To go beyond the assumptions of energy efficiency: a sociological understanding of rebound effects

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1. INTRODUCTION

Sometimes, measures taken to protect the environment have unexpected effects on society. The European target of cutting greenhouse gas emissions by 20% by 2020 has generated a substantial body of energy efficiency policies, but real-world observations indicate that energy savings realised in practice fall short of energy savings estimates based on physical principles incorporated in engineering models. A partial explanation of this trend consists in what is called “rebound effect” or “take-back”. Given its potential importance to sustainable consumption and production, some energy economists serve this unintended phenomenon as an argument against the set of assumptions revolving around the energy efficiency.

If the rebound effect is subsequently mentioned as something requiring serious attention, social sciences rarely explore the counterproductive effect of technical improvements in energy efficiency beyond the evocation of the mechanism as an explanation. This paper is one of the first contributions towards the challenge of a more inter-disciplinary understanding. Concretely, I am learning the interest in a sociological approach within the framework of a new research project with economists and engineers. The aim of our scientific collaboration is to study the rebound effects linked to the increased efficiency of energy use by Belgian households, in order to analyse the policy instruments to attenuate, neutralize or possibly prevent such patterns of consumption. The fact that more than 90% of human activity of modern societies is taking place in the household sector makes it interesting to identify the driving forces of an increase in the energetic throughput in this sector.

This energy and environmentally-related challenge demand new thinking in every domain of research from basic to applied. However, before exploring sociological ways of conceptualising and investigating the rebound effects in the energy-related practices of households, it seems fundamental to briefly review existing knowledge in energy economics about these tensions between the pursuit of wellbeing and the need to remain within ecological limits. The paper concludes with discussion on key policy issues.

2. THE SCIENTIFIC FOUNDATIONS OF REBOUND EFFECTS IN ENERGY ECONOMICS AND THEIR SHORTCOMINGS IN HOUSEHOLD SECTOR

To start, we need to understand how energy economics analyse the rebound effects in household or ‘lifestyle’ sector (personal travel, home heating, leisure activities e.g.). To this end, a short introduction to scientific foundations will go back to the beginning. Afterwards, we will look further into empirical evidence for take-back in domestic energy consumption.

This first step in its analysis will lead us to spot the variety of methodological and theoretical weaknesses within the research community.

2.1. Background and conceptual contribution towards take-back in energy economics

In the economic literature, the starting point of conceptualizing the rebound effect backs on the "Jevons' Paradox" (1865). The pioneering works of Stanley Jevons note that, as technical improvements increase the efficiency with which a resource is used, total consumption of that resource may increase rather than decrease. In other words, efficiency improvements also affect the demand for resources and energy and often an increase in efficiency by 1% will cause a reduction in resource use that is far below 1% or, sometimes, it can even cause an increase in resource use. The rebound effect is usually measured as a percentage of engineering savings (Sorrel, 2009). When the take-back is higher than 100%, the effect is called 'backfire'. In the long run, increased use of resources due to backfire may hamper economic growth, as resource scarcity crowds out technical change. Regarding energy consumption, a first systematic treatment can be found in Brookes (1979) and, later, in Khazzoom (1980), leading to the Khazzoom-Brookes or KB postulate (a term coined by Saunders (1992)), which states that energy efficiency improvements justified to the micro-level leads to levels of energy consumption at the macro-level which are higher than they would have been in the absence of those improvements.

In the wake of these early contributions, the scale of observation constitutes a watershed of typical approaches to rebound effects in energy economics. In the discipline, one commonly focuses on the effects that the lower costs of energy services[1], due to technological improvements, have on consumer behaviour, both individually and economy-wide. The 'macro-economic' or 'economy-wide rebound effects' imply that decreased demand for a resource like energy leads to a lower resource price making new uses economically viable. As my research focuses on household energy use, a view of rebound effects is undertaken from the micro-side. At both levels, the rebound effects consist of two types: direct and indirect. The 'direct rebound effect' is the increased total consumption of the energy service under consideration. In other words, for micro-economists, there is a 'direct effect' whereby households consume more of the energy service, after energy-efficiency improvements. This type of take-back is the sum of the substitution effect and the (direct) income effect. The 'direct rebound effect' is closely linked to the elasticity of substitution[2]. The 'indirect rebound effect' also depends on the elasticities of demand for each of the goods or services, and the energy consumption associated with each commodity. Indeed, the 'indirect (income) effect' or 'product substitution effect' is the increased consumption of other final consumption goods and services by households. The individual may, for example, decide to spend more money on 'luxury' services, e.g. going on holiday by plane. This is also an income effect, because the budget (or nominal income) of the households is still not used up after enjoying the (extra) quantity of the energy service under consideration.

These different effects throw back the interest in energy efficiency into doubt. Could total energy use be higher than if there had been no efficiency response? Above all, the terms of response need to be clarified. Energy efficiency is difficult to calculate. It depends on the

[1] Energy service means here any service provided to households and that uses energy, whatever is the energy vector or the technological system.

[2] A price or income elasticity is the ratio of the % change in demand to a % change in price or income.

definition of the service provided by an activity and its possible substitution. It is supposed to be purely technological and discards any 'behavioural interference' that raises key issues about empirical evidence for rebound effects in household energy consumption.

2.2. Dispelling the misconception about the evidence for rebound effects

In energy economics, the existence of rebound effects is admitted and observed but, among the experts, opinions diverge on the significance of the rebound phenomena. A recent report produced by the Sussex Energy Group for the Technology and Policy Assessment function of the UK Energy Research Centre notices that empirical investigations are rare, ambiguous and, often not very conclusive (Sorrel, 2007). There are few quantitative estimates of economy-wide effects, and several studies suggest that these effects may exceed 50% in some cases. Thus, the evidence and arguments used in support of the backfire hypothesis are insufficient to demonstrate its validity, but they nevertheless pose an important challenge to conventional wisdom. Indeed, there is a large body of literature suggesting that the direct rebound effect is real with regard to personal transport (Greene et al., 1999; Jones, 1993; Johansson & Shipper, 1997; Haughton & Sarkar, 1996; Small &van Dender, 2005; West, 2004), space heating (Schwarz & Taylor, 1995; Hsueh & Gerner, 1993; Klein, 1987; Guertin et al., 2003; Haas & Biermayer, 2000) and other consumer energy services in OECD. For these different sectors and major end-uses, the econometric studies and direct measurements of the rebound effect find that the effect is in the range of 10-40%. However, all assume 'pure' energy efficiency improvements. Subsequently, the basis to draw any general conclusions seems to be inadequate. Furthermore, we can note a series of methodological deficiencies.

It is true that the phenomenon is complex for quantitative observation. Firstly, the rebound effects differ by end-use and sector of the economy. Responses at the micro-level (e.g. consumers) are different than those at the macro-level (regional economy). Besides, the results depend to a large extent on the assumptions about the elasticity of substitution of energy for other factors of production. In micro-economics, the studies on rebound effects usually concentrate on the demand of one particular energy service such as mobility or room temperature. This scientific practice tends to overestimate price effects although Lovins claims that the rebound effect is more likely to be an income effect rather than a price effect (1988, p.158). In a multi-service model, the feedback could be stronger than suggested by the single-service model if substitutability between services is high and if the demand for energy increases with income. In addition, only energy was explicitly considered as an input to the production of the service. However, other inputs may also be relevant for the production of energy services, such as capital goods and 'time' (e.g. the time necessary for driving a certain distance). Lastly, the economic model implicitly assumes reversibility of investment in energy saving devices. Households would, therefore, constantly adjust their capital stock to new optimal levels whenever capital and energy prices change. This assumption about consumers relies on the neo-classical framework whose several theoretical arguments seem to be questionable.

At least three principles of this conceptual model appear out of touch with the social world and how it uses energy resources. First and foremost, the main attribute given to consumers by the neo-classical analysis, that is to say the familiar assumption of 'rational choice', contends that consumers make decision by calculating the individual expected net benefits. Nevertheless, in social sciences, many empirical studies show that the insatiable wants for

goods don't correspond to a stable way of thinking in current societies which seems rather than plural, not only instrumental but also axiological, institutional and cognitive. These different rationalities are above all limited, and this salient feature contradicts the neo-classical idea of fully informed consumers. The micro-economy explains how individuals spend their financial resources, how they evaluate different possibilities and how they take purchasing decisions with the purpose of maximizing their satisfaction. But, given that service markets are characterized by the great variety of products, comparing the available products requires considerable capacities for researching information and equally considerable capacities for analyzing it. Lastly, the neo-classical model fails to take account of a number of constraints and other influential factors like the role of institutions and of social relations, the different temporalities and spaces, etc. So, to some extent, this theoretical approach is proving to be too static to gain a complete insight into the processes in methods of structuring through the dynamics of rebound effects. That's why it seems wise to broaden the conceptual framework and to supplement empirical material.

3. CONCEPTUALIZING A GROUNDED MODEL FOR EXPLORING ENERGY EFFICIENCY'S EFFECTS IN DAILY PRACTICES

Whereas the rebound effects have been seriously underestimated or neglected by experts and policymakers, overall household energy consumption has risen over the past thirty years in spite of the energy-efficiency innovations in accommodations and mobility. The energy use of a car produced thirty years ago is higher than a current car, but the total fuel consumption in the countries of OCED is nowadays above past average, with a gap of 60 percent. In the same way, the current housings of industrialized nations are more energy saver than buildings built thirty years ago, however, they are also bigger. For instance, the surface area per French citizen has increased from 25 to 38 m² between 1973 and 2006 (Ademe, 2010). What is that keeps increasing numbers of people living in resource intensive ways? This question and the difficulties in quantifying these unexpected effects of their energy efficient equipments lead to develop a complementary, qualitative approach to embedding energy consumption in ordinary practices, beyond the walls of the economists' laboratory.

3.1. The households' view of energy savings as a first insight of rebound effects

Sociology is grounded on fieldwork, and if I take the social organization of everyday life as the main focus, it is immediately apparent that rather than concentrating on 'resources' like energy, the key issue is on of first understanding the services of these resources make possible: heating, lighting, cooking etc. and then thinking about how these services change. So, this is the way I survey the households' experiences of energy savings in Belgium. The first step of this research in progress at the Centre for Studies on Sustainable Development was an explorative focus group with individuals selected according to criteria based on household income, composition, age, gender and dwelling location (big cities, small towns, suburbs or countryside). These diversified panels are advantageous to maximize the exploration of different perspectives within a group setting. Indeed, the idea behind this method is that group processes can help people to clarify how they save energy at home, or in mobility to work, but also what they think about and why they think that way.
This fresh material shows a variety of tensions between the pursuit of wellbeing and the need to remain within ecological limits. As regards energy savings, and according to the

respondents of focus group, public awareness campaigns have an influence on investments in energy efficiency at home (insulation, heater, photovoltaic modules, electrical domestic A++, or adjustable pliers and economic lightings) and on rational energy uses for mobility to work, by limiting the petrol consumptions of car (carpool, LPG fuel, public transports, biking or walking). Besides, the respondents criticize passive behaviours towards energy savings in daily practices but, they also understand people who have fun with travelling by plane. In spite of a same discourse about the responsibility for environment, they consider energy consumption as a right and they use their energy savings for more enjoyments and pleasures like: cinema, restaurants, and sports in club, clothes, food or motorbike during week-ends. These energy-related practices are several examples of indirect rebound effects in consumerist society. As for the direct rebound effects, the respondents don't perceive in their ordinary activities. They talk more about their cognitive efforts for energy savings. Moreover, investments in energy efficient equipments are not a simple matter of willpower during a period of economic crisis. Lastly, several stories about friends' criticism for being stingy are collected and they suggest that individuals are not only self-interested. Thus, these empirical results bring in alternate points of view that diverge from the neo-classical assumptions about consumers and that give ground for new thinking in the rebound of their energy consumption.

3.2. Looking further into practice and transition theories

To contribute to the scientific and political understanding of the processes behind what is called "rebound effect", a 'practice theory' approach has been chosen as the basis of their sociological framework. This train of thoughts is a promising approach rather than a conceptually achieved theory, closer to what occurring in ordinary life. Indeed, the practice centred framework is able to move away from an expert understanding of reality and to approach the lay household's one. Furthermore, this analysis of social practices is sufficiently integrative to encompass most of the data coming from a lot of disciplines and other field studies. Following Reckwitz, a practice can be defined as "a routinized type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz, 2002). The conceptual interest consists in making sense of behaviour thanks to a multi-dimensional view which incorporates both internal (i.e. the aspects of individual decisions) and external elements (the contextual or situational variables). That's why a practice theory approach seems to be a heuristic tool that allows to enrich the outlook on domestic energy consumption. If this theoretical framework sheds light on inertia and change, the model of transition theory can fill the need to deepen these aspects about the side effects of technical improvements in energy efficiency. While the practice theory considers that a social change is linked to heterogeneous elements (material objects, skills, symbolic images and meanings), the transition theory is good at describing the multi-level interactions of such components whose timings of change are variable, depending on whether they take part in niche-innovations, socio-technical regimes, or the landscape level (Geels, 2004). Thus, the principles of those theories guide my reflexion to new ways of seeing the dynamics inherent in the rebounds of energy consumption.

3.3. Linking the rebound effects to an integrated analysis of transformations induced by energy efficiency

As the preceding sections suggest, the increased concern from various parties and the (re)use of some expert considerations (by lay people) should not make us believe that the energy consumption or energy savings are considered and experienced as practice in itself for everyone. The energy is not a practice in itself but a component of practice among many others. The energy-efficiency equipment of the practices constitutes the front door in this project, the questions from which I start and that I deal from its context. The efforts to conceptualize and explain the transformation of energy-related practice demand and require engagement with a significantly different set of concerns and considerations. The model is designed in order to dissect the relations between practices, and between various materials (not only the objects of energy-efficiency innovations but including also some infrastructures at the landscape level); images and forms of competences and understanding of which practices are themselves composed. Through these theoretical approaches, the aim of linking the rebound effects to an integrated analysis of transformations induced by energy-efficiency is to initiate an inter-disciplinary discussion about the mechanisms of take-backs and the means of remedying for them.

Of course, the model presented in this short paper involves some simplifications. Subsequently, to show how it can gain an insight into the spheres of daily activity where the existence of rebound effects is well admitted by energy economics, I propose to apply this new approach to the practice of home heating. To be recognized as a practice, a certain degree of repetition is needed. It is the regular performance of a practice, of its doings and sayings, which maintains a practice as an entity. Social interaction is framed by a variety of constraints that, in turn, strongly contribute to the regularity of communication, resource allocation, preference formation and problem solving that characterise most social phenomena. Behavioural changes linked to energy use are no exception – whether successful or not. So, how does the practice of space heating transform when central heater is acquired and enters a Belgian household? In this model, basing on empirical data the long time perspectives of emerging energy technology progress are scrutinized. If I thus compare the current situation of home heating with its common practice in 1900, I observe that central heaters are actively appropriated or domesticated to the detriment of coal or wood stove. In the material field, this introduction of energy efficient technology is accompanied by the putting in radiators and pipes, even by an extension of surface area per household. However, all the residential stock of buildings is not changed. Belgium's buildings are relatively old because of low demolition rate (at 0,075 percent a year one the lowest in Europe[3]) and growth in the building stock of only 1 percent, compared to a 1,5 percent average among Belgium's peers[4]. It is an element at the landscape level whose timing of innovations is very slow-acting. On the other hand, I can notice a shift in the socio-technical regime of heating. During the past winters, indoor temperatures were between 25 degrees C in the kitchen and 15 degrees C in other rooms. Nowadays, all the rooms of housing are routinely heated to 21 or 22 degrees C, this is what households come to expect and when that happens, anything else is deemed odd. Therefore, the practice of home heating has evolved and contemporary regimes of comfort are constituted through a range of

[3] Statbel.be on Buildings; Federal Statistical Office.

[4] Belgostat, *Building Renovation and Modernisation in Europe: State of the Art Review*, Erabuild, January 2008.

regulations and technical procedures, knowledge of thermostat's functioning, understandings of ordinary indoor clothing, global building materials and air-conditioning industries, conventions of ventilation, sweat and smell, and actual built environments designed and run in a particular way.
The approach dissects all these elements which change the complex constellation of practice in the modern way of heating. Its transformation is not only a matter of individual choice. To recognize as social something so scattered at first sight implies taking a step back and looking from higher at all these facts until trends appear. In the past, heating with a coal or wood stove brings together the heat for cooking, washing bodies and clothes, spending time in family. As this system of practices occurred in the same room, we can understand the dynamics of rebound effects in the use of more efficient central heater. This appliance makes possible a new compartmentalization of ordinary practices which separates in the everyday life and in domestic spaces different sectors of household activity, i.e., heating, cooking, showering, etc. It is important to stress that this drawing of the practice as an entity, is not only visible to analysts. This entity makes sense to the practitioners themselves. This meaningfulness doesn't mean that people have a discursive knowledge of those practices; it can also be practical and implicit. For this reason, 50 households will be interviewed in-depth in their dwellings. Before starting this sociological fieldwork, there is the selection of practices to be further studied. In this project, the model presented above is used to analyse the contingent practices and their interactions (influences, consistency, exclusion, integration etc) with other energy-related activities, so as to undertake a detailed examination of those which are very prone to rebound. To this project phase, economists and engineers contribute by providing data collections and by specifying the main observable variables. The next step will consist in feeding their results into the model.
At this state of the research, the analysis allows us to formulate working hypothesis as for the underlying drivers of rebound effects. The indirect ones could be encouraged by the energy efficient equipments which disconnect a series of existing practices, as it is the case for central heaters. Inversely, the dissemination of cars in the practices of mobility to work have many direct effects whose drivers seem to rest on the fact that this kind of transport makes possible to put the journey of children to school and the mobility for shopping together on the route to work. In the old days, these different displacements are realized separately and delegated to grandparents or to wives who did not get into the labour market. There are many other determinants which will be integrated into this conceptual scheme. Among them, the project will pay attention to households' incomes since it is sometimes referred to as being one of the most explanatory variables of rebound effects.

4. CONCLUDING REMARKS AND POLICY IMPLICATION

As the research is still in its early stages, the first step aims at assessing the evidence for rebound effects and the importance of their arguments against energy-efficiency policies. Several misconceptions have to be dispelled. The core message of this talk deals with the conceptual framework of take-backs. In energy economics, the neo-classical model focuses on individuals in its explanations of the counterproductive effects induced at the micro-level by energy-efficiency policies. Nowadays, its theoretical projections seem to have performative effects, including the selection of policy instruments like raising taxes for energy consumption. If the energy price increases fast and remains high on the markets, the micro-economists considers that the rebound effects could be limited by rational individuals.

But social cohesion could be also threatened. That's why I develop an alternate model of understanding which places the social nor in individuals, but in the practices themselves. This new approach to rebound effects studies the impact of energy efficient equipments on households' practices, by examining how the material, cognitive, institutional and symbolic factors interact in influencing the spheres of daily activity. This conceptual scheme of take-backs paves the way for revitalizing their inter-disciplinary analysis. For this next project phase, the analysis through income deciles will be instrumental for the examination of social cohesion (including energy poverty). As policies cannot treat the whole population as a group, the analysis by income groups will help to develop adequate climate change policies, supported by targeted instruments.

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