INVESTMENT IN ENERGY EFFICIENCY, ADOPTION OF RENEWABLE ENERGY AND HOUSEHOLD BEHAVIOUR: EVIDENCE FROM OECD COUNTRIES

Prudence Dato, IREGE-Savoie Mont Blanc University, +33(0)4-50-09-24-40, prudence.dato@univ-savoie.fr

Overview

Most of the world's electricity (60%) is consumed in residential and commercial buildings (IEA, 2008a). Specifically, residential buildings contribute 23% to global final energy demand (IEA, 2007) and 17% to world CO2 emissions (OECD/IEA, 2015). Moreover, cooking, lighting, water heating, appliances and space heating in the residential sector account for 5%, 5%, 16%, 21% and 53%, respectively (IEA, 2008b). Therefore, there is great potential to reduce overall energy demand in the residential sector. In order to reduce the amount of energy used to get the same service, a household can decide to invest in energy efficient technology that results in saving energy. In 2014 for example, improvements in energy efficiency were driven by space heating efficiency improvements (e.g., following home renovation), water heating, lighting and appliances in residential buildings (IEA/OECD, 2014). Energy conservation actions can also be curtailments (Jansson et al., 2009), which refer to behaviour changes such as scheduling, turning off lights, cutting down on heating or air conditioning and switching off standby mode. By reducing its consumption of energy, a household contributes to reductions in future greenhouse gas (GHG) emissions. In one policy scenario of the International Energy Agency (IEA), 72% of the global decrease in CO2 emissions between 2010 and 2020 will come from energy efficiency improvements (Knittel et al., 2014).

There are some possible synergies between energy efficiency measures and renewable energy adoption in the sense that the former reduces energy demand so that the latter can further cut future GHG emissions. A household can also invest in renewable energy by installing solar panels or wind turbines, which represented a share of 19% of world final energy consumption in 2012 (RENS21, 2014). This investment produces clean energy and contributes to reducing CO2 emissions. For example, the deployment of renewable energy could reduce annual CO2 emissions by 8.6 Gt by 2030 (IRENA, 2014). Additionally, the IRENA (2014) report states that such emissions savings, combined with energy-efficiency gains, would be sufficient to set the world on a path to prevent catastrophic climate change. Furthermore, Dato (2016) shows that it favours full transition to the sole use of renewable energy. Though investments in both energy efficiency and renewable energy are costly, they yield future gains that make them profitable after several years of use. Thus, clean energy adoption and investment in energy efficiency are both important for a transition to a green economy. There is considerable literature on either demand for clean energy (Gerpott and Mahmudova, 2010; Sardianou and Genoudi, 2013; Zhai and Williams, 2012) or investment in energy efficiency (Dietz et al., 2009; Heslop et al., 1981; Howarth, 1997; Urban and Ščasn`y, 2012) in the residential sector. To our knowledge, there is no specific study that investigates household behaviour with respect to joint adoption of renewable energy and investment in energy efficiency; and the relationship between the two.

Methods

This paper fills a gap in the literature and makes three contributions. First, we use a simple theoretical model to investigate the possible interactions between the decisions to invest in energy efficiency and in renewable energy. In this model, we assume that a household devotes its energy budget to buy non-clean energy and to undertake investments in energy efficiency and in renewable energy, which contribute to a transition to a low carbon economy. The household gets some private or direct utility for using energy services (non-clean and renewable energy). The amount of the non-clean energy and that of the renewable energy which are used depend on the level of investment in energy efficiency. The household may also gain some additional environment-related satisfaction due to the contribution of the investments in energy efficiency and in renewable energy in reducing CO2 emissions. This may depend on the cross effect of the two decisions. The theoretical model is followed by empirical investigations of the interaction between the two decisions. We explore whether the decision to adopt renewable energy and to invest in energy efficiency in the residential sector are related. We use a bivariate probit (biprobit) model for the joint decision. Additionally, we investigate the determinants of the interaction between the two decisions by using generalised ordered logit model. Basically, we intend to explain why some households decide to invest both in energy efficiency and in renewable energy, while others decide to only invest in renewable energy or to only invest in energy efficiency, or to do nothing. The household that only adopts renewable energy or only reduces its energy consumption, contributes to the energy transition better than the household who does nothing, and less than the one who undertakes the two investments. For the two empirical investigations, we use the survey on Environmental

Policy and Individual Behaviour Change (EPIC) from the Organisation for Economic Co-operation and Development (OECD). This survey was carried out in 2008 and 2011 across a total of fifteen countries and several areas (energy, food, transport, waste and water) and provides evidence on what affects household decision-making. Precisely, it provides information about socio-economic and environmental factors, attitudes and policy at the household level that can influence actual household decisions to invest in energy efficiency and to adopt renewable energy.

Results

First, we theoretically show that there is a cross effect threshold below (resp. above) which investment decisions in energy efficiency and in renewable energy of the household are substitutes (resp. complements). As a consequence, there are interactions between the two decisions. Moreover, we show that the effect of the energy budget on this cross effect threshold depends on its effect on the marginal opportunity cost of undertaking the two investments.

Second, the results of the biprobit model show that there is a positive interrelation between the decision of the household to invest in energy efficiency and to adopt renewable energy due to unobserved characteristics such as environmental motivations. In fact, environmental conscientiousness as a true environmental motivation is not observed and may lead to such a positive correlation, in the sense that a more pro-environmental household is more likely to invest in energy efficiency and in renewable energy. Thus, the bivariate probit model is more appropriate than separate univariate probit models. Moreover, the paper provides evidence about factors that affect the probability of adopting renewable energy and that of investing in energy efficiency. Notably, people living in poorer households are less likely to invest in energy efficiency and may end up using a high share of their income to pay for electricity. This is referred to as energy poverty in the literature. There is evidence of split incentives regarding decisions to invest in energy efficiency and to invest in renewable energy. The fact that a household owns a residence increases its probability of undertaking investments in energy efficiency and in renewable energy. Regarding dwelling characteristics, we find that the type of dwelling and its size have a significant effect on the decision to invest in energy efficiency and no effect on the decision to adopt renewable energy. Also, environmental motivations and commitment have mixed effects on both investment in energy efficiency and adoption of renewable energy. Trust in researchers, scientists and experts has a positive effect on the two decisions.

Third, in the generalised ordered logit model we find that people living in wealthier households are more likely to jointly invest in energy efficiency and in renewable energy if they have already undertaken any of these investments, and if not, they are more likely to undertake one of the investments as well. In the same vein, tenants are less likely to combine the two investments due to split incentives. Also, a household that has already undertaken one of the investments and is living in a detached dwelling is more likely to make additional efforts to invest in the second, while size of the residence has no significant effect. This limitation can be overcome by environmental motivations. In this sense, people who have already undertaken one of the investments and for whom environmental issues are generally more important than non-environmental issues, are more likely to have an additional motivation to address barriers that could prevent them from fully contributing to the energy transition. Also, participation in charitable, environmental and local organisations has a positive effect, as does trust in scientists and local authorities.

Conclusions

With respect to policy, one should first consider the two decisions when designing incentive instruments for renewable energy adoption and for energy efficiency investment. Policies that rely on factors that jointly affect the two decisions would benefit from the synergies that may exist between them. For example, promoting a net zero-energy building by investing in both energy efficiency measures and renewable energy would facilitate reliance solely on renewable energy sources. Energy demand would therefore be markedly reduced due to efficiency gains, so that the remaining energy needs would be satisfied by means of renewable energy. Second, regulation of housing markets could help address split incentives by offering incentives to tenants to undertake investments in energy efficiency and in renewable energy as well. Financial support to reduce the costs of dismantling and re-installation of renewable energy equipment could provide incentives to tenants to undertake such investments as well. Third, policies targeting investment in energy efficiency need to be improved. In many countries, financial support for energy conservation systems are mainly profitable for wealthier households. Poorer households are financially limited, the requirement to invest before applying for reimbursement renders participation in financial support schemes unaffordable. Therefore, it is necessary to set green grants which should be interest-free eco-loans targeting only energy-poor households. Fourth, it may be of great interest to work with existing charitable, environmental and local organisations to communicate with their members on the importance of energy transition. They are predisposed to better understanding the crucial contribution of the energy transition in protecting the environment. Moreover, scientists or national or local authorities are the most suited to communicating about the energy transition. Therefore, they should be more involved in raising awareness and in publicising academic findings to a mainstream audience.