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Integration of energy issues into the design process of sustainable neighborhoods

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ABSTRACT: The increasing importance of sustainability in urban and architectural design progressively influences the conception of urban neighborhoods. Among the multiple aspects of this evolution, the reduction of global energy consumption plays a crucial role. Its full achievement involves carrying out different complementary strategies in a structured approach at the territorial, urban, architectural and constructive levels. Analyses made during the realization of the Ecoparc neighborhood in Neuchâtel (Switzerland) provide the opportunity to illustrate these multiple issues.

Keywords: Sustainable housing and neighborhood, urban wasteland regeneration, energy

1. THEORETICAL BACKGROUND

The reduction of energy consumption plays a crucial role in every strategy aiming at the sustainable development of built environment. Various complementary strategies are necessary to reach this objective, in order to act simultaneously on the different potentials of energy saving. Presenting the current profile of energy consumption in Switzerland, Table 1 illustrates the diversity of parameters to be taken into account [1]. For planners and architects, this diversity involves situating their action in a defined framework. One way to structure this approach is to analyze the problem by considering the different levels of intervention, from territorial development strategies to constructive details conception.

Table 1: The current energy consumption profile (in mean power per inhabitant) in Switzerland.

Sector	[W/pers]	P [W/pers]
Food	350	350 (5%)
Housing		2'110 (33%)
Construction	300	
Exploitation	1'630	
Infrastructures	180	
Services		1'350 (21%)
Construction	170	
Exploitation	1'060	
Infrastructures	120	
Industry		960 (15%)
Transportation		1'600 (25%)
Railway	60	
Road	1'200	
Aviation	340	
Total		6'370 (100%)

1.1 Territorial and urban scale

Different studies have shown a strong correlation between low density and energy consumption due to mobility. This relationship has notably been analyzed in the works of P. Newman and J. Kenworthy on automobile dependence, comparing different types of big cities in the world [2]. The same tendencies were observed in other research regarding different urban conurbations in Europe such as, for example, Ile-de-France or Milan [3] [4]. Recent works on urban regions in Switzerland like Neuchâtel for example, also demonstrate that a low density tends to generate more automobile use and thereby more energy consumption for mobility [5].

Taking these observations into account, planners now foster strategies based on densification principles, using the broadly unused potential existing within already built-up areas. As K. Wiliams observed, an intensification of land use is a necessary condition to reach more sustainability, but it is certainly not sufficient [6]. The strategies have indeed to integrate other parameters, notably a coordinated development of urbanization and public transportation (PT), functional mixing and promotion of high quality of life for users.

The concrete transposition of these principles could differ from one urban region to another, but the majority of planning policies integrate the notion of "strategic pole", i.e. the localization of dense neighborhoods near PT junctions and grouping of different kinds of activities (working, housing, etc.).

At the urban level, different works have demonstrated that parking strategy also plays a crucial role in promoting the use of PT [2]. It appears essential here to determine the parking capacity by considering the optimal needs of the strategic poles, avoiding commodity parking as far as possible.

1.2 Architectural and constructive scale

The integration of a global energy concept into the design process of the neighborhood - infrastructures and buildings - is necessary to reach an optimal equilibrium between user comfort and energy consumption for heating and electricity.

The first step is to act on the reduction of heating and electricity demand, notably by an appropriate definition of standards and a bioclimatic approach. The reduction of energy demand favors the integration of renewable energy devices, in order to satisfy - totally or partially - the remaining demand. The choice of the renewable energy (PV, solar captors, wood heating, etc.) could strongly differ from one building to another, its efficiency in ecological and financial terms being directly linked with the building specificity.

Parallel to heating and electricity management during the operational phase, it is also possible to reduce energy use for the construction of the building itself. This aim involves the integration of life-cycle analyses (LCA) into the decision process regarding materials, in order to avoid those leading to important environmental impacts.

1.3 User information

To say the least, the user can also play an important role in the final energy consumption. Appropriate use of the devices, buildings and infrastructures can reinforce neighborhood sustainability. Incoherent use, on the other hand, can lead to a drop in performance or to technical dysfunction. Different investigations show that the building's architecture (form, orientation, etc.) could influence the building's energy consumption by as a much as 50%, the constructive choices (thermal insulation, glass quality, etc.) by as much as 30% and the technical installations by as much as almost 80%. After these conception and realization parameters, user influence is still important, estimated as the equivalent of almost 50% (Table 2). It is judicious here to explain the building conception, especially the devices linked to passive strategies such as, for example, solar protections or openings for natural ventilation.

Table 2: Potential influence of different parameters on building energy consumption [7].

Parameters	Potential of energy saving	Influence on costs
Architecture	As much as 50%	Negative
Construction	As much as 30%	Low
Technical inst.	As much as 80%	Medium
User	Almost 50%	None

2. THE EXAMPLE OF THE ECOPARC NEIGHBORHOOD IN NEUCHATEL

Aiming at the regeneration of an urban wasteland near the station of Neuchâtel, the Ecoparc project aims to provide a tangible demonstration of sustainable densification, associating notably coherent integration of contemporary architectural expression, reduced energy consumption (mobility, infrastructures, buildings), functional synergies and quality of life in urban context. After some years of planning and monitoring, the first results are available for analyses and considerations.

2.1 Densification of a disused railway area

The Ecoparc project is realized on a derelict land of almost 4 ha and includes diversified functions such as lofts in old industrial structures, various new housing schemes (social mixing), administrative area and schools (functional mixing). The building potential of this area gives the opportunity for developing almost 85'000 m^2, including both Federal Office of Statistics (FOS) buildings [8].

Benefiting from the proximity of the railway station, the bus lines and the urban funicular and connected to existing pedestrian networks, the project promotes the sustainable mobility of the inhabitants, students and workers (Fig. 1-2). In terms of human density, it is characterized by a mean of almost 406 pers/ha, much higher than the mean of the city of Neuchâtel (97 pers/ha), which strongly confirms its vocation of strategic pole.

Figure 1: Localization of the Ecoparc Project next to the railway station (doc. Bauart).

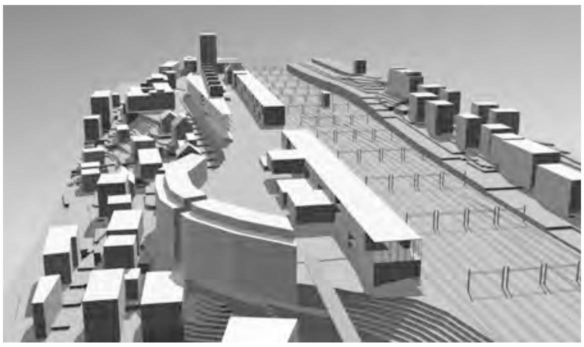

Figure 2: View of the Ecoparc Project with the FOS tower as urban landmark (doc. Bauart).

On the urban scale, the optimization of parking size, whose capacity corresponds to almost 69 % of the maximal authorized size, contributes to limiting automobile travel (Fig. 3) and also to optimizing the financial investment.

This choice, made in close collaboration with the different project partners (notably FOS, State of Neuchâtel, Helvetia Patria and CFF), contributes to valorizing the proximity of the railway station, especially for the students and workers coming from the whole urban region.

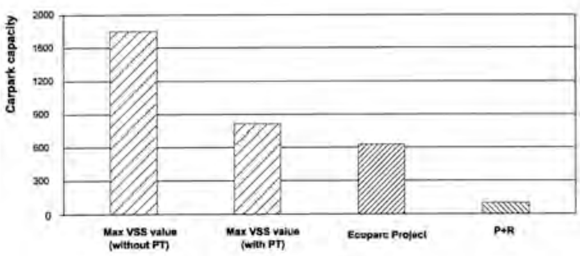

Figure 3: Optimization of parking size (VSS values taken from [10]).

The creation of a new neighborhood on this disused railway area concretely demonstrates the possibility of sustainable densification (Fig. 4). In Switzerland, the objective for the territorial development is the stabilization of ground consumption at 400 m2/pers in Switzerland, which corresponds to the mean in 1995 [9]. The regeneration of urban wastelands with a similar density as the Ecoparc project's, will play a crucial role in this purpose. Their potential contribution can be estimated at more than 50 % of this target [11].

Figure 4 : View of the apartment buildings on the East part of the site (doc. Bauart).

2.2 Minimization of energy demand

On the building scale, the project involves a strong reduction of energy use for heating and electricity, attempting to combine satisfactory user comfort with minimal non-renewable energy consumption. The concept is based primarily on a strong reduction in energy demand, secondly on the integration of renewable sources to satisfy the residual demand.

The reduction of heating demand includes high quality thermal insulation, valorization of solar gains in winter, taking advantage of the South orientation, and transfer of internal gains, especially in the first FOS building (calculation center).

The reduction of electricity demand includes the valorization of natural lighting and the minimization of artificial cooling needs. This aim is essentially reached by the integration of efficient solar protections, internal thermal mass and windows conceived for passive night cooling.

All the new buildings meet the requirements of the Minergy label standard. The detailed monitoring of both FOS buildings, in operation since respectively 1998 and 2004, shows that the effective performances - in terms of user comfort and energy consumption - are quite near of the expected values through dynamic simulations (Fig. 5-6) [12].

2.3 Integration of renewable energy

At the beginning of the neighborhood planning process, a study made in collaboration with Sorane compared different strategy for energy production, integrating environmental, energetic and financial criteria [13].

These analyses led to the conclusion that the best strategy here was to develop a semi-decentralized heating production concretized by the implementation of different production plants, one for each realization step of the neighborhood development, and by the choice of the most appropriate renewable energy source, in relationship to the specificity of each step : solar captors (1'200 m^2) with seasonal storage (2'400 m^3) for FOS buildings, solar captors for housing and wood-burning heating for schools. This strategy leads to the optimal choice, taking into account the different criteria, and avoids disproportional pre-investment for the first realization steps.

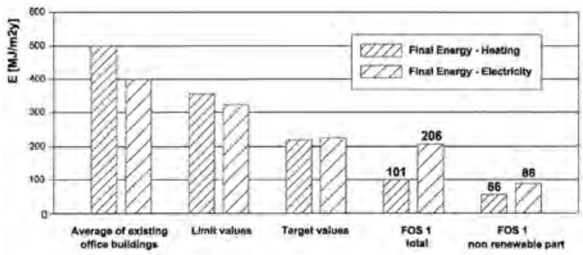

Figure 5: Energy consumption of the first FOS building (data Sorane, 2006).

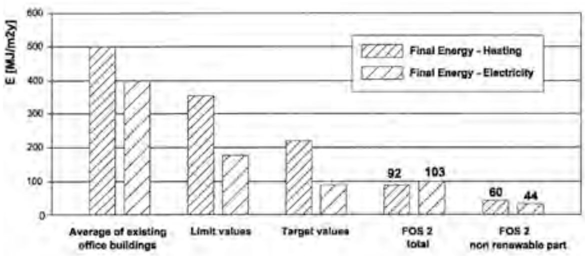

Figure 6: Energy consumption of the second FOS building (data Sorane, 2006).

2.4 Choice of materials

The design process of the buildings includes the realization of life-cycle analyses, especially for the materials that are present in large quantity, for example structure and façade elements. The purpose is also to minimize use of polluting substances. The definitive choice integrates many aspects, linked with technical, esthetic or economic aspects, and it is impossible to systematically choose the most ecological product. The advantage of LCA results is meanwhile to have concrete data to help in research for the optimal choice.

2.5 Communication to users

The project philosophy has also to be extended and passed on to users living and working in the Ecoparc neighborhood. In this perspective, different actions have been developed to heighten users' awareness of the different aspects of energy issues and sustainability. Developed with the support of the Federal Office of Housing, the research project "USE IT" focused on the problematic of information transfer between developers and users. These analyses led to the proposal of a new tool, in the form of an on-line user guide, and to its experimentation on the first housing buildings of the neighborhood [14].

Figure 8 presents an estimation of the global energy consumption for a user living in the Ecoparc housing (mobility, construction and exploitation of infrastructures, construction and exploitation of buildings), in comparison with a peripheral neighborhood. It notably confirmed the importance of acting simultaneously on the different energy-saving potentials.

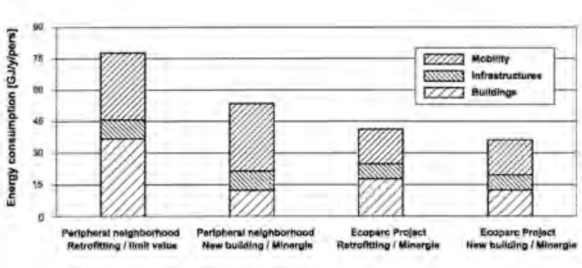

Figure 8: Estimation of the global energy consumption for a user living in a peripheral neighborhood and in the Ecoparc housing.

3. CONCLUSION

Experience acquired during the development of the Ecoparc project illustrates a structured approach to energy issues in the design process of a neighborhood. On the territorial and urban scale, the project provides a demonstration of the possibility of sustainable densification. At the architectural and constructive level, the approach experiments with diverse kinds of passive and low energy design. In addition, the effective results obtained by monitoring the buildings show that the values measured come very near to the expected value.

Beyond the energy issues highlighted by the present paper, the operational integration of sustainability criteria has to involve a holistic approach, simultaneously taking into account environmental, socio-cultural and economic issues such as housing flexibility, quality of life, functional synergies and cost management [15]. Based on interdisciplinary monitoring, the simultaneous consideration of these multiple issues is made possible by an initial evaluation for each criterion, and then by an optimizing synthesis leading progressively to dynamic integration into the design process. The Ecoparc project benefits in this way from the setting-up of a specific indicator-system conceived as a tool to support the decision-making process [11].

It has been clearly observed throughout the project that cooperative communication between the different partners, the local authorities, the users and the planners constitutes an essential condition for the development of such a complex and long-term operation in a sustainable perspective.

REFERENCES

[1] GAY J.-B., "Quel bâtiment pour une société à 2000 W ?". Proceedings of CISBAT'99, Lausanne, September 1999, pp. 177-183.
[2] NEWMAN P. & KENWORTHY J., Sustainability and cities : overcoming automobile dependence. Washington, Island Press, 1999.
[3] FOUCHIER V., "La densité urbaine dans le projet de territoire : quelle contribution au développement durable ?". Lausanne, Conference, 10th March 2005.
[4] CAMAGNI R. & al., "Forme urbaine et mobilité : les coûts collectifs des différents types d'extension urbaine dans l'agglomération milanaise". RERU, 2002, 1, pp. 105-140.
[5] RERAT P., "Etalement, fragmentation, mobilité : analyse des tendances de l'urbanisation dans la région de Neuchâtel". Urbia, 2005, 1, pp. 41-60.
[6] WILLIAMS K., "Does intensifying cities make them more sustainable?" in WILLIAMS K. & al., Achieving sustainable urban form. London, Spon, 2000, pp. 30-45.
[7] ASSOCIATION MINERGIE, La maison Minergie. Guide de conception. Bern, May 2000.
[8] JAKOB M., Quartier Ecoparc. Bauart #1. Birkhäuser, Basel-Berlin-Boston, 2004.
[9] CONSEIL FEDERAL SUISSE : Stratégie 2002 pour le développement durable. Bern, 2002.
[10] VSS : Parkieren : Grenzbedarf, reduzierter Bedarf, Angebot. Schweizer Norm SN 640 290. Zürich, VSS, 1993.
[11] REY E. : Régénération des friches urbaines et développement durable : vers une évaluation intégrée à la dynamique du projet (PhD in progress). Université Catholique de Louvain, Louvain-la-Neuve, Intermediary report, December 2005.
[12] REY E. & AIULFI D., "Double-skin façade as a contribution to sustainable architecture : The FOS tower in Neuchâtel". Proceedings of CISBAT 2005, Lausanne, September 2005, pp. 83-87.
[13] SORANE SA, Quartier "Crêt-Taconnet Est" à Neuchâtel. Etude de variantes de production énergétique. Lausanne, Final report, 2001
[14] GUYE A. et REY E., Projet de recherche USE IT. Neuchâtel, Association Ecoparc, Final report, 2006 (http://www.quartierecoparc.ch).
[15] SIA : Construction durable - Bâtiment. Zürich, Recommandation SIA 112/1, 2004.