

Fuelwood consumption in Niger: A review

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Abstract

Wood, as source of energy, is a major concern for developing countries. In Niger, despite the efforts made in promoting the use of modern sources of energy for cooking, up to 94% of households still rely on wood as primary source of energy. The present work reviews the main theories that explain fuelwood consumption and the different strategies adopted by Niger for alleviating the problem. Based on criticisms addressed to these strategies two programs, for urban and rural areas, are proposed. The aim of these programs is to actively promote the use of coal and liquefied petroleum gas (LPG). Given the country's experience in carrying out diverse development projects and the natural resources it produces (coal exploitation and LPG production), it appears that the proposed programs are realizable. However, governmental commitment and further studies are required in order to address practical related issues.

Keywords: fuelwood; energy consumption; energy policies; developing country, Niger

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1. Introduction

Being a saharo-sahelian country, Niger is facing a crucial problem of land desertification which impacts its economic and social development. With 80% of its land area covered by desert, Niger suffers from recurrent drought, soil nutrient depletion and food shortage as its economy is essentially agricultural and concentrated in the southern tiny fertile part. Since the country's independence in 1960, successive governments, International institutions (IMF, World Bank, and many others) and non-governmental organizations (NGO) have been implementing strategies aiming at reducing and containing the Sahara desert and thus keeping productive the tiny fertile soil of the south. Those strategies consisted essentially in restoring the degraded land by planting trees and changing household's energy consumption habits. The 3rd of August was instituted as a national day for planting trees. "Plants nurseries" (*pépinières* in French) have been created in major cities of the country in order to supervise, promote and advise people on tree planting. Campaigns have been engaged to advertize the benefit of switching to more environment- friendly sources of energy, namely coal and LPG.

However, despite decades of efforts, in rural as well as in urban area, wood constitutes and remains the principal source of energy, especially in cooking and heating. Most of the country's forests have been destroyed, the Sahara desert is becoming increasingly threatening and subsequently, drought has become frequent. With the fast growing population and an increasing demand of wood, the southern fertile band is no longer enough productive to sustain people's need. Food crisis has become cyclic with an almost five-year occurrence.

Paradoxically, Niger has important reserves of coal in its northern part. The *Société Nigérienne de Charbon* (SONICHAR) operates an open pit mine nearby Anou Araren since 1975. Other unexploited reserves have been discovered. However, the coal production is mostly exported while only a tiny portion is offered to the national market. Apart from isolated cases of use such as electricity production in Agadez city, coal is nearly inexistent in households. Niger has also been importing LPG, and has recently started producing its own LPG thanks to oil production conjointly managed by the Nigerien government and the Chinese national petroleum corporation company (CNPC). While there is a relatively low tendency of LPG use in urban areas, in rural areas households are resistant to any change in their energy consumption habits.

Inducing changes in energy consumption patterns will undeniably be an important step in preserving the environment which is a key factor for a sustainable development. Given the failure of most of strategies carried out so far, there is an urgent need for new approaches. What can be learnt from previous strategies? What are the factors preventing households from switching from wood to coal or LPG?

Providing answer to these questions requires a meticulous analysis of the situation. Most of the previous strategies relied on advertising and accessories subsidies (stove) and were essentially based on urban life style. With 79% of the country's population living in rural areas against only 21% (INS, 2012) living in urban areas, there is a necessity to adopt different and appropriate approaches for each category of population. For instance, in urban area people buy wood whereas in rural areas people don't buy it. They collect it for free in the bushes or their farms. The question is how to bring rural people that use a gratuitous source of energy (wood) to switch to a costly one (coal or LPG). If in urban areas the problem can apparently be pictured as an outcome of a trade- off wood cost versus coal or gas costs, in rural areas it is much a problem of rationality (free versus costly).

Unfortunately, In Niger, there is a lack of sufficient scientific studies trying to determine the fundamental reasons that explain household's inertia in changing their energy consumption patterns. The present work reviews the different theories that explain the fuelwood problem and the strategies implemented in Niger to promote the use of modern sources of energy. Moreover, it proposes two programs aimed at generalizing the usage of coal in urban as well as in rural areas.

The present work is significant in many ways. First, energy consumption is a daunting problem for developing countries, especially those located in Africa. Improving energy consumption can solve numerous problems (UNDP, 2006). According to the report from UNDP, providing clean, modern and sufficient energy improves women conditions; boost economic development through production growth. It also contributes in the urbanization of the population and improving lifestyle

Second, despite the severity of the problem, few academic works have attempted to bring their contributions. Most of the figures retrieved concerning energy consumption in Niger were compiled by international institutions such as FAO, IMF, UNPD, and many others. The national database is either scattered, which limit the access, or highly aggregate. The programs proposed at the section 5 need in-field researches so that they can be adequately implemented. They constitute a framework for anyone interested in the energy consumption problem in Niger as well as in other countries with similar conditions.

Third, upon completion, entrepreneurs and managers can find data concerning consumer's energy consumption preference. The data can help in developing and expanding the coal and gas market to the rural areas. Thus, it can open opportunities for new businesses.

Fourth, findings from the study can help government and NGOs to refine their strategies regarding energy consumption in Niger. Particularly, the study will highlight factors that can be controlled by means of policies and factors that need incentives.

Finally, the work will be an important contribution to environmental protection. Niger, as many Sahelian countries is dominated by the ever growing Sahara desert. It is generally admitted that preserving forest and planting new trees is a barrier to the desertification. Another solution consists in an efficient use of wood and other biomass. However, adopting alternative, clean, and efficient sources of energy would be a great advance in reducing wood consumption. Indirectly, the alternative sources of energy will contribute in preventing land desertification.

2. Fuelwood and poverty

Fuelwood consumption is a poverty-related problem that still remains a big concern for developing countries. The linkage between poverty and fuelwood consumption stemmed in an effort by the United Nations to prioritize sustainable development in which environment plays a major role. In 1987 the Brundtland Commission, also known as the World Commission on Environment and Development (WCED) issued its first report on poverty and environment. Subsequently, theories and analyses have been deepening the understanding of the phenomenon. Among them the energy ladder hypothesis (Arnold, Köhlin, & Persson, 2006), the poverty-environment hypothesis (Duraiappah, 1998; Wunder, 2001), the environmental Kuznets curve (Foster & Rosenzweig, 2003) and the village computable general equilibrium (CGE) models (Shi, Heerink, & QU, 2009).

Relaying on the above theories, studies in different continents explained household energy consumption patterns as a function of multiple sets of variables, social, demographic, and economic among others. The energy ladder is one of the most used hypotheses in explaining households' energy consumption patterns. It relies on the theory of consumer behavior (Hosier & Kipondya, 1993). The fundamental idea is that households exhibit a gradual and progressive energy consumption pattern according to their economic status. As their income increases, they will switch from biomass fuels to modern fuels. Thus, wood, along with other biomass fuels, is considered as an inferior good. Numerous studies support the energy ladder hypothesis as they found income elasticity to be negatively associated to wood demand (Arnold, Köhlin, & Persson, 2006; Rajmohan & Weerahewa, 2010). Because the question of income is tightly associated to socio-demographic, economic and geographic conditions (Leach & Gowan, 1987), most of studies adopted a rural versus urban approaches. Given the assumption that the average income is higher in urban than rural area, rural households will use wood for cooking purpose whereas those in urban area will use more modern sources of energy namely coal, gas or electricity.

Miah, Foysal, Koike, and Kobayashi (2011) studied the difference in energy consumption patterns in rural and semi-urban of Noakhali in Bangladesh. Along with other determinants, the authors' work provided evidence on the predominance of biomass energy in rural areas whereas standard commercial energy (natural gas and electricity) remain the main source of energy in sub-urban areas. In the Noakhali area 98% of rural households use firewood as biomass energy and an average of 73% of them use it for cooking purpose. In sub-urban areas, 100% of the households used electricity, candle and natural gas, 60% kerosene and 13% petrol electricity. When it comes to income, the data collected are consistent with the energy ladder hypothesis with a total income twice larger for semi-urban area than its corresponding in rural areas. The study doesn't report the use of wood for cooking purpose in sub-urban areas.

In the same perspective, Rajmohan and Weerahewa (2010) determined household energy consumption patterns in Sri Lanka. Their findings show that, as a whole, energy consumption is progressively moving towards modern fuels with a cadence higher in urban than rural areas. Consistent with the energy ladder hypothesis, the authors have found the budget in urban area negatively associated with wood and kerosene while liquefied petroleum gas and electricity present a positive elasticity. The gradual move towards modern sources of energy has also been reported in Hosier and Kipondya (1993). Carrying out a survey in urban Tanzanian areas, the authors notice a significant shift towards electricity and kerosene away from fuelwood, charcoal and LPG. Fuel price was found to be the main cause to this change.

In Rwanda, up to 90% of energy needs are covered by biomass. Firewood, the principal source of energy accounts for 54% of primary energy balance (Cyulinyana, 2011). Cyulinyana (2011) analyzed the energy consumption problem under the angle of poverty and environmental concerns. With a GDP of 370\$, a tiny land area (26338 km²) and an overpopulation (344 per km²); Rwanda faces a dual issue of poverty and energy scarcity. Given the relatively high price of energy sources, the rate of poverty (56.9%) prevents households from moving up in the energy ladder towards modern medium. Thereby, woodfuel remains and will remain the main source of energy in Rwanda for medium and even long term and it contributes to the national economic growth (Cyulinyana, 2011).

In an Ethiopian context, Mekonnen and Köhlin (2008) found that household assets (such as livestock and land size) and characteristics (such as family size and age-sex composition of members) are determinants in dung and wood consumption as fuel. Thereby, their study confirm the energy ladder idea as they suggested that a focus on asset-poor households to address the limited use of manure in Amhara region.

A study from Chen, Heerink, and Van Den Berg (2006) explored energy consumption in three villages in a poor, forest-rich region in Southeast China. 60% of the interviewed households use firewood exclusively for cooking purpose. Coal, bottle gas and biogas are used as alternative sources of cooking energy with a proportion of 2 and 0.5 per cent for bottle gas and biogas respectively. Consistent with Chen, Heerink, and Van Den Berg (2006), Démurger and Fournier (2010) worked on rural households from northern China in an attempt to estimate the determinants of wood consumption in the township of Labagoumen. The authors considered wood consumption for cooking and heating purposes as explained variables. Consistent with the poverty-environment and energy ladder hypotheses, their findings show that household economic wealth is a significant and negative determinant of firewood consumption, and Firewood can therefore be considered as an inferior good for the whole population in the rural area under study.

In northern Nigeria, fuelwood remains the main source of fuel. According to a study by Musa (1996), there are two factors determining households' fuel choices: affordability and availability of different fuels. Though Nigeria is a producer of kerosene and gas, inadequate supply and across boarder smuggling has led to price instability and shortage. Hence, in rural regions, wood shavings and charcoal are respectively the main source of energy especially for cooking purpose. Urban regions are dominated by respectively kerosene, electricity and gas.

Nevertheless, despite the number of evidences supporting the role of income in energy consumption, other

factors play an important role (Heltberg, 2005). As noticed by Rajmohan and Weerahewa (2010), the pattern observed among the urban poor indicates that income is not the main factor that determines their energy consumption pattern but, there could be certain other factors that influence their fuel choice. Some scholars reported that relatively few of the observed income elasticities are significantly different from zero and those that are range from -0.31 to 0.06 (Arnold, Köhlin, & Persson, 2006).

3. Fuelwood Consumption and Environment

The poverty-environment hypothesis explains the linkage between poverty and environment in the sense that the poor are both the agents and victims of environmental degradation (Angelsen, 1997). Globally, the poverty-environment hypothesis can be viewed from two different perspectives. The poverty perspective gives emphasis on the preeminent role of the environment in determining the magnitude of poverty because the poor depend on the income derived from natural resources base (Angelsen, 1997). In the other hand, the environmental perspective put stress on the role of poverty in environmental degradation (Ghimire, 1994).

In energy consumption literature, there are contradictory debates concerning the poverty-environment hypothesis. These contradictions are also found in numerous studies. For instance, in a rural Nepal context, poorer households were found to collect less firewood than wealthier households in the same village (Baland, Bardhan, Mookherjee, & Sarkar, 2010). Démurger and Fournier (2010) have found, however, strong evidences supporting the poverty-environment view in rural China. The authors found that, all other things being equal, wealth is a significant and negative determinant of household fuelwood consumption and thus wealthier households consume less firewood than the poorest. From the environmental view of the poverty-environment hypothesis, those facts confirm that poor people rely more on wood than richer people. And as Adeoti, Idowu, and Falegan (2001) demonstrated, poorer people, not only consume more fuelwood, but this energy carrier makes them even poorer. The same implications are found in Chen, Heerink, and Van Den Berg (2006).

4. Methodology

Relying on secondary data retrieved from published journals, international institutions' reports and national database, the present article first presents an overview of the actual energy consumption in Niger. Then, it relates the different plans and strategies adopted by the Nigerien government in order to induce changes in households' energy consumption habits. Given the lack of significant improvements since 1960s, the plans and strategies implemented are subject to many criticisms.

Based on the criticisms addressed to the strategies adopted so far, the present study proposes two different plans for rural and urban areas. According to IEA (2006), two complementary approaches can be used to induce changes in biomass consumption: promoting more efficient and sustainable use of traditional biomass; and encouraging people to switch to modern cooking fuels and technologies (IEA, 2006). Households' choice of a particular energy carrier is influenced by numbers of factors (Thom, 1994). These factors are either from the supply side or from the demand side (Leach & Gowan, 1987). For instance, households' location has been used in different studies to determine energy consumption patterns. This variable is very important in the sense that, depending whether they live in rural or urban areas, households present different characteristics such as income level, environment, and access to energy sources. Thus, an approach based on dwelling area has a greater chance of success.

5. Programs proposal for coal and LPG usage in Niger

The approach proposed relies on encouraging people to switch to modern cooking fuels and technologies. It contents two action plans for urban and rural households distinctively. For urban households, two energy carriers, coal and LPG, are targeted whereas only coal is retained for rural households. However, the success of these plans, like any other, will depend on government implication (IEA, 2006).

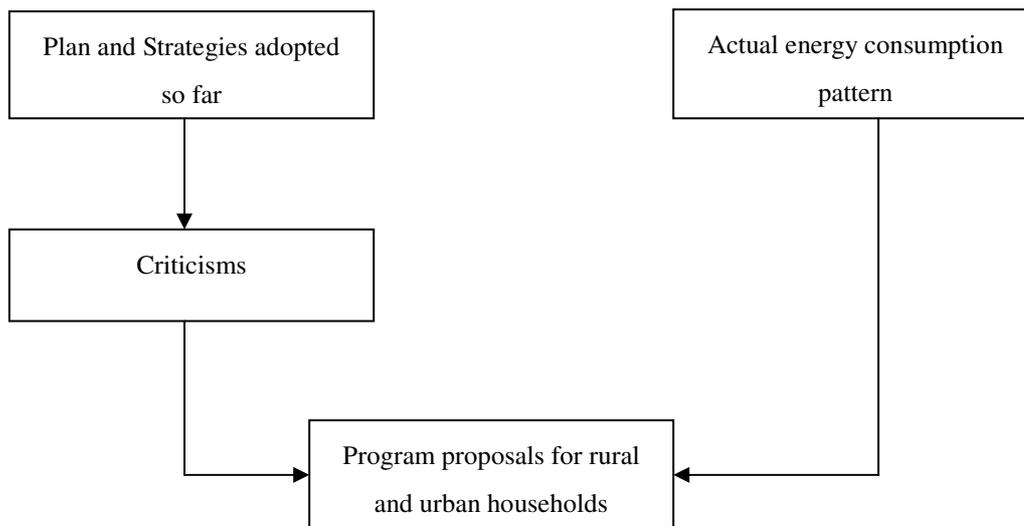


Figure 1. Conceptual framework

5.1 Program for urban households

The Brazilian experience in terms of developing energy efficiency programs is an excellent benchmark for developing countries such as Niger. For instance, the Brazilian LPG program, which can be customized to the Nigerien context, is based on three actions: 1) developing a delivery network, 2) providing subsidies to users and 3) establishing a low-income assistance scheme (Jannuzzi & Sanga, 2004; IEA, 2006).

However, replicating the Brazilian experience in Niger will requires preliminary actions. At the present, fuelwood is the most competitive and available energy carrier in urban areas. Therefore, it is necessary to regulate the wood commerce by adopting a strict control of wood exploitation and increasing the price of cutting permit (Louvel, 1987).

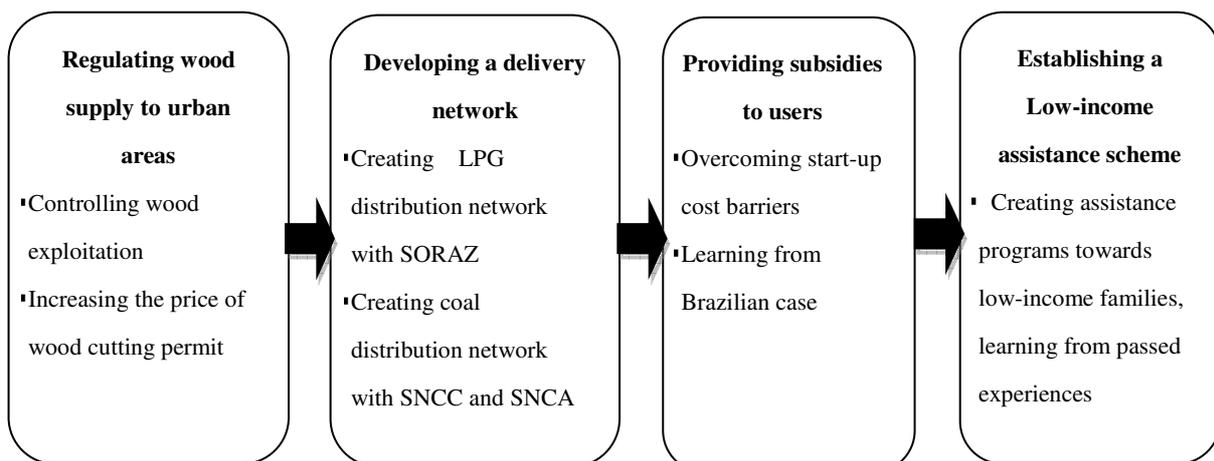


Figure 2. Program for urban households

Developing a delivery network for coal and LPG is feasible given diverse reasons. Niger has been producing and commercializing coal since 1975 via two companies namely SOMAIR and SONICHAR. Important reserves have yet to be exploited. In addition, the country has become LPG producer thanks to oil exploitation conjointly being operated with CPNC, a Chinese company. SORAZ is the company in charge of distributing LPG as well as refined oil. Moreover, two other companies, SNCC and SNCA, have been created respectively in 2005 and 2006

to promote the use of coal as substitute of wood. These constitute a strong prerequisite to establishing a reliable distribution network in major cities, for both coal and LPG.

Subsidies are necessary to overcome affordability barriers due to the changes switching to coal or LPG implies. Niger disposes one of the lowest incomes per capita in the world. Thus, the start-up cost of acquiring new stoves or paying a deposit for fuel canister is simply out of reach of many people. Therefore government assistance is fundamental.

In long run, many households cannot sustainably afford coal and LPG. To overcome this obstacle, assistance programs have to be created towards low-income families. There is an experience that could be used in that sense. The former president, Mamadou Tandja, initiated cash distribution to families in need in order to help them starting up a business. This action was a success and continues till a coup d'état interrupted it in April 2010. Reinventing the same action, but for the sole purpose of promoting the use of coal and LPG, could help low-income families to gradually give up wood.

5.2 Program for rural households

Rural areas differ largely from urban areas in terms of income level and wood supply. Rural families don't buy wood. They fetch it from bushes or their farms. Thus, promoting the use of coal in rural areas implies two new expenses: the coal itself and adequate stoves. These two expenses constitute fundamentally, the main barriers for rural households to abandon wood. Overcoming these particular obstacles will require: 1) a strong advertising campaign, 2) pilot projects, 3) the implication of microfinance institutions and 4) a reliable distribution network as well.

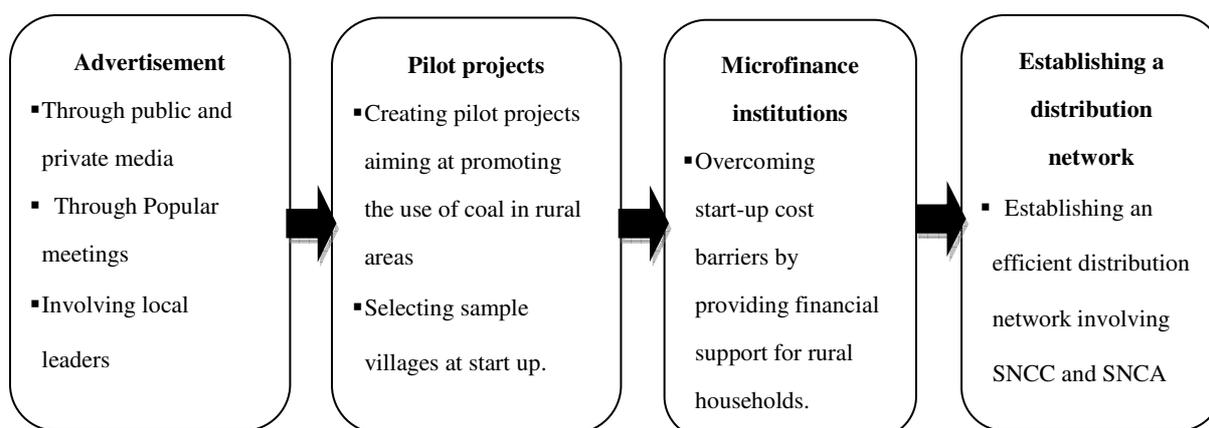


Figure 3. Program for rural households

Because it will be practically impossible to control wood consumption in rural areas, one of the alternative solutions is making people aware of the benefit of switching to coal and the danger of holding on in wood. This can be done through public and private media as well as through popular “in-field” meetings. In most of villages, there are well organized structures involving local leaders that can be used as propagandists.

There are a lot of development projects in deferent parts of Niger (Worldvision, Goal, Plan, and many others). Funded by international institutions, these projects work together with rural populations in many ways in order to help them fighting poverty. Unfortunately, up to date, there isn't any project aiming at promoting the use of modern source of energy in rural areas. The pilot project “Evaluation of Briquette Acceptability in Niger” was a success. Such kind of projects could be the backbone of enlarging the use of coal to rural areas.

The role of micro-finances has been explained in many studies. These institutions are particularly important in rural areas where farmers have no income for long periods of the year (IEA, 2006). Providing financial supports in terms of loans with comprehensive reimbursement schemes can be an important incentive for

acquiring new stoves and coal. In Niger, microfinance structures already exist. However, they have to extend their interventions in energy programs.

As for urban areas, there is a need for an efficient distribution network. This is necessary to prevent coal shortage especially in remote areas. With the two companies SNCC and SNCA, it is possible to cover the maximum of villages.

6. Conclusion

Despite the efforts that have been made since 1960, there is little change in Nigeriens energy consumption habit. Up to 94% of households still rely on wood as source of energy for cooking purpose. Given that the Sahara desert covers about 2/3 of the country's land area and is encroaching at a rate of 200,000 hectares every year, new adequate policies have to be established. The existing policies deal with the fuelwood problem in an indirect way as they are part of global development plans. If no urgent actions are taken, the desert will finally threat the national sustainability in terms of food supply. This situation is even problematic as more than 60% of the inhabitants are famers and rely solely on rainfall to grow crops.

As stated in the introduction, promoting the use of coal or LPG is a crucial step towards preserving the environment in one hand but also towards the improvement of many situations in another hand. Women condition, economic development through production growth, urbanization of the population and improving lifestyle are among the benefits that can be achieved when promoting modern fuels usage.

Nevertheless, inducing changes in households' energy consumption pattern requires specific programs as in the Brazilian case. There are structural and behavioral barriers at both supply and demand side. In addition, fundamental differences exist between households depending on their living areas. Thus, energy programs have to take into account all these specificities. For instance, the above proposed programs are distinctively specific to rural and urban areas. They combine existing achievements and new prospective possibilities.

Niger has an interesting experience in development projects. With the new energy framework adopted in 2004, the creation of two energy-related companies (SNCC and SNCA), the coal extraction and the recent LPG production, the country has a strong prerequisite in establishing sound and sustainable energy policies for cooking. However, there is a need of political commitment in short and long run to ensure the continuity of any action.

In addition, further studies are needed in order to determine the ways to implant new plans and policies. For instance, establishing distribution network and dividing households in different categories will requires specific studies. Especially, it will be interesting to determine how perceptive are households regarding governmental actions towards switching to modern fuels. Households may express some resistance to any change. Consequently, what incentives could the government offer in exchange?

7. List of Abbreviations

- LPG:** Liquefied Petroleum Gas
- IMF:** International Monetary Fund
- NGO:** Non-Governmental Organizations
- CNPC:** Chinese National Petroleum Corporation
- UNDP:** United Nations Development Program
- REEEP:** Renewable Energy and Energy Efficiency Partnership
- SNCC:** Société Nigérienne de Carbonisation du Charbon minéral
- SNCA:** Société Nigérienne du Charbon de l'Azawak
- IEA:** International Energy Agency

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