

EQUITEE: an innovative software tool to test and monitor strategies for energy transition

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Abstract

EQUITEE is an innovative software tool developed to help local communities test and monitor strategies for energy transition and climate action plans. The software is used by actors involved in territorial planning: communities, urban planning agencies, developers, government departments, or research departments. By statistically treating individual and household data (population, type of habitat, economic activity profile and natural urban development, etc.), the software automatically provides authorities with local diagnoses, allows interactive forecasting, and permits them to monitor chosen indicators throughout the lifetime of the action plan.

Thanks to this project, regional planners can combine all kinds of indicators to provide diagnoses from the regional to the neighborhood scales. The data is dynamically visualized in interactive analytical maps. During meetings, land use scenarios are developed and tested; the software ensures the consistency of assumptions across sectors and scales of work. EQUITEE finally brings together all the tools required to manage land use programs and helps to plan and to monitor the spatiotemporal penetration of actions, to measure their impacts and compare the expected goals.

EQUITEE is being used to accompany the regional planning initiative in “Coeur d’Hérault”, a territory between the city of Montpellier and the Larzac Plateau in the Southeast of France. This territory of about 70,000 inhabitants faces a rapid growth in population, and strong urban sprawl. Real estate needs compete with those of the preservation of agricultural and natural

soils. The challenge for “Coeur d’Hérault” is to articulate – in theory and practice – energy transition and achievement of Factor 4, while reducing inequalities and fuel poverty, through land planning, and policies dedicated to habitat, mobility, social and environmental issues.

Introduction

EQUITEE is an innovative software tool developed to help local communities test and monitor strategies for energy transition and climate action plans. The software is used by actors involved in territorial planning: communities, urban planning agencies, developers, government departments, research departments. By statistically treating individual and household data (population, type of habitat, economic activity profile and natural urban development, etc.), this software automatically provides authorities with local diagnoses, allows interactive forecasting, and permits them to monitor chosen indicators throughout the lifetime of the action plan.

Thanks to successive research and development projects (National Research Agency ANR, National Agency for Environment and Energy Efficiency ADEME, National Agency for Housing Improvement ANAH) targeting urban durability, social dynamics and energy planning, EQUITEE provides expert results and analysis on: energy consumption, greenhouse gases emissions, energy bills and climate vulnerabilities, and various durability indicators (social and functional mix, land use). The software development has been supported by the public bank for investments bpiFrance.

Thanks to this software, regional planners can combine all kinds of indicators to provide diagnoses from the regional to the neighborhood scales. The data is dynamically visual-

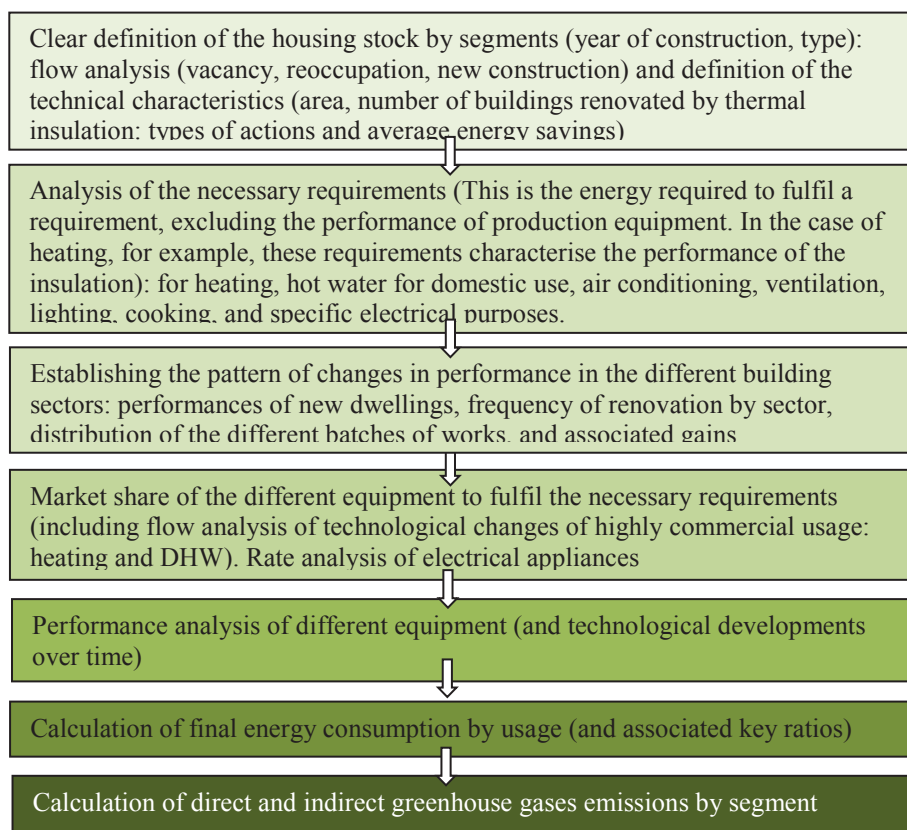


Figure 1. Bottom-up prospective methodology, example for the residential sector.

ized in interactive analytical maps. During meetings, land use scenarios are developed and tested; the software ensures the consistency of assumptions across sectors and scales of work. The software's timescale varies from short term (2015–2020) to long term strategies (2030–2050). The parameters used in the models are as close as possible to the indicators already used by municipal and regional services for their operational programs such as housing, transportation, economic development and urban planning. EQUITEE finally brings together all the tools required to manage land use programs and helps to plan and to monitor the spatiotemporal penetration of actions, to measure their impacts and compare the expected goals.

This paper illustrates the use of EQUITEE for two planning projects: (i) the regional planning initiative in “Coeur d’Hérault”: to articulate – in theory and practice – energy transition and achievement of Factor 4, and (ii) a sectorial action plan to face fuel poverty in Lorient. These projects are still ongoing; and the conclusion of this paper focuses on EQUITEE's functionalities and future developments.

Methodology

EQUITEE's sources of input are: detailed information from (i) the INSEE¹ census (population data and individual level data on housing, mobility), (ii) databases concerning fiscal and social income, (iii) localized data concerning public and private activities, (iv) the household budget survey, and (v) energy databases developed by BURGEAP. EQUITEE rebuilds balance

sheets and energy bills on the basis of a bottom-up analysis of the needs and behavior of households: in their homes, for travel, or consumption of goods or services. This approach breaks down each category of consumption via the actor, the intended use, the technology and its associated performance, and the energy source. The calculations are made at the level of each household, and the results presented at the level of the neighborhood.² The analyses are designed to segment populations according to their socio-economic profiles, type of habitat, mobility needs, and eligibility for current aid programs.

Automatic trend scenarios are proposed for consideration based on the evolution of the main parameters from 1999 to 2010; these trends may of course be changed by the user.

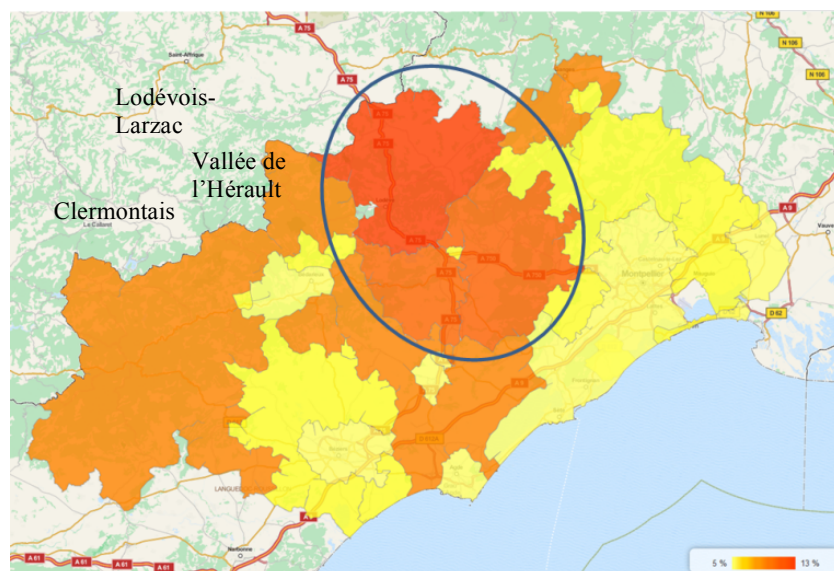
Changes in the population and its spatial distribution drive the needs for housing and daily mobility. The population growth scenarios are entered exogenously for the whole territory, while the population distribution on this territory is forecasted by analyzing past residential mobility practices according to household structure and standard of living.

Users can also specify new locations within the community for services and shopping facilities: the software integrates these locations for mobility analyses by calculating new kilometric and temporal accessibilities, and modal means of transport.

However, EQUITEE is not a real Land Use and Transport Interaction software: the software does not estimate impacts of new transport infrastructure (such as railway stations, new

1. National institute of statistical and economic information.

2. IRIS level, which is the most detailed geographical statistics available in France from the 1999 general population census.



Figures 2. Fuel poverty rate in housing.

roads) on urban sprawl. It also does not address new distribution of jobs in the territory.

The development of the tool is implemented in partnership with the urban community of Mulhouse and Lorient to validate the choice of segmentation and the results compared with existing data from their services, their planning agencies and their energy agencies. The results were also validated, particularly for the residential sector, in the context of the work undertaken for National Agency for Housing Improvement (ANAH).

Urban planning project for the Territory of “Coeur d’Hérault”

EQUITEE is being used to accompany the regional planning initiative in “Coeur d’Hérault”, a territory between the city of Montpellier and the Larzac Plateau in the Southeast of France. This territory of about 70,000 inhabitants faces a rapid growth in population, and strong urban sprawl. Real estate needs compete with those of the preservation of agricultural and natural soils. The challenge for “Coeur d’Hérault” is to articulate – in theory and practice – energy transition and achievement of Factor 4, while reducing inequalities and fuel poverty, through land planning, and policies dedicated to habitat, mobility, social and environmental issues.

The study highlights the need to adopt a dynamic approach in the treatment of these vulnerabilities, to reflect migration and residential mobility.

As a result of (i) low income households in the hinterland (ii) type of housing stock, and (iii) heating requirements that increase due to climate as we approach the Larzac and the Cévennes, the territory of the “Coeur d’Hérault” is particularly affected by fuel poverty.³ Figure 2 highlights the vulnerability of Lodévois-Larzac (in the north of the territory) where 13 % of its population is living in fuel poverty: this area is three times



Figure 3. Profile of Households in fuel poverty.

more vulnerable than the major cities of the Department. In a few communities, this fuel poverty rate even extends to more than 30 % of households.

Analysis of profiles of households living in fuel poverty (Figure 3) underlines the predominance of elderly homeowners, but also the specificity of Lodévois-Larzac (middle bar), which is facing greater vulnerability of low income households under 65 years old.

In addition to the fuel poverty related to housing, we analyze the proportion of households spending more than 10 % of their disposable income for their daily mobility: for work, school, shopping and other purposes. In this hinterland territory, which is facing a deficit of public transport infrastructure, the use of cars is predominant, with long distances, and there-

3. According to the Energy Effort Rate (Grenelle de l'Environnement): a household who spends more than 10 % of its income on the energy costs of its housing is facing “fuel poverty”.

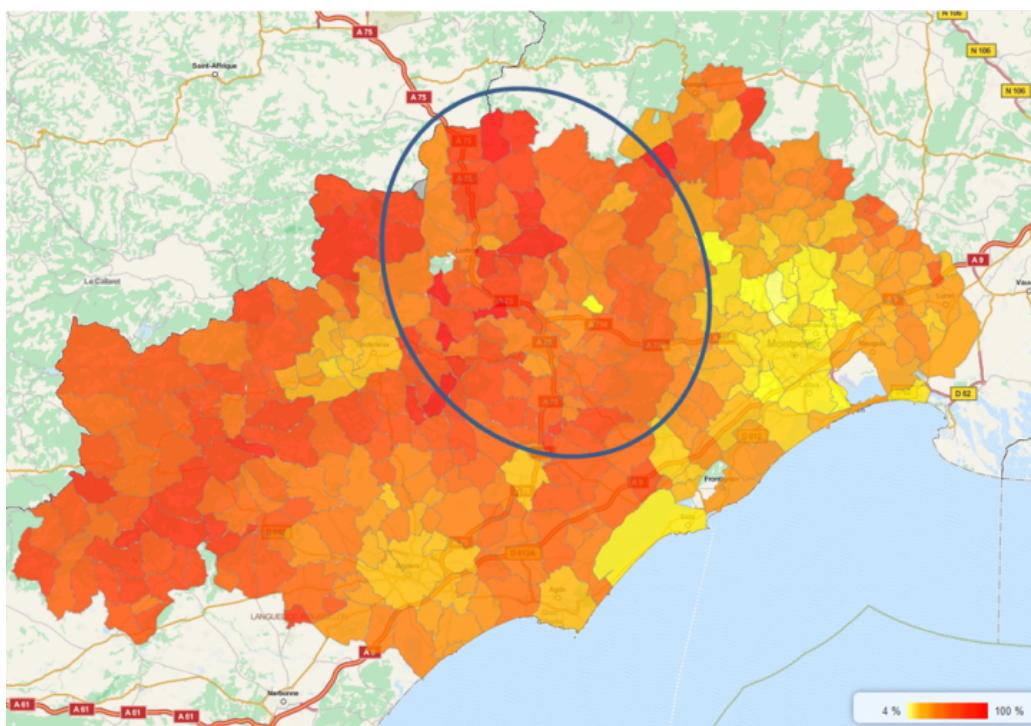


Figure 4. Fuel poverty rate due to daily mobility.

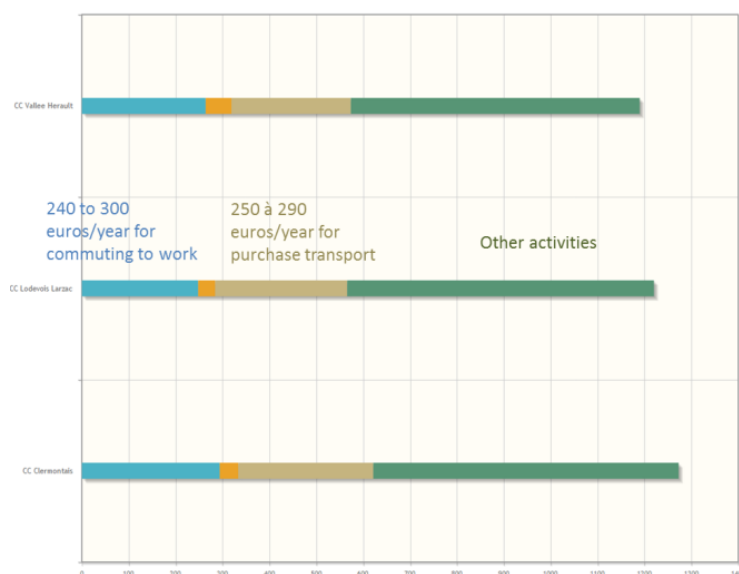


Figure 5. Fuel poverty rate due to daily mobility.

fore a high budget for transport. These distances are directly (i) related to the localization of workplaces in the territory, and (ii) dependent on the accessibility of services and commercial facilities in each living area.

Processing the data of the population census for the territory of “Cœur d’Herault”, we determined that the average distances to the workplace range between 30 and 45 km, whereas they are only a few kilometers within large metropolitan areas. The cities of Gignac, Clermont l’Herault, and Lodeve, located on highway or expressways, allow these long-distance but short duration commutes (less than 35 minutes).

With only few hyper- and supermarkets located in these 3 cities, distances to commercial facilities also range from 1 to 17 km depending on residence location. The notion of “loop of displacement”, which means to combine job⁴, scholar and shopping displacements, was not considered.

Consequently, average expenditure for daily mobility is between 1,200 and 1,300 euros per year per person. 50 % of these expenditures are “necessary and obligatory” for work, school and shopping. And thus, between 20 and 80 % (according to location) of households spend more than 10 % of their financial resources for their mobility.

Figures 6 and 7 present a social analysis of residential migration according to the income of new residents: households that dispose of high financial resources are attracted to the inner suburbs of Montpellier (Figure 6) whereas households with low financial resources refuted are relegated to the troubled neighborhoods of Montpellier and the suburbs (Figure 7). This kind of segregation (low income in the North-West and high income in the South-East) is the consequence of (i) the proximity to jobs and amenities in Montpellier and (ii) the upper and middle classes who look to acquire detached homes with gardens near this major city. Farther out, low-income households who can no longer afford to live inside Montpellier or don’t want to live in troubled inner-city neighborhoods are installed.

The prospective analysis consisted in extending construction patterns of new buildings observed during the past decade as well as patterns of residential migration according to population profiles. The analysis also incorporates trends for renovations according to household profiles, substitutions of equipment and energy prices.

4. But inactivity rates are important in these territories.

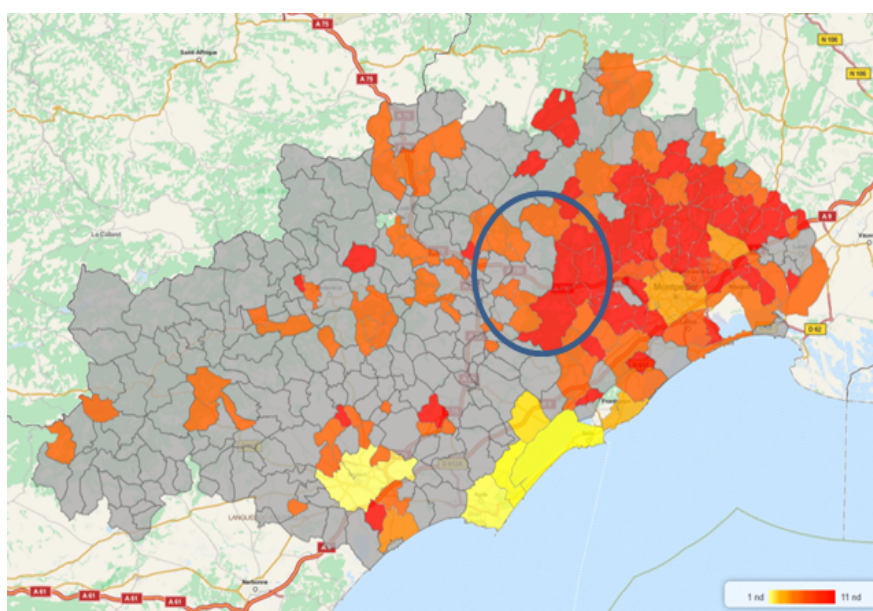
The results show divergent trends with regard to resilience and sustainability:

- Greenhouse gas emissions fall substantially in the Lodévois (-20 %, mainly due to substitutions of obsolete heating systems), while the decrease is significantly lower (-4 %) in the Vallée de l'Hérault that faces a major population growth through migration.
- Fuel poverty in habitat increases in Lodévois (+2 % or in numbers +400 households), which is welcoming poor new inhabitants; while it drops (-1 %) in the Vallée de l'Hérault where richer new inhabitants are welcomed.

The lessons learned are important with regard to planning strategy, and underline three axes for action:

1. How to promote social diversity in the east of the territory (Vallée de l'Hérault):

- Through densification of existing neighborhoods (like the Build In My Back Yard program, where smaller blocks are less expensive than larger ones and thus more affordable for low-income households).
- By accepting higher rates of public and low-cost housing in this sector.
- Through the development of land management by public authorities, to avoid widespread new housing, and supervise scheduled operations planning.



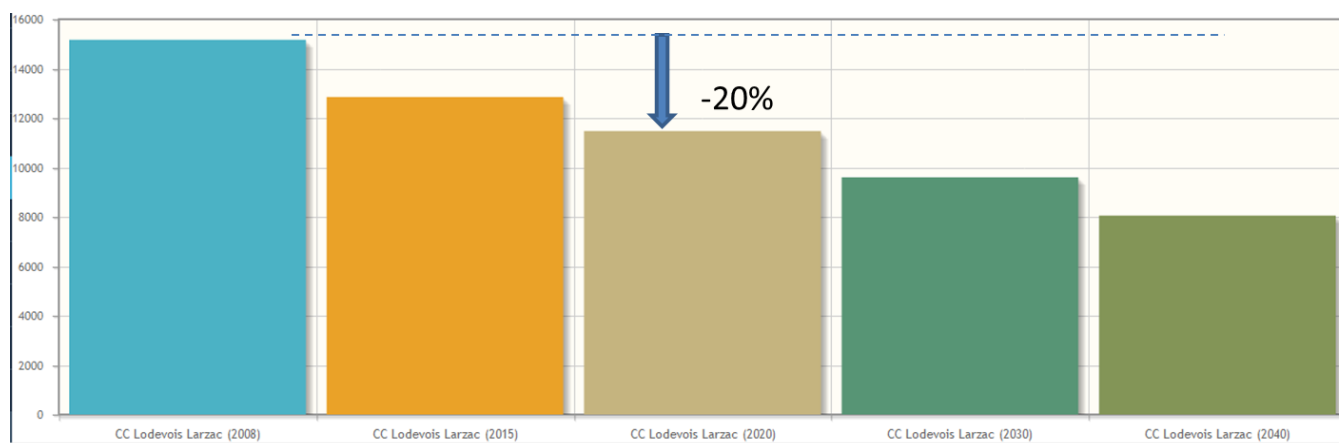


Figure 8. Decreasing greenhouse gases emissions, from 2008, 2015, 2020, 2030, 2040 in Lodévois.

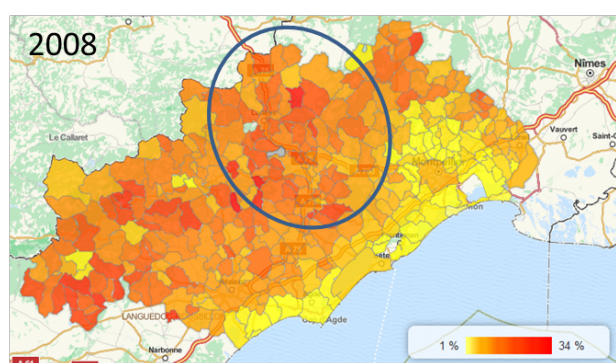


Figure 9. Trends for fuel poverty rates in housing, 2008 in Coeur d'Hérault.

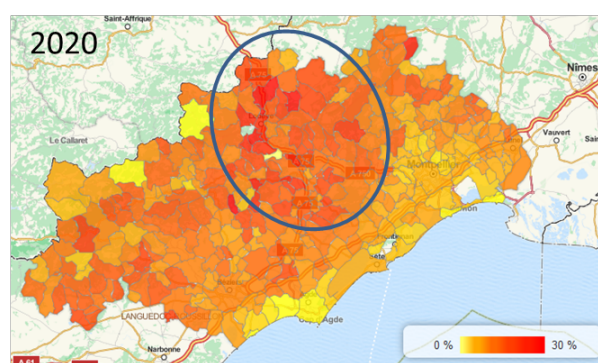


Figure 10. Trends for fuel poverty rates in housing, 2020 in Coeur d'Hérault.

2. The second axis is how to improve the living conditions of poor households in the west of the country (Lodévois-Larzac).

- With a refurbishment of the building stock especially in this part of the country welcoming a large part of low-income or inactive households (on the contrary of the Eastern territory, where the dynamics of the property market tend to support renovations, thanks to active and high-income new habitants).
- By imposing criteria for maximum energy efficiency renovations in the Eastern territory.

3. And finally, the third axis is how to deal with the reception of a new population, in improving the resilience of the territory thanks to its infra- and superstructure development:

- By strengthening the commercial development scheme (political planning of new shopping and business areas) in the rural North West part of the territory.

Sectorial action plan: fuel poverty in the urban community of Lorient

The most recent estimate concerning households that suffer from fuel poverty due to housing energy expenditures reaches nearly 15 % of the metropolitan French population; 22 % of the population is in fuel poverty either for housing or neces-

sary daily mobility costs (National institute of statistical and economic information, January 2015). These estimates far exceed the number of households assisted by national and local programs aimed at attacking fuel poverty.

In the urban community of Lorient, 8,400 households are estimated to suffer from fuel poverty, nearly 10 % of the territory's population.

Among these households, the impact of a major renovation program was modeled thanks to EQUITEE software with the objective of reducing the energy bill below 10 €/m² (related energy savings of 35 % in the context of Lorient). The model shows that this type of program implemented in the private residential stock would get 65 % of households (5,400 households) out of fuel poverty. Applied to the public sector, 10 % more households could be lifted out of fuel poverty. 25 % of the households would remain in fuel poverty, despite the major renovation of their homes, either because of the inadequate surface of the housing compared to the size of the households (1,500 households), or because of too few resources (900 households).

Our findings point towards strategic directions in terms of action, but these strategies must be balanced against eligibility and feasibility criteria:

- Although 8,400 households are in fuel poverty, the implementation of the standard program Habiter Mieux (national refurbishment program), whose effectiveness has

been proven in the individual residential dwellings stock, would be effective for only 3,800 households. Among these “targets”, over two-thirds have a reference person over 65 years, who may be reluctant to make major and *intrusive* renovation work. This consideration of the sociological profile of the occupant would lead to major renovations of 1,200 homes, and first substitutions heating equipment for 2,600 dwellings.

- The diffusion of a refurbishment program within the collective residential dwellings stock, which would still leave 1,600 households in fuel poverty, is strongly constrained by (i) the technical difficulty to act in collective buildings, (ii) the difficulty of convince condominiums to initiate proceedings, and (iii) acceptance of regulated rentals to receive aid of ANAH.
- More than half of the households in fuel poverty have moved within the last 5 years. This fact would justify a reflection to develop a strong incentive for renovation at the time of change of occupant in urban areas. This obligation or a strong incentive could be conditioned by limited rents linked to minimum comfort.
- Among households living in detached houses, residential mobility is lower: the vast majority of households in fuel poverty in this individual dwelling stock have moved there over 10 years ago. This finding penalizes refurbishment commitment which generally occurs following the arrival. It also exacerbates mismatches between the surface of the housing and the size/resources of a household due to aging or departures from spouses or children. Thus, with housing of about 130 m², the size of the accommodation is a cause for fuel poverty for more than 1,100 households for occupants under 65, and nearly 300 households over 65. For these households, it seems pertinent to consider programs acting on the adaptation of housing to the actual needs of occupants: temporary isolation rooms, Housing Division, co-tenants, or relocation assistance (in possible contradiction with strategies of home support for seniors).
- Residential migration patterns show a large share of households moving to the city of Lorient or towards the “hinterland” along the main expressway. An analysis of the profiles of households who moved in the last five years in these hinterland towns highlights the high proportion of households with very low and modest financial resources, especially in old houses: 30 to 60 % of newcomers.
- This finding emphasizes the multiple energy vulnerability of populations of these territories for housing and transport. Nearly 50 % of households in multipolar territories⁵ already spend more than 10 % of their disposable income for everyday mobility, in contrast to nearly 10 % of those living in the major urban centers.
- Thanks to a theoretical simulation made at national level, even if there was a 10 km limit imposed on commuting, it would not improve energy vulnerability linked to transportation for more than 30 % of vulnerable households, for which work-related commuting does not constitute the majority of trips). The “provision” of efficient vehicles (ca. 4 l/100 km) would be the most effective path to treat approximately 80 % of transport vulnerabilities.

Conclusion

The use of EQUITEE software makes it possible to draw operational diagnoses concerning energy consumption, greenhouse gas emissions and the vulnerability of territories and their populations. These diagnoses and forecasting simulations question (i) the strategy for territory planning, and (ii) the scope of existing programs against fuel poverty. They emphasize, with a systemic view, the impact of residential mobility and migration on the development of the vulnerability of territories:

- Consequences of welcoming populations in vulnerable territories facing dilapidated housing and low accessibility;
- Associated action plans to fight against fuel poverty in housing and mobility:
 - construction permits planning,
 - aid for improving the energy performance of the building stock,
 - personal assistance policies,
 - political support in the adaptation between a housing (type and size) and its occupant,
 - localization of new commercial services and business areas,
 - public transport policies targeting modal shift,
 - actions to support the provision of efficient vehicles when the use of public transport is inadequate.

The software permits to quantify and guide the nature and location of optimal actions.

EQUITEE finally brings together all the tools required to manage land use programs and helps to plan and to monitor the spatiotemporal penetration of actions, to measure their impacts and compare the expected goals.

For future developments, EQUITEE should be completed with a Land Use and Transport Interaction software.

Endnotes

Licence:	mode SAAS
Technical system:	AIGLE
Data bases:	INSEE (RGP, ERFS, BPE, STETS), SITADEL, CORINE LAND COVER, AGRESTE, EACEI ...
Results:	.CSV, .SHP

5. A multipolar territory is dependant of several and remote areas for work and shopping.

