Renewal of Walloon suburban neighbourhoods and perspectives for a research project on "suburban densification"

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Abstract
This paper addresses the challenges and conditions of a sustainability transition of suburban areas in Wallonia (Belgium), articulated around energy efficiency in the building and in the transportation sectors. Three scenarios focused on the evolution of the existing building stock are modelled and assessed (the insulation of buildings, an increase in the built density and demolition / reconstruction). Our main findings show that, beyond the traditional polarization of the debates on energy efficiency of our built environment between the "compact city" and the "sprawled city", a new pragmatic paradigm, focused on the transition of suburban areas by "densification", can make suburban areas evolve towards more sustainability. However, these main results focused on energy efficiency need to be studied in a larger framework to concretely operationalize a suburban sustainability transition. In this perspective, concrete prospects for a further research project on "suburban densification" are proposed. There address the opportunities for transnational cooperation as well as the proposition of potential research activities.

1. Introduction and context

There is general agreement that urban forms affect sustainability and that urban sprawl is a major issue for sustainable development (EEA, 2006). The impacts, causes and consequences of urban sprawl are now well documented. Urban sprawl is namely known to represent a significant contribution to the overall energy consumption of a territory, for energy needs in buildings and for transport. But although it is often defined in terms of "undesirable" land-use patterns in the scientific field (e.g. Ewing, 1994, UTF, 1999), urban sprawl also often induces lower land prices and more affordable housings (Gordon and Richardson, 1997). Moreover, low-density developments still constitute one of the preferred living accommodations (Couch and Karecha, 2006; Howley, 2009). However, continuing to promote such development model, even at very high construction standards that limit the heating energy requirements of buildings, will not help to solve numerous problems, such as soil waterproofing, car dependency or higher costs for infrastructure and collective services.

Opponents of sprawl often articulates the "compact city" model, in opposition to the "sprawled city" model, around the concepts of centrality, high density, mix use and performing urban transportation systems. They argue that more compact urban forms would significantly reduce energy consumption both in the building and transportation sectors (e.g. Newman and Kenworthy, 1999; Steemers 2003; Ewing et al., 2008,). However, although numerous research and policies pretend that it is crucial to favour compactness of cities and to thwart urban sprawl, there do not propose adequate tool or policies that could concretely be implemented to meet these goals. Moreover, several impacts linked to high compactness (such as congestion, pollution, increase of land prices, etc.) are not really addressed.

Finally, in numerous European countries, the renewal rate of the building stock is quite low (1 to 2% per year in Wallonia (Belgium)) and numerous low-density suburban neighbourhoods are already developed, which means that the main challenge to address concerns the renewal of this existing building stock and its transition towards more energy efficiency.

Urban sprawl is familiar in many European regions and particularly in Wallonia (Belgium), where 52% of the existing building stock is made of detached and semi-detached houses. Because of the personal preferences of households for single family houses with large gardens, and the regulatory framework, which allows this kind of developments to grow, urban sprawl is a concern in a large part of the regional territory. The Walloon urban sprawl presents several specificities in comparison with neighbouring regions. According to cadastral data, 50% of the census blocks have a mean housing density between five and twelve dwellings per hectare. In comparison to Flanders, where public authorities are trying to reduce the size of the plots in new developments, or in the Netherlands, where land supplies are historically limited, land pressure stay limited in Wallonia and land supplies are still available in large quantity, especially far from existing cores. Walloon suburban neighbourhoods are spread out on the whole territory according to land supplies availability and car accessibility (which is high because the transportation network is very developed all over the region).

In this context, the main objective of this short paper is to investigate the sustainability transition of existing Walloon suburban neighbourhoods, with a focus on energy efficiency both in the building and the transportation sectors. To this extend, Section 2 presents the method developed to assess energy efficiency of suburban neighbourhoods as well as an application of this method to twelve renewal scenarios representing three main possible strategies: the insulation of existing buildings, an increase in the built density and demolition / reconstruction. In Section 3, we develop further the strategy of densification by considering the opportunity to develop a new research program on "suburban densification". In Section 4, we summarize our main results.

2. The energy efficiency of suburban neighbourhoods

2.1. Method and assumptions

A method was developed to evaluate energy consumption of suburban neighbourhoods and renewal scenarios. The first part of the method allows to calculate the energy requirements for buildings and was presented extensively by Marique and Reiter (2012a). This methodology combines a typological classification of buildings, thermal dynamic simulations and statistical treatments of national censuses in order to assess the annual energy consumption for space heating, at the neighbourhood scale.

The second part of the energy assessment deals with the energy consumption for daily mobility that is assessed thanks to a performance index developed by Boussaux and Witlox (2009) and adapted by Marique and Reiter (2012b) for suburban areas. This index is expressed in kWh/travel.person and represents, for a territorial unit, the mean energy consumption for travels for one person living within a particular neighbourhood. This index takes into account the distances travelled, the means of transport used and their relative consumption rates.

Note that data used in the framework of this paper only concern home-to-work and home-to-school travels, but we could use the same methodology with data coming from in situ survey to take into account all the purposes of travel. Although there are becoming less meaningful in daily travel patterns in the Western world due to the dramatic growth in other activities (Graham, 2000), they have more structural power than other forms of travel because they are systematic and repetitive.

2.2. How to intervene in suburban neighbourhoods

Three main types of scenarios focused on possible evolutions of the existing suburban building stock are then defined, modelled and assessed to answer a first main questions: "how to intervene in suburban areas to improve energy efficiency of the existing building stock?"

The first scenario consists in improving the insulation of the existing suburban building stock without any others interventions in the existing neighbourhoods (that keep their characteristics in terms of density, diversity of functions, etc.). Five sub-scenarios (A1 to A5) are defined to capture different levels of intervention, from the insulation of the roof to a complete retrofitting of the built envelope to the “passive house” standard.

The second main scenario deals with a smooth increase in the built density of existing neighbourhoods, by the construction of new energy-efficient houses or apartments. Four sub-scenarios are defined. In B1, new dwellings are built on remaining unoccupied plots. In B2, existing plots are divided to allow the construction of new dwellings at the bottom of the plots. In B3, new dwellings (detached houses) are built between existing houses and in B4, new dwellings (terraced houses) are built between existing houses (see Figure 1 for an illustration of these four sub-scenarios).

The third main scenario is more theoretical and consists in investigating the energy efficiency of the demolition of existing neighbourhoods followed by the re-building of new ones, presenting different characteristics as far as density, urban form, diversity of functions, etc. are concerned. Three sub-scenarios are defined. In C1, the urban form of the neighborhood remains unchanged (detached houses built on large individual plots) but houses are re-built according to the actual European standard for new buildings. In the two last sub-scenarios, the number of dwellings and the built surface area remain constant but in C2 new dwellings are terraced houses (ground floor + 1 floor) organized in traditional urban blocks and in C3 new dwellings are collective apartments buildings (ground floor + 2 or 3 floors), as illustrate on Figure 2. In sub-scenarios C2 and C3, new dwellings are also built according to the actual standard for new buildings as far as energy requirements for heating are concerned.

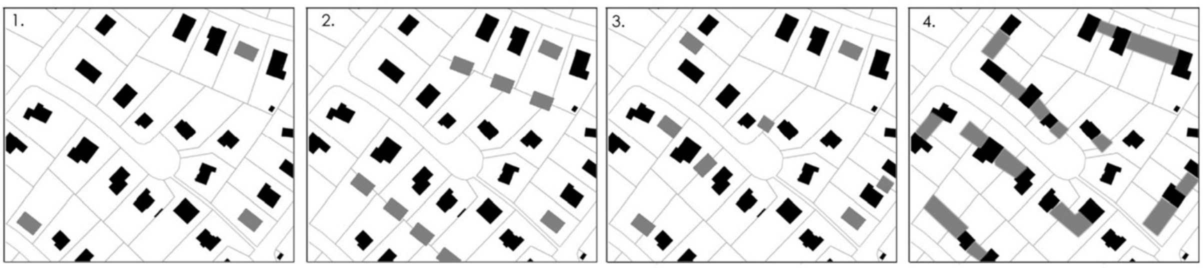

Figure 1: Sub-scenarios B1 to B4 dealing with an increase in the built density of existing suburban neighbourhoods (existing houses are in black, new dwellings are in grey).

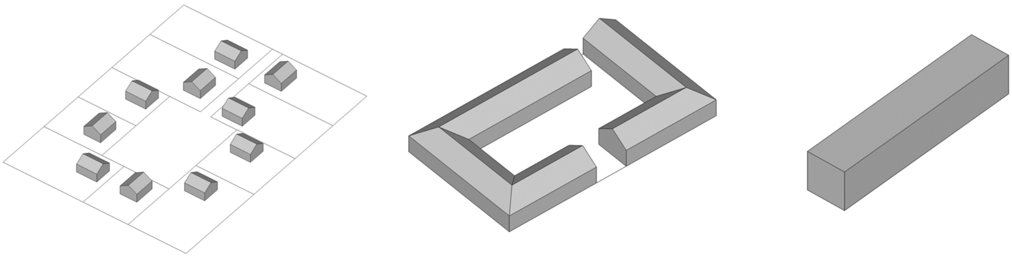

Figure 2: Sub-scenarios C1 to C3 relating to demolition / reconstruction (C1. Detached houses, C2. Terraced houses in urban block and C3. Apartment building).

Table 1: Reductions in energy consumption for heating buildings; for the twelve renewal scenarios

A.INSULATION		B.DENSITY		C.DEMOLITION / RECONSTRUCTION	
Scenarios	**Energy consumption reductions**	**Scenarios**	**Energy consumption reductions**	**Scenarios**	**Energy consumption reductions**
A1.Insulation in the roofs	-7,3%	B1.Unoccupied plots	-5,2%	C1.Reconstruction “detached houses”	-45,2%
A2.Insulation in the roofs + double glazing	-14,8%	B2.Bottom of the plots	-17,4%	C2.Reconstruction “urban blocks”	-68,1%
A3.Retroffiting to actual standard	-45,2%	B3.Detached houses between existing houses	-12,9%	C3.Reconstruction “apartment buildings”	-70,4%
A4.Retroffiting to low energy standard	-59,2%	B4.Terraced houses between existing houses	-30,4%		
A5.Retroffiting to passive standard	-89,8%				

As highlighted in Table 1, from an energy point of view, all the scenarios present interesting results (from -7,3% if only the roofs of the existing buildings are insulated to -70,4% if more compact urban forms are promoted (apartments buildings), at the actual energy requirements standard, and -89,8% if more efficient insulation standards are promoted in retrofitting (scenario A5). Combining very efficient insulation standards when reconstructing a more compact urban form will give even better results. An increase in the built density of the existing neighbourhoods allows to improve the energy efficiency of existing neighbourhoods, by the construction of houses with better energy performances than the current dwellings (B1 to B3). In B4, results are better because both the insulation of new buildings and the building distribution (terraced houses) are mobilized together. Another interesting scenario, assimilated to B4, is the building of new collective dwellings in existing neighbourhoods where large land opportunities remains available (for example, in the centre of suburban blocks that were only urbanized on their perimeter). To optimize the energy consumption reductions obtained for the scenarios dealing with an increase in the built density, it seems necessary to also improve the insulation of existing buildings. It is also interesting to mention that, for one fixed level of insulation (e.g. the actual energy requirements fixed in the European Directive on the Energy Performance of Buildings), the most efficient strategies consist in rebuilding the existing neighbourhoods in a more compact urban form (urban blocks or apartment buildings). These scenarios allow, for example, a reduction of respectively 68,1% and 70,4% while the “detached houses” scenario is related to a reduction of 45,2% only. These results highlight that, for a fixed level of insulation, the energy efficiency of detached houses remains low.

2.3. Where to intervene to limit car dependency and transportation energy consumption?

Scenarios dealing with an increase in the built density and the demolition / reconstruction of neighbourhoods cannot be recommended all over the territory. The impact of the location of the neighbourhoods on transport energy consumption must be taken into account to avoid increasing car dependency and transportation energy consumption. To this extend, an application of the energy performance index on the whole regional territory highlights the variation of transportation energy consumption according to the location of the neighborhood (Marique et al. 2013; Figure 3). The parameters that have the strongest impact on the variation of transport energy consumption are the diversity of functions in the neighbourhood and its built density. Transportation energy consumption is strongly determined by the distance travelled. Mode choice has less of an impact.

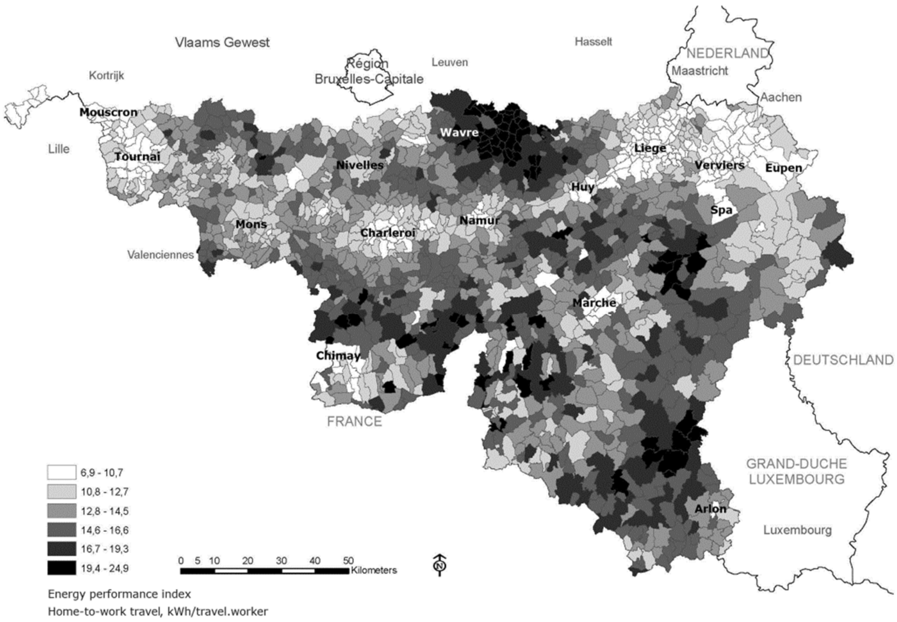

Figure 3: Energy performance index for home-to-work travel, in kWh/person.travel, at the neighborhood scale (Marique et al., 2013).

These results are finally used to try to identify the most appropriate suburban neighbourhoods, where an increase in the built density and demolition/reconstruction could be favoured without increasing the energy performance index for commuting. This simulation is based on the proximity between one suburban neighbourhood and one or more existing core, dense and presenting a great variety of functions. Figure 4 highlights, in yellow, the most appropriate suburban neighbourhoods. Suburban neighbourhoods located further from existing cores are represented in green. In those neighbourhoods, an increase in the built density and demolition/reconstruction is not recommended. Because of their location and characteristics, transport energy consumption is expected to be high. This first application of territorial prospection will be further developed, namely by taking into account accessibility criteria such as distance to train station, bus services, etc.

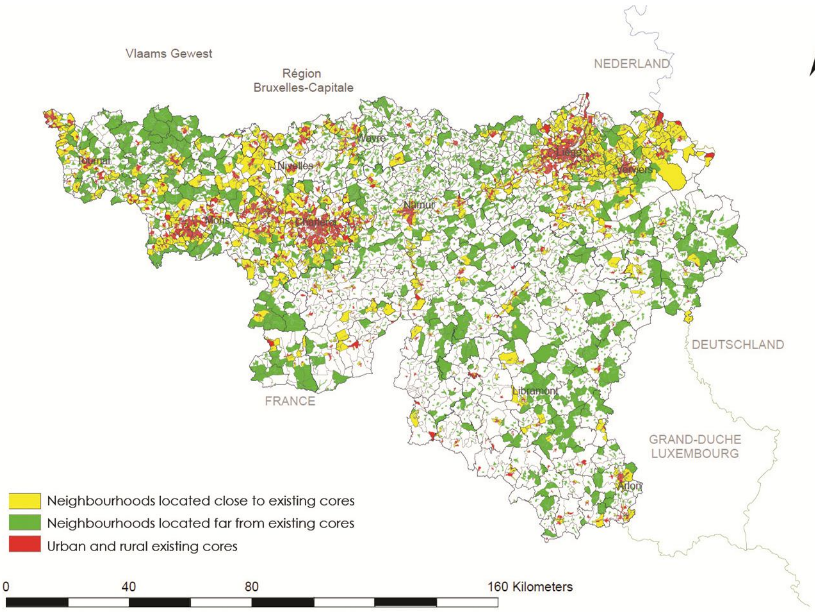

Figure 4: Suburban neighborhoods located close to an urban/rural core (in yellow).

3. Opportunities and perspectives for a research program on suburban densification and the Bimby development model

The analyses of the former section were focused on energy efficiency. In parallel to this issue, it is also important to take into account brakes and opportunities of each strategy in a broader context. As far as the insulation of existing buildings is concerned, a huge reduction in building energy consumption can be highlighted. Insulating techniques are technically possible but this strategy represents a huge cost of investment for private owners and this strategy does not allow for any reduction of transport energy consumption. As far as demolition / reconstruction is concerned, the main positive impacts are the possibility to relocate neighbourhoods and to build more compact urban forms but there are numerous brakes which seems very difficult to overpass (social acceptability, funding, adaptation of the regulation framework, impact on the whole life cycle of buildings, etc.). By contrast, when it relates to an increase in the built density of existing neighbourhoods, the strategy seems more realistic and feasible. It is in this perspective that the following of the paper will be developed, with some reflections on the idea to develop an international research program dedicated to this issue.

Our reflections on suburban densification are inspired by recent French works dedicated to the issue of Bimby, or *Built In My Back Yard*. This neologism was launched in the context of a research program financed by the French National Research Agency (ANR) (Miet and Le Foll, 2013). In this perspective, the main objective of a research project dedicated to the theme of Bimby would be to strengthen a housing development model able to make use of the large land resources available in the gardens of urban outskirts.

3.1. What can be the benefits of suburban densification and garden developments?

As highlighted in the previous sections, the densification strategy relates to a parsimonious use of the energy resources due to both, the energy efficiency of buildings and the limitation of transport needs.

In parallel, by reducing the need to extend urban sprawl into the countryside, the densification strategy also relates to a parsimonious use of land as well as to the preservation of open landscape.

It is well-known in urban economics that concavity is the dominant relationship between urban land price and parcel size (Colwell and Munneke, 1999). In other words, as lot size decreases, the total price decreases but the price per unit of surface (the marginal price) increases. As a consequence, plot division lead to create land values! With the potential added value, the densification strategy might be an efficient way to accommodate new forms of housing. Indeed, as recently put forward by Sabatier and Fordin (2012), when property owner decide to sell a portion of their land, the benefits can be used to meet housing challenges such as population ageing or building's energy performance. In other words, we see here concrete relationships between the densification scenario and the insulation scenario.

The Bimby housing development model is closely tied to self-provided housing. Self-provision can be further divided into two major forms: self-building where households put their own labour in the construction process and self-promotion where the prospective owner is mostly active in coordination and commissions a company to build the dwelling. Although sometimes considered as a primitive approach to housing provision, self-provided housing is actually a major form of housing supply in industrialized societies, particularly in North West Europe. Compared to commercial developments, self-provided has the important advantage to reduce building costs. From recent French analysis, the reduction can be estimated to 10-15% (Castel and Jardinier, 2011). The key reasons are the internalization of different tasks by the households and the absence of profit margins for the developer. As a consequence, to strengthen the Bimby development model can ease the demand for affordable housing. This benefit becomes crucial in regions with a growing number of households and in suburban belts where the issue of housing affordability is acute. Another advantage is the stronger relation with local builder and, therefore, with the local economy.

Besides the environmental dimension, the development of a project on smooth suburban intensification provides opportunities from an economic as well as from a social point of view. Although there are many reasons in favour of garden development, there are also many arguments against developing on gardens (such as increased risks of flash flooding, breach of privacy, increase in traffic, loss of habitats and biodiversity). In this perspective, the research project should not only be intended to quantitatively strengthen the development models, but also to qualitatively improve it.

3.2. An opportunity for transnational cooperation

Without contest, transnational cooperation will be very helpful in the strengthening and the improvement of the Bimby housing development. The potential interest of international cooperation in this domain relates to the great variability of garden developments thorough Europe. While building on garden land remains marginal in most European countries, recent governmental estimations show that housing construction in gardens might represent up to 25% of the UK housing production[1]. With such a situation, there is no doubt that continental planners could gain precious insights from the UK past mistakes and experiences.

[1] Source: http://news.bbc.co.uk/2/hi/8728633.stm (accessed 2 May 2013)

A key explanation of the quantitative importance of garden development in the UK is the compact city strategy. Considering this issue, Adams and Watkins (2002) distinguished between the planning objective of containment and the more ambitious planning objective of compaction. In containment policies, greenfield urban extensions of rather low densities are accepted as long as they are adjacent to existing urban areas. By contrast, the compact city objective aims to increase density and the share of building construction within urbanized perimeters or, if necessary, on selected sites directly adjacent to existing urban areas. In the 90s, British policies against sprawl have evolved with a shift from mere urban containment to one of urban compaction.

As developed by Sayce et al. (2012), the strict compaction policy has put strong pressure on English gardens. In their recent research, they notably noticed that the level of conflicts between developers and local residents (and through them local politicians) is highly dependent on planning practices, particularly the integration of house building in gardens in a coherent local planning framework.

By contrast to the situation in the UK, housing construction in gardens remains marginal in countries like France or Belgium. Due to the strong urban sprawl which has characterized those two nations in the last half-century, they definitely represent a huge potential for the Bimby development model. In those nations, urban sprawl has not been appropriately contained and large residential parcels have become commonplace in suburban spaces. By contrast, The Netherlands or Germany have developed a planning tradition that allow a more efficient use of the land resource (Sellers, 2004; Halleux et al., 2012).

3.3. Potential research activities

The issue of residential developments on gardens was explicitly considered in a pioneer paper published by Whitehand and Larkham (1991). They pointed out that, compared to urban regeneration within high-density inner-city areas, the issue of garden development has attracted little attention among scholars. They also stated that this weak interest is in sharp contrast to the great concern that such forms of development can create for the households living in their immediate vicinity. To date, despite its potential for smooth suburban intensification and urban compactness, the theme of residential developments on gardens has continued to be relatively little researched (Sayce et al., 2010). Therefore, research activities of our project will aim to shed light on the multi-facetted issue of garden developments (legal, spatial, architectural, financial, etc.) through four levels of analysis: the national-regional scale, the urban scale, the neighbourhood scale and the micro-scale.

At the national-regional level, research attention should focus on authorities with attributions in the field of planning and land policy. On this subject, a differentiation has to be made between “local” land policy and “supra-local” land policy. The former relates to the use of existing laws by local authorities while the latter relates to the action of national or regional authorities when they amend their legislations (Comby, 2013).

The urban region scale relates to the level of the job catchment areas. The aim is to identify the localities and the neighbourhoods where the densification can be the most useful to reorganize functional urban areas. At this level, priority will be given to the energy issue.

At the neighbourhood scale, a specific attention will be paid to suburban locations where former parcel divisions have already significantly transformed the physical environment. Issues such as population density, traffic movement, noise and townscape will be considered. The operational objective will be to prepare "densification methodological guides" designed for local planners and local decision-makers, to help them to judge the desirable evolutions of the suburban neighbourhoods they are in charge of. An important issue to consider is the desirable importance of demolition and high-density dwelling types (apartments).

The micro-scale relate to the level of the parcel as well as to the level of the household. A key issue relate here to the investment choices of households, in relation to the following questions: (i) what are the main reasons that lead owners to divide their plot to produce a new land supply; (ii) what are the residential preferences that push households to seek housing produced via the Bimby development model (Sabatier and Fordin, 2012)? To answer those questions, research methodologies should be developed in the different partners regions to achieve comparable results. The issue of planning regulation will also be considered at this micro-scale, by analysing procedures and requirements allowing to achieve parcel division or land readjustment.

4. Conclusions

Three main strategies focused on the renewal of Walloon existing suburban neighbourhoods (the insulation of buildings, an increase in the built density and demolition / reconstruction) were theoretically studied in the first part of this paper and showed that beyond the traditional polarization of the debates on energy efficiency of our built environment between the "compact city" and the "sprawled city", a new pragmatic paradigm, focused on the sustainability transition of suburban areas by densification can make existing suburban neighbourhoods evolve towards more energy efficiency, both in the building and in the transportation sectors. This exercise also showed the interest of including the impact of location on daily mobility in energy balances. The second part of the paper presented research perspectives articulated around a densification of existing suburban areas and presented the numerous aspects that should be addressed in a transnational cooperative research project, in order to quantitatively strengthen and to qualitatively improve suburban densification in Wallonia and elsewhere in Europe.

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