

# Systemic approach for climate energy plans at the territory scale

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## Abstract

This paper points out the main results coming from a research project called ASPECT 2050. This project aims at developing multi-level and multi-sector approaches in order to set up, at city and region level, Territorial Climate and Energy Action Plans (PCET) which can sustain climate mitigation policies in France.

In a first part, we analyze the main interactions between changes in urban form (physical layout and design of a city), mobility and energy management of the built environment that influence Greenhouse Gas (GHG) emissions. Four types of interactions have been identified: (1) interactions between urban forms, households and businesses location and mobility; (2) interactions between accessibility and urban sprawl; (3) interactions between land markets, housing policies and urban sprawl; (4) interactions between urban forms and local management of energy. We explain how these interactions are responsible of an increasing emission of GHG in urban regions like Greater Lyon.

In the second part, we present the setting up of new principles for policy action and instruments required to minimize GHG emissions due to these interactions: (1) integrated multi-level policies between cities, inter-municipal local authorities and regions; (2) contractual partnerships to enhance linkages between long-term urban and transport policies; (3) co-finance the implementation of interrelated policies over time and create corrective mechanisms of the market.

## Introduction

Territorial Climate and Energy Action Plans (PCET) have been introduced in France in 2004. Up to now, more than 200 collectivities and territories are involved in the elaboration of a PCET. The second Grenelle law made them compulsory from 2012 for cities of more than 50,000 inhabitants. Considering this law, PCET have to define a strategic vision on the expected territorial changes, necessary to meet mitigation and adaptation objectives, and at the same time to define actions that local authorities have to support in order to achieve these objectives. The second Grenelle law stresses particularly on two main characteristics of this new type of PCET: they should become more prospective and multi-sector plans; they should take into account synergies between actions by considering their cumulative effects on GHG emissions. In addition, they have to be compatible with urban plans (PLU), mobility plans (PDU) and inter-municipal territorial coherence plans (SCOT). But this tools are sectorial and do not depend on the same level of governance – local and inter-municipal levels for urban policies and regional level for transportation policies – Regarding the “Grenelle de l’environnement” debates (French government, business<sup>1</sup> and civil society high-level debates on new measures for a sustainable development) and laws, the challenge is to renew the way by which such plans are elaborated and applied in a more efficient and collaborative way at city and region levels. The main objective of ASPECT2050 project, supported by the ANR (the French National Research Agency), is to analyze the main interactions between urban form, mobility and energy management of the

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1. Law no. 2010-788 of 12 July 2010 on national commitment to the environment. It can be consulted on [www.legifrance.gouv.fr](http://www.legifrance.gouv.fr), the French public service broadcasting law.

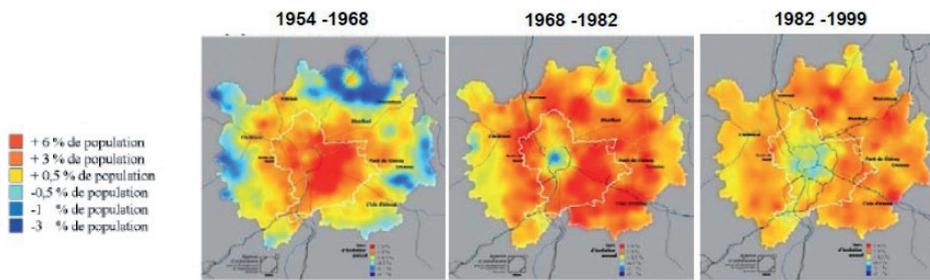


Figure 1: Evolution of population on the territory of the urban area of Lyon (UrbaLyon by INSEE).

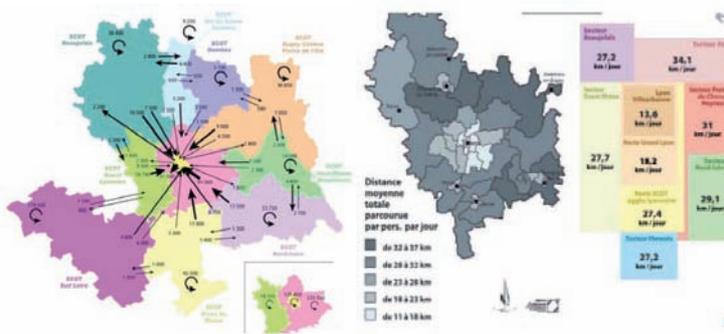


Figure 2: Commuting flows within the "InterScot\*" and average distance traveled per day (EMD 2006).

\*The SCOT was introduced by the law SRU (Solidarity and Urban Renovation) in 2000 and permits the implementation of inter-municipal planning. The InterScot is a cooperative approach between SCOT holders; its level of governance is the union of the SCOT territories. The Grand Lyon InterScot started in 2004 and counts eleven SCOT.

built environment that influence GHG emissions. The hypothesis is that once these interactions will be better known, it could be possible to set up multi-level and multi-sector climate attenuation policies that minimize the GHG emissions due to these interactions and more broadly to urban dynamics.

In the first part of the paper, arguing the importance of these interactions in the mechanisms producing urban GHG emissions, we will present four significant interactions that local authorities have to consider in their climate attenuation plans. This analysis is based on elements of the literature and the collection of data (statistics and figures) coming from the city urban region studied: the Greater Lyon.

In the second part, we present combining action principles and tools which can be used to limit urban dynamics that increase GHG emissions. We show that stronger coherence between two main types of policies could have an efficient effect on GHGs emissions reduction:

- housing and urban planning policies,
- transportation policies encouraging commuting choices.

Nevertheless, considering the fact that land use features and building markets influence the households and business location choices, we suggest that better coherence between these policies is not the only tool required to better control GHGs emissions. In addition, local authorities need to develop more foresighted land use policies, to establish multi-level contrac-

tual partnerships including new financing tools and to use proper levers (incentives and disincentives) inducing behavioral change of location and commuting in order to limit GHGs emissions. The PCET would be the place to lay down such a combination of policies and action tools.

### Significant interactions between urban form and mobility increasing urban GHGs emissions: the case study of Grand Lyon

Considering the state of the art of the literature, we have identified three main interactions that could lead to increase energy consumption and GHG emissions in city urban regions:

- the interactions between urban forms, location choices and mobility practices,
- the interactions between car accessibility, housing markets, urban sprawl and CO<sub>2</sub> emissions,
- the interactions between urban form and local management of energy.

Referring to this framework, we have performed a territorial diagnosis of the Greater Lyon by combining the different variables of these related interactions.

#### URBAN SPRAWL OF ACTIVITIES AND HOUSING

In the urban area of Lyon, there is an expansion of the living area, especially in the eastern territories (see Figure 1). Internal migration within the urban area from the center of the city (Lyon, Villeurbanne and inner suburbs) to the rest of the urban area has been the main cause of those demographic developments.

Indeed, during the 1990s, the employment in the central part of the city has declined to the benefit of the South-east and North-east parts of the city.

#### URBAN SPRAWL, ACCESSIBILITY AND MOBILITY PRACTICES

The movements described above (**urban sprawl of activities and housing**) have led to an extension of the geographical links between housing and jobs. To illustrate, in 1975, most of the municipalities of the Greater Lyon had more than 50 % of their active workers working in the city, while in 1999 the only city in this situation was Lyon (the other cities were at around 25 %). This trend has led to the formation of a "large monocentric city", surrounding by a few medium size cities (such as Villeurbanne) and by an important number of small cities. This structure implies radial travels (weight of the center in commuting

flows). Thus, the average travel distances gradually decreases in cities near the center: up to 34.1 km for an inhabitant of the far Northeast and 13.6 km for the resident of Lyon.

**CONSEQUENCES ON CO<sub>2</sub> EMISSIONS**

A study led in 2009 by the “Laboratoire d’économie des transports” (LET) confirms that housing location directly impacts the emissions associated with travel: at the same income, a resident of the outer suburbs emits approximately twice as much CO<sub>2</sub> than a resident in the center.

The causes of these phenomena in a long term perspective have been mostly the increasing of:

- **Car accessibility**, partly due to the opening of new surrounding motor ways in the east side of the agglomeration,
- The pressure of **land and housing markets**.

**URBAN SPRAWL, CAR ACCESSIBILITY AND HOUSING MARKET**

Within the urban area of Greater Lyon, **road accessibility policies** have led to link the center to an important part of the urban area within 30 min (over 64 % of the population). This **accessibility** has led to a steady increase of the urban area perimeter (considered in our discussion as the living area).

The rising price of **housing market** in the central areas has resulted in the **relocation of businesses and households**.

Rental prices have increased in the metropolitan area in the mid-2000s (see Figure 5). It makes the availability of accommodation in the center of the city for low and middle income households difficult. As the overall budget for housing and transport is lower in the fringes of the city, the economic factor was a strong motivation to leave the city center. A survey conducted in the suburb called “Mions”, as part of the PREDIT (Research, Experimentation and Innovation in land Transport Program; started and implemented by the French ministries in charge of research, transport, environment and industry, the ADEME and the ANVAR – French research associations –) researches program, has shown that third owners were “resigned owners”, that is to say homeowners in a place where they don’t want to live. This cumulative effect has been identified as one of the main cause of the increasing GHG emissions due to the daily commuting distance.

**TWO PHENOMENA REINFORCING THE PREVIOUS TENDENCIES**

The combination of these two phenomena (**car accessibility and housing market pressure**) led many vulnerable owners to move in the outer suburbs of Lyon as Figure 6 shows.

**URBAN FORMS AND LOCAL MANAGEMENT OF ENERGY**

In addition, the Greater Lyon diagnosis has revealed two major types of influences between **urban forms and local management of energy**:

- The shape of the built environment and the location of building influence the energy consumption. In central areas, the compactness, the envelope surface and the contiguity of buildings minimize energy demand, whereas in the sprawl areas the big size of the housing, the energy used (fuel) tend to increase GHG emissions.

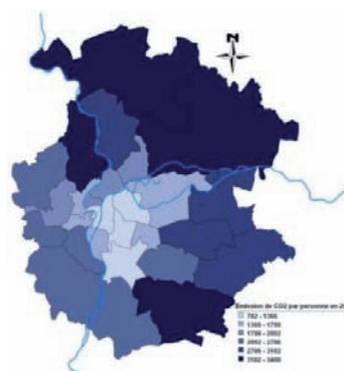


Figure 3: CO<sub>2</sub> emissions per person per day related to transport (LET, 2006).

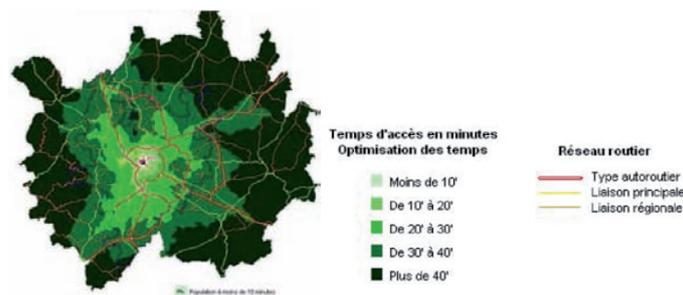


Figure 4: Access time in minutes to downtown, (CERTU, 2007).

- In addition, urban form impacts the potential for exploitation of renewable energy: in central areas, building density and mix of functions are favorable to centralized district heating, whereas the suburbs, with disperse single family housing, are more favorable to solar energy.

The existing situation on the Greater Lyon helped to illustrate this point. Indeed, the energy consumption of individual housing emits more GHGs than collective ones – final energy consumption around 165 kWh/m<sup>2</sup> for an individual home built before 1975, around 116 kWh/m<sup>2</sup> for a collective one – however, according to a recent study, the potential for producing renewable energy is bigger in individual home, in a ratio of 1 to 6.

**KEY CHALLENGES FOR CLIMATE ENERGY PLANS**

Considering this diagnosis, the main following measures will be included in the new PCET of the Greater Lyon:

- A better compatibility between urban forms and mobility,
- A plan to retrofit housing in the central areas and to extend the heating system,
- The focus on urban regeneration of Brownfield areas that will require longer time to be rebuilt (as the “Confluence” project environmental rehabilitation of former industrial sites in the south of Lyon),
- The extension of collective transport lines and the increasing frequency of railways between urban poles,
- The development of biomass and the solar panels in surrounding areas.

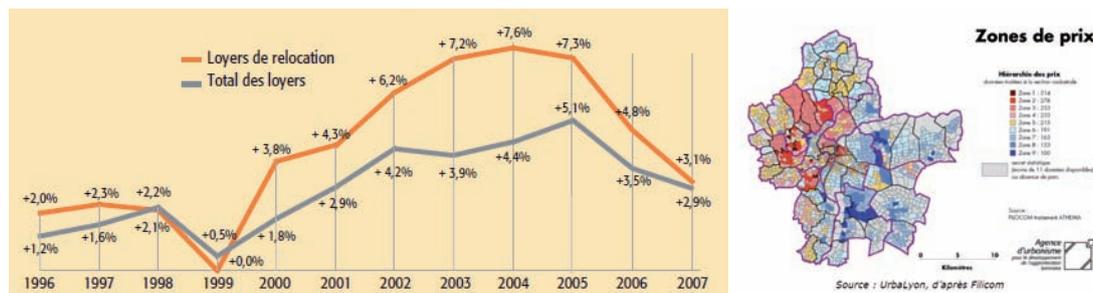


Figure 5: Rental prices evolution and distribution (PLH, UrbaLyon).

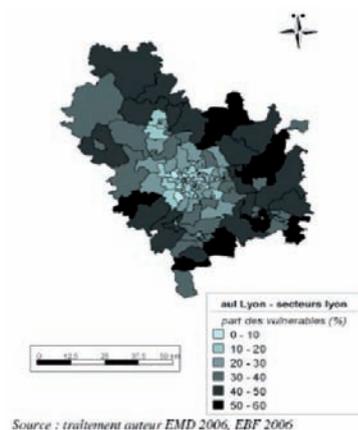


Figure 6: Percentage of vulnerable (LET, 1999).

If these policies don't seem really innovative, the methodology used to elaborate this new PCET definitely is. The Greater Lyon organized a climate conference involving stakeholders and asked to an engineering office to evaluate the potential cumulative effects generated by these measures in a prospective perspective. This process highlighted the synergies between policy actions that should be reinforced in the future. In addition, it revealed that the local authority do not have the right tools (contractual partnerships and multi-level negotiations) to build these synergies in a long term period. Finally, it showed the need to reinforce the co-financing tools allowing the development of interrelated actions between cities.

## Policy action principles in order to minimize urban GHG emissions

### A NEED TO MULTI-LEVEL POLICIES NEGOTIATED BETWEEN CITIES, INTER-MUNICIPAL LOCAL AUTHORITIES AND REGIONS

The first part has shown that disperse urban forms and individual location choices increase car dependency, if new road and highway infrastructures are not combined with a more regulated urban planning reinforcing existing urban poles and limiting the growth of small size cities.

Nevertheless, in order to apply such strategic vision, the Greater Lyon needs to:

- use its territorial plan (SCOT) not only to build a “political compromise” on the “places of growth” (with the mayors of the cities included in the Greater-Lyon territory), but to

negotiate a multi-level growth strategy which could satisfy the expectations of the majority of mayors and of the region;

- To organize an increasing dialogue between multi-level authorities (cities, Greater Lyon, Region) in order to avoid negative impacts between actions that will be decided at different levels of governance in order to contain urban dynamics that contribute to GHG emissions.

For instance, some actions could be contradictory: when the region plans to build a new west highway ring without envisaging a toll filtering metropolitan mobility and daily transit, the Greater Lyon tries to carry out a SCOT restraining housing construction in small cities close to the new highway. Actually, the increasing accessibility of suburban areas makes urban sprawl difficult to control, if local authorities at different levels (city, Greater Lyon and regional levels) cannot build a shared vision of a management growth strategy that includes a polycentric development linked to the extension of the public transport network and infrastructures. For instance, the development of regional railway lines could change the modal split in favor of public transport, if such transport provide a competitive price and service (in terms of frequency, on-time and accessibility) and if toll taxes are applied in new highway rings in order to avoid their use for daily home-work trips.

As institutional actors who play a leading role in urban development and transportation planning do not depend on the same level of governance – local and inter-municipal levels for urban policies and regional level for transportation policies – there is a need to establish more multi-level policies and commitments between these actors in order to renew urban and transportation plans coherently in a medium and long term perspective.

The analysis carried out in the Greater Lyon in the context of the renewal of the climate plan demonstrates that the relations between urban and transportation policies must be reinforced by a multi-level collaborative planning approach. This approach cannot only be based on prescription and planning tools but requires contractual agreements and crossing financial supports. As the scheme in Figure 7 shows, it is a necessary but not a sufficient condition. Indeed the pressure of land market can reactivate the disperse relocation of inhabitants and enterprises, if local authorities cannot implement a multilevel land use strategy in order to anticipate urban projects linked to transportation infrastructures.

Our analysis has shown that local authorities have to intervene on these interactions to be able to set up climate plans that could minimize GHG emissions at urban region and city scales

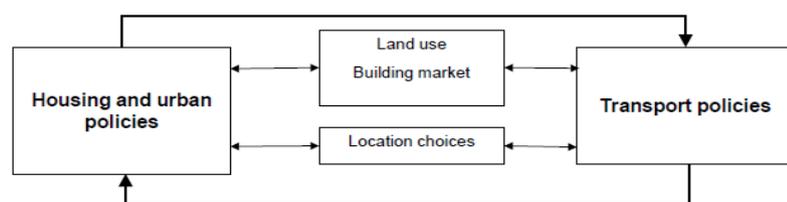


Figure 7: Policy scheme.

in the perspective of a long-term attenuation and adaptation strategy.

To conclude, two key lessons emerge from the work done in the early phases of the project ASPECT2050.

#### CONTRACTUAL PARTNERSHIPS TO ENHANCE LINKAGES BETWEEN LONG-TERM URBAN AND TRANSPORTATION POLICIES

Considering the interactions described in the first part, local authorities cannot expect to reduce GHGs emissions without consolidating contractual partnerships between multi-level urban planning authorities and city departments and between transport planning authorities. It appears then necessary to enhance the coherence between “upstream” policies (land policy, regulatory or fiscal tools) and corrective “downstream” policies (mobility, social housing and urban projects ...).

Linkages between urban and transport planning can be reinforced by “building bridges” between planning documents such as urban plans (PLU), mobility plans (PDU) and inter-municipal territorial coherence plans (SCOT). For instance, the “Grenelle de l’environnement” debates and laws drawn new tools:

The DOO (Document of Orientations and Objectives), which:

- can identify areas in which the opening of new zones for urbanization is subject to their service by public transport,
- may define areas near existing or planned public transport, in which the PLU must impose a minimum density of construction,
- this “conditioning” objectives must be part of the contractual partnerships conclude between levels of authorities

Taxes on real estate gains after the completion of public transport infrastructures :

- Fixed by the transport authority
- intended only to fund the development, redevelopment or modernization of equipment or transport infrastructure,
- this taxes could be negotiated between the transport authority and the Greater Lyon.

Complementary rules have to be included in such multi-sector documents in order to produce an expected common result. As in France, such plans are sometimes not totally applied, contractual partnerships allow to define the strategic decisions and investments that cannot be thrown back into doubt in the future.

For instance, the assumption that densification induces a decrease of GHGs emissions seems insufficient. Indeed, it has to be bounded to multi-level negotiations on urban planning; which permits accessibility gains and the implementation of

proper actions (incentives and disincentives) inducing behavioral change of location and commuting. One example of such a practice is the “axis contracts”: a community can contract with a transportation authority (AOT) to structure the urban densification along the public transport axes:

- The AOT is committed to a transportation project;
- The local authority promotes density and mixed-use urban development around the project.

Such approach permitted the creation of a new tram line in the agglomeration of Grenoble in 2008. No political authority has competence on its entire functional space; the urban community – commonly known as the METRO – is composed of 26 municipalities which each have jurisdiction in planning (redaction of the PLU) while the METRO is responsible for some roads and soft modes and the joint union of public transport (SMTC) – the AOT – has the responsibility for the transportation policies (elaboration of the PDU) at the region scale.

Tram served the densest areas of the city while car use dominated in the peripheral areas. Yet, attendance would have been insufficient in these sparsely populated areas to ensure the profitability of a new line of public transport. In order to permit its creation, the different actors committed themselves by the way of an “axis contract” which define policies leading to consistency between urban and transport planning.

These kinds of linkages make more effective the application of PCET measures and expected results in terms of GHG emissions.

#### CO-FINANCE THE IMPLEMENTATION OF INTERRELATED POLICIES OVER TIME AND CREATE CORRECTIVE MECHANISMS OF THE MARKET

As one of the main difficulties to build long-term interrelated policies is to find financial supports, the measures aiming at limiting car daily trips such as motorway toll, congestion tax and metered parking can be used to support urban densification projects. For instance, the buying of land by local authorities permits to foresight and control the market evolutions. In addition, the new Grenelle law permits to a transportation authority to collect from a promoter the increasing land value-added generated by an additional collective transport service. This new land value-added tax allows the transportation authority to finance new projects of well-served districts.

In addition, a more anticipating land use policy can help to establish co-financing partnerships between multi-level actors. For instance, the Greater Lyon helps medium-size cities to finance their densification and mixed-use projects around transport stations. One of the challenges is to set up more inclusive urban projects in order to maintain low-income populations

close to cities centers and transport stations. Another tool envisaged to extend the urban renewal activity of local authorities is to collect value-added taxes from promoters and owners who can sell their building or housing at higher prices because they benefit from the renewal of public spaces and amenities delivered by the city.

The application of these tools should be in coherence with the other measures included in climate territory plans; inducing behavioral changes in mobility practices and encouraging building renovation, energy saving and local energy production and distribution.

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