# *MODELLING THE IMPACT OF NIGERIA HOUSEHOLD ENERGY POLICIES ON ENERGY CONSUMPTION AND CO2 EMISSIONS*

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## Overview

The 5th assessment report of the Intergovernmental Panel on Climate change (IPCC) established that global warming has been induced by anthropogenic greenhouse gas (GHG) emissions [1]. Most GHG emissions arise from energy-related activities such as combustion of fossil fuels for electricity generation, transportation, and other economic activities. This has become the reason why energy production and consumption pattern has been given special attention in tackling climate change. Carbon dioxide ($CO_2$) has been identified as the most prominent GHG which is produced by anthropogenic activities [2]. The impact of climate change is felt by everyone and can be seen in global rising temperatures. Nigeria has had its own share of the adverse impacts of climate change. For example; the Post Disaster Need Assessment (PDNA) report following the 2012 flood in Nigeria showed that the total worth of the damage amounted to USD 17 billion which was about 1.4% of the real GDP in that year [3]. As a result of the devastating impacts of climate change, countries across the world are now tasked to come up with effective policies to mitigate GHG emissions while providing energy security. The federal government of Nigeria has developed the National Renewable Energy and Energy Efficiency Policy (NREEEP). The policy document highlights some initiatives for the household sector. A major programme is to incorporate the use of energy efficient appliances which includes the use of liquified petroleum gas (LPG) for cooking in all households by 2030. The household sector consumes around 80% of the total national energy demand and is also not left out in the efforts towards combating climate change. Most of the household energy-related activities like lighting and cooking produce GHGs [4]. Here we quantify the amount of energy and $CO_2$ emissions that could be avoided by the implementation of the NREEEP for the Nigeria household sector. We also extended our analysis by examining the ripple effects if the policies are sustained to mid-century.

## Methods

Energy modelling and scenario analysis are the commonest methods for energy policy analysis. In this paper, we employ the Long-range Energy Alternatives Planning Systems (LEAP) modelling framework to project Nigeria household energy demand and the associated CO2 emissions from 2010 - 2050. LEAP is a scenario-based energy-economy-environment modelling tool developed by the Stockholm Environment Institute, Boston. It uses an accounting framework to systematically analyse national energy systems by tracking energy consumption up to resource extraction. With respect to the demand side, LEAP endogenously calculates the energy demand as the product of the activity level and energy intensities for all end uses [5]. LEAP also consist of a Technology and Environmental Database (TED) which is equipped with the IPCC Tier 1 GHG emission factors. For quantifying Nigeria household energy demand, the sector is disaggregated into urban and rural households as well as electrified and non-electrified households. Six energy severcies are considered which are cooking, lighting, refrigeration, air conditioning, water heating and other electrical appliances such as fans and audio-visuals. Households' data for calibrating the model were taken from the reports of the household surveys of the National Bureau of Statistics, Energy Commission of Nigeria, National Population Commission, and the United Nations [6-12], We built two scenarios, namely: Reference (REF) scenario and Energy Policy (EPO) scenario.

## Results

Our analysis suggests that if the household energy policies are fully implemented, about 71% reduction in energy demand is achievable by 2030 compared to the REF scenario. Analysis indicate that about 54% of energy savings will come from rural households in 2030, as they all gradually move away from the use of inefficient traditional biomass cooking equipment to LPG. We also observed that energy savings in 2050 will be more in the urban areas accounting for around 65% of the total energy savings which is because of urbanisation. The study further indicates that final CO2 emissions will increase in the EPO scenario by 62% relative to the REF scenario. Greater percentage (96%) of the increase in CO2 emissions in the EPO scenario is observed to come from the rural households. This is because, by 2030, over 90% of the rural households that depend on traditional solid biomass for cooking will now be using LPG and this will, in turn, increase CO2 emissions. If the policies are sustained, the ripple effect indicates that by 2050, total household energy demand will reduce by 66% whereas CO2 emissions will increase by 34%. Our results indicate that the current household energy policies are not effective from the perspective of climate change mitigation. We also observed that cooking remains the most energy intensive activity in the Nigeria household sector across the two scenarios. To improve our understanding, we built a new energy policy scenario (NEPO) by changing the percentage of households depending on LPG for cooking by 2030 and also introduce improved woodstoves. The result of the NEPO scenario shows that with the introduction of new policies, CO2 emissions will fall by 70% in both 2030 and 2050. Energy demand is also observed to reduce by around 1% and 4% by 2030 and 2050 respectively relative to the EPO scenario We also analyse the ratio of fuels consumption across all scenarios.

## Conclusions

Achieving one goal might impede the achievement of another desirable goal. Hence, there is need for tradeoffs between modern energy access and CO2 mitigation in Nigeria. To keep the journey towards low-carbon development in Nigeria on the right track as related to the household sector, it is recommended that the use of biogas from wastes, liquid biofuels, improved wood stoves, efficient electric stoves and solar cookers for cooking should be integrated into the NREEEP. In addition to these, we also recommend that these policies should be sustained beyond 2030 and further energy savings and CO2 mitigation policies should be introduced as new and environmentally friendly cooking technologies are developed. Finally, it is worthwhile to state that our analysis has been limited due to non-availability of data which is a major problem in Nigeria. While acknowledging this limitation, we believe that our findings will be useful to Nigeria policy makers. They can use our results as a preliminary evidence to assess the effectiveness of different household energy policies in order to formulate strategies to help achieve international climate agreements, satisfy unmet energy demand as well as have insights for policy decisions beyond 2030.

## References


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