***SHEDDING LIGHT ON MOROCCAN HOUSEHOLDS ENERGY EXPENDITURES***

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## Overview

Energy consumption in the residential sector is expected to grow by an average of 1.4%/year from 2012 to 2040 in OCDE countries, against an average increase of 2.1%/year in the same period for non OCDE countries (International Energy Agency, 2017). In developing countries, rising income, urbanization, and standards of living improvement along with a growth of the demand for appliances, are the main drivers of energy growth. To satisfy households energy demand in a sustainable manner, the understanding of their consumption patterns fursnishes a detailed picture on how people consume and use energy depending on their lifestyle and income level. The importance of understanding households energy consumption patterns is twofold. First, it allows policymakers to tailor their energy policies with respect to the most significant drivers of household consumption and their relative impact depending on households income level. Second, it is relevant in a context of energy transition where new energy sources such as rooftop PV can compete with conventional ones ( for example electricity and butane), changing the energy landscape in the residential sector in developing countries with high solar potential.

In the recent years, a large body of literature on the determinants of households’ energy consumption has emerged, especially for electricity consumption. Energy requirements of households are generally assessed using three main categories: economic factors, demographic factors, and dwelling attributes. The most widely used economic determinant is income for which total household expenditures is used as a proxy (Pachauri, 2004). The effect of income in energy expendiutres is unconclusive. Whereas (Salari and Javid, 2017) found a significant positive effect between both variables in the United States, (Hussain and Asad, 2012) found a negative relationship between income and electricity expenditures in Pakisan. As for income, the findings on the impact of household age, sex, education level and home ownership are unconclusive as well (Prete et al., 2017), (Bousquet et al., 2014) .

## This paper aims at analyzing the factors influencing household energy requirements in Morocco for a random cross-section of households covering the entire area of the country. This study is to our knowledge the first attempt at analyzing total energy requirements at the individual household level, in the Moroccan context, using national level representative survey data. The study focuses mainly on two dominant energy sources used by Moroccan households: electricity and butane. The paper aims also at exploring the potential susbstitution of electricity with PV production, especially for households who belong to the fourth and fifth income quintile. Finally, this study suggests some policy recommandations to alleviate the energy burden on households based on tailored energy policies depending on households income level.

## Methods

We first use the ordinary least square (OLS) estimation to derive the impact of income, location, dwelling characteristics and head of household characteristics on total energy, electricity and butane expenditures. A quantile regression (QR) model is then used to assess the impact of the independent variables on each quantile of the dependent variables . The comparison of QR and OLS estimation are useful to clearly identify the heterogeneity in the profile of households energy demand.

## Preleminary results

The results show that the share of energy in total income is more than three timers higher for the first income quintile (11%) compared to the fifth quintile (3%). The first quintile in Morocco is then above the energy poverty treshhold of 10% widely accepted in the literature.

In the urban area, the 20% richest spend 3% of their income in electricity and 2% in butane whereas the 20% poorest spend 5% and 3% of their income in electricity and butane respectively. On the one hand, this suggest that the energy budget for the 20% richest is low wich may reveal weak incitations for the richest howseholds to adopt PV panels instead of using the grid. Public policies aiming at increasing the penetration of solar panels in the residential sector may be more aggressive to exploit the full potential of distributed PV production, especially among the richest households. With the expected increase in the penetration of air conditioners in the coming years, the share of enrgy in total income for the richest households may rise, increasing the profitability of PV as a source of energy. On the other hand, as the 20% poorest spend a significant part of their income in energy, PV off-grid solutions and energy efficient programs may enhance energy access for households in a situation of energy poverty.

We also find that income has a significant effect in energy expenditures in Morocco. Households in rural areas spend more in energy than urbans and energy expenditures are higher when the household head is a female rather than a male. It is also found that an increase in the level of education of the head of household generates more energy spending compared to medium and low educated head of household. Compared to occupied head of households, housewives, aged people and retired are more likely to have higher energy expenditures. The QR estimation results show that the impact of the independent variables is more significant for the 90th percentile compared to the 10th percentile.

## Conclusions

## The effects of demographic, socio-economic and household dwelling characteritics may differ across income quintiles. Understanding the effect of each driver of energy consumption depending on the household income and the location may be useful for policymakers to well target their energy policy to progressively introduce PV panels in the residential sector in substitution to electricity use. The next step of this analysis is to do a prospective analysis on the deformation of households energy budget due to the expected massive penetration of air conditioners in Morocco and analyse how PV panels could absorb household mid-day peak demand.

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