The two faces of energy poverty: Can we talk about energy need in transport sector?

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1. Introduction

Since the 70ies, many cities have experienced urban sprawl, which increases distances between different places of daily activities inside the city and tends to increase car dependence (Wiel 2002, Jouffe and Massot 2013). This phenomenon has two major impacts: it entails repercussions on the environment by an increase in GHG emissions and sealing of landscapes. Furthermore, it puts a strain on households' budgets, especially in a context where, despite the current stagnation of fuel prices, a long run raising energy prices could be expected. Research concerned with mobility, accessibility and land-use planning has taken up this topic of energy vulnerability (Polacchini and Orfeuil 1999, Gertz, Altenburg et al. 2009, Jouffe and Massot 2013). In parallel, a research field has developed, which focuses on the burden of energy expenses in the residential sector. The analysis led so far mainly adopt normative approaches of the issue. They aim to quantify the share of affected households and analyse policy measures to target them (Boardmann 1991, Boardmann 2010, Hills 2011, Hills 2012).

While the quantification of the housing energy burden has been broadly explored, no consensus so far exists on how to measure the phenomenon of transport-related vulnerability. The weakness of the European literature dealing with the connections between housing, transport, and energy expenses is any of the evidences (Mattioli 2015). The French attempts to assess transport-related energy expenses – sometimes combined with housing-energy expenses, mainly pursue objectives at territorial levels, leaving aside individual households. Either through the use of Land Use and Transport Interaction (LUTI), or thanks to original methods, the explorations led up until now mainly aim at calculating the energy consumption of territories (Antoni, Flety et al. 2009), or at understanding the effect of implementing budget restrictions on urban development. Despite the interest of these works, they leave largely unexplored the definition of households' transportation needs.

The absence of unconventional indicators to measure transport-related vulnerability of households also hinders the aggregation of both housing and transport-related energy burdens, which should help to identify households suffering from "double vulnerability". In the previous studies we performed, the housing energy poverty was determined thanks to a normative methodology inspired by Hills' work (Mayer, Nimal et al. 2014). Aiming to combine both aspects of the fuel vulnerability, an approach relying on normative conception of the transport is then essential to remain consistent, and then overpass the limitations of using fixed thresholds to identify vulnerable households.

In order to develop a normative definition of transport-related vulnerability, our ongoing work proposes first to identify clearly the methodologies followed in the various attempts to deal with transport-related expenses of households. On that basis, the second step of this research shall identify the elements enabling the establishment of a definition of transport needs.

Despite the evident interest of this perspective in identifying households exposed to transport-related vulnerability, this article shall discuss neither the definition of indicators for the identification of vulnerable households (i.e. Hills), nor the integration of normative of transportation needs in this later. This will be developed in a second phase of researches.

2. How could be defined the concept of normative transport?

In this section, we investigate the literature that provides methods for estimating or analysing households' transport expenses. **This work aims to create a list of transport sector related expenses**, according to the users' needs,

and to contribute in the set-up of comfort standards. Two different approaches are explored: the methods focusing on people's behaviour, and the modelling, which give geo-referenced representation of households' expenditures.

- Study of the transport budget by behavioural method

Driven by the European realisation on the lack of unconventional indicators or thresholds to stimulate debate upon poverty, many institutes have developed methodologies to offer governments and organisations decent living standards. We chose to base our analysis on the National Observatory of Poverty and Social Exclusion (ONPES[1]) method as well as the Joseph Rowntree Foundation's (JRF) one because the same methodology was applied; indeed ONPES' method derives from JRF's one. These studies relied **on some consensus amongst groups of citizens determining the needs of the population**, and have been validated by experts.

In the following table, are displayed the criteria that are considered to be discriminant in establishing a quantifiable decent mobility budget, for each of the reviewed behavioural methods.

Table 1: Comparison of the main normative transport components in the ONPES and JRF's methods (Joseph Rowntree Foundation 2008, CREDOC and IRES 2014)

	ONPES	JRF
Journey character		
Home-Work (2 trips*200 working days)	X	
Holidays	X	
Accessibility to jobs, shops and services		X
Journey's expenses		
Car purchase	X	
Car possession-related expenses (insurance, maintenance)	X	
Car use-related expenses (fuel) ; by average kilometre cost	X	
Parking	X	
Taxi needs (emergency, late evening trips, supermarket)		X
Public transport subscription costs (for non-driver adults and children >3 years old)	X	X
Bicycle and related equipment (for every adult and child >3 years old)	X	

One of the main differences between these two approaches lies on the possession of a car, which is not supposed to be a prerequisite in the British report, whereas the French citizens assume every household must own one vehicle, including for single households. From this major contrast derives a discrepancy in the definition of the trips: the French institute considered an average quantity of kilometres per year while the British assertion on the public transports allows an unlimited amount of journeys for a fixed price. Table 2 sums up the resulted budgets that have been computed after these two sources.

Table 2: Comparison of transport minimum income standard and transport reference budget, distinguished by household types (CREDOC and IRES 2014, Joseph Rowntree Foundation 2015)

Transport expenses (€)	Single active person	Retired couple	Couple with children	Lone parents
JRF	161	67	431	276
ONPES	297	318	420	331

Considering all the costs of a car could generally rise higher expenses than public transports use, we observe that the ONPES' budgets reach an upper level for almost every type of households. We found out the only exception is the families with children, for whom acquiring several subscriptions to public transports represents an amount of money that corresponds approximately to the expenses for the possession and use of a car. Therefore, the possession of a car should probably be influenced by a **strict necessity**, related to the characteristics of both the territory, and the households that are modelled.

[1] Observatoire National de la Pauvreté et de l'Exclusion Sociale.

- *Study of the transport budget by territorial method*

Despite the fact studies do not necessarily consider either the interaction between housing and transport expenses or the definition of vulnerability thresholds, they provide interesting reflections between transport-related energy consumptions.

Antoni, Flety et al. (2009) explore the possibility to define energy consumption labels for territories, based on the mobility need, i.e. access to amenities and work. Asides, Nicolas, Vanco et al. (2012) aim at identifying a link between urban morphology and households' vulnerability. These works permit to spot priority areas for public action regarding transport. Mercier, Ovtracht et al. (2013) adapt stress tests from the world of finance to the urban field, in order to identify the most sensitive areas to potential brutal increases of oil price. This later studies spots car dependence as strongly responsible for exposure to shocks. Coulombel (2010), for its part, takes advantage of LUTI tools to reveal the drivers of residential mobility.

In order to serve their various objectives, these works define specific methodologies to calculate mobility expenses. **The following takes advantage of the authors' reflections in order to highlight elements that should be included in a definition of mobility needs. In Table 3 are summed up the specificities and components for each of the reviewed sources.** Regarding transport modes, in as much as these studies focus on expenses, either in term of financial budget, or in term of energy consumption, they mainly consider solely motorised transportation modes: car and public transports. Thus, a special focus is made here on car-related calculations.

The former section has stressed the difference of vision between France and Great Britain, regarding car ownership. The French attitude considering it as a necessary standard of living is here confirmed. Only two of the reviewed works do not systematically include fixed costs of car ownership in their calculations: the e-mob project, which wishes to evidence the important impacts of cars on households' budget, and Antoni, Flety et al. (2009) that focus on energetic elements (i.e. fuel consumption).
Considering owning a car as a necessity leads to assume every household as car dependent. While in dense city centres, much of the mobility could rely on public transport networks, car ownership is far from being the rule. As stressed in the e-mob project, integrating fixed costs for car ownership to all households would build a model diverging from reality, overestimating transport budgets for many people. **Before imputing the cost of car ownership to households, it should be identified if they are actually compelled to use a car.**

Regarding the inclusion of the vehicle cost of purchase, the studies in Table 3 reveal two distinct logics. The e-mob project assigns to every situation the same purchase price. The aim of this tool is indeed to enable households to compare different locations regarding aggregated housing and transportation expenses. The value of the initial cost therefore is of little importance to the objective pursued. However, **the inclusion of a purchase amount is justified here by the will to measure the "remaining income" of households: considering only the marginal costs of use (including fiscal dispositions), several simulations conclude car as being cheaper than public transport.**
Other models differentiate the cost of purchase according to households' income. Nicolas, Vanco et al. (2012) exploit "l'enquête budget des familles[2]" to define three motorisation classes. **Nevertheless, for the definition of normative transportation needs, arbitration between the need to own a vehicle or not is more important than the actual cost of purchase.**

All studies take into account the variable costs of using a car. They are split into fuel, maintenance and sometimes insurance (which may be included in the fixed costs). Very few details are given on maintenance costs and insurance. The study of Mercier, Ovtracht et al. (2013) is based on the values given by ADETEC (2012): respectively 0.06€/km and 0.02€/km. Fuel consumption is sometimes differentiated according to the power (Nicolas, Vanco et al. 2012). For the definition of normative transportation needs, this differentiation is important in that it allows integrating coherent fiscal dispositions. Finally, regarding consumption, not all studies go into the same level of details. Antoni, Flety et al. (2009) and the e-mob project share a similar approach; insofar as the objective is to compare situations (e-mob) or territories (Antoni, Flety et al. 2009), the importance of differentiating between vehicles is limited. The integration of differentiated consumptions according to road networks, however, could provide higher precision. When such differentiation is undertaken, the software COPERT is used.

Finally, the number of kilometres travelled is calculated using various methods. In order to improve the results provided by methods using crow fly distances with corrective coefficients for each mode, a method using models of traffic is developed (Coulombel 2010). It provides the actual distance travelled and the time of access based on

[2] French survey that provides an estimation of the average households' consumption upon goods and services.

the hours at which the trip is held. This method represents an interesting evolution for taking into account travel times, which are fundamental for determining time budgets[3]: not only is speed a function of distance, but also of the type of network and the fluidity of the traffic. However, the study of Mercier, Ovtracht et al. (2013) considers only average access time, obtained through broad audience tools (mappy, MVV Womo[4]). This approach is justified by the wish to obtain average travel times, and that specialised software available to authors are calibrated on peak hours (which is not consistent with the fact that many leisure trips happen outside of these). Furthermore, as mentioned forehead, the inclusion of non-motorised modes such as walk of bicycle could complete the approach, particularly regarding time budgets. Antoni, Flety et al. (2009) propose a probabilistic method, dependent of distances, to distribute modal choices between walk and car. This method could be adapted to include bicycle use.

Table 3: Normative transport components of the main reviewed sources

		Antoni, Flety et al. (2009)	E-MOB project (2015)	Mercier, Ovtracht et al. (2013)	Nicolas, Vanco et al. (2012)	Coulombel (2010)
Housing & mobility						
Housing		-	X	X	-	X
	threshold	-	-	X	-	-
	Expenses calculation	-	X	X	-	X
Mobility		X	X	X	X	X
	Threshold	-	-	*X*	*X*	-
	Expenses calculation	*X*	*X*	*X*	*X*	*X*
Combined	Threshold/Other		X (other)	X (threshold)	-	X (other)
	Mobility					
Mode	Car	X	X	X	X	X
	Public transports	-	X	X	X	X
	Bicycle	-	ND	-	-	-
	foot	X	ND	ND	-	-
Distance	Residence - work	X	X	X	X	X
	Access to amenities	X	X	X	X	X
Financial costs related to car use	Fix costs	-	X	-	X	X
	Variables (incl. fiscal dispositions)	X	X	X	X	X
	Consumption	7l/100km	5l/100km	0,12€/km (base)	Differentiated	Differentiated
	Vehicles	Essence type	Diesel type	-	Differentiated	Non differentiated
Non-financial cost	Time budget		X	X	-	X

The elements that emerge from this analyse advocate in favour of the integration, not only of variable costs (including fuel price) but also fixed costs, which are important to capture the dynamics of residential mobility. In the case of shifts from car to public transport, significant time budget is also identified as a major obstacle. The importance of considering households' income as one of the determinants of acceptable transportation budget was also highlighted.

3. EIFER's method/definition

According to the study we would have to perform, various databases must be exploited. Indeed, the ENTD can provide the distances and duration of trips all over the territories of France whereas the territorialised EMD must be obtained after local partnerships. Accuracy and scale level may then vary. Ultimately, the "Budget des Familles" was found to be an interesting and reliable source of information.

[3] As well as for the integration of walk and bicycle

[4] http://en.mappy.com/#/0/M2/THome/N0,0,9.18346,48.76688/Z11/, http://www.mvv-muenchen.de/de/aktuelles/presse/pressemitteilungen/detail/datum/2011/05/09/mvv-stellt-neuen-wohn-und-mobilitaetsrechner-womo-ins-netz-93/index.html

Based on the observations made in the former parts, we propose elements of method to define a normative need for mobility.

In particular, our study proposes to value car dependence. It compares car budgets to time budgets for local trips. While Mercier, Ovtracht et al. (2013) value the resilience of a territory based on the number of job opportunities reachable in 60 minutes, we consider that time spent in transports has not the same financial value depending on households' incomes. For a determined trip, this aims to represent that lower revenues households could have higher interest in using cheaper modes (i.e. public transport): the financial savings would represent a higher share of the total revenue. This approach wishes to participate in defining normative needs, and not to capture actual behaviours. A *relative car budget* and *relative alternative-transport time budget* are defined as presented hereunder. The *relative car budget* aims to value how much money would a household save through alternative transports use rather than car use. *Relative alternative-transport time budget* aims to value the excess of time spent by using alternative transports rather than by using private car, and gives it a monetised value that depends on the income of the studied household.

$$Relative\ car\ budget^{5}$$
$$= (Cost\ of\ the\ average\ daily\ trips\ if\ held\ by\ car)$$
$$- (Cost\ of\ average\ daily\ trips\ if\ made\ by\ public\ means)$$

$$Relative\ alternative\ transport\ time\ budget$$
$$= [(average\ daily\ duration\ of\ public\ transport\ use)$$
$$- (average\ daily\ drive\ duration)] \times Income$$

If the *Relative car budget* is lower than the *Relative alternative transport time budget*, the household is actually car-dependent. It is noteworthy that only public transports are accounted as alternative transportation means. Further reflexions could lead to include Bicycle and walk using a probabilistic method, similar to the one applied by Mercier, Ovtracht et al. (2013).

Furthermore, the former part has revealed the importance to include both fixed and variable costs for transport. Nonetheless since our method considers only expenses per kilometre, the inclusion of fixed costs requires particular attention. Regarding the incorporation of public transport, the energy part of the costs cannot be identified in the regular tariffs. Fixed and variable expenses are then considered as a whole, per kilometre. For cars, a possibility to include purchase prices would be to use a depreciation factor. Hence, a final expense can be computed for each household, according to the type of this later and to the characteristics of the territory.

4. Conclusion

In this paper, an analytic review upon the definition of normative transport needs was presented. Consequently, the conclusion is that the normative transport definition relies on some major components: the integration of various transport modes and the car dependence condition.

Nonetheless, it remains important to reach a consensus in the reference vocabulary. Indeed, a clear difference should be made between normative definition and mobility constraints.

Besides, most of the sources that we presented were specifically focussed on the French context, where transport and mobility issues are tackled via the question of fuel poverty. Nevertheless, British studies, where transport poverty is revealed as the main approach, have shown a different point of view, which is equally valuable.

This work will then complete the previous results, and reinforce the former methodology (Mayer, Nimal et al. 2014) using normative definitions for both transport and housing energy burdens. Indeed, the expenses computed thanks to this process are meant to address mobility fuel poverty, using a declination of the LIHC indicator.

Ultimately, this method was recently developed and must then be validated on some case studies to be proved as relevant and robust.

[5] Same trips (i.e. origins and destinations) must be considered for both public means and private car.

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