



EWT/ Eco Web Town

Magazine of Sustainable Design

Edizione SCUT, Università Chieti-Pescara

Registrazione al tribunale di Pescara n° 9/2011 del 07/04/2011

ISSN: 2039-2656

RICERCA EWT Sostenibilità e Innovazione nel Progetto della Città
Il quadro delle esperienze di ricerca in corso nelle scuole di Architettura italiane

Building at Positive Energy for the Urban Regeneration of Informal Settlement *Chiara Tonelli*

ERC keywords

SH3-1: Environment, resources and sustainability
SH3-8: Mobility, tourism, transportation and logistics
PE8-8: Mechanical and manufacturing engineering
PE8-10: Production technology, process engineering
PE8-12: Sustainable design

Abstract:

The article describes the research that the Department of Architecture of Roma TRE is conducting within the three-year program 2014-2016 of Great Scientific and Technological Relevance of the Italian Ministry for Foreign Affairs in the Environment and Energy sector for the bilateral exchange Italy - Argentina, in collaboration with the University of San Martin UNSAM of Buenos Aires.

The Rome TRE Solar Decathlon prototypes for informal neighbourhoods of the city of Rome are the starting point of the research. Purpose of the exchange is the technology transfer of innovative solutions, achieved with the prototyping mentioned above, with the work of adapting to climate, housing patterns, and characteristics of settlement areas in building informal Argentine to trigger processes of urban regeneration.

The Great Scientific and Technological Program in the Environment and Energy sector of MAE

Periodically, the Italian Ministry for Foreign Affairs announces plans for the bilateral exchange between Italy and other foreign countries. As part of those organized for the three year period 2014-2016, the Department of Architecture of Roma TRE got the co-financing for a technology transfer project of Great Importance Science and Technology in the 'Environment and Energy sector' for the bilateral exchange Italy - Argentina, in collaboration with the Department of Architecture of the University of San Martin UNSAM in Argentina.

The proposed research will investigate the opportunity to transfer in informal neighbourhoods of the city of Buenos Aires innovations developed by the University Roma TRE with the design and construction of housing prototypes sustainable and energy efficient. These prototypes have been designed to participate in 2012 and 2014 editions of the International Solar Decathlon competition. They appear to be characterized by low cost and attractive design, low power consumption and high production efficiency, short time of implementation, easiness of assembly and reversibility, low primary energy of the entire life cycle of materials (mainly renewable) and components.

In particular, *Rhome for denCity*, the prototype created for the Solar Decathlon 2014, was conceived, for its flexibility and low power consumption, to replace the precarious buildings of the Italian periphery affected by illegal settlements, where social housing solutions are suggested.

On these prototypes, the Department is carrying out a performance monitoring during the entire calendar year and plans to develop their flexibility to make them suitable to fit into informal settlements and trigger processes of urban regeneration, with the work of adapting to latitude and housing characteristics of the Argentinian informal settlement, called *Villa*.

Purpose of the exchange is the transfer of technical know-how acquired and its adaptation to Argentine climatic conditions and housing, also in view of the fact that the buildings built prototypes have gained international prizes for the performances provided, winning awards within the activities under the international Solar Decathlon program, where universities around the world are selected to design and build prototypes of homes to nearly zero energy.

Here below the framework of the scientific research is described and the two objects of the experiment: the social housing prototype built for the Solar Decathlon and the informal Argentine area selected for this study.

The scientific framework

The big cities are the urban model more current and growing up actually. Here on average in the world every week 1.3 million people migrate to, looking for a better quality of life, fleeing famine, natural disasters, war, or terrorism. The United Nation Populations Fund - UNFPA – foresees that in 2030, for the first time in human history, more than half of the world's population will live in cities. In the world, there are already 25 megacities, huge urban agglomerations with more than 10 million inhabitants, which soon will exceed 20. Important consequence of this, both in emerging countries than in most industrialized, is the growing presence of some people trying to survive in precarious conditions in informal settlements. It is estimated that 1 in 7 people living in such conditions, for about one billion people in the world. Although the problem is still small in Italy, there are, however, substantial increases in the number of informal settlements in our cities. This growth should be combined with the characteristics of the housing units in the suburbs of the largest Italian cities. Here buildings built between the Second World War and 80 years prevail, with poor systems and envelops characteristics that raise the energy consumption with not optimal indoor comfort conditions. The great consistency of this type of real estate assets at European level implies that over 40% of electricity consumption in our continent is due to building¹, for heating, cooling, and lighting, with a peak recorded in housing². Also, since over 75% of Europe's electricity originates from fossil fuels or nuclear, such consumption is directly related to environmental pollution (fig. 1 and 2).

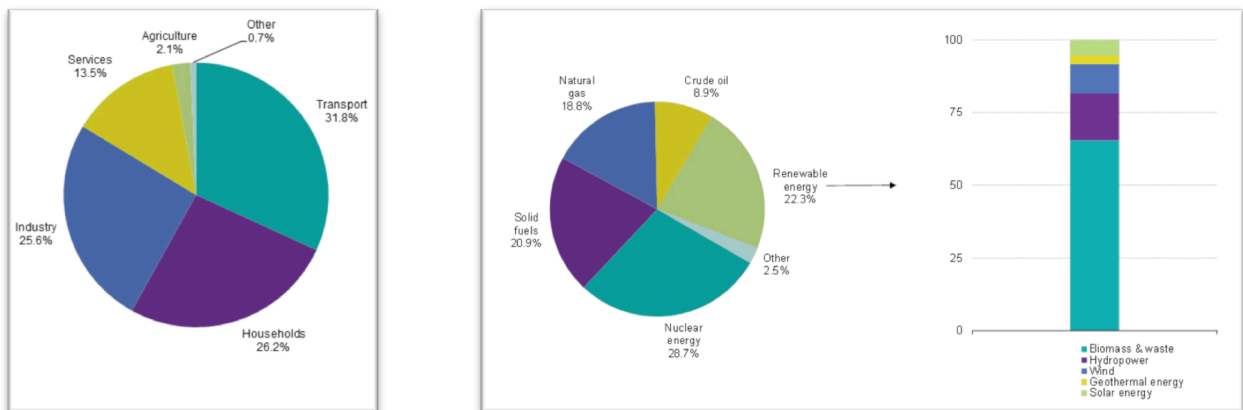


Fig. 1. Final energy consumption, EU-28, 2012 (% of total, based on tonnes of oil equivalent). Source: Eurostat 2014.

Fig. 2. Production of primary energy, EU-28, 2012 (% of total based on tonnes of oil equivalent). Source: Eurostat 2014.

This situation makes us understand the urgency to conduct retrofitting operations on existing housing, in order to improve the liveability, reduce fuel consumption and CO₂ emissions and trigger regenerative processes for the neighbourhoods where these buildings fit.

However, often, the precarious conditions of illegal buildings or the poor quality of buildings made with urgency in the post-war period make it economically viable to proceed to the redevelopment and argue in favour demolition and reconstruction of buildings with positive energy, i.e. producing more energy than they consume. This allows starting a more comprehensive urban regeneration, where the excess energy can supply the needs of the existing not renewed buildings, through smart connected networks.

In Argentina, despite the greater availability of fossil fuels comparing to Europe's, it begins to perceive the need to use less intensive energy construction. This is accompanied by the presence, in proportions well above the Italian and European case, in large urban centres, of actually illegal settlements (*Villa*) where poverty and uncomfortable comfort conditions make living unhealthy, unsafe and carrier of social problems.

RhOME and Solar Decathlon

Every two years, universities from all over the world are invited to submit proposals for the Solar Decathlon competition, sponsored by the US Department of Energy (www.solardecathlon.org). Twenty of them are selected to participate in the competition with the aim to design, produce, assemble an energy efficient housing prototype, powered by solar energy, and simulate there a real home life. In the edition of 2014, which was based in Versailles in France, following the European direction for saving land and energy efficiency, the competition aimed to seek solutions in terms of urban density to solve housing problems of the participant University's City (Tonelli, Cardone, Di Battista and Di Benedetto, 2013).

Between June and July 2014, the teams, representing 16 countries from three different continents, have assembled their homes in the smart solar village that was built in 10 days in the gardens of Versailles. Each house has been subjected to 10 contests that, through direct monitoring between 20 prototypes or international juries assessments, have shown their own characteristics and technical performances.

The University of Roma TRE presented «RhOME for Dencity, a home for Rome», a project to solve the housing problems in the Roman hinterland, where often pre-existing archaeological heritage is combined with illegal buildings, as happens in the area of the «Torre del Fiscale», the district within the «Appian Park» chosen for the experimentation.

The proposed urban regeneration replaced slums with new wooden buildings of five floors, located in the voids of the existing urban fabric, with flexible housing solutions, able to shelter different users. The housing model guarantees a social mix, ensuring high standards of comfort and low energy consumption. The use of natural materials and the passive behaviour are basic principles, where renewability, reuse, and recycling are key concepts.

In this district, sustainable mobility is encouraged, creating exchange nodes for transport ways by bike and car sharing. Different facilities are provided, in order to create multifunctional district (Dierna and Orlandi, 2009). Wastewater treatment allows purifying black water in closed cycles; energy systems of production and distribution are present. Waste are collected and reused, following the idea of their treatment as resources for new production cycles (fig.3).



Fig. 3. The RhOME for denCity masterplan in Tor Fiscale district in Rome.

The Villa of Rio Reconquista

In the province of Buenos Aires there are many informal urban realities, of huge sizes. The subject for experimentation of the research co-funded by the Italian Ministry for Foreign Affairs was identified in the northeast district between the metropolitan area of Buenos Aires and the Conca of Río Reconquista, where environmental and social characteristics strongly influence the social living dynamics of the informal settlements. The area overlooking the banks of the River Reconquista is a spontaneous neighbourhood, object of study, with around 150,000 inhabitants. In general, the distribution of the denser housing is along the main public transport lines, creating a heterogeneous urban edge that slopes down to the areas along the riverbanks, where a disorderly growth develops, and steadily increasing (fig.4).



Fig. 4. Some buildings of the Villa along the riverside Reconstituta. In this area the risk of flooding is also connected to the issue of illegal dumping of waste from domestic ones, to those at high risk, such cars burned. The inhabitants of these places have a special relationship with the waste, since if they are from a hand a high source of pollution and disease, on the other hand are a resource to meet survival needs.

The lack of infrastructure of neighbourhoods adds a set of incompatible uses and connections disorganized of services that become propitious for triggering of healthcare infections.

In summary, the area is a peripheral one, mainly inhabited by people with limited financial resources, with a lack of basic services, precarious housing, and deteriorated environmental conditions. The neighbourhoods object of experimentation have settled on land reclaimed from the river, that only up to a decade ago were uninhabited green fields. They acted as free zone to allow the flooding of the river itself. Their consolidation is achieved through solid urban waste that contaminated the entire area. Furthermore, the lack of water supply and sewerage increased the land contamination, by percolation of sewage. Recent investigations have demonstrated the presence of toxic waste liquids into the river and canals along where settle the houses of the most vulnerable families.

Because of climate change in recent years, an increase in flooding has caused pejorative living conditions, which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Methodology and results

Through quantitative and qualitative analysis of the problem, in accordance with the recent restrictions in terms of use of land and energy consumption in buildings, active in Europe, the research investigates the relationship between the housing crisis, due to large migration, and the possible answer, also linked to an offer of social housing, to the new set of users, trying to identify the conditions that allow the transfer to Argentina of the solutions developed for the Italian and European context.

Research methods

The research is still in its beginning and the comparison of the two contexts presents a high complexity and strong discrepancy. The technology transfer hypothesized therefore requires a strong adaptation and reinforcement of basic knowledge. For these reasons, the first year of the research is all geared to the definition of the state of comparative between Italy and Argentina, which is useful to define the framework for the subsequent years of the project, through:

- a. Comparison between technical rules that regulate the building sector in both countries, focusing in particular on social housing ones;
- b. Comparison of the average energy consumption, comfort levels, and housing standards in the two countries;
- c. Sociological analysis on demography and average composition of households in the two countries;
- d. Comparative analysis between lifestyles of the two countries;

- e. Comparative analysis between climate and latitude of the selected areas in Argentina and those that have been the subject of tests in Italy;
- f. Definition of the framework of needs comparing the problems that require urgent solution in the two countries;
- g. Definition of a list of available solutions, such as performance response.

In parallel, from the Italian side, it continues the study and experimentation on building prototypes to be transferred, through:

- h. Performance monitoring in different seasons of the year;
- i. Adjustments, replacements of parts or components and finishes;
- j. Identification of the cheapest solutions to provide equal response to the demands defined above.

Expected results

The research expects to establish innovative, sustainable, and energy-efficient housing for the urban regeneration of an Argentinian *Villa*. The aim combines the definition of settlement models with sustainable and energy efficient buildings to get the optimization of cluster adapted to the Argentina context.

The urban centres will gain extensive form, following the line of research of the first prototype made by the Italian team for Solar Decathlon Europe 2012, or acquire an intensive urban, following the line of research of the second prototype for Solar Decathlon Europe 2014.

A general clean up of this brownfield is not politically addressed and economically approachable, and it is outside of the research timetable. However, educational activities are already in place in the district, through the creation of social and learning support.

In parallel, what has been designed and tested for the Solar Decathlon could be applied in these areas through two distinct ways:

- on the one hand, designing constructions similar to those designed for Roma, namely multi-storey buildings, along the borders of the informal areas, in which part of the most vulnerable families could be transferred, with the aim of curbing the growth of settlements and create housing conditions such as to trigger virtuous social processes;
- on the other hand, to define a handbook of techniques to be applied to existing informal houses, transferred from the technological solutions developed for the above mentioned prototypes, that can allow, by small steps, to improve indoor comfort. This action is aimed to increase health safety and security, particularly with respect to water protection, and through a widespread greater liveability trigger a process of urban regeneration, allowing an increase of the social conditions of the neighbourhood.

To this end, the Italian unit is responsible for defining the technology and the production system of the construction, for selecting materials with low primary energy, exploiting local resources and manpower, for focusing on systems integration, and finally, for assessing through digital simulation, the thermal behaviour and the energy production. The Argentine unit, however, will provide the urban settlement criteria.

Expected results of the project are:

- Exchange of scientific and technological knowledge;
- Exchange of contacts between Italian companies leader in the production of components for sustainable buildings and Argentine stakeholders (public utilities);
- Definition of design solutions for the prefabrication of components combinable and variables in order to generate a wide range of urban solutions with limited cost;
- Realization of samples and prototypes examples of techniques and technologies for passive buildings and energy efficient;
- Launch of local production chains that can autonomously trigger these processes, after pilot activities;
- Involvement of the younger generation (students) in participatory processes aimed at the design and construction of energy efficient homes.

Dissemination methods

Each research needs targeted actions to disseminate the path and the results, for scientific and educational training. In this case, the transfer of technical know-how, technology, production, and construction of these prototypes will include meetings, workshops, and lectures and guided tours to areas of Argentina and Italian prototypes. The expected results of the activities of the first year will lead to define a comparative useful for the impact on bilateral scientific and technological relations. On the one hand, the framework will enable the development of research in the study and analysis of the problems of informal neighbourhoods in the contemporary metropolis, with warm-temperate latitudes in particular. On the other hand, workshops will be organized, with the aim to make the comparison on urban regeneration policies in Italy and Argentina, with particular attention to informal buildings and settlements.

At the of Argentine level the knowledge framework which will be developed will be useful to establish terms, constraints and opportunities for the transfer of knowledge in Argentina from Italian and European construction field.

Technology transfer is, therefore, the key word of the program. On the Argentine it comes to receiving constructive models and casing, regulations and actions that can improve their real estate and urban settlement, building on environmental policies and reducing energy consumption by now well established in Europe, in order to acquire tools to deal the problem before it is consolidated in an irreversible manner. From the Italian side, the policies of containment and impoundment of the illegal settlements experienced in Argentina may be beneficial to allow tackling the problem before it claims uncontrollably on our national territory, affected in recent years by consistent waves of migration.

Conclusions

Along with bigger sustainability and human comfort requirements, today's unprecedented levels of urbanization contribute to the increasing complexity of urban design in its environmental context. With more than half the world's population living in cities and buildings accounting for about 50% of total energy consumption including building-related transportation, the construction and operation of cities has become a major drain on the world's resources and a crucial contributor to environmental degradation, particularly through such egregious modern phenomena as urban sprawl and artificial indoor environment design. Cities import, transform, and throw away immense quantities of resources and pollutants every day. Yet they also embed vast resources in themselves, whether as underground or energy potential for instance.

Urban areas drive environmental change at multiple scales, bringing urban ecology and urban systems engineering at the forefront of addressing the challenge of sustainable living. Material demands of production and human consumption alter land use and cover, biodiversity, and hydro-systems from local to regional scales; urban waste discharge affects local to global biogeochemical cycles and climate.

The role of cities in the conservation of both our built heritage and our natural resources is undeniable.

A renewed multidisciplinary approach of natural and social sciences - including art and culture - with architecture and urban studies is needed for understanding, improving and planning radically altered local environments and their regional and global effects.

Key research questions are brought up in the context of designing and operating cities that provide high urban and living quality with small ecological footprint.

The growing European population, thanks to migration as well and stricter regulations in planning of landscape have increased the need to densify urban spaces.

We need to ensure a sustainable co-evolution of the built and the natural environment to densify urban spaces – from buildings to public spaces all the way to whole cities – by increasing and triggering positive impacts on our quality of life, our well-being, and health, without negatively impinging our natural environment.

To match urban research and technological devices could be the way for addressing the study of ecosystems in which proactive and smart environments interact seamlessly with users as a frontier of social sciences and technology, especially if users are educated to engage in participatory creation of cultural and social contents.

Notes

1. See the UE Directive 2010/31/UE.

2. According to the survey Cresme RIUSO03, only in Italy, the stock of residential buildings in 2013 amounted to 11.8 million units annually consuming almost 319 TWh between thermal and electrical uses, for an annual expenditure of households of more than 45 billion euro. The most energy segment, identified in the last quintile of consumption (20% of the buildings that have higher consumption), has nearly 2.4 million buildings with a consumption of nearly 105 TWh of over 14.5 billion euro per year (Cresme 2014).

Author

Chiara Tonelli, associate professor in Architectural Technology at the Department of Architecture of the University of Roma Tre and visiting professor at TUM of Monaco (Germany) for the AY 2014-15, has coordinated the two Italian teams ever admitted at Solar Decathlon, which in 2012 was awarded the third prize and in 2014 the first prize.

Bibliographical references

Cresme, *Rapporto RIUSO03. Ristrutturazione Edilizia, Riqualificazione Energetica, Rigenerazione Urbana*, febbraio 2014, http://www.awn.it/AWN/Engine/RAServeFile.php/f/RAPPORTO_riuso03.pdf.

Dierna S., Orlandi F. (2009) *Ecoefficienza per la città diffusa: linee-guida per il recupero energetico e ambientale degli insediamenti informali nella periferia romana*, Alinea, Firenze, IT.

Tonelli C, Cardone B, Di Battista C, Di Benedetto F (2013). Dal "Sacro Gra" a "La grande bellezza": la proposta italiana per il Solar Decathlon 2014. ECO WEB TOWN, ISSN: 2039-2656

Eco Web Town, N° 10-11, II-III 2014