

International Conference for  
**Sustainable Design of the  
Built Environment**  
**SDBE 2017**

---

*Proceedings*



*Editors*

---

*Heba Elsharkawy*

*Sahar Zahiri*

*Jack Clough*



**SDBE**  
Sustainable Development  
of the Built Environment



University of  
**Strathclyde**  
Glasgow

# Towards a sustainable renewal of peri-urban neighbourhoods of single-family houses in Switzerland

Judith Drouilles, Sophie Lufkin, Emmanuel Rey

Laboratory of Architecture and Sustainable Technologies (LAST), Institute of Architecture (IA), School of Architecture, Civil and Environmental Engineering (ENAC), Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland, [judith.drouilles@epfl.ch](mailto:judith.drouilles@epfl.ch)

**Abstract:** Resulting from the society shift of the post-war period, urban growth and urban sprawl of infrastructure and settlements of individual housing are today at the centre of public policies' focus, in particular due to their widely criticized environmental impacts. If sustainable urban planning strategies aim at avoiding the construction of new peripheral residential developments, few studies question the future evolution of existing peripheral neighbourhoods – although their inhabitants will face increased economic, social and environmental issues in the coming decades.

The on-going research presented in the paper investigates the possibility of a sustainable renewal of peri-urban neighbourhoods of single-family houses in Switzerland by 2050. In this framework, the paper first defines the research framework characterized by the recent evolution of public policies. The revision of the territorial planning law (LTP) of 2014 intends to reorient future urban developments toward existing and well-connected built-up areas. The 2050 energy strategy and the “2000-W society” vision provide a framework to consider the overall energy transition in Switzerland, as well as specific targets to reduce households' overall energy consumption. Then the study presents the design framework of peri-urban renewal paths. It relies on the identification of peri-urban residential municipalities within the Swiss territorial context, and the elaboration of a pre-operational typology of peri-urban neighbourhoods of single-family houses. Finally, the paper presents four design scenarios based on a wide literature review and a series of interviews with urban planning and architecture experts to undertake a feasible renewal of existing peri-urban neighbourhoods of single-family houses by 2050.

**Keywords:** Peri-urban residential areas, policy framework, energy transition, design scenarios, Switzerland

## Introduction

Most current projects and designs focus on denser built-up areas of the urban-regions. The compact city vision considers the well-connected urban areas and does not provide any broad renewal strategy for the peripheral areas however exposed to growing environmental pressures (Rey, 2011). Nevertheless, low-density districts are more and more coveted and considered as an important land- and construction-bank showing a non-negligible potential for the production of new dwellings. Several exploratory approaches have started investigating a potential increase in density within single-family houses developments (ANR, 2011; Beyeler, 2014). They implement soft densification strategies to avoid individual property's constraints, and focus on private and individual motivations at the scale of a dwelling or a plot, leaving aside an overall vision at the neighbourhood or municipality scale.

The on-going *Living Peripheries* research, presented in this paper, aims at offering new ideas and concepts to investigate the adaptation capacity of existing peri-urban neighbourhoods of single-family houses to social and societal evolutions by 2050. It considers both the current sustainability challenges and research limitations, in terms of lack of overall neighbourhood scale vision and absence of specifically adapted strategies.

The first section of the paper focusing on the research framework, reports the recent evolutions of the policy framework and their restrictive impacts on territorial planning. The second part presents the composition, organization and specificities of the Swiss territorial

context and the resulting typology of peri-urban neighbourhoods of single-family houses. Those elements represent the design framework for four theoretical design scenarios introduced in the last section. They envision common trends and alternative paths to adapt peri-urban neighbourhoods by the horizon of 2050.

## **Research framework**

### ***Evolution of urban-planning regulatory requirements***

Considering the extent of urban sprawl, the Swiss administration and population were pushed to implement means to preserve their living environment (Rey, 2012). The policy framework about territorial planning has consequently been adapted to protect land and landscapes as non-renewable resources. The federal law on nature and landscape protection was the first to enter into force in 1966. However, it is not until mid-2000s and the awareness of a growth of urban lands at a pace of 1m<sup>2</sup> per second that the legislative dynamic soared. The initiative “some space for men and nature”, also called “initiative for the landscape”, intended in 2007 to introduce new legislative means to control urban sprawl (Salomon Cavin, 2015). Although this attempt was unsuccessful, it set the stage for both the revision of the federal law on territorial planning (LTP), approved by referendum in March 2013, and the federal law on secondary homes which came into force on the 1<sup>st</sup> January 2016. Both laws fix a strong framework on territorial planning and aim at stopping irrational land consumption.

LTP's ambition shows a will to discontinue current planning practices. It relies on two main principles: the preservation of landscape as a strong identity reference for the country, and the regulation of land consumption. The landscape preservation depends on the management of land uses, between agriculture, forest, built-up areas and natural spaces of leisure. According to LTP, any additional land consumption must be consonant with real demographic needs, with the public transport network, and with the principle of compactness and development towards the inside. The goal is to restrain urban sprawl and to promote high quality living environments and local amenities.

Two mandatory documents guarantee the implementation of the law at local level. (1) Based on a strategic and prospective vision of the region, the cantonal master plans define the distribution of land uses at large scale. (2) In compliance with the latter, municipal affectation plans outline the precise distribution of land uses on the municipal territory. In the case of planning new urban developments, their size depends on the expected needs in terms of housing for the next fifteen years. (CH, 2013).

Each canton is responsible for the implementation of the LTP at local scale by considering their own specificities. The cantonal master plan of Vaud implies significant constraints regarding the sizing of new built-up areas, especially when peri-urban planning is concerned. The document defends the idea of a strong network of centres. The aim is to maintain a hierarchy from cantonal centres to local centres. In order to translate this goal into urban planning the Canton attributes an annual growth rate to each municipality located outside the compact built-up areas, based on a prospective estimation of future demographic evolution. A closest observation of municipalities allows the attribution of an annual growth rate depending on the types of identified areas. In the more remote areas, the annual growth rate is limited to 0.75%, but in the centre of the village or in the well-connected areas, growth rate goes from 1.5% to 1.7%. The final sizing of new urban development areas depends on a theoretical living area of 50 m<sup>2</sup> per person and a minimal

density of 0.4 (State of Vaud, 2016). For instance, a municipality, which has a growth capacity of 100 inhabitants, is able to create a new development of a maximum of 12,500 m<sup>2</sup> to comply with the minimal density of 0.4 for the creation of 5000 m<sup>2</sup> of residential (living) areas.

The revision of the LTP and its interpretation in the Canton of Vaud clearly aim at containing urban sprawl. This context raises the issues of the transformation and adaptation of peripheral territories resulting from the urban expansion processes. They are located in the less attractive areas that have been attributed low margins of demographic growth. Nowadays, density is presented as the main solution to improve sustainability. However, according to the recent evolution of the policy framework, it appears difficult that density should be an exclusive answer for the dispersed urban areas transformation.

### ***Energy transition***

Facing growing environmental preoccupations, Switzerland has redefined its long-term energy strategy through a new energy law, approved by referendum in May 2017. The law aims at insuring “a sufficient, safe, cheap and clean energy supply” by fostering renewable energies produced in Switzerland. The new law complies with the theoretical framework of the “2,000-W society” vision used as reference to envision a long-term energy transition (Novatlantis et al, 2011). It sets gradual targets to achieve a reduction of the non-renewable primary energy (NRPE) consumption by 2050 and 2150. By 2050, intermediate objectives target a NRPE reduction to a mean power per person (MPP) owing to all aspects of life of 2,000 W and an annual global warming potential (GWP) of two tons of CO<sub>2</sub> equivalents (CO<sub>2</sub>e) per person. By 2150, the overall MPP should reach 2,000 W of primary energy (PE) including 500 W of NRPE and GWP should be limited to one ton of CO<sub>2</sub>e per person per year.

“The efficiency path for energy” (SIA, 2011) provides the normative framework for the energy transition of the built environment towards the 2050 horizon. It relies on specific targets for each building type and three categories of environmental impacts: (1) the building construction and materials (embodied impacts), (2) the use of the building (operational impacts) and (3) the mobility of the building’s users. This policy is very demanding for dwellings located in peri-urban residential areas, commonly composed of single-family houses with a bigger living area of 117 m<sup>2</sup>. The resulting average living area per person is 46.8 m<sup>2</sup> compared to 42.4 m<sup>2</sup> in urban centres (Fig. 1). Regarding mobility, the 2010 micro-census on mobility and transports (FSO et al, 2012) results show that peri-urban residential municipalities’ inhabitants have the most energy demanding mobility, with an average daily distance of 45.5 km and an almost exclusive recourse to individual car (73% of the travelled distances) (Fig. 2).

The challenge extent to reach the intermediate targets in the scope of the “2,000-W society” requires both a transformation of the dwelling stock, in terms of new construction and renovation projects, and an improvement of mobility practices. A previous study, which still has some ongoing developments, investigated the question of the compliance to the intermediate targets through a series of prospective theoretical scenarios (Drouilles et al, 2017a). It highlighted on the one hand how current construction practices combined with a reduction of the living area per person were able to meet the requirements. On the other hand, it showed how an evolution of lifestyles was essential to achieve the drastic reduction of the energy consumptions owing to mobility, along with the improvement of technical aspects.

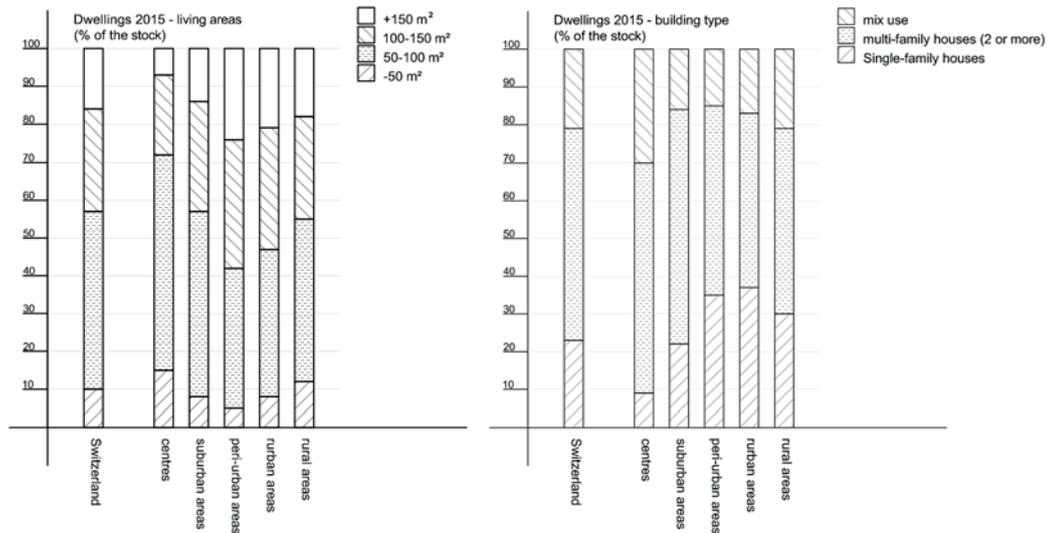


Figure 1. Dwelling stock features by territorial entity (FSO, 2015)

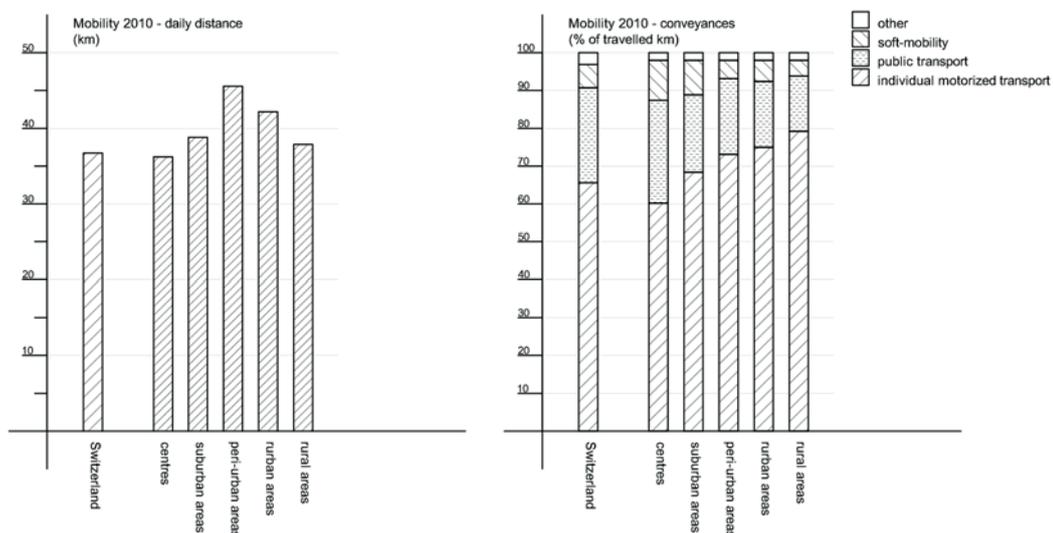


Figure 2. Mobility features by territorial entity (FSO et al. 2012)

## Design framework

### *Urban features in Switzerland*

In Switzerland, 84% of the population lives in urban areas among the 49 urban regions and 28 isolated cities (FSO, 2014). The urban continuum from Geneva to St. Gallen, encompassing Bern, Basel and Zurich (Fig. 3), bears witness to the metropolization process (Rey et al, 2015). The Alpine forests or peaks, unsuited for urban development, represent 58% percent of the 41'285 km<sup>2</sup> of the country. Therefore, most of the population gathers on the Swiss Plateau (from Geneva to St. Gallen). Given those peculiar topographic features, land is a limited resource to preserve.

In order to understand better the urban territories organization and diversity, the Swiss Federal statistical office (FSO) and the territorial planning office (ARE) built a new typology of "municipalities with urban character" in 2012 (FSO, 2014). The definition delimitates a wider buffer zone between urban centres and countryside areas. The

proportion of working commuters is the functional criteria used to identify the influence of the urban region on the territory. The newly delimited peripheral zone gathers the ‘urban-region’s other municipalities’, i.e. all the built-up areas dispersed outside the compact urban areas.

### ***Peri-urban residential municipalities***

The fast evolution and growth of cities leads to the constant redefinition of what is urban. In this context, the delimitation of a peri-urban territorial entity becomes a delicate question. The generalisation of urban areas due to the settlements’ dispersion and the progressive disappearance of the city/countryside duality are recurrent topics of debate (Schuler et al, 2004). Therefore, peri-urban areas have acquired a quality of buffer zone or “in-between” that makes the definition task harder (Sieverts, 2004; Da Cunha et al, 2015).

To clarify our words, let us briefly look at the vast territories of the “urban region’s other municipalities”. This category qualifies a buffer zone between two very distinct territories: (1) central and suburban municipalities, with an average density of 1’050 inhabitants per km<sup>2</sup>, and (2) multi-orientated or rural municipalities where the average population density is 70 inhabitants per km<sup>2</sup> (Fig. 3). The whole of the category is qualified as ‘urban’ although it clearly gathers a great diversity of areas. Current definitions underline the lack of concepts to understand the features of the peri-urban areas, which are neither entirely urban nor entirely rural.

To bridge this gap, our research project aims at building a subcategory within the “urban region’s other municipalities” category. Based on the state of the art of the peri-urban question, we listed six main mandatory components for the delimitation of the peri-urban residential municipalities (Tab.1) (Drouilles et al. 2017a). The goal was to target areas representative enough and under enough pressure to justify the design of transformation scenarios for the 2050 horizon.

Table 1: Identification criteria of the peri-urban residential municipalities

<b>Criteria</b>	<b>Description</b>	<b>Source</b>
1	Located within the urban-region’s perimeter	[FSO, 2014; INSEE, 2015]
2	More than one third of the working population commutes to the urban centre	[FSO, 2014; INSEE, 2015]
3	Located outside the compact built-up areas of the centre	[FSO, 2005]
4	Population density higher than 150 inhabitants per km <sup>2</sup>	[OECD, 2011]
5	More than 50% of single-family houses within the building stock	[Bauer et al, 1976; FSO 2005]
6	Population growth between 1950 and 2000, at least 30% in 10 years	[Garnier, 1984; EEA, 2006]

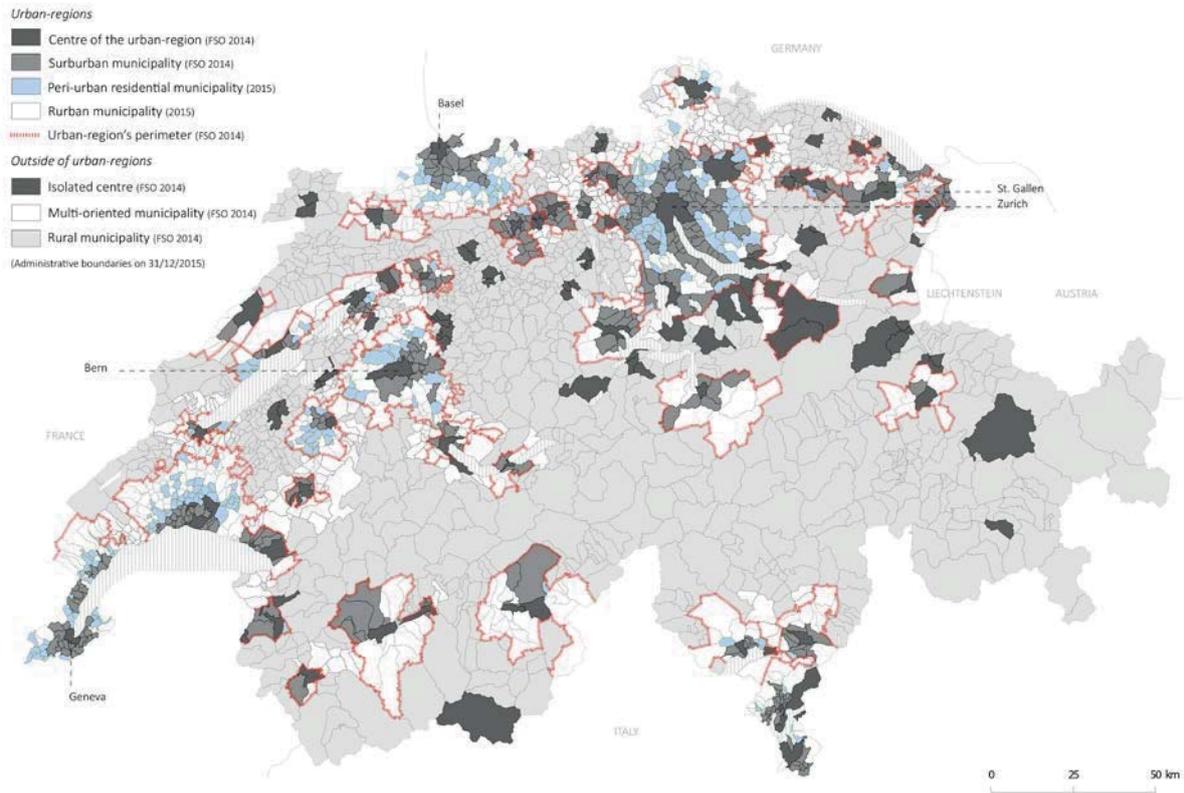


Figure 3. Swiss territorial entities and peri-urban residential municipalities. (FSO, 2012)

### ***Typology of peri-urban neighbourhoods of single-family houses***

Considering the challenges and constraints faced by single-family houses, several current studies investigate their future both from the point of view of the building's transformation (Beyeler, 2014) and from the conditions of their permanence in the territory (Bosshard et al, 2014). Designing evolution projects for those areas appears as the next coherent step of the research about the future of the dispersed urbanization. It is the ambition of the *Living Peripheries* research project to propose a decision support on the future of the peri-urban neighbourhoods of single-family houses based on the design of prospective transformation scenarios at neighbourhood scale.

A research by design workflow requires a strong framework to be reliable on and reproducible in further studies. In the scope of the *Living Peripheries* research, we chose to elaborate a typology of peri-urban neighbourhoods of single-family houses as a pre-operational tool. A pre-operational tool does not aim at building new knowledge but it rather provides a framework for an efficient design process (France, 1981). In order to do so, after the inventory of 138 neighbourhoods of single-family houses in the identified 38 peri-urban residential municipalities of the Lausanne's urban region, we built a typology based on three criteria – the distance to the closest train station, the date of the neighbourhood's first constructions and the neighbourhood size (Drouilles et al, 2017b). Those criteria influence the design process as explained below. (1) Depending on the location and the integration to the public transport network, LTP allows a higher growth rate to encourage the densification of the areas that benefit from a better accessibility. Moreover, the distance to the train station influences the type of alternative mobility scenarios proposed in a neighbourhood: soft-mobility means could be fostered rather than a heavier public

transport. (2) The current energy performance and future retrofit actions depend on the buildings construction period, in relation to the building age and the implementation of energy requirements. The neighbourhoods started in the 50s-80s are in a more urgent situation, considering the poor performance of buildings from this period (Institut d'architecture TRANSFORM, 2016). (3) The neighbourhood's size and population influence the design possibilities: more dwellings and population signify a higher demand in terms of equipment, mobility and amenities.

The resulting typology applied on the peri-urban residential municipalities of Lausanne gathers five types of neighbourhoods of single-family houses (Tab. 2). From each type, a representative neighbourhood was selected as case study to implement and assess several design scenarios to consider a peri-urban transition by 2050 (Fig. 4).

Table 2: Typology of peri-urban neighbourhoods of single-family houses in Lausanne classification criteria and average reference values (*n.* = neighbourhoods)

Criteria	Type 1	Type 2	Type 3	Type 4	Type 5
Distance to train station	< 1 km		> 1 km		> 1 km
First constructions	1950 - 1976		1950 - 1976		1976 - 2000
Neighbourhoods' size	> 5 ha	< 5 ha	> 5 ha	< 5 ha	< 5 ha
<b>Average values</b>	11 n. - 9%	8 n. - 6.5%	35 n. - 28%	43 n. - 35%	18 n. - 14.5%



Figure 4. 5 types of peri-urban neighbourhoods of single-family houses in the urban region of Lausanne. Each type is shown on a 500m x 500m square.

### Considerations for the future

The elaboration of four theoretical design scenarios for peri-urban neighbourhoods of single-family houses (Fig. 5) relies on several methodological steps. First, the elaboration of the typology allowed a better understanding of the Swiss context and the territorial integration of the peri-urban neighbourhoods. Then a literature review on societal medium term prospective evolutions revealed some common trends and strong signals (DATAR 2010; Moreau 2014; Kaufmann and Ravalet 2016). Based on those initial steps, we designed some exploratory propositions that were partly comforted, invalidated or completed by a series of interviews conducted in winter 2016 with fifteen urban planning and architecture experts. Finally, about 250 questionnaires distributed in spring 2017 among the five case studies, enriched the observation's findings. The final outputs provided a strong framework for us to enunciate four theoretical design scenarios for the adaptation of peri-urban residential

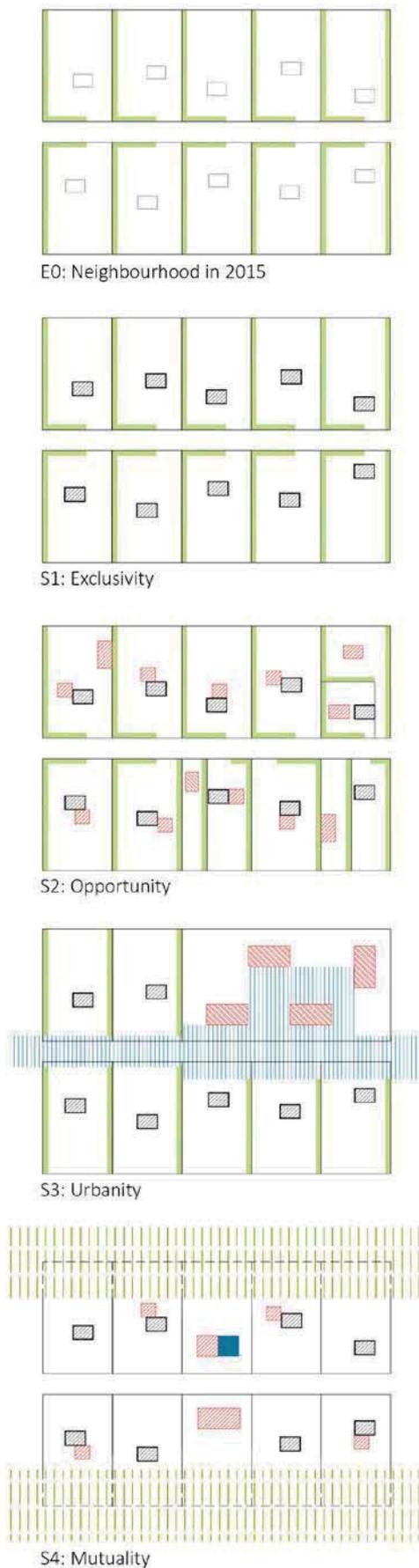


Figure 5. Theoretical design scenarios

neighbourhoods for the 2050 horizon. The scenarios rely on a proactive approach, which does not seek completeness but rather aims at being operational and feasible.

### **Exclusivity**

The scenario “Exclusivity” (Fig. 5 – S1) considers that single-family houses will become a kind of exceptional property in the context of the LTP’s application. According to the Canton’s strategy, urban development dynamics concentrate new constructions in the central area of the villages to ensure maintaining its vitality. The relative share of single-family houses in the dwelling stock is slowly decreasing to the advantage of denser constructions. These new dynamics will transform single-family houses into rare properties that are affordable only by the wealthiest households.

The scenario foresees a demographic stagnation and aims at the conservation of the exclusive and individual aspect of the neighbourhoods of single-family houses. Being an exceptional property, a single-family house represents a patrimony to be preserved. Therefore, the owners will try to maintain the value and identity of their property avoiding any subdivision of the plot or any excessive modification of the building. In most cases, the houses will only be renovated to comply with legal energy performance requirements. At neighbourhood scale, the investments are minor since the inhabitants’ lifestyles remain self- and dwelling-centred.

### **Opportunity**

The scenario “Opportunity” (Fig. 5 – S2) follows a mechanism of soft densification according to the current practice. It implements a neighbourhood renewal and relies on each plot opportunities. Each owner is the principal actor in the process. They assess their own individual needs to reduce or increase the living area, build a new independent settlement, subdivide their plot, or create a revenue stream.

Individual and private interests guide the transformations in this scenario. For this reason, the effects on demography are difficultly assessed

and controlled. The scenario implies the current life-styles perpetuation, but a higher social and functional mix is possible. Mobility practices still mostly depend on individual cars although some households, more sensible to environmental issues, could recourse to alternative conveyances.

### ***Urbanity***

The scenario “Urbanity” (Fig. 5 – S3) assumes a strong municipal involvement in the neighbourhood renewal. To address the specific issues of neighbourhoods of single-family houses – linked to economic limitations and constraints when selling or inheriting – a neighbourhood planning is developed from an analysis of the plots’ features and their economic implications.

This scenario refers to current practices in urban design and applies them in the peri-urban context. The neighbourhood renewal focuses on the development of a public polarity that works as an urbanity landmark and meets dwellings and equipment demand by (at least) 2050, in the framework of the LTP’s requirements. The feasibility of this scenario depends on a sufficient capital gain to finance the improvement of public spaces (e.g. increase of the pedestrian free flow, creation of public parking spots, etc.).

Neighbourhood planning allows a long-term prevision of needs as well as the intake of adapted solutions in terms of dwellings, equipment and services. The scenario also includes a mobility plan, which implements an alternative network with bike- and car-sharing systems. It aims at enabling the access to the railway network and reducing the car dependency.

### ***Mutuality***

The scenario “Mutuality” (Fig. 5 – S4) considers the peri-urban areas as laboratory to develop different concepts than those commonly applied in the current practice of urban design. This scenario questions the neighbourhood’s relation to its immediate environment, i.e. natural, agricultural and forest areas that surround it. It foresees a demographic growth according to LTP’s requirements.

Two main objectives of this scenario are an improved landscape integration and the development of shared activities. The landscape integration is achieved through the protection and the mutualisation of land to increase biodiversity and improve local food production. The feasibility of this scenario depends on the implementation of land and economic compensation mechanisms for the owners whose property loses value in the process of sharing and preserving soils. This compensation could consist in building bonuses or land compensations elsewhere in the neighbourhood, in an area more suited to receive higher density projects, e.g. closer to the historic built-up areas of the village centre.

The increase of shared activities in the neighbourhood relies on the development of several specific reference spaces used as associative or community rooms and involves communication and pedagogy activities to disseminate sustainable practices among the neighbourhood’s inhabitants.

### **Conclusion**

Current approaches supporting the built environment sustainability aim to encourage densification and urban renewal processes in the urban-region’s most attractive sectors. Numerous projects bear witness to the vitality of centres’ urban transition. However, it is unclear what the future of the low-density peripheral territories should be. They are usually

seen only as the compact and sustainable city's negative, but those territories are actually under strong constraints when considering environmental, social, energy or economic issues. Moreover, the solutions developed in the dense urban areas are neither adapted to the low-density areas where, for instance, the living environment already exceeds the objectives of revegetation rates, nor recommendable since it is not viable to promote density in all areas and increase the population dispersion on the territory.

Working on peri-urban areas invites looking at things from a different perspective. In Switzerland for instance, the recent adaptation of new laws at federal level, which clearly act to limit urban sprawl, strengthens this approach. Hence, the revision of territorial planning laws reduces the possibility to create new urban areas and promotes development towards the inside. Those elements and the highly performing Swiss public transport network make Switzerland an interesting laboratory for investigating the peri-urban topic.

In this specific context, the *Living Peripheries* project questions the adaptation capacities of peri-urban neighbourhoods of single-family houses through design. It considers several evolution paths from a stagnation and pursuit of current trends, to a transition towards new peri-urban forms. Four theoretical design scenarios assume four feasible paths to implement by 2050. The scenarios "Exclusivity" and "Opportunity" assume that the peri-urban neighbourhoods will stay outside the metropolitan development dynamics, either because the developments happen elsewhere or because the internal growth remains uncontrolled. The scenarios "Urbanity" and "Mutuality" assume both a connection to the larger scale through an overall planning and a proximity redevelopment with the implementation of local amenities.

The research innovates by considering peri-urban residential municipalities as experimentation sites and by designing scenarios at neighbourhood scale. Regarding the design scenarios' implementation into five real peri-urban neighbourhoods, a multi-criteria approach is used to achieve the integration of land, economic and temporal constraints. Within the timeframe of 35 years and adapted to each case study, the design options assume a population growth, a retrofit dynamic and economic constraints within the framework set by public policies and territorial features.

Following this design phase, each variant is assessed according to a series of sustainability indicators in order to provide a decision support to consider some sustainable peri-urbanism paths for each type of neighbourhoods. Based on the specific features of each types and each neighbourhoods, the research's next steps will show whether the peri-urban neighbourhoods of single-family houses are able to undertake adaptations that would benefit the community resilience to changes owing to a shift towards more sustainable behaviours, practices or lifestyles.

## Acknowledgement

This research is supported by the Swiss National Science Foundation in the framework of the "*Living Peripheries*" project (Project n°100013\_152586/1).

## References

ANR. (2011). *Le projet BIMBY en quelques mots | Bimby » Build In My BackYard* [online]. Available from: <http://bimby.fr/2011/01/le-projet-de-recherche-bimby-en-quelques-mots> [accessed 11 November 2013].

Beyeler, M. (2014). *Métamorphose : transformer sa maison au fil de la vie*. Lausanne: Presses Polytechniques et Universitaires Romandes.

Bosshard, M., Kurath, S., Luchsinger, C., Primas, U., Weiss, T. and Helfenstein, H. (2014). *Zukunft Einfamilienhaus?: Detached houses - the future?*. Zürcher Hochschule für Angewandte Wissenschaften, ed. Sulgen: Niggli.

Da Cunha, A. and Hermann, L. (2015). Villes de l'entre-deux et entre-ville: penser l'intermédiation urbaine. *Urbia*, Intermédialités et hybridations: l'entre-ville reconsidéré(17), pp.10–18.

Da Cunha, A. and Ruegg, J. (2003). *Développement durable et aménagement du territoire*. PPUR presses polytechniques.

DATAR. (2010). *Prospective périurbaine et autre fabrique de territoires*. La documentation française. Available from: <http://territoires2040.datar.gouv.fr>.

Drouilles, J., Lufkin, S. and Rey, E. (2017a). "Energy transition potential in peri-urban dwellings: Assessment of theoretical scenarios in the Swiss context". *Energy and Buildings*, May 2017.

Drouilles, J., Lufkin, S. and Rey, E. (2017b). "Peri-urban communities in transition: transformation scenarios of neighbourhoods towards sustainability". In: *Proceedings of 33rd PLEA International conference: Design to Thrive*. Edinburgh: Network for comfort and energy use in buildings (NCEUB), pp.4787–4794.

EEA. (2006). The impacts of urban sprawl. In: *Urban sprawl in Europe - The ignored challenge*. EEA report. Luxembourg: Office for Official Publications of the European Communities, pp.28–37.

France. Plan Construction. (1981). Typologie opérationnelle de l'habitat ancien (1850-1948) : actes du colloque ("Vers une typologie opérationnelle..."), Royaumont, 10 janvier 1979 : (titre extérieur: Typologie de l'habitat ancien 1850-1948), Paris.

Frank, F. and Rey, E. (2015). "Zone Villa: Grandeur et décadence d'un modèle". *Les cahiers de l'ASPAN, Le futur de la zone villa*, pp.4–11.

FSO and ARE. (2012). *La mobilité en Suisse. Résultats du microrecensement mobilité et transports 2010*. Neuchâtel: OFS (Office fédérale de la statistique).

FSO. (2014) Espace à caractère urbain, en 2012.

Institut d'architecture TRANSFORM. Ed. (2016). Approche globale pour l'enveloppe du bâtiment : rénovation énergétique. Haute Ecole d'ingénierie et d'Architecture (HEIA) Fribourg. Fribourg.

Kaufmann, V. and Ravalet, E. (2016). From Weak Signals to Mobility Scenarios: A Prospective Study of France in 2050. *Transportation Research Procedia*, 19, pp.18–32.

Moreau, A. (2014). *Perspectives de ménages 2010-2030; Demande de logements et population active; Canton de Vaud*. Lausanne: Statistique Vaud.

Novatlantis, SIA and Swissenergy. (2011). *Smarter Living: moving forward to a sustainable energy future with the 2000 watt society*. Bern.

Rey, E. (2012). "Les démarches pour favoriser un développement territorial durable en Suisse". In: Nussaume, Y., Perysinaki, A.-M., and Sery, J., eds. *La maison individuelle: vers des paysages soutenables?* Études et recherches. Paris: Éditions de la Villette.

Rey, E. (2011). *Quartiers durables. Défis et opportunités pour le développement urbain* [online]. ARE, O. fédéral du développement territorial and OFEN, O. fédéral de l'énergie, eds. Berne. Available from: [www.quartiersdurables.ch](http://www.quartiersdurables.ch) [accessed 21 October 2017].

Rey, E. and Frank, F. (2015). "Métropolisation de la Suisse: entrave ou opportunité pour la durabilité?". *Cahier spécial de TRACES: 8e édition du forum Ecoparc*, 6 November 2015.

Rogers, R. and Gumuchdjan, P. (1998). *Cities for a small planet*. Icon Editions. Boulder, Colo.: Westview.

Salomon Cavin, J. (2015). "La Suisse s'urbanise... tant mieux!". *Cahier spécial de TRACES: 8e édition du forum Ecoparc*, 6 November 2015.

Schuler, M., Perlik, M. and Pasche, N. (2004). *Non urbain, campagne ou périphérie - où se trouve l'espace rural aujourd'hui? Analyse du développement de l'urbanisation et de l'économie en Suisse*. Berne: ARE (Office fédéral du développement territorial).

SIA. (2011). *SIA 2040 'La voie SIA vers l'efficacité énergétique'*.

Sieverts, T. (2004). *Entre-ville: une lecture de la Zwischenstadt*. Marseille: Ed. Parenthèses.

State of Vaud. (2016). 4e adaptation du plan directeur cantonal. Lausanne, Switzerland: Service du développement territorial. Available from: <http://www.vd.ch/themes/territoire/amenagement/lat-revisee/4e-adaptation-du-plan-directeur-cantonal/>.

**ISBN: 978-1-9997971-0-2**  
**Project website: [www.newton-sdbe.uk](http://www.newton-sdbe.uk)**  
**Twitter: @Newton\_SDBE**