Towards a Sustainable Architecture.
The raise of the smart grid network

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Abstract

Housing has represented one of the most ancient aspects in the social life of humankind. The need of a shelter has developed through millennia from the basic forms of dolmen to the current deconstructivist and emotional architectures that contribute to the identification of cities, countries and cultures.

Although the new architectural styles have deeply developed from their basic solutions, they still respond to the same needs of housing, social aggregator and icons. Nonetheless, the transformation the architecture has encountered in the centuries can be divided in four main groups, depending on features like architectural composition, material use and energy requirements.

These groups can be defined as sustainable primitive solutions, technology dependent architectures, passive architectures and finally the active architectures that have arisen in the last years.

The thesis research analyzes the development of these four groups through the investigation of those forces and principles that have contributed and enforced the development of the peculiarities of the built forms of the respective period. In particular, the research focuses on the development of active housing in regard to the current economical and energetic crises, highlighting the transformation of housing from a pure architectonic process to a wider concept of sustainable energy producer.

On a further stage, the research underlines the opportunities that active architectures offer in terms of energy production while overtaking the “NYMBism” that is often correlated with energy facilities. Finally, it analyses the development of smart grids, water management and biogas production as important tools for the development of a network of architectures that become diffuse small energy facilities and sustainable resource consumers.
Aims and Objectives

This research paper proposes a strategy for addressing the issues related with population growth, energy demand, environmental degradation and resource depletion.

The thesis report investigates the potentialities that the architecture process has to become an important stakeholder in the green economy of the XXI century, highlighting technical developments, design opportunities and responsibilities in the consumption patterns of the society.
Introduction

We live in a world that has just started using energy: with the growth of new economies, in particular the BRIC group, to whom China and India belong to, the number of people that will be willing to achieve the western standards of life will increase dramatically very soon.

However, the amounts of resources we are nowadays using are far higher than the ones the planet is able to provide globally: the 20% of the humankind is using the 80% of the global availability of resources while the big majority of the world population is struggling to survive with the remaining 20%. (World Watch Institute, 2008)

Many scientists agree that the crude oil will be depleted in the next 20-30 years since the global year production has been stable since 2004 and the demand has rapidly increased. (EIA, 2008) In technical terms, the Hubbard peak has been achieved with the consequence that the global production of crude oil will not expand any further.

Besides, the increase of population from the current 6,5 billion to the 9 billion expected in 2030 represents a further challenge in the provision of energy at cheap price worldwide. (UN, 2006)

The contemporary development of these factors is a main challenge for our society: population growth, new market development, environmental degradation and resource depletion are phenomena that are occurring all in the same time.

This dramatic situation leads to a global issue: how can we provide same opportunities to everybody without changing our living system?

The answer to this question represents a major challenge in the next future, especially in the western society where the dependence on energy and resources is the highest. However, the level of dependence is not equal in every country: while in Europe the lower dependence on private transportation and a tighter structure of urban-rural linkage can provide rapid solutions, the American model of suburbia and satellite cities represents a major issue in regards to energy savings. (Newman P., 2008)

The answer to the financial and economical crisis that has indeed started from the United States has been very different from countries worldwide, but the stimulus packages delivered by the biggest economies, have mainly been towards renewable energy sources and more efficient energy
technologies. (EIA, 2008) However, the development of clean renewable sources of energy does not occur with the same pace of the growing demand of energy.

Furthermore, the urbanization phenomenon that is occurring globally is another threat for our cities’ development: for the first time in history, in 2008 the urban population has overtaken the rural one, demanding more energy for housing and infrastructure developments in city regions. (UN, 2006) What is the future of our cities then?

All these issues represent challenges for our future development, as stated in “Our Common Future”, the report of the United Nation that has established the principles of sustainable development. In particular, the report establishes the way we can achieve sustainability suggesting “more rapid economic growth in both industrial and developing countries, more free market access for the products of developing countries, lower interest rates, greater technology transfer and significantly larger capital flows”. (UN, 1987) This prescription implies a highly technological approach based on a more and better management and technology.

A sustainable world can therefore be re-designed and re-built only from the bottom up, identifying designers, consumers and governmental authorities as stakeholders of the changing process.

The response to climate and society changing from the architectural field is a revolution in the way dwellings are designed: from an energy thirst organisms, buildings have to become knots of a network system that produce and release energy instead of demanding it. In this regards, it is important to highlight how the energy demand for the housing area represents the 30% (EIA, 2008) of the total use of energy in the world, both in terms of building process and heating-cooling system.

In Sweden for instance, the proportion of renewable energy in district heating has increased from 24% in 1990 to 55% in 2006, while in average the demand of energy in buildings have fallen from 140 KWh/m² per year to 120 KWh/m² per year, with further improving margins (Swedish Energy Agency, 2009).

These results highlight how the awareness of these issues can encourage society to discover new technical solutions and develop more sustainable behavior concerning energetic consumption and can therefore promote knowledge around passive design solution as a tool for decreasing energy demand. This opportunity represents a new area for the architectonic debate that in the last decades has struggled in finding a new language and style, offering new challenges and margins for the development of new trends and concepts.
Methods

The research develops from a simple observation of the built environment in European cities and the recognition of the different features of the architectures in the old continent. The investigation of the differences in the style and design concepts in the buildings is developed through review of literature material, scientific journals and lectures the author have followed at the Faculty of Architecture and Built Environment in Italy, Australia and Sweden. The working experiences of the author in Italy and the Netherlands have greatly contributed for the analysis process and the considerations among architectural principles and practices.

The economical, industrial and financial crises of the year 2008 have provided reflections among energy and environmental issues.

The research has developed through field observation and following literature investigation with the help of experts in human environment, engineers, architects and urban planners.

The case studies have been chosen in regards to the extreme conditions of the climate in Nordic countries, and with the aim of providing a thesis work related with the Master of Science course at the faculty of Architecture and Built Environment of the Royal University of Technology of Stockholm.

The discussion of the project has been developed through the SWOT analysis method, highlighting Strengths, Weakness, Opportunities and Threats of the proposed solution.
The four era of Architecture development

Introduction

The word “architecture” comes from the ancient Greek words “arché”, meaning principle, and “tecton” construction. It therefore refers to a “building principle” that every human built manufacture owns as intrinsic, hidden characteristic. Nonetheless, this building principle has not been a unique form but it has assumed different features depending on the historical time and the area of its development. In this regard we can understand why architecture assumes different features and styles while providing the same function, for instance housing.

Many different examples of architectures can be found worldwide with similar building principles that gave birth to astonishing different results: these discrepancies rely in the different climatic, cultural and resource background of those places the architectures belong to.

Nonetheless, it is possible to group the development of architecture in four different eras through the recognition of important changing in its features.

![Image](image1.png)

Figure: 1  The Colosseum, symbol of Rome; Sketch of Ville Savoir, Le Corbusier

The first group represents the most ancient form of architectures that worldwide had to respond to the need of a shelter in very different climatic context without the use of any other energy source than biomass. This group has developed during thousands years since the Neolithic era and is still widely used by primitive populations even nowadays in remote areas of Africa, Asia, Americas and Oceania.

The second stage of architecture development starts with the mayor transformation brought by the industrial revolution that encouraged the use of machinery and energy in the architectural process:
The four era of Architecture development

heaters, air conditioners, and other mechanized devices purchased those functions that were previously provided by passive design solutions. This phase in the architectural development relied completely in the assumption that fossil fuels were easily available and at cheap price.

The oil crisis of 1973 represented a new transformation in the architecture field: the skyrocketing price of fuels and therefore energy, warned designers and consumers about the fragility of those architectures that were highly dependent on machinery for mitigating the climate in the buildings. For this reasons the designers focused the attention on previous architectures and rediscovered the potentialities of passive design as a cheap solution for climate control. The results of these studies are visible in many countries worldwide but represent an exception in the landscape of cheap architectures that the real estate market developed since the 80’s when the energy price decreased.

The rapid depletion of the energy resources together with the raise of new economic realities like the BRICS emerging powers, exacerbate the debate among energy availability and sustainable development.

The increase in population and therefore consumers have occurred on the same time the energy resources were decreasing, bringing the architectural debate back to the oil crisis of the 70’s.

This new reality occurred in the same moment technologies and renewable sources had developed considerably and had achieved high popularity in the market. This opportunity allowed the integration of complex technological solutions in the architectures and offered new possibilities to customers in terms of energy use and money savings. (Haughton G., 1994)
The sustainable primitive architectures

Since ancient time human kind has lived in areas with hostile climatic conditions due to historical, cultural and sociologic reasons. The ability of mankind in adapting to climatic features has been between the reasons the primate have evolved as the dominant animal species in the planet: the understanding of climate and the importance of planning and building in response to environment characteristics allowed the humans to survive harsh winters or drought periods worldwide.

Examples of these skills are still evident in many buildings that preserve the features of the ancient architecture of those places, from the mud hut in Sahel region to the Alpine wooden houses in Europe. (Ryn, 1996)

Populations that never came in touch developed similar characteristics for their dwellings while addressing similar climatic issues: in this sense we can appreciate how the Indians of the Midwest developed a conic tent made by banded timber beams and animal leather covering, similar to those that central Asian population developed with the Yurt tent. In many examples worldwide people used similar concepts for adapting to climate: they primarily all used local materials which eventually would produce an amount of waste that would be part of the local ecosystem such as timber, leaves, mud and stone that could be reabsorbed by the environment. It is very important to highlight how in many part of the world a very important resource such as water was scarcely used in the building process.

Figure: 2 Sustainable architectures in Africa, Europe and Asia

The lack of machines for providing heating and cooling was addressed mainly through passive design solutions and the use of the biomass as a source of energy heating even though this was not a primary solution of the problem, but was a secondary application that had mainly the function of food processing and of social catalyst (role that nowadays is covered by the television).
In these regards, the design of compact buildings with small windows was a very efficient system for preventing heat spread while the extensive use of timber could address an insulating function with the use of a local material. In other cases the thickness of the walls realized in stone and lime provided an efficient thermal mass effect that could regulate the climate with solar radiation gain.

In extremely cold environment, such as the polar area, the housing system developed by Inuit populations express one of the most interesting examples of climate control housing: the igloo system employs ice of the arctic pack ice sheet to mitigate the harsh polar conditions: snow was used as brick block since the air pockets trapped in it made it an incredible insulator. On the outside, temperatures could have been as low as −45 °C, but on the inside the temperature could have ranged from −7 °C to 16 °C when warmed by body heat alone. Moreover, the dome shape of the building contributed to reduce heat spread and its drag shape diminished the cooling effect of the blowing winds.

Figure: 3 Passive design solutions for cool and warm climates in the Arctic and in Southeast Asia

In hot climates the solutions applied vary deeply according to the feature of the area: in some places the heat was made bearable thanks to breezes and fresh winds coming from the sea, but in territories far from water basins the temperature could sensibly increase, encouraging the development of new solutions.

The shape of the buildings is the first feature to be analyzed: while the compact shape was a key aspect of dwellings in cold climates, the composition of different volumes with wide overtures and shaded paths became the principal feature of warm environments. In many cultures the suspension on timber poles increased the heat spread through the building and favored the ventilation process that naturally occurs due to difference of pressure in the opposite facades of the buildings. In others instead where the amount of timber was scarce, the use of important thermal mass became the dominant feature of the architecture design.
On a deeper analysis, shaded courtyards, verandas, patios, balconies and other shaded areas in the buildings became important tools for climatic control. In particular, in the Mediterranean area the Roman Empire contributed to the spread of the “Domus Romana”, a court building with pools for the collection of rainwater that exploited the evaporative cooling effect of the water for controlling the internal climate.

In the Persian area instead, the dry air of the deserted flats and the lack of water for evaporation exploitation, permitted the development of wind towers that are still in use in modern Iran nowadays. These constructions were a particular chimney divided into several sections by vertical septs in brickwork: during the night the tower cooled down while during the day the air in contact with the masonry cooled down as well, becoming denser for the decrease in temperature, dropped down and entered the building reducing the temperature in the internal environments.

Figure: 4 Passive design solutions in the Mediterranean and wind cooling towers in Persia.

This is a tangible proof of how, ancient populations have applied concepts of thermo-physic to designing process in relation to the site, materials availability and to culture. The awareness of these climatic features has permitted civilization worldwide and it has been a pillar in the social society development: the control of the climatic harsh conditions permitted humankind to become sedentary and therefore establish agriculture, grazing and all the consequent developments.
The dark age of the technology dependent architectures

This huge amount of knowledge and cultural heritage were left apart after the spread of the industrial revolution that encouraged designers, planners and architects to break all the limits that a design that responds to climatic condition needs.

The faith in the technology and the cheap access to energy broke the relation between design and climate needs that had been the driving force until that moment: it was not necessary anymore to design according to climate features since the machines could provide temperature control in the building, independently from outside conditions such as sunlight, winds, humidity and temperature in general.

The cheap and easy access to energy sources was the engine of this process: the installation of machines operated by mechanical power and the use of new energy sources in dwellings became symbol of progress, development and social prestige in western society.

The era of steel and glass was a rediscovery of human potentialities over the nature: the architects could finally design buildings that would have been unsuitable for living in previous centuries, and therefore refused those designing concepts and rules that became synonym of antiquity and backwardness.

Figure: 5 The Glass House (1949) by Philip Johnson in New Canaan, Connecticut, USA.

This revolution from first era architecture to this new energy thirsty one achieved a dramatic boost after the discovery of the Béton Armé in the France of the XIX century: this technology soon became the driving force of the modern movement that spread in the XX century worldwide as the answer to urbanization and housing phenomena.
To this extent, it is important to highlight the role the industrialization process had in the development of new architectural models: the mass production of steel and glass was the driving force for the next development of skyscrapers but also infrastructures and building machines.

One undervalued discovery in this period has been the mechanical elevator: how could the skyline of our cities been transformed without this machine that allows people to live vertically in this new totemic entities that become centralize engines of sociality, business and governmental control?

Although the industrial revolution is mainly identified as a changing in the manufacturing field, its consequences had many implications in society and in its functioning. In this regards the revolution of the transportation system opened new routes and markets to the industrial output: new goods were available from faraway lands and the building sector in particular could appreciate new and exotic materials that could adorn westerns’ floors and footpaths.

The consequences of this process have been a massive use of machinery in building activities and a high dependence on heaters and air conditioners for climate control in dwellings with a consequent growth in demand for energy sources. According to many scientists, the growing demand of electricity for supporting the economies of western and developing countries societies have highly contributed to the global warming that affect the planet nowadays. The consequent increase of temperature in many countries have meant a higher demand of energy for cooling systems, establishing a sort of cycling phenomena of demand-request that increase the costs for maintaining housing comfort.

The global market economy have contributed to this escalation: transporting materials from faraway territories meant the production of high levels of carbon dioxide in the atmosphere due to transportation that in most of the cases is leaded by fossil fuels. The depletion of natural resources,
in particular in developing countries and wild protected areas, is a mayor treat to the environment and regional ecosystems.

Figure: 7 Conditioners on a building facade and the Titanium ceiling of the Los Angeles Walt Disney concert hall.

This whole revolution, as stated before, was entirely based on the idea that the energy could be abundant and easily accessible. It is important to highlight how the building market represents one of the most important fields in terms of economy, employment and revenues in capitalistic societies: the Irish and Spanish examples of the last years show how the constructing market can drive the economy of a whole country, in the positive and negative meaning of the term. The growing costs of energy sources and the example of the Ukraine-Russia crisis in 2006 winter that left Europe on the brink of energetic blackout have encouraged many countries to reestablish a policy of energetic independence or at least a policy of reduction of energetic demand in the next future.
The passive architectures

As previously reported, the development of industrialized architectures had deep consequences in the development of the capitalistic society of the Western world. The urbanization process that has created the urban – rural linkage has contributed to the development of the whole society through the growth of building companies, manufacturing, energy production and so on. The building process permitted the growth of many industrial areas through the growth principle: increasing the demand, the output consequently expanded and permitted employment and consumistic policies. (Thomson et al., 1990)

This model has been successful in the sense that it has contributed to the growth of a capitalistic society based on consumption that has also been able to develop education and health systems. However, this model has reached its top: the limited amount of resources is a key concept for the limit of the growth of the capitalistic society. The model that has been purchased by the western countries is nowadays not achievable for other countries: the amount of resources needed would surpass the carrying capacities of the earth. (UN, 1987) In the other hand, the goods used even in those developed areas are not replicable on a long term: this issue has been highlighted during the oil crisis of 1973. With the establishment of the OPEC cartel in those years the increase of awareness among the weakness of the western developing principle appeared evident: for the first time in history, the United States were not able to supply their internal demand with own reserves, but had to rely on foreign imports for their necessities.

This alarm and drastic increase in the price of the commodity contributed to the establishment of a debate among the role of architecture in terms of energy dependence: the era of cheap and easily available energy sources seemed to be at the end and a new strategy for development needed to be addressed. (McLennan et al., 2004)
In many countries worldwide this awareness brought new light in the architecture debate: the role of the architect was not anymore the one of simply volume composer, but became closer to the one of a professionist that had to consider many more parameters in his profession: energy, sustainability, economization of the building process became paradigms of the design stage.

In the other hand, the drop of the oil prices in the following years decreased the attention among those themes and the faith in growth and in technological development contributed to the abandonment of interest among sustainable architectures. The common belief of lasting wellness and perpetual growth enforced the consumistic principle of the western society, in particular the American model of suburbia where the satellite city is connected through infrastructures to the core urban area. The development that has occurred in those years was based on the credit market principle where a buyer would use the financial market in order to purchase a private property that subsequently have to heat, cool and depend on resources for its functioning.

However, in this climate many architects understood that the crisis was just postponed and that sooner or later the energy shortage would have stroked back. This awareness contributed to the establishment of sustainable cities worldwide, with the aim of providing a living lab for the development of sustainable cities. Examples from Germany, Sweden, and Australia are discussed in these pages.
Sustainable Cities in the black forest: the case of Freiburg in Germany.

The City of Freiburg comprises a population of approximately 260,000 people in the southwest of Germany near the French and Swiss borders (European Union, 2005). It is the center of the southern Baden region, where there is a high concentration of industries in the chemical fibers sector, wood processing, electrical engineering, design and manufacturing of medical apparatus, and pharmaceuticals.

Freiburg may justly refer to itself as a birthplace of the green movement. The successful campaign against the proposed nuclear power plant in nearby Whyl over thirty years ago became one of the founding legends of the Green Alternative Movement. During the late seventies, a colorful coalition of student and antinuclear activists, as well as proponents of a new social movement began to mobilize and settle in this small size German city. (Vauban, 2009)

Initially, the area was attractive for only visionaries and artists, groups and associations searching for alternatives to nuclear power. However, as early as 1986, (the year of the Chernobyl disaster), the municipal council decided to abandon nuclear power. Solar energy was to become the new principle source of energy. That same year, Freiburg became one of the first cities in Germany to establish an Environmental Protection Office, becoming an example for the fight against global warming.

Today, the emissions are reduced by 14% compared to 1992 levels but the aim is to further improve these achievements reaching a 40% reduction in 2030.

One of the most common feature that characterize the city is the high number of photovoltaic systems that cover public buildings, such as the city hall, the schools and the stadium, as much as the private residential buildings.
The City has helped the spread of solar technology by creating a website where the public can directly access information and analyze the possibilities that this kind of technology can have in everyday’s people life.

But the real revolution is the building energy efficiency that here finds its highest expression in the work of architects such as Rolf Disch that has made Freiburg a living lab of the passive house, both for the architectural and technical side. Freiburg since 1992 had introduced standards for new construction 30% lower than the German Federal government. In 2011 these limits will be even more demanding: the new houses can have only up to 15 kWh/m² per year (now up to 50), while the European average is around 200-230 kWh/m² year. Many homes use for heating and cooling especially geothermal heat pumps, or a mix of solar thermal or biomass. (Vauban, 2009)

The most common practices for improvements in buildings energy efficiency are on thermal external insulation, installation of triple-glazed windows and passive design solutions.

Some financial institutions such as the German Deutschbank have agreed to provide facilitated loans for these types of intervention, creating involvement in the public in this renovation process.

On a broader sense, the city traffic has been reduced significantly over time, reinforcing the tram network and building bike paths everywhere, at the same time eliminating from the city center parking places.

Today, the citizens of Freiburg are aware that building energy-efficiency and clean energy are also a tourist attraction for the city, contributing to boost the entire production and sales activities in the area.
Sustainable district in Stockholm: the case of Hammarby Sjöstad

The building and property sector in Sweden is responsible for a very high proportion of the environmental impact on society: it accounts for almost the 40% of the total energy use, over the 40% of the use of materials, and a considerable share of waste. Consistent amounts of greenhouse gases are generated by the housing sector, and it accounts for about the 20% of Sweden’s total emissions of carbon dioxide. (Miljöförvaltningen, 1995)

The Hammarby Sjöstad development is a mayor example of urban requalification in the Stockholm region. The transformation of the former industrial and harbor area was part of the 1996 Stockholm bid for the Olympic Games of 2004 and a far-reaching environmental program was worked out for this event. The objective of the municipality was to create a village that could demand 50 percent less energy than an equivalent residential building in Stockholm area, with an expected energy demand of about 60kWh/m² per year.

The main features of the area comprise 200 hectares of urban development that retrain a brown field with 9,000 new apartments, 400,000 m² of new paved area for business, new canals and quays, a water-lock, several bridges and a tramway. The project is expected to be completed in the year 2012 after an 11 stages designing process (Vestbro D. U., 2003)

Hammarby Sjöstad is a community more than a single collage of different sustainable solutions. The success of this project relies in the efficiency these different applications achieve while working
together: issues like transportations, urban mobility, public spaces, energetic demand and management of waste and water have a common planned strategy.

The area around the lake Hammarby Sjö was considered attractive due to the strategy the planners were encouraging in the 1990’s of building inwards, i.e. building on already exploited areas instead of promoting further urban sprawl and exploitation of green spaces (Inghe J et al., 2003)

The designers aim in the area was to encourage the model of a mixed function with residential, commercial and workplace environments in order to provide lively streets and blocks especially in night hours. The planning scheme promoted lit-up small green spaces, traffic solutions with good overview instead of large parks, traffic impediments and empty streets at night. However, an important difference is that Hammarby Sjöstad is situated along lakes and canals, where the desire for views of the water represented an important urban design factor and an economical driving force. In this regards, U-shaped blocks provided the best solution for views of water by a maximum number of households while still allowing fairly high floor area ratios (Vestbro D. U., 2003).

Architecturally, Hammarby Sjöstad is influenced by the ideals of neo-modernism, with its strong admiration of glass, steel and other metals, a fact that contributes to the depletion of the bedrock and to energy-waste during production and increase in energy demand due to heat loss. The average size of the apartments is bigger than the average in the Stockholm area, they frequently have more than one balcony, and many of them are oversized in relation to functional requirements. In this sense the Hammarby Sjöstad model cannot be completely considered a successful model of sustainable design, even though important differences can be found between the first and the last designed buildings. (Vestbro, 2002)

On a passive design solutions level we can appreciate many different aspects developed by the architects involved. It is important to highlight how the drag coefficient of the house responds to a feature of climate spread control and is a factor common to all the buildings of the area. The compact solutions indeed present the lowest surface that can spread heat in a condition of parity of volume with an articulated and composed volume solution. The proportion between overtures and insulated wall mass reflects the idea of preserving heat spread with a modest lighting effect, even though relevant differences can be observed between buildings of the first stage and later ones. In particular is possible to appreciate how the amount of surface covered by glass varies accordingly to the orientation of the façade, presenting higher overtures in the southern side.
In many buildings in Hammarby Sjöstad is possible to appreciate balconies that present different features compared to southern European ones. In particular is common to observe glass walls that border the edge of the balconies, delimiting a glass volume that has the function of creating a greenhouse technical solution that exploit the solar radiation for increasing the outside temperature in the balcony. It is also possible to appreciate solutions that are developed in order to evict the thermal bridge effect in the balconies: reinforced concrete septum externally bear the weight of the balcony that is just approached to the main building, being an element not in direct communication with the internal slab.

An efficient solution is represented in many buildings by the green roof solution that employs sedum plants in order to increase the insulating effect of the roof and increase the runoff capacity of the area.
Sustainable architectures in Australia: the case of Southern Queensland

The British colony of Australia represents a unique background that conditioned the development of an autochthon architectural style in the island. Considering the British Empire in his maximum extension, we can observe how Australia represents the only case where the climate is particularly hot and the local population represents a very particular case in terms of human settlements. While in the rest of the empire the British reinterpreted the local building traditions, like in India, Burma or South Africa, or exported the Victorian style house, such in the New England or in Tanzania, in the Australian case the lack of a local tradition brought the British to import an unsuitable model for the hot humid Queenslander climate. (M. McGuire, 2004)

The aborigines that lived for hundred thousand years in those territories were nomads and not brought to consider bounders in their living space. This vision, unique in the history of human kind, reflects the landscape of the Australian territory: the infinite amount of land and the lack of people and land predators, together with the lack of important natural barriers (except the blue mountains in new south Wales) brought the native populations to develop a concept of space and territory that does not comprehend the concept of limits or aggregation in a single area.

Nevertheless, the housing forms developed by the aborigines reflect the concepts of sustainability that have been commons for many populations worldwide before the industrial revolutions: the materials employed are the ones that were available in loco like wood, leaves and straw and the possibility of abandoning this materials after the temporary use of the hut reflects the Australian aborigine concept of “everything belongs to the land, everything has to return to the land”.

Figure: 12 Aboriginal hut in southern Australia. Ivan Cusini courtesy.
Another interesting feature of these houses is the construction technique of suspending the floor from the ground with timber poles, and the opened walls that encourage ventilation which contributes to heat spread.

The misconception of supremacy of the white men above the natives brought the British to consider the Australian aborigines as savages, underdeveloped and therefore these features of local design were not investigated or anyhow taken into consideration. However, the colony of Queensland, permanently affected by lack of man labor, required local materials for the development of dwellings, and therefore developed a housing prototyped called “Queenslander”. These new houses showed some kind of inspiration from the Polynesian suspended straw huts and the Indian and Burmese wooden houses with verandahs and shaded windows. The Queenslander appeared as a suspended wooden house that laid on mangrove poles and aluminum roof, frequently hosting porches or verandah in the front and in the back of the building or more commonly having a balcony, covered by the roof, running all around the perimeter of the house. (Avery et al., 2004)

The Queenslander had very interesting features in terms of passive design, but the metal roof vanished all the positive effects of these solutions, developing an oven effect in the hottest summer days.

The industrialization of Australia, possible just because of the great immigration that followed the Second War World, brought the modern movement and the post-modern movement in the architectural field, abandoning the Queenslander as an architectural prototype in favor of the new brick house that reflected the American style of those years. The tremendous heat of the summer in Queensland obliged the employment of massive cooling systems that were encouraged by the low costs of electricity in Australia.

Nevertheless, the lack of a common culture in architecture that could identify a Queenslander style and the threat the global warming represent for the Australian ecosystem, brought the designers to research a new common language that starting from the late 70’s could respond to these needs. The drop of oil prices in the 80’s and 90’s slowed down this process, but the rise of the costs in the new century revitalized those forces that were pushing towards a development of a new design style.

The Sub tropical design takes birth by the needs of identifying an architectural Queenslander style and in the same time address environmental issues. The result is an extraordinary range of solutions that respond to the climate needs and in the same time defines a Queenslander style of life.

Suspended, articulated and composed volumes with prominent balconies and roofs, patios, verandahs and shaded courtyards bounded by deciduous trees characterize the architecture of the last decades and defined a style of life for the outdoor and open space in contraposition to the closed air-conditioned environments of the previous century.
Orientation, cross ventilation, shading and use of local materials and collection of rainwater are the main feature of a new Queenslander house and has also established a new style of life, made for the outliving and the contact with the outstanding Australian natural environment.

![Diagram](image-url)

**Figure**: 13 Cross ventilation and outside living in sustainable Queensland architecture

In terms of energy demand is possible to analyze the data collected by the Research House, a living lab developed by the Central Queensland University since the year 2001 (Queensland Government, 2006). The project involves the design, construction and monitoring of a four-bedroom house in Rockhampton in central Queensland, based on the elements of Smart Housing: social, environmental and economic sustainability. The sensors mounted in strategic places of the houses monitored parameters such as energy consumption, temperature, humidity and water demand and the data collected have been compared with a common house in the same region. The results after 6 years show how the amount of energy required by a smart house is in average the 15% lower than a common house in Queensland. (University Central Queensland, 2006)
The active architectures development

The development of Active architecture has been relatively slow, mainly due to the low cost of raw materials in the market in the last decades of the last century. However, in the last 10 years, with the access of the BRIC economies in the World Trade Organization, there have been an increasing awareness among the growing request of resources and energy in these developing countries. In these background, in many countries worldwide, but in particular in the highly energy dependent Europe, the development of passive architectures has acquired an increasing level of attention.

Awareness among climate change and sustainable development, together with increasing cost of the energy bills, encouraged many governments to establish new parameters for the consume of resources in the society. The high cost of renewable energy facilities have been a further reason for decreasing the energy requirement in a strategy policy for meeting the international targets of the Kyoto protocol and the European 20-20-20 rule.

The consequences in the architecture field are very challenging: the task of architects is not just a spatial and stylistic exercise but it has a deep impact in the whole economy since it determines the amount of resources needed for the construction and maintenance of the building. Furthermore, the design process determines the life style of the inhabitants, suggesting a more or less sustainable consumption pattern: for example, an architecture that has proper lighting does not require artificial illumination that relies on energy for its functioning.

An Active Architecture can therefore be defined as a building that delivers more energy than the one that it needs for providing comfort and utilities to the inhabitants.
For reaching this goal, an active house has to achieve a high level of excellence in the passive design solutions, so that the amount of resources needed for the functioning of the building might be as low as possible and therefore deliver the extra energy produced to the grid.

An ideal active house has different levels of sustainability: it mainly consumes low amounts of electric energy for its appliances, has a very low consumption for heating and cooling, uses local materials and requires low amounts of water for its functioning. On a further stage, developments are occurring in the field of biogas production from household sewage, so that the handling of waste and energy production occurs jointly on a local scale, with savings in terms of energy transportation and infrastructures development.

An ideal active house has a responsible use of materials, preferring local or regional ones and with the use of sustainable systems for transportation in the building areas during the construction phase.

**Smart grid development**

One of the most important features of an active house is represented by the development of smart grid solutions.

A smart grid includes an intelligent monitoring system that keeps track of all electricity flowing in the system. It also incorporates the use of superconductive transmission lines for less power loss, as well as the capability of integrating alternative sources of electricity such as solar and wind. When power is least expensive a smart grid could turn on selected home appliances such as washing machines or factory processes that can run at arbitrary hours. At peak times it could turn off selected appliances to reduce demand. (Siddiqui, 2008)
The success of a smart grid solution is due to the fact that the energy peak production occurs during daytime, a period when normally people are working outside the walls of their house, and it therefore maximizes the output producing energy during the expensive time and it demands it when the industries and public places are not operating.

Portland General Electric in the United States, for example, gives its customers the option to pay based on Time of Use if they have a smart meter installed. The utility charges $0.11 per kilowatt-hour when demand for electricity is the highest, $0.064/kWh when demand is at partial peak and $0.037/kWh during off-peak demand times. Many utilities employ a much greater difference between on-peak and off-peak prices to further promote peak demand reduction. (Energy Information Administration, 2009)

Supporters of renewable energy favor smarter grids, because most renewable energy sources are intermittent in nature, depending on natural phenomena (the sun, wind, waves) to generate power. Thus, any type of power infrastructure using a significant portion of intermittent renewable energy resources must have means of effectively reducing electrical demand by "load shedding" in the event that the natural phenomena necessary to generate power do not occur. By increasing electricity prices exactly when the desired natural phenomena are not present, consumers will, in theory, decrease consumption.

Another aspect in the development of smart grid is that the higher cost of energy will make consumers more concerned about wasting it. The smart meters will show consumers how much energy they are using and will also allow flexible pricing, suggesting smart appliances how to properly use the energy demand.

As the CEO of General Electric in Europe Keith Redfearn has stated, “Higher electricity costs at peak times will mean less spare capacity, which is generally the most expensive and often the most polluting. The biggest opportunity is to flatten out the peaks in demand since electricity at peak times costs 15 times more than at off-peak times. Just a 5 per cent reduction in peak demand in the UK would remove the need to build five mid-sized gas-fired power plants” (Keith, 2009)
Governmental policies for Active Architectures: the Italian case of Conto Energia

The development of Active Architecture can receive an important contribution with the implementation of governmental policies and incentives for their development. An interesting example is the “Conto energia” (energy bill), a governmental policy that has been one key point in the success of the investments in the field of solar panel for energy production. The program provides incentives for the installation of photovoltaic systems for the production of electric energy and commits the government to pay the kw/h produced with a slightly higher cost than the one of the grid.

Furthermore, the governmental protocol allows the investor to reduce the initial investment for the acquisition of a solar thermal module or a photovoltaic appliance of up to 55% the initial cost through tax cut in the personal income of the investor. This means that a 25000€ solar micro facility can be purchased at a price around 14000€, an affordable last-longing investment, considering the pay-back time that accordingly to the geographical latitude varies between 12 and 15 years. The life expectancy of the solar panels of 20 years suggests a profitable investment, especially due to the high cost of the KW in the Italian market. (Conto Energia, 2009)

The “Conto Energia” has been an efficient policy for guiding investors towards this sustainable solution and the amount of request has skyrocketed in the last two years. In the same time, the cost of the KW/h produced has been decreased in order to meet the great demand and due to the improvement in the efficiency of the solar panels. The government is therefore decreasing the incentives in proportion with the developments that the photovoltaic industry is achieving in terms of cost reduction and efficiency.
Another successful governmental policy has been implemented for the reduction of energy demand in the buildings in 2007, with the introduction of the energetic certification of the building.

This certificate classifies the buildings according to the amount of energy they consume per year both for heating and cooling. The building therefore assumes a market value that depends also on the energetic class it belongs to: for example an A class building in a suburban area might have a higher value than a building in class F in the city center of similar size.

The first results show a decreasing demand of energy in the housing market and a rising interest in the development of more efficient and environmentally friendly architectures.

Figure: 17 Examples of Energetic certification of the buildings in Italy; Energy demands for housing, 1990-2007.

Figure: 18 Energy demands for housing in Italy, 1930-2007.
Household sewage and waste Biogas development

One of the most interesting developments that active architectures are addressing is the possibility of producing biogas from excreta and kitchen waste.

An interesting pilot experiment is headed by Sintex Industries, an Indian company active in plastics and textiles manufactures. The company is testing a new biogas digester that may help satisfy two of India's major needs: energy and sanitation.

The biogas digester is able to turn human excrement and kitchen garbage into fuel that can be used for cooking or generating electricity. The digester uses bacteria to break down the waste into sludge which can be used as fertilizer. In the process the bacteria emit methane that is stored in a canister and then pumped into the distribution system.

A one cubic meter digester can convert the waste generated by a four person family into enough fuel to cook all its meals. A device like the one in figure (18) would cost about $425 and could be able to provide biogas for the needs of a family of four people.

The experiment under analysis is a biogas plant in a South Delhi neighborhood where around 1,000 people use a public toilet constructed by a nonprofit foundation: the biogas digester attached to it provides enough gas for a 600-student school for heating and cooking. (Nestor, 2009)

Another interesting example is the biogas facility developed by the Kigali Institute of Science, Technology and Management in Rwanda.

The country has recently been involved in conflict and ethnic war that has also had the consequence of having 120,000 prisoners incarcerated because of the genocidal campaign.

The prisons in the country are therefore overcrowded by a factor of 10, creating a situation where the facilities have significantly increased energy needs. The overcrowding also leads to large amounts...
of human waste that the prisons cannot adequately process, due to under capacity of the sewage system.
Prior to the construction of the biogas facilities in the prisons, part of the human waste was released in the natural environment, causing pollution of drinkable water and the spread of illnesses like typhus and cholera.
The process requires putting a given amount of human or other animal waste into a "digester," which ferments it using bacteria to release methane gas that can be captured and then burned as fuel. Attached is a "compensating chamber" that replenishes the supply of bacteria to keep the operation self-sustaining. Within four weeks, 100 cubic meters of waste can be transformed into 50 cubic meters of fuel.
According to the university’s rector the Rwandan biogas facilities, which are currently in half of the 30 prisons around the country, now contribute half of the energy needs for cooking and lighting in each location. (Farivar, 2005)
Water scarcity and water reuse development in architecture

An important issue related with the biogas production is the availability of water resources. For the fermenter to be efficient, the sludge that is reversioned in the tank must have the adequate amount of water as a percentage of the volume in order to efficiently favor the bacterial digestion. (Farivar, 2005)

However, water reserves are one of the most threatened natural resources since the growth of the population has increased dramatically the amount of water needs for drinking, sanitation, agriculture and manufacturing. For this reason, water recycling and reuse represents an opportunity in terms of reduction of the wasted water and contamination of pure drinkable wells. (FAO, 2009)

The reuse of domestic wastewaters for secondary, non-potable applications in many countries has been hampered by the lack of regulations governing water quality criteria. Examples of domestic reuse schemes in Europe range from single house systems which take water from sinks, showers and baths for reuse in toilet flushing, landscape irrigation and, less frequently, secondary uses such as car washing, to multi-house (or apartment) schemes with dual supply systems. (Paul Jeffrey, 2007)

Hotels, service stations, schools, and other public buildings are common contexts for water recycling throughout Europe and there are now several ‘off the shelf’ systems available.

The most common systems used throughout Europe consist in a combined pipe system where rainwater is collected in a tank completely covered in the ground and then connected to washing
machines, dishwashing machines, gardening hose and car washing facilities. Another tank collects instead the water that is released by the water basins, shower and baths and is connected with the flushing system of the toilets. This simple system sensibly reduces the request of fresh drinkable water since it is just used for personal sanitation, while the recycled water provides all the other needs.

The cost benefit analysis highlights the importance of governmental policies for the development of water saving systems: high prices of water goods sensibly reduce the amortization time for the investment and therefore encourages private consumers to responsibly address the water consume issue through smart management of the water system.
Study case: Active House in Aarhus, Denmark

An interesting example of active house has been designed by the Architect Rikke Lildholdt in Lystrup, a suburb of Denmark’s second city, Aarhus. The weather in the region would not suggest any solar technology, being the climate mostly cloudy and rainy for a long portion of the year. However, the energy captured is enough for running a 4 people family needs and even create a surplus of energy that is sold to the grid. With an energy surplus of 9 kWh/m²/year, it takes approximately 40 years for the house to generate the same amount of energy that was used to produce its building materials. At that point, the house will have returned more to nature than it consumed. A solar heat pump and 7 m² solar collectors generate energy for heating and hot water, while 50 m² solar cells generate more electricity than the home consumes. A central computer controls the windows automatically and regulates the internal temperature, further diminishing any unnecessary heat loss. Sensors that register heat, CO² and humidity in all rooms and an outside weather station are combined with an intelligent control system to ensure that the house adjusts to the family’s need for a comfortable indoor climate. (Purcell, 2009)

The project was conceived as a more comfortable and user-friendly response to the Passive House, which has set the standard for sustainable living in the last decade in many part of northern and central Europe, in particular in Scandinavia, Germany and Austria. Passive houses mostly rely on incredibly effective insulation, plus a heat exchanger that warms fresh air on the way in during winter. However, a true Passive House has no conventional heating system because, in theory, it doesn’t need one, but in practice, owners tend to install back-up systems, because they do not feel comfortable being obliged to adapt to lower temperatures.

Figure: 21 The active house in Lystrup, Aarhus, Denmark
Another relevant difference with Passive Houses, which are typically only open to the south, there are huge windows on all sides. In Lystrup instead, the design uses a big amount of glass surfaces, equivalent to 40% of the floor surface area and roughly double the average window space. Even on the grim, drizzly days of Danish weather, the rooms are remarkably bright due to the triple glazing windows, and they therefore diminish the amount of artificial lighting required even though they cannot match well-insulated walls for heat efficiency.

The solar panels provide hot water for under floor radiators, but when the sun doesn't shine, an electric pump provides auxiliary energy. For eight months a year, the solar cells produce excess energy to sell to the grid. In the winter months, the house buys back electricity from the wind power facilities of Denmark.

![Figure: 22 Section and energy consumption in the active house](image)

The house has two flat-screen televisions and a washing machine, but no tumble dryer, in order to meet an energy consumption target of 4,000 KWh per year - a little less than the Danish average. The house was worth £500,000 for its construction, but the amount of money saved for heating, cooling and energy provision, together with the income provided by the trade of extra energy will diminish this high investment in 25 years time, a quarter of the average life-time of a house in the region. (Purcell, 2009)
Study case: Active House in Malmö, Sweden

Architect Karin Adalberth, in collaboration with E. ON, one of the biggest energy producers in Europe, has designed Villa Åkarp, just outside the Swedish city of Malmo. The designer and the electric company have developed a plan where the resident purchases a small amount of energy from the network during the dark winter months of Sweden and sells in massive quantities during the summer months of sunshine. The house will be able to deliver 1400 kWh as a surplus produced by the difference between the 2600 kWh purchased during winter and the sold 4000 kWh of summer time. Villa Åkarp follows a wide variety of strategies for achieving energy performance excellence even though the design is that of a traditional Swedish building.

The designer has focused on seven strategies for achieving the goal of a sustainable active house: wall insulation, natural ventilation, ground isolation, heat exchange production, energy production, water savers on the taps and energy efficient electronic equipment. (Erlandsson, 2009)

To achieve these ambitious targets, the designer has implemented a sensible amount of energy efficient technologies. Coatings and insulation of the foundation, triple-glazed windows that allow both access to a considerable amount of natural light, both to keep warm environments.

![Figure: 23 The active house Villa Akarp, Malmö suburb, Sweden](image)

Bodyheat, lighting, refrigerators, computers and many other things generate heat within the house and can go a long way to preconditioning the house before designers need to support ‘heating’ through machinery systems to cover the difference. The heating system itself includes an 18 m² solarthermal collector, an accumulator tank, and traditional radiators. The solar thermal system both heats the house and (pre)heats the domestic hot water. The 2,000 liter accumulator tank retains enough heat for use during the evening and mornings while a connected fuel pellet heater is used to
heat the house’s radiator and domestic hot water during the winter or any other time the solar thermal system cannot meet the demand.

A particularly innovative system uses the tempered sanitary lines exiting the house to preheat the incoming water lines to help reduce the amount of energy needed to bring the cold exterior water up to usable temperatures.

Figure: 24 villa Åkarp, ground floor plan

Thirty-two square meters of solar panels are used to produce energy for the house. However, due to the climatic conditions of Sweden, the solar panels are used primarily between April and October. The calculated energy balance is 4,000 kwh sold back to the grid and 2,600 kwh purchased annually, leaving a net positive energy balance of 1400kWh green energy.

While the residence is definitely a huge step forward in terms of design and sustainable architecture, still has relatively high cost, especially because of all the technologies and devices needed to cut energy needs and maximize the energy produced. The designer estimates that to build Villa Akarp cost about 66,000€ more that to build a traditional house. But despite the high cost, the project certainly deserves considerable praise for its innovation and forward-looking sustainable design (Erlandsson, 2009)
Discussion

As analyzed in the previous chapter, the cheap cost of energy sources that occurred in the 80’s and 90’s encouraged the consumistic model of the western society, in particular the American model of suburbia.

The development that has occurred in those years was based on the credit market principle where a buyer would use the financial market in order to purchase a private property: cheap houses that were built with scarce isolation and that required a big amount of resources for heating and cooling were affordable to a high number of customers.

The insolvency that has become famous as “Subprime Default” has been the main cause of the financial and consequent economic crisis that has stroke the United States since 2007. One of the possible causes behind these insolvencies of American customers can be found in the price of the oil barrel traded for over 140$ (Financial Time, 2009). The high price of fuel commodities for heating and cooling brought many families to cross their financial capacities and therefore they became insolvent towards the banking system that subsequently collapse beneath huge amount of debts.

The high dependence on fossil fuels generated a chain reaction in a society based on cheap energy for its functioning, sinking the banking, financial and lately industrial system.

Figure: 25  Households net saving rates as a percentage of household disposable income. Source: OECD Factbook 2009
As figures 24 and 25 show, the net saving rates of the American families dropped to almost 0% in the same time the oil barrel achieved a relative peak of 70$ per barrels: the low income families had to spend more and more money for heating their houses and meeting their transportation needs than before. This growth in expenses for providing basic needs was the basis of the collapse of the financial system in the US low income family that was suddenly not able to repay the debts it had purchased for buying the house.

The crisis of the year 2008 highlighted how a society strongly dependent on fossil fuel energy is not sustainable. The rapid depletion of the resources will contribute to increase their cost, and the development of new renewable technologies by itself does not offer a trustworthy solution to the growing energetic demand of an increasing global population.

The housing market, accounting in large measure on the energetic demand, can highly contribute to decrease the need of energy and use in a much more efficient way the resources employed in the designing and building process. Concepts such as grey-energy, passive design and recycle of building components can become key aspect of the XXI century design.

The definition of sustainable development offered by the Brundtland commission “as development that meets the needs of the present without compromising the ability of the future generations to meet their own needs” (UN, 1987) can be associated with the idea of sustainable architectural development. We could therefore define sustainable design “as a design that optimize the resources and demands the less amount of energy for the construction and functioning of the architecture”.

The idea of a house as a thirsty organism that demands gas, electricity and water from the global net, should be converted in an independent system that becomes producers instead of receiver. Building
for the climate means understanding the needs and the peculiarities of a specific place, and therefore adapt and develop an architectural solution that communicates with this environmental needs. Many of the features of the future architectures are present in the ancient buildings of those places, and with a responsible use of technology the future buildings will conjugate modernity, technology and cultural heritage on a sustainable level.

The concept of passive design does not mean a refusal of technology and machineries: the idea of diminishing the request of energy does not mean that heaters and coolers won’t be necessary in the next future, but their use can be moderate through a proper designed solution that contributes to mitigate interior climate in buildings and therefore diminish the energy request for their functioning.

Energy efficiency is nowadays considered to be “the fifth fuel”: it can help to satisfy growing demand for energy just as surely as coal, gas, oil or uranium can, but with the advantage of being clean and infinitely available. (EIA, 2008)

The development of smart grid solutions does not assume a mere role of technological attachment to the building, but it becomes the engine and core center of the architectural process. The smart grid cannot indeed be efficient if the design of the manufacture does not reflect the features of a passive architecture where the energy demand is as low as possible: the lower the energy demand of a building, the higher the amount of energy that can be sold and traded in the network. This feature contributes to the success of the investment every customer has to face: if the efficiency is high, than the return of the investment has a shorter amount of time and it therefore becomes more and more attractive to private investors.

The financial aspect represents the most difficult barrier for the development of active architectures, even thought this obstacle is more established in the common opinion more than based on real facts. The cost of an active house is estimated to be the 10% higher than an equivalent size building, but this parameter does not take into consideration the expenses that a household has to face in the lifetime of the building. (Siddiqui, 2008)

On a schematic way we can describe the house price as a sum of two monthly expenditures for the inhabitants: one for paying back the mortgage rate, and one for electrical and functional bills. This scenario is the typical case of a real estate house like the ones offered at low price in the American market of the Subprime Mortgage System.
The graph shows the difference between a common house and an active house on a financial basis: despite the active house are in average 10% more expensive, (Siddiqui, 2008) they do not require additional expenditures for providing electricity and heating, but they instead are able to sell part of the accumulated energy and therefore provide an income.

It is important to highlight in these regards the switch from a resource-based economy to a financial one based on the bank and mortgage system: the money that is currently paying resources like oil, coal and gas is used to finance the debt with the banking system. Sustainability does not simply develop the technological aspect of the design process but it establishes a chain reaction in the whole economic system. The meaning of sustainability is therefore enlarged and involves many different aspects in the development of sustainable economies and societies: land use, infrastructural development, transportation, water accessibility and energy demand are all aspects that contribute to the achievement of sustainable societies.

Another further possibility that raise with the development of the smart grid is represented by the widespread use of electric cars: the overcapacity of solar panels or small wind turbines could be used for recharging the car, especially during night time when demand is low and the car is not required.

Increasing people’s responsibility among energy use and consume is a further positive aspect that arise from smart grid networks: allowing people to gain a profit from the electricity sold to the network represent an extreme valid tool for people to save and consume energy responsibly.

In this sense it becomes very efficient to promote the development of smart grid solutions so that the high burden of investments for energy security is switched from the public finances to the private market, with the enormous advantage of creating consensus among the public opinion instead of concern due to dangerous and polluting energy facilities. On a broader sense, the NIMBISM that accompanies every massive infrastructural development can be easily overtaken, since the population doesn’t perceive any threat to their health and security, but instead have the feeling of
being part of the solution to the energy crisis. On a further stage, the opportunity of preserving green areas from the edification is a key aspect in active architectures: the production of energy on a local basis does not require the construction of infrastructures like energy facilities and correlated implants like pipes and energy cables for providing electricity and heating systems.

**Governmental issues and tax revenues**

The role of governments is of vital importance since the development of a young and not mature technology requires high incentive from the public sector. In the other hand, as the case of biofuels industry in Brazil shows (World Watch Institute, 2008), the investments that the government have to face are highly rewarded by the revenues the industry is able to perform when the technology is mature enough for being competitive in the real market.

This competitive goal, identified as “grid parity” by the economist, is achievable in a very short time period since the cost of the renewable energies is constantly decreasing due to technological development, and the fossil fuels are raising their costs due to the increasing demand and lower availability.

One undervalued issue related with the consumption system is the amount of money that every government collects through the adoption of direct and indirect taxation of the energy sources. For every KW/h consumed, the government collects a fee which can therefore highly contribute to the budget of the state and differently from other forms of taxation it cannot easily be evaded.

For this reason the energy independent micro producer can represent a big problem for the government that cannot collect money from the consumed energy but instead must refund the private producers for the energy provided.

In the other hand, the development of smart grid solution based on clean sources of energy can highly contribute to reduce the enormous amount of money that annually every country spends for the health system. In a study of the World Bank, China’s fossil air pollution is responsible for US$ 50 billion in health cost every year while in the European Union these costs are estimated as US$70 billion (Droege P., 2007). Lower income from the taxation is therefore compensated by lower health system costs.

Another important tool for addressing political lobbyism is the improvement of the carbon credits tax that every polluter has to pay in relation to the greenhouse gas emitted: the higher the cost of the credits, the more effective becomes the use of smart grid solutions.
Energy corporation Lobbies

An underestimated issue in the development of Active Architecture is represented by the lobby activity of the energy corporation. The depletion of energy resources will necessarily lead to an increase in the price of the commodities, therefore implementing the liquidity of electric and energy corporations worldwide. The establishment of independent micro producer represents a threat for this industry sector, since their source of energy is mainly represented by solar panels and geothermal appliances. Resistance at political level represents nowadays the strongest concern for the development of Active architectures. In the other hand, the development of new corporations in the field of renewable energies and sustainable energy sources will enforce this barrier and promote the development of smart meters and biogas solutions in the architectural field.

Challenges for the future

The development of active architecture is currently under studies in many countries worldwide. The opportunities that these technologies have both in economical and environmental terms are very high, as widely discussed in this paper. However, the cost of this technology in terms of electricity production, compared with other sources of energy like gas and coal, shows a big difference in the final price of the kW/h produced, so that without governmental subsides, active architectures remain an elite object. Nonetheless, the rapid technological development, together with the increase in the energy price and environmental concern, suggests that smart grid networks, biogas production from household sewage and water recycling technology will all soon become part of the architectures of the new century.
Conclusions

The energy and resource crisis we have in front of us requires a switch in the way our society, economy and lifestyle are currently established.

We face today the consequences of the wrong assumptions that energy and resources are available on infinite scale: the depletion of these fundamental elements of our economy represents a major threat to our society's development.

The capacity of the system to change from a resource dependent society to a technological efficient one is the key issue we have to solve for assuring our future. The key to the success of our development relies in our ability to switch our living system from a resource based one, to a financial and technological one.

The achievement of a sustainable society does not occur through the development of a unique solution that can be applied in every field, but it occurs through the development of network solutions that together operate towards the common objective. In particular, the energy needs won't be met through the construction of new infrastructures like nuclear facilities, but it will occur through the development of many small and smart solutions replicated in the territory.

For achieving these ambitious goals, we do not need a top-down approach where the solution comes as a miracle of technology, but we instead need a more realistic approach bottom-up where the final solution of the energetic and resource issue is a combination of many smart solutions in every aspect of our society.

In architecture for example, the awareness of the impact that the building process has in the whole economical system is the starting point for the adoption of active smart solutions: being the building sector responsible for nearly a third of the global emissions, architecture has a great importance in the transformation process towards a sustainable society.

Stakeholders in this path are people from every single aspect of the society, since the use of resources is established by the way every individual behaves in relation to the environment. However, the way architects, engineers and planners design our society have great influence to the Way people will be willing to adopt sustainable or unsustainable habits.

Urbanism, architecture and engineering assume a tight correlation in the establishment of a sustainable society that integrates energy consumption, resources' demand, waste disposal, infrastructural development and social integration.
The case studies analyzed in this research paper have highlighted how the sustainable approach have common principles and goals, but they however differ in the way they purchase these aims since the features of the environment and the climate are a peculiarity of the place the architectures belong to. Therefore, the sustainable approach has a common starting point and a common goal, but it has many different paths for the achievement of its targets.
References


