issue as a major socioeconomic pressing need. The direct and indirect effects of energy poverty are pervasive and far-reaching, affecting various aspects of daily life and contributing to broader systemic inequalities. Access to energy is a critical indicator for addressing issues of class and gender inequality, food security, climate change, access to health and education (IDB, 2023), and the development of economic activities (Oda and Tsujita, 2011).

In fact, access to clean, affordable energy is essential for development and underpins the achievement of around two-thirds of the SDGs, influencing areas from ending extreme poverty and securing global

[1] Calculated by Our World in Data based on the World Bank.

peace to achieving gender equality (Fuso Nerini et al., 2017). Additionally, efforts to achieve zero hunger can be significantly bolstered by providing the energy needed for food production, transformation, and preservation, thereby enhancing both food security and nutrition (WFP, 2019).

Energy poverty can also impact security, education and productivity (Pueyo and Maestre, 2019). Insecure energy access or difficulty in paying the bills can lead to increased reliance on informal and illegal energy connections, which are often unsafe and unreliable. These connections can pose significant safety risks, including fire hazards and electrical accidents (Geyevu and Mbandlwa, 2022). This situation also hampers reading skills and internet access, disrupting the learning process and limiting access to information. Consequently, it negatively affects overall educational outcomes.

Thus, ensuring access to energy services is fundamental to improving living standards. This is important not only for simpler needs such as home lighting and food refrigeration, but also for more complex issues related to comfort and health, such as heating homes in colder climates or using air conditioning in tropical regions experiencing extreme temperatures.

Subsidies In The Power Sector

2

Subsidies can arise as a result of government interventions to encourage public policy plans or even to correct market failures. Specifically in the energy sector, subsidies can be established to achieve specific policy objectives, such as: (i) providing affordable energy to low-income consumers; (ii) correct price externalities in the market; (iii) induce technological learning and reduce the costs of new technologies; (iv) reduce dependence on imports and improve energy security; and (v) create economic activities and jobs (IRENA 2020).

Just as there are several objectives, there are also different forms of subsidies, which can be granted through various types of interventions. Koplow (2004) carried out a survey on the application of subsidies in the global energy sector (see Table 2). According to the author, there are subsidies materialized through the direct transfer of resources by governments, support for research and development, tax incentives and regulatory exemptions. Another widely adopted type of intervention is cross-subsidization, which occurs when a group of consumers is exempt from certain costs, which are borne by other market agents. The table below illustrates this variety.

Type of intervention	Description
Access	Policies governing terms of access to national onshore and offshore resources (e.g., leasing).
Cross-Subsidies	Policies that reduce costs for certain types of customers or regions, increasing charges for other clients or regions.
Direct Expenses	Direct budgetary expenses for purposes related to energy.
Import/Export Restriction	Restrictions on the free market flow of energy products and services between countries.
Information	Provision of market-related information that would otherwise have to be acquired by private market participants.

Loans	Provision of loans or below-market guarantees for activities related to energy.
Price Controls	Direct regulation of retail or wholesale energy market prices.
Purchase Requirements	Mandatory purchase of certain products, such as national coal, regardless of other economically more attractive choices.
R&D	Partial or total government funding for research and development related to energy.
Risk	Insurance or compensation provided by the government at below-market prices for energy-related risks.
Fiscal/Tax	Special taxes or exemptions for energy-related activities.

Table 2 – Common forms of government intervention in energy markets. – Source: Adapted from KOPLOW, 2004.

During the consolidation of energy markets, several subsidy formats were implemented to meet different objectives. However, recently, with the purpose of minimizing the impacts of global warming and, consequently, meeting the goals established in the Paris Agreement, the energy sector, and especially the power sector, assumed an important role in the energy transition and raised discussions about efforts to meet established environmental goals. Thus, for some time now, subsidies for energy (and power) generation from renewable sources have been gaining ground in the countries involved.

In this context, the main agenda is the purpose of maintaining incentives, including subsidies, towards a cleaner power matrix, which may conflict with the objectives of the energy transition as a whole, including the need to keep electricity bills affordable to consumers, who generally pay for these subsidies and other costs through final electricity tariffs. This is even more important in developing countries, where affordable energy plays a central role in development goals, and particularly remarkable in those where renewable power generation, especially solar and wind, are already the most competitive sources, such as Brazil.

In this way, the debate on the cost/benefit ratio of subsidies in the energy (including power) sector must be widely discussed, in order to find a more sustainable way to promote decarbonization, expand liberalization, modernization and digitalization without excessively increasing the cost supported by consumers, especially the most vulnerable.

On the energy transition agenda, many countries have been encouraging the growth of energy generation through renewable sources for years. According to the report IRENA (2020), from 2015 onwards, several incentive methods were adopted with the aim of promoting renewable generation:

- In general, European Union support was based on Feed-in (FiTis) policies, Feed-in Premiums (often delivered through CfDs), Green certificates (GC) and investment grants;
- China has become a major global driver of renewable power generation deployment. In China, solar PV and wind power energy have benefited from FiTs to accelerate their deployment;
- Japan, in an effort to reduce its dependence on fossil fuel imports, has relied on the deployment of renewable power (primarily solar photovoltaics) through FiTs;

- The United States made use of federal tax incentives provided by specific policies and programs. This includes a combination of ongoing payments – notably through the Production Tax Credit (PTC) – and one-off tax incentives for investments, including the Investment Tax Credit (ITC) for solar power, but also through other policies.

Although the energy transition agenda is taking increasing space in the power sector, other subsidy policies related to the production and use of energy are also applied, such as means of maintaining the payment capacity of the most vulnerable consumers, both structurally and cyclically. In addition, the post-pandemic scenario and the Russia-Ukraine war created the need for most European countries to protect families and companies from price increases in the wholesale and retail energy markets.

It is clear that it is difficult for a subsidy policy not to have negative consequences or externalities, even if it is implemented for a limited period of time, no matter how well-intentioned it may be. However, it is worth the effort to monitor market developments to adapt such policies to any new realities that may arise. The perpetuation of subsidies without appropriate reanalysis can have critical undesirable economic and social consequences.

Particularly in the power sector, the situation can be even more critical. Despite some examples of success, there are many cases in which subsidy policies end up benefiting business owners and families with higher income and consumption. Thus, despite all government efforts, the financial resources allocated do not always reach the population that needs it most, with an aggravating factor: in various situations governments are not completely clear about who benefits from the existing subsidies (World Bank, 2023).

Therefore, subsidies can materialize in different ways, but in all of them there is a direct impact on the market's balance. If subsidies did not exist, it would be easier to verify negative externalities.

Regarding the fight against energy poverty, the absence of subsidies for the least assisted population, for example, can be considered as a deprivation of basic subsistence consumption. This situation is undesirable for society as a whole, as the consumption of goods below the needs reflects on crucial indicators of a nation, such as socioeconomic development, for example.

Another emblematic example is the need to decarbonize the economy, in which there is a worldwide call for the migration from fossil-intensive sources to renewable resources. To accelerate this movement, governments have, for years, encouraged renewable power generation sources by subsidizing them.

However, it is important to emphasize that, both in theory and in practice, there is a consensus that tariff subsidies, when not adequately designed, tend to privilege more advantaged groups in detriment of the less assisted ones, bringing greater costs to the economy, society and the environment.

Additionally, the impact of tariff subsidies, raising final power bills, can be an obstacle to the energy transition and the modernization of the power sector. Tariff subsidies decrease space for financing (throughout tariffs) CAPEX needs to meet, for example, the expansion of distributed energy resources and grid resilience (to face extreme weather events, which have become more frequent and severe with climate change).

3 Case Studies

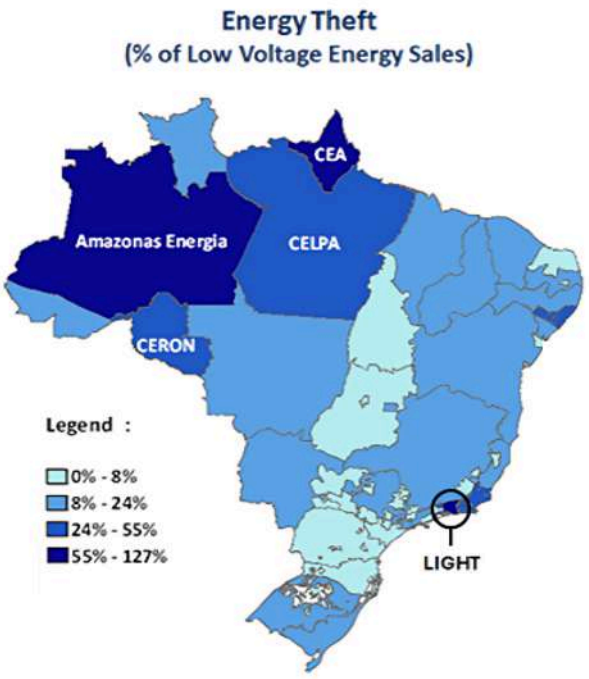
3.1. ELECTRICITY THEFT AND SOCIAL VULNERABILITY IN BRAZIL: AN ANALYSIS OF RIO DE JANEIRO'S CRITICAL SITUATION

3.1.1. Introduction

Today, 99.8% of Brazilian families have access to electricity services – roughly 90 million households in total. However, part of these services is provided irregularly through unauthorized connections to the grid or manipulation of electricity meters. Electricity theft to avoid proper consumption invoicing. According to the Brazilian Energy and Regulatory Agency (ANEEL), in 2022 nearly 35 TWh, or more than 6% of the country's load, was not billed because of theft.

Brazil is divided into 27 states and 54 electricity distribution concessions. Due to the country's large area – 8,512 km^2 –, concessions are very heterogeneous, especially in terms of market size, population density and socioeconomic conditions. Therefore, electricity theft levels also vary significantly throughout Brazilian concessions, from less than 5% to more than 100% of low voltage formal consumption, depending on the region and concession, as shown below.

Figure 1 - Energy theft in Brazil - Source: ABRADEE



Light, the power utility in Rio de Janeiro's metropolitan area, which was founded by Canadian entrepreneurs in 1905, is one of the Brazilian concessions where this situation is most critical. The company provides electricity to roughly 4 million consumers, around 11 million people – 5% of the country's population. On the other hand, due to Rio's highly social complex environment, more than 20% of Brazil's total electricity theft occurs in Light's concession. In 2022, roughly 7 TWh were stolen in the concession, 56% of Light's low voltage formal consumption, or 20% of its grid load.

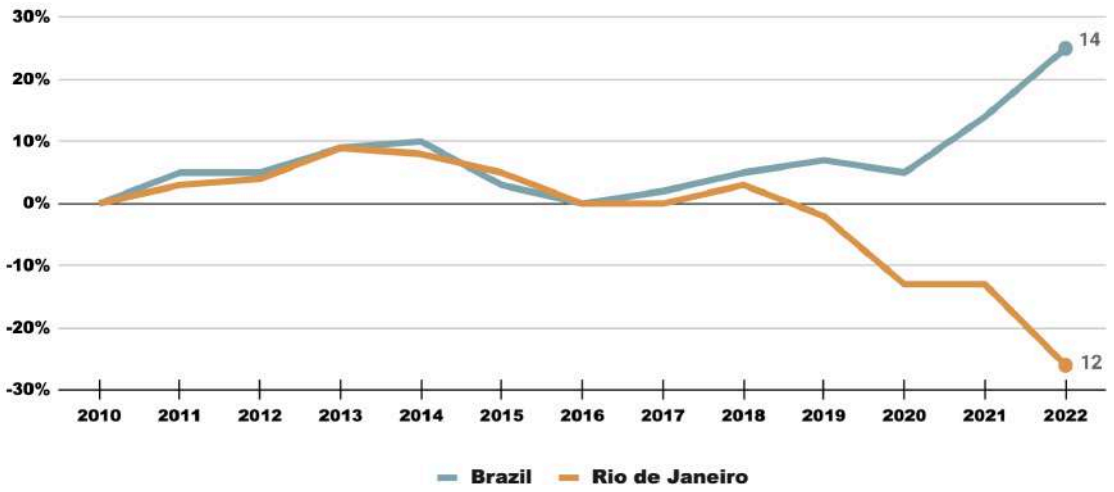
There are many historical reasons for this critical situation. Besides the marginalization from the colonial period and the first years of the Republic, that resulted in the formation of ghettos (slams, known as "favelas"), extreme poverty in other parts of Brazil forced several migratory waves from the rural countryside to the large cities, mainly Rio de Janeiro and São Paulo. The new inhabitants found these metropolitan areas unprepared to receive them in terms of urban infrastructure. The existing slums swelled, and many new ones were created. As a result, an informal economy – which does not pay taxes – flourished, as well as areas with severe social vulnerabilities and a lack of public power presence.

To worsen this scenario, since the early 90s drug dealing increased substantially, affecting most slums. The appalling result is that many of these areas have been controlled by drug gangs. More recently, since the 2000s, a new form of illegal armed territory control appeared, the Militias, armed groups that operate in parallel to the formal security forces, often composed of agents or former agents of the state. They are notorious, especially in Rio de Janeiro, for illegal activities such as homicides, extortion, and control of essential services, including power distribution. Thus, a vast territory in Rio's state has been historically dominated by organized crime groups, drug gangs or militias, which makes power distribution even more complex.

3.1.2. Rio's economic and institutional decline

The deterioration of Rio's economic situation has been impacting this negative scenario even further. Since 2016, its governments have been deeply involved in significant corruption scandals and the economic development of the state declined significantly compared to Brazil's performance, as can be seen in the chart below.

Graphic 1 - GDP per capita, PPP (cumulative growth) - Source: WB and IBGE



The economic underperformance of the state was shocked with structural issues, such as inequalities and high living costs. Rio has become the third most unequal state of Brazil, according to the Brazilian Census in 2022, and its average income is below national levels. Also, among the main state capitals, the city of Rio is where the basic food basket is more expensive.

Because of these harsh economic fragilities, in a context of conjunctural decline and pernicious corruption, the state bankrupted, leading to a more deteriorated institutional environment and a greater challenge to maintain territory control. As a result, the areas dominated by parallel control spread throughout the state.

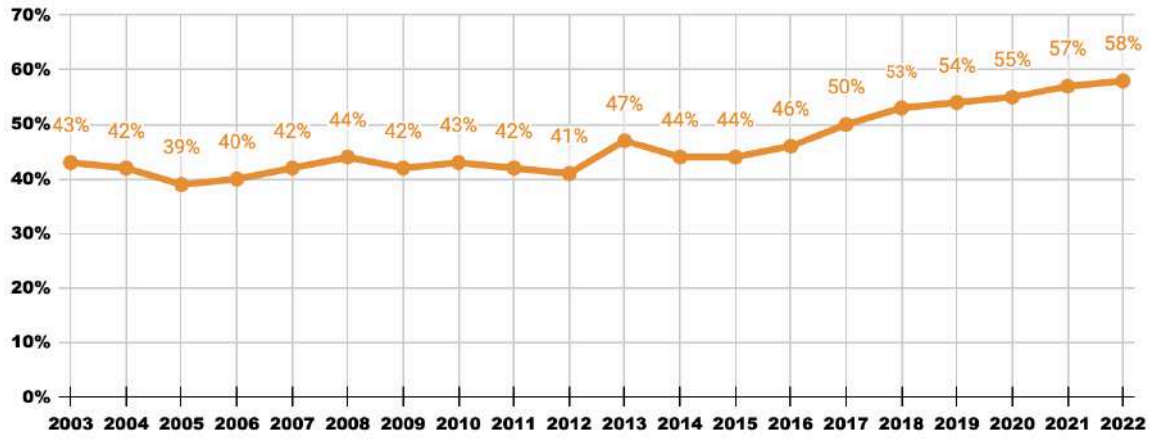
According to studies carried out by the Fluminense Federal University (UFF) in partnership with the "Fogo Cruzado" Institute, which created a map with the evolution of territorial control in the state, looking at the last 16 years, Rio's metropolitan region under the control of armed groups has doubled. The region's territorial control rate grew from 8.8% in 2008 to 18.2% in 2023. During this period, militias grew 205%, tripling their territorial control, and drug gangs had an average growth close to 80%. Since Light operates in Rio's metropolitan region, roughly 20% of its consumers are in areas dominated by parallel control, comprising an enormous challenge to the utility, especially with regards to electricity theft control. In many of these areas, gangs and militias not only obstruct Light's operations but also appropriate power distribution billing, imposing clandestine costs on consumers for the stolen electricity.

3.1.3. Light challenges

During the 80s and 90s, Light was a state-owned company, controlled by successive government administrations which had a tolerant relationship with electricity theft, especially in poorer areas. Most of the corresponding cost of the theft was added to the electricity bill of the regular consumers. This has resulted in high power tariffs and an enormous waste of power by those that could consume freely.

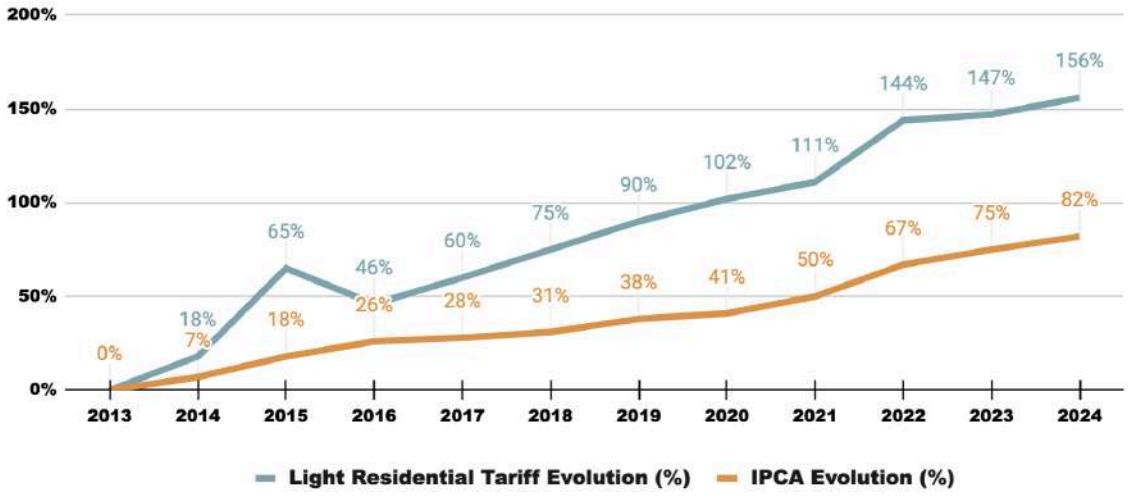
In the mid-90s, Light was privatized. Since then, for almost three decades, the Company has developed several efforts to fight against electricity theft, investing large financial resources to pursue this goal. Nevertheless, its electricity theft levels did not decrease, reaching more than 50% of its low-tension market since 2018.

Graphic 2 - Light's energy theft (% of low tension power market) - Source: Light



Several reasons led to this situation: First - Rio's economic deterioration as well as the state's territorial armed control growth, which brought enormous challenges to electricity theft combat; Second - Light's final tariffs increased significantly since 2013, as demonstrated in the following chart.

Graphic 3 - Variation of Light's residential tariffs (%) - Source: ANEEL



It is important to highlight that the tariff increases observed in the chart above was not associated with Light's power distribution services, but with the increase in the costs of the so-called "Parcel A", which are passed through by the distribution company to other agents to cover the costs of sector charges, generation and transmission. Particularly, sector charges have increased significantly since 2013, almost tripling its participation in Light's final tariffs.

The main reason for the increase in sector charges was the increase of the subsidies (incentives) carried out on final tariffs, which today represent, on average, roughly 14% of Light's final tariffs (see Graphic 4, below). In fact, the Brazilian power sector has evolved over the last decades in such a way that tariff subsidies have exploded.

There were actions established with the aim of promoting the competitiveness of renewable sources and guaranteeing energy accessibility for the most vulnerable users, besides stimulating distributed generation. There is also the Brazilian particularity, involving subsidies costs in the isolated systems - the CCC Account, which transfers funds to power generators in the isolated systems, mostly diesel thermal plants, more expensive and polluter than average power generation in the National Interconnected System.

Although some subsidies have their origins in the 1970s, such as the CCC, subsidies intensified after the early 2000s, when the Energy Development Account (CDE) was created to consolidate the subsidy programs included in the SEB. Currently, the CDE is a charge that covers practically all subsidies granted in the Brazilian electricity sector, with some exceptions, such as most subsidies to distributed generation, which are cross-subsidized throughout final tariffs of each DisCo.

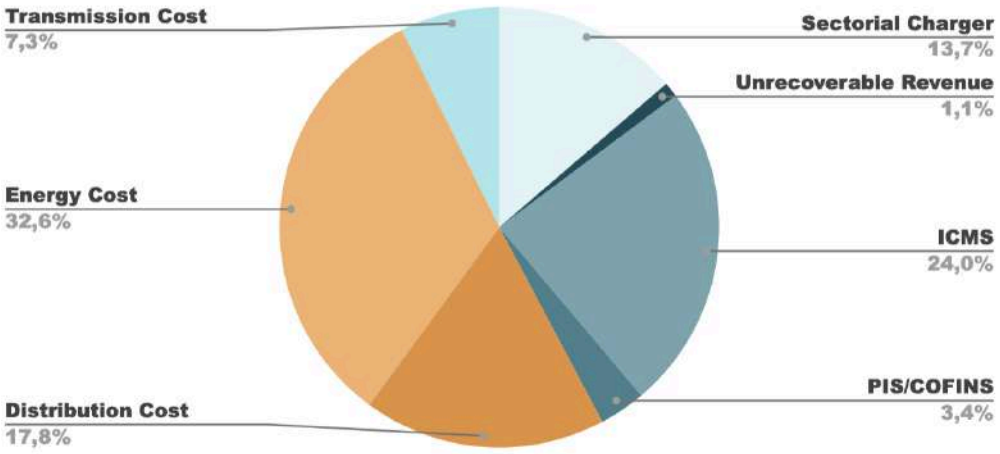
In practice, it is observed that subsidies in Brazil represent a burden on tariff and, even more critical, are increasing over the years, in an unsustainable cycle. For example, in 2013 the CDE cost R$ 14 billion and the expectation for 2024 is a cost of R$ 37 billion.

Another item with a significant weight in Light's tariffs is related to the energy the utility purchases to supply its captive market and losses (technical and electricity theft). One of the reasons for this high weight relates to the rules applicable for Brazil's regulated power market. Under those rules, whereas

buyers of electricity in the free market typically purchase electricity exclusively from the least-cost options available (typically solar and wind), distribution utilities in the regulated market purchase a costlier mix of technologies. Because of this practice, the average cost of contracts in the regulated market (which serves all low voltage consumers, including those in social complex regions) is much higher than contracts in the deregulated market.

As a result, today the weight of Parcel A items (which include the above-mentioned subsidies and purchased energy for regulated market) and taxes on Light's tariffs is 82%, as per the chart below.

Graphic 4 - Composition of Light's tariffs - Source: ANEEL



In turn, the legal criteria for the application of the Social Tariff in the country prove to be insufficient to serve low-income consumers in the South, Southeast and Central-West regions, such as Light, given that their cost of living and electricity consumption are higher than the national average, while Social Tariff is based on national minimum wage, as explained in subsection 4.1.6.

As a result, mainly because of the economic losses with electricity theft (since power purchase costs passed through tariffs are lower than actual costs), Light experienced severe financial difficulties over the last decade, which led to instability in its corporate control and governance. In this period, the company experienced several different administrations, CEOs and board of directors, leading to an absence of long-term strategic planning, which could help the company struggle with its concession area's huge challenges, especially with regards to social complexity.

Unable to meet the financial obligations of the concession, the company filed for Judicial Reorganization in May 2023. More recently, in May 2024, Light finally reached an agreement with its debtholders. The operationalization of this agreement should be concluded over the next 12 months, together with the concession's grant renewal, currently under discussion with the Brazilian government in a joint effort to bring sustainability to the electrical energy distribution concession to the state of Rio de Janeiro.

3.1.4. The pacification Program (UPP) experience

Light's experience in fighting against electricity theft in very complex regions had an important chapter more than a decade ago, by 2009, when Rio's government started implementing the Police Pacification Program (UPP), an initiative to regain territorial control, based, mainly, in massive police control.

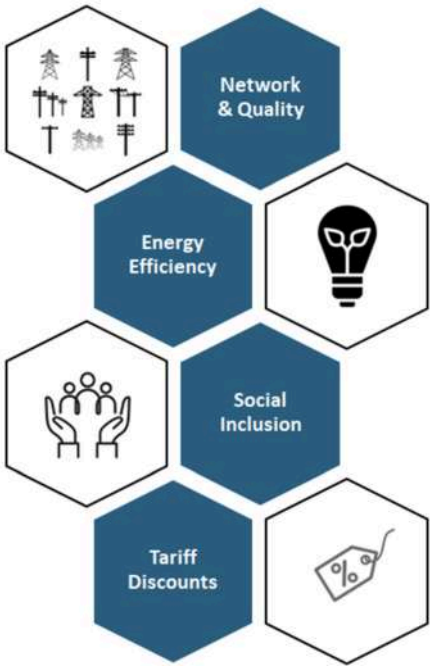
It is important to highlight that, in the regions where the UPP Program was installed, electricity theft levels were extremely high, mainly because for Light it was almost impossible to fight against theft without risking its workforce. Therefore, electricity waste was very high as well. In fact, it was estimated that more than 50% of the stolen electricity would not be consumed if properly paid by consumers in those regions, since price signals don't exist under energy theft. In addition, service quality was very precarious, due to illegal connections to the grid that often led to overload, service interruptions, fire hazards and accidents.

In this sense, for Light, the Program was a great opportunity to have access to areas that were previously dominated by parallel powers and try to create a new formal relationship with the population, decreasing electricity waste and theft, working together with government authorities to renew the distribution network and improve the quality of the service in the slums included in the Program. In addition, the company has implemented its Efficient Community Project, designed to fit the needs of low-income areas in Rio.

The Efficient Community Project aimed not only to reduce energy consumption, but also to strengthen the relationship between Light and the population, improving service quality and empowering clients. Basing its actions on distribution network improvements, energy saving education, social inclusion and special tariff discounts (beyond the Social Tariff discount), Light has been able to reduce electricity theft in these areas while the Pacification Program lasted.

3.1.5. Pillars of Light's strategy at UPP regions

Figure 2



Unfortunately, by 2016, the UPP Program had little left, mostly because of Rio state's bankruptcy. Another reason for the program's lack of long term results, pointed out by specialists at the time, was the absence of social initiatives that could be implemented by the state's government together with the public security enforcement. In fact, the social arm of the Program, called social UPP, did not get off the ground. Most of the regions continued to lack public services from the state and never had investments in infrastructure, especially in basic sanitation.

Thus, the positive impact of the Program has practically disappeared. Even worse, the UPP phenomenon caused drug-dealing leaders to seek new regions for their illicit activity, without losing contact with their original areas, meaning that, in a few years, like a "metastasis", they spread throughout all regions of the state.

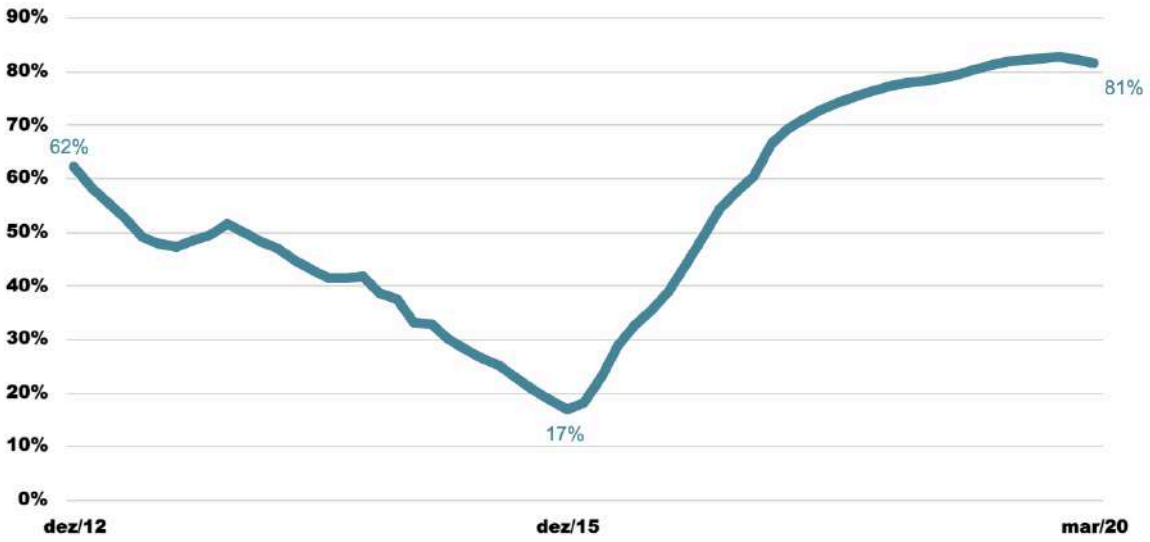
Yet, undoubtedly the UPP Program was a unique and very important experience for Light in its attempt to control electricity theft, especially with regards to regions dominated by parallel control. The data in the following table demonstrate this effect. After the installation of the UPPs, when it became possible for the company to operate, loss rates experienced a reduction of 72% to 91%.

Low Income Community	% Losses / Total Load		Variation
	Before UPP	With UPP	
Santa Marta	0,95	0,08	-0,91
Cidade de Deus	0,52	0,14	-0,72
Chapéu Mangueira e Babilônia	0,63	0,15	-0,76
Cabritos e Tabajaras	0,62	0,12	-0,8
Formiga	0,73	0,09	-0,87
Batan	0,62	0,11	-0,83

Table 3 - Power loss rate on communities covered by the UPP program - Source: "Aspectos regulatórios relacionados a perdas não técnicas em Áreas com Severas Restrições Operativas" (Light).

Another example of this phenomenon is shown in the following figure, which presents the evolution of energy losses at "Morro do Alemão". It is possible to observe three distinct moments: before, during and after the UPP. The end of the program, and the consequent impossibility of carrying out control operations, pressed the level of losses to increase again to levels of around 82% by 2020.

Graphic 5 - Energy losses at Morro do Alemão - Source: Light



To sum up, this experience was only possible with the UPP Program pursued by Rio's state, which included strong police control in areas dominated by parallel power, allowing Light to operate in those regions without putting in risk the lives of its workforce. Where Light was able to reach the UPP communities, its approach to decrease electricity theft was conceived to end the mutual disregarding between the utility and the consumers. There, Light would halt a situation where,on the one hand, most consumers do not pay for electricity and, on the other hand, they receive poor service from the utility.

Nonetheless, even with the help of the UPP Program while it lasted, huge challenges remained for Light, mostly because of the significant social complexity of the communities (lack of infrastructure, large informality and deep poverty). In addition, Light faced the challenge of tailoring each family's electricity bill to its ability to pay, a task that would have been easier if more families could benefit from the Social Tariff or be eligible for permanent tariff discounts. Unfortunately, this reality has not changed so far.

3.1.6. Tariff flexibility to low-income consumers

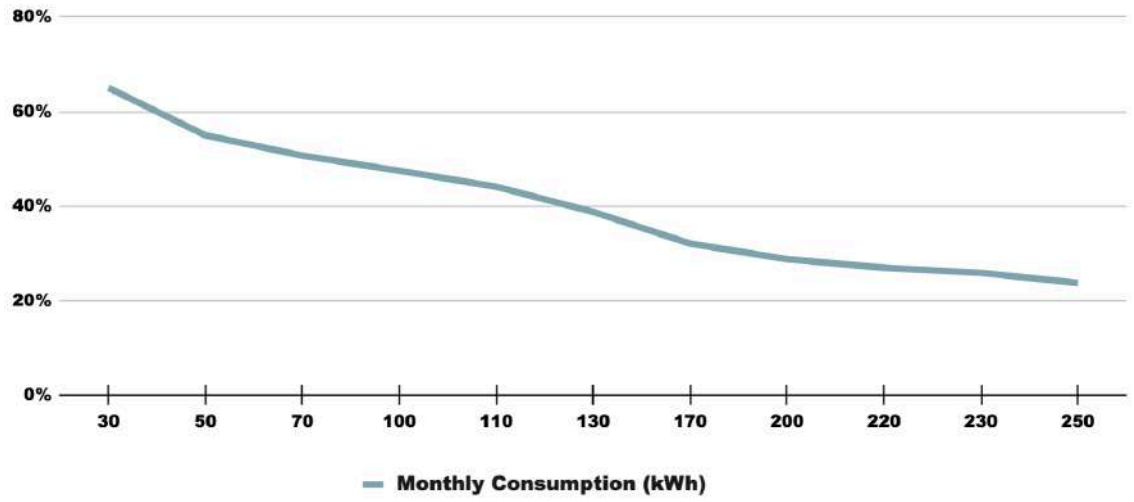
Social Tariff is still limited in Light's concession and is not enough to help fitting power bills to the region's low-income families. In addition, considering the huge tariff increase experienced over the last decade, today the situation is even more critical.

Current Light's final residential tariffs, including taxes, are roughly R$ 1/kW. For instance, a low-income family that consumes 200 kWh per month, which is common in Light's concession, will pay around R$ 200 per month, which can be very high compared to their income. Moreover, even if this family has access to the Social Tariff, its final discount will be around 30%, leading to a final bill of R$ 140 per month, which is still relatively high.

In fact, due to a set of conditions, the benefit of the Social Tariff is limited in Light's concession, where roughly 20% of the consumers have access to the benefit. First, the cost of living is higher, compared to the country's average, which means that the Social Tariff income threshold (half a minimum wage per capita) leaves out a significant portion of the population that is unable to pay for electricity bills with

the normal rate. Second, and most important, because the typical heat of Rio and the unhealthy urban layout of many slums (houses “stuck” together, preventing air circulation) induce the use of air conditioning, which reduces the discount granted by the Social Tariff, calibrated to vary inversely with consumption.

Graphic 6 - Average social tariff discount - Source: Authors



Light has tried to change this situation, bringing the subject to several stakeholders, such as the Parliament, the Ministry of Mines and Energy (MME) and ANEEL. More than seeking for a change in the Social Tariff’s specific law, the company has always looked for a more flexible tariff structure that could allow invoicing final consumers located in highly complex regions with lower tariffs, better fitted to the family’s income and consumption.

In fact, final tariffs are a central piece to facilitate the commercial relationship between the utility and its consumers. Therefore, it is important to have enough flexibility in the tariff structure so that the public service is better provided considering the social challenges faced by utilities in Brazil. Understanding that, ANEEL has started an important regulatory innovation, creating the tariff sandbox program through pilot projects to be conducted by distribution companies. As a result of the first public call within the program, which took place in 2022, there are six projects that began their execution in 2023, and new projects will start in 2024.

Light has presented an innovative project on the 2024 tariff sandbox program, focusing on social complex regions, aiming to test a tariff intervention that addresses, in an economic-behavioral way, aspects that could help decrease electricity theft and delinquency in those areas. Based on its previous experience (including the UPP Program) and interesting experiences in the water & sewage sector in Rio de Janeiro, Light's intention in this project is to experiment a fixed billing modality associated with non-tariff incentive mechanisms. Subsequently, it aims to evaluate the feasibility of expanding the model tested in the construction of a new public policy focused on mitigating the serious problems of electricity theft and delinquency the concession has been experiencing.

To sum up, Light’s Tariff Sandbox project seeks innovation in providing incentives for adequate consumer behavior in highly complex regions, through new tools to regularize power consumption in

areas that traditionally contribute to failing to meet the sector's common regulatory standard for losses and delinquency.

Finally, MME has recently (in June 2024) published a Decree No. 12.068 (related to the renewal process of several DisCos, including Light), settling, among other issues, guidelines to tariff discounts in regions with high levels of energy theft. The detailed regulation of the decree is not in place yet, but can be an important tool to bring more sustainability to Light's concession.

3.1.7. Final considerations

In Brazil, public utilities, such as Light, must be everywhere, even in regions where public authorities do not act, bringing enormous complexity to their physical operations and financial sustainability. In addition to the lack of infrastructure, there is often the presence of armed parallel power, especially in Rio de Janeiro, turning service provision much more difficult, due to the risk imposed on the utility's workforce.

On the other hand, the relevance of the regular provision of basic services, such as water and power distribution, is very important for the population of highly complex regions, especially those with very precarious infrastructure conditions. Therefore, the regulatory framework has a crucial role to this process, seeking, simultaneously: (i) utilities' financial sustainability; (ii) continuous incentives for efficiency gains, that can be passed-through tariffs; (iii) adequate services to the population; and (iv) preservation of utility's workforce's lives.

For example, adequate tariff design, under discussion on ANEEL's Tariff Sandbox Program and in other initiatives by Brazilian authorities, such as MME, is part of the regulatory and legal framework and can be a powerful tool to create an environment more suited to socially degraded regions. In addition, legal policies that aim to reduce tariff incentives (subsidies) that are no longer necessary for Brazil's power system are crucial, together with measures that are able to reduce the cost of power contracts that supply regulated consumers.

A complex debate, with no easy solution, but, without a doubt, extremely relevant to address energy poverty in Rio de Janeiro and Brazil.

3.2. ENERGY POVERTY IN COLOMBIA AND STRATEGIES FOR ITS MITIGATION

3.2.1. Background

In the early 1990s, Colombia's electricity sector was largely state-controlled, with limited private sector involvement and a heavy reliance on hydroelectric power. The 1991 blackout exposed the system's susceptibility to climatic variations and operational inefficiencies. In response, the Colombian government initiated a series of structural reforms to modernize and liberalize the electricity market (Alvarez Sierra & Tamayo Plata, 2006).

The cornerstone of these reforms was the enactment of Law 142 and Law 143 in 1994. Law 142, known as the Public Services Law, established the legal framework for the provision of public utilities,

including electricity, under principles of efficiency, quality, and user protection. Law 143, the Electricity Law, specifically addressed the restructuring of the electricity sector. It introduced competition, encouraged private investment, and unbundled the electricity industry into generation, transmission, distribution, and commercialization segments (Alvarez Sierra & Tamayo Plata, 2006).

These reforms led to the creation of the Energy and Gas Regulatory Commission (CREG), which was tasked with overseeing the market and ensuring fair competition. The introduction of the Wholesale Electricity Market (MEM) in 1995 allowed for the trading of electricity between generators and large consumers, further enhancing market efficiency.

Over the subsequent decades, these changes fostered significant improvements in the sector. Private investment arose, new generation capacity was added, and a more diversified energy mix was developed (nonetheless it is still highly dependent on hydroelectric power). In recent years, the regulatory framework evolved to support the integration of renewable energy sources, aligning with global trends towards sustainability.

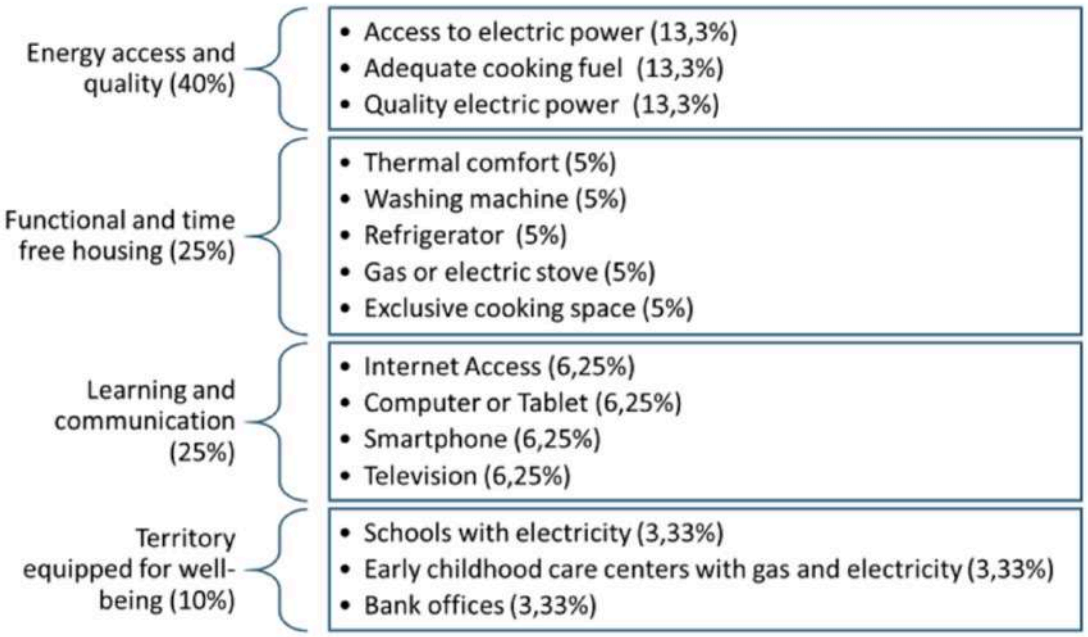
3.2.2. Energy poverty in Colombia

As mentioned, multidimensional indices are considered the most appropriate tools for measuring energy poverty, as they capture the complexity and various dimensions of the issue. Unlike single-factor measures, these indices take into account a range of factors, including economic, social, and technical aspects. Gonzalez et al. (2021) consider a multidimensional approach to measure energy poverty that encompasses availability, accessibility and affordability of energy, taking Argentina, Brazil, Uruguay and Paraguay as case studies. Gill et al. (2022) use five dimensions and six indicators to measure energy poverty in Pakistan. The five dimensions include cooking, lighting, services provided by means of household appliances, entertainment/education and communication.

In the context of Colombia, the first report of the multi-state energy poverty index (Promigas, 2022) proposes a method to measure energy poverty. This index considers four dimensions: 1) energy access and quality; 2) functional and time free housing; 3) learning and communication; and 4) territory equipped for well-being. Each dimension is further divided into different indicators as depicted in Figure 1.

The proposed index follows the Alkire-Foster (AF) multidimensional poverty measurement methodology. The AF method is a widely used approach for measuring multidimensional poverty, developed by Sabina Alkire and James Foster (Alkire & Foster, 2011). Unlike traditional income-based measures of poverty, the AF method captures a series of needs that individuals or households experience simultaneously. In this way, the method recognizes that poverty is not just about lack of income but involves various deprivations across different dimensions. Once the dimensions are established, specific indicators are attributed to each one. For example, as indicated in Figure 1, the dimension “Energy access and quality”, that has a 40% weight of the multidimensional index, is associated with the indicators of access to electric power, adequate fuel for cooking and quality electric power, each one with equal weight of 13.3%, respectively.

Figure 3. Dimensions and indicators of energy poverty in Colombia - Source: Own elaboration based on Promigas, 2022



The double cut-off point method is used to identify energy-poor households. Once the dimensions and indicators have been defined, a deprivation function is defined for each indicator with its respective cut-off point, so that it is possible to construct a detailed diagnosis of the deprivations recorded by the population. Subsequently, an aggregate cut-off point is set that refers to the accumulation of deprivations that will be taken as the threshold for defining that a household is multidimensionally poor. In this case, the aggregate cut-off point was set at 30%; that is, members of a household that accumulates at least 30% of the weighted deprivations of the index are considered poor.

The results show that 18.5% of the Colombian population is in a situation of energy poverty. This represents almost two out of 10 Colombians, which adds up about 9.6 million people. Among the energy-poor population, 8% do not have access to electricity, 61.8% live in municipalities with poor electricity service, and 47.7% cook with firewood and coal.

Figure 2 presents a comprehensive overview of the electricity supply situation and energy poverty in Colombia. It clearly depicts that the highest concentration of energy poverty and lower electricity coverage corresponds to Non-Interconnected Zones (Zonas No Interconectadas - ZNI), which heavily rely on fossil fuel-based generation sources. Conversely, regions closer to the central areas of the country, where the SIN operates predominantly using hydroelectric generation, exhibit higher coverage rates and lower energy poverty levels.

Furthermore, Figure 2 also highlights the distribution of energy poverty across Colombia's departments. Note that Quindío, San Andrés and Bogotá report the lowest energy poverty; while departments located in Non-Interconnected Zones, such as Vaupés and Vichada, exhibit the highest percentage of energy poverty. The study also showed that energy poverty in remote rural areas is 11 times that of large urban centers. Furthermore, the energy poor face barriers that prevent them from

achieving the realizations that energy enables. While the poor accumulate 46.9% of the deprivations, the non-poor accumulate 10.8% (Promigas, 2022).

3.2.3. Actions to mitigate energy poverty in Colombia

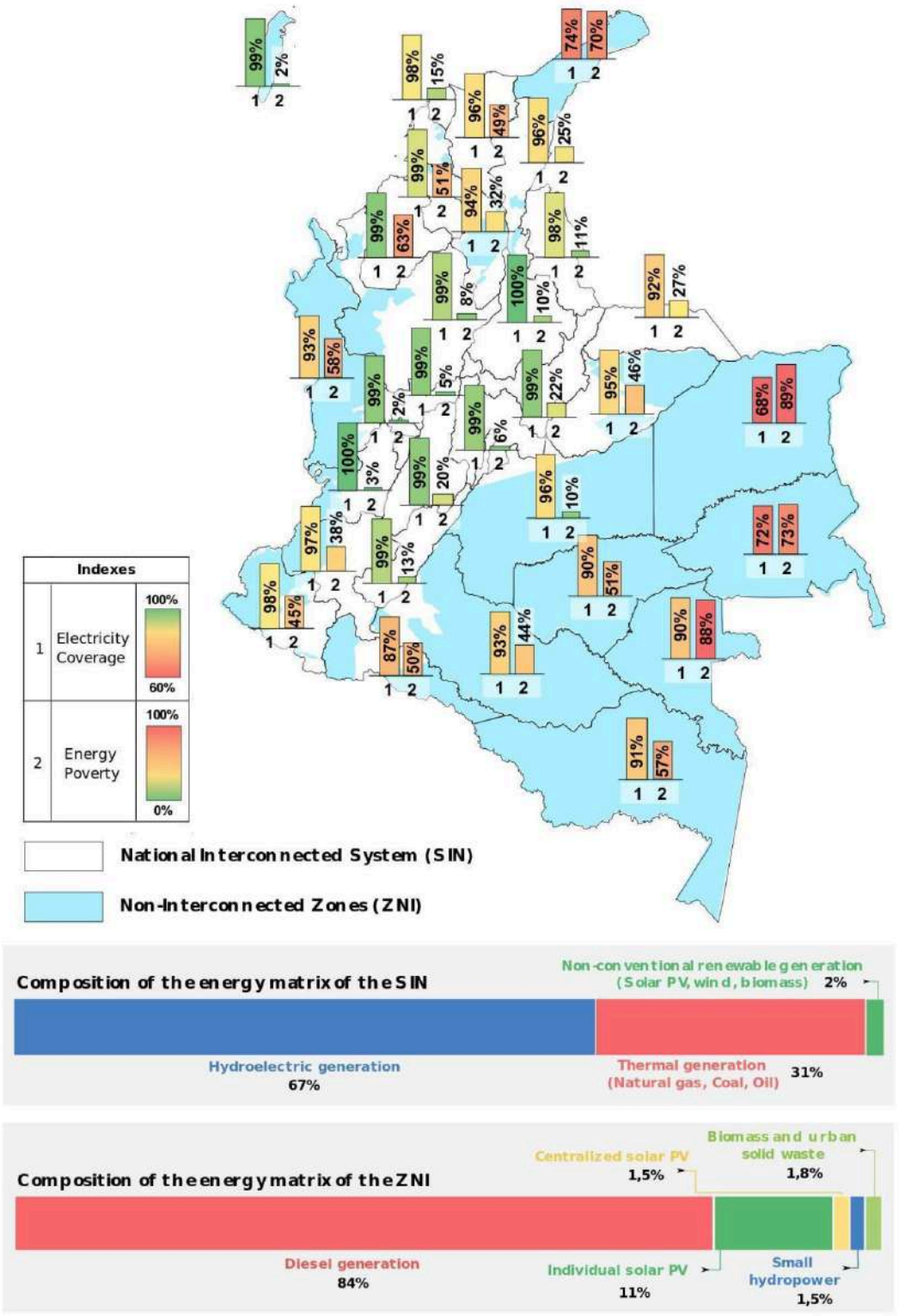
Colombia has implemented several programs to mitigate energy poverty, aimed at ensuring access to reliable and affordable electricity for its population. Key initiatives include electricity supply to ZNI, subsidies for low-income households to pay energy bills, incentives for inclusion of renewable energy and an approach towards energetic justice within the energetic transition vision of Colombia.

3.2.3.1. Electricity supply in non-Interconnected zones

Currently, the Colombian electricity sector is characterized by a diverse energy mix and a significant reliance on hydropower, which account for approximately 67% of the country's electricity generation, followed by approximately 31% of thermoelectric generation, and only approximately 2% of Non-Conventional Renewable Energy Sources (NCRES).

The ZNI in Colombia covers remote and rural areas, making up about 52% of the national territory but only around 4% of the population. Despite Colombia's significant potential for NCRES, most areas in the ZNI rely on expensive and polluting diesel generators, which make up 84% of the installed generation capacity in these zones. Only 15 areas have projects that combine renewable energy with diesel production units to provide electricity to small communities (IPSE, 2022a). This dependence on fossil fuels significantly increases the cost of energy generation, further compounded by the challenges of transporting fuel to these areas, often requiring river or air transport due to difficult road access, resulting in higher energy costs and limited supply.

Figure 4 - Overview of the electricity supply situation and energy poverty in Colombia - Source: Authors based on (Promigas, 2022), (DANE, 2021), (XM, 2022).



Providing electricity to these areas presents significant challenges for energy service providers due to their remote locations, difficult access, and potential environmental impacts, which often make expanding transmission networks unfeasible (Blasques & Pinho, 2012). Additionally, ZNI communities have low population density, limited payment capacity, and low collection rates, with an Unmet Basic Needs Index exceeding 70% (DANE, 2024). These areas also have low average energy consumption, high service provision costs, low levels of micro-metering, and a significant reliance on fossil fuels (IPSE, 2022a). The combined challenges of transporting primary energy resources and the limited on-site generation options lead to a scarce, inadequate, and costly energy supply, while the communities' ability to pay for energy remains low.

Colombia has sustainable rural energization programs (UPME, 2015; UPME et al., 2023). Furthermore, the Institute for Planning and Promotion of Energy Solutions for Non-Interconnected Zones (IPSE) dedicates to improving energy access in remote areas not connected to the National Interconnected System (SIN). IPSE concentrates on the planning, promotion, and execution of energy projects using renewable energy resources, with the aim of improving the quality of life and economic prospects for communities in the ZNI (IPSE, 2022b).

3.2.3.2. Subsidies for energy bills - Stratified tariff structure for fair electricity prices

In Colombia, the tariff system for public utilities, including electricity, water, and gas, is based on a stratification model that categorizes residential properties into six socioeconomic strata. This system aims to ensure that utility costs are equitable and reflect the residents' ability to pay. Stratum 1 represents the lowest-income households, which receive the highest subsidies to make basic services affordable. Conversely, Stratum 6 includes the wealthiest households, which pay higher tariffs that effectively cross-subsidize the lower strata. This stratified tariff structure is designed to promote social equity by redistributing the financial burden of utility costs, thereby supporting more vulnerable communities and fostering inclusive economic development (Bonilla et al., 2014).

The main drawbacks of this stratification model include potential inefficiencies and inequities in resource allocation. The model may misclassify households due to outdated or inaccurate socioeconomic data, leading to some high-income households receiving subsidies while other low-income households not receiving adequate support. Additionally, the system can create disincentives for economic mobility, as households might be reluctant to improve their living conditions if it means moving to a higher stratum with increased utility costs.

3.2.3.3. Incentives for inclusion of renewable energy

Although Colombia has a privileged geographical location, its progress in the implementation of non-conventional renewable energy sources has been rather slow due to political and socioeconomic factors. Nonetheless, Colombia has shown an increasing commitment to adopting clean technologies and curbing carbon emissions. In this sense, several incentives have been implemented to promote renewable energy, supported by specific laws and decrees, as per the list below with the main incentives. It is important to highlight that most of them are non-tariff, thus, they do not affect final power tariffs directly.

1. Law 1715 of 2014: This law is the cornerstone for the promotion of renewable energy in Colombia. It aims to integrate non-conventional renewable energies into the national energy system and provides tax incentives such as:

- Income tax deduction for investments in renewable energy projects;
- VAT exemption for equipment and services related to renewable energy projects;
- Exemption from customs duties for the importation of renewable energy equipment;
- Accelerated depreciation of assets used in renewable energy projects.

2. Decree 2143 of 2015: This decree regulates the procedures to obtain the benefits outlined in Law 1715. It details the requirements and processes for companies to access tax incentives, and promotes the development of renewable energy projects.

3. Resolution CREG 030 of 2018: Issued by the Energy and Gas Regulatory Commission, this resolution establishes rules for connecting small-scale renewable energy generation systems (below 1 MW) to the national grid. It facilitates net metering, allowing producers to sell excess energy back to the grid.

4. Decree 0570 of 2018: This decree promotes the development of large-scale renewable energy projects through competitive bidding processes, ensuring transparency and fair competition in the allocation of renewable energy contracts.

5. Law 2099 of 2021: Also known as the "Energy Transition Law," it updates and expands the incentives from Law 1715, further promoting renewable energy and energy efficiency. It includes new measures to facilitate the integration of renewable energy sources and enhance regulatory frameworks.

Currently, there are no studies relating the impacts of incentives of renewable energy on energy poverty in Colombia. Nonetheless, one can infer that such impacts would be positive particularly in rural and remote areas, such as Non-interconnected Zones. The incentives of renewable energy in those regions may increase access to electricity, by promoting decentralized energy systems such as solar and wind power. This improved access enhances living standards, education, and economic opportunities, thus reducing energy poverty.

Moreover, considering ZNI's main particularities - remote locations, with difficult access (making the expansion of transmission networks unfeasible), very low population density (4% of the country's population in 52% of its territory), limited payment capacity, and significant reliance on fossil fuels - encouraging the adoption of renewable energy can help lower the overall cost of electricity production and distribution, together with environmental and health benefits by reducing emissions and air pollution.

3.2.3.4. An approach towards energy justice

Two of the pillars of Colombia's energy transition are equity and social participation. This implies the democratization of energy resources and their management in a partnership structure that guarantees fair electricity prices. The vision of the energy transition in Colombia also promotes the creation of energy communities based on cultural, ethnic, territorial and productive characteristics, allowing the participation of final users in the electricity value chain as consumers and generators, therefore alleviating energy poverty. In this regard, one of the aspects of the National Energy Plan 2024-2054 (UPME, 2024) is to guide sustainable growth, foster social and economic equity, and meet national challenges. One of these challenges includes energy justice, which involves different aspects such as a country's energy resources, economy, society and environment.

Energy justice derives from the broad definition of justice and is concerned with the fair sharing of energy benefits (Sovacool & Dworkin, 2015). Energy justice relates to the concept of energy poverty in that it involves access to affordable, reliable, and sustainable energy; however, it also focuses on reducing the negative impacts of energy production and consumption.

Most researchers adopt a conceptual framework in which energy justice is characterized along three main dimensions: the first is distributive justice, which refers to the non-uniform distribution of the costs and benefits of building and operating energy systems; the second dimension is procedural, which relates to the adoption of equitable decision-making processes that primarily involve vulnerable and marginalized communities in a non-discriminatory manner (Jenkins et al., 2016); the third dimension is recognition of justice that refers to the forms of cultural and political discrimination suffered by some segments of the population. Subsequently, from Heffron & McCauley (2017), a new dimension was adopted that refers to restorative justice. The main objective of this dimension is to compensate victims in case of injustice.

In Moreno Ayala et al. (2023) it is illustrated that traditional cost minimization models do not reflect energy justice concerns, and therefore the authors propose mathematical functions to be considered in expansion plans in Colombia to maximize social welfare related to access to electricity in a reliable and affordable manner, thus impacting energy poverty.

3.2.4. Final considerations

Colombia faces a significant challenge in mitigating high levels of energy poverty, with two out of every ten Colombians affected. The situation is particularly severe in rural areas and Non-Interconnected Zones (ZNI), where energy poverty rates are extremely high. Addressing this issue requires targeted efforts to improve access to reliable and affordable energy, especially for the most vulnerable communities.

Several programs have been proposed and implemented to mitigate energy poverty, including incentives for non-conventional renewable energy sources, subsidies for low-income households, and electrification initiatives in the ZNI. These efforts aim to improve access to affordable and reliable energy, but they require long-term government commitment and planning in a country with complex social and political conflicts like Colombia. Ensuring the success and sustainability of these programs involves addressing underlying issues, securing stable funding, and fostering collaboration between public and private sectors.

Given the potential negative impacts associated with subsidies, particularly in sectors like renewable energy, their design and implementation must be carefully planned. Subsidies should be carefully targeted to achieve specific policy goals, while minimizing unintended consequences such as market distortions or inequitable distribution of benefits, which often occur when subsidies are funded by tariffs.

Colombia is committed to a just energy transition, where one of the key pillars is energy justice. This includes ensuring community participation in decision-making processes and the democratization of energy resources. By involving local communities and prioritizing equitable access to energy, Colombia aims to create a more inclusive and sustainable energy future.

3.3. DELIVERING EFFICIENT SUBSIDIES FOR CLEAN ENERGY EMPOWERMENT: THE INDIA STORY

India, the world's most populous country with an estimated 1.4+ billion citizens, is poised to become its third largest economy within this decade. It also aims to become *Viksit Bharat,* i.e., "Developed India" by 2047, the 100th anniversary of its independence from British rule.

India ranks fourth globally in total renewable energy (RE) installed capacity, fourth in wind power capacity, and fifth in solar power capacity[2]. Renewables comprise over 40% of its power capacity[3], but less than 4% of its total energy mix[4]. In this article, we will explore how consistent and coherent policies and targeted subsidies have made India a renewables powerhouse. We will also examine some cases to see the challenges of phasing out complex and interdependent subsidies criss-crossing across sectors, and why India needs to continue some fossil fuel subsidies – while promoting renewables – to support energy access, availability, and affordability for its people, hundreds of millions of whom have recently exited multidimensional poverty, and need handholding to get past energy poverty.

Between 2014 and 2024, India's GDP almost doubled from US$ 2 trillion to US$ 3.9 trillion, ranking it amongst the global top five, though its per capita GDP is only US$ 2,370 compared to China's US$ 13,140 and the USA's US$ 85,370[5]. This is changing, however, with India's developmental efforts yielding notable results: between 2013-14 and 2022-23, multidimensional poverty declined from 29.17% to 11.28%, improving the lives of almost 250 million people[6].

THIS SOCIOECONOMIC UPLIFTMENT HAS MAJOR IMPLICATIONS FOR INDIA'S CONVENTIONAL AND CLEAN ENERGY SECTORS, AND ITS AMBITION TO ACHIEVE NET-ZERO BY 2070.

As poverty reduces and the quality of life improves, energy demand increases across all sectors: power, domestic uses like cooking and appliances, transportation, construction, agriculture, and industry. Energy, that was once surplus due to low demand, can quickly become deficient and expensive if production and tariffs do not match demand growth and the purchasing power of consumers.

India averaged a 4.5% energy consumption growth rate between 1981 and 2010[7], but this has escalated in the past decade with the GDP: in 2023, fossil fuel consumption spiked by 8% year-on-year with an overall energy consumption share of 89%, and, on 30 May 2024, electricity demand peaked to an all-time high of 250 GW, recording the highest ever single-day energy consumption[8].

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[2] Invest India. Sector: Renewable Energy. 2024. (link)
[3] Ministry of Power, India. Power Sector at a Glance: All India. May 2023 (link).
[4] NITI Aayog, India. *India's Climate and Energy Dashboard: Primary Energy Supply.* 2023. (link)
[5] Forbes India. *The Top 10 Largest Economies in the World in 2024*. 2024. (link)
[6] Press Information Bureau, India. *24.82 Crore Indians Escape Multidimensional Poverty in last 9 years*. 2024. (link)
[7] Ramakrishna, G. & Rena, R. *An Empirical Analysis of Energy Consumption and Economic Growth in India: Are they Casually Related?* STUDIA OECONOMICA, 58(2): 22-40. 2013. (link)
[8] CNBCTV18. Indian Energy Exchange Reports 28.9% Jump in May 2024 Volumes. 2024. (link)

India is now the world's third largest energy consumer, though its per capita consumption is still only a quarter of China's and a tenth of the USA's[9]. Most Indians rely on a mix of fossil fuel and RE subsidies – US$ 39 billion in 2023 across sources[10] – for basic access to electricity and daily-use fuels. However, even with subsidized energy access, most households, which earn US$ ~258 monthly on average[11], spend ~5-7% of their income on electricity and domestic fuels, and another 6-9% on conveyance – exceeding expenditure on other basics such as clothing and education[12].

Ironically, then, the reduction in multidimensional poverty and rapid socioeconomic growth could intensify India's energy poverty and insecurity. Thus, for the near and medium terms, energy subsidies – for RE *and* fossil fuels – are critical to ensure energy access, availability, and affordability for much of the population. Prime Minister Narendra Modi emphasized this at the G7 meeting in June 2024, stating that India's energy priorities are based on *"*four principles – availability, accessibility, affordability and acceptability.*"*[13]

India's energy mix comprises 58.18% coal, 36.52% oil and natural gas, 3.74% renewables – including large hydropower, and 1.6% nuclear.[14] Though fossil fuels continue to be the energy bedrock, India is rapidly ramping up its RE capacity – mostly for power generation, spurred by the precipitous fall in the cost of solar panels in the past decade, a solid wind energy sector, and sustained policy-led public and private sector investments.

India's foray into renewables, then termed "non-conventional" energy, started in the early 1970s to counter global oil supply and price shocks, acting on the imperative for energy security. The then-impoverished country was also keen to harness its solar, wind, and large hydropower capacities to lessen the exorbitant capex impact of imported oil and gas, and redirect its limited resources towards developmental goals. To organize these efforts, India established the Department of Non-conventional Energy Sources in 1982, which evolved into the Ministry of New and Renewable Energy in 2006.

The sustainability imperative was added to India's energy security and affordability mix with the quickening descent of the world into the triple planetary crises of climate change, pollution, and biodiversity loss – and India's carbon footprint shooting up in recent years in tandem with its economic growth. It also aligns well with India's interest in developing domestic renewables to reduce dependence on imported fossil fuels.

In 2015, India set a steep target of 175 GW RE capacity by 2022[15] – including 100 GW solar, 60 GW wind, 10 GW bioenergy, and 5 GW small hydropower, up from its 2014-15 capacity of ~40 GW[16]. In 2019, it added large hydropower to its basket of renewables (~47 GW in 2024[17]). India's solar capacity grew 31x from 2.6 GW in 2014 to 84.27 GW in 2024, while wind capacity more than doubled from 21 GW to ~47 GW.[18]

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9 BP. *Statistical Review of World Energy: Primary Energy Consumption Per Capita*. 2022.
10 IISD. Mapping India's Energy Subsidies 2023. (link).
11 Sunaina Chadha. *India's Average Monthly Salary in Urban India is Rs 21,647*. Jul 2023 (link).
12 NSSO. *Survey on Household Consumption Expenditure 2022-23*. Jun 2024 (link).
13 Prime Minister's Office, India. *PM's Address at the Outreach Session of the G7 Summit*. PMIndia. Jun 2024. (link).
14 NITI Aayog, India. *India's Climate and Energy Dashboard: Primary Energy Supply.* 2023. (link)
15 Press Information Bureau, India. *Ministry of New and Renewable Energy – Year End Review, 2015.* (link)
16 Ministry of New and Renewable Energy, India. *Year-wise Achievements*. (link)
17 Invest India. *Sector: Renewable Energy.* 2024. (link)
18 Invest India. *Sector: Renewable Energy.* 2024. (link)

Despite tepid public response to the plan to install 40 GW of solar rooftops by 2022 due to financing and deployment difficulties (only 12.46 GW of grid connected solar rooftop capacity, mostly institutional, was added till May 2024), and supply chain and other disruptions during the COVID-19 pandemic, India is set to achieve 200 GW RE capacity in June 2024 (193.57 GW in May 2024).[19]

Also in 2015, at COP21 in Paris, India announced its Nationally Determined Contribution (NDC) to have 40% of its installed power capacity from non-fossil fuel sources by 2030. By 2022, India had surpassed the 40% target, almost nine years in advance, and upped its NDC ambition to 50% non-fossil fuel based power capacity by 2030.

This is a fast-moving target, as the quantum of power needed is constantly increasing with growing demand, and generation and transmission must keep pace. India's new target, of 500 GW non-fossil fuel-based energy by 2030, comprising mostly renewables, will supplement – not replace – its fossil fuel base. Also, despite India's RE tariffs being among the lowest globally, when combined with storage, even with subsidies, these are not competitive versus fossil fuels. So, India's energy trilemma of access, affordability, and sustainability continues.

While the trilemma is not unique to India, its large, economically weak population and limited natural and financial resources make it especially challenging to balance its developmental priorities with energy transition aspirations. Unpacking the layers of subsidies and incentives of India's vast and complex energy system, including hefty – and sometimes inefficient – fossil fuel subsidies, needs a well-planned, pragmatic, and patient approach.

INDIA'S RE AND FOSSIL FUEL SUBSIDIES ARE INTENDED TO SOLVE FOR STATE CAPACITY CONSTRAINTS TO ALLEVIATE ENERGY POVERTY, RATHER THAN GENERATE PROFITS FOR CORPORATES.

For example, in 1950, when newly independent India adopted its Constitution, its per capita power consumption was a meagre 18.17 kilowatt-hours (kWh).[20] Over 75 years, India has achieved near-complete electricity access[21] and has increased its power generation capacity to ~400 GW, increasing per capita consumption to 1,297 kWh by 2022.[22] This is still only a fraction of China's 2022 per capita consumption of 6,199 kWh and the USA's 12,702 kWh.[23]

Similarly, 85% of Indians today have access to clean cooking fuels[24], and two-thirds of Indians now use public mobility systems.[25] Each such milestone to reduce energy poverty by improving access, creating affordability, introducing cleaner energy sources, and shielding people from the volatility of global energy markets has been driven by myriad subsidies in the RE, fossil fuel, power transmission, and supporting sectors – including US$ 36 billion in fossil fuel subsidies alone in 2023 – delivered via an intricate network of policy mechanisms.

It is important to understand the history of India's energy subsidies to contextualize today's complexities. India faced an extreme balance of payments crisis in 1991 that compelled it to liberalize the economy. Through the 1990s, the cash-strapped government administered petrol, diesel, kerosene,

[19] Ministry of New and Renewable Energy, India. *Physical Progress*. 2024. (link)
[20] Central Electricity Authority, India. *All India Electricity Statistics*. General Review 2022 (link).
[21] Press Information Bureau, India. *156 GW Power Capacity under Construction, More than 469 GW Electricity Capacity Comprising 322 GW Expected to be Added by 2031-2032: Union Power and New & Renewable Energy Minister*. Feb. 2024 (link).
[22] NITI Aayog, India. *India's Climate and Energy Dashboard: Primary Energy Supply.* 2023. (link)
[23] Statista. *Electricity Consumption per capita Worldwide in 2022, by Selected Country. 2024.* (link)
[24] Mani, et. al. *State of Clean Cooking Energy Access in India: Insights from IRES*. CEEW. Sept. 2021 (link).
[25] UITP. *Boosting Employment and Accessibility: Investing in India's Public Transport Sector*. Oct. 2020 (link).

and liquefied petroleum gas (LPG) prices, and used subsidies to cover the gap between procurement costs and the (lower) government set price caps, spending on average US$ ~4.4 billion annually[26] to keep energy affordable.

As the economy strengthened, the subsidies bill escalated, touching US$ ~17 billion in 2010-2011.[27] Price regulation was dismantled by 2002, and petrol and diesel subsidies were phased out in 2010 and 2014 respectively.[28] Taxes were imposed on fuel sales, which are now a major source of revenue for the central and state governments, earning US$ ~90 billion in 2023-24.[29]

Targeted subsidies are being used to promote clean cooking access. In 2014, only ~145 million domestic consumers (mostly urban, high-income households) had LPG.[30] The government launched a campaign asking affluent families to voluntarily surrender their gas subsidies to help poor families transition from open burning of coal and biomass to cleaner LPG. Over 11 million consumers gave up their LPG subsidies[31], and in 2016, these funds were repurposed into the *Pradhan Mantri Ujjwala Yojana* (PMUY) scheme, which gave an US$ 2.3 (INR 200) subsidy per LPG cylinder – a quarter of its cost – for up to 12 refills a year per household.[32] Between 2016 and 2024, PMUY benefitted 95.9 million consumers[33], and, overall, ~324 million domestic consumers now have LPG access – more than double the number in 2014.

INDIA'S POWER SECTOR HAS MANY SUBSIDIES TO PROMOTE AFFORDABLE ENERGY ACCESS.

Nearly 57% of power is generated from fossil fuels, mainly coal. The government spends US$ ~6.2 billion annually to subsidize coal production and consumption,[34] but in a smart twist, also earns US$ ~4.4 billion each year by levying a "coal cess" – a form of carbon tax – on every ton of coal produced or imported, thus offsetting a large chunk of the expense.[35]

As of 2014, ~311 million Indians – almost equal to USA's entire population – lacked access to grid-based electricity.[36] In 2017, India launched the *Pradhan Mantri Sahaj Bijli Har Ghar Yojana* (SAUBHAGYA) scheme for universal household electrification via last mile connectivity. By 2022, ~29 million additional households had been electrified,[37] bringing electrification to ~97% of households, supported by US$ 19.6 billion in subsidies.[38]

However, power supply is still patchy and low quality, even in most urban areas. The average household receives only 20.6 hours of grid power daily, and this falls to 18.5 hours in rural areas. Most households, rural and urban, face supply interruptions at least once a day.[39]

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[26] Patrick Crow. *Decontrol in India*. Oil and Gas Journal. Nov. 1997 (link).
[27] IISD-TERI. *A Citizens' Guide to Energy Subsidies in India*. 2012 (link).
[28] Raha, Harihar, Gupta. *The India story: Ensuring Energy Access, Security, Justice, and Sustainability for a Fifth of Humanity*. D. Scholten Handbook on Geopolitics of the Energy Transition pp. 431. 2023.
[29] PPAC. *Contribution of the Petroleum Sector to the Exchequer*. 2024 (link).
[30] Press Information Bureau, India. *Dharmendra Pradhan Pitches for Clean Energy Cooking Fuel Innovations*. Mar 2021 (link).
[31] Ministry of Petroleum and Natural Gas, India. *Give it Up*. 2023 (link).
[32] Mani, et. al. *State of Clean Cooking Energy Access in India: Insights from IRES*. CEEW. Sept. 2021 (link).
[33] Ministry of Petroleum and Natural Gas, India. *Ujjwala Dashboard*. 2024 (link).
[34] IISD. *Mapping India's Energy Subsidies 2023*. (link).
[35] Ministry of Coal, India. *Strategy Paper on Coal Import Substitution: Inter-Ministerial Committee Report*. Mar 2024 (link).
[36] Ghosh, et. al. *Power for All: Electricity Access Challenge in India*. Nov. 2014 (link).
[37] PIB. *SAUBHAGYA Electrification Scheme - A Total 2.86 Crore Households Have Been Electrified – Union Power & NRE Minister Shri R. K. Singh*. Mar 2023 (link).
[38] IISD. *Mapping India's Energy Subsidies 2023*. (link).
[39] Agrawal, et. al. *State of Electricity Access in India: Insights from the India Residential Energy Survey* (IRES 2020). CEEW. Oct. 2020 (link).

Many Indian states also offer partly or fully subsidized electricity for curated groups to induct them into the formal energy system – and often, to curry political favors. For example, the government of the National Capital Territory of Delhi is giving "free" electricity to residents who consume less than 200 units per month, using taxpayer funds to fully subsidize ~85% of residents, irrespective of their income brackets.[40]

Further, India's residential and agricultural electricity consumption is usually cross subsidized by industrial and commercial users. Tariffs are tiered on connection types and units used, and rise steeply once base levels are crossed. Power distribution companies (discoms) charge industries 20–120% higher tariffs during peak-load hours,[41] though data indicates that when mark-ups exceed 20%, discoms lose revenue as the price-sensitive industries lower usage.[42] Industrial units also switch to captive power production where possible to avoid paying artificially inflated tariffs, and to increase RE offtake beyond the share bundled into the grid.[43]

INDIA USES A RANGE OF SUBSIDIES AND INCENTIVES FOR PRODUCERS, CONSUMERS, AND OTHER KEY STAKEHOLDERS, TO SPUR THE RE SECTOR TO DELIVER ACCESSIBLE, AFFORDABLE AND CLEAN ENERGY.

For instance, India offers a two-part Central Financial Assistance towards achieving its 40 GW grid-connected rooftop target – one for residential consumers to finance the setup cost (ranging between US$ 214-240 per kW for the first 3 kW), and the second encorages discoms to connect rooftop plants to the grid.[44]

In 2024, India launched the *Pradhan Mantri Surya Ghar: Muft Bijli Yojana* to subsidize rooftop solar systems for 10 million low-income households,[45] and has embarked upon an US$ 61 million scheme to electrify 100,000 Particularly Vulnerable Tribal Groups (PVTG) households using off-grid solar power.[46]

On the manufacturing side, the Production Linked Incentives (PLI) scheme is helping build an integrated value chain for high efficiency solar PV modules, using an initial outlay of US$ 2.8 billion. It aims to create ~48 GW of solar manufacturing capacity covering polysilicon, ingots, wafers, modules, and cells by providing companies a 5-year depreciating incentive to invest in minimum 1 GW manufacturing capacity.[47]

A major solar scheme offers an interesting study of subsidies. The *Pradhan Mantri Kisan Urja Suraksha evan Utthaan Mahabhiyan* (PM-KUSUM) was initiated in March 2019 to set up 10 GW of decentralized solar with two million standalone solar pumps to replace diesel generators in off-grid areas, and solarizing 1.5 million existing grid-connected irrigation pumps.[48] The aim was to reduce the cost burden of free electricity given to farmers, improve farmers' incomes through excess power sale to the grid, improve irrigation access, and reduce groundwater misuse. While some farmers did transition from diesel generator-based pumps to solar pumps, PM-KUSUM did not get the envisioned success.

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[40] Delhi Govt. *Economic Survey of Delhi, 2022-23. Chapter 11: Energy*. Mar 2023 (link).
[41] CEA. *Electricity Tariff and Duty Average Rates India 2023*. Mar 2023 (link).
[42] Nikhil Tyagi & Rahul Tongia. *Getting India's Electricity Prices "Right": More Than Violations of 20% Cross-Subsidy Limit*. CSEP. 2023. (link).
[43] Sanjay Vijaykumar. *How Industries Shifted to Captive Power Generation*. The Hindu. May 2022 (link).
[44] Ministry of New and Renewable Energy, India. *Grid Connected Rooftop Solar Programme.* 2024. (link)
[45] PM Suryodyay Yojana 2024. *PM Surya Ghar Free Electricity Scheme 2024*. 2024. (link)
[46] Ministry of New and Renewable Energy, Government of India. *New Solar Power Scheme for PVTG Habitations / Villages under PM Janman*, 2024. (Link)
[47] Press Information Bureau, India. *MNRE Formulates Policies to Develop Domestic Solar Manufacturing Capabilities*. 2023. (link)
[48] Anas Rahman, Shalu Agrawal, and Abhishek Jain. *Powering Agriculture in India: Strategies to Boost Components A and C under the PM-KUSUM Scheme*. CEEW-Shakti. Aug. 2021 (link).

Decentralized farm-based solar plants could not fetch competitive tariffs compared to utility scale solar, and farmers were unwilling to pay even a nominal fee to adopt solar irrigation over free grid electricity.

India's 46.5 GW onshore wind energy sector also has an annual manufacturing base of 15 GW (May 2024). Developers receive up to 80% Accelerated Depreciation benefit which allows them to write off the projects' asset value early on to reduce tax liability concessional custom duty exemption on select wind power generator components, and waiver of Inter State Transmission System charges on power sale by projects commissioned by 30 June 2025.[49]

India has declared a Wind Renewable Purchase Obligation (RPO) trajectory up to 2030 and, in June 2024, approved Viability Gap Funding (VGF) for offshore wind energy, outlaying US$ ~69.5 billion for installation, commissioning, and support services for the first 1 GW.[50]

India has been trying, for decades, to bring its bioenergy sector to commercial viability by tapping its vast agrarian economy, which employs almost half the population. It has invested in biomass for power, heat, and liquid fuels to improve farmers' incomes and create local jobs to reduce rural financial and energy poverty, monetize agricultural waste, and reduce air, water, and land pollution. The National Bioenergy Programme 2021-2026 has schemes for waste-to-energy, biomass, and biogas, and offers Central Financial Assistance for the manufacturing of pellets and briquettes for co-firing in thermal power plants.[51] India today has 10.5 GW biomass-based cogeneration capacity.

However, even with numerous subsidies, India's electricity – fossil fuel *and* renewables-based – and clean cooking access remain precarious. About 15% of households are yet to access to clean cooking fuels; the average low-income household spends 7-9% of its monthly income refilling each gas cylinder; and 38% still 'stack' biomass with LPG to reduce costs.[52] Cleaner alternatives such as biofuels are still not affordable or available at scale, and while renewables with storage is considerably more expensive than fossil fuel-based power, India does not charge any premium for green electricity and bundles both into the grid.

IT IS ALSO IMPORTANT TO UNDERSTAND THE INTERPLAY AND IMPACT OF CROSS-SECTOR AND LEGACY SUBSIDIES IN EACH COMPLEX REAL-WORLD SITUATION IN DEVELOPING ECONOMIES, RATHER THAN FOCUS ON A PARTICULAR SUBSIDY IN ISOLATION, OR COMPARE SUBSIDIES IN SIMPLISTIC BINARIES.

A brief case study will illustrate this. India's rapid industrialization and urbanization has edged out the share of agricultural output from 35% in 1990 to less than 15% of the GDP today,[53] eroding the incomes of farming communities. Many Indian states, therefore, provide fully subsidized i.e., "free" electricity to farmers for domestic, agricultural, and irrigation use.[54] While well-intentioned, rampant misuse and politicization of these subsidies have crippled the finances of state power utilities and drastically declined groundwater levels, besides wreaking havoc with "wicked problems" along agricultural value chains.

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[49] Ministry of New and Renewable Energy, India. *Wind Overview*. 2024. (link)
[50] Press Information Bureau, India. *Cabinet Approves VGF Scheme for Implementation of Offshore Wind Energy Projects*. 2024. (link)
[51] Ministry of New and Renewable Energy, India. *Bioenergy Overview*. 2024. (link)
[52] Mani, et. al. *State of Clean Cooking Energy Access in India: Insights from IRES*. CEEW. Sept. 2021 (link).
[53] PTI. *Share of Agriculture in India's GDP Declined to 15% in FY23: Govt*. Economic Times. Dec 2019 (link).
[54] Nick Ryan. *Replacing an Inefficient Policy of Free Agricultural Electricity in India*. J-Pal South Asia. 2018 (link).

For instance, the state of Uttar Pradesh (UP) forms the heart of India's northern agrarian belt, and is India's highest producer and exporter of sugar.[55] UP subsidizes power for tubewell irrigation with massive allocations - totaling US$ 287 million in just 2024.[56] This may have been sustainable with cross subsidizing by a large base of industrial power consumers, but 70% of UP's discom consumers are agricultural – and recipients of the subsidy. This has locked the discoms in a vicious cycle of loss-making power procurement and supply.[57]

Compounding the challenge, the central government has set a minimum procurement price of US$ ~4.4 per quintal of sugarcane,[58] forcing sugar mills, which purchase power at expensive industrial tariffs, to *also* pay artificially inflated prices to procure sugarcane from farmers, *and* to then sell the processed sugar at the government prescribed minimum support price (MSP) of US$ 0.37 per kg – even lower than the global all-time low US$ 0.45 per kg sugar rate.[59].[60]

Unable to leverage global commodity prices, the sugar mills, to reduce costs and become profitable, started producing biomass-based power and selling it to UP's discoms. But the financially crippled discoms rarely paid the sugar mills' power bills. Already uncompetitive in the global sugar market, burdened with the cost of transporting sugarcane from the farm to the mill and then sugar from the mill to the markets, and now losing discom revenue, the sugar mills began defaulting on their payments to farmers. In 2019, UP's sugar mills demanded US$ ~120 million in arrears from discoms to start paying their own arrears to sugarcane farmers.[61]

This case underscores how a vicious cycle of unrelated, inefficient subsidies involving a wide range of stakeholders, each struggling with financial and energy poverty, taking independent yet interlinked decisions, can spiral out of control.[62]

Zooming out of India to the global stage, a comment by the United Nations Secretary General António Guterres needs reflection: *"the Godfathers of climate chaos – the fossil fuel industry – rake in record profits and feast off trillions in taxpayer-funded subsidies."*[63]

This is true: in 2022, global fossil fuel subsidies touched US$ 7.1 trillion[64] – nearly double the industry's record profits that year.[65] Between 2017 and 2019, the G20 spent an average half a trillion dollars (US$ 584 billion) annually in *"direct budgetary transfers and tax expenditure, price support, public finance, and state-owned enterprise investment to support production and consumption of fossil fuels at home and abroad."*[66]

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55 Indian Sugar. *Press Release – 17 Nov 2022.* (link).

56 Arpita Malik. *Uttar Pradesh Budget Analysis 2024-2025. PRS Legislative Research*. Feb 2024 (link).

57 Prateek Aggarwal, Karthik Ganesan, and Danwant Narayanaswamy. *Cost-effectiveness of Discom Operations in Uttar Pradesh*. CEEW. Jun 2020 (link).

58 PIB. *Cabinet Approves 'Fair and Remunerative Price' (FRP) of Sugarcane Payable by Sugar Factories for Sugar Season 2024-25 (October-September)*. Feb 2024 (link).

59 IndexMundi. *Commodity Prices: Sugar*. Apr. 2024 (link).

60 DFPD. *Sugar Policy*. 2019 (link).

61 Virendra Singh Rawat. *UP Sugar Mills Demand Rs 1,000 Crore Power Dues to Pay Cane Farmer*s. Business-Standard. Oct 2019 (link).

62 PTI. *UP Sugar Mills Owe Rs 4,832 cr to Cane Farmers as on Sep 1: Ministry. Business-Standard*. Sept. 2022 (link).

63 António Guterres. *Secretary-General's Special Address on Climate Action "A Moment of Truth."* Jun 2024 (link).

64 Including explicit and implicit subsidies: Explicit subsidies also include direct support to producers, such as accelerated depreciation, but these are relatively small. Implicit subsidies occur when the retail price fails to include external costs, inclusive of the standard consumption tax.

65 IMF. *Fossil Fuel Subsidies*. 2024 (link).

66 Shuva Raha and Tulika Gupta. *G20 and GDP: The Cost of Uncoupling from Fossil Fuels*. GSI Journal Issue 9. March 2023 (link).

However, it is important to distinguish the purpose of each subsidy rather than deride all fossil fuel subsidies or praise all renewables-related ones. Subsidies set up to maintain and improve affordable energy access are essential for a just and inclusive clean energy transition, especially in developing countries. It is highly complex to phase out or repurpose efficient *and* inefficient subsidies, whether of fossil fuels or renewables. Arbitrary actions without situational context and sensitivity can trigger financial poverty, energy poverty, and developmental deficits.

India's 2023 G20 Presidency recognized this need to balance development and sustainability, with members agreeing to *"phase-out and rationalize, over the medium term, inefficient fossil fuel subsidies… while providing targeted support for the poorest and most vulnerable."*[67] The 2024 Brazil G20 Presidency's Think20 Engagement Group is advocating for repurposing fossil fuel subsidies for social welfare and clean energy.[68]

India has strived hard, leveraging scarce resources, to balance its energy access, affordability, and sustainability imperatives with the developmental needs of its vast population and growing economy. Its renewables journey has set global benchmarks, and its pragmatic, human-centric approach to alleviating energy poverty augurs well as it strides to become *Viksit Bharat* by 2047.

3.4. THE ENERGY POVERTY CONTEXT IN NIGERIA

3.4.1. Background of the Nigerian energy sector

Nigeria boasts one of the largest economies in Africa, contributing significantly to the continent's economic landscape. As Africa's largest economy by GDP, Nigeria accounts for roughly 16% of the continent's total GDP, with a GDP estimated at around US$ 470 billion in 2022.[69] The oil and gas sector is the cornerstone of the economy, contributing about 90% of export earnings and over half of government revenues. Agriculture is another crucial sector, employing a significant portion of the workforce and producing staple crops such as cocoa, rice, and cassava. The telecommunications sector has also seen rapid growth, driven by increased mobile and internet penetration. The services sector, including banking, finance, and real estate, has supported Nigeria's economic expansion and diversification.

Nigeria experienced significant economic expansion between 2000 and 2014, with an average growth rate of 7%. However, from 2015 onwards, the economic scenario shifted dramatically, with reduced growth rates and high inflation. This downturn was partly due to a decline in global oil prices, significantly impacting Nigeria's oil-dependent economy. The current government has implemented reforms and social programs to stabilize and diversify the economy. These initiatives focus on macroeconomic conditions and cash transfers. Despite these challenges, Nigeria remains a key player in Africa's economy, leveraging its substantial natural resources and large, young population to drive future growth.[70]

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[67] G20. *G20 New Delhi Leaders' Declaration*. Sept. 2023 (link).

[68] Meyer, et. al. *The Brazilian G20 Presidency and the Case for Building a New Global Political Consensus on Energy and Finance: The Twin Challenges of Climate and Development*. CEBRI Journal No. 8. Dec 2023 (link).

[69] https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=A9&most_recent_value_desc=true&skipRedirection=true&view=map

[70] https://www.worldbank.org/en/country/nigeria/overview

Nigeria's energy sector is a pivotal element of its economy, characterized by a diverse mix of traditional and renewable energy sources. The country relies heavily on oil and natural gas, with approximately 80% of its power generation derived from gas and the remainder primarily from oil. Fossil fuels, oil, gas, and coal collectively account for only 25% of the total energy supply, while bioenergy and waste contribute around 74,5.[71].

Energy poverty remains a significant challenge in Nigeria, affecting millions nationwide. Approximately 40% of the population lacks access to reliable electricity, leaving a substantial portion of households and businesses dependent on costly and polluting alternatives like diesel generators.[72] Access to clean and modern cooking fuels is also limited, with around 85% of the population relying on traditional biomass such as wood and charcoal for cooking, which means 186 million people and poses severe health and environmental risks.[73]

Affordability in Nigeria's power sector is a critical issue for socioeconomic development. The sector is trapped in a vicious cycle of tariff regulation and subsidies that prevent electricity prices from reflecting actual costs. While these subsidies aim to make energy more accessible, they often strain public finances and deter much-needed investments. Additionally, the reliability of electricity remains a significant problem, with frequent power outages disrupting daily life and business operations. This unreliable supply forces businesses to rely on expensive and polluting diesel generators, increasing operational costs and environmental impact. Addressing energy poverty in Nigeria requires comprehensive policy interventions, increased investment in infrastructure, and promotion of renewable energy solutions. These steps are essential to ensure equitable access to clean, affordable, and reliable energy for all citizens, thereby fostering economic growth and improving the overall quality of life.

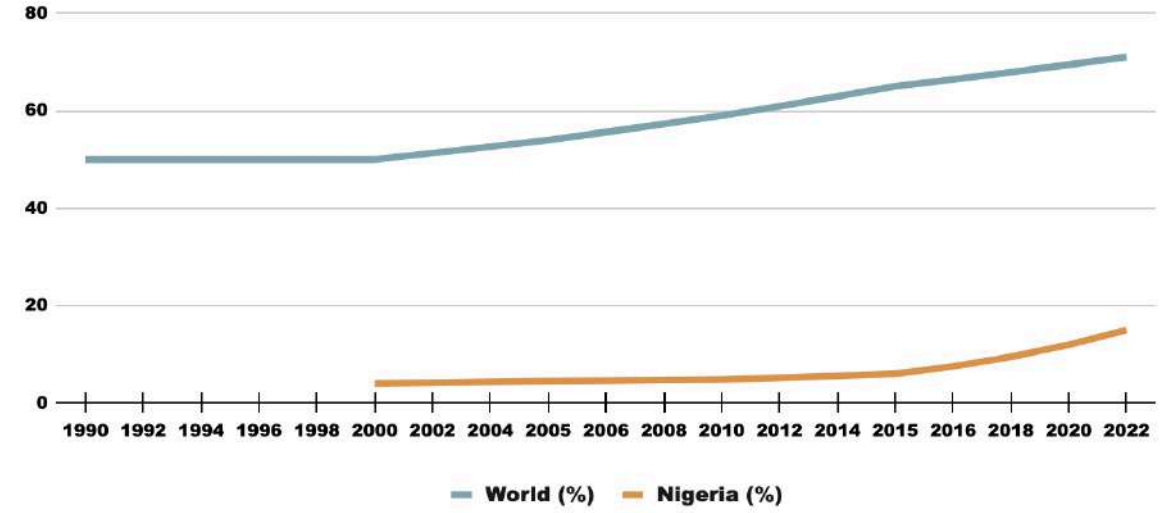
3.4.2. Energy poverty issues in Nigeria

According to the IEA, IRENA, UNSD, World Bank, and WHO (2024)[74], Nigeria has the largest population without access to electricity, with 86 million people affected. This issue is particularly acute in rural areas, where around 75% of the population lacks electricity access, compared to 20% in urban areas. The disparity in access also varies significantly with income levels. Among the bottom 20% of income earners, only 20% have access to electricity, whereas in the top 20% of income earners, around 75% have access. These figures highlight the profound inequalities in energy access across different regions and socioeconomic groups in Nigeria.

Despite the critical scenario of electricity access, Nigeria has made significant improvements since the 2000s. According to the IEA Energy Access Database,[75] the country has been steadily closing the gap in electricity access.

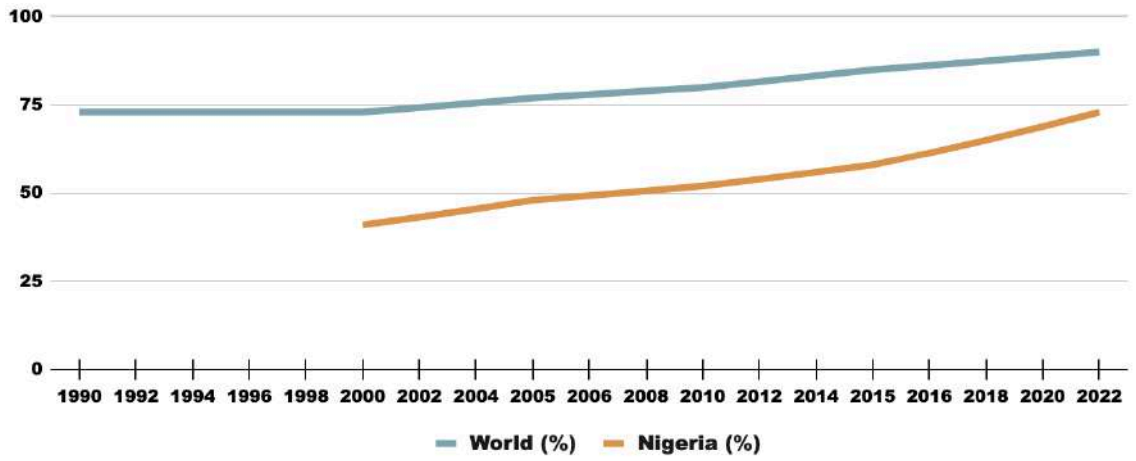
[71] https://www.iea.org/countries/nigeria
[72] https://www.iea.org/news/progress-on-basic-energy-access-reverses-for-first-time-in-a-decade and https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity
[73] https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all
[74] https://www.iea.org/news/progress-on-basic-energy-access-reverses-for-first-time-in-a-decade
[75] https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity

Graphic 7 - Nigeria's electricity access evolution



Nigeria also faces significant challenges regarding access to modern and clean cooking fuels, ranking third globally in the number of people without access. According to the IEA, IRENA, UNSD, World Bank, and WHO (2024)[76], 161 million Nigerians lack access to clean cooking solutions, representing 74% of the population. However, there have been notable improvements in recent years. From 2017 to 2022, Nigeria saw an average increase of 3.2% per year in access to modern cooking fuels, primarily natural gas and LPG.

Graphic 8 - Nigeria's clean cooking access evolution[77]



The lack of access to modern energy and energy services significantly impacts the Nigerian people and the economy. Households without electricity spend around 6% of their income on lighting, compared to 4.5% for those with off-grid electricity and only 2% for those connected to the grid.[78] This disparity highlights the economic burden on those lacking reliable electricity access. Moreover, the lack of access to modern cooking fuels disproportionately affects women and girls, who spend more time collecting firewood and suffer from the negative health impacts of prolonged exposure to smoke from traditional

[76] https://www.iea.org/news/progress-on-basic-energy-access-reverses-for-first-time-in-a-decade
[77] https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity
[78] https://www.iea.org/news/progress-on-basic-energy-access-reverses-for-first-time-in-a-decade

cooking methods.[79] Gender-focused initiatives can play a crucial role in alleviating energy poverty by addressing these specific challenges.[80]

Furthermore, energy poverty in Nigeria exhibits significant regional and locational differences, particularly between urban and rural areas. Rural households are more likely to lack access to modern energy services, necessitating a contextualized approach to address energy poverty across the country effectively. Comprehensive strategies considering these diverse needs are essential for making meaningful progress in providing equitable energy access to all Nigerians.

3.4.3. Energy poverty reduction initiatives

The recent advancements in reducing energy poverty reflect the country's efforts to enhance energy access and address health and environmental issues. This progress reflects substantial efforts and investments to enhance the electricity infrastructure and expand access. While challenges remain, particularly in rural and low-income areas, these improvements demonstrate that Nigeria has implemented a set of initiatives that were able to change the situation and improve the overall quality of life for its citizens.

Among the various initiatives aimed at improving energy access in Nigeria, three are particularly noteworthy. First, in 2006, the Nigerian government established the Rural Electrification Agency (REA) to address the lack of electricity access in rural areas. Accompanying the agency, the Rural Electrification Fund was created with support from the World Bank and the African Development Bank. The primary goal of this fund is to support programs and projects that include technical assistance, capacity building, off-grid solutions, and energy-efficient appliances. Additionally, Nigeria implemented mini-grid regulations in 2016 to promote isolated or interconnected microgrids, though most projects funded under these regulations have relied on off-grid solutions.

In addition to these efforts, Nigeria has pursued integrated energy planning through the Energy Commission of Nigeria (ECN). The ECN has developed the National Energy Masterplan and the National Energy Policy, with the latest versions in 2022.[81] An essential planning tool, the Integrated Energy Planning Tool, was developed in partnership with Sustainable Energy for All and The Rockefeller Foundation. This tool provides decision-makers and practitioners with detailed data to strategize for improving energy access. It supports comprehensive analyses, including the electrification status of schools and health facilities, the number of households unable to afford solar home systems, regions favorable to mini-grids, and the optimal technology mix for cost-effective electricity access.[82]

The Integrated Energy Planning Tool has facilitated comprehensive analyses on expanding clean cooking fuels, electrification, and energy for productive activities in Nigeria. Regarding electricity access, the plan specifies the electrification status of schools and health facilities, identifies the number of households unable to afford solar home systems, highlights regions more favorable to mini-grids, and determines the least-cost technology mix. For clean cooking fuels, the plan details the geospatial

[79] https://www.iea.org/news/progress-on-basic-energy-access-reverses-for-first-time-in-a-decade (formatar) and https://www.nepjol.info/index.php/josem/article/view/45339
[80] https://infinitypress.info/index.php/jsds/article/view/1588/0
[81] https://energy.gov.ng/index.php
[82] https://nigeria-iep.sdg7energyplanning.org/

distribution of current fuel use and identifies opportunities for LPG, biogas, and electric cooking. It also outlines the multidimensional benefits of expanding these solutions up to 2030.

This robust and comprehensive analysis supports informed decision-making, enabling the prioritization of programs and investments in the country. By providing detailed data and strategic insights, the tool helps ensure that efforts to improve energy access are effective and equitable, addressing the diverse needs of Nigeria's population and promoting sustainable development.

Another significant initiative in Nigeria's energy sector is the National Gas Expansion Programme (NGEP), launched in 2020 by the Ministry of Petroleum Resources and the Nigerian National Petroleum Corporation (NNPC).[83] The NGEP promotes Compressed Natural Gas (CNG) for transportation and Liquefied Petroleum Gas (LPG) for cooking and small industrial complexes. To support this initiative, the Nigerian Central Bank established an intervention facility with N250 billion to stimulate investments in the development of value chains and the necessary infrastructure for gas markets.[84] This program aims to enhance the domestic utilization of Nigeria's abundant natural gas resources, reduce reliance on traditional biomass fuels, and foster economic growth through improved energy access and industrial development.

Finally, some analysts argue that Nigeria is trapped in a vicious cycle of inadequate grid supply. The country's macroeconomic issues and low productivity have increased reliance on the residential sector for electricity consumption. This dependence, coupled with the low income of a significant portion of the population, has resulted in limited utility revenue. The government has resorted to tariff regulations and subsidies to address affordability and liquidity gaps, further perpetuating the cycle. The primary consequence of this situation is a lack of infrastructure and system expansion investment, as new projects face significant challenges in recovering their investments. The continued poor infrastructure and low investment in the grid lead to an unreliable and low-quality power system characterized by frequent shortages and rising energy prices.[85]

Thus, continuous efforts and targeted policies are essential to sustain momentum and reduce energy poverty in Nigeria. These efforts must be coupled with improvements in the governance of the energy sector to ensure that all Nigerians have reliable access to electricity and clean cooking fuels affordably.

3.4.4. The Issue of energy subsidies in Nigeria

Nigeria's energy sector is marked by inefficiencies and significant financial struggles, with power utilities heavily indebted by approximately US$ 8.575 billion. The existing tariff structures are inadequate, leading to financial instability, as tariffs do not reflect the true cost of energy production and distribution. This results in significant cross-subsidies where industrial consumers subsidize residential tariffs, contributing to frequent power outages and reliance on expensive, private generators. Additionally, the cost-reflective tariff model has not been fully implemented, deterring private investment in the sector.

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83 https://www.iea.org/policies/13420-framework-for-the-implementation-of-intervention-facility-for-the-national-gas-expansion-programme

84 https://www.cbn.gov.ng/out/2021/ccd/cbn%20update%20(september%202020).pdf

85 https://energyforgrowth.org/wp-content/uploads/2021/10/Affordable-Electricity-for-Nigerians-Starts-with-Higher-Income-2.pdf

The huge issue of energy subsidies in Nigeria dates back to the 1970s to make energy more affordable for its population; a key milestone includes the introduction of subsidies in 1973. Formal policies were established in the 1980s under military rule to cushion the impact of global oil price fluctuations on domestic fuel prices. As of 2024, the Nigerian government is actively reforming its energy subsidy policy due to its financial burden. In May 2023, President Bola Tinubu announced the removal of fuel subsidies, arguing that this was necessary to free up funds for development projects. The government plans to redirect the savings, estimated at around US$ 10 billion annually, towards infrastructure development, healthcare, and education. Specific projects include investments in renewable energy sources like solar and wind, upgrading the national electricity grid, and improving public transportation systems.[86]

The primary issues with Nigeria's energy subsidies include a significant economic burden. The government spends approximately US$ 7 billion annually on fossil fuel subsidies, which limits its ability to invest in renewable energy and infrastructure. In contrast, investments in renewables and energy infrastructure are significantly lower, with less than US$ 1 billion allocated annually. Subsidy programs are also claimed to be plagued by corruption, resulting in billions of dollars lost over the years.[87] Additionally, continued subsidization of fossil fuels hinders the transition to cleaner energy sources, contributing to higher carbon emissions and environmental degradation.[88]

The persistence of subsidies in Nigeria can be attributed to several factors. Political pressure plays a significant role, as subsidies are popular among citizens and politically challenging to remove. Leaders often use them to gain public support and votes. Additionally, Nigeria's heavy economic dependency on the oil sector complicates efforts to shift towards alternative energy sources, as reducing subsidies could have significant economic repercussions. Institutional inertia also hampers reform, with bureaucratic resistance and vested interests within the government and oil industry creating substantial obstacles to change.

Several efforts have been made to reform energy subsidies in Nigeria. President Olusegun Obasanjo's failed reduction attempt in 2003, due to public opposition and the significant but controversial subsidy removal by President Goodluck Jonathan in 2012, led to widespread protests and partial reinstatement of the subsidies. In 2023, President Tinubu's administration fully removed subsidies, emphasizing the need for fiscal stability and reinvestment in public services. Additionally, alternative energy initiatives such as the Nigeria Electrification Project (NEP)[89] and the National Renewable Energy and Energy Efficiency Policy (NREEEP)[90] aim to diversify energy sources and reduce dependence on fossil fuels, targeting 5,000 MW of solar capacity by 2030.

Effective subsidy reform proposals include implementing a phased approach to subsidy removal, gradually reducing them over several years while investing in social safety nets to mitigate economic shocks. Establishing targeted support for vulnerable populations, such as direct cash transfers or subsidies for essential services like healthcare and education, is also crucial. Additionally, redirecting funds from subsidies to infrastructure projects, especially renewable energy and electricity grid improvements, can support the aim to install 5,000 MW of solar capacity by 2030. Engaging in public

[86] https://mpra.ub.uni-muenchen.de/118360/1/Evans%20et%20al.%202023%20Subsidy%20Removal.pdf formatar ; https://cseaafrica.org/wp-content/uploads/2019/01/Energy-Subsides-in-Nigeria_.pdf
[87] https://www.pwc.com/ng/en/assets/pdf/fuel-subsidy-in-nigeria-issues-challenges-and-the-way-forward.pdf
[88] https://www.iisd.org/publications/report/citizens-guide-energy-subsidies-nigeria
[89] https://nep.rea.gov.ng/about-nep/
[90] https://www.power.gov.ng/download/NREEE%20POLICY%202015-%20FEC%20APPROVED%20COPY.pdf

education campaigns to explain the benefits of subsidy reform and build support for the transition is also essential.[91]

3.4.5. Final considerations

The discussion on Nigeria's energy sector highlights several significant challenges and opportunities in providing universal access to electricity and clean cooking fuels. Nigeria, one of Africa's largest economies, relies heavily on the oil and gas sector, contributing substantially to its GDP and export earnings. However, the energy sector relies heavily on traditional biomass and low electricity usage, revealing a critical need for diversifying energy sources and expanding access to modern energy services. Addressing these challenges is essential for improving the overall quality of life and fostering economic growth.

One of Nigeria's most significant challenges in achieving universal energy access is the multidimensional impact of energy poverty. Lack of access to reliable electricity forces households to spend a significant portion of their income on inefficient and polluting energy sources. This not only imposes an economic burden but also has severe health and environmental implications, particularly for women and girls who are disproportionately affected by the lack of clean cooking fuels. The negative health impacts from indoor air pollution and the time spent collecting firewood underscore the need for targeted interventions to promote gender equality and improve public health.

Renewable energy sources such as solar and biogas offer promising solutions to Nigeria's energy challenges. Expanding the use of these renewables can help reduce reliance on traditional biomass and fossil fuels, providing cleaner and more sustainable energy options. Initiatives like the National Gas Expansion Programme (NGEP) and the mini-grid regulations aim to enhance the use of natural gas and promote off-grid solutions, respectively. These efforts are crucial for extending energy access to underserved areas and supporting economic activities that depend on reliable energy supply.

Energy subsidies in Nigeria are closely linked to energy poverty. Although designed to make energy affordable, they have often been inefficiently targeted, benefiting wealthier urban populations more than rural or poorer households. The sudden removal of subsidies can exacerbate energy poverty by increasing fuel costs without adequate compensatory measures. However, well-implemented subsidy reform can reduce energy poverty by reallocating funds to expand electricity access, particularly in rural areas, and improving the reliability and affordability of energy services.

Improving governance in the energy sector is critical to sustaining momentum in reducing energy poverty. Effective governance involves transparent regulations, efficient utility revenue management, and fostering investment in infrastructure and system expansion. By addressing these governance issues, Nigeria can break the vicious cycle of inadequate grid supply and limited utility revenue, ultimately creating a more reliable and efficient power system. This comprehensive approach will help ensure equitable access to electricity and clean cooking fuels, promoting sustainable development and improving the overall quality of life for all Nigerians.

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[91] https://mpra.ub.uni-muenchen.de/118360/1/Evans%20et%20al.%202023%20Subsidy%20Removal.pdf ;https://cseaafrica.org/wp-content/uploads/2019/01/Energy-Subsides-in-Nigeria_.pdf ; https://www.pwc.com/ng/en/assets/pdf/fuel-subsidy-in-nigeria-issues-challenges-and-the-way-forward.pdf ; https://www.iisd.org/publications/report/citizens-guide-energy-subsidies-nigeria

Policy Recommendations

4

The previous sections of this policy paper demonstrate that unnecessary subsidies included in electricity tariffs may have a very negative impact on energy poverty, mostly because it can lead to high tariffs, unaffordable by more vulnerable consumers. In this context, there is a need for designing effective social tariffs as well as strengthening measures to mitigate the distortions caused by unnecessary tariff subsidies, or other tariff policies that bring allocative inefficiencies to small consumers' tariffs.

This section discusses recommendations to mitigate the effects of tariff subsidies (or other inefficiencies) to alleviate the issues related to energy poverty. These recommendations involve more comprehensive strategies that focus on improving the institutional and power sector's regulatory environment, as well as specific initiatives with direct impact on the population exposed to energy poverty.

STRENGTHENING REGULATORY AGENCIES

One of the pillars of the liberalizing reforms in the power sectors around the world from the late 1980s onwards was the creation of regulatory agencies. In general, the mission of these authorities is to promote the pillars of efficiency, sustainability and efficiency in the electricity sector. It should be noted that regulatory agencies play a central role in the search for reasonable tariffs, in guaranteeing the economic-financial balance of utilities providing network services, in ensuring equal competition between agents and in promoting innovation.

However, in recent years, there has been a tendency towards decreasing the role of regulatory agencies in several countries' power sectors around the world, even the ones with more advanced regulatory frameworks, such as Brazil. This weakening of regulatory activity potentially brings notable damage to companies and consumers in terms of efficiency and, at the same time, the correct allocation of costs and risks between power sector agents.

On these bases, it is extremely important to pursue policies that strengthen regulatory agencies, enforcing their independence and autonomy. In addition, it is necessary to attract and retain qualified technical staff, compatible with the high complexity and impact of the regulatory decisions taken by the agencies.

This strengthening of regulatory agencies creates conditions for regulatory rules to be designed based on a technical and economical basis, fostering competition and favoring final consumers.

GUARANTEEING COMPETITION ON ISONOMIC AND FAIR BASIS

The implementation of measures to unbundle the power industry from the end of the 1980s onwards sought for competition in the generation segment as a fundamental goal. At the time, there was great concern about guaranteeing access to the network on an isonomic basis, which in many cases was implemented by the correct regulatory framework.

However, the diffusion of variable renewable sources, which at first came with once necessary tariff subsidies, has brought new challenges in the search for efficient power trading markets, in addition to inflated tariffs in the countries where subsidies lasted much more than needed.

As a way to deal with this problem, it is recommended that competition between sources tries to focus on attributes that meet the requirements of the power systems, such as energy, capacity and flexibility. The focus on attributes is better fitted to the promotion of competition between different power generation sources, compatible with the required security of supply at the lowest possible cost. At the same time, the formation of market reserves for specific power generation sources should be avoided, due to the negative implications in terms of inefficiencies brought by these market reserves.

Finally, as the issue of environmental sustainability is a growing concern, it is important to define environmental attributes. For example, limits on greenhouse gas emissions can be defined.

REDUCING POWER CONTRACT PRICES FOR REGULATED CONSUMERS

Another item with a significant weight in final tariffs is related to the energy the utility purchases to supply its captive market. Depending on the country, the power market design is such that buyers of power in the free market typically purchase electricity exclusively from the least-cost options available (typically solar and wind), whereas distribution utilities in the regulated market purchase a costlier (and often more polluting) mix of technologies. Because of this practice, the average cost of contracts in the regulated market (which usually serves low voltage consumers, including those in social complex regions) is much higher than contracts in the deregulated market.

Therefore, it is crucial to seek measures that change regulatory rules for power purchases in the regulated market, seeking reduction in its contract prices.

PROVIDING ADEQUATE ECONOMIC SIGNALS FOR NETWORK USAGE

The neutrality of network usage tariffs must be reinforced as a basic premise in promoting competition in power markets. Furthermore, economic signals must be given that induce projects to be installed in locations of greatest value for power systems in order to minimize systemic costs.

Therefore, it is advised that there are no subsidies in network usage tariffs for specific sources and/or technologies, nor for specific consumers. Furthermore, it is recommended the presence of locational signals that are effective in allocating costs to agents depending on the costs that each agent imputes to the electrical grid.

MODERNIZING TARIFF STRUCTURES

Considering the emergence of new technologies, the trend towards decentralization of power systems and the new consumption patterns of increasingly active and engaged consumers, there is a clear need to design tariffs compatible with this new reality. In this sense, it is recommended that measures be adopted to modernize tariff structures.

Issues such as the presence of time signals in tariffs, demand charging in tariffs and implementation of specific tariffs for consumers with distributed generation systems tend to assume relevance. In the specific case of low-income consumers, an alternative to be debated is the implementation of prepayment mechanisms.

Finally, in order to test new tariff modalities before large-scale implementation, it is important to carry out tariff sandboxes that make it possible to assess consumer responses to new tariff structures and the real gains.

RATIONALIZING TARIFF SUBSIDIES

It is important to recognize that there will continue to be situations in which the granting of subsidies will be necessary. However, those cases should be exclusively based on studies that attest that their expected gains are greater than expected extra costs to consumers and/or taxpayers in general.

Furthermore, all subsidies should be temporary in nature, settling its duration in advance.

However, this is not the case of many countries' tariffs, such as Brazil. It is very common to find situations in which subsidies for renewable sources, for example, are perpetuated, even after they become the most competitive sources. In addition, it is not rare to find subsidies to fossil fuel sources (such as coal and natural gas) perpetuated, unnecessarily increasing tariffs and gas emissions.

Under these circumstances, other strategies involve ending existing subsidies (as much as possible) and removing remaining subsidies from consumer tariffs, funding them through general national or regional revenue sources such as taxation. This approach would alleviate the financial burden on low-income households, contributing to keeping energy affordable and accessible. It would also allow better transparency, shedding light to the budget impacts of such incentives, which can strengthen the debate about their legitimacy and adequacy. By reallocating subsidy costs to public funds, the regressive impact of high energy tariffs can be mitigated, in order to promote social equity while supporting only essential public policies.

Finally, it is important that consumers in the electricity sector only pay for subsidies whose objectives are natural to the electricity sector. In this sense, subsidies with objectives in other spheres must be funded in other instances. For example, although subsidies for social purposes are worthy, this type of incentive should be funded with treasury resources instead of being financed through electricity bills.

DESIGNING EFFECTIVE SOCIAL TARIFFS

Social tariffs are a powerful instrument to address energy poverty when well structured and designed. To make social tariffs more effective, it is crucial to consider the specific needs of vulnerable communities, accounting for regional disparities, climate and geographical particularities, as well as seasonal variations. For this purpose, it is important to guarantee that social tariffs specifically address

the needs of the most vulnerable populations, with precise criteria of eligibility, ensuring equitable access to energy for those who truly need it and at a satisfactory level to promote dignity.

The policy should recognize and look into regional differences, such as the distinct challenges faced by low-income families in different states or areas, which can be heterogeneous. Also, it should reflect the unique climate and geographical conditions of each region, acknowledging that energy needs and purchasing power can vary significantly across the same legal and regulatory jurisdiction. Finally, social tariffs should account for seasonal fluctuations in energy demand, providing additional support during unusual or extreme weather periods to ensure continuous and affordable energy access.

In fact, previous experience in developing countries indicates that "social tariffs" can be a powerful tool to mitigate energy poverty, increasing affordability, decreasing electricity waste, decreasing electricity theft and enhancing quality.

TAILORING POLICIES FOR SOCIOECONOMIC PROBLEMS

Another worthy implementation is tailoring public policies to address complex socioeconomic issues such as electricity theft and fraud. Adopting advanced technologies and control tools can help prevent these illicit activities, thereby mitigating their impact on tariff rates and ensuring the efficient operation of energy distributors, which normally leads to better quality, breaking the cycle involving electricity theft and poverty. Moreover, establishing a trust bond between utilities and households is crucial. This can be achieved by means of social projects that empower community leaders and foster collaboration, addressing socioeconomic needs beyond power consumption. By integrating technological solutions with community engagement initiatives, there is room to create a sustainable framework that not only protects the financial health of public power, but also promotes social cohesion and collaboration within vulnerable communities.

FOSTERING ENERGY EFFICIENCY

Energy efficiency projects offer substantial benefits, particularly in vulnerable communities. By introducing more efficient appliances, these projects can significantly reduce power usage costs for households, providing financial relief to low-income families who often face high-energy expenses compared to their income. Moreover, the adoption of cleaner, energy-efficient cooking methods can greatly enhance indoor air quality, reducing health risks associated with toxic emissions from traditional cooking fuels, which are common in extremely poor communities. These initiatives not only promote economic savings but also contribute to healthier living environments, fostering a better quality of life for these households.

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Rodrigo Polito is a journalist and researcher specialist in the energy market with over 20 years of experience. From 2003 to 2023, he wrote stories about business and trends in Energy and Oil & Gas markets to Brazilian magazines and newspapers, such as Brasil Energia and Valor Econômico. He has been working at PSR since 2022 in the Communication & Marketing cluster and supporting regulatory team. Rodrigo holds a degree in Journalism from PUC-Rio, with a Master Business Administration (MBA) in Economics and Management in Energy Market, from Coppead/UFRJ, and graduate in Oil & Gas, from Coppe/UFRJ. He also holds a Master's degree in Public Policies, Strategies and Development from UFRJ. Rodrigo was second place in the "Procel/Eletrobras Journalism Award" in 2006, and winner of the "Schneider Electric Journalism Award" in 2015. He was also the organizer of the Brazilian book "Setor Elétrico Brasileiro 2012-2018: Resiliência ou Transição?", published in 2018.

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Shuva Raha leads CEEW's International Cooperation portfolio spanning four regions – Asia-Oceania, Africa-MENA, Europe, and the Americas, and is a member of the CEO's Foresight team. She drives global governance-centric energy-development-climate initiatives amidst geoeconomic transformations, covering energy and resource security, decarbonization, sustainable finance, sustainable production and consumption, and climate resilience. She engages with governments, industry, and institutions to impact sustainable development at scale, expand CEEW's influence as a voice for emerging economies, and take the 'India Story' global. Shuva leads CEEW's advisory to India's G20, Quad, and UN Energy Compact initiatives via partnerships with Union Ministries; she is a Global Solutions Initiative Fellow, and a UNFCCC CoP Observer since 2016. Her co-authored 2020 report *Jobs, Growth and Sustainability: A New Social Contract for India's Recovery* is archived at the US Library of Congress. Shuva has ~25 years of experience in public policy, project management, corporate operations, and branding. Previously, as Head – New Initiatives, Energy & Infrastructure at the Confederation of Indian Industry, she led key assignments such as CII's work with the International Solar Alliance. Before transitioning to a career in public policy, Shuva was Chief Operating Officer of CMYK Multimedia, the infotech subsidiary of Pioneer Newsgroup, New Delhi. Shuva manages her family's philanthropic initiative to finance the education of underprivileged students via the Subir Raha Memorial Scholarship. She is a Postgraduate in Advertising & Communications Management from NMIMS, Mumbai, where she ranked first and was awarded the Advertising Agencies Association of India Raman Memorial Trophy. She has a BSc Honours with Distinction in Life Sciences and Biochemistry from St. Xavier's College, Mumbai.

Thais Morais Abadio holds a Bachelor's degree in Electrical Engineering, and Post-Graduation in Strategic Business Management. Since April 2024 she has worked as a regulatory affairs advisor at Light Distribution Company, which is the company responsible for distributing electricity in Rio de Janeiro, Brazil, more specifically supporting the activities carried out by the Superintendence of Regulatory Strategy, Compliance and Governance. Before joining the Light team, she worked at the electric energy distributor in the metropolitan region of São Paulo, Brazil, for almost 9 years, most of the time as manager of technical and commercial regulation at Enel Brasil. She was also part of Energisa's technical and commercial regulation team between 2013 and 2015, which is a large utility group that provides energy services in all regions of Brazil.

Tulika Gupta's role as a Research Analyst & Coordinator at The Council entails building awareness and understanding of its wide-ranging and insightful work, high-level government and industry stakeholder engagement, and coordinating strategic outreach initiatives. A trained lawyer, Tulika has spent time exploring the intersection of law, policy and politics by working with think tanks such as the Vidhi Centre for Legal Policy and international organizations such as the Asian-African Legal Consultative Organisation and the International Law Commission, where she learnt how to analyze the law and understand how it is crafted to balance socio-political, economic or geopolitical interests. A stint at Aarna Law presented the unique chance for Tulika to work on a competition to design a multilateral treaty for green investment, sparking an interest in facilitating solutions to the climate crisis. Tulika has represented India at international moot court competitions such as the Foreign Direct Investment International Arbitration Moot in Buenos Aires where she was awarded a Special Mention for Advocacy. She has a BSL LLB from ILS Law College Pune and a Diploma in International Law from the Indian Society of International Law, New Delhi.

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