CITIES, ENERGY AND CLIMATE CHANGE:
THE CASE OF FRENCH RESIDENTIAL ENERGY DEMAND

Laure LAMPIN
Centre International de Recherche sur l'Environnement et le Développement (*CIRED*)
45bis av. de la Belle Gabrielle, 94736 Nogent-sur-Marne CEDEX, France
&
Ecole des Ponts ParisTech
6–8, avenue Blaise-Pascal, Cité Descartes, Champs-sur-Marne, 77455 Marne-la-Vallée
Email: lampin@centre-cired.fr; Phone: +33 (0)1 4394 7367; Fax: +33 (0)1 4394 7370

and

Fabio GRAZI
Agence Française de Développement (*AFD*), *Division of Economic Research*
5, rue Roland Barthes, 75012 Paris, France
Email : grazif@afd.fr

Overview

Through directly acting on the demand for mobility and housing by individuals, cities and urban form may play a crucial role to reduce the urban energy demand affecting climate change. A vast literature exists that has revealed the significantly negative impact of urban form and density on the demand for transport via the commuting behavior.[1] Yet very few studies have focused on the effect of urban density and spatial planning in altering housing choices and residential energy use. This article aims to fill this void and show the importance of the residential dimension of the energy demand in the climate change debate.

Method

To achieve this, a two-step method was developed. The first step consisted of building a conceptual framework that allowed to capture the relationship between population density and residential energy demand through four different impact mechanisms (see also Figure 1 for an illustration of this):

i. *Housing-size effect*. It describes the impact of residential density on the available surface of household dwellings, which in turn affects the energy used.
ii. *Housing-type effect*. It explains the effect of density on the type of dwelling (apartments in the city center vs. detached houses in the peripheries), which is likely to affect the demand on energy.
iii. *Energy-source effect*. It concerns the influence of urban density on the energy sources available (gas and electricity mainly), which is expected to affect the demand on residential energy by urban households through energy parameters such as heat production efficiency or price.
iv. *Heat-island effect*. It deals with residential density affecting the energy requirements by individuals through altering the average city temperature.

[1]Results from meta-analytical estimation of the impact of urban form on transport demand show that, on average, the density elasticity of mobility is 0.12 (Lampin, 2012).

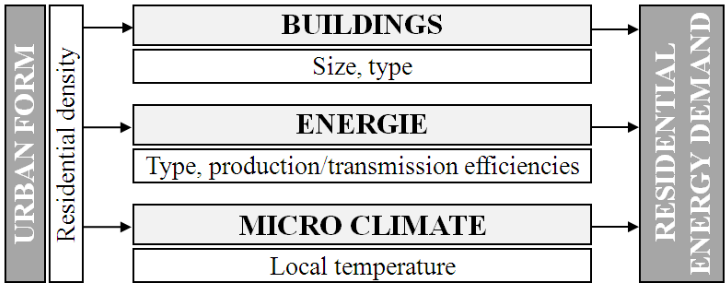

Figure 1: *Schematic representation of the impact mechanisms of urban form on residential energy use*

In the second step, the framework was tested using multichoice logit random utility models and linear functions and empirical estimations were performed using a comprehensive dataset of 27,940 observations from the 2006 French National Housing survey. Potential endogeneity issues were also treated through two-stage residual inclusion (2SRI) (Terza et al., 2008) and two-stage least square (2SLS) methods (Wooldridge, 2002).

Results

We found that population density has a significantly negative effect on residential energy consumption in cities. In particular, households living in twice-denser locations face 7% to 9% lower energy consumption in residential sector. This finding results from the aggregation of the net effects of the four impact mechanisms tested, each of which showed significant and quantitatively similar effects, though of different nature: *a*) increasing density acts so as to curb energy demand in cities via reduced housing sizes and compact dwellings; *b*) increasing density causes temperature to increase in central denser areas through micro-climate changes, which in turn reduces heat requirements during wintertime; *c*) increasing density fosters fossil switch towards gas use in dense areas, which in turn raises the residential energy demand through price effect.

Conclusions

Coupling this work with analyses showing the contribution of density in significantly reducing transport-related energy use provides promising quantitative insights in support of the role of urban form and spatial planning in curbing energy demand and associated carbon emissions.

References

Grazi, F. and Lampin, L., 2012. "On cities, energy and carbon emissions." Mimeo. April, 2012.

Lampin, L., 2012. "Meta-analysis of Energy Use in Cities." Austrian Association for Energy Economics – First International PhD-Day. Mars, 2012.

Terza, J.V., Basu, A., Rathouz, P.J., 2008. "Two-Stage Residual Inclusion Estimation: Addressing Endogeneity in Health Econometric Modeling." *J Health Econ* 27, 531–543.

Wooldridge, J.M., 2002. *Econometric Analysis of Cross Section and Panel Data*. MIT Press.