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LUCIA CECCHERINI NELLI
preface
MARCO SALA

Mediterranean Green Architecture
Research and Innovation

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UNIVERSITÀ DEGLI STUDI FIRENZE | DIDA DIPARTIMENTO DI ARCHITETTURA

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Many thanks to all the contributing authors for their tireless efforts in providing with their valuable research that has made this book possible.
Special thanks to ABITA Centre researchers and professors of the University of Florence and particularly to professor Ali Sayigh that every two year organize together with the professors Marco Sala and Fernando Recalde Leon the Med Green Forum in Florence with the Internation student Award competition.

in copertina
Descrizione immagine di copertina
Grafica Med Green Forum Giulia Sala

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Dipartimento di Architettura
Università degli Studi di Firenze
via della Mattonaia, 8 Firenze 50121

ISBN 978-88-3338-024-7

Stampato su carta di pura cellulosa *Fedrigoni Arcoset*

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SUMMARY


Coca-Cola
EL CAPRICHO ANDAL

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Centro Interuniversitario Abita

Cairo: the tipical effect of tents used as street shading devices ©Antonella Trombadore

Think Mediterranean

To switch from a simple consideration of the housing problem and the evolution of building technologies to the application of a "smart city Mediterranean" model, means to analyse and address in an integrated way, all components of cultural, socio-economic and technological that will influence the processes of cities transformation. It needs therefore to refer to a holistic model for defining and optimizing resources in a flexible and adaptive manner, strengthening and enhancing connections to the new green economy and changing society.

This book raises the editorial series ABITA Architettura Bioecologica e Innovazioni Tecnologiche per l'Ambiente, suggesting not only a new design and editorial format, but also presenting a concrete contribution to the international debate, providing a stimulus to move eventually to a theoretical stage in the policy of real experiments, owing to university research on the role of scientific support to the cities management.

It is important today to think about the best strategies for the transformation of Mediterranean Cities in order to offer reliable answers to population growth and migration, taking into account all the issues that these phenomena trigger.

Mediterranean areas previsions by 2025 indicate a population increase of the 25% with the requirement of a large number of new dwellings, as well as to the restructuring, renovation and functional upgrade of existing buildings, lacking in many aspects today.

On the Mediterranean north shore we are witnessing a buildings spread, a population reduction in town centers and a suburbs increase; the southern and eastern shores are characterized by strong urban growth, limited technical and financial capacities of urban centers and a large increase in uncontrolled construction zones.

The pressure on this Mediterranean coast, with an expected increase in population (20 million by 2025) and a doubling of annual tourist numbers, (currently 137 million in coastal regions, with an increase of 2.3% for year) will require a strong development and construction of transport in coastal urban areas.

On the other hand, we are seeing more civil society requests involving the private industry commitment and requirement of the public authorities coordination.
We must find a concrete expression of agreement and respond to an increasingly strong demand for reconciling life comfort, public health and sustainable development, as well as become a strategic program responsible for many regions.
Taking into account the cultural and environmental aspects of our Mediterranean regions, planning leads to a different way of living and promotes the historical content of architectural traditions as well as fosters technological potential density of cultural influences. This approach will also allow for a useful review of the policies developed by the northern European countries that drove research fields on buildings efficiency, energy and environmental issues.
The several countries subscribed to the Kyoto Protocol (including Italy, France, Spain) are committed to national and regional policies. The energy building consumption in Italy is very high (40-45%).
A strong Mediterranean climatic means the problem of summer comfort and consumption of water and natural resources, requiring specific solutions tailored to coastal regions. The climate in these areas also generates the search for a new economic approach linked to energy consumption, to improve conditions of existing buildings, waste management and transport.
Today, the estimated average time spent in a closed or semi-inclosed area is around 20-22 hours a day, meaning strong health problems and built environments comfort.
There are potential gains with tertiary buildings such as increased productivity and lower sick leave related to environmental problems, as suggested by a study which also involves the dangerous materials problem.
Construction is one of the primary activities in the Mediterranean sector with 1.3 million people employed and a budget of 100 billion. Additionally there is a multiplier effect: every new construction sector job generates another two jobs in the global economy. This stimulating effect is aimed at local economy, local materials and small businesses. Unfortunately, this sector has the most number serious accidents and it is indispensable to invest in specific security and control research.


GREEN ARCHITECTURE AND SMART BUILDING ENVELOPE IN THE MEDITERRANEAN BASIN

Lucia Ceccherini Nelli
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Centro Interuniversitario Abita

Antinori Winery ARCHEA Associates Bargino (Florence)
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Greening the building obtains a relative improvement of the building's energy efficiency, environmental balance as well as increasing the biodiversity. Greening systems are a construction practice to reduce solar heating in buildings, to restore the environmental integrity of urban Mediterranean areas, improving the characteristics of green façades and green roofs. Greening solutions offer a number of benefits as a characteristic of current urban design; such as the relationship between building energy efficiency and its effect on the environment. The vegetation integration in vertical greening systems is a sustainable approach for buildings currently being developed. Greening the building envelope especially in Mediterranean climate and in the warm season, reduces the peak temperature on the wall surfaces with climbers' plants. Some studies demonstrate that greenings buildings technology for roofs or facades, can increase the dynamic thermal characteristics of the wall surfaces temperature to reach a good thermal behavior of the building envelope. Few case studies are analyzed in this paper, taking into account energy savings strategies to reduce energy consumption in buildings.

Introduction

The use of vegetation in the building envelope is an interesting sustainable strategy to save energy. Green rooves, façades greened with climbing plants or living wall systems using modular pre-vegetated panels or vertical greening systems, are solutions that can be used as energy saving methods for the built environment.

Many technical solutions are under development for vertical greening systems, especially for wall systems, while for the green rooves greening technologies are more consolidated.

Green facades are particularly beneficial for insulation control and waterproofing, durability, maintenance, nutrients, choice of plants related to the climate conditions, materials involved, etc.

Greening facades have interesting thermal performances, vegetation creates shade against the wall, reducing the effect of the solar gains on the building envelope during the warm

Green roof on the Virtual Competence Building Information Communication Technology, ICT, Lucca, Italy. © Lucia Ceccherini Nelli

period. Plants absorb solar radiation for their growth and biological functions, such as transpiration, photosynthesis and evaporation, so they constitute a solar barrier envelope. Sun radiation penetrates the green façade, affecting the interior environment of buildings. Plant cover reduces air movement, controlling the humidity of the walls.
In Mediterranean regions, the negative effect of roof and wall overheating can be reduced by an appropriate use of plant cover, that can radically decrease thermal loads and increase thermal behavior in buildings.

Energy Strategies and Thermal Performance of Greening Buildings

Several studies deal with the effect of landscaping solutions on the building envelope to reach good thermal performances, in particular they have shown how vegetation barriers lead to lower surface temperatures on the building envelope.
The heating/cooling thermal improvement effects caused by green walls behind outer walls are determined by various combinations of building design. Leaves act as optical filters, while the deeper layers act as an insulating material. Leaves also create a strip of air which acts as an additional thermal insulation that reduces wind strength. The thermal response of the building depends on the density of the plant cover and the height of the vegetation. The density of plant cover against the wall provides value in terms of insulation characteristics and thermal resistance.
The exploitation of plant-covered walls or rooves becomes extremely efficient in neu-

Benefit Mediterranean climate		
Direct green	Energy saving for heating	1.2%
Direct green	Temperature decrease	4.5°
	Energy saving for cooling	43%
Indirect green	Energy saving for heating	1.2%
	Temperature decrease	4.5°
	Energy saving for cooling	43%
Flowerpot	Energy saving for heating	6.3%
	Temperature decrease	4.5°
	Energy saving for cooling	43%
Felt layers	Energy saving for heating	4%
	Temperature decrease	4.5°
	Energy saving for cooling	43%

Table 1. Energy saving (calculated with Termo 8.0 software, for heating, energy saving for cooling and temperature decrease for Mediterranean climate - from Alexandri, E, Jones P.2008 Temperature decrease in a urban canyon due to green walls and green roofs in diverse climates. Building and Environment 43 (2008) 480-493).

tralizing the solar impact and regulating the microclimate around the built environment (data provided by the research of E.A Eumorfopoulou and KJ Kontoleon in Experimental approach to the contribution of plant covered walls to the thermal behavior of building envelopes – Building and Environment – Elsevier n.44 2009).

Green façades and living wall systems created with filtered pre-vegetated panels have different characteristics from the other greening systems that influence thermal characteristics of the wall.

The thickness of the foliage and wind velocity depends the thermal transmittance and insulation properties (study conducted by the research group of K.Perini, M.Ottelè, E.M. Haas, R. Raiteri in Greening the building envelope, façade greening and living wall system – Open Journal of Ecology, vol 1 n.1 1-8-2011) shows the potential of vertical green layers on reducing the wind velocity around building façades.

The environmental benefits of greening systems depends on the scale of the place in which they are positioned, some of those work in large surfaces and their benefits are apparent at the neighborhood or city scale.

Greening at a larger scale regard mainly the improvement of air quality and urban wildlife (bio- diversity) and the mitigation of urban heat island effect.

The greening modules based on felt layers have a high environmental burden due to the durability aspect and the materials used.

Wall	Stratigraphy	K (W/m²K) Transmittance value without plant coating	K (W/m²K) Transmittance value with plant coating	Improvement expressed %
Light wood wall	1 cm chalk plaster 3 cm battens 8 cm mineral fibers 8 cm interspace 8 mm glazing	0,32	0,31	3,12
Brick with insulation	1 cm chalk plaster 3 cm insulation 24 cm bricks 2 cm plaster lime cement	0,54	0,51	5,56
Brick without insulation	1 cm chalk plaster 24 cm bricks 1 cm chalk plaster	1,24	1,16	6,45
Concrete wall	30 cm concrete with inert non-porous without cavity	2,06	1,74	15,53
Natural stone	30 cm natural stone	2,53	2,06	18,58

Table 2 - Increased thermal resistance resulting from the adoption of a coating plant evergreen, some different buildings walls with compositions and stratography (Baumann, Rudi, Begrunte Architektur).

Since the development in this field is growing rapidly especially during the last few years, many systems with different materials and characteristics are readily available. The different systems and materials can influence the environment either positively and negatively. Greening the building envelope, considering the benefits and materials involved, is a sustainable option for new constructions and retrofitting.

Plant foliages that cover wall sections with reference to measurements of table 2, indicate that a less insulated wall can provide a better thermal performance using green systems for the envelope façade. The influence of greening on wall surfaces can improve passive design increasing thermal behavior and comfort in building, reducing the need of cooling and contributing to the sustainability of building design.

Greening systems

The green structures design take into account many aspects such as the integration with the building envelope, a sustainable material choice that not only considers the environmental impact, but also the symbiosis between the medium growing and the vegetation, which is a key element for the success of the greening system.

The Eco-boulevard in Vallecas built in 2007 is an urban recycling operation consisting of the following actions: insertion of an air tree-social dynamizer over an existing urbanization area. This system, is capable of lowering temperature by around 10º C, depending on humidity conditions and temperature. The system goes into action when a temperature sensor detects temperatures above 27ºC in its surroundings. It is particularly ef‣cient with high temperatures and low relative humidity (typical conditions in Madrid during the summer).
The Air Trees are an exportable nature, so they may be re-installed in similar locations or in other types of situations requiring an urban activity or reactivation © www.archdaily.com

Advantages:

- A living surface that changes with the seasons.
- Contribution to local environment and ecology, increasing biomass in the city.
- Aesthetics, visual improvement.
- Cooling in summer and thermal insulation in winter, reduces energy consumption.
- Protection of the wall against direct sunlight, making an efficient thermal insulator (shade).
- Reduction of heat fluctuation (50%).

Switzerland, Sihl City complex in Zurich. Five species of different climbers using a Jakob steel system. Wall is ‣ve years old. Structure such as net system or cable and wire net.

Spontaneous vegetation covers the building.

- Reduction of the exterior temperature by 5.5°C = reduction of air-conditioning energy bill by 50-70%, cooling effect.
- Reduction of heat loss in winter (walls opposite where sunlight falls).
- Screening against currents of cold air = 75% reduction in cooling, possible to reduce energy demand by 25% (depending on the thickness of the plants).
- Filtration of dust and other particulate contaminants, protecting against atmospheric pollution.
- Protection against heavy rain and hail.
- Protection of construction materials, screening ultraviolet light.
- Reduction of exterior noise by urban acoustic screen.
- Formation of an air cushion between plants and wall.

Contribution to the Biodiversity of Urban Space:

- Presence of large numbers of invertebrates, meaning food for birds as well as nesting sites.
- Source of food for insects, hibernation sites.

Vertical green can be divided in three main branches, namely green façades, wall vegetations and living wall system.

MMW Architects designed this green wall installation as a stunt project called Skien's MerSmak-festival in the back yard of the Lundetangen Pub in Norway. They constructed the bamboo scaffold system, measuring 12m x 6m x 0.3m and attached it to an existing concrete wall with plastic strips. The bags were attached to the scaffolding with plastic strips. © MMW Architects

- Green façades, with climbing plants against a façade from the ground or from planter boxes, are the easiest way to cover the vertical surfaces with vegetation. There are two main categories, plants rooted into the ground and plants that are rooted in an artificial substrate at grade with a watering system. Green façades can be applied directly to the wall or indirectly to the wall with a supporting system. A large variety of plants can be used for making green façades. Hedera plants (common ivy) are the most common.
- Wall vegetations (spontaneous growing of plants on structures), are growing without any human intervention in a natural way with irregular patterns. This type of vegetation can be typically found on older buildings and monuments. Concrete panels with a variety of large pores are a new development to create green structures within a short period of time (1-2 years). These panels are also a type of façade which are suitable to plant vegetation on them.
- Living wall systems involving pre-vegetated or 'prefabricated' modular panels, or in situ applied panels, are quite a modern technology. A watering system and nutrients distribution are always required and the modular panels are replaceable. There are various types of living wall systems which are already applied and applicable. Living walls are distinct from green façades in that they support vegetation that is rooted in substrate attached the wall itself, rather than being rooted at the base of the wall, and as a consequence, have been likened more to vertical living systems. Living wall systems can be used either outdoors or

Green wall at the "Universidad del Claustro de Sor Juana", Mexico city. Mexico City is famous for its high levels of air pollution, it is interesting to see if planted walls can have a signi‣cant impact in such a dif‣cult situation.
© pinterest.com

indoors. A large variety of plants as herbs can be used on the living wall panels. A few examples of living wall systems are described in the case studies in this report.

opposite page
Vertical Garden of Patrick Blanc, Caixa Forum, Madrid 2007
© John Gideon

Case Studies

Children library San Vincente town square, Spain Arch. José Maria Chofre

Few case studies, in Mediterranean climatic conditions, are analyzed in this paper to discuss the comfort brought by the green building envelope. Many contemporary architects are seeking to achieve a closer relationship with the environment. As a result, the criteria for sustainability and natural processes are starting to be taken into account in the design and construction of buildings.

Detail of the green front made with living wall system
©urbanarbolismo.com

The following are some examples of case studies between projects, retrofit and new buildings that use the green façade or rooves differently.
Here we have a six story tall green wall by architect Jose Maria Chofre, which is realized with a living wall system.
The articulated design, teamed with the variety of foliage covers the new children's library in eastern Spain. The six-story green wall consists of a metal framework built on a dividing vertical garden facade between the library and a building with actual living quarters. Plants are added into the framework between a couple of metal grates using mock felt, which can be accessed efficiently from several aisles at the back. A suspended scaffold hangs from the front and allows for maintenance.
Many types of flora and herbaceous plants have been added into the installation.
One type of plant has been arranged in each square: smaller flowers, herbs and plants fill at the top, instead ivy and brackens grow at the bottom of the garden. The abundant foliage makes for an interesting design.A metal framework built over the concrete storage is used spraying water for plants. A suspended platform at the front allows for cutting back and substituting every type of species.

opposite page
The ceramic wall with indigenous succulents Ibiza
©urbanarbolismo.com

Hotel Ushuaia, Ibiza, Spain, Urbanarbolismo

Vegetation covers several walls of the Hotel Ushuaia's garden in Ibiza acting as an acoustic barrier between the open-air disco in the central courtyard of the hotel and the nearby appartments. The green wall has been made with ceramic racks. The configuration of garden vegetation substrate collaborates to create an anechoic effect: each of the holes serves to absorb sound.

The main garden surrounds the terrace of one of the restaurant hotels and avoids the concentration of noise at that point, making this area comfortable and intimate. The double wall made by the ceramic wine racks resembles a vertical garden studded with local plants. A variety of plants have been chosen with the local climate in mind, such as: crassula, euphorbia, echeveria, aeonium, kalanchoe, sedum and sedeveria. These species come from some ecosystems where they are located vertically in little substrate and can provide a multitude of colors throughout the year. The wall is low-maintenance and sustainable since its plants thrive in little soil, can withstand strong heat and need only be watered once a month in Winter, and once a week in Summer.

The Gate Residence multiuse complex Cairo 2015-2019 Egypt, Vincent Callebaut Architectures (VCA)

The multi-use complex in Cairo of the Vincent Callebaut Architecture is inspired by the structure of the coral reefs. The complex, named 'The Gate Residence', is a connected conglomerate designed to combat global warming. It resembles an organism with green terraces and a solar roof.

The Gate Residence, with the green trees and renewable energy systems, Vincent Callebauts
© inhabitat.com

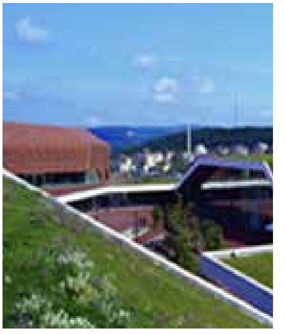
The Gate Project uses renewable energies and technologies to encourage energy saving and a 50 percent reduction in carbon. A second white steel skin enables upstairs integration photovoltaic cells, the thermal tubes, and the vertical living walls. The plate surface of the roof is like a cavity of giant trees, towards the basement. The structure is weighed with playground areas, gardens, orchards, swimming pools and many types of sports areas. The building is designed according to the solar cycle, prevailing wind direction. A number of different species have been planted within the green facade. The building integrates various renewable energy sources such as photovoltaics, wind turbines, geothermal energy and biomass. On the roof there are wind catchers, which are very common in traditional Egyptian architecture. These devices function in three ways: they direct airflow using direct wind entry, wind-assisted or solar-assisted temperature gradients.
Nine of these devices are installed onsite and are meant to stimulate natural passive cooling. In addition to these, the complex features solar water heating tubes and vertical axis wind turbines. The living units have multi-sensors to determine the number of people in the room, the motion, temperature and light levels. A user interface enables the inhabitants to control different zones within their living spaces.
Nine 'mega trees' act as wind catchers, known in Arabic as "Malqaf" and work by redirecting airflow to provide a natural cooling system. They naturally ventilate the basement spaces and refresh the patios and boulevard. The building uses innovative new solar PV cell technology to generate power, cells use visible and infrared light and ultraviolet ra-

The green tree wind catchers and detail of the front Gate Residence
© inhabitat.com Vincent Callebauts

diation. The solar roof is covered by walkable solar panels that shadow above the patios and the boulevard to generate a big part of the electricity necessary for the building. Living walls allow the overall reduction building temperature of the Gate and they are a method for water recycling by purifying polluted water and absorbing the dissolved nutrients. The building contains 'smart homes' with multi-sensors able to control the different zones, rooms, temperature and ventilation. Solar water heating systems deliver hot water to all of the bathrooms and kitchens for most of the year. Water is collected in glass-metal tubes on the roof that are exposed to the sunlight and help to warm the water.

The Meydan Retail Complex, Istanbul, Turkey - ONZ Architects

The Meydan Retail Complex, built in Istanbul, Turkey, by the Foreign Office Architects (FOA) is another example of architecture constructed to represent a model of green policy. The project features an open and airy multi-level louvered building, which acts as the entryway for the eco-park. The low-lying retail complex functions as a mall but also as a true urban center in one of the fastest growing areas of Istanbul.

Hypogeum Meydan Retail Complex
© http://www.miesarch.com/

opposite page
Aerial view of the Hypogeum Meydan Retail Complex Friedrich Ludewig Metro Asset Management - Mies Arch Prize
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The parking lot is underground, thus releasing part of the ground floor for a large square. Skylights make daylight in the shops, thus creating a link between the sales space and the hanging gardens.

In addition to the green roof that naturally cools the underlying environments, Meydan is equipped with natural ventilation and heating and cooling by wells; this is a primacy in Turkey.

Public lighting is powered by solar panels and since many of the spaces are external or illuminated by skylights, electric lighting has been minimized. The project also maximizes shading and creates windswept repairs with the use of architectural masses.

Located in a suburban area on the Asian sector of Istanbul, with its geometry and circulation strategy, the complex anticipates its subsequent integration into a dense inner city context as an alternative to the usual out-of-town retail box development.

The central square, through a series of new pedestrian paths, connects to the underground parking and to the ground floor through two trails. To organize the retail volumes as an extension of the surround ing topography, rather than as sheds on an asphalt platform – as is common with out of town retail developments – all rooves connected to the surrounding topography at several points are designed as gardens with extensive vegetation.

In addition to physical continuities between the new development and the surrounding context, roof lights have been introduced to retail areas to create visual contact between the retail spaces and the gardens on the rooves.

In this way, the experience of shopping at Meydan connects with the urban space beyond.

In regards to environmental sustainability, this building becomes a revolutionary con-

cept of 'mall,' because it transforms the usual industrial suburban warehouse into a clever and sustainable landscaping complex with functional technology devices.
The geometry and placement of the scheme maximizes natural shading and creation of wind shelters, and uses architectural masses to change and improve the local environment instead of resorting to mechanical reparative measures.

ACXT Technology Interpretation Center, Derio Spain, 2009
The ACXT Center for the Interpretation of Technology was designed by Gonzalo Carro and Javier Perez Uribarri designers, using energy conservation systems. The studio is part of Vizcaya Technology Park, located in Spain, and acts as a center of interpretation that introduces student visitors to all types of developmental technologies.
The 8,500 square-foot building uses geothermal heating and cooling, and a building-integrated photovoltaic system. Many windows lining the front of the structure allow hallways to bath in natural light. Additionally, the roof is lined with grass, and solar panels have been integrated into its triangular shape, providing continuity to the surrounding greenery.


The central square, ACXT Technology Interpretation Center, Derio Spain.
© Aitor Ortiz


Views of the solar-powered hydroponic food belt.
© http://inhabitat.com

opposite page
Medianera architectural integration in the urban contest -Section and Front
© www.domusweb.it

OAXIS: solar-powered hydroponic food belt in the Arabian Peninsula

There are already several projects in the Arabian peninsula that use hydroponics to provide food in the desert. One of these is the OAXIS Sahara Forest Project, which has received a great deal of international attention. This project proposes a solar-powered hydroponic food belt as a solution.

The system is original because it blends together existing technologies into a linear and modular architectural composition. It consists of prefabricated and recycled steel structures equipped with super efficient irrigation technology, that uses roughly 80 percent less water than most farms require. Solar panels on the roof provide all the energy that the structure needs, and also feed the artificial LED lighting, helping to promote greater crop growth.

Medianera verde - Green Side-Wall in Barcelona, Spain by Capella Garcia Arquitectura, 2011

The Green Side-Wall construction in Barcelona, Spain is a self-supporting galvanized steel structure containing eight individual levels of plants in a vertical garden. This construction was promoted by the city of Barcelona because after the demolition of part of the building, it was necessary to think of a concept to cover the facade because of its conspicuousness.

The structure has a pyramidal shape and the shrinkage of the building reaches twenty-one meters in height. Upper levels are accessible by way of interior steps. From the first to the eighth level, metal platforms are provided on which the flower-trough modules are arranged perimetrally, on two distinct levels. The access to the vertical greenery allows maintenance and replanting without the use of elevated platforms.

There are many advantages to a green facade in a city centre, from both environmental and aesthetic points of view. First of all, there is the obvious visual enhancement brought about by covering a formerly exposed blind wall in a city street. The green facade is a surface continually changing. It is a live structure that protects the wall of the building against the weather. It generates oxygen and absorbs CO2, keeping the inside cool inside during the Summer and warm during Winter. It protects against pollution - filtering out the dust and other particulate contaminants - and against heavy rain and hail, as well as forming an accoustic screen that dampens noise.

Finally, it contributes to ensuring biodiversity because it is populated by different species of fauna and flora. Water consumption is minimized by means of an automatic drop-by-drop irrigation system.

This system is very unique because it is equipped with controlled drainage and an automatic dosing of fertilizer. Nesting boxes are also integrated. In general, the project has been inspired by the concept of "xeriscaping", which advocates the rational use of irrigation water, the planting of local species, and, in general, eco-efficient design and maintenance criteria.

Design elements

- Easy maintenance: regular programming and substitution of plants, cleaning of structure
  Fire-safety system

Particular of the green facade
© www.domusweb.it

- Safe from vandalism, different wall treatment on ground floor, anti-graffiti.
- Protection of maintenance circuit, life-line, grilles
- Safe maintenance: Parks and Gardens, folding ladder, access key
- Lightning protection system.
- Minimum overhang height: 2.50m (regulation)
- Autonomy of structure, inspired by a tree.
- Automatic watering with drop-by-drop metered system. Minimisation of water consumption.
- Dosing of fertilizer and nutrients.
- Lightened soil, anti-evaporation in summer.
- Controlled drainage.
- Prefabricated galvanized steel structure, with anti-corrosion treatment. Cables with plastic casing, light-colored, anti-reflective materials, small diameter (heating).
- Prior waterproofing and insulation of the side wall of the existing building.
- Integration of nesting boxes.
- Modular plastic flower troughs, light, easily substituted, standard dimensions 1000 x 320 x 550 (h) mm.

View of the vertical garden used to cover the empty wall of the near building and particular of the structure.

- Wall built with brown Bierzo quartzite, laid in the manner of a dry-stone wall, which continues into the paving in front of the facade to form a little courtyard.
- Street furniture integrated into the design.
- Integration of information and identification plaques.
- Xeriscaped garden with very low water consumption, using indigenous and endemic species.

Results

Vertical greening systems built in the Mediterranean climate involve the following environmental benefits: insulation properties, durability aspects, maintenance, plant choice related to the warm climate conditions and materials. The design systems take into account many aspects, such as symbiosis between the growing medium and the vegetation and integration with the building envelope - a sustainable material choice considering the environmental impact. These are key elements for the success of the greening system. In particular, energy saving aspects related to the reduction of energy needed for heating and cooling, have to be taken into account.

Urban sustainable design, new constructions and retrofitting projects, can afford the right choice of greening system within the right parameters, as the climate type and building characteristics, to avoid damages and maintenance problems caused by an inappropriate design. The multiple benefits of vertical greening systems could allow to a more sustainable urban design and compensate the lack of green spaces inside dense cities for the wellbeing of the dwellers and reduce energy losses.

References

Bellomo A. 2003, *Pareti verdi*, in Sistemi editoriali, Napoli, Italy

Katia P. 2013, *Retrofitting with vegetation recent building heritage applying a design tool—the case study of a school building*, in Frontiers of Architectural Research, Volume 2, Issue 3, Pages 267-277

Lambertini A. 2007, *Giardini in verticale,* in Verbavolant, Firenze, page 240.

Pacheco-Torgal F., Cabeza L. F., Labrincha J., Giuntini de Magalhaes A. 2014, *Eco-efficient Construction and Building Materials: Life Cycle Assessment (LCA), Eco-Labelling and Case Studies*, in Woodhead Publishing.

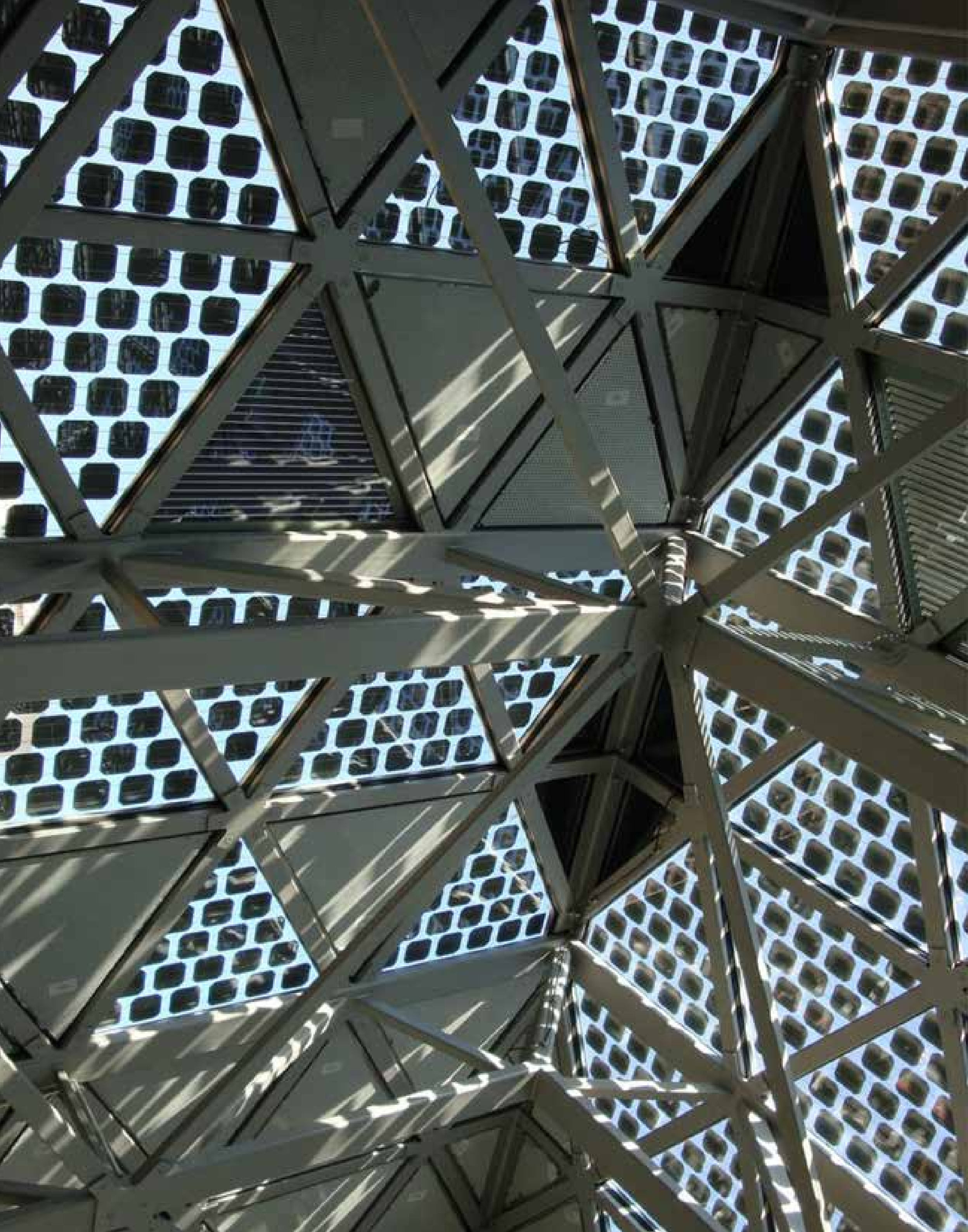
Perini K., Ottelé M., Haas E. M., Raiteri R., *Greening the building envelope, façade greening and living wall systems*, Vol.1, N.1, 1-8- 2011) Open Journal of Ecology, <http://dx.doi.org/10.4236/oje.2011.11001>

Perini K., Ottelé M. 2013, *Vertical greening systems: contribution to thermal behaviour on the building envelope and environmental sustainability*, in Eco-Architecture IV n. 239

Poli T. 2006, *Pelle Verde*, in Modulo, n.319, pages 164-172

Pulselli R.M., Simoncini E., Pulselli F.M., Bastianoni S. 2006. *Energy analysis of building manufacturing, main- tenancy and use: Em-building indices for evaluate housing sustainability,* in Energy and Buildings, pages 620-628.

Arash Zia, Kaveh Zia, Airya Norouzi Larki, *A Comparative Study on Green Wall Systems, in Science and Education Publishing*, novembre.



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Cité Du Design in St. Etienne, France, 2009 PV 25 kWp. LiN Architects
© LiN Architects

Renewable energy technologies currently play a key role in building energy performance. The construction sector offers great potential for the reduction of energy consumption in buildings, and leads the EU to adopt common strategies for Member States related to energy performance in buildings, to achieve the objective that all new buildings will be Nearly Zero Energy Buildings (NZEB) by 2020.

When using the integrated approach, the solar systems become part of the general building design, in fact they can become regular building elements.

The solar elements cannot be separate elements, added in a later phase of the building process, or when the architectural design is complete. They must rather replace other building elements, thereby serving dual functions and reducing total costs.

In fact, the integration of renewable energy technologies such as photovoltaic systems and collectors in buildings offers many possibilities within the NZEB scenario.

Photovoltaics technologies and thermal collectors are widely available at competitive prices in the building sector. However, innovative approaches must be explored and implemented to find new architectural solutions at the building scale.

A case of success is Nieuwland, Amersfoort's new housing area, which furthermore aims to demonstrate the technological and architectural potential of BIPV, reduced BIPV costs in terms of both module costs (economy of scale) and BOS-costs (through optimised integration). The project of the urban development started in 1994, and most of the building was concluded in 2000. Now it is in continuous expansion.

The buildings are PV integrated in many ways. Within the roof, pergola, facades and shading devices, the performance of the PV system is optimized in the design and improves the quality control commissioning procedures, with a co-operation between building companies, utilities, town planners and PV industry. In the year 2000, one MW power integrated system was installed.

The project includes over five hundred and fifty houses, an elementary school, a kindergarten and a sports complex. The requirements regarding the PV houses were developed by

Nieuwland, Amersfoort's new housing area PV application. Intersection view between the different typologies of PV integration, with solar portals connecting buildings, PV roof integration of the terraced house and PV integration in the roof skylights. © Lucia Ceccherini Nelli

PV integration with a shelter glass-glass modules
© Lucia Ceccherini Nelli

REMU in cooperation with Ecofys. The idea was to use well proven concepts for the technical integration of solar modules in the building. Guidelines were developed regarding orientation, inclination and ventilation. The resulting architectural designs show a great variety of PV buildings, oriented between SE and SW, with tilt angles for the solar modules between 20° and 90°.

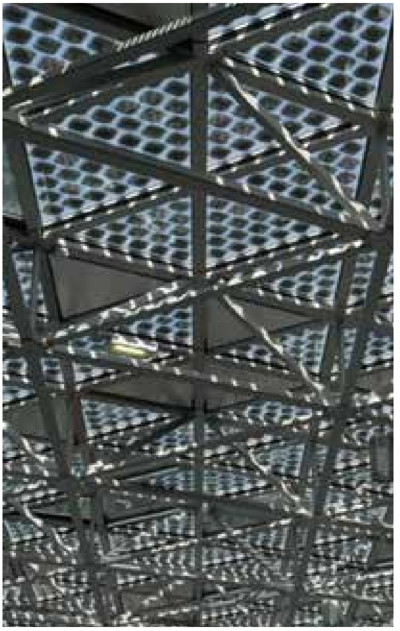
As a result of recent European policy to improve energy efficiency in buildings, and consid-

ering IEA recommendations, based on the best practices (IEA SHC Task 41), the integration of active solar energy technologies into buildings represents a great potential in terms of design benefits and also for cost benefits to achieve high quality standards for NZEB.
For many years, active solar technologies have been intended as a mechanical system of the building, used only for energy production and to make interiors more comfortable for occupants. Since solar thermal and PVs systems need to be entirely exposed to solar radiation in order to maximize their efficiency, more frequently they are installed on the building surfaces, on roofs and into façades.
When integrated into façades, renewable energy is not an addition to the architectural design, but an efficient complement that is aimed to save energy and represents the image of the building exposed to the whole world.
The right strategy consists of paying attention to the project design, planning the integration of active solar devices from the very early stage of the architectural process, improving the architectural integration quality and flexibility of active solar products and devices.

opposite page
Admistrative Federal of‣ces in Berlin
© Lucia Ceccherini Nelli

Today, prefabrication has become a very common practice, used for large scale buildings, based on a frame structure which is closed by façade panels. These panels are designed to be used in modular constructions, they result in high-level quality standards and time-saving on the construction site.
The present work focuses on the architectural integration of an active solar energy product, designed to be a renewable power source, integrated into buildings, with the result of a significant reduction of the global primary energy demand and consequently, provides benefits for the environment.
Thanks to the simultaneous production of electrical and thermal power, this solar concentrator shows a great potential for the field of building construction, and is particularly suitable for applications in farms, solar greenhouses, small industries, hotels, resorts, sports centres (changing rooms, swimming pools etc.), beauty centres and SPAs.
The challenge is to realize a multifunctional façade system, through a multidisciplinary approach involving, in both new and existing building stock, several items such as the architectural project, design, functionality and technical issues, economic issues related to cost optimization of industrial production processes, market placement and return on investment
The integration of photovoltaics into buildings is a huge development because it affects the combination of both markets, BIPV systems and contribution of the renewable elec-

tricity production. PV installation integrated into building rooves and facades allows the possibility of combining energy production with other functions of the building envelope, such as shading, weather shielding and heat production.
Costs saved through these combined functions can be substantial, especially in expensive façade systems where cladding costs may be equal to the PV modules costs.
From the technological point of view, no high value land is required and no separate support structure is necessary. The most important factor is that electricity is generated at the point of use. This avoids transmission and distribution of energy losses reducing company's utilities and maintenance costs.
'Multiple integration' is perhaps an appropriate expression for this phenomenon, because the integration should involve the building envelope, starting from the planning of the construction materials. Multiple integration does not produce multiple costs, it results in multiple savings of landscape, cladding materials and engineering efforts. The manufacturing process of cladding materials should lead to further cost reductions. Integration starts at the beginning of the planning process of a building construction or renovation and continues until the building is finished.
However, the integration of PV into the architectural design offers more than cost benefits. It also allows designer to create efficient buildings with good internal comfort and a good aesthetics.
Citè Du Design in St. Etienne, France, was designed in 2009 and hosts auditoriums, meet-



Cite Du Design in St. Etienne, France, 2009 PV 25 kWp. LiN Architects © LiN Architects

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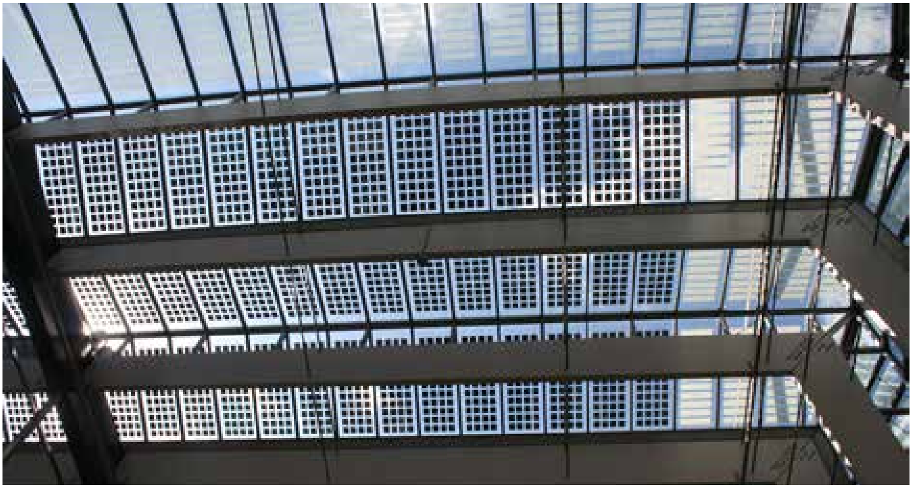
Detail of the PV roof of the Rotterdam railway station
© Lucia Ceccherini Nelli

The aereal view shows the detailed areas where PV panels are istalled
© Rijksoverheid

ing rooms, an exhibition space, a media library, and indoor gardens with an observation tower located alongside the long hall. The white 3D envelope structure forms the walls and roof of the complex, and the interior of the hall is left open without any supports or beams to get in the way. The building is integrated with photovoltaic for 25 kWp, the solar energy produced is used for the heat exchange and recovery systems. The Platine envelope, consisting of 14,000 equilateral triangles measuring 1,2 m per side is a graduated and reactive skin: modulation between opaque and clear, insulated or interclimatic, open or closed.

Pre-conditioned air from the internal gardens, which are not heated, is drawn into the system to heat the nearby rooms. The envelope consists of 14,000 equilateral triangles measuring 1.2m per side is a graduated and reactive skin.



Another important and recent integration of PV is the system realized on the railway station in Rotterdam. The design of the CS Team (a co-operation between MVSA Meyer en Van Schooten Architecten, Benthem Crouwel and West) has realised a glass roof which stretches over all the tracks, (156m wide and 250m long), and is covered with PV-cells that are 10.000mq of the total roof area of 28,000 mq. This is the largest application of solar energy in a station roof in The Netherlands and is also one of the largest rooftop solar projects in Europe. The solar cells are placed on the parts of the roof that get the most sun, taking into account the high buildings around Rotterdam Central. The glass panels vary in light transmittance by using different patterns in the solar cells. Where the roof has the greatest efficiency in terms of sunlight, the cell density is the highest.

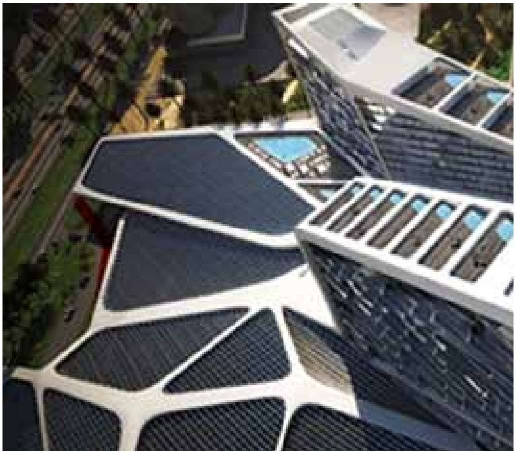
The solar cells that are integrated in the roof have a high degree of transparency, so there is ample light. The solar cells represent an 8% reduction in the station's CO2 emissions.

Desert Learning Centre, Al Ain Zoo a 150 kW solar photovoltaic power
The Sheikh Zayed Desert Learning Centre is a leading example in sustainable design, and falls directly in line with the Abu Dhabi Vision 2030 to develop Abu Dhabi as a sustainable Emirate, with LEED platinum certi‣cation © Emirates News Agency, WAM

The cells are expected to generate 320MW per annum, which is enough energy for 100 households.

Interesting PV integrations are realised not only in Europe but also in the Arab Emirates that are setting global standards for sustainable construction. The Desert Learning Centre, Al Ain Zoo is an outstanding example of this. With an investment of around 60 million euros, the visitor centre for Al Ain Zoo, is a good building in terms technology and sustainability. The building is particularly efficient in term of services for cooling, ventilation, energy supply and water efficiency.

The building has obtained the LEED Platinum and Estidama 5 Pearl certification for the implementation of earth pre-cooling for ventilation, the use of concrete core cooling over 100mq and the first use of adiabatic cooling towers. Water savings adding up to 80 per cent are achieved by a 170mc stormwater storage, a vacuum toilet system, greywater recycling, adiabatic cooling towers and TSE irrigation. The ventilation system uses soil/air pre-cooling for a total air volume of up to 63,000 m³ per hour. Optimal adaptation to the local climate is provided by smart cooling strategies: The cooling load is minimised by passive means, e.g. an insulated building envelope and a high thermal mass, whereas efficiency is maximised by the division of temperature levels (separate temperature levels for dehumidificiation and sensible cooling), waste-heat recovery and solar absorption cooling. For energy supply, the building has a photovoltaic system producing more than 200 MWh per year via a gross area of about 1,500 m² of tempered glass located on the roof.



Graft Lab's complex in Dubai is a multi-use Vertical village building

Graft Lab's Vertical Village in Dubai is a multi-use building and accompanying by massive array of solar collectors was designed to work smarter, not harder, which is expected to earn it a LEED Gold certification when it is completed.

The Vertical Village in Dubai of the Graft Lab architects incorporates the most basic strategies of energy-efficiency in hot climates: reducing solar gain and maximizing solar production, every hockey stick shaped construction inside the village is self shading on its north face and on the east west alliance to decrease long angle sun diffusion.

The solar roof, which the complex is equipped with, behaves like a leaf, with veins that break the solar field into manageable portions and help transport energy, which in this case is solar heated water that is used to reduce the amount of air conditioning the building requires.

A large number of solar collectors are on the south end of the complex and automatically follow the sun to maximize solar-energy production.

The roof of the village has veins like a leaf which can break up the solar field into reduces parts, to rich a better control of sun radiation.

The last example is the sustainable Masdar city in the desert in the Emirates, Masdar City is designed by the British architects Foster and Partners, is an innovative smart city where architecture reinterpret traditional Arab settlements with the addiction to be carbon neutral and zero waste.

The settlement is extended for 640-hectare and the key component proposed by the Abu Dhabi government is to establish the development of renewable energy and clean-technology solutions to be self-sufficient by oil.

Masdar Masterplan and Typical Masdar massive architecture with mashrabiyas and the shadowed porch.
© Foster + Partners

The city has the ambition of attracting the highest levels of expertise for sustainable building, in fact includes the headquarters for the International Renewable Energy Agency and the Masdar Institute.

The City location is strategic is linked to Abu Dhabi's neighbouring communities and the international airport, connected by the existing road and rail routes.

The masterplan is designed to be highly flexible and is developed into two sectors to encourage walking. With its shaded streets and courtyards, the city offers an attractive pedestrian environment, buildings and streets are sheltered from climatic extremes conditions. The land surrounding the city will contain wind and photovoltaic farms, allowing the community to be entirely energy self-sufficient. The Masdar Institute campus is able to consume less energy because buildings combine passive and intelligent design: 95 percent less in domestic hot water energy; 75 percent less in cooling demand; 70 percent less in both electricity and potable water. The campus integrates the best practices in sustainable development, narrow corridors smart shadowed facades and environmentally friendly materials, the campus reduces heat in the summer and uses solar panels, integrate into roofs, to generate renewable energy for energy needs. Windows in the residential buildings are protected by a contemporary reinterpretation of mashrabiya, a type of latticed projecting bow window, constructed with sustainably developed, glass-reinforced concrete and coloured with local sand to integrate with its desert context and to minimise maintenance. The principal characterisation of the buildings are the perforated screens, traditionally known as mashrabiya realised with terracotta tiles, this kind of design solution provides privacy within an urban fabric that is closely knit to recreate spaces of social gathering and interaction.






Central square with the multi storey buildings. View of the photovoltaic shelters on the roofs.
Paticular of the undulating baconies.
Detail of mashrabiyas.
© Nigel Young/ Foster+Partners

Photo of the Masdar Institute Courtyard showing the wind tower, and the layered facades of residential units. Photo Copyrights: Nigel Young/ Foster+Partners A 45m-high wind tower in Masdar City takes inspiration from traditional Arab technology. It produces a cooling effect, by directing hot air up and out of its surrounding area, as well as bringing cooler air from above down to the surface. © Nigel Young/ Foster+Partners

The perforated screens design makes in evidence the importance of regional vernacular expression, revisiting Masdar buildings facades allow an adequate daylight distribution in each room and use the sun light as the main light source for a greater portion of the year, with a consequent reduction of the demand for artificial lighting. [1]
Sustainability as criteria of design explores the use of a diverse range of materials such as terracotta tiles, aluminium and recycled steel as well as GRC screens to create buildings that have good thermal insulation properties. A strong sustainable characterisation is given by the wind tower, in the central part of Masdar city, a tall (45 metres) cylinder tower capable of provoking a convection current as hot air rises simply by standing near or under the tower, this creates a natural current of air flowing from the street level of the city and up out to the top of the tower – the breeze creates pulls of hot air out of the city and makes life in the plaza below considerably more pleasant and refreshed. By adjusting the tower louvres it can catch any prevailing wind and therefore "pull down" flowing air, sending it cascading into the plaza and provide a breeze reducing the perceived temperatures by as much as 5°C. Buildings being compact and narrow, also means, the breeze

Particular of the base of the wind tower and the internal tower view.
© tripadvisor.com

Wind tower- Louvres (in the upper part of the tower) are automatic and are controlled by sensors, whitch monitored direction of the prevailing winds. Mist jets, positioned near louvres, make air humid and cool the ground acting as a an evaporative cooling device.
© Masdar company

can be channelled more tightly, making it faster and more effective. A second use of the tower is that the tower is able to have social benefits reporting to the habitants' data coming from the use of the city on all aspects of its energy and water use. This data helps the habitants to learn what is and what is not working, and to make needed tweaks. Some data will be shared publicly to give the residents an idea of where energy is being wasted and where kudos have been earned. LED lights run up, from each of the three legs of the tower.

When they are green, the city is running at better than it's daily goal for energy consumption, when the lights are red the city has exceeded it's limits by some amount. This kind of alert should convince population to reduce their consumption in the respect of the environment.

IRENA HQ building use passive design strategies, in particular an integrated shading envelope for the maximum daylight and views.The exterior façade is characterized by a curving form, incorporating either horizontal or vertical shading devices depending on the specific orientation of the elevation, the envelope materials include high-performance shielded glass and high-efficiency insulation, as well as aluminium panels.

The city is built on a platform and underground are positioned infrastructures and public transports. Utility services include:

IRENA HQ Building Photo: Aidan Imanova.
© MenaFN.com

Masdar Solar PV plant
© MenaFN.com

- Energy primarily supplied by the city's solar power plants,
- District cooling for air conditioning,
- Wet utilities [water, wastewater, re-use water, and storm water],
- Telecommunications,
- Waste management and recycling

A 10MW solar photovoltaic plant is operational within Masdar City, realised with a 22-hectare field of 87,777 solar plants, power generated is used for the Masdar Institute buildings and many other building others additional energy form photovoltaic is provided by PV modules on rooftops. Wind farms outside the city perimeter will also be used to generate 20 megawatts to the city.

Suntech Power supplied 18,228 solar poly crystalline panels and First Solar supplied 69,552 thin-film modules for this system. The PV system produces about 17,500 megawatt-hours of electricity per year and offsets 15,000 tonnes of carbon emissions per year. On top of the ground installations, the PV system on the various roofs has a total capacity of 1MW.

Besides this large 10MW installation, there's also CPV technology installation.

During the planning phase of Masdar's solar systems, Masdar and Spain's Instituto De Sistemas Fotovoltaicos de Concentración S.A. -(ISFOC) performed an extensive feasibility study to examine the effects of dust, ambient temperature, ground fog and haze on the energy output and reliability of CPV technologies. On top of that, keeping the equipment clean is another challenge in this arid part of the world, where sweet water for cleaning is mostly acquired through desalination. This turns out expensive.

Company Energy Innovation supplied an HCPV (Heliostat Concentrator Photovolta-

HCPV (Heliostat Concentrator Photovoltaic) installation with Sun•ower technology. The Beam Down Tower at Masdar is a step forward in concentrated solar power (CSP). Unlike other plants, the system re•ects sunlight twice, once from the heliostats to the central tower and once from the tower down to a collection platform at the system's base. © Kamran Jebreili

ic) installation with their Sunflower technology. HCPV technology is often picked in hot climates over Si and thin film technologies. HCPV is suitable for desert climate because is able to withstand high temperature conditions.

Sunflower's HCPV system uses triple junction cells. One advantage over standard Si cells, is that these solar cells have a more favourable temperature coefficient, meaning the performance is less affected by high ambient temperatures. The Solar Hub is located in Masdar City and with this solar testing and R&D hub, it aims to accelerate the development of solar energy solutions in the UAE and the Middle East.

Masdar's new EcoVilla, in January 2017 was built the prototype and represents a residential future that is The Eco-Villa, a pilot project incorporating water and energy-saving technologies, is a 405 square-metre the first villa to achieve a 4 Pearl rating according to the Abu Dhabi Urban Planning Council's Estidama Pearl Building Rating System. It will use around 72 per cent less energy and 35 per cent less water than a typical comparably sized villa in Abu Dhabi, displacing an estimated 63 tonnes of carbon dioxide annually. The four-bedroom property is expected to consume just 97 kilowatt hours (kWh) of electricity per square metre. Fully equipped with 87 rooftop solar panels, the prototype is capable of supplying as much as 40,000 kWh of electricity to the national grid. A suite of passive energy and water-saving design features further reduce its impact on the environment.

Once a family moves into the property, Masdar's sustainability team will monitor the villa's


Eco Villas - Eighty nine rooftop solar panels generate as much electricity as the Eco-Villa consumes from the electricity grid.
© masdar Company

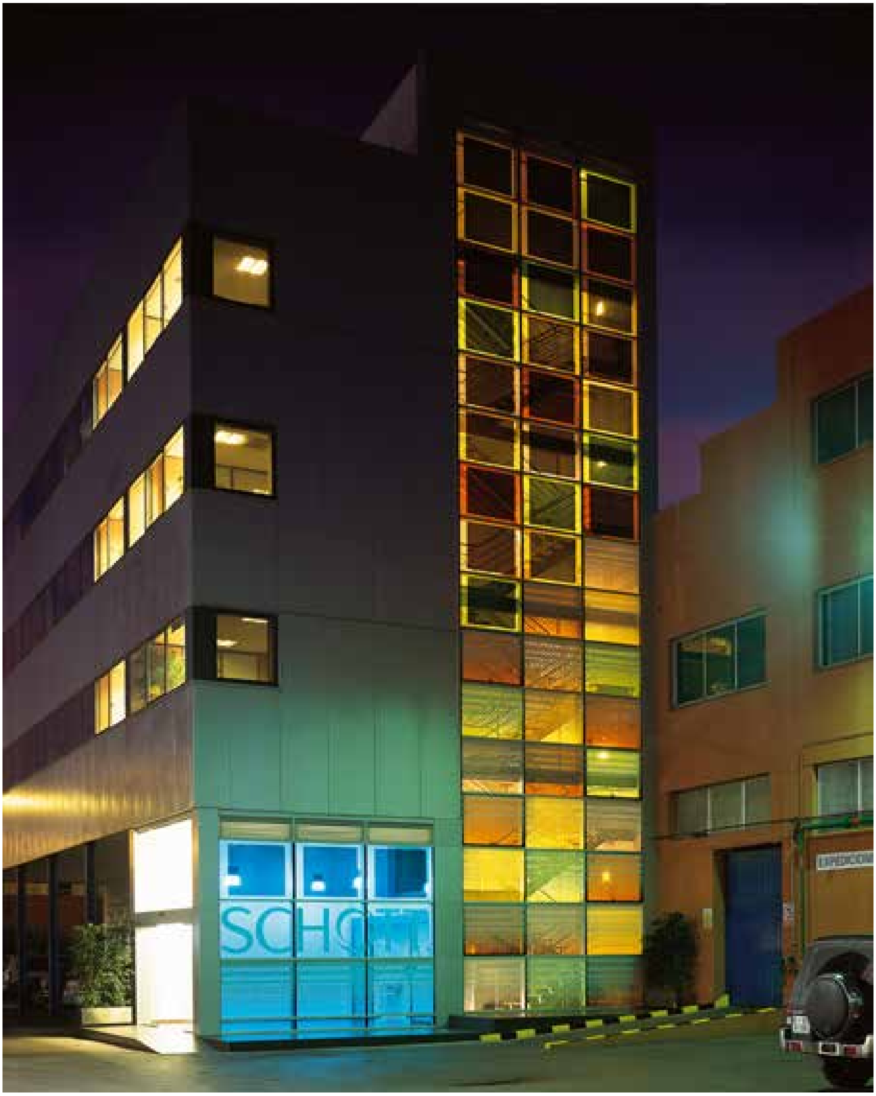
energy, water and waste management performance. The data collected will enable the design of the Eco-Villa to be further refined, supporting the eventual commercialisation of the building concept. The prototype want to demonstrate that sustainable design can be implemented according to the specific environmental, social and economic demands of the Gulf region.

opposite page
View of Masdar villas with the metal mashrabiya shading devices
© Masdar company

Conclusion

From the analysis of the European research FOSTEr in MED project for the diffusion of the integration of PV in Buildings in the Mediterranean regions (http://www.foster-inmed.eu/index.php/) emerges that in the countries such as: Egypt, Jordan, Lebanon, Tunisia, areas involved in the EU project, are characterised by the growth of electricity consumption. A peak in summer is linked to the increasing diffusion of air conditioning systems. In all the previous countries, the increasing price of electricity causes the need to evaluate the diversification of sources used to produce electricity. The analysis showed that PV technologies are not diffused in that countries. These technologies are considered expensive in relation to the price of electricity provided by national grids; generally, the low price of electricity is due to the high level of subsidies related to the use of fossil fuels. Population and administrations are not aware of benefits coming from PV technologies diffusion. Furthermore, PV technologies diffusion could be supported by different factors: population growth; increasing consumption; increasing fuels and electricity and political instability in the area. Additional important drivers consist in the increasing interest of Gulf countries to invest in renewable energy technologies and the development of commercial agreements with PV technologies producers such as Spain, Germany, Ja-

pan, USA. The context in Italy and Spain is considerably different. The European Union policies against climate change forced countries to invest for promoting the renewable energy diffusion. Both countries introduced a generous system of incentives (feed-in tariffs) to foster the diffusion of PV technologies. The incentives permitted to achieve the EU targets required. However, in the last two years, Italian and Spanish Governments decided to cut the feed-in tariffs. Furthermore, two factors could drive PV demand, without incentives, consist in the increasing awareness regarding PV system adoption benefits and PV system decreasing prices. Indeed, two additional factors able to support PV technologies investments in Italy and Spain are the increase of electricity cost and demand. Innovative technologies could help to overcome the problems caused by lack of space in condominiums and aesthetic concerns for historic buildings and inner city areas.



Photovoltaic solar facade and new entrance hall of the SCHOTT Iberica of‣ce building in Sant Adrià del Besós (Barcelona).
The innovative solution is an integrated innovative PV panel ASI THRU Color, the result of the collaboration between SCHOTT SOLAR and CISOL (Centre d'investigatiò solar)

References

El Amrousi, M. 2017, *Masdar City: As an Example of Sustainable Facades and Building Skins*, International Journal of Structural and Civil Engineering Research Vol. 6, No. 1, February 2017.

El Demery I., 2010, *Sustainable architectural design: Reviving traditional design and adapting modern solutions*, Archnet-IJAR, International Journal of Architectural Research, vol. 4, no. 1, pp. 99-110, 2010.

Web sites

EU Reasearch - Foster in Med <http://www.fosterinmed.eu/> (01/17)

Cite Du Design in St. Etienne, France: solar powered design < http://projects.mcrit.com/esponfutures/index.php/principal/46-cite-du-design-in-st-etienne> (05/17)

Furuto A "Vertical Village / GRAFT Architects" 13 Apr 2012. ArchDaily. Accessed 13 Mar 2018. <https://www.archdaily.com/225687/vertical-village-graft-architects/> ISSN 0719-8884 (05/17)

Foster and Partners Masdar City contents and images https://www.fosterandpartners.com/projects/masdar-city/ (07/17)

Haider H, 2010, *Completion of Masdar City pushed back*, <http://khaleejtimes.com/DisplayArticle09.asp?xfile=data/theuae/2010/October/theuae_October256.xml&section=theuae.>

Imanova A, 2015, *Woods Bagot unveils renewable energy HQ in Masdar City, Abu Dhabi* <http://www.designmena.com/thoughts/woods-bagot-unveils-renewable-energy-hq-in-masdar-city-abu-dhabi>

Leech N, 2013, *Masdar City: Role model for a sustainable future* <http://www.thenational.ae/uae/masdar-city-role-model-for-a-sustainable-future#page2.>

Yassine W and Elgendy K, 2011, *Passive Cooling: Responding to Electricity Demand in the UAE* <http://www.carboun.com/sustainable-design/passive-cooling-responding-to-uae%E2%80%99s-soaring-electricity-demand/. >

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Meyer children Hospital in Florence, Italy, PV 32 kWp. CSPE Associates
© Lucia Ceccherini Nelli

Project
CSPE (Centro Studi Progettazione Edilizia) Firenze
Environmental Sustainable Programme
Centro ABITA Firenze
Structural Engineer
a&i ingegneri associati; Studio tecnico Chiarugi
Electrical Engineer
Studio Lombardini Engineering S.r.l

In the last ten years, many PV integrations into architecture have been realized. The following are some PV integrated systems realised in public buildings in Tuscany during the last few years, designed and monitored by the researchers of the ABITA Interuniversity Centre of the University of Florence.

Meyer Pediatric Hospital in Florence, Italy

The first case study is the Meyer pediatric hospital in Florence. This space is innovative and sustainable, with material light, colors and landscape perception. Characteristics such as advanced technology and environmental sustainability design successfully establish new synergies between the old Ognissanti Villa, the landscape and the new pavilion.

The main atrium is characterised by a structure formed by laminated timber columns, the space is used as a foyer and reception area for the whole hospital complex.

To avoid overheating, the shading is provided by semi-transparent PV panels. The ventilation openings at the top and botton of the greenhouse are controlled by BEMS. A further open area is controlled by the doors.

Innovative technologies in Meyer Children's Hospital include:

- Sun pipes and light ducts: daylight inside the hospital will not only be a good solution for energy saving, but will lift the atmosphere.
- Green roof: the original idea, that the hospital was a place in which psychological aspects were very important for children and parents, suggested that the creation of green roof terracing with gardens allowed for walking and looking at the view at the hills and the green of the park.
- Buffer space on north facade: to be used during rainy days in winter as a hall. The particular section and orientation of the buffer space will contribute to solar gains during Winter, and in Summer will be partially open to reduce overheating.
- Optimum insulation inside walls: simulations have been performed in order to find the optimal quantity for cavity insulation.

The Meyer Children's Hospital in Florence, external view of the PV greenhouse
© Lucia Ceccherini Nelli

View of the glass atrium, with the photovoltaic integration
© Lucia Ceccherini Nelli

opposite page
Main Atrium with glass-glass PV panels and informative display
© Lucia Ceccherini Nelli

- Recycled insulation material: used on the first and second floors.
- Radiant panels: to achieve a better and uniform temperature in patient rooms.
- Condensing Comby Boilers: for a high efficiency heating system.
- Shading for patient rooms and halls: to reduce the direct component of the daylight.

The Meyer's photovoltaic greenhouse has a Southern exposition with unobstructed solar access to the main solar glazing of the walls and roof, in order to maximize the collection of winter sunshine. It is not only a particular type of structure but also, and more importantly, a particular kind of space. The design not only considers energy and environmental aspects, but also social impact. The primary objective is to create a pleasant space for semi-outdoor activities, useable throughout most of the year without need for any extra energy space: a social space well integrated into the adjacent green park.
PV installation integrated into building greenhouse facades allows the possibility to combine energy production with other functions of the building envelope, such as shading, weather shielding and heat production.
Cost savings through these combined functions can be substantial, e.g. in expensive facade systems where cladding costs may equal the costs of the PV modules. Additionally, no high-value land is required and no separate support structure is necessary. Electricity is generated at the point of use.
This avoids transmission and distribution losses and reduces the utility company's capital and maintenance costs. The Photovoltaic system is 30k Wp and realised with glass/glass


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PV modules. It consists of 181 photovoltaic modules made with glazing of different sizes, and the total output is 32,000 Wp. The modules have been integrated in the photovoltaic facade of the greenhouse of the main entrance of the building.
The majority of the PV panels have size 2.20 x 0.938 m with a power of 201 Wp, each can transform direct current into alternating current. They are inlaid in small groups within the wooden structure of on the roof, the control panel and interface with the network. The system is composed of three PV fields, east, west and central lots, each field feeds each of the three phases of the electrical network of the hospital. In order to optimize conversion efficiency of the modules connected to each inverter, they have the same tolerance. Four are the sections in which are divided the types of the PV modules (B1, B2, B1 / 2, B2 / 2) and can be grouped essentially in two types: modules of a length of two meters that produce 200 W, and modules one meter long that produce 88 W. The SE project has achieved electrically compatible modules in order to avoid the mismatching of current in the strings.
The modules are certified and both sides are made from tempered glass HST (guaranteed 20 years).

Energy savings measures

The designed hospital creates a healing environment and landscape for patients. The hospital has a lot of open, airy and bright spaces with high ceilings, which creates a comfortable place and peaceful setting for little patients and their families. The hospital is well integrated in the surrounding environment with a greenhouse, landscaped rooves, skylights, open 'buffer' space, and an energy-efficient hybrid ventilation system. To monitor and conserve energy, the hospital design also includes a 'building energy management system' and light tubes, that create natural light throughout the building. The hospital consumes 40% less energy for heating and cooling and electricity than a standard newly-built Italian hospital.
Innovative technologies in Meyer Children's Hospital include:

- Sun pipes and light ducts: daylight inside the hospital will not only be a good solution for energy saving, but will lift good spirits
- Green roof: the green roof has a strong character in this project. The original idea, that the hospital is a place in which psychological aspects are very important for children and parents, suggested that the creation of green roof terracing with gardens would allow for walking and looking at the view at the surrounding hills and the green of the park

Aereal view of the Hospital with the green roof Meyer. Hospital houses 3 wings. The east wing hosts the university and research unit; the west wing, the outpatient facilities; and a central block houses the administrative department. The main entrance of the hospital leads to a glazed passageway to a 'healing garden', which further leads to the spacious upper atrium. The upper atrium features a play area for children that open towards a green roof. © Firenze today

- Buffer space on north facade: will be used during rainy days in winter as a hall; the particular section and orientation of the buffer space will contribute to solar gains during winter. In summer, it is partly openable to reduce overheating
- Optimum insulation inside walls: simulations have been done to find the optimum for cavity insulation.
- Insulation material used on the first and second floors is recycled material
- Radiant panels: to achieve a better and uniform temperature in patient rooms
- Condensing Comby Boilers for a high efficiency heating system
- Shading for patient rooms and halls to reduce the direct component of the daylight.

opposite page
South facade with intelligent skin integrated with photovoltaic
© Lucia Ceccherini Nelli

Virtual Competence building ICT Lucca

The building is characterized by bioclimatic criteria with the use of renewable energies and all the efforts necessary to reduce energy building consumption. The project was developed in collaboration with the Province of Lucca, taking into account the environmental context where is situated, identifying architectural and formal choices that reduce its environmental impact, and allowing architecture integrated with renewable energy systems able to reduce consumption in terms of heating, conditioning and lighting.

The complex is made up of three buildings linked by a greenhouse space that characterizes the architecture, transforming the junction space between the three volumes. The space is dedicated to host offices and laboratories, in a large covered square, that can be used throughout all periods of the year.

The greenhouse is characterized by the integration of semi-transparent polycrystalline photovoltaic panels with many openings on the vertical closing surfaces. This creates comfortable conditions in the internal space for the occupants. The architecture is designed to minimize winter thermal losses and ensure good thermal performances in terms of inertia even in summer.

The south and east facades are characterized by the presence of an innovative, dynamic and variable façade component that allows variable configurations in relation to the different seasons of the year. Another system installed are the geothermal probes, linked to a radiant heating system, that allows to achieve optimal overall energy performance for heating and cooling. The building has 3 PV integrated systems installed additionally.

The photovoltaic façade system will consist of 84 PV modules.

The photovoltaic facade is classified as an 'integrated and intelligent system,' has a power of 15.96 kW and an estimated production of 12.840,59 kWh of energy per year, resulting from 84 modules occupying an area of 120.71 sqm.

Synthesis of the main PV Characteristics:

Number of available surfaces 28
Total Available 120.71 m² extension
Total extension used 120.71 m²
Total area 120.71 m² modules
Inclination of the modules (Tilt) 90°
Orientation of the modules (azimuth) 7th
Annual solar radiation on the surface of the modules 1 074,01 kWh / m²
Technical Data

Total power 15.96 kW
Total number of modules 84
Number inverter 6
Total annual energy 12 kWh 840.59
- Model SANYO HIP, - Model ITALY SMA SB 3300TL HC
Strings x 7 x 2 Modules

The greenhouse photovoltaic glass roof has a power of 5.76 kWp and an estimated annual production of 6615.98 kWh, resulting in twenty four transparent glass-glass photovoltaic panels (system glass room), sized 3.020 x 1.620 m, arranged in parallel rows of 12 panels each and occupying an area of 117.5 sqm. In the upper part of the structure, which form proper

Central atrium, skylight PV integration.
© Lucia Ceccherini Nelli

opposite page
Central atrium, view of the glass balconies and detail of the glass roof
PV laminate, glass-glass (6 +6) modules made from elements of tempered glass that meet the technical and performance audits conducted in accordance with the main terms and conditions of the site: atmospheric characteristics, thermal and mechanical properties
© Lucia Ceccherini Nelli

coverage, the twenty four panels will be arranged in two rows, to produce a total of 5.76 kW. Each panel has a peak of 240 W, produced by 96 cells. The PV array is divided into a 6 sub-1 string, each connected to an inverter. Each string will be equipped with an insulated and blocking diode. The inverters are to be installed outside in a sheltered from direct sunlight and accessible for visual inspection and maintenance activities.

 

The interface device will provide surveillance of the phase voltages and network protection for minimum or maximum voltage and frequency.
The system is sized in two different inclinations of panels: 16° and 13°.

Technical details of the section with panels for the 16 °angle
Number of surfaces available: 1
Extending the total available: 58,70 m²
Total extension used 58,70 m²
Total surface area 58,70 m² modules
Inclination of the modules (Tilt) 16 °
Orientation of the modules (azimuth) 7th
Annual solar radiation on the surface of the modules 1 541.21 kWh / m²

Technical Data
Total power 2.88 kW
Total number of modules 12
Total number of inverters 3
energy performance 3327.69 kWh total annual energy
form Module Module with 96 solar cells with a power of 240 W
inverter Brand - Model SMA ITALY - SB 1100 Modules strings x 1 x 4

Another part of the roof is covered with Phin ‣lm
© A. Rullani
MSA Associates





Green roof with sun tubes.
They control the problematic aspects of sunlight. They reduce glare and inconsistent light patterns. They also screen infrared rays that can overheat interiors as well as ultraviolet rays that can fade furniture and fabrics. © Lucia Ceccherini Nelli

Didactic visit with students of the green roof with sun pipes. © Lucia Ceccherini Nelli

A green roof on the top of the building is partially covered with vegetation and a growing medium, planted over a waterproofing membrane. It include many layers such as a root barrier, drainage and irrigation systems. In the middle of the roof, a tree also grows within a small plot.

The green roof serves several purposes for the building, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, decreasing stress of the people around the roof by providing a more aesthetically pleasing landscape, and helping to lower urban air temperatures by mitigating the heat island effect.

The green roof has many natural functions given by plants, that filter water and treat air in a suburban landscape. This is an intensive green roof, which is thicker with a depth of 15 cm, and can support a wider variety of plants.

PV integration as shading devices in the University library and classroom building in Sesto Fiorentino
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opposite page
PV ‣eld and piranometer
© Lucia Ceccherini Nelli

University classrooms and library in Sesto Fiorentino, Florence

In the year 2000, Sesto Fiorentino University library and classroom was retrofitted with an integrated PV shading devices system, realised in the courtyard of the building. The integrated photovoltaic system, totalling 20 kWp power occupies a surface of 300 sqm. The system is composed of 160 PV glass or tedlar transparent modules, with a power of 125 Wp each, divided into five subsystems of 4000 Wp each. Every subsystem has a dedicated inverter and is completed with interconnection box.

The photovoltaic system is composed of the following:

- Principle structure: 4 reticular beams of 22 m each, positioned on the shortest side of the internal court.
- Secondary structure: 25 beams realised with two-steel IPE, supported by the principal beams.
- Modules structure: the photovoltaic modules are positioned for the longest side along beam direction. Modules are made from transparent glass or tedlar, and are supported by an aluminium tripod. They are then sustained and screwed down to the aluminium easels with three L-steel profiles.

- Footbridges: to guarantee maintenance operations and security grills, footbridges have been constructed from Alugril or Orsogril. These are positioned behind the PV modules on the principal and secondary beams. In the executive project, many handrails were added, however during a function check it was decided to keep the handrails off to improve photovoltaic efficiency in winter.

Photovoltaic modules are 35° tilted and south oriented. The electricity produced in DC current by PV modules will be fed, after conversion into alternate 400 V and 50Hz, into the building grid connected to the Medium Voltage Distribution National Grid. The energy produced will be measured trough a proper meter, installed by the grid manager and accounted for under the directive n° 224/00 by the National Energy Authority.

On the basis of sun values on the floor and the plane of the modules tilted at 35°, and assuming an average energy efficiency of 75% in different situations, system electricity production - as agreed electrical energy given to the ENEL grid - is approimately 32.996 kWh per annum.

Components description and general scheme of the system

The PV system is provided to produce energy in conjuction with the electrical grid of the building in low voltage and alternate current. The system will be connected electrically to the part of the network belonging to the client. At the connection point, the voltage is 400 Vac three-phase, 50 Hz frequency.

The energy produced will be fed into the grid, according to the technical and economic conditions of the exchange service as defined by Electrical and Gas Authority directive n. 224/2000.

The principal elements that constitute the system are the following:

- 160 photovoltaic modules in polycrystalline silicon, 125 Wp each
- 5 inverter one phase power 3.3 kW DC, 4.2 kWp photovoltaic side
- interface panel for grid connection low tension, accordingly CEI 11.20 regulations

Detail of the PV modules.
© Lucia Ceccherini Nelli

Conversion and electric energy delivery:
Five inverters are dedicated to the 5 subsystems, for the energy conversion from DC to AC current. The inverters convert the energy of the PV generator in an alternate three-phase current, for energy distribution into the grid. There are five inverters installed, manufactured by the firm Sun Power Solartechnik. Model SP 3100-600.

opposite page
PV shading devices for the physic Laboratoriesr
© Lucia Ceccherini Nelli

Physic University laboratories - Sesto Fiorentino 50kWp

Another example of the PV integration system is in the Department of Physics of the University of Florence. This building is located in the same square area of the University library and classroom building.
The University of Florence has given a great deal of attention to the integration of renewable energy systems in its buildings.
The photovoltaic modules are placed in the field with the following values of tilt and azimuth: 1/2/3 Subfields: TILT 30.0° - 32° azimuth. The project involves the construction of three PV generators connected in parallel to the general framework QAC. The building is divided into several portions with two, three or four floors, arranged to form two quadrilaterals which enclose two interior courtyards. On the cover of one of the portions of the building are two and three-storey steel structures with a height of one storey. These have aesthetic function; portions of the four-storey building are arranged at the vertices of quadrilaterals as turrets. The parties involved in the project of building are constituted by a cover portion (with metallic structure) and a facade on the side opposite to Via

of Ideas. Two of the generators will be installed on the front so as to achieve a sun screen, the third generator will instead be installed on the cover in part by exploiting the existing metal structure.
The three subfields are composed respectively of 60, 54 and 74 PV modules of variable strings divided by 9 to 12 modules.

The total number of panels, each divided by the PV field is equal to:
subfield 1 54 modules of 290Wp - 15.66 kWp
subfield 2 60 modules of 290Wp - 17.40 kWp
DATA FIELD FRONT PANEL
Manufacturer SCHOTT SOLAR
Model POLY TM 290
Peak power of 290 Wp
Number of cells n. 80 connected in series
Module efficiency 13.7%

Detail of the roof PV modules. ©
© Lucia Ceccherini Nelli

opposite page
Detail of the roof PV modules thin ‣lm and mono christalline cells
© Lucia Ceccherini Nelli

The PV system involves a shading device structure greatly appreciated by the occupants, because the shadows caused by the hanging PV panels in summer and spring provide good shade at the facade, improving internal comfort.
subfield 3 74 modules of 225Wp - 16.65 kWp
The total installed peak power is equal to: 49,71 kWp.

Total annual production field solar:
51,766 kWh
The photovoltaic modules are of the type used at high peak power composed of 60 multicrystalline solar cells 156x156 mm.
The body is made from anodized aluminum frame with high resistivity to corrosion, tempered glass solar low iron content, with maximum load equal to 550kg/mq. Presence of three bypass diodes to minimize the power loss caused by eventual shading or damage.

University home students Florence 20 kWp

The university residential student structure is very simple. The system is integrated into the type of coverage for the building used as a place in university residences because of Mezzetta in Florence.

The system is grid-connected and the connection mode is ‘three-phase low voltage.’ The power is 19.92 kWp, and the estimated production of 21.320 kWh of energy per annum (minimum guarantee), ninety-four derived from amorphous silicon modules occupying an area of 220 M2CA and thirty-four monocrystalline silicon modules occupying an area of 44 mq. Approximate power: 12,784 kWp; 7,14 kWp respectively. Modules in amorphous Si thin film.

The photovoltaic panels are made of 10/10 high corrosion resistance aluminum sheet, with dimensions of 5700 mm x 467 mm to support the laminates, and are mounted parallel to the cover plates of the building.

The metal sheet cover must be able to adapt to the underlying curve through a system of extruded aluminum profiles, and should not interfere with the drainage of water.

The profile of the sheet is integrated with a system of spacer elements and stiffening in extruded aluminum, that are anchored through the cover to the support structure below. The spacer elements are formed by two types of extruded drawn aluminum profiles, one omega-shaped, and one inverted T-shaped. The omega-shaped are anchored at the rafters of the existing structure, and the T-shaped are positioned orthogonally. Both constitute the longitudinal strength of the panels and anchoring elements. Having to adapt to a curved structure, both profiles (omega and T) as well as panels, must be supplied already calendered with a specific radius of curvature.

At the bottom of the cover there will be a row of PV modules arranged in hybrid material (monocrystalline silicon surrounded by ultra-thin amorphous silicon layers) parallel to the roof surface.
The modules will be positioned adjacently and fixed to the cover by means of aluminum profile, in adherence to the existing roof covering, exploiting the existing inclination (about 35° above the horizon). This plant (consisting of No. 34 modules) of the rated power of 7.14 kWp, will complement the other system, receiving an implant 'mixed' by a total of 19.92 kWp. Generator (G1 + G2).

PV integration in public buildings

It is beneficial to integrate PV systems in public buildings in order to encourage firms to find new processes and technical solutions, keeping in mind that an interesting borders amelioration exists, whether to a level of cost or increase in device efficiency.
A significant achievement of new product development, one more suitable for architectural application, is the effect of the support's mechanisms, which have up now been adopted by several countries.
The most recent typology of photovoltaic technology application is the study of buildings integrated systems: according to the dimension of the plant, PV systems can be used as an integrative source or contribution to the global building electricity budget.
These applications introduce different advantages:
- energy produced near the user has a greater value than energy furnished by the traditional electrical power station.
- electric energy production during insulation times allows a reduction of net demand during the day, when there is greatest request. Hypothesising a high development of the building integration of PV systems, it is possible to foresee a levelling of the daily peak request, usually corresponding to more expensive kWh electrical costs. It is a more and more interesting alternative, particularly for the increasing use of conditioning systems in the residential, commercial and public sector.
- The installation of PV modules could also decrease global building costs, because they can function as constructive elements, replacing glass or tile facades.
- The adoption of these systems allows the assimilation of an 'energetic conscience', with a positive increase in the use of electric energy produced and exchanged with the grid. It is necessary to highlight the PV system's esthetic value: the silicon cell has a pleasant appearance and a particular effect, making it an interesting material for contemporary architecture. It is possible to use different coloured cells, adapting them to each context.

References

Ceccherini Nelli L., 2003, I*ntegrazione Architettonica del fotovoltaico, casi studio in Toscana*, Alinea, Firenze

Ceccherini Nelli L., 2004, *Impianto fotovoltaico integrato da 20 kWp per l'edificio aule e biblioteca a Sesto Fiorentino*, Alinea, Firenze.

Ceccherini Nelli L. 2006 Italian case studies in CD rom, *EULEB EUropean high quality Low Energy Buildings*, Dortmund, 2006.

Ceccherini Nelli L., 2007, *Schermature fotovoltaiche*, Alinea, Firenze .

Ceccherini Nelli L., 2007, *Fotovoltaico in architettura*, Alinea, Firenze.

Three research projects

ARCHITECTURAL INTEGRATION OF PHOTOVOLTAIC/THERMAL LINEAR SOLAR CONCENTRATOR SYSTEMS

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Photovoltaic thermal concentrator, builkding integration in vertical shading devices
© Lucia Ceccherini Nelli

The construction sector offers a great potential for reducing energy consumption, especially with the integration of Renewable energy technologies to increase energy performance in buildings.
EU is adopting common strategies for the Member States related to energy performance in buildings to achieve the objective that all new buildings will be Zero Energy Buildings (ZEB).
The integration of renewable energy technologies such as photovoltaic systems and solar collectors in buildings offer many possibilities within the ZEB scenario.
Photovoltaics technologies and thermal collectors are widely available at competitive prices in building sectors. However, innovative approaches have to be explored in terms of architectural design and implementation, in order to match this innovative technological component to the scale of the building.
A performing energy production solution for architectural integration are PV/ST low concentrated solar systems, modules are prefabricated and could be integrated as façade components.
The component is flexible and easy to install and manage, characterized by a modern and attractive design, which could be integrated both on new and existing buildings.
Thanks to the synergistic combination of power generation (using PV cells) and high-quality heat capture, the concentrator system can reduce the overall energy consumption, in particular, the simultaneous reduction in building cooling and lighting loads.
The system consists of solutions able to be encapsulated an integrated PV/ST solar concentrator in the opaque envelope, in particular in modular prefabricated systems.
This research analyzes many prefabricated components able to contain one or more elements of the solar concentrator system, many solutions differs on architectural typologies, materials used, such as wood, metal, and bricks.
In the PV/ST solar concentrator, the thermal energy production is achieved thanks to the recovery of the heat generated by the solar cells used to produce hot water.

This device, developed by CREAR of the University of Florence (Prof. eng. Alberto Reatti and eng. Alessandro Cappelletti) and the architects of the Depertment of Architecture with Centro ABITA helps in the research to find suitable design for installation on building roofs and greenhouses, to allow the system to convert solar energy into both electricity and hot water with the best efficiency.
The device consists of a series of the linear low concentrator with mono axial sun tracking and a semi-parabolic profile reflector to concentrate the solar radiation into a string of mono-crystalline cells PV with a 20x concentration factor.
PV will be gaining an increasing relevance in the ZEBs design, thanks to its features and potentialities to be combined with solar thermal, for this reason, there is a need to rethink designed features of PV components integrated into buildings. This kind of systems could be suitable for any kind of energy and thermal demand of the building, reducing building integration costs. In a ZEB scenario, a PV/ST concentrator is very suitable for generating energy and producing hot water, 'on site' and 'at site'; this increase the use of PV/ST from the architectural scale to a wider scale. The research described in the present work focus the relationships between PV/ST and the architecture envelope, in particular, the PV/ST devices used integrated to the opaque Building envelope.
The European policy is improving energy efficiency in buildings, and considering IEA recommendations based on the best practices (IEA SHC Task 41) to achieve high-quality architecture for buildings integrating solar energy systems towards ZEB, the integration of active solar energy technologies into buildings represents a great design benefit but also cost benefits.
For many years, active solar technologies have been intended as just a mechanical system of the building, aimed only to the energy production and to make interiors more comfortable for occupants. Since solar thermal and PVs systems need to be entirely exposed to solar radiation in order to maximize their efficient, more frequently they are installed on the building areas most exposed to sun radiation such as roofs and façades.
When integrated into façades, the use of renewable energy, should not be considered as an addition to the architectural design, but rather a modern complement of design aimed to save energy for the building.
The most useful strategy is to pay attention to the project design planning integration of the active solar devices from the early stage of the architectural process, improving the architectural integration quality and flexibility of the active solar products and devices.
Today, prefabrication, consisting of a frame structure which is closed by façade panels, has become a very common practice used for large scale buildings offering many differ-

ent possibilities in term of architectural composition of different modular elements and also reducing on-site construction time.

The main application, of different technical solutions, is for new development of large-scale residential and office buildings and for deep renovation of the existing building stock.

Furthermore, large-scale innovative renewable energy sources can be integrated (e.g. solar thermal, photovoltaics, Hybrid-technologies etc).

The present work focuses on the architectural integration of an active solar energy product designed to be integrated into buildings, to reduce the global primary energy consumption and consequently the impact on the environment.

The integration of the system consists of finding many architectural solutions able to allocate one or more concentrator elements reaching a high amount of energy with a contemporary design, something that can be industrialized optimizing costs of production.

Thanks to the simultaneous production of electrical and thermal power, this solar concentrator shows a great potential for its application in the construction field, being particularly suitable for applications in farms, solar greenhouses, small industries, hotels, resorts, sports centers (changing room, swimming pool etc.), beauty centers and SPAs.

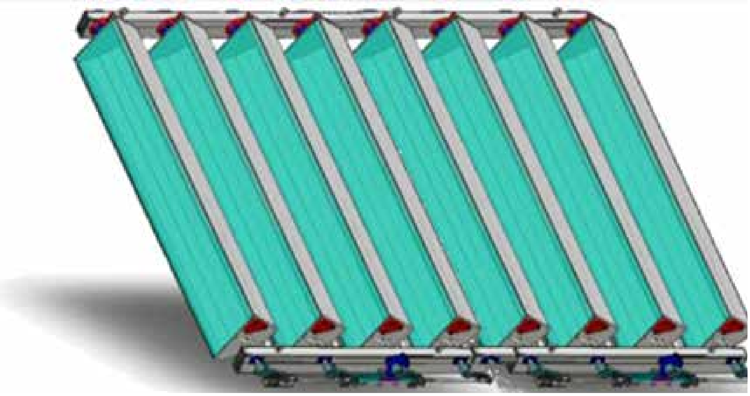
The challenge is to realize a multifunctional façade systems, through a multidisciplinary approach to the architectural project, dealing with aesthetic, functional and technical issues, as well as economic issues on cost optimization of industrial production process, market placement and return of the investment related to the application of this innovative system both in new and existing building.

Parabolic PV/T device component description

The PV/ST device consists of a small-size photovoltaic/thermal linear solar concentrator system using a low profile semi parabolic reflector to concentrate the solar radiation into a linear focus of PV mono-crystalline cells mounted on a specific support which has been designed and built to recover under thermal power the amount of solar power not converted by PV cells. Thermal power is collected by using water flowing through two pipes placed in the aluminum solar receiver, which allows to reduce solar cells temperature and to provide thermal energy recovery for heating domestic water and heating applications.

The combination of the mirror and the receiver results with a nominal concentration factor of 20x.

Therefore, solar rays, if perpendicular to the flat upper face of the receiver, are concentrated in the solar receiver, where PV cells are mounted. It is located near one of the borders of the concentrator upper side, with the cell facing the mirror at angle 45° with respect to the upper



Modular Solar concentrator assembled in 8 elements.
© CREAR Unifi

face. The device uses a mono-axis solar tracking system based on the specific electronic circuit to optimize high annual power generation. The prototype built up by CREAR consists of four production units, each one with the long solar receiver and a semi-parabolic cross-section mirror. All units are identical, from 2000 to 3000 mm length, and have a flat upper part with a 310 mm useful width windows receiving the solar irradiation.

opposite page **View with three movable concentartor elements. and view with many movable concentartor elements with color glasses**
© V. Vezzosi design sheme

Metal façade integration with the PV/ST concentrator

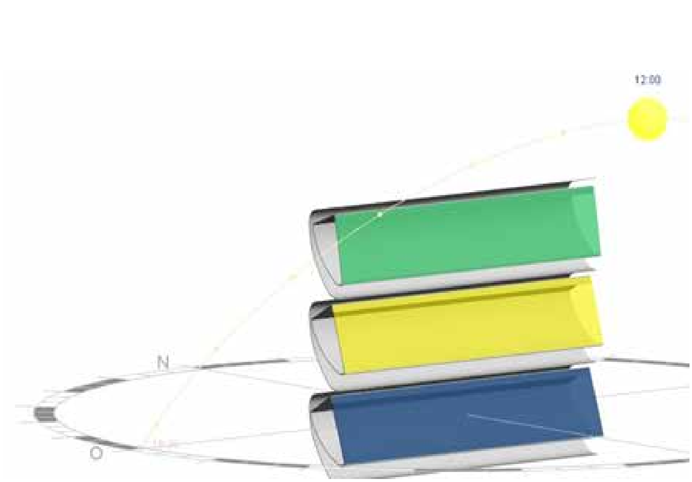
Considering the small dimension which makes the solar concentrator easily mountable in a building facade, it is suitable to be included in innovative facade solution integrating equipment, to fulfill all the load needs related to a typical use of a large-scale building. Integration on existing buildings appears to be a more complex practice than on new buildings since it needs to comply with an existing context. As standardized products are often not applicable in all situations.

In the case of new buildings, it becomes much easier especially when the integration is designed right from the conceptual stage.

The PV and solar thermal collector systems, when integrated into a building, become part of the general structure design and also often become general building elements (Hestnes, 1999). From an economical point of view, it is necessary that the systems are integrated into the building envelope so that not any extra investments is needed on the support structure.

These systems must replace the conventional building elements in addition to their ability to produce energy and serve also the function to reduce the total cost.

Therefore, energy systems in a building must be designed as an integral part of the build-



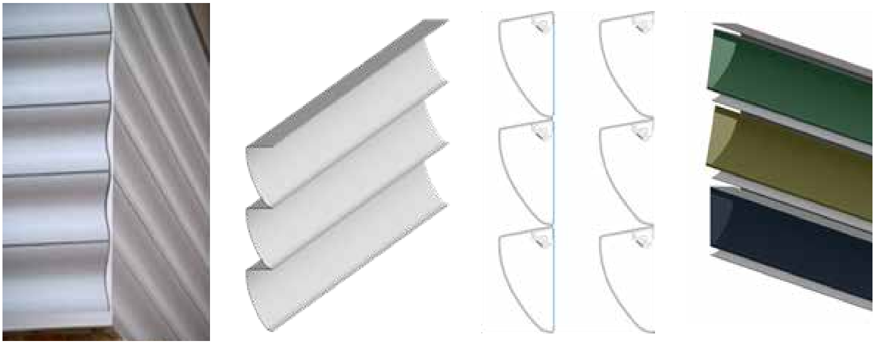
ing design. These systems must be taken very early in the design phase and should not be treated as separate elements that are added after the design when the building is completed. The main objective of the present study is to develop the concept design of a prefabricated innovative opaque envelope, incorporating a series of linear semi parabolic concentrators with mono axial sun tracking system.

This approach shows several advantages first of all providing interesting architectural solutions and reaches benefits for the best energy solution, so it is necessary:

1. to evaluate the best orientation of the surface;
2. the possibility to have the correct rotation of the concentrator;
3. to optimize the integration of one or more concentrator elements into the opaque façade to optimize the best solar tracking (vertical application);
4. to optimize the integration of one or more concentrator elements into the opaque façade to optimize the best solar tracking (horizontal application);
5. to optimize the number of concentrator elements needed to have a reasonable electric and thermal peak output;
6. to evaluate the adoption of color glasses on the external surface.

Solar concentrator device integrated on building façade with horizontal or vertical con▸gurations.

The integration of the PV/ST solar concentrator in the building envelope provides a distinctive character to the architectural design of the building, considering both configurations horizontal or vertical integration. The PV/ST solar concentrator structure is made of extrud-



An example of envelope where is possible the integration with PV/ST devices; The system can be adopted with transparent glasses or without glass; System with color glasses.
© V. Vezzosi design sheme

ed aluminum which is either anodized or painted. The entire system follows the sun radiation during the day thank an electrical mechanism controlled by sensors which provide the right rotation, corresponding to the best thermal and electric energy production. Integration of the component in an opaque envelope facade made by the metal structure is one of the most appropriate solutions because envelope surface is more reflective than other surfaces and presents a better albedo. We have analyzed the characteristics for an aluminum body of 310mm large and 170 mm wide and about 3000 mm long, like prefabricated measures or building height between floors although other dimensions are possible for horizontal or vertical assemblement.

opposite page
Few examples of façade integration
© Photomontages Lucia Ceccherini Nelli

Architectural integration for ventilated facades

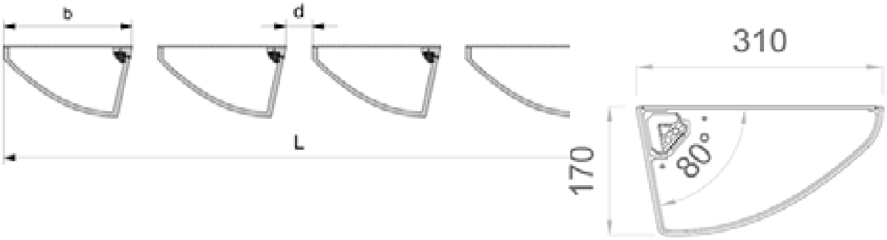
Ventilated facades are developed to protect buildings against the combined action of sun and wind and keeping the building dry, with high level aesthetic characteristics and good insulation from heat and sound.
In terms of thermal energy, ventilated walls can reduce the amount of heat that buildings absorb in hot weather conditions due to partial reflection of solar radiation by the covering and the ventilated air gap and to the application of insulating material, thus achieving a good reduction in the costs of air conditioning. On the contrary, in winter, The building system, thanks to its "chimney effect", set up efficient natural ventilation, managing heat transfer guaranteeing a high level of living comfort. With depth technological innovations, ventilated walls are earning increasing recognition in the world of contemporary architecture, permitting free interpretation of facades in a modern and brand new style, the perfect answer to demanding project and performance requirements. Ventilated facades are multi-layer structural solution that enables "dry" installation of the covering elements



In short, the advantages to integrating PV/ST concentrator devices on ventilated facades are:
- Easy integration in the aluminum structure;
- Protection of the walls against the direct action of atmospheric agents;
- Elimination of beat bridges leading to energy saving;
- Elimination of surface condensation;
- Easy maintenance;
- Easy on-site installation of the electric and thermal devices;
- Creation of a technical working space for pipe and duct connections.

System characteristics description

The (PV/ST) solar generator is constituted by one or more units, connected together, each one built up about 3000 mm long solar receiver and a semi-parabolic cross-section mirror, as shown in the image above. The combination of the mirror and the receiver results in a concentrator with a nominal concentration factor of 20x. All the units have a flat upper part receiving the solar irradiation. An Alanod Miro-Sun KKSP 500 µm thick anodized reflective aluminum film is glued on the parabolic mirror internal surface. Therefore, solar rays, if perpendicular to the flat upper face of the receiver, are concentrated in the solar receiver, where PV cells are mounted. It is located near one of the borders of the concentrator upper side, with the cell facing the mirror at angle 45° with respect to the upper face. The cells are 28 mm long and 10 mm wide.
The ratio of the flat window and solar cell width results in a geometrical concentering factor



Section of the concentrator and dimensions. © CREAR UNIFI

equal to 22.72x. Since the cover glass and the mirror film result in an overall optical efficiency equal to 80%, the practical concentration ratio achieved is 18.2x. not to collimate with the cells mounted in the solar receiver reducing the power generation of the device. Generated power can run to zero if the concentrated solar flux misses the cells. The low projected overall concentrating factor allows for a low profile (166 mm) semi-parabolic mirror as well as reasonable mechanical tolerances in device construction (1-1,5 mm) and in the solar tracking system (2°-3°), which reduce the cost of practical realization of the. The energy evaluation is produced through the equivalent hour of the maximum power output; the procedure calculates the average value of sun hours, using the sun position angles, the incident angle of the device and the available energy curve, then it considers an 18.3% PV cell efficiency.

opposite page **Few examples of façade integration** © Photomontages Lucia Ceccherini Nelli

SYSTEM CHARACTERISTICS
(DSR = 850 W/ m2, TAMB = 20-25 °C, AND WIND = 1 m/s) 139
Characteristics Specifications and Experimental Results
Units tested 1 Overall External Size L×W×H - 300×135×35 cm
Single Semi-parabola Size L×W×H; 293×25×16.6 cm
Concentration Ratio 18.2 X
Total Aperture Area 1.85 m2
Mono crystalline 280×10 mm cells 272
No. of cells on each concentrator 68 Total Solar Cell Area 0.076 m2
Nominal Cell Efficiency 18.3 %
Glass Efficiency 91 %
Outlet Fluid Temperature 50°C
Max Thermal Efficiency 51.3 %
Nominal DC Peak Output 162.1 W
Max Electrical Efficiency 10.2 %
Total Efficiency 61.5 %






*As reported in Reatti and Cappelletti et al (2015, 2016) research papers
The output from this evaluation shows an electric energy production as high as 173 kWh the Est-West tracking and 130 kWh for the sun altitude cases.
The calculation procedure also considers the effects of the mutual shadowing among mirrors constituting the solar generator. The procedure evaluates the reduction of the surface that receives solar radiation: when at least one-half of the available surface is shadowed the power production is considered not high enough and, therefore, neglected. The Est-West case is the more penalized because the minimum loss is the 30% when d = 20 cm, while increases to 74% when d increased to 30 cm. As a result, the electric energy production for a 3-meter long parabola is expected to be 130 kWh for one year. Referring to the horizontal case, the parabolic mirrors are not significantly shadowed if their distance is larger than 25 cm 30. In this case, the electric energy production in a year is about 120 kWh.
As reported in Cappelletti et al (2016, 2015a) the thermal energy production is five-time respect the electric production so, in the case of the vertical device, the thermal production in a year is 640 kWh and for horizontal device 610 kWh.
A conventional photovoltaic plant, with 1 kWp installed on a 7m2 occupied area, produces about 1200 kWh/year. This means that ten devices as shown in Fig. 1 is required to produce the same electricity. Even if the surface required to produce the same amount of electrical energy is now 9 m2 the thermal energy generation is of 6000 kWh. Moreover, solar concentrator fluid outcoming is operated at a higher temperature than hybrid flat PV/ST panels and, therefore, the thermal power is better usable.
These results are referred to a south wall installation and Table 1 reports the available production depending on the other main orientations. The values refer to the percentage respect of the south case. The horizontal case is penalized a lot, mainly for Est and West orientations.

Conclusions

Integrating PV/ST systems into buildings is not only for clean energy but also to use them as multifunctional elements where they replace the conventional building elements.
The device is developed as fundamental part of the building envelope with added aesthetics. When these systems are considered very early in the design process, they can perform very well both technically and aesthetically. The overall reduction in construction cost resulting from the multifunctional use of these systems is another important feature of integration.

Orientation	Vertical (est-ovest) energy production [%]	Horizontal (sun altitude) energy production [%]
EST	76	56
SOUTH-EST	87	80
SOUTH-WEST	87	80
WEST	76	56

Table 3. Energy production Vs orientation, for a 3-meter long device.

The concentrated solar technology can be an interesting solution for the auto-energy-production in buildings to support the zero energy philosophy.

The paper presents some design solution of the integrated device with a parabolic hybrid PV concentrator. The device is a mono axial concentrator designed for home energy production, that is modified increasing its length to permit the use on the facades. The analyzed solutions are based on two arrangement option for the rotation axis: horizontal or vertical.

The analysis shows how the two arrangement present a similar energy production about 120kWh of electricity and about 600-640 kWh when the device looks the south. The solution with the vertical device presents better performance on all wall orientation, the solution with the horizontal device could be used limitedly in the Est-south and West-south range.

Future work will consider the replacement of the monocrystalline cells with triple-junction cells. Such a solution would in a PV efficiency nearly double than in the case of monocrystalline cells and, therefore also the electric energy yearly produced can be significantly increased.

Integration of concentrator systems into the building as multifunctional building envelope will not only produce renewable energy for building needs but will also add value to the overall building by enriching the architectural expression, thereby increasing its marketability.

Also, integration process must be developed in such a way that it is acceptable by people so that in the coming days, more buildings will have PV/ST systems well integrated and not used only as mere technical elements. References for PV/ST solar concentrator.

References

Attivissimo F., Di Nisio A., Savino M., and Spadavecchia M., May 2012, *Uncertainty Analysis in Photovoltaic Cell Parameter Estimation*, IEEE Trans. Instrum. Meas., vol. 61, no. 5, pp. 1334-1342

Barreiro C., Jansson P. M., Thompson A., and Schmalzel J. L., 2011, *PV by-pass diode performance in landscape and portrait modalities*, in 2011 37th IEEE Photovoltaic Specialists Conference,.

Cappelletti A., Catelani M., Ciani L., Kazimierczuk M. K., and Reatti A., 2016, "*Practical Issues and Characterization of a Photovoltaic/Thermal Linear Focus 20x Solar Concentrator*," IEEE Trans. Instrum. Meas., pp. 1-12.

Cappelletti A., Reatti A., and Martelli F., 2015, *Numerical and Experimental Analysis of a CPV/T Receiver Suitable for Low Solar Concentration Factors*, Energy Procedia, vol. 82, pp. 724-729.

Cappelletti A., Spadi A., and Reatti A., 2014, *Performances issue's analysis of an innovative low concentrated solar panel for energy production in buildings*, in Energy Procedia, vol. 81, pp. 22-29.

Cappelletti A., Spadi A., and Reatti A., Dec. 2015, *Performances Issue's Analysis of an Innovative Low Concentrated Solar Panel for Energy Production in Buildings*, Energy Procedia, vol. 81, pp. 22-29.

Ciani L., Catelani M., Carnevale E. A, Donati, L., and Bruzzi M., May 2015, *Evaluation of the Aging Process of Dye-Sensitized Solar Cells Under Different Stress Conditions*, IEEE Trans. Instrum. Meas., vol. 64, no. 5, pp. 1179-1187.

Cristaldi L., Faifer M., Rossi M., and Toscani S., Jan. 2014. *An Improved Model-Based Maximum Power Point Tracker for Photovoltaic Panels*, IEEE Trans. Instrum. Meas., vol. 63, no. 1, pp. 63-71.

Kim, Y. S., Kang S.-M., and Winston R., Sep. 2014,*Tracking control of high-concentration photovoltaic systems for minimizing power losses*, Prog. Photovoltaics Res. Appl., vol. 22, no. 9, pp. 1001-1009.

McSharry P. E., 2006, *Assessing photovoltaic performance using local linear quantile regression*, in Proceedings of the Energy and Power Systems, pp. 165-169.

Paul D., Mukherjee D., and Chaudhuri S. R. B., 2006, *Assessing Solar PV Behavior Under Varying Environmental Conditions -A Statisticalapproach*," in 2006 International Conference on Electrical and Computer Engineering, pp. 217-220.

Petrone G.,Spagnuolo G., Teodorescu R., Veerachary M., and Vitelli M., 2008, *Reliability Issues in Photovoltaic Power Processing Systems*, IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2569-2580.

Salameh Z. M., Borowy B. S., and Amin A. R. A., Jul. 2008, *Photovoltaic module-site matching based on the capacity factors*, IEEE Trans. Energy Convers., vol. 10, no. 2, pp. 326-332, Jun. 1995.


Inexpensive piping and installation
Can handle higher temperatures
Simple integration with existing systems
Suitable for installation in fields and on roofs
No risk for overheating
Provides greater energy efficiency
Lower environmental impact in life cycle analysis (LCA)
Wind-safe positioning
Options for hot water, electricity and steam in the same system

DYNAMIC SHADING DEVICE A PHOTOVOLTAIC AND THERMAL SOLAR CONCENTRATOR FOR ARCHITECTURAL INTEGRATION

Lucia Ceccherini Nelli
Università degli Studi di Firenze
Centro Interuniversitario Abita

Linear concentrator system
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Photovoltaic/Thermal solar concentrator (PV/ST) device system described in this paragraph is studied by Arch. Giulia Chieli in collaboration with the researchers of Centro Abita, this project is elaborated for the thesis of the ABITA Master course. The component studied is a solar concentrator system for external shading devices suitable for different building typologies such as office facilities or residential houses.

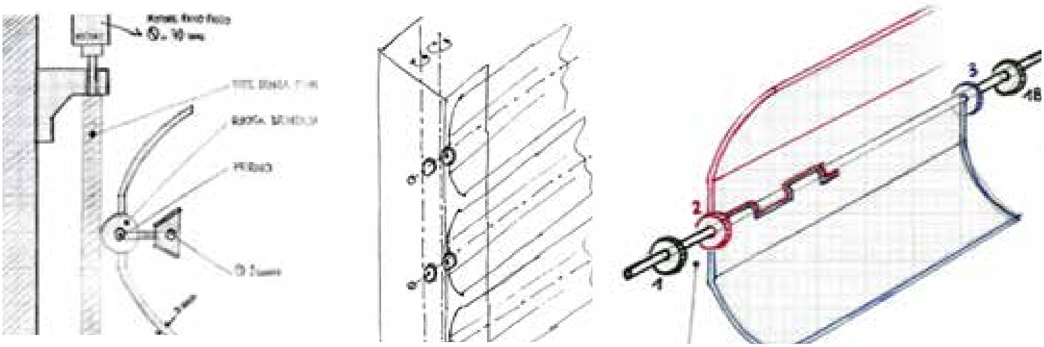
The novelty of the project is an integrated PV7ST movable shading device, with an attractive design for efficient shading device in buildings, the system can change tilt angle and configuration, allowing the best lighting comfort while producing energy.

This device consists of a series of linear low concentrator monoaxial sun tracking with a semi-parabolic profile reflector, concentrating solar radiation into a focus where is a string of mono-crystalline cells PV, with 5,5x concentration factor. The best thermal energy production is guarantee by the cooling system whereby hot water is produced.

The contribution of this study is a new concept and the development of solar thermal concentrator systems, for the integration in the architecture design, with a performing dynamic design.

Shading devices are elements that can greatly meliorate thermal comfort in buildings and this study contributes to make in evidence the adaptability in new buildings and renovation projects.

A common features of the shading system available in the market is the option to tilt the shovels so to change the brightness conditions inside a building according to user needs: the handling can be manual, mechanical or controlled by a sensor sensitive to external climate change so that the building's envelope can manage itself. A sector that has been already experienced is the one of photovoltaic brise-soleil: this element can be realized applying a photovoltaic film in the shovel's surface or using small-scale PV panels, in place of shovels, so to form a shading system.



Images of the component with rotating axis and movable wings.

Concentrated solar technology integrated into architecture

As reported in the G.Chieli Master thesis, the active material is represented by photovoltaic cells or pipes in which a heat-transfer liquid flows.

The components of the Solar concentrated photovoltaic system are:

1. Receiver
2. Reflector
3. Tracking System
4. Inverter

The Receiver is in correspondence of the focal line of the system, where sun's rays are concentrated, in the same place is PV stripe. The solar energy high concentration produces high temperature, for this reason a heat sink is required. The heat sink prevents PV cells degradation and the loss of efficiency (about -0,5% every degree exceeding the operating temperature of 40 degrees).

The dissipation system use the flow of a low-temperature liquid, or passive in case a heat sink with straight fin applied. The Concentration Factor subdivides concentration system in Low concentration system (LCPV), and High concentration system (HCPV), when suns are higher than 300 x.

Thanks to this principle it is possible to reduce the quantity of PV material used and thereby the costs of the system. As known, in a standard PV panel, the price of the photovoltaic material affects the final price for the 70%. Monocrystalline silicon cells are used for LCPV, and they still are the one with greater efficiency. For HCPV are used Multi-junction cells because of their character to endure deterioration when subject to high temperature.

The Tracking System is a fundamental device while concentration system can only converge direct solar radiation. The system's optical axis has to be aligned with the source of light so that the system can give the greater amount of energy. Tracking systems can be single or dual axis tracker: dual axis trackers adapt themselves both to azimuth and altitude while in case of single axis tracker the choice of the right axis must be done considering the features of the installation place. A system that follows the sun in North-South direction has the maximum performance during the central hours of the day and collects more energy in summer, vice versa a tracker that follows the sun in East-West direction catch collect energy steadily during the year.

Like in any other PV System an inverter is required to change the direct current in alternating current.

These systems are based on physic reflection and refraction, for this reason, mirrors, and lens have to be kept clean to avoid efficiency losses.

The problems experienced in HCPV considerably decrease with small size and small concentration systems: smaller Concentration Factors correspond to lower temperature so that it is possible to use monocrystalline cells, moreover, heat can be dissipated using heat-transfer fluids as in a classic solar thermal collector. Furthermore, because of the smaller size, costs for maintenance are significantly reduced.

For all these reasons the use of a low concentration system are very suitable for retrofit in buildings.

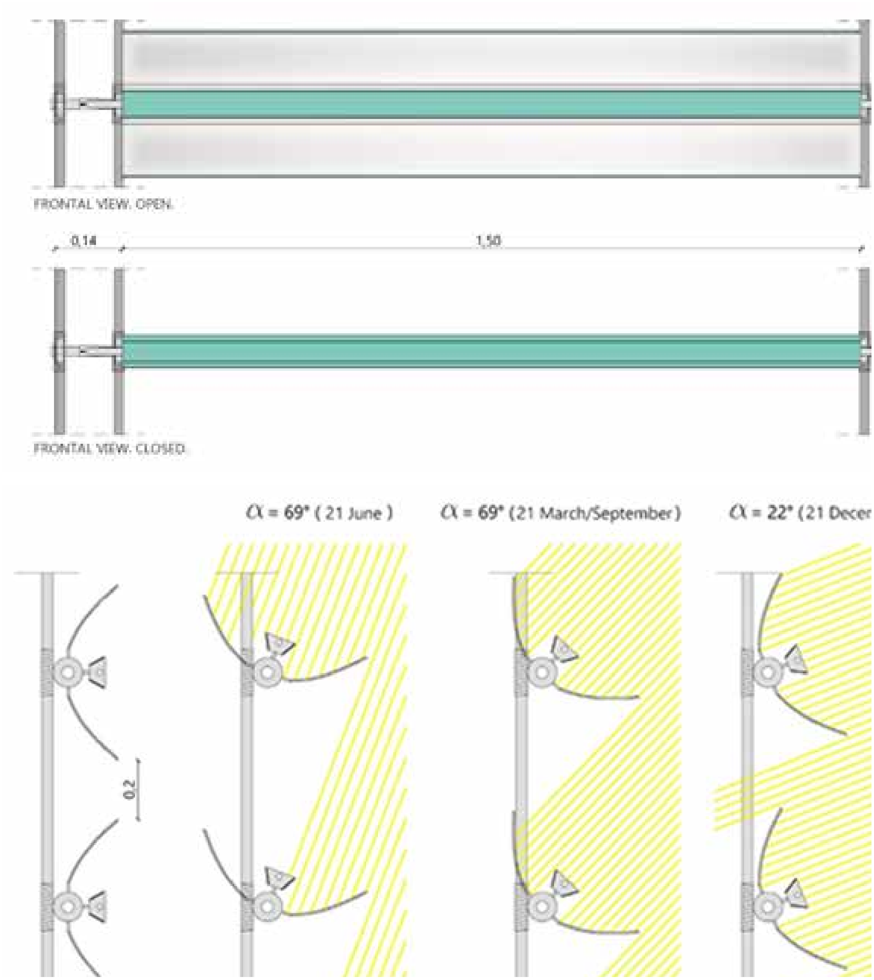
The topic of integration has a bigger importance in research projects although they present also bigger complexity regarding shape, gears, and technology so that their prices are not competitive and the use of normal brise-soleil combined with classic PV panel is still preferred.

The PV/ST shading device component

The device has been thought as composed of two wings, semi-parabolic parts able to revolve around their focal line, with an opening-closing movement, and to move together revolving upwards and downwards so to follow the sun apparent motion.

The mechanism responsible for the handling system is: the mono-axially tracking and the opening-closing movements of the parabolic wings are provided by the anchorage of the component to a central linear pivot. Three cogwheels are mounted around the linear pivot: one is welded to the pivot itself and regulate the integral movement of the whole device, the other two cogwheels are respectively welded to one wing of the device and regulate opening and closing of the brise-soleil. The motion is transmitted to the cogwheel by three screw pumps controlled by two small engines able to react to the impulse of a climatic sensor (or eventually controlled by internal users).

The handling gears are hidden behind two aluminum carters through which the whole shad-



Section and elevation view of the system. Latitude 44° Position of the receiver of the solar concentrator during sun exposition.
© G. Chieli

ing system is anchored to the building's façade. In the internal part of the carters, there are also notches in which the pivots are situated so to fasten their position and stability. The device has been designed to work as a brise-soleil producing energy in its open configuration by standing always perpendicular to the sun's rays, following the sun apparent motion and directing the sun rays, through its mirror part, to the focal line of the system. In case of absence of sun, during night time or in every situation in which the maximal

Axonometric view of the component. © G.Chieli

brightness is desirable, the two parabolic wings can be closed so that the device's dimension results reduced for more than one-third in comparison to its dimension in the open configuration. This option not only solves a real need but also give to the device a changing appearance so that the whole façade can change according to clime and passage of time in conformity with the dictates of dynamic architecture.

The internal part of the two aluminum wings is coated with a reflective film (reflectivity from 85% to 95% depending on the product) suitable for outdoor using thanks to its weather-resistant property. The external part can be basically coated at will, according to the aesthetic effect desired. More simply and economically it can be painted in every color and nuance.

Corresponding with the focal line of the parabola is mounted an extruded profile with a trapezoidal shape in which find place the PV cells and the electrical network required for the transport of the produced energy.

As for every concentrator system, a cooling device is necessary due to the high temperature reached along the focal line. In case of low concentration system, an adequate cooling can be achieved by the flowing of an heat-transfer liquid along the focal line, in this case inside the trapezoidal profile. In this way, the liquid, not only works as cooler but can be also be used to produce domestic hot water from a renewable source that can be used in the building itself.

To provide this dual use a simple distribution system is required, the same used in standard solar thermal collector usually located on the roof of buildings. The choice of this cooling system not only allows the shading device to produce both electrical and thermal energy but also does not complicate its functioning because the technology used is common and run-in in the field of the classic thermal collector. Inside the trapezoidal profile, properly isolated so to not dissipate the heat, flows a conduct with a 1,5 cm diameter in which runs the heat-transfer liquid. This conduct is connected, through specific hoses, to a column pipe which diame-

Engineering Prototype		Project	
Colletting Surface	0,25 m	Colletting Surface	0,22 m
Lenght	3 m	Lenght	1,5 m
Distance between elements	0,2 m	Distance between elements	0,1 m
Annual Production	600 Thermal kWh	Annual Production	265 Thermal kWh
Annual Production	120 Electric kWh	Annual Production	53 Electric kWh

ter, of 3 cm, adequate to ensure hot water's distribution. This pipes, one at the beginning and one at the end of the parabolic element, are situated inside the aluminum carter that hides and protects also the screw pump and all the handling system's gears. The conduct inside the trapezoidal profile has also the function of structural pivot being connecting to the second pivot, a little bigger, where the two parabolic wings are mounted and are free to rotate. This bigger pivot allows also the simultaneous rotation of the shading system so to follow the apparent motion of the sun. The trapezoidal profile is designed so that the PV cell is mounted in its oblique sides having a surface of 3x150 cm= 450 cm2 each. The surface corresponding to the bigger parallel side, the one visible in the front view, is completely free so that can be painted or coated according to the will planners.
Once defined the concentrator dimensions, the Concentration Factor C has been calculated as follows:

C = Collecting Surface / PV surface
Collecting Surface = 0,11x1,5 m= 0,165 m2
PV Surface = 0,02x1,5 = 0,03 m2 (G.Chieli design project)
C = 0,165/0,03 = 5,5 x
C is referred to one of the two specular parabolic wing.

Once completed the design of the single shading element, the linear devices have been assembled together so to form a shading module. The module's dimensions are 1,5 m width x 3 m height so that one module is high enough to cover the standard floor's height. The width has been determined considering both aesthetical and technical reasons: the largest dimension would have influenced too much the total weight of the module so that more complicated handling systems would have been required. On the other hand with a smaller dimension, the building's façade would have appeared too fragmented.

Photomontage of the integration of the solar concentrator close wings in façade. © G.Chieli

The 1,5 m width results moreover suitable for the building of different dimensions and proportions.

Every module is assembled with 7 linear shad ing elements, placed at a calculated distance so that they can't shade with each other and the global efficiency of the system is not reduced. This calculated distance allows also the internal user to have always the perception of the outside environment also when the elements are in the open-working configuration.Productivity of a linear shading element (relating to a horizontal element facing south)

The choice of a suitable distance between the shading elements affect both the aesthetic and the energy production: the shading of part of them can indeed be the cause of a drastic loss of efficiency if not attentively calculated. A distance of 10 cm has been chosen because mutual shading between the element is not present in winter time, when there is a bigger need of electrical and thermal energy, while during summer time efficiency losses are around 50%.

The energy production has been calculated by interpolating experimental data derived from tests conducted by a team from Arch. G. Chieli and the Engineering Department of the Florence University.

The design process has paid attention to maintain a simple but innovative aspect able to be integrated especially for retrofit. The possibility to color the system is aesthetically innovative in the fields of PV/ST concentrators. At the same time the system is very simple, and the system is also not expensive in comparison with the other systems existing in the market, and this was the second big purpose of the project.

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Photomontage of the integration of the solar concentrator close wings in façade
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References

Cappelletti M., Catelani L., Ciani M. K., Kazimierczuk, and Reatti A., 2016, *Practical Issues and Characterization of a Photovoltaic/Thermal Linear Focus 20x Solar Concentrator*, IEEE Trans. Instrum. Meas., pp. 1-12.

Cappelletti, Reatti A., Martelli F., 2015, *Numerical and Experimental Analysis of a CPV/T Receiver Suitable for Low Solar Concentration Factors,* in Energy Procedia, vol. 82, pages 724-729.

Cappelletti, Spadi A., and A. Reatti, 2014, *Performances issue's analysis of an innovative low concentrated solar panel for energy production in buildings*, in Energy Procedia, vol. 81, pages 22-29.

Catelani M., Ciani L., Kazimierczuk M. K., Reatti A., 2016, *Matlab PV solar concentrator performance prediction based on triple junction solar cell model,* in Measurement: Journal of the International Measurement Confederation, N. 88, pp. 310-317.

ENEA, 2014, ENEA Atlante italiano della radiazione solare, <http://www.solaritaly.enea.it/>.

Ceccherini Nelli L., 2006, *Fotovoltaico in architettura*, Alinea, Firenze.

Ceccherini Nelli L., 2007, *Schermature fotovoltaiche*, Alinea, Firenze.

Menegolo A., 2010, *Fotovoltaico a concentrazione,* tesi di laurea in fisica, Università degli Studi di Padova.

Merotto S., 2013, F*otovoltaico a Concentrazione: le celle multigiunzione,* tesi di laurea ingegneria, Università degli Studi di Padova.

Pozzetti L., 2013, *Sistemi Fotovoltaici a bassa concentrazione per integrazione architettonica*, tesi di dottorato di ricerca in fisica, Ferrara.

INTEGRATION STRATEGIES OF LUMINESCENT SOLAR CONCENTRATORS PANEL: A CASE STUDY IN FLORENCE - ITALY

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Centro Interuniversitario Abita

Report: The Cutting Edge of Research - EPFL's SwissTech Convention Center, Arch. Richter Dahl Rocha & Associés Architectes © FG+SG fotografie de architectura

Another research applied to a case study, for the integration of renewable energies in buildings, is the application of luminescent (LSC) panels as concentrator systems. The study is realised by Arch. Giada Gallo Afflitto for her second level ABITA Master thesis.

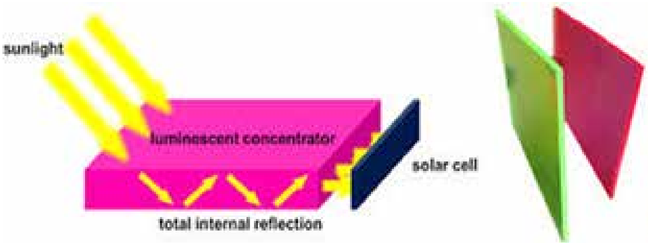
The system studied is realized with colour dye-sensitized solar cells, some produced by ENI Donegani Institute and analysed by Politecnico di Milano.

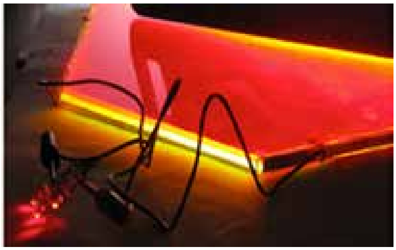
The Luminescent Solar Concentrator modules have the capability to produce electricity on transparent coloured surfaces. These systems are suitable for use in architecture and can be integrated in the building envelope, such as in vertical walls. The principal characteristic of these panels is their unnecessary need to be south oriented, because LSC panels also perform efficiently in the presence of diffused light. The visual effects of the dyed LSC integration are analysed to find the potential use of such a component in the built environment especially for retrofit in buildings.

A typical LSC panel consists of three elements: a layer containing fluorophores (fluorescent molecules), a waveguide plate in PMMA or similar and lastly, solar cells along the edges of the plate. The characteristics of these panels are: a multi-coloured coloration, transparency, lightweight system (so they are good for building integrated photovoltaics), use of direct or diffused light, no heat production, decreased quantification of solar cells, use of low-cost materials, 10% efficiency and also an ability to glow during the night with their own colourful light.

The integration of the LSC panels in the building envelope can greatly contribute to the production of electricity and characterize the envelope through transparency and colour. However, during the planning stage, it is necessary to focus on the internal and external context of the building, because LSC panels are characterized by very bright colours such as yellow and red, and the usage of these colours can create visual discomfort and dazzling light if they are not used correctly.

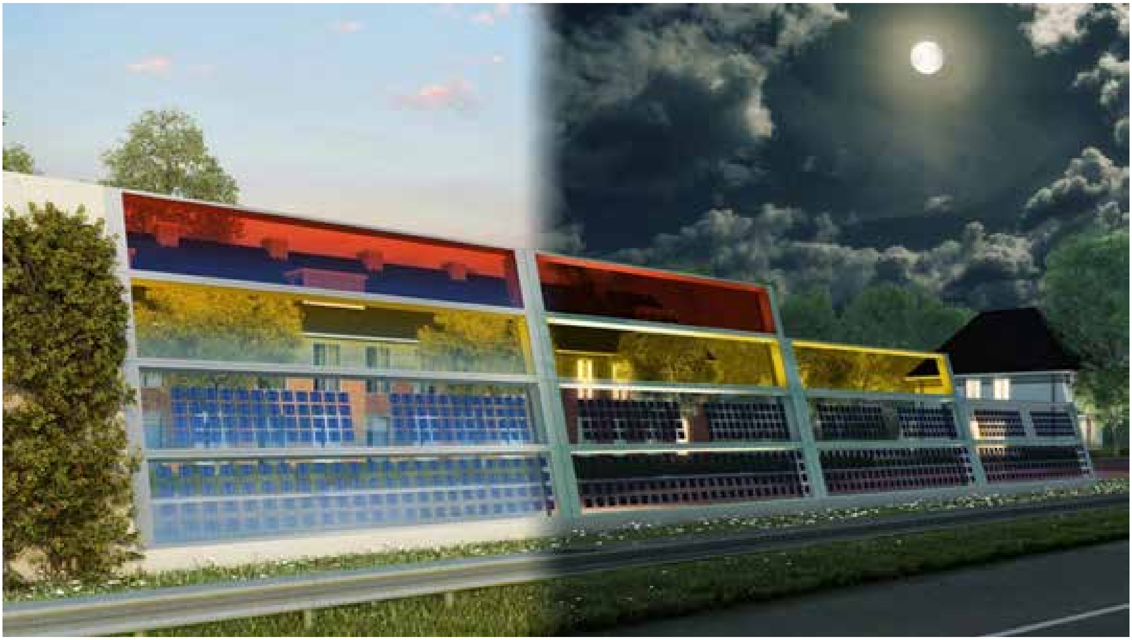
A case study - Integration of Colour LSC panels for an energy retrofit in the university student dormitory in Florence. The case study of the Luzi dormitory is a student residential building





Eni's project, shelter realised with LSC, Luminescent Solar Concentrator panels https://energy.
© ENI

situated North of the city center. The use of LSC panels could be a valid aesthetical alternative, probably more appropriate to represent dormitory iconography and provide a significant improvement to the quality and performance of the energy of the building.
The LSC panels belong to the family of concentration systems, which use optical systems as mirrors or lenses to focus the solar radiation into high efficiency PV cells. The ability to produce energy from sunrise to sunset is the greatest characteristic of these devices. This solves the problem of each panel's disposition to a certain inclination and orientation. Generally, the LSC panel is composed of flat plate waveguide (Plexiglas, glass or similar), which has high optical quality. The flat plate is a matrix of this system and it is covered with a desired thickness of fluorophores. These are particular chromophores, which are colorful and are able to light up in particular situations. Presence of such particles makes the system photoactive; it means that the panel can convert the incidental



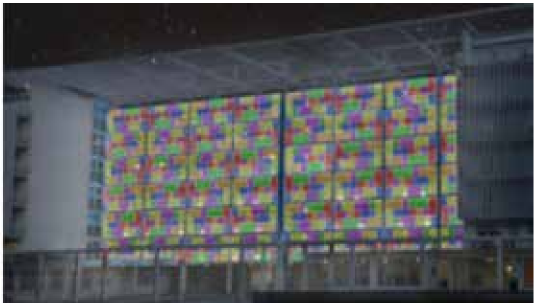
SONOBs (Solar Noise Barriers) - A2 Hightway installation research project the solar panels could function in diffuse and dark lighting conditions. © youtrade.com

photons on the surface into energy. Along the edges of the plate, there are PV cells that absorb the solar radiation, which is turned into electricity. The most important characteristic of LSC panels is the ability to convert the solar radiation into more efficient wavelengths: ultraviolet radiation (UV). The matrix material of the LSC panel is transparent, colorful and very light so it is perfect to use in different architectural contexts.

A typical LSC panel is divided into only three parts: a thin layer containing organic molecules and a flat plate, a transparent plate waveguide and finally, a small Si-monocrystalline PV cell along the edge of the plate.

The second important characteristic of LSC panel is the matrix in polymeric material like PMMA or glass. Part of the UV radiation is absorbed from LSC panel so that during summer time the energy demand for indoor cooling decreases and is hence cost efficient. The remaining part of sunlight range goes unchanged through the plate, illuminating indoor areas.

The Arch. G. Gallo Afflitto master thesis analyse the case study of Luzi University student hall integrated with LSC coloured modules.



Luzi university student house. Second research analysis with day and night time views, showing another colour project distribution.
© G Gallo Af•itto GiadaGalloAf•itto

Analysing the local solar condition results show that the building is unfavorably directed and the shadow factor is too pronounced. It is not currently possible to integrate the classic PV cells on the rooftops for aesthetic or urbanistic reasons, and therefore it could be necessary to integrate LSC panels.

This building is quite simple, divided by vertical structure that suspends from balconies. The dormitory is six stories high and surrounded by other two to three-story buildings. There is also a square in front of it.

If we integrated classic PV panels in front of this building, they would not perform well because of the limited solar energy accident (the front of the building has North-Western exposure), and due to the shade-factor and albedo that exists in this area. In fact, the shadows created by the surrounding buildings hinder the sunlight at the front. Because of this, there would be an increase of cost, time and return on investment.

In effect, the shading coefficient, calculated on "Solarius-PV" ACCA software, is equal to 0.25, while reflectance values are equal to 0.26 (monthly average albedo value). However using classic PV cells in Si-Polycrystalline on M. Luzi dorm, we would have a greater return than we would for LSC panels.

Nevertheless, we prefer these second categories because the first type produces an overheating on the skin of the building and because they are more appropriate to represent the iconography of a university dormitory. We have then drawn four different dispositions of panels on the dormitory surface and for every possible scenario; we have designed a daily and night time view.

Energy analysis

Through the study of existing examples about LSC panels like Eni's bike sharing shelter in Rome (500 Wp from 60 mq of transparent photoactive yellow plates), and studies of Sergio Brovelli from the University of Milano - Bicocca, it is deduced that these

panels have about 10% efficiency. Sergio Brovelli's team studies are based on the use of particular plates dyed by chromophores, which can propagate sun light for long distances without energy dispersing (because concentrators are incorporated of particular colloidal crystals, nanomaterials). Therefore, fluorescence can propagate for long distances without losses and it is possible to make LSC panels hundreds of centimeters in width. If directly used in buildings (windows for example), they do not increase costs. For Eindhoven University, the colour of LSC panels influences yield of panels, in effect a blue dye is more efficient than red dye (21,9% ± 1,6% versus 10,83% ± 1,4%), for example. Using colourful (red, blue, yellow, violet and green) LSC panels with 10% efficiency on M. Luzi dorm we would have only 50 KW (by 770 modules for 1000 mq). Nowadays, 10% performance for LSC panels is too low to persuade the public administration to finance such far-sighted projects, but scientific research offers prototypes that are more and more powerful and durable every day (Quantum-Dots, EuTT with organic binders like Thenoyl Trifluoroacetone, etc.).
In effect, if we had LSC panels with 30% performance, surely classic PV panels would disappear from the market because LSC panels do not produce heat, for low cost and weight and for great building integration.

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Congress palace, Montreal, Canada colour facade
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References

Aste N., Adhikari R.S. and Del Pero C. *An algorithm 2012, for designing dynamic solar shading system*, in Energy Procedia, vol. 30, pages 1079-1089.

Aste N., Del Pero C., Tagliabue L. C., Leonforte F., Testa D., Fusco R. 2015, *Performance monitoring and building integration assessment of innovative LSC components*, in Clean Electrical Power (ICCEP), International Conference on IEEE.

Aste N, Tagliabue L C, Del Pero C, Testa D, Fusco R. 2015, *Performance analysis of a large-area luminescent solar concentrator module*, in Renewable Energy, vol. 76, pages 330-337.

Aste N., Tagliabue L. C., Palladino P., Testa D. 2015, *Integration of a luminescent solar concentrator: Effects on daylight, correlated color temperature, illuminance level and color rendering index*, in Solar Energy, vol. 114, pages 174-182.

Desmet L., Ras M. A. J., De Boer D. K. G., Debije M. G. 2012, *Monocrystalline silicon photovoltaic luminescent solar concentrator with 4.2% power conversion efficiency*, in Optical Society of America.

Li Y., Olsen J., Nunez- Ortega K., Dong W., 2012, A *structurally modified perylene dye for efficient luminescent solar concentrators*, in Solar Energy, Vol. 136, pages 668-674.

Meinardi F., Colombo A., Velizhanin K. A., Simonutti R., Lorenzon M., Beverina L., Viswanatha R., Klimov V. I., Brovelli S. 2014, *Large-area luminescent solar concentrators based on 'Stokes-shift-engineered', nanocrystals in a mass-polymerized PMMA matrix*, in Nature Photonics.

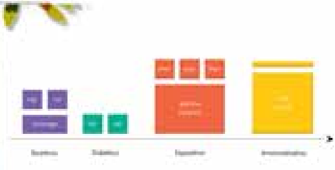
Myong S.Y., Jeon S.W. 2016, *Efficient outdoor performance of esthetic bifacial a-Si: H semi-transparent PV modules*, in Applied Energy, vol. 164, pages 312-320.

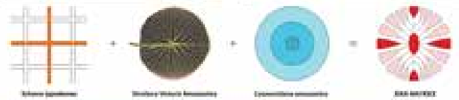
Wang T., Zhang J., Ma W., Lou Y., Wang L., Hu Z., Wu W., Wang X., Zou G., Zhang Q. 2011, *Luminescent solar concentrator employing rare heart complex with zero self-absorption loss*, in Elsevier.

Zarcone R., Brocato M., Bernardoni P., Vincenzi D. 2016, *Building integrated a photovoltaic system for a solar infrastructure: Liv-lib' project, in SHC 2015, International Conference on Solar Heating and Cooling for Buildings and Industry*, in Energy Procedia, vol. 91, pages 887 - 896.





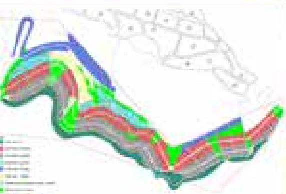



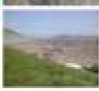
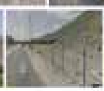
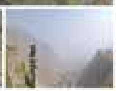


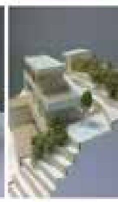
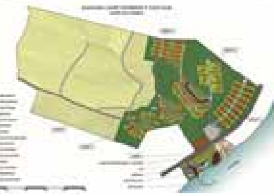


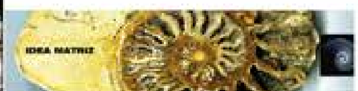






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MODERN PARADIGMS FOSTERING THE ENVIRONMENTAL REVOLUTION

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Green design
© F. Recalde Leon

The Mediterranean basin is suffering from an evolving global terrorism threat, which has increase, its pressure over the past 5 years since 911 New York Twin Tower horror. Since the late 1980s, the number of people applying for asylum has increased exponentially over the past decade, being a Pan European policy issue, stressing on reducing the flow, while trying to distinguish genuine asylum-seekers from purely “economic” migrants[1], or even worst “terrorist” infiltration. As a result of the 1985’s Schengen Agreement[2], there is free travel within Europe for Union member citizens who have the right to live and work anywhere within the EU but citizens of non-EU or non-EEA states do not have those rights unless they possess the EU Long Term Residence Permit or are family members of EU citizens. The Organization for Economic Co-operation and Development (OECD), positively focus that is obviously beyond the immediate power of the EU to eradicate the root causes of all migration. But over time, if the EU wants to reduce migratory pressure, it will have to provide more development aid, debt relief, and fair trade, and it will need to be better equipped to prevent conflict and keep the peace in trouble spots around the world.
These objectives lie at the heart of the EU’s common foreign and security policy[3].
- Foster and support new sources of growth through innovation, environmentally friendly ‘green growth’ strategies and the development of emerging economies.
- Ensure that people of all ages can develop the skills to work productively and satisfyingly in the jobs of tomorrow.
On the other side, global level transitional economies are struggling to implement “Sustainable Development[4]” practices and policies in which the transference of Eco Technology is

[1] Prospect Magazine, June 2000 / OECD Observer No 221-222, summer 2000.
[2] The Schengen area and cooperation, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:l33020.
[3] Common Foreign and Security Policy (CFSP) of the European Union “EU Member states have committed themselves to a Common Foreign Security Policy for the European Union. The European Security and Defence Policy aims to strengthen the EU’s external ability to act through the development of civilian and military capabilities in Conflict Prevention and Crisis Management”. http://eeas.europa.eu/cfsp/index_en.htm.
[4] ec.europa.eu/environment/eussd.

one of the conditions for transforming the local Productive Matrix and therefore acting in real economy and within local socio environmental ecosystems. In this respect we have been acting a Knowledge Transfer educational policy at two levels: At Bachelor & Post degree university level with Environmental Design & Technology Laboratory teaching for architecture and urban design and through Master ABITA Post Degree actions fostering Energy Managers specialization. Within the "MedGreenForum" ABITA's innitiative is defining a methodological strategy for the implementation of full immersive "GreenForumDesign Workshops" to be promoted by local institutions in North African Countries and South America under ABITA (www.centroabita.unifi.it) WREC (www.wrec.org.uk) networks. We strongly believe that the Academic community to actively promotes and fosters real project solutions which will be the content of "Immersive Multisectoral Green Forum Design Workshops" providing "Training by Doing" strategies, under eco sustainable policies and developing Professional and Academic Post Degree training for Public bodies in particular national Board of Architects and Engineers, and Municipalities.[5]

The term "paradigm" beyond the limits today that will set Kuhn in his famous work (1978, orig. 1962[6]).

It is not limited to each of the different disciplines, but includes the whole of science and rationality. Kuhn remnants of the positivists to be here fully overcome. There are in crisis paradigms of science, but the paradigm of science as a way of knowing. A scientific paradigm can be defined as a principle of distinction-relations-oppositions fundamental among some matrices notions that generate and control thought, that is, the formation of theories and the production of speeches by members of a particular scientific community[7].

Let's consider that a paradigm shift in a person, although mature slowly, is suddenly performed as "one way cognitive" awareness in a visual way, such as changing the "gestalt"[8] or change in a religious or ideological conversion.

[5] Public structures the ones that at the end will or will not act sustainable development actions on the territory.
[6] http://plato.stanford.edu/entries/thomas-kuhn / The Structure of Scientific Revolutions, publ. University of Chicago Press, 1962.
[7] Morin Edgar Science avec conscience. Edgar Morin, Science avec conscience, Librairie Artheme Fayard, 1982.
[8] http://dictionary.reference.com/browse/gestalt. 1922, from German Gestaltqualität (1890, introduced by German philosopher Christian von Ehrenfels, 1859-1932), from German gestalt "shape, form, figure, configuration, appearance," abstracted from ungestalt "deformity," noun use of adj. ungestalt "misshapen," from gestalt, obsolete past participle of stellen "to place, arrange" (see stall (n.1)). As a school of psychology, it was founded c.1912 by M Wertheimer, K. Koffka, W. Köhler.

1. A Systemic Holistic and Multi_sectorial methodological approach for Project Development.

The occidental anthropocentrism thought has created false dichotomies between what is "alive" and what is "death", what is "animated" and "inanimate": man and nature. The ongoing environmental crisis, sign of a new historical era, a knowledge crisis of modernity and rationality. Environmental degradation-the entropic death of the planet is the result of the forms of knowledge through which humanity has built the world and destroyed by his claim of unity, universality, generality and totality[9].

We need to think of man and nature not as something separate, but in a process of permanent union or "interconnectedness"[10] a natural way of life.

Therefore what ABITA's has been developing within its International Relationship policies, (Peru, 2006_2014; Ecuador 2002_2015, Montenegro 2012_2014, China 2010_2015) is in fact an interdisciplinary project. This last one, "is based on ecology science per excellence of interrelations- and the thought of complexity - inspired to articulate the different disciplines and fields of knowledge.[11]

Let's put it this way. more than a "holistic view of reality or an interdisciplinary approach that articulates multiple worldviews and knowledge paradigms calling different disciplines, environmental complexity is the field where converge various epistemologies, rationalities and imagined that transforms nature and building opening a sustainable future"[12].

The model of science that originated in the Renaissance was the basis for scientific and technological relevance of our occidental culture. However, the twentieth century's explosion of knowledge, disciplines and approaches has found that traditional science model is not only insufficient, but, above all, an inhibitor of what could be the true sustainable progress, both particular and integrated, from different areas of knowledge.

It is hoped that the new emerging paradigm "the environmental one" will allows us to overcome the naive realism, leaving the reductionist interpretation and enter into the logic of a comprehensive, systemic and ecological coherence that is, entering a more universal science, a truly interdisciplinary one.

As is well focus on M. Martínez Miguélez 1990 essay[13],"nature is a polysystemic all warring when reduced to its elements……. this "all polysystemic", which is the global nature, com-

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[9] http://polis.revues.org/4605, pg 1.
[10] J. Lajo, QÑ; párrafo 33
[11] http://polis.revues.org/4605, pg 8.
[12] http://polis.revues.org/4605, pg 12.
[13] Un nuevo Paradigma para la Ciencia del Tercer Milenio *Miguel Martínez Miguélez" 1990 http://www.slideshare.net/sugo2001/un-nuevo-paradigma?from_action=save.

pels us even to go one step further in this direction. It forces us to adopt an interdisciplinary approach to capture the richness of the interaction between different subsystems studying particular disciplines. It is not just about adding several disciplines, pooling their efforts for the solution of a problem, that is, not about some multidisciplinary use, as is often done. Interdisciplinary requires respecting the interaction between study subjects of different disciplines and achieve integration of their contributions in a coherent and logical whole".

The approach to environmental complexity in E. Leff essay, "inscribes itself in the scope of physis generativity, the ecology of the mind, the sciences of complexity and the interdisciplinary methods of complex thought. The environmental complexity is conceived in the perspective of a crisis in knowledge, the objectivation of the world, the intervention of knowledge over nature and the emergency of hybrid entities which overflow the traditional meaning of ontology and epistemology. ….. where the being is reshaped, identities are rebuilt, and new social actors are forged in a politics of the difference, guided under the desire for knowledge and justice, and the social reappropriation of the world and of nature"[14].

2. Green New Deal: the environmental re_evolution

The environmental re_evolution (Fiber, Rubber, Plastic) as we have named the Interuniversity Research Center ABITA & Partners strategy for Developing Countries, is based on the "Green New Deal" paradigm launched at the Schumacher College[15] Conferences in Nov. 2008 (http://www.schumachercollege.org.uk/). A true alternative for post crisis new economic activities based on a social and environmental responsibility strategies. The radical approach as proposed by Jeremy Rifkin[16] with his Third Technolocal Revolution (the environmental one) needs a re_visitation of the ongoing paradigm, where resources (energetic, environmental ones) are infinite. Use less to say that contem porary history has demonstrated the contrary.

http://polis.revues.org/4605, pg 12

Based on UN and EU policies in which the only true alternative for post-crisis strategies

[14] Enrique Leff, « La Complejidad Ambiental », Polis [En línea], 16 | 2007, Publicado el 31 julio 2012, consultado el 16 agosto 2015. URL: http://polis.revues.org/4605.

[15] Dartington Hall, Totnes, Devon, UK, the College seeks to offer a positive educational space which integrates the concerns of governments, NGOs, businesses and individuals to learn on numerous levels about subjects relating to environmental and social sustainability.

[16] (Denver, 1943) promoter of the THE THIRD REVOLUTION: MOVING ON THE LOW CARBON ROAD, www.foet.org.

is based on Sustainable Development searching for economic and political alternatives for environmental pollution such as: the ecologic reconversion of industrial systems, creation of work places in "green" activities and the renewable energy revolution fostering a reconciliation with violated nature. The energetic independence from fossil resources towards the developing of green infrastructure markets for renewable technologies becomes a road map for "New Energy Economy" within responsible action lives.

To achieve such strategy at least three conditions have to be reached:

a. A systemic and multi_sectorial approach for project development (economist, architects, engineers, sociologist, environmentalist, researchers, entrepreneurs, public officers, etc)
b. Concentrate on BAT technologies (best advanced available technologies) or at least on AT (available technologies) for recycling and reuse transformation technologies.
c. Promote training and education within Eco Business Incubators in destination Countries[17].

The Green New Deal[18] "is a package of policy proposals that aims to address global warming, and financial crises. It echoes the New Deal, the social and economic programs launched by US President Franklin D. Roosevelt in the wake of the Wall Street Crash of 1929 and the onset of the Great Depression. The proposals of the Green New Deal generally echo the recommendations of UN-mandated organizations especially as these relate to reforms to measurement of fundamental ecosystem risk and financial liabilities to better reflect ecosystem valuations and reduce systematic incentives to invest in "dirty" over "clean" industries.

3. Nature & Man equal rights, bases for Sustainable Development

Encliclica Laudato Si of Pope Francis well points out the need for harmonizing man & nature. In fact in the appeal of Pope Francis this need is steadily focus:

1. "LAUDATO SI', mi' Signore" - "Praise be to you, my Lord". In the words of this beautiful canticle, Saint Francis of Assisi reminds us that our common home is like a sister with whom we share our life and a beautiful mother who opens her arms to embrace us. "Praise be to you, my Lord, through our Sister, Mother Earth, who sustains and governs us, and who produces various fruit with colored flowers and herbs"[19].
2. This sister now cries out to us because of the harm we have inflicted on her by our irre-

[17] Environmental Bio_Centers, towards the incubation of Sustainable Endogenous Development. The Italian vision is recognized as an integrated training technological hybridation technology action, applied to energetic cogeneration projects and bio ecological architecture / sustainable urbanism.
[18] https://en.wikipedia.org/wiki/Green_New_Deal.
[19] http://w2.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html#_ftn1.

sponsible use and abuse of the goods with which God has endowed her. We have come to see ourselves as her lords and masters, entitled to plunder her at will. The violence present in our hearts, wounded by sin, is also reflected in the symptoms of sickness evident in the soil, in the water, in the air and in all forms of life. This is why the earth herself, burdened and laid waste, is among the most abandoned and maltreated of our poor; she "groans in travail" (Rom 8:22). We have forgotten that we ourselves are dust of the earth (cf. Gen 2:7); our very bodies are made up of her elements, we breathe her air and we receive life and refreshment from her waters.

My appeal[20]

13. The urgent challenge to protect our common home includes a concern to bring the whole human family together to seek a sustainable and integral development, for we know that things can change. The Creator does not abandon us; he never forsakes his loving plan or repents of having created us. Humanity still has the ability to work together in building our common home. Here I want to recognize, encourage and thank all those striving in countless ways to guarantee the protection of the home which we share. Particular appreciation is owed to those who tirelessly seek to resolve the tragic effects of environmental degradation on the lives of the world's poorest. Young people demand change. They wonder how anyone can claim to be building a better future without thinking of the environmental crisis and the sufferings of the excluded.
14. I urgently appeal, then, for a new dialogue about how we are shaping the future of our planet. We need a conversation which includes everyone, since the environmental challenge we are undergoing, and its human roots, concern and affect us all. The worldwide ecological movement has already made considerable progress and led to the establishment of numerous organizations committed to raising awareness of these challenges. Regrettably, many efforts to seek concrete solutions to the environmental crisis have proved ineffective, not only because of powerful opposition but also because of a more general lack of interest. Obstructionist attitudes, even on the part of believers, can range from denial of the problem to indifference, nonchalant resignation or blind confidence in technical solutions. We require a new and universal solidarity. As the bishops of Southern Africa have stated: "Everyone's talents and involvement are needed to redress the damage caused by human abuse of God's creation". [22] All of us can cooperate as instruments of God for the care of creation, each according to his or her own culture, experience, involvements and talents".

[20] http://w2.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html.

Solar_Eco Farm Resort & Productive Country's Club / Advanced food security (soil-less) farming chain with strong renewable energies Integration. Idea fosters a new vision of farm tourism, oriented on top quality country housing optimizing resource use, helping create an 'enabling environment' and thinking innovative. Support the development of 'green living' with strong production of agro industries production, contributing therefore to increase added value in green business within eco tourism experience where "Salus per Acqua" SPA health and well being, a leading market strategy all based on modern 'Green Design Architecture'.

Another important conceptual issue to be take into consideration are the modern States Constitutions of Ecuador (2008) and Bolivia (2009)[21] who foster some added value for this thought:

"Fundamental principles", Chapter Two / Rights of good living/ Section One

[21] The proposals of the Buen Vivir drawn from an indigenous perspective in Ecuador and Bolivia, reveal an interpretation of nature opposed the mercantilist one that characterizes the progress paradigm in western capitalist modernity. A visittothe thoughtsabout the particularities of theAndean ancestral cosmovision -holistic, of interdependence and interconnection between all beings- helps to understand the counter-hegemonicpotential of Buen Vivir incorporated into the struggle of the indigenous movements in the context of neo-extractivism on the XXI century. Bruna Muriel Huertas Fuscaldo y Vivian Urquidi, « O Buen Vivire os saberes ancestrais frente ao neo-extrativismo do século XXI », Polis [En línea], 40 | 2015, Publicado el 16 mayo 2015, consultado el 16 agosto 2015. URL: http://polis.revues.org/10643
Julien Vanhulst, « El laberinto de los discursos del Buen vivir: entre Sumak Kawsay y Socialismo del siglo XXI », Polis [En línea], 40 | 2015, Publicado el 16 mayo 2015, consultado el 16 agosto 2015. URL: http://polis.revues.org/10727.

Water and food

Art. 12.

The human right to water is essential and indispensable. Water is a strategic national assets for public use, inalienable, imprescriptible, indefeasible, and essential for life.

Art. 13.-

Individuals and communities have the right to secure access permanent healthy, adequate and nutritious food; preferably produced locally and in accordance with their different identities

and cultural traditions. The Ecuadorian State shall promote food sovereignty.

Section Two / Healthy Environment

Art. 14.

It recognizes the right of the population to live in an environment healthy and ecologically balanced environment that guarantees sustainability and good living, sumak kawsay. It is of public interest environmental preservation, conservation ecosystems, biodiversity and integrity of the genetic patrimony the country, the prevention of environmental damage and recovery degraded natural areas.

Art. 15.

The State shall promote, in the public and private sector, the use of environmentally clean and alternative energy technologies do not polluting and low impact. Energy sovereignty will not be achieved to the detriment of food sovereignty, or affect the right to water.

Chapter Seven / Rights of nature

Art. 71.

Nature or Pacha Mama, where it reproduces and performs life, has the right to be fully respects their existence and maintenance and regeneration of its vital cycles, structure, functions

and evolutionary processes. Any person, community, people or nationality may require the public authority to enforce the rights of nature. For apply and interpret these rights principles were observed established in the Constitution, as appropriate. The State will encourage natural and legal persons, and collectively, to protect nature, and promote respect for all the elements that form an ecosystem.

Art. 72.-

Nature is entitled to restoration. This restoration It will be independent of the obligation of the State and people or corporations to compensate individuals and groups depend on affected natural systems. In cases of severe or permanent environmental impact, including caused by the exploitation of non-renewable natural resources, State shall establish the most effective mechanisms for achieving restoration, and take appropriate measures to eliminate or mitigate harmful environmental consequences.

Art. 73.

The State will apply precaution and restriction for Activities that may lead to the extinction of species, destruction of ecosystems or the permanent alteration of natural cycles. The introduction of organisms and organic and inorganic material is prohibited that can permanently alter the national genetic heritage.

Art. 74.

Individuals, communities, peoples and nationalities will right to benefit from the environment and the natural resources they allow good living. Environmental services will not be subject to appropriation; their production, delivery, use and exploitation shall be governed by the State".

4. The knowledge economy & knowledge management Paradigm

The dominance of knowledge, and its importance in modern society and economy, essentially determine the competitiveness on the corporate and national levels, representing the factors of definition and success of development vision, strategies and appropriate policies on the micro and macro levels.[22] In the last 15 years, the importance of the many issues related to the knowledge and its management is rapidly growing, both in academic and research circles. There is a growing importance of global processes, regardless of their advantages and weaknesses, or their causes and consequences. They produce the capacity for competitiveness in the global market, as the most important component of the economic power of some states, regardless of the mutual state dependence, as a result of globalization. The success and stability of modern companies predominantly depend on the continuity of innovation. It imposes a shortened life cycle of goods and services. Economic growth and development depend on the continuity of technological revolutions that change the structural characteristics of the socio-economic relations. In all these fields, a knowledge is obligating component, and therefore it imposes, among other things, the idea of its paradigmatic. A paradigmatic knowledge is indisputable today for several reasons, but primarily because of its dominant importance for the future of humanity and sustainable development.

[22] KNOWLEDGE - KEYSTONE OF THE MODERN ECONOMY http://www.sphub.org/books/knowledge-keystone-of-the-modern-economy ISBN 978-961-6948-00-5; ISBN 978-961-6948-01-2 (pdf) 1. Drašković, Veselin 269835520.

In addition, another reason is the number of theoretical concepts containing knowledge:

- the concept of knowledge as the only unlimited resource and the key factor for sustainable devel opment,
- the concept of knowledge as a product, because production of knowledge is the most important determinant of modern economics,
- the concept of codified knowledge, which becomes the most important component of the economic relations,
- the concept of economy knowledge and society knowledge as the most important consequences of an information society development, and
- the concept of the new economy (hereafter n.e.) as questionable theoretical and methodological construction, found in the jargon and articles of many authors.

5. Green Infrastructure and Urban Eco Technologies, the organic and the sustainable living paradigm

Green Infrastructure is addressing the spatial structure of natural and semi-natural areas but also other environmental features which enable citizens to benefit from its multiple services. The underlying principle of Green Infrastructure is that the same area of land can frequently offer multiple benefits if its ecosystems are in a healthy state. Green Infrastructure investments are generally characterized by a high level of return over time, provide job opportunities, and can be a cost-effective alternative or be complementary to 'grey' infrastructure and intensive land use change. It serves the interests of both people and nature[23] The Commission has adopted a Green Infrastructure Strategy, 'to promote the deployment of green infrastructure in the EU in urban and rural areas' Ecological integrity, economic prosperity and social equity is what we call Sustainable/Integral Planning or/and Urban Collaborative Planning changing paradigmatic trend for "green living", a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful, for healthier natural living, fostering the organic and sustainable living paradigm, promoting solar cities and eco neighborhoods.

[23] http://ec.europa.eu/environment/nature/ecosystems/.

Solar_Eco Farm Resort & Productive Country's Club / key concepts:

- Solar_Eco Farm Resort & Productive Country's Club
- Eco Ef▸cient Country Housing with Recycling and Dried Eco Ef▸cient Building Technologies/
- Added value Agribusiness cluster chain development /
- Food security & cleaner production with
- international quality & standards/
- Environmental management & territorial eco_ef▸ciency for market placement narrowing the Urban Rural gap/
- Green Solar Eco Farm Social Housing and Productive Compounds/

MEDITERRANEAN SMART CITIES: MULTILEVEL GOVERNANCE IN ENERGY POLICIES AND MEASURES

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© Antonella Trombadore

"Mediterranean" vision

With 80% of European citizens living in urban areas, cities have a crucial role to play in the transition towards a low-carbon economy. Faced with the challenge of ensuring the quality of life of their citizens while becoming more energy efficient, cities must look at the system level and develop integrated urban development strategies that will make them both sustainable and better places to live.

Cities in the Mediterranean need to change and develop to overcome growing difficulties and adapt to the increasingly knowledge-intensive economies. Cities need to become 'smart cities'. The "Smart Cities in the Mediterranean" Strategic Partnership aims to work for 'smartering' cities in the Mediterranean region by sharing resources, knowhow and experience. European and Mediterranean cities, although different from each other, they have similar needs that can be tackled best through a common approach.[1]

Greening the building allows obtaining a relevant improvement of building envelope efficiency, environmental balance as well as increases the biodiversity. Greening systems are a construction practice to reduce solar heating in buildings, to restore the environmental integrity of urban Mediterranean areas, improving the characteristics of green façades and green roofs. Greening solutions offer multiple benefits as a component of current urban design; such as the relation between the environmental benefits and building energy saving. The vegetation integration in vertical greening systems is a sustainable approach for new and existing buildings envelopes. Greening the building envelope especially in Mediterranean climate and in the warm season, reduces the peak temperature on the wall surfaces with climbers' plants. Some studies demonstrate that greenings buildings technologies for roofs or facades, can increase the dynamic thermal characteristics of the wall surfaces temperature to reach a good thermal behavior of building envelope. Few case studies are analyzed in this paper taking into account energy savings strategies to reduce energy consumption in buildings.

[1] https://eu-smartcities.eu.

Cairo: the tipical effect of traf‣c.
Tents used as street shading devices ©Antonella Trombadore

opposite page
Amman: typical town congestion
©Antonella Trombadore

The European framework: NEEAP - SEAP - CoM

The Directive 2012/27/EU establishes a set of binding measures to help the EU in reaching its 20% Energy Efficiency (EE) target by 2020[2]. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain from its production to its final consumption and to transpose the Directive's provisions into their national laws by June 5th, 2014.

On one side, public authorities play a key role in the reduction of EU energy consumption and the increase of renewable energy capacity[3].

Member States (MS) must produce and implement National Energy Efficiency Action Plans (NEEAPs) and National Renewable Energy Action Plans, furthermore they have the obligation to produce detailed action plans in specific sectors such as the renovation of buildings or the application of high-efficiency cogeneration and efficient district heating and cooling systems.

[2] To reach the EU's energy efficiency targets, individual EU countries have set their own indicative national energy efficiency targets. New national measures have to ensure major energy savings for consumers and industry alike. Some of them are directly related with buildings and Article 7 of the Energy Efficiency Directive can be implemented by having in place or establishing one or a combination of the following policy measures: (i) energy efficiency obligation schemes (EEOS) or alternative policy measures.

[3] Energy efficiency has to be increased at all stages of the energy chain from generation to final consumption. At the same time, the benefits of energy efficiency must outweigh the costs, for instance those involved in renovations. EU measures therefore focus on sectors where the potential for savings is greatest such as buildings. The EU has set itself a 20% energy savings target by 2020 when compared to the projected use of energy in 2020. At an EU summit in October 2014, EU countries agreed on a new energy efficiency target of 27% or greater by 2030 and the European Commission had proposed 30% in its Energy Efficiency Communication. The EU has adopted a number of measures to improve energy efficiency in Europe. They include (among others) the preparation of National Energy Efficiency Action Plans every three years by EU countries.

Local and regional authorities are also developing plans at their own level and other public authorities play an important role too.
National energy regulatory authorities should provide incentives for grid operators (heat, cold and electricity) to enable network users to produce renewable energy and implement energy efficiency measures.
Secondly, Covenant of Mayors (CoM) holds a pivotal role in achieving the Europe targets set by the EU Climate Action and Energy Package.
Nevertheless, due to a number of barriers, municipalities in many countries are hesitant in adhering to the CoM or preparing and implementing the necessary Sustainable Energy Action Plan (SEAP): very often these plans are set up as individual actions, not interconnected with regional energy efficiency policies and measures and without a well-defined governance framework.
The energy efficiency planning requires a multidisciplinary approach, involving different actors (at local, regional and national scale), large number of stakeholders as well as different types of energy contracts.
Besides, very often local authorities and municipalities do not have enough expertise and appropriate staff to manage this complex area.

- How can the regional level support local strategic energy planning in order to facilitate the transition from a centralized model to a distributed model?

- What should be the organizational structure of the public sector to play a proactive role at local level in energy efficiency?
- What are the indicators that should be monitored to verify the effectiveness of the actions under the SEAP, according to the social, cultural as well as urban/architectonical context and climatic conditions?
- What should be the relationship among different levels of governance (national/regional/local level) to fulfil effective and rapid actions of energy planning?
- What are the most suitable tools to support an integrated planning approach and monitor its results and effects at local scale?
- What are the new social patterns, economic models, experts network to share knowledge experience and best practices?

How to develop a Sustainable Energy Action Plan (SEAP) in South Mediterranean Cities. The Guidebook developed by Covenant of Mayors[4]

What is the Covenant of Mayors (CoM)?

The CoM initiative is a voluntary commitment by local authorities (regions, cities, towns) to implement energy and climate change mitigation measures to reduce their overall CO2 emissions by at least 20% by 2020.
The implementation of the agreed measures should take place at the local level in the territory within the competence of the local authority and, where relevant, with the consultation and participation of national authorities.
The political commitment undertaken by all CoM signatories is declared in the CoM core text, which must be approved by the municipal council (or equivalent body, including national authorities).

What is a Sustainable Energy Action Plan (SEAP)?

The SEAP document defines the concrete actions, responsibilities and timing to achieve the local authority's long-term energy consumption and CO2 emissions reduction targets for their geographical area. The SEAP is the document by which CoM signatories demonstrate how they will reach the 20% CO2 emissions reduction commitment by 2020.
The SEAP should not be thought of as an ironclad document. It may optimise reduc-

[4] http://www.covenantofmayors.eu

tions to revise the SEAP on a regular basis as localities gain experience, achieve results and incorporate new climate science and technologies.

The SEAP should be formulated such that projects arising in the future are developed to support the SEAP objectives. Efficient use of energy, renewable energy sources and other reduction actions should inform decision-making for all new projects, even if the initial SEAP has been approved.

SEAP Sustainable Energy Action Plan parameters

The SEAP covers the geographical area governed by the local authority (region, city, and town) and includes actions by both public and private sectors.

For CoM signatories, action in the following sectors is mandatory in the SEAP: buildings including municipal, residential and commercial buildings, transportation and municipal lighting. Other sectors that provide significant emissions reduction potential may also be included, such as waste and water treatment plants, local heat and electricity production, urban and land-use planning, and industry.

The SEAP's bottom-up approach focuses on actions within the competence of the local authority and, where relevant, the national authorities. For each sector, it considers actions and measures that will influence energy production and consumption in the long term, and encourage markets for energy- efficient products and services as well as changes in consumption patterns. To ensure effective implementation of the SEAP, actions proposed should be within the framework of national plans and actions such as the National Energy Efficiency Action Plans (NEEAPS) and the National Renewable Energy Action Plans (NREAPs).

The SEAP should be elaborated based on a sound knowledge of local energy consumption and greenhouse gas (GHG) emissions. For that purpose, local authorities will first need to undertake a Baseline Emissions Inventory (BEI) to establish a realistic picture of their current situation in terms of energy production and consumption, and associated CO2 emissions.

The local authorities will use this information to establish a clear vision, set priorities for action, evaluate the impact of proposed actions and monitor progress in their implementation.

Timeframe

The timeframe for CoM signatories is 20% CO2 emissions reduction by 2020. Local authorities may cover a longer period; in such cases, CoM signatory SEAPs must include a clear outline of the strategic actions intended, along with intermediate 2020 values and objectives, that will satisfy their CoM commitment.

Recognising that it is not always possible to plan in detail concrete actions and budgets for a long timeframe, local authorities may distinguish between a vision, with long-term strategy and goals in the sectors, and detailed actions in the next three to five years towards achieving it.

CoM signatories must submit their SEAPs to the JRC for evaluation and approval within one year of signing the commitment via "My Covenant", a password-protected area of the CoM website. They also commit to regular Implementation Reports.

SEAP elaboration: 10 elements

The local authority may decide the degree of detail required to satisfy the SEAP's three functions as a working instrument over the course of implementation; a communication tool towards stakeholders; and a document for municipal council assent and, where relevant, national authority involvement. It should be sufficient to avoid further discussion at the political level during the implementation and monitoring phases.

Ten key elements should be kept in mind when elaborating a SEAP:

1. Approval

Strong political support by municipal council or equivalent decision-making body is a prerequisite for the successful design, implementation and monitoring of a SEAP. Local authorities must ensure that the vision and actions proposed in the approved SEAP are aligned with and integrated into relevant national and/or regional plans (such as the National Energy Efficiency Action Plans [NEEAPS] and National Renewable Energy Action Plans [NREAPs]), strategic development plans or land-use plans. The SEAP should therefore be approved by the municipal council (or equivalent body, including national authorities).

2. Governance

An appropriate governance structure is fundamental to successful implementation. The SEAP should outline which structures are in place or how they will be organised to implement the proposed actions successfully. Local authorities should ensure that the SEAP is taken into account at different levels and by different departments, including those at a national level. The SEAP should also specify the human resources required and how they will be made available, as well as the implementation and monitoring strategy. The local authority should consider training and capacity-building to avoid delays in implementation. Municipalities with limited autonomy or opportunity for recruiting staff should draft recommendations to national authorities, including a request for suitable technicians and administrators to carry out some actions foreseen in the SEAP.

3. Stakeholders
The involvement of relevant stakeholders throughout drafting and implementing the SEAP is crucial.
The SEAP should describe how each stakeholder will be involved or consulted during the preparation of the SEAP document, and how each will participate in the implementation and monitoring of the planned actions.

4. Financing
The SEAP should identify the financing resources for each step of its development, implementation and monitoring. It should take into consideration the financial resources needed to build capacity within the municipality and to compensate external stakeholders such as architects, consultants, banks, developers and facility management involved in elaborating the SEAP.

5. CO2 reduction commitment
The principle behind the SEAP is a meaningful, actionable commitment by local authorities to reduce energy consumption and consequently CO2 emissions in their jurisdictions. For CoM signatories, the SEAP must include the signatory's statement of commitment to reduce emissions by at least 20% by 2020 within the geographical area under its responsibility for the areas of activity, relevant to its mandate. The commitment should be based on the quantification of associated CO2 emitted in the baseline year.

6. Baseline Emission Inventory (BEI)
The ideal baseline year to set energy and emissions reduction targets is 1990. A more recent baseline year – the closest to 1990 – could be considered if data are lacking. Municipalities with no such data can take the year they initiated data collection as their baseline year. Municipalities that set longer term targets (e.g. by 2030) must set an intermediary 2020 target that satisfies the -20% reduction commitment to allow for benchmarking and comparisons with other CoM signatories. Targets should be based on a reference called the Business-as-Usual (BAU) scenario, as explained in the section, "Establish emission targets". The SEAP should be elaborated based on a sound knowledge of local energy consumption and greenhouse gas (GHG) emissions. The BEI and subsequent inventories are essential instruments that give local authorities a clear picture of current conditions and priorities for action,

as well as a means of evaluating impact and monitoring progress. The BEI also sustains motivation as all parties see the result of their efforts. The BEI is a CoM requirement and an integral part of a SEAP.

7. Measures

The local authority should identify and prioritise the required and/or most effective sectors in which to implement reduction actions. The local authority should establish a long-term vision with clear objectives for each sector. The SEAP must include a coherent set of measures covering the selected sectors. Measures should be aligned with identified priorities and measurable in terms of energy consumption and CO2 emissions reduction. Suggestions for measures and actions in various sectors are provided in the section, “Elaborate the plan”.

8. Actions

The SEAP must provide a clear outline of the specific actions the local authority intends to take to reach its targets. It should include:

- long-term strategy and goals in selected and/or mandatory sectors, as well as public procurement;
- detailed actions for the next three to five years that will advance towards the long-term strategy and goals.

For each action, include the department and persons in charge of implementation and monitoring, a timeline (start, end, and major milestones), a cost estimate and financing source(s), the estimated energy saving/increased renewable energy production, and the associated estimated CO2 reduction.

9. Monitoring and reporting

Regular monitoring using relevant indicators allows local authorities to evaluate progress towards targets over time and adopt corrective measures if necessary. The SEAP should briefly outline how the local authority (or relevant decision-making body) intends to ensure monitoring throughout implementation of the planned actions. CoM signatories must submit an Implementation Report every second year following the submission of the SEAP.

10. Submitting SEAP templates

CoM signatories commit to submitting their SEAPs within the year following signing.

STEEP (Systems Thinking for Ef‣cient Energy Planning) ©smartsteep.eu

The SEAP must be uploaded in the national language or in English via the CoM website. Signatories are also required at that time to fill in an on-line SEAP template in English summarising their BEI results and the key elements of their SEAP.

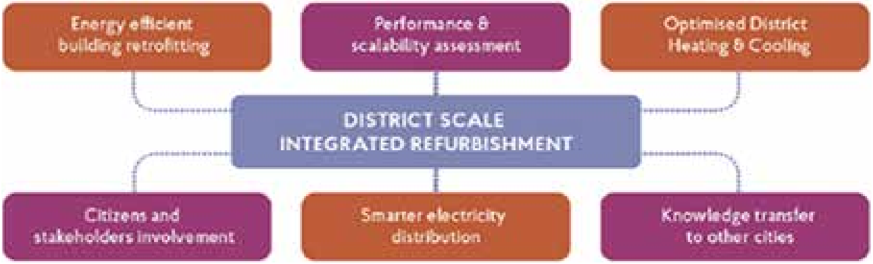
National and international research and innovation activities

STEEP is an innovative project that aims to develop Energy Master Plans for districts in each of the three participating cities, adopting a 'systems thinking' methodology in combination with open-data sourcing to achieve carbon reduction targets and overcome the barriers to energy efficiency. The three partner cities have decided to join together in order to improve efficiency along all the key aspects of the 'energy value chain', applying smart city concepts in an integrated manner and learning from each other's expertise. The Institute for Future Cities at University of Strathclyde is coordinating the overall project, with partner organisations taking the lead in different work packages.

The term systems thinking is a broad description for the process of understanding complex systems behaviour. In the context of the STEEP project, systems thinking has been applied to the issue of energy master planning. Systems thinking is based on the idea that the component parts of a system can best be understood in the context of relationships with each other and with other systems, rather than in isolation. A systems thinking approach is grounded in the principle that the only way to fully understand a problematic situation is to understand the parts in relation to the whole.

To achieve this holistic picture or map of interconnected parts, the particular issue at hand needs to be understood by the stakeholders using a particular Problem Structuring Method or PSM. A number of PSMs were considered in the development of the STEEP project before the most appropriate method was identified as Hierarchical Process Modelling (HPM). HPM enables analysis of the understanding and performance of a system in terms of the processes that are necessary to achieve the trasnformational goal of the system (the messy

Bridging the gap between demonstration and large-scale replication



problem that requires intervention). Each city will therefore engage in a process of stakeholder workshops, where a conceptual model of the target transformation consisting of the various processes, which constitute an overall objective (an energy efficient zone), will be mapped outfor each city district.

The STEP UP project brings together four ambitious, European cities (Ghent, Glasgow, Gothenburg and Riga) with experience of the Covenant of Mayors' Sustainable Energy Action Plans (SEAP) energy planning process and a number of common characteristics and socio-economic factors that will enhance their ability to work together and learn from each other. The Sustainable Energy Action Plans each city has produced all outline clear and ambitious energy efficiency and CO2 reduction targets.

From within the four cities, STEP UP is a partnership of twelve organisations comprised from city government, academia, and business.

The project combines expertise in energy planning, economics, finance, technology, project management and delivery and has representatives from each city council, ensuring the active participation and political commitment of the cities themselves.

In each city, linking with local partnerships and stakeholder groups, STEP UP will be able to facilitate the delivery of real projects in participating cities by using a multi-disciplinary and integrated approach.

The focus will be on holistic solutions that deliver real economic, environmental and technological advances in each city with regards to smart city planning.

Strategies Towards Energy Performance and Urban Planning (STEP-UP) aims to bring together excellence on energy planning from four ambitious, European cities together with their industrial and research partners, running from Autumn 2012 to Spring 2015.

This modelling process will also rate how well each city is doing in its performance of each of these processes, therefore helping to identify where action needs to be taken.

In the context of the STEEP project, the implementation of the systems approach described above requires engagement with project partners and wider stakeholders in each city district. The modelling process in each district will be a continuous iterative process based on feedback and discussion, rather than strategic planning.

The ongoing modelling process enables stakeholders to gain more knowledge about the problematic situation thus leading to the creation of a learning system. As areas for improvement are identified, actions will be drawn from each model to form the basis of an energy master-plan with relevant objectives.

By engaging stakeholders in process modelling, STEEP hopes to facilitate a more sophisticated approach to the issue of energy planning at the district and city level. For a full introduction to systems thinking and our approach however, please see our online webinar, produced by the University of Bristol and which can be found in the resources section.

The combination of a local government, commercial and research partner from each city, together with links into local partnerships and stakeholder groups, will help ensure that STEP UP will be able to facilitate the delivery of integrated actions and projects in participating cities by using a multi-disciplinary and integrated approach. The range of expertise and experience of the partners will ensure the provision of holistic solutions that deliver real economic, environmental and technological advances in each city with regards to smart city planning.

The active involvement of city councils will ensure that the plans meet the needs of the cities' citizens, businesses and existing infrastructure, as well as being economically feasible.

STEP UP tools and techniques, such as energy mapping and stakeholder analysis, have been shared in a guide for city energy planning. The guide, together with a brochure on developing innovative low-carbon projects based on the experiences of the participating cities in identifying and developing their own projects, is intended to inspire other cities. Indra Van Sande, from the city of Ghent, explains: "We took an innovative approach that integrates energy planning into wider city plans and policy objectives. So as well as reducing CO2 emissions, we are also working towards other goals, including improved energy security, food strategy, eradication of fuel poverty and greater urban regeneration and economic growth."

The SINFONIA project is a five-year initiative to deploy large-scale, integrated and scalable energy solutions in mid-sized European cities. At the heart of the initiative is a unique cooperation between the cities of Bolzano and Innsbruck, working hand in hand to achieve 40 to 50% primary energy savings and increase the share of renewables by 20% in two pioneer districts. This will be done through an integrated set of measures combining the retrofitting of more than 100,000 m² of living surface, optimisation of the electricity grid, and solutions for district heating and cooling.

A large part of the project is therefore dedicated to the transferability and scalability of the solutions deployed in the two pioneer districts. To achieve this, SINFONIA will define a

Bridging the gap between demonstration and large-scale replication. Low Carbon Cities for Better Living. @ sinfonia-smartcities.eu. @ pleecproject.eu. @ smart-cities.eu.

limited set of district typologies and corresponding refurbishment models, enabling cities to easily assess their needs and efficiently define their long-term refurbishment strategies. To further ensure their scalability and transferability, these models and typologies will be tested and validated with all stakeholders involved – public and private, from citizen to energy regulators – not only in Innsbruck and Bolzano, but also in five 'early adopter' cities which are actively participating in SINFONIA: Pafos (CY), Rosenheim (DE), Seville (ES), La Rochelle (FR)and Borås (SE).

The PLEEC project – "Planning for Energy Efficient Cities" – funded by the EU Seventh Framework Programme uses an integrative approach to achieve the sustainable, energy – efficient, smart city. By coordinating strategies and combining best practices, PLEEC develops a general model for energy efficiency and sustainable city planning. University of Copenhagen (DK) will allow a better link and cooperation between the two projects.

Since 2007, the TUWIEN team works on the issue of smart cities. In cooperation with different partners and in the run of distinct projects financed by private or public stakeholders and actors the European Smart City Model was developed. Basically it provides an integrative approach to profile and benchmark European medium-sized cities and is regarded as an instrument for effective learning processes regarding urban innovations in specific fields of urban development. Currently, the 3rd release of the smart city model is already available.

University of Copenhagen (DK) will allow a better link and cooperation between the two projects.

Smart City Index is a contribution to the development of Smart Cities in Italy, which is taking place in a slow and uneven. Between, who for 10 years carried out a systematic monitoring of the spread of ICT (broadband platforms for digital services), it has created the Smart City Index, a ranking of all 116 provincial capitals "primary" identified by ISTAT.

@ italiansmartcity.it

@ between.it

Between set itself the objective of measuring the level of "smartness" of the Italian cities with a methodology as objective as possible and dynamic.

The PLEEC project – "Planning for Energy Efficient Cities"
Smart Cities _Theoretical background

For various reasons, cities aim at improving their competitiveness and their position in comparison to other cities (Begg 1999). Since the European integration process has diminished, differences in economic, social and environmental standards (Pichler- Milanovic 2005), cities have converged in their basic conditions for competition, which is increasingly scaled down from the national level to the level of cities and regions (Storper 1995). However, socio-economic inequalities are still considerable on a regional level, although the efforts of Cohesion Policy have largely succeeded in reducing disparities between the richer and the poorer countries. Nevertheless new member states face a growing economic gap between central urban areas and remote rural regions (Kramar 2006). This trend enhances the importance of specific local characteristics, which provide comparative advantages competing for increasingly footloose and mobile global enterprises, investors, tourists and capital (Parkinson et al. 2003, Giffinger et al. 2003).

Facing this development, urban competitiveness andcorresponding strategic approaches have become important efforts of urban politics.In this situation, city rankings have experienced a remarkable boom and increasingly attract public attention. In these comparative studies, cities are evaluated and ranked with regard to different economic, social and geographical characteristics in order to reveal the best (and the worst) places regarding either quality of life or conditions for economic activities. In this way, the comparison of cities can support stakeholders on the one hand, but it can also be an important guide for future city development on the other.

Having realized these specific potentials of city rankings, policymakers increasingly make use of their results. Thus, city rankings have become an important empirical base for disclosing comparative advantages and sharpening specific profiles and consequently for defining goals and strategies for future development. Secondly, positive results in a widely published and approved city ranking can also be used as a central part of a city's marketing strategy as a top rank in a highly reputed ranking definitely helps to improve the international image of a city. As part of this process, city rankings reinforce the competitive perspective steering urban development; their placing focuses the strategic efforts of urban politics mostly on strengths, neglecting weaknesses.

The Smart Cities' Approach

Smart City projects are developed as a consequence of increasing city competition in Europe, which has been induced by economic globalisation and political integration processes (Begg 1999) and which very obviously enforced cities to steer urban development in a more strategic way: Since European cities are characterised by diverging historic backgrounds, different functions and conflicting interests, a specific positioning within the European urban system is a rather complex challenge, which demands well-reflected strategic planning and governance endeavours based on local conditions. Hence, the specific strengths and weaknesses of a city are the central base for defining future development options.

The "European Smart Cities" approach, which was elaborated by Vienna University of Technology (Centre of Regional Science) in 2007 and revised for the specific requirements of the PLEEC project in 2013, concentrates on medium-sized cities and their perspectives for competitive and sustainable development. Even though the vast majority of the urban population lives in such cities, the main focus of urban research tends to be on 'global' metropolises.

As a result, the challenges of medium-sized cities, which can be rather different, remain unexplored to a certain degree.

Medium-sized cities, which have to compete with larger metropolises on corresponding issues, appear to be less equipped in terms of resources and organizing capacities. In order to enforce endogenous development and to achieve a good position, these cities have to identify their strengths and opportunities even more carefully and to ensure comparative advantages in various key resources against other cities of the same level.

City rankings and city profiles describing a broad variety of characteristics can be helpful tools to identify specific assets of a city in a benchmarking process. Rankings, which have become quite common recently, largely differ in their approaches or methods: due to diverging objectives and methodological approaches, they often produce deviating results. Therefore, the following chapter does not primarily aim at providing a ranking of cities, but at elaborating individual city profiles, which allow and support comparative benchmarking from different perspectives.

These "Smart City"-profiles aim at supporting a forward-looking and evidence-based strategic planning considering two different components of urban development: First, the evaluation of cities has to consider issues as awareness, flexibility, transformability, synergy, individuality and self-decisive behaviour. Especially awareness seems important for a "smart" city as certain potentials can only be mobilised if inhabitants, companies or administrations are well aware of the cities' position.

This kind of assessment must not be confined to the internal structure of the city but has to consider its surrounding regions and its position in the regional system of cities.

Second, the profiles should not only focus on single aspects, but consider all fields of urban development, which requires a clear and transparent identification of characteristics for the evaluation (Giffinger et al. 2007). In this context the "Smart City"-profiles identify six key fields of urban development (see Figure 2) incorporating the main aspects of "Smartness", as indicated in the following definition: "Smart City is a city well performing in [relevant key fields of urban development],built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens." (Giffinger et al. 2007).

The aim of Meethink Energy project

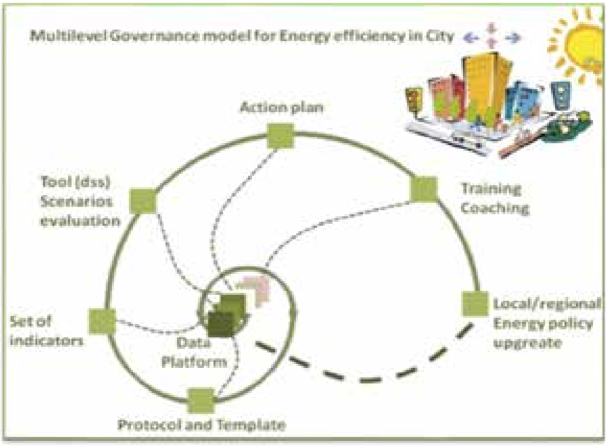
MEETHINK_Energy is an european research project leaded by Tuscany Region under Horizon 2020 call for proposal, involving 30 municipalities of 6 different European countries (Albania, Greece, Italy, Serbia, Slovenia, and Spain). The project will stimulate a multilevel governance model by joining regional with local authorities and involving policy makers, technicians, stakeholders in a bottom-up integrated approach. The core of the project focuses on the definition of a common protocol and on the identification of common criteria and energy efficiency performance indicators, as well as on a pilot phase during which the multilevel governance model will be tested in collaboration with small and medium-sized city partners. Several potential scenarios will be evaluated and the multilevel governance model will allow to improve the quality and the effectiveness of energy policies and measures as well as the connection among different key-actors and levels of government.

The core of the project focuses on the definition of a common protocol and the identification of common criteria and energy efficiency performance indicators, as well as on a pilot

phase during which the multilevel governance model will be tested in collaboration with city partners. Several scenarios will be evaluated and the multilevel governance model will allow to improve the quality and the effectiveness of energy implementation policies and the connection among different actors and levels of government.
With a focus on three thematic priority areas (energy efficiency in buildings & districts, in particular public bodies buildings; renewable energy sources & distributed energy generation; energy in urban mobility), the aim of the project will be achieved by sharing activities through large-scale networking, peer-to-peer learning and best practices, by assessing the training gaps and needs of the participating municipalities in reference to energy efficiency planning and implementation; by developing a detailed capacity building strategy for public authorities at different levels of governments.
At the same time, a common ICT platform will be integrated with existing networks (e.g. PLEEC, Europeansmartcities 3.0). The platform, supported by a peer to peer methodology, will be structured with three different access levels (free access, policy makers, technicians) and it will be made up by a data sharing tool, open data repositories, a decision support system and a communication website. The platform will support public authorities in monitoring and evaluating their current situation with the aim to identify strengths, weaknesses and opportunities as a baseline for evaluating the next energy efficiency policies and measures. The platform will allow to involve public/private stakeholders and promote a multidisciplinary Think Tank network across the EU.
Moreover, the project will support MS public authorities to implement article 7 of the EE Directive by setting up, revising and implementing robust Energy Efficiency Obligation schemes (EEOs) or alternative policy measures while providing appropriate information and tools and to strengthen the capacity of EU regions and municipalities in institutionalising sustainable energy policies into their operations and committing and fulfilling their Covenant of Mayors obligations.

The added value of multilevel governance approach

While many initiatives focus on the local level only, MEETHINK Energy project will also highlight the regional dimension of energy efficiency efforts. This aspect assumes a great relevance, for example, in the field of mobility, where a big share of transport energy use is related to commuting which is usually not confined to municipality boundaries but subject to a functional region. Also other important aspects, as renewable energy production, management or land use planning, will be characterized by a considerable regional dimension.



Multilevel Governance model for Energy ef‣ciency in City

The regional dimension will foster the multilevel governance approach in specific three ways:

- The regional dimension will drive the indicators framework, the database structure and the monitoring tool;
- The regional structural and cohesion funds managing authorities will be involved in the selection of energy saving packages during the development and evaluation phase of Local Action Plans scenarios in order to reduce the governance gap among regional and local planning and to achieve synergies and effectiveness of integrated actions;
- Through the engagement of several municipalities of the same region in the project, MEETHINK Energy project will set-up regional groups to foster debates on regional issues, supplementing the local agenda.

Moreover, the regional groups will allow a fast exchange of ideas and approaches to implement energy efficiency measures in similar policy contexts, while the cross-national exchange between partner cities will promote new thinking and critical perspectives on local practices.

MEETHINK_Energy project wants to make a real input to achieve the European targets by improving legislation through action of learning and dissemination of Best Practices on sustainable building and knowledge transfer. A special attention will be dedicated to the building sector (improving energy saving - energy efficiency in existing building).

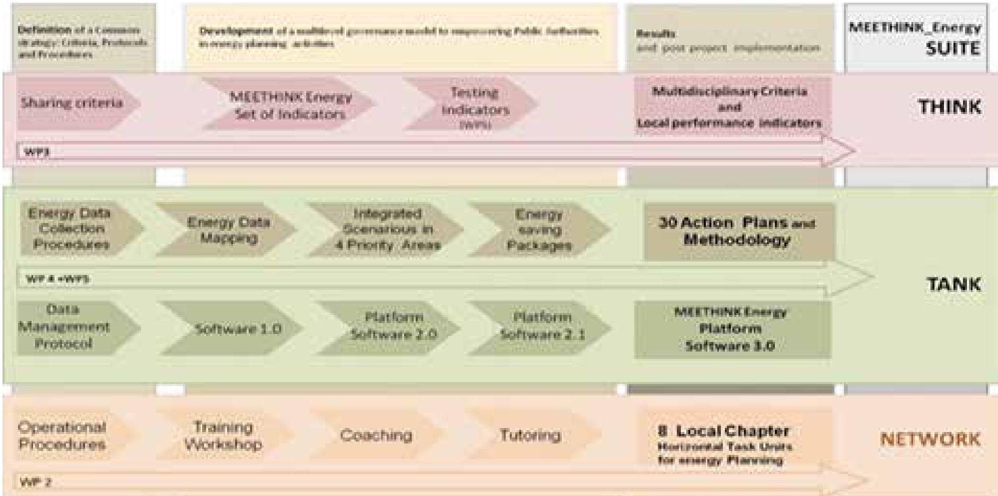
The general objective of the MEETHINK is to experiment an innovative approach in

Level approach	Objectives	Main results	Field	
Policy	Integrated approach – multilevel – regional scale Definition of the energy efficiency performance indicators in order to asses the potential scenarios and integrated solutions for a comprehensive city planning. Stimulating interactions between stakeholders/officers/administrators and citizens/final users, to ensure the opinions and views of all interested parties.	New integrated management model	***Governance***	***THINK***
Measure	This is the project level where project definition takes place, in terms of scenarios, integrated technological solutions and socio-economic measures. The development of a strategic plan and creation of scenarios, consolidating the foundations to support properly an Action plan. Valuation and analysis of SEAPs results, in order to keep track of the gap between achieved results and achieved goals, in reference to the EU 2020 targets. And to compare others position in respect to the EU targets and other SEAPs achievements.	Scenarios Action Plan SEAPs evaluation and monitoring	***Planning***	
Tool	One of the components of the MEETHINK-Suite multilevel governance model and tool, *as support decision system*, to close the distances between policy choices, planning at the regional/local scale, fostering the building capacity on Energy Efficiency Governance integrated approach, data management, monitoring and results analysis of SEAPs in respect with EU 2020 targets.	Data base, Protocol Decision support system software	***DATA*** ***Platform*** ***Suite***	***TANK***
People	Think tank network - Knowledge exchange New level of "advanced municipality" Skills and policy capacity building to define new Energy saving target and visions	Local Chapter Cross-departmental tasks unit	***Skills and Knowledge***	***NETWORK***

empowering public authorities to develop, finance and implement ambitious sustainable energy policies and plans on the basis of reliable data and analyses in sectors with high energy saving potential such as buildings, industry and urban mobility with a geographical coverage of clear European added-value and considering capacity building as an integral part of the project proposals-including EED implementing bodies, joining regional with local authorities and involving policy makers, stakeholders and technicians in a bottom-up integrated approach.

This general objective will be pursued by implementing a new multilevel governance model/methodology (from motivation, planning, implementation, to monitoring and evaluating), identifying a set of common criteria and multidisciplinary performance indicators in order to drive ambitious integrated regional and/or local SEAPs to reduce policy gaps among several levels of government.

The model will be supported by an international network and tools (platform, database,



Multilevel Integrated approach: 4 LEVEL Policy, Measure, Tool, People-

software) to reach a vertical and horizontal cooperation, generating synergies and economies of scale on the defined priority areas.

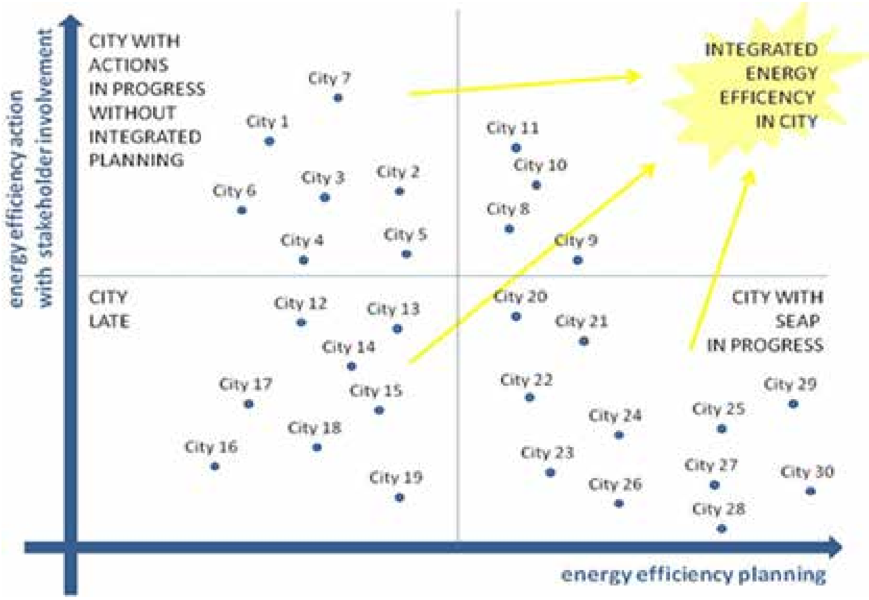
Target Groups

MEETHINK_Energy targets Regional/Local Administrations of 30 European small and medium-sized cities: under 5,000 (small), 30.000/300.000 (medium) inhabitants. More than 1500 public agents/trainees/trainers should essentially benefit and take forward the project results in the short and long term, according to the stage of local planning activity. The participating municipalities might very likely be involved in very different stages of their actions. Some might consider to join the Covenant of Mayors, others might have already submitted an Action Plan and work on its implementation or are even close to the evaluation stage and might have to follow up on its results. It would make sense to support the municipalities in the specific stage. There are two main groups:

1. Municipalities which need to get started: Help to map their stakeholders, identify energy problems (data), develop an Action plan, etc.

2. Municipalities which are in the process: Help to prioritize their existing Action Plan, probably critically review, monitor implementation and evaluate impacts.

Again, as a unique selling point for MEETHINK, the project puts more attention to the second point with a focus on evaluation of the Covenant of Mayors efforts in the different municipalities. It would be really an added value of the project. All cities of Tuscany and

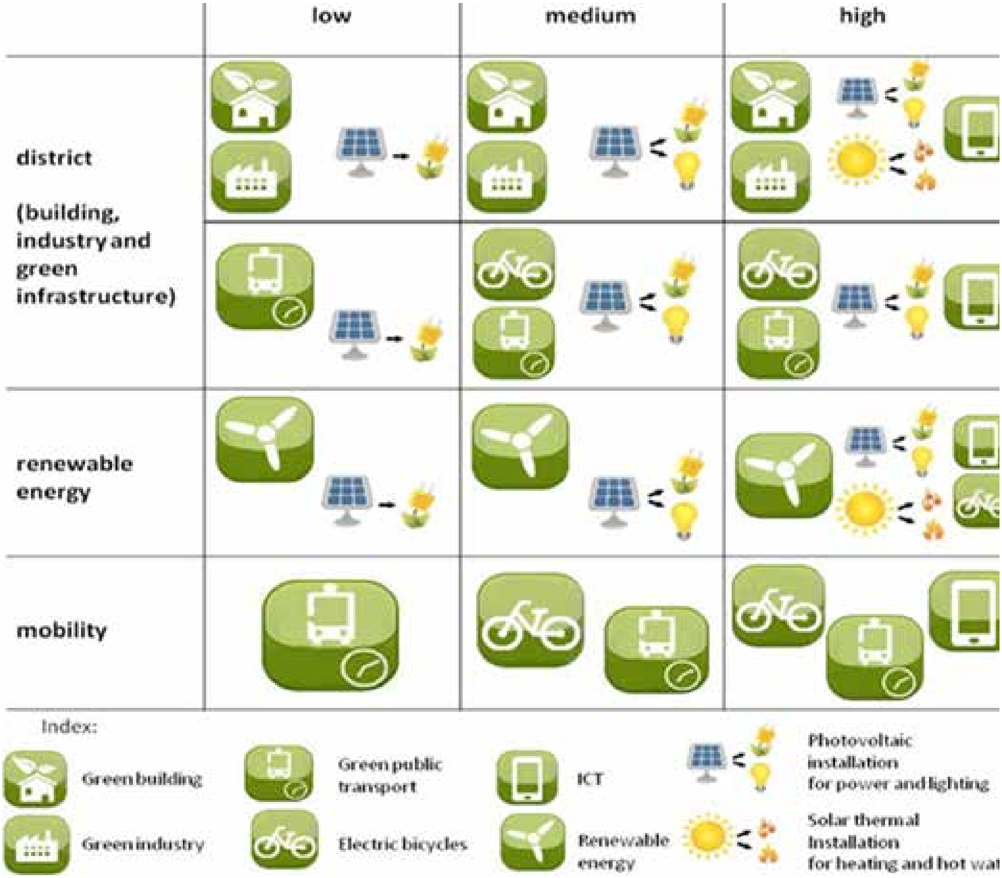


Sardinia Regions and a couple in Greece and Slovenia are already in the CoM. It would show that we are working already on the next step in some municipalities ("Covenant of Mayors 2.0").

MEETHINK-Energy will involve local experts and technicians of public authorities (as trainees/trainers) with experience in/or building and city planning, Energy efficiency Action Plans and the capability as trainers to conduct activities at European level, to consolidate the "MEETHINK peer to peer methodology network". A network where a group of agents/experts from different cities working on similar issues evaluates local policies, programmes and practices being implemented in a particular city and gives recommendations on possible action areas or improvements.

IMPACT

Impacts are expected on the accuracy and efficacy of the New Energy/City Action plans and the calibration of the existing ones, specifically in reference to three priority areas (energy efficiency in buildings and districts; renewable energy sources and distributed energy generation; and energy in urban mobility), a time/cost reduction during the planning development and recalibration processes, possibility to access to qualified and

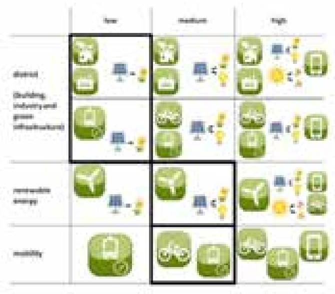


The chart de‣nes the actions and strategies that should be combined in the three thematic priority areas (energy ef‣ciency in buildings and districts; renewable energy sources and distributed energy generation; and energy in urban mobility).

highly qualified personnel especially in the case of small and medium sized cities, smartness/ experience exchange container, not only a database but a knowledge and experience open source library. MEETHINK_Energy project wants to make a real input in the achievement of a better energy efficiency, promoting renewable energy and reducing GHG emissions, by creating an international platform and improving legislation through action of learning and dissemination of Best Practices on sustainable building and knowledge transfer.

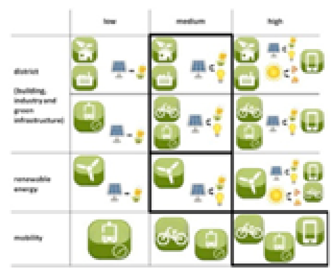
The following chart defines the three thematic priority areas (energy efficiency in buildings and districts; renewable energy sources and distributed energy generation; and energy in urban mobility), of Action Plans where to intervene in order to achieve the best of energy efficiency. In each area will be considered three action levels (low, medium, high), that are

Example: ***Scenarios*** 1:



In this case the intervention on the district (building, industry and green infrastructure) action level is low, proposing the installation of photovoltaic system to satisfy a percentage of the own consumption of energy and for the electrical supply for public vehicles, excluding illumination;
on the renewable energy action the level of action is medium, for a proposed action for the installation of a renewable systems to cover a range of energy disposed for energy management of green infrastructure and public lighting;
on the mobility action the action level is medium, where the proposed action is to strength the public transportation system and integrating it with a bicycle mobility infrastructure;
At the end the outcomes will reveal the remaining gap for each city, in order to achieve EU 2020 objectives for energy efficiency and gas emission.

Example: ***Scenarios*** 2:



In this case the intervention on the district (building, industry and green infrastructure) action level is medium, proposing an installation of a photovoltaic system to satisfy a percentage of the energy consumption, green infrastructure and public illumination;
on the renewable energy action the level is medium, proposing the installation of renewable systems for energy and public lighting management;
On the mobility action, the level is high and the proposed action is to strength the public transportation system, integrating it with a bicycle mobility infrastructure supported by an ict management model.
At the end, the outcomes will reveal the remaining gap for each city, in order to achieve EU 2020 objectives for energy efficiency and gas emission.

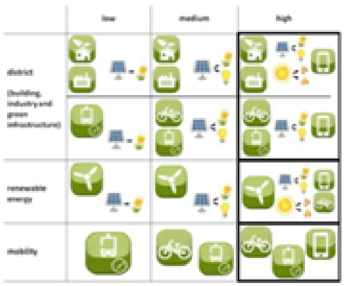
conditioned by municipalities' vision, needs, priorities, stakeholder involvement and budget.

The intended target is to reach in each area of action the highest level of integration. The level of each action is, as described before, determined by external matters, for each action the level of action could be different as represented in the following images (e.g scenarios 1, 2 and 3). In any case is important to highlight that all the impact areas have their own characteristics, needs for solutions, methodologies and tools.

The expected impact will reflect the multilevel approach of the project:

- Policy/Governance: New multilevel integrated management model.
- Measure: Criteria, set of indicators, scenarios, Action Plan SEAPs evaluation and monitoring.
- Tool: Data base, Protocol, Decision support system software.

Example ***Scenarios*** 3:



In this case the intervention on the district (building, industry and green infrastructure) action level is high, proposing an installation of a photovoltaic system to satisfy a percentage of the energy consumption and public illumination, plus a solar thermal system for hot water production supported by an installation of a Building Automation system;
On the renewable energy action the level is high, proposing the installation of renewable systems to fully cover public illumination and green infrastructure management supported by an ICT model.
On the mobility action level is high and the proposed action is to strength the public transportation system, integrating it with a bicycle mobility infrastructure supported by an ict management model.

- People / Skill and Knowledge / Network: implement technical skill as well as policy awareness in order to define new cross sectors strategies in energy planning. Structure as Local Chapters (at national level) as support and training expert group of Think Tank network; Cross-departmental tasks unit (at municipality level).

In the long term, MEETHINK-Energy will support the achievement of EU long term 2030 and 2050 energy saving targets and GHG reduction goals outlined by the "Roadmap for moving to a competitive low-carbon economy in 2050" the EU "Energy Roadmap 2050"[5] and in the "EU policy framework for climate and energy in the period from 2020 to 2030".
In the short term, it will have a direct impact on a number of EU Directives where real energy performance is crucial to effective implementation.
By focusing on real Municipalities energy data, collection, analysis and monitoring of SEAPs data, MEETHINK-Energy addresses one of the main barriers to enhance the capacity of public authorities to plan and implement sustainable energy policies and measures.
The project will contribute to implement the awareness and capacity building in the field of energy efficiency multidisciplinary planning of more than 1500 public officers (police makers, funding managers, technicians, city/energy planners, decision makers and administrators) of 30 municipalities of 6 different European countries (Albania, Greece, Italy, Serbia, Slovenia, and Spain). Thanks to the common experimentation activities, they will become able to apply locally the set of common criteria and multidisciplinary performance indicators

[5] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Energy Roadmap 2050 - COM/2011/0885 final.

in order to drive ambitious integrated regional and/or local Sustainable Energy Action Plans.
The Think Tank mission, in the short-medium period, is to train other officers into their respective countries/region/municipalities, to diffuse MEETHINK-Energy methodology and integrated solution capabilities on energy efficiency and city planning. At the same time will be the first members of the peer to peer exchanging information (energy consumptions/savings data, know-how, experiences, failures, best practices, etc.) network, sharing concepts and helping officers of other municipalities in building up robust and accurate energy/city plans.

Project Partners

RT- Regione Toscana - Coordinator, IT. UCPH - Kobenhavns Universitet, DK. Except, NL. Tecopy SA, ES. ANCI Toscana - Associazione Nazionale Comuni Italiani Toscana, IT. CRES - Centre for Renewable Energy Sources and Saving Foundation, EL. RAS - Regione Autonoma della Sardegna, IT. ENERAGEN - Asociación de Agencias Españolas de Gestión de la Energía, ES. LEA Promurje - Lokalna Energetska Agencija za Pomurje, SI. Vojvodina - Provincial Secretariat for Energy and Mineral Resources, RS. AEA - Albania Energy Association, AL.

References

Bradbury D. 2006, *Mediterranean Modern*, Thames & Hudson, London.

Sala M., Ceccherini Nelli L., D'Audino E., Trombadore A. 2007, *Schermature Solari*, Alinea Editrice, Firenze.

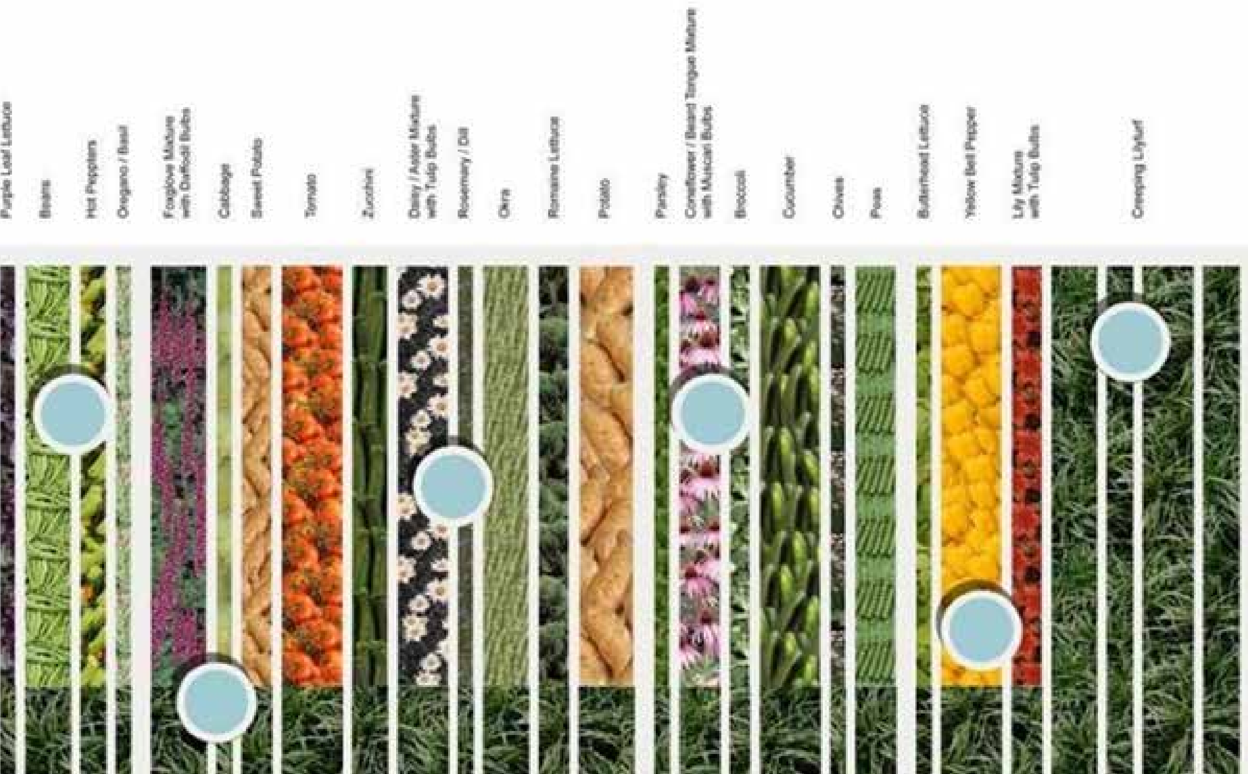
Santamouris M., Wouters P. 2006, *Building Ventilation. The State of the Art*, Earthscan Ltd, London, UK.

Santamouris M. 2001, *Energy and Climate in the Urban Built Environment Ed*, Earthscan Ltd, London, UK.

Trombadore A. 2009, *Processi di trasformazione Urbana e qualità architettonica ambientale: il progetto Med Indo Cities*. In: Sala M. (a cura di) *100 tesi….sostenibili*, Alinea Editrice, Firenze, pages 47-52.

Trombadore A., Gallo P., Lusardi A. P. 2001, *Potenzialità e prestazioni dell'organismo edilizio esistente*. In: Sala M., (a cura di) *Recupero Edilizio e Bioclimatica*, Sistemi Editoriali - Gruppo editoriale Esselibri - Simone, Napoli, pages 59-96.

Yannas S., Erell E., Molina J. L. 2005, *Roof Cooling Techniques: A Design Handbook*, Earthscan Ltd, London, UK.


Purple Leaf Lettuce
Beans
Hot Peppers
Oregano / Basil
Foxglove Mixture with Daffodil Bulbs
Cabbage
Sweet Potato
Tomato
Zucchini
Daisy / Aster Mixture with Tulip Bulbs
Rosemary / Dill
Okra
Romaine Lettuce
Potato
Parsley
Coneflower / Beard Tongue Mixture with Muscari Bulbs
Broccoli
Cucumber
Chives
Peas
Butterhead Lettuce
Yellow Bell Pepper
Lily Mixture with Tulip Bulbs
Creeping Lilyturf

URBAN AGRICULTURE ARCHITECTURE AND SUSTAINABLE CITY

Chiara Casazza
Università degli Studi di Firenze
Centro Interuniversitario Abita

Chicago's Grand Crossing, Rooftop Haven for Urban Agriculture Arch. John Ronan Architect © Ronan ArchitypeReview

Introduction

In the last few years a large number of projects, in the fields of planning and architecture, which aim to integrate food production in urban spaces at different scales (both at urban and building ones) can be registered. These experiences take advantage of existing green areas, making them suitable for food production, but also of alternative urban and building spaces such as courtyards, pocket spaces, brownfield sites, flat roofs, terraces.

This practice goes under the name of Urban Agriculture and it is spreading in a large number of cities as it carries benefits and implications toward urban sustainability (environmental, economic, social and institutional) and in addition as it involves several aspects of contemporary urban life: city greening, shared spaces, requalification of abandoned or degraded areas, buildings and urban periphery fringes, local healthy food production, education, social inclusion, citizens participation, relationship strengthening between city dwellers and agriculture, job creation trhough a new urban local food market.

Urban Agriculture is acquiring the interest of the scientific community, and therefore it is becoming a concrete strategy for the city of the future involving two fronts:

- Food: food security, education, health, diet, awareness, sustainable production;
- City: urban regeneration sustainability, urban greening, citizens participation, social inclusion.

Urban Agriculture: definition

The term Urban Agriculture became popular during the Seventies thanks to the academic and urban planner Jac Smith who defined it "food and fuel grown within the daily rhythm of the city or town, produced directly for the market and frequently processed and marketed by the farmers or their close associates"[1]

[1] SMIT, J. NASR J. (1992) Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources", Environment and Urbanization, Vol. 4, No. 2, October 1992.

↑ **Gotham Green rooftop commercial farm Brooklyn, NY.** © gothamgreens.com.

Community Garden in an abandoned area owned by da GM Supplier of the Year Ideal Group. © girldriverusa.blogspot.it

opposite page **Productive hydroponic rooftop of Bell Book and Candle restaurant NY.** © telegraph.co.uk

Orti DiPinti Community Garden in an abandoned area owned by Comune di Firenze. © ortidipinti.it

According to his opinion through urban agriculture cities could have the opportunity to be come resources preservers, instead of consumers, protecting biodiversity, enhancing the quality of life, regenerating brownfield sites and unused spaces. By the way it's in the recent years that the trend is acquiring strength again (crop production has actually always been an important features in our cities, even if intermittent, from the medieval hortus conclusus, passing through Howard Garden City, and the Victory Gardens during the World Wars) as it responds to the common need of a sustainable city.

A more recent literature defines Urban Agriculture as "an industry located within (intra-urban) or on the fringe (peri-urban) of a town, an urban centre, a city or metropolis, which grows or raises, processes and distributes a diversity of food and non-food products, (re-)using mainly human and material resources, inputs and services found in and around that urban area, and in turn supplying human and material resources, outputs and services largely to that urban area."[2]

Nowadays the phenomena it's developing carrying different characteristics, approaches, forms, expressions, and also technologies since it responds to different needs.

Therefore projects in the field of architecture and planning, that aim to integrate food production in urban contexts with different spatial and architectonical solutions, are spreading.

In developing countries urban agriculture is diffused as a strategy in order to guarantee food security and healthy food access, while in megalopolis in order to overcome the food deserts problem and to drastically reduce food miles and consequentially those emissions due to food transport, preservation and packaging.

In large European or North America cities urban agriculture is enriched with other features and values such as sustainability and alternative food models.

[2] MOUGEOT, L.J.A. (2000) "Urban agriculture: definition, presence, potentials and risks" Thematic Paper 1 International Conference on Growing Cities Growing Food: Urban Agriculture on the Policy Agenda La Habana Cuba Oct. 1999.


In these contexts urban food production is distinguished by multifunctionality and eco-systems services creation, and furthermore it responds to certain sheared exigencies: short food chain, proximity between consumers and production, environmental and alimentary education, citizens' participation and inclusion in the town management, city greening and shared green spaces, urban requalification, wellbeing, health.

Indeed it's interesting how the Council on Agriculture Science and Technology CAST[3] stresses the accent on some of the most important aspects and implications of an urban food production referring to it as a "a complex system encompassing a spectrum of interest, from a traditional core of activities associated with the production, processing, marketing, distribution, and consumption, to a multiplicity of other benefits and services that are less widely acknowledge and documented. These include recreation and leisure, economic vitality and business entrepreneurship, individual health and well being, community health and wellbeing, landscape beautification, and environmental restoration and remeditation".

It is immediately clear how crop production it's only the first issue concerning Urban Agriculture, as it carries different meanings and performances: city greening (carrying all the consequential benefits), agriculture environmental footprint reduction (in terms of transport and soil consumption), local Km0 production enhancing the local retail market, new jobs, wellbeing, education and health due both to the conscious consumption of food and the farming activities, social inclusion.

The reasons of its development

The reasons of the development of experiences and projects that aim to integrate food production in city spaces and buildings (Building Integrated Agriculture BIA[4]) need to be

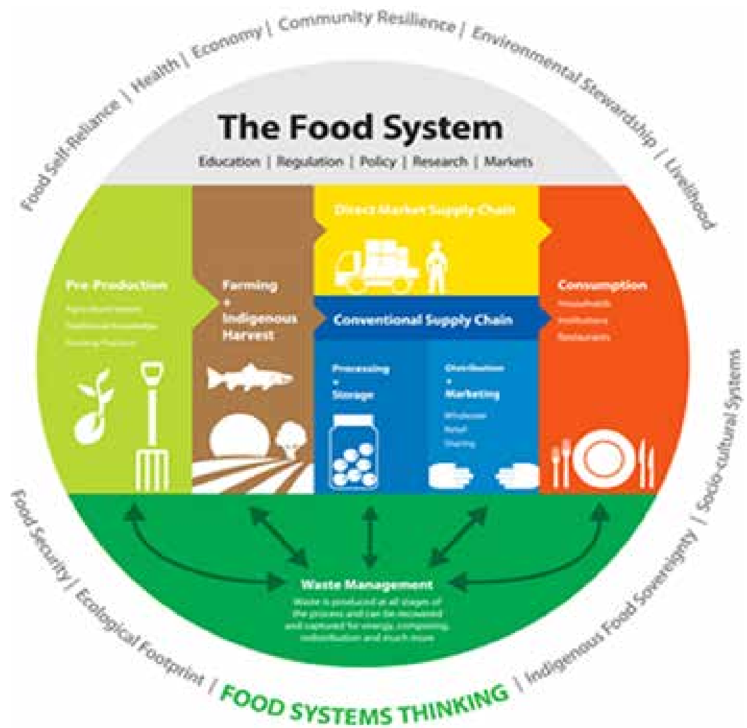
[3] BUTLER, L. MONOREK, D.M. Urban Agriculture and Agricultural Communities opportunities for common ground, Ames Council on Agriculture Science and Technology 2002.

[4] ASTEE, L.Y., KISHNANI N.T. (2010) "Building Integrated Agriculture: Utilising Rooftops for Sustainable Food Crop Cultivation in Singapore" Journal of Green Building: Spring 2010, Vol. 5, No. 2, pp. 105-113.

analysed. In the last fifty years we assisted to a strengthening of the gap between countryside life and urban life, and to the enlarging of the distance (spatial and psychological) between food production and consumers due to the development of large organized distribution of grocery goods and due to globalization. These elements caused the loss of awareness toward food (its quality, its provenience), the loss of the social, cultural and educational values of rural life, vast land exploitation, environmental food print (due to transport and food conserving) but it also brought other problems such as health and alimentary diseases.
Since always towns have been strongly linked to and dependent from food production: they were surrounded by productive land and every town was hosting markets were vegetables and animals were brought and sold. Instead after the industrial revolution things have changed: food started coming from outside the city area, already packed, prepared and even cooked and it started travelling even thousands miles from the production site with consequences in terms of transports and consumers' awareness.
In addition to that agriculture was influenced by industrialization and increased its ecological footprint because of fossil fuels usage, energy consumption, co2 emissions (for transports) and chemical pesticides and fertilizers. Recently something started to change and initiatives aiming to recover awareness toward food production and sustainable food chain, food quality, education and local products are spreading. Furthermore consumers became aware of the industrial agriculture and food chain unsustainability asking for consciousness, impact reduction, and also traceability. Those above-mentioned are not the only challenges our cities need to face. In this critic global situation contemporary towns are furthermore needing to face several problems in terms of sustainability, health, quality of life and environment: lack of green shared spaces, bad air quality, bad water management, and poor periphery areas (where degrade, poverty and situations of socio-economic disadvantages are concentrated). Furthermore urbanization and expansions of peripheries caused the proliferation of unappealing spaces without identity or function, and lack of vegetation and space quality.
In a large number of countries urban agriculture is emerging as a trend as a possibility to face the challenges of our contemporary cities, while integrating food production in urban spaces and buildings.

Food Planning and Urban Agriculture

Urban Agriculture, as a strategy for urban regeneration actions, is definitely a complex phenomenon, that needs to be investigated and understood with a system thinking



The Food System. @bcfoodsystem.com

approach[5]: indeed it involves different disciplines and issues and it is linked to all the other aspects of the so called Urban Food System such as consumers, market, transport, energy, water, health and diet. Traditionally the food issue has always been faced by agricultural policies without considering its linkages and influences on urban settlements as the place where food is sent, consumed and where the exigencies develop.

Nowadays recent approaches tend to consider food in the same manner as other infrastructures, developing the concept of Urban Food System and enhancing Urban Food Planning Strategies, with some concrete experiences such as the Toronto Food Charter or the Portland Food System strategy. The term Urban Food System includes all the activities of the food

[5] PHILIPS, A. (2013) "Designing Urban Agriculture: A Complete Guide to the Planning, Design, Construction, Maintenance and Management of Edible Landscapes" Wiley 288p.

chain (production, transport, processing, selling, consuming and wastes) and the goal of a sustainable Urban Food System is understanding and planning their connection with other urban features: transports food selling, preparing and serving, alimentary education, recreational activities, therapeutic activities, city waste management. Therefore restaurants, retail stores, supermarket, hospitals, canteens, schools could introduce food production different aims, or could be linked in an urban local food system. What needs to be highlighted is the fact that Urban Agriculture is one of the actions and strategies enhanced by all the Urban Food System plans or strategies, as its social, environmental and economical impact on the town and the citizens is well known.

Thos Public Administrations that adopted urban food strategies are well aware of Urban Agriculture's value and impact toward citizens participation, sociality, social inclusion urban greening and urban regeneration, education, health, local and km0 food supporting and last but not least toward the local market. The strength and the importance of Urban Agriculture therefore appears escpecially if it is included in a productive green infrastructure, a food network in the city for the city itself. These Urban Food Planning, shows furthermore the will of re-design the city "with food in mind", linking urban, food planning and space and buildings design.

Architecture and Urban Agriculture

As Urban Agriculture is an issue that involves different disciplines, and since it consists in a range of agricultural (and related to it) activities that take place in an urban context, their architectural integration at different scales needs to be investigated.

Planners and Architects are asked to design and find solutions in terms of space, technology and functions, to understand Urban Agriculture's effects on the urban environment at different scales (city and neighbourhood planning, garden and open space design, building design, product and component design), and to understand it could be integrated and regulated (in this direction some American towns such as San Francisco and Detroit are devolving specific laws and rules in order to make urban agricultural institutional) becoming a new space typology and relating itself with politics and stakeholders involved.

Therefore agriculture in urban contexts becomes a new element, a new type of space and use with specific performances and effects on the urban environment.

Clearly our cities and our buildings are not conceived to host agriculture and some criticisms need to be solved: small spaces availability, polluted soil, artificial surfaces, building static requirements.



Value Farm Biennale di Shenzhen Hong Kong Bi-città di Urbanism\Architecture 2013 (UABB): the project explores the possibilities of urban agriculture in enhancing and supporting the community.

Brooklyn Grange a Rooftop Commercial and Educational Farm in New York on the rooftop of an abandoned building. ©brooklyngrangefarm.com

Those spaces that have the potential to host Urban Agriculture projects can be summarized as follows:

- at urban scale: green areas, parks, gardens, pocket spaces, brownfield sites, vacant lots;
- at building scale: terraces, flat roofs, facades, backyard gardens.

Different technologies are investigated or adapted (and transferred) from agriculture to architecture (greenhouses, hydroponic growing systems, containerised growing) in order to make the abovementioned spaces suitable for crop production. In particular designers can take advantage of traditional growing systems devices (in ground, in vase, raised beds, greenhouse, green roof, vertical green) and hydroponic (or soil-less/soil simulant) growing systems devices (greenhouse, growth-cell, hydroponic vase, hydroponic tower, vertical farm, vertical green and living wall).

These last ones are especially suitable in case of artificial surfaces and when lightness, productivity and crops protection are highly required. The role of architects acquires importance in this new field of project in order to find solutions for the integration of agriculture at the urban scales involved and as abovementioned it ranges indeed from planning, landscape and garden design, technological component design, to industrial design.

Designing and Integrating Agriculture needs an holistic and management approach, as various issues and stakeholders are involved: indeed the urban one is a complex environment under a physic, spatial, economic, cultural, landscape, social, administrative and also historic point of view, and urban agriculture, just like all the other space typologies and uses, needs to relate itself to all these aspects.

Moreover the role that Urban Agriculture can play it's multiple according to its declinations:

community gardens and Jardins Partagés, allotment gardens, backyard gardens and household vegetable gardens, pocket vegetable gardens, commercial and entrepreneurial urban agriculture, urban commercial greenhouses, educational and school urban agriculture and vegetable gardens, vertical farms. According to that in order to describe Urban Agriculture in urban areas two main approaches were identified: bottom-up approach and top-down approach.

Under the definition of bottom-up approach are identified those interventions that originate from the users, from the citizens themselves, that take possession (sometimes also independently) and modify spaces giving them new quality and function.

The top-down approach involves those cases supported by a plan or a project that aim to introduce urban agriculture in order to produce or sell food and modify people habits and make them aware of the importance of a sustainable production of local healthy grown food.

In conclusion it's clear how Urban Agriculture consists of a complex phenomena that involves different kind of approaches and intervention typologies such as low tech and high tech solutions (from community gardens to vertical farms), that characterizes the city at different scales (territory, town, neighbourhood, building and house), and that responds to several exigencies and requirements fitting different users. The importance and the choice of Urban Agriculture as a strategy to reach a sustainable city originates indeed from the fact that it implies and involves several aspects of contemporary urban life, like the creation of green shared spaces, requalification of abandoned or degraded spaces and urban periphery fringes, local healthy food production, education, rebuilt of the relationship between city dwellers and agriculture.

References

Astee L.Y., Kishnani N.T. 2010, *Building Integrated Agriculture: Utilising Rooftops for Sustainable Food Crop Cultivation in Singapore*, in Journal of Green Building. Vol. 5, N. 2, pp. 105-113.

Boganini L., Carta A., Casazza C., Sala M. 2013, The Urban Agriculture: a classification of possibilitIES ICFEEB conference, China.

Butler L., Monorek D.M. 2002, *Urban Agriculture and Agricultural Communities opportunities for common ground*, Ames Council on Agriculture Science and Technology.

Despommier D. 2013, *Farming up the city: the rise of urban vertical farm Trends*, In Biotechnology, N. 7 Vol. 31.

Gorgolewski M., Komisar J., Narsr J. 2011, *Carrot City: Creating Places for Urban Agriculture*, Monacelli Press, New York.

Kaufman J., Bailkey M. 2000, *Farming Inside Cities: Entrepreneurial Urban Agriculture in the United States*, Lincoln Institute of Land Policy Working Paper.

Lee-Smith D. 2009, *Carrot City: Design for Urban Agriculture*, in RUAF Urban Agriculture Magazine.

Lee-Smith D. 2009, *Integrating urban agriculture in the urban landscape*, in RUAF Urban Agriculture Magazine.

Mougeot L.J.A. 2000, *Urban agriculture: definition, presence, potentials and risks*, Thematic Paper 1 International Conference on Growing Cities Growing Food: Urban Agriculture on the Policy Agenda La Habana, Cuba.

Palazzo V. 2003, *Tecnologie ambientali per l'integrazione di verde agricolo in aree urbane*, Tesi di Dottorato, Università degli Studi di Napoli Federico II.

Philips A. 2013, *Designing Urban Agriculture: A Complete Guide to the Planning, Design, Construction, Maintenance and Management* of Edible Landscapes, Wiley, p. 288.

Pothukuchi K., Kauffman J. 1999, *Placing the food system on the urban agenda: The role of municipal institutions in food systems planning*, Agriculture and Human Values, N. 16, pages 212-224.

Smit J., Nasr J. 1992, *Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources*, Environment and Urbanization, N. 2, Vol. 4.

Sommariva E. 2012, *Agricoltura Urbana strategie per la città dopo la crisi*, Atti XV conferenza Nazionale Società Italiana Urbanisti-L'urbanistica che cambia rischi e valori, Pescara.

Viljoen A. 2005, *Continuous productive urban landscapes: designing urban agriculture for sustainable cities*, Elesevier Architectural Press, Oxford, p. 304.

ASSESSMENT TOOLS FOR CITY SMARTNESS. CITIES ARE THE CRUCIAL POINT OF STRATEGIES LOOKING TO SOLVE LAND AND TERRITORY PROBLEMS

Zaira Grasso
Master Abita

Union point, sustainable city
near Boston, United States

The environmental impact caused by the failure of the management of cities and their territories, both for land use and natural resources, and globalization have exposed cities to an abnormal growth, leaving large areas almost abandoned or unattended, with its consequent issues. To contrast problematic development of the territory, the European Community has addressed specific directives to guide city/regional administration governments into the principles of sustainable development, climate change and active participation of citizens.

Nowadays the need for complex work of territorial and urban "regeneration" is growing on a daily basis. This means the territory requires a "strategic program" that guides the changing and evolution processes, taking into account cultural identities, vocations and any particular characteristics of the territory of the city. The bottom-up methodology is the only way to integrate an organic vision of policies and a long term coordination of local "smart" activities, providing stimulus and guidance, to create development principals, that should be kept untouched and independent from political ideals and structures.

Is important for local administrations to expose their expertise and skills in designing territorial and urban "smart" networks, supported by a set of standards, methods and instruments intended to facilitate the interaction of territories, unification of systems, technologies and data collection (units), so monitoring results can easily be exchanged, producing a know-how (best practices) sharing model that will benefit citizens and city/territory development. In order to achieve territorial regeneration it is very important to keep the integrity of smartness on a systemic vision, as well as the identification relevant of levers of action to improve the performance, the comparison with other realities and the dissemination of best practices. Following these principles and to be effective a "smart literacy" (training) must be developed in the population, with a view to having an active and participatory citizenship.

If the mission is focused on meeting the highest needs of the Maslow's pyramid, the vision is focused to achieve sustainable urban and regional models, in its three components: social, environmental and economic as well as cultural in order to develop an integrated and interactive model, with a dynamic equilibrium, continually reshaped and rebuilt, in the process

to achieve a progressive fulfillment of needs and quality improvement, in relation with the forces of change and plurality of those components.
Decision making at all levels requires a solid foundation, in order to trigger a self-regulating mechanism for an integrated environment and development, but this model cannot exist without an accurate system of indicators. The cities taking part in the European Campaign for Sustainable Cities have already shown themselves to be conscious of decision-making and controlling activities, in particular those related with the environmental monitoring systems, the evaluation of impacts and accounting, the budget, the information and revision, on different types of indicators.
These include those relating to the quality of urban environment, urban flows, urban patterns, and, most importantly, indicators of an urban sustainability. At the same time these indicators are tools of reporting, analysis, guidance, monitoring and verification in the continuous processes of sustainability improvement. The issue and practice of valid indicators is extensively addressed for individual economic, social, environmental contexts.
Research and testing of valid indicators for sustainability is still ongoing. It is to be considered that multiple components from institutional to economic, social, environmental and cultural penetrate sustainability. All the different types of indicators must always respond to the three requirements: relevance, analytical consistency and measurability.
The relevance, significance and appropriateness of what it manages and measures, must permit the comparison in space and time, allowing it to compare current conditions and trends; the analytical consistency representing the specific needs of environmental management, must ensure clarity of content, widely recognized by the scientific community, which allows a comparison with thresholds, standards, benchmarks, and relevant national and international monitoring results achieved; measurability, makes them real, based on data that is available, documented, reliable, verifiable, updated in real time in respect to the initiatives and the effects desired. In the specific case of urban sustainability refering to the city and its territory, where the aim is to look for indicators that are able to keep the same interdependence and interconnection of components, during the evolution processes of the town and/or community. Connecting and overlapping the multiple components, the indicators research should be built as concisely and as accurate as possible and measurable. They will measure planning implementation results, overall well-being and achievements for the individuals and the community.
The indicators should drive the concept of wellness to become proportionate with the context, culture and with the survival of biological forms and ecosystems for future gener-

ations. The research of indicators should, therefore, be linked to the peculiarities of the cultural and geopolitical reality under study: in this case, to the Mediterranean in the European context. Contextualization should lead and highlight the strengths and weaknesses of the macro-region, but also to assess lifestyle and behaviours.

Strengths

- Natural heritage, landscape
- Artistic heritage and culture
- Urban morphology, territory and coastline unique
- Biodiversity
- Typical crop
- Typical artifacts
- Wealth of historical cities
- Uniqueness of each city, with the "historic city", with the core characteristics of compact and articolation
- Public space such structures elements, divided into squares and widening
- Mix social and of activity
- Social relations and inclusivity
- Level of district and neighborhood.

Weaknesses

- Scarcity and fragility of the territory
- Exposure to natural disasters and / or poor maintenance
- Climate Change
- Immigration problems
- Persistent levels of unemployment
- Moonlighting work
- Increase in the social gap and gender
- Problems of internal cohesion in the slums
- Illegal buildings spread over vast areas
- Slums and suburbs
- Use of land, also in connection with oversized forecast of population growth
- Environmental crime
- Increasing intensity of transport and mobility
- Pollution

- Consumption patterns are difficult to change
- Imbalance of tourist flows.

Strengths and weaknesses will help to "calibrate" the goals to be achieved in respect to the context, allowing to define objectives of Sustainable Mediterranean Smart Cities. The uniqueness of each city will contribute to the definition of specific targets and within the same target in a given time, to the continuous improvement of quality, becoming a well-being in line with the carrying capacity of the environment and intergenerational perspective.
In the choice of indicators it will be impossible to refer to the six characteristics that make a medium-sized city smat for the EU, integrating them with the overall vision and systemic smart city provided by the "Agenzia per l'Italia". This set of indicators will be modulated in a multilevel structure that combines and declining indicators going from the local level to the city, to the minimum intervention unit (district, abandoned area, ...); the latter, initially chosen to "test" the indicators and assess relevance, analytical consistency and measurability, increasing the best practice policy.

THINK BLUE, THE NEW GREEN. BLUE ARCHITECTURE AND SYSTEMIC DESIGN

Cecilia Tosto
Master Abita

The new frontier of ecology climbs over the green economy toward a concept that overturns the actual understanding of the economy and production, a new model developed by the name of Blue Economy.

The Blue Economy, theorized by Gunter Pauli, inspired by natural ecosystems (for example the survival strategies of animals and insects) and intends to tackle the issues concerning the sustainability not only by investing in environmental protection and into more efficient, but by looking also to benefit from regeneration, reusing what are considered waste of our time in order to make it possible for everyone to benefit from the eternal creative flow and by the abundance found in nature.

Inspired by natural ecosystems, where everything is reused in a cycle called “cascade”, where waste production becomes the raw materials of a new phase.

An increasingly open, a virtuous circle, which exceeds the limits of the Red Economy (characterized by mass consumption at low cost, with products made above all by borrowing resources from the future) and looks beyond the benefits of the Green Economy (the whose products are made with environmentally friendly processes and people, but that inevitably are expensive to support and reserved for an elite of consumers in a few countries in the globalized world).

Gunter Pauli, in his “Blue Economy”, says: “it is amazing how little natural logic exists in modern society. To cool down a building air conditioning systems people pumping cold air upwards. To purify water entering chemicals that destroy all forms of life.

Greenhouses heat the air, not the roots. We pay over $ 100 per kilowatt-hour of electricity supplied from an accumulator which pollutes the environment. Such actions are the basis of a failed economic model, a model of “Red Economy” that borrows from nature, humanity, and the common good, without worrying about how to repay the debt if not handing it to the future. “

The blue economy is based on the development of physical principles, using scientific techniques such as bio-mimicry, which is based on the study and imitation of the characteristics of living species to find new production techniques and improve existing ones, dividing the territory and local resources becomes shortages in new wealth, reducing to zero CO2 emissions.

The blue economy hugging the architecture and multiple disciplines. It results in systemic design[1] able to manage and optimize, in all phases of the project, the mutual dialogue between the various actors (so that they can develop evolving consistently) and adjusting the network input and output. The individual parts of the system are intertwined, forming a virtuous network (autopoietic) of relations between the flows of matter, energy and information.

> We will realize sooner or later the issue to be solved is not to generate less waste, but not to waste the waste products. (G. Pauli)

In nature there are not exists "waste" according to the idea that it has the consumer society: any waste or residual becomes the raw material for a new process and a new product. This must also apply to the artifacts of human of which production processes, use and disposal, must answer to the perfect natural efficiency of teaching, which operates according to "closed cycles". The development of the technologies required to include not only costs (that are increasingly demanded by new investments), but also the opportunity to create new wealth and many new jobs with high intellectual content.

Production processes "clean", use of renewables, energy saving and resources, active management of the waste cycle, enhancement of every natural good: these are the pillars of an industrial system that has as its goal to produce wealth without neglecting health protection and the conservation of resources.

In recent years I emerged a series of examples and best practices, as in Scotland, the Netherlands and South Tyrol in the municipalities, which go towards models of "community" that self-produced energy.

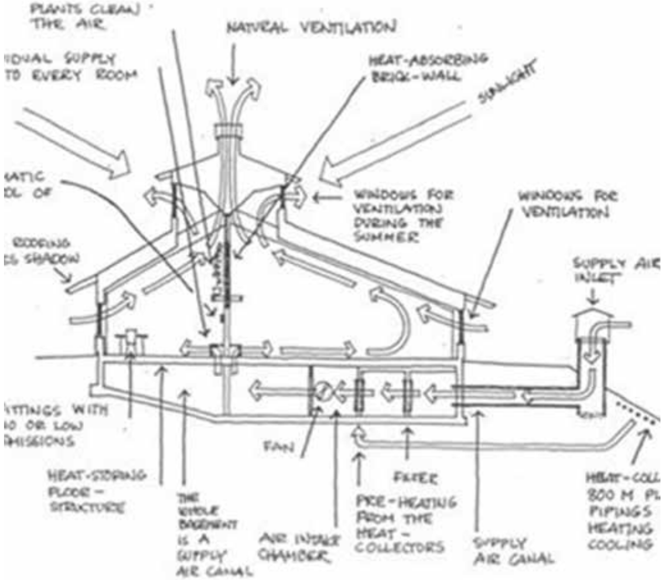
The vision for the future can be expected as more prevention, investment in water management, optimization of the waste cycle and "Blue Production", a path to a environmentally sustainable economic perspective and entrepreneurial.

Through the virtuous circle of supply chain and the potential of biomass, you can get 100% recovery of the materials used in production processes and therefore all the waste, not only for energy but also as a conversion in organic materials, such as paper, hemp, wool, straw, textiles, throughout the supply chain related to the cultivation, such as the one linked to construction.

---

[1] The Design is the design of the systemic relationships between people, assets and resources of a territory, in order to enhance the culture, local resources, development and welfare.

A process which, starting from the first resource of natural material, then allows you to manage it in all its phases and can even handle them as waste to convert them back into resources.
An example shared by the Blue Economy architecture is the little known debate concerning the way the houses are built in some insects, and one of the most interesting in this area concerns the termite mounds.
Termites, for example, in tropical countries fail to realize that very special buildings up to twelve meters high (like a skyscraper ten kilometres for us humans), consisting of a mixture of herbs, saliva and droppings that dries in the wind and the sun It solidifies.
The "buildings" erected by termites, have been studied by the team that carries out the project TERMES (Termite Emulation of Regulatory Mound by Environment Simulation), have organic shapes that resemble fractals development of complex mathematical functions, which have their own logic in reference to fluid dynamics, in this case air.
One of the peculiarities of termite mounds regards the internal temperature, which is maintained at 26 ° C through a skilful adjustment of the air flow in and out. The interior of the structures is in fact composed of a series of galleries and wind towers that depending on their inclination, allow air to gain speed at certain points or to slow down in others, ensuring optimum conditions of temperature, ventilation and humidity, also for the growth of a particular fungus of which the termites primarily feed.
The logical construction of the mounds was used in several buildings including the school Laggarber (in Timra in Sweden) and the Eastgate Centre in Harare, Zimbabwe.
Another example of Blue Architecture is represented by the study of the cooling surface of the mantle of zebras and its application in building to control the heat of the surface.
The mantle of zebras is known to be an effective control system of the heat; in fact, while the white reflects light reducing the surface temperature, the black does the opposite by absorbing the heat, and the pressure difference between the warmer air and cooler of the strips of the mantle triggers a series of micro current that are able to reduce the temperature sensed by the zebra up to a maximum of 9°C.
The principle adopted by these animals was taken by the Swedish Andres Nysquit for the project of Daiwa House in Sendai, Japan: the Daiwa House uses a combination of white and black to adjust the temperature outside the building, which in summer lowered by about 5 ° C by making an energy saving of 20%.
Researcher John Dabiri has taken inspiration from the fish swim and their shed tiny vortices, applied similar principles to the spatial design of wind farms.
By placing vertical-axis turbines (different from the traditional horizontal-axis, propeller-style turbines) close together in a strategic array, energy is gathered by each turbine, while simul-



Wind and ventilation system

taneously directing wind to nearby turbines. Dabiri's research team, supported in part by Windspire Energy Inc., is currently working to determine ideal positioning of turbines to achieve optimal power output.

The largest issue facing wind farms is the space required for propeller-style turbines to function properly. FLOWE's vertical-axis turbine design demands less space to operate. Turbines are placed in close proximity as a necessary part of the spatial design, significantly decreasing the acreage necessary to gather wind power.

Sometimes just watch and take lessons from nature to find solutions useful and innovative.

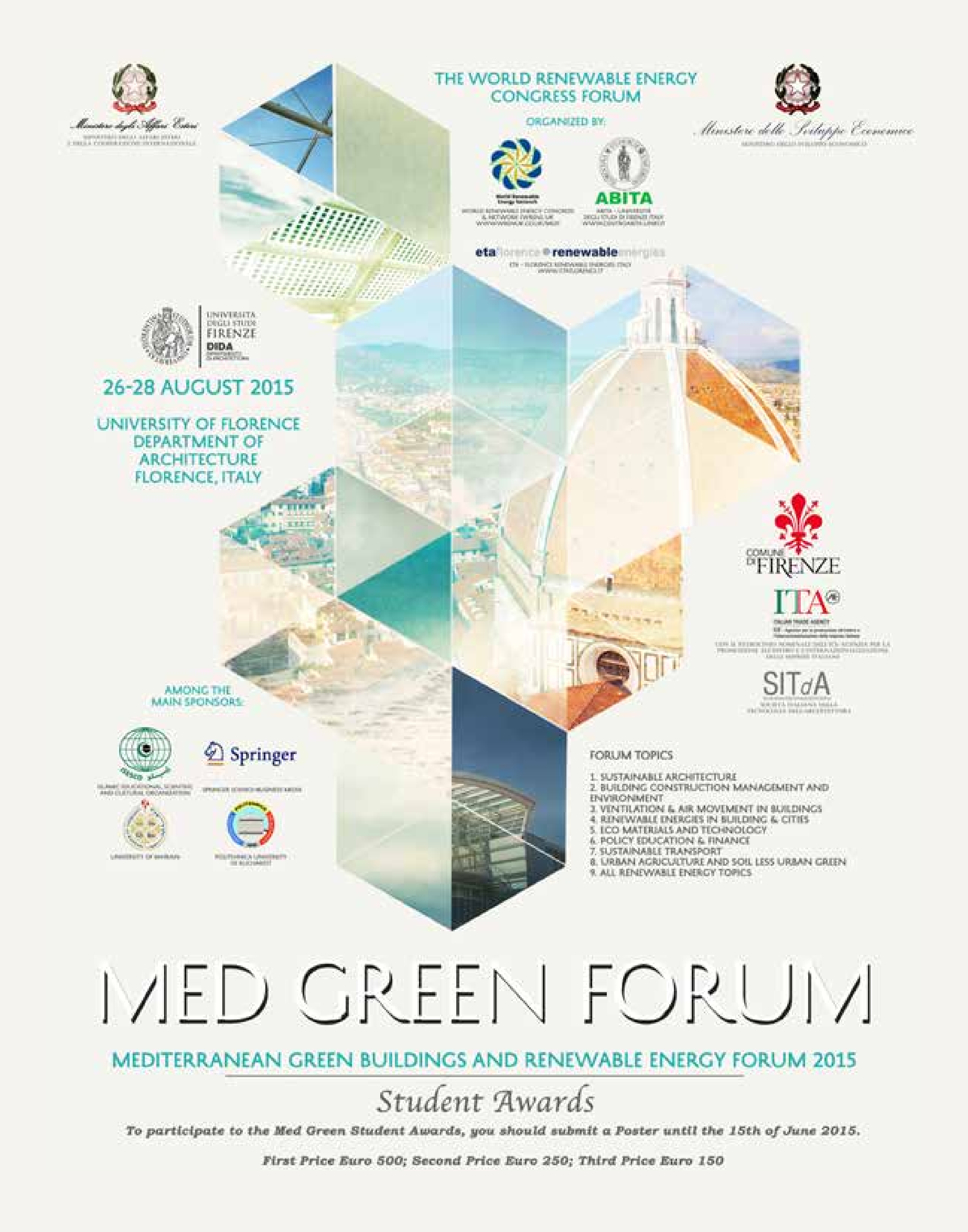
Researchers at Columbia University in New York, after looking closely at the behavior and above all the physical characteristics of the so-called 'silver ants' Sahara (Cataglyphis bombycina), have launched a project that could bring important changes in terms of thermal insulation.

The idea of Nanfang Yu, head of research, was to study in detail the way that this particular insect is able to withstand temperatures that reach 70°C.

Some features like the glow silver thick fur that covers the body seems to have extraordinary reflective capacity of thermal dispersion.

From here, the idea of artificially recreate the characteristics of the hairs of the ants to produce surfaces more resistant to high temperatures.

These thermoreflective materials can be applied on top of buildings or on solar panels and can, according to researchers, to represent the new frontier of passive cooling.
This continuous flow of analysis and corrective feedback processes will not only make us closer to "zero emissions" but will make an integral and positive activities, stimulating the research of continuous best output.
In the crisis of ideas and business models that characterize the Western mainstream, the Blue Economy can be innovation in approach and model.
What is needed above all is to change the way you think, inspired by criteria bio-imitation, which goes beyond what we know, to learn to do more with what the earth gives us, also thinking of the future generations. Because maybe, "the most precious gift we can give to our children is to give them the freedom to think and, more importantly, to act out from the pack."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Student Awards
To participate to the Med Green Student Awards, you should submit a Poster until the 15th of June 2015.
First Price Euro 500; Second Price Euro 250; Third Price Euro 150

MED GREEN FORUM STUDENT AWARD COMPETITION 2015_2017

Fernando Recalde Leon
Università degli Studi di Firenze
Centro Interuniversitario Abita

The thrid & fourth bi-annual World Renewable Energy Congress & Network Forum & student Award aimed at the international community focusing on the Mediterranean countries. The first forum was held in 2010 in France followed by Morocco in 2012 and the third forum was held in Florence, Italy on 26-28 August 15, while the MGF 4 was held 4, 31 July – 3 August 2017
The Forum highlighted the importance of growing renewable energy applications in 2 main sectors: Electricity Generation & the Sustainable Building Sector.
The Mediterranean region was chosen to illustrate the viability of using Renewable Energy to satisfy all its energy needs and to demonstrate the effectiveness of using renewable energy in these countries to act as a beacon of light for the rest of the world to follow, leading to A BETTER, CLEANER AND SAFER WORLD (ww.medgreenforum.com Prof. Ali Sahyig Chair MG 3&4 Florence Italy).
The MED Green Student Award 2015_2017 were organised by the World Renewable Energy Congress and Network (WREC/WREN) in the UK and the Department of Architecture, University of Florence, ABITA Interuniversity Research Center Headquearters, Florence Italy. Auspice for MGF 3 Student Awards by the Italian Ministry of Foreign Affairs, Ministry of Economy & Italian Trade Agency, & ISESCO as well as Springer, Polytechnic University of Bucharest, and University of Bahrain & Municipality of Florence and the University of Florence.
The MGF 4 instead was supported by the following institutions:
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CECEP China Energy Conservation & Env. Protection Group www.xcl.cecep.cn
DEPUTY DIRECTOR_Mr. Zhuang Dialum

The Jury committee for MGF 2015.
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The Topics of the Student Award Competition were:
1. Sustainable architecture.
2. Building construction management and environment.
3. Ventilation & air movement in buildings.
4. Renewable energies in building & cities.
5. Eco materials and technology.
6. Policy education & finance.
7. Sustainable transport.
8. Urban agriculture and soil less urban green.
9. All renewable energy topics.

Egyptian winners with Jury members and Groups Supervisor: Prof Mohsen Aboulnaga
© Mohsen Aboulnaga

The Jury committee for the MGF was formed by the Chairman of MED Green Forum:

1. Prof Marc Sala, Vice Chair - MED Green Forum & Prof of Green Architecture, University of Florence, Florence, Italy.
2. Dr Bill Watts, GM - Max Fordham, London, U.K.
3. Prof. Fernando Recalde, Professor of Green Technologies, University of Florence, Florence, Italy.
4. Dr Ruxandra Crutescu, Spiru Haret, Faculty of Architecture, University of Bucharest, Romania
5. Prof Dr Fouad Al Ansari, Chair of the Dept of Architecture, University of Bahrain, Manama, Kingdom of Bahrain.

MGF Student Awards focus on exploring the accademic production of Student in Architectural faculties' world wide that have been achieving good performance of their work at Workshop & Design courses that focus on Sustainable Buildings and Smart Cities experience on the following themes.
Will follow few table of some participants at the competition, that deaply rapresent architectural solutions for buildings integrated in cities created for green infrastructure.

Pictures of the winners ceremony and posters. © Mohsen Aboulnaga.

Ecological integrity, economic prosperity and social equity is what is called Sustainable/Integral Planning or/and Urban Collaborative Planning changing paradigmatic trend for "green living", a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful, for healthier natural living, fostering the organic and sustainable living paradigm, promoting solar cities and eco neighbourhoods.

Pictures of the winners ceremony and the three winner and their posters. @Mohsen Aboulnaga.

The 3 winners Posters

1st Prize	2nd Prize	3rd Prize
		
Mohamed Gad, Asser Elkady, Sara Essam, Shereen n Al Garhy	Assem Shafik, Ahmed Hussein, Mohamed Sayed, Zeyad Seddik, Ahmed Sultan	Toqa Khalifa, Lydia Hossam, Norhan Mamdouh, Marina Adel, Nour El Moez

A New Paradigm of Green, SMART, and Sustainable Architecture

LEGO Headquarters Building Design in New Cairo, Greater Cairo, Egypt

Objectives

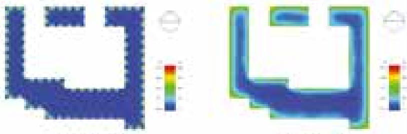
Integrated Renewable
Future Green Sustainable
SMART
Adaptable
Efficient Local Materials

Methodology

1. Site Analysis
2. Problems SWOT
3. Solutions
4. Application
5. Simulation
6. Conclusion Suggestions

Environmental Analysis and Results

Environmental Section — Environmental Section



Daylighting **Before** Applying Light Shelves — Daylighting **After** Applying Light Shelves

Conclusions

50% Reduction in Fuel Consumption for Electricity

40% Reduction in HVAC

60% Reduction in Electricity

55% Reduction in Artifical Lighting

38% Renewable Energy

3D View of the Final Project Showing Green Features

3D View Showing Smart and Green Strategies

38% Demand Covered by Renewable Sources

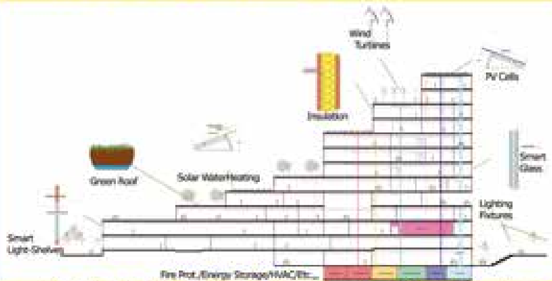
BioDiversity

3D Layout Showing Smart and Green Strategies

Future Developments

- Bike Lanes
- E. Cars
- Water Conserv.
- Water Recycling
- Green Edu.
- Nearby Recycling

Analysis of Smart and Green Strategies

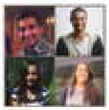


Detailed Arch. Section Showing Smart and Green Strategies

Cairo University
Faculty of Engineering
Dept. of Architectural Engineering
AET Programme
Cairo, Egypt

NATIONALITY:
Egyptian

PROFESSOR NAME:
Prof. Dr. Mohsen Aboulnaga



STUDENT/S NAME:
Aroinohamedgad@gmail.com
A. El-Kady M. Gad
S. Ali S. El-Garhy

Designing a Green, Sustainable and Smart Building

5th Settlement, New Cairo - Cairo, Egypt

1- Introduction

The project is the headquarters office building of National Geographic. The corporate is a research based educational institution; accordingly this should be highly reflected on its headquarters.

2- Objectives

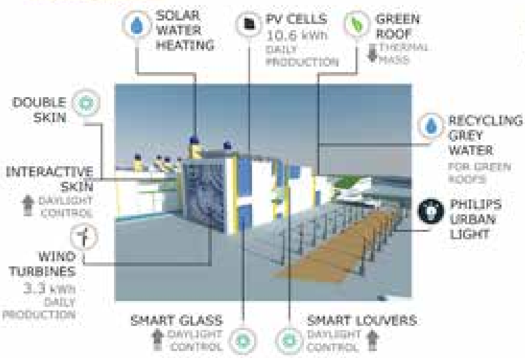
1. **Green Building** — Minimizing Carbon Emissions
2. **Sustainable Building** — Self-Sufficient Building
3. **Low Energy Building** — Energy Efficient Building
4. **Smart Building** — Integrating Smart Systems to Meet Objective
5. **Passive** — Integrative Active and Passive Systems within the Building

3-Methodology

- 01 **NATURAL LIGHTING** — Smart Glazing, Double Skin, Light Shelves
- 02 **ARTIFICIAL LIGHTING** — Smart LED Panels, Dimming Sensors, Motion Sensor, Urban Light
- 03 **ACCESS & SECURITY** — ID Card System, Destination Elevators, People
- 04 **HVAC** — Temprature, Humidity, Pressure, CO2, Occupancy Sensors
- 05 **ENERGY** — Solar Panels, Green Roofs, Solar Water Heating, Recycling Grey Water, Wind Turbines
- 06 **BMS** — Energy Control
- 07 **FIRE SYSTEM** — Fire Detection, Extinguishing System

4- Existing Building Case

5-Results



6-Conclusion

Tackling various systems in a building to make it more efficient, and integrating solutions together will make the system Green, Sustainable and SMART. Also, will increase Efficiency of the Building

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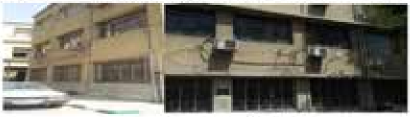
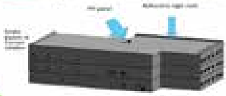
Retrofitting of an Inefficient Existing Building to be Sustainable, Green and Smart

Electrical Power Engineering Building at Faculty of Engineering Campus, Cairo University



What about new smart educational building?

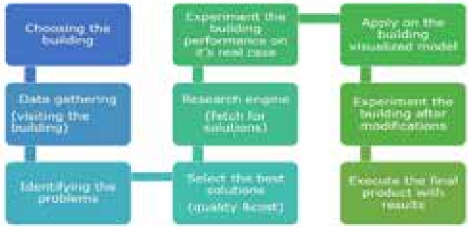
The electrical power engineering building had been built as a conventional building in 1936. Due to the new technology and the students' needs we had thought of turning it to a smart, sustainable and energy efficient building.

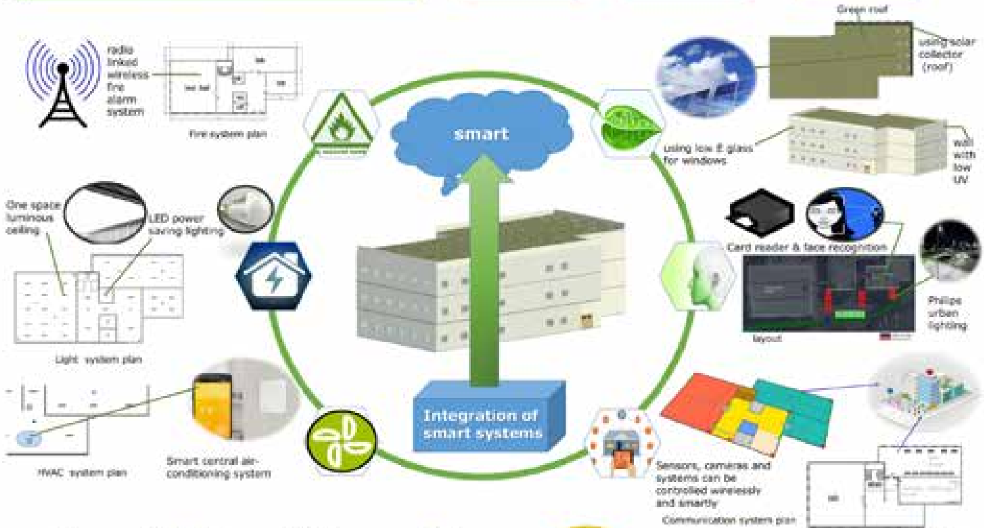


3D shot

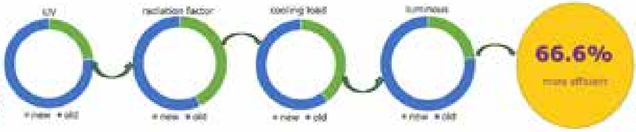
Objectives

Methodology





Results



Conclusion

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STUDENT/S NAME:
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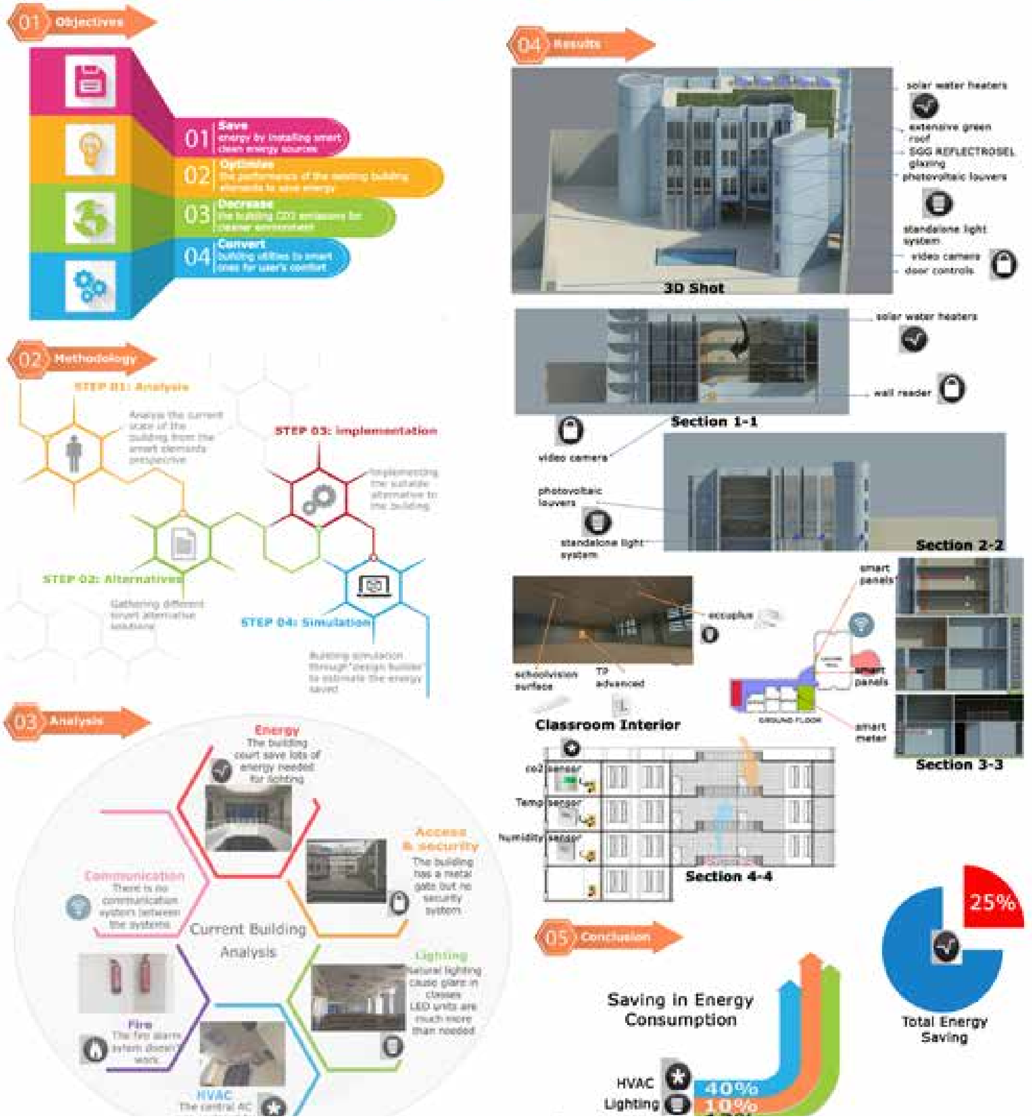
Aya Ayman Ibrahim
Mirette Mounir
Mostafa Hisham

Green and SMART building

The Credit-Hour Building, Faculty of Engineering, Cairo University



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Retrofitting of an Inefficient Existing Building to be a Sustainable, Green and Smart Building

CIVIL Department Building, Faculty of Engineering, Cairo University, Cairo, Egypt.

1.PROBLEM STATEMENT

Our problem is to turn an existing building which has inefficient energy performance into an efficient one through applying sustainable solutions and integrating green and smart systems.

Fig.1: Civil Dept. building before retrofitting

2.BUILDING INFO.

- **Location**: Cairo, Egypt.
- **Number of Floors:** 3 floors
- **Users:**
  - Students
  - Professors
  - Teaching Assistances
  - Workers
  - Visitors

3.ASSESMENT

Building problems:

- No renewable energy resources
- No BMS
- High heat gain
- No security management
- No natural lighting or ventilation

4.OBJECTIVES

5.METHDOLOGY

Problem Identification
- Problem Statement
- Project's Objectives

Building Assessment
- Existing Systems
- Design Builder Simulation

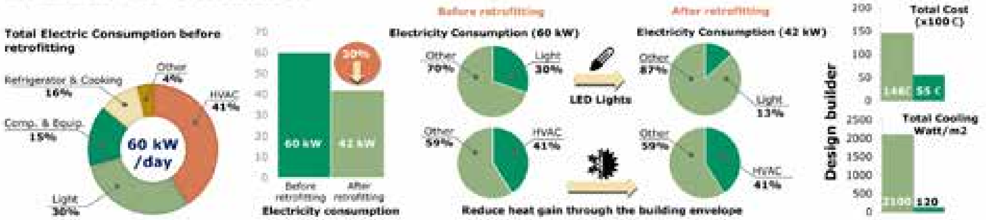
Integrated solutions
- Energy/ HVAC
- Communication/ Control
- Lighting
- Smart materials

Results & Conclusions
- Design Builder Simulation
- Comparison:
  - Energy Consumption
  - Costs

6.GREEN INTEGRATED SOLUTIONS

Fig.2: Civil Dept. building after retrofitting including green and smart solutions

7.RESULTS AND CONCLUSION



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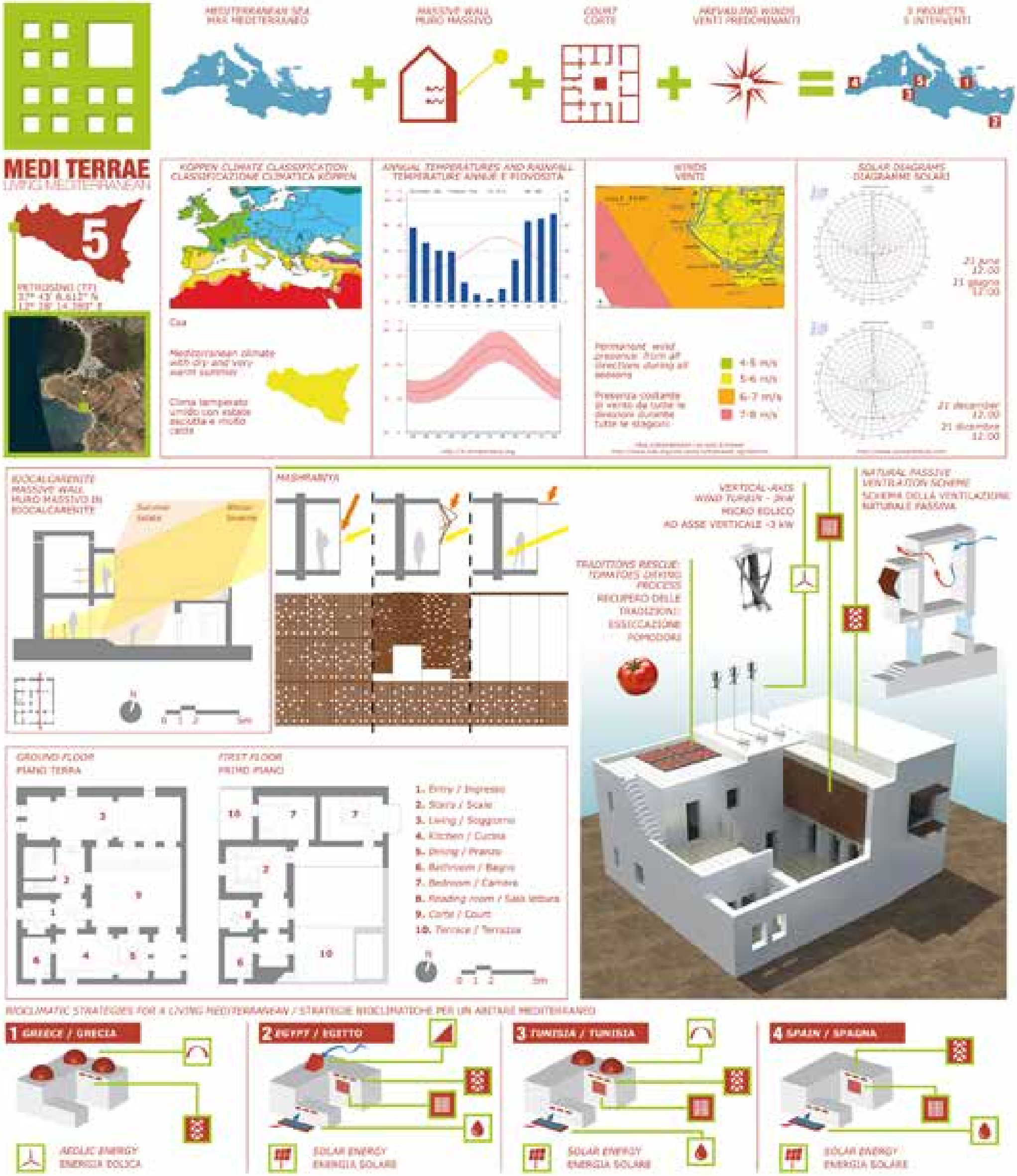
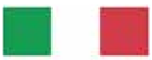


UNIVERSITÀ DEGLI STUDI DI PALERMO

d'Arch



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NATIONALITY:

Italian

INSERT PROFESSOR PICTURE

PROFESSOR NAME:

Tiziana Firrone

INSERT STUDENT/S PICTURE

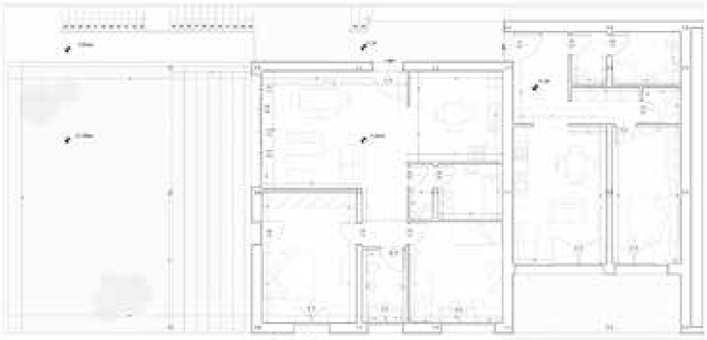
STUDENT/S NAME:

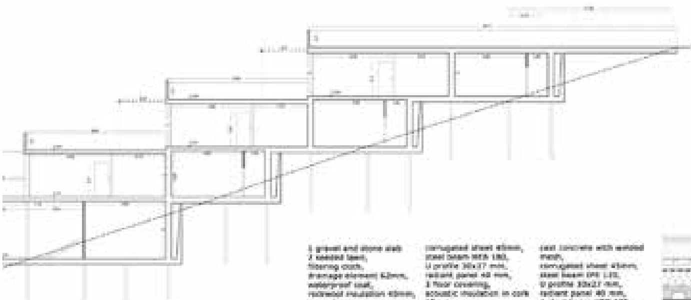
Federico Napoli

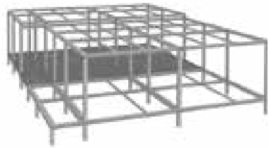
The project involves the construction of l
xury apartments in Casuarinas, neig
borhood of the Peruvian capital of Lim
The study area is 797.87 square meters and is locat
on a slope with a vertical drop of 16 meters; its acce
is inLos Pensamientos street which allows you to g
to a large parking area with fifteen car parks in serv
ce of the apartments and is bordered to the west wi
Los Crisamentos street, on the south by a large par

The fundamental objective of the project is the attem
to integrate the building with the surrounding natur
environment, hence the idea of a three floors buildin
organized in three steps distributed along the slop
Each floor consists of two units: The first unit, thoug
to host 2 people, has terrace of 15 sqm overlooki
the park; the second one consists in an appartme
for a 4 people family and it owns a large garden
about 100sqm. The apartments also come with a p
vate space to wineries located on the ground floo
Flanked to the north elevation of the building is
stone staircase that allows access to six apar
ments and connects the parking lots to the win
ries. Furthermore, given the obvious gap betwee
the top floor of the parking and the ground floo
to facilitate access to the apartments was pla
ned in the project a diagonal lift near the stair

The building consists of a steel structure that rests o
a reinforced concrete foundation made up of poles d
ven into the ground, while the covering system is des
gned as a roof garden, a kind of "green lung" which n
only improves the quality of housing and the aesth
tics of the building, but it also shows purely function
aspects such as, for example, the recovery of rainwat



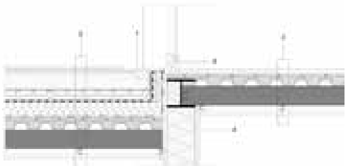


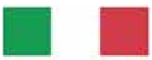


1 gravel and stone slab
2 seeded lawn,
filtering cloth,
drainage element 62mm,
waterproof coat,
redwood insulation 45mm,
vapor barrier,
cast concrete with welded
mesh,

corrugated sheet 45mm,
steel beam HEB 180,
U profile 30x27 mm,
radiant panel 40 mm,
3 floor covering,
acoustic insulation in cork
15mm,
bedding screed,

cast concrete with welded
mesh,
corrugated sheet 45mm,
steel beam IPE 120,
U profile 30x27 mm,
radiant panel 40 mm,
4 steel beam HEB 180,
5 aluminium frame





INSERT FLAG IMAGE

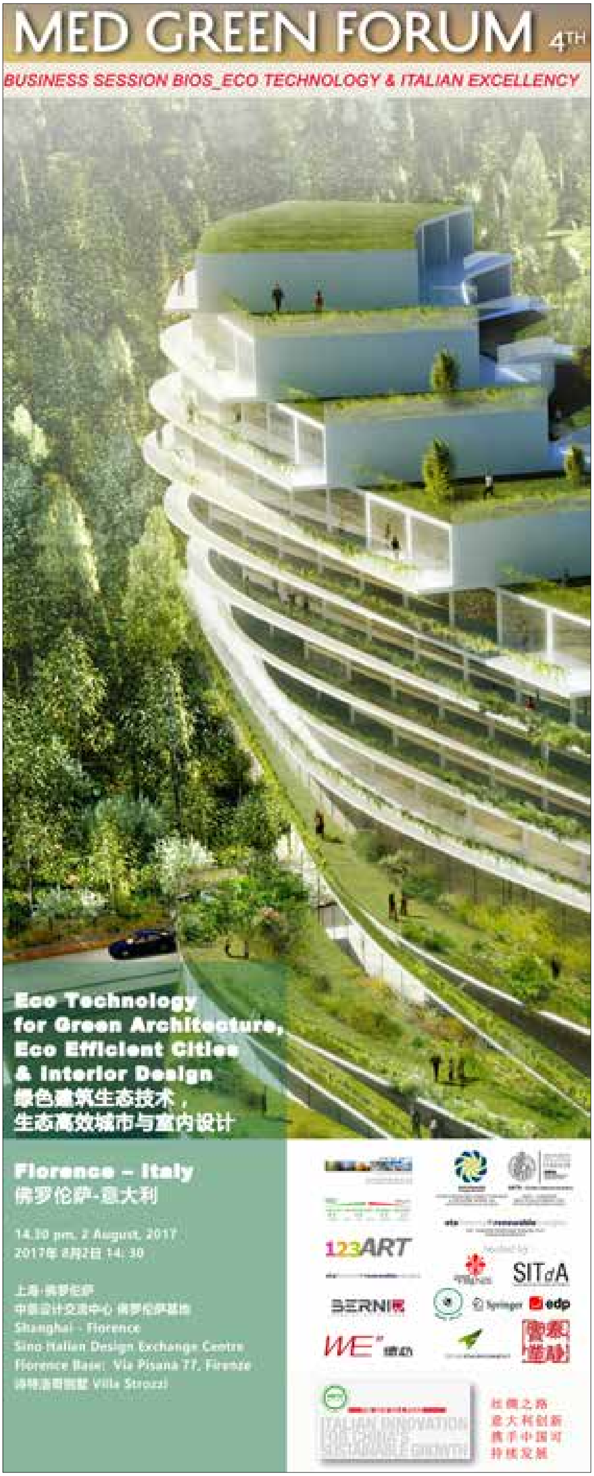
NATIONALITY:
Italian

STUDENT/S NAME:

Ilaria Giachi, Annalisa Franchi
Fabio Ferrara, Giulia Luongo

opposite page
Picture with Prof. Ali Sayigh, Marco Sala and Fernando Recalde Leon, during the award ceremony at Villa Strozzi
© Mohsen Aboulnaga

Picture of one side exhibition in the Med Green Forum venue
© Mohsen Aboulnaga



The MED GEEN FORM STUDENTS AWARD COMPETITION took place in Florence at the ente of the Mediterranean Green Buildings & Renewable Energy Forum – 4 Med Green Forum – 4, 31 July – 3 August 2017 in Florence, Italy. On the 3rd wednesday afternoon, at Villa Strozzi Prof Sayigh, chairman of the Forum, opened the dialogue session between the Italian Industry and representatives in China by CCTV which was broadcast live worldwide. This session was organized by Prof Fernando Recalde & Prof Marco Sala. Afterward, prices were given to the 5 winners of the poster completion. 13 countries had entered 33 posters. Prof Marco Sala and Prof Ali Sayigh presented the winners with the Forum medals. The Forum was attended by 103 participants representing 40 countries. The Proceedings will be published by Springer. The three Organizations: WREN, ABITA and ETA are working together to highlight the importance of sustainable buildings and renewable energy especially in regions of abundant sunshine.

MED GREEN FORUM 4

MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017

Med Green Students Award

Develop a Sustainable Building in the Context of Sustainable Development Measures

Building no. 40, Faculty of Engineering, Cairo University, Egypt

Introduction

Developing the existing building to be sustainable and energy efficient, and converting it from an energy consuming building into an energy consuming and generating building, through the application of the latest green technologies and systems

Tools:

1. Renewable energy
2. Green roof
3. Efficient envelop
4. Reduce water consumption
5. Clean transport
6. Eco-Materials

Objectives

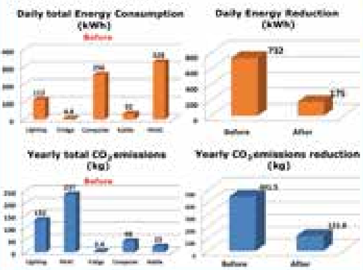
1. Reduce consumption
2. Sustainable transport
3. Efficient energy usage
4. Renewable energy
5. Smart building

Methodology

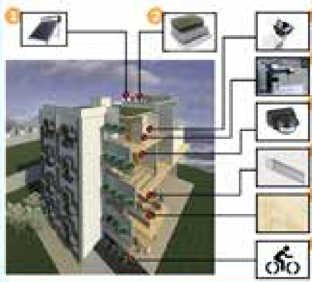
Introduction → Objectives → Analysis → (Site analysis | Building envelop | Water | Energy consumption | Material and insulation | CO_2 emissions) → Retrofitting process → Results → Conclusions

Analysis

Energy Consumption and CO_2 emissions before and after retrofitting

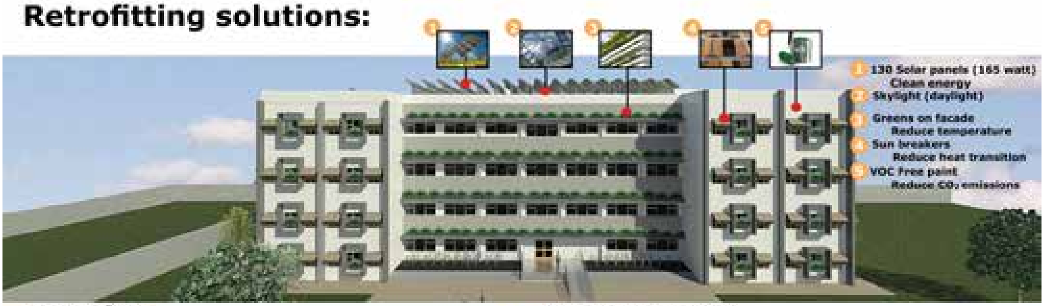


3D view of the final project showing green features and process

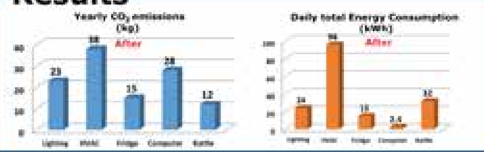


1. Solar water heating system — Clean energy to provide hot water
2. Green roof (Extensive roof) — Insulation to reduce heat transition
3. Efficient toilets — Use 4.8 liter/flush
4. Efficient water taps — Average flow rate 3 liter/minute
5. Motion sensoir -light sensor — Reduce energy consumption
6. LED Lamps use 10 watt — Reduce energy consumption
7. Marble flooring (Low embodied energy)
8. Bike lane (Clean transportation)

Retrofitting solutions:



Results



Conclusions

100%	75%	35%	65%	60%	70%
Renewable energy usage	Energy consumption	Lighting consumption	Cooling load reduction	Water consumption	CO_2 emissions reduction

MED GREEN FORUM 4

MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017

Med Green Students Award

Professor Name:

Affiliation:

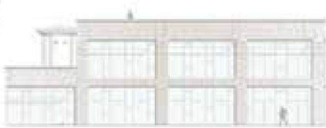
Students name:

Concept

Description of the project

Bioclimatic and energy strategies

General Planimetry



Technology description

MED GREEN FORUM 4

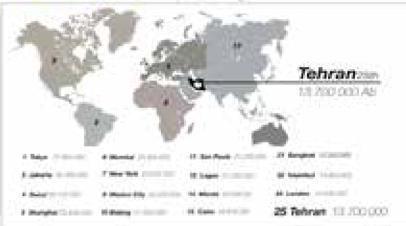
MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017

Med Green Students Award

Professor Name: MARIA DE SANTIS
Affiliation: University of Florence, School of Architecture
Students name: SHIRIN AMINI email: shi.amini@gmail.com

Topic: 1 – **Qanat**: from historic infrastructure to sustainable resource for urban development - The Baharestan Square Area - Shirin Amini - Master Degree

The Problem: 2015 | 30 Megacities in the World

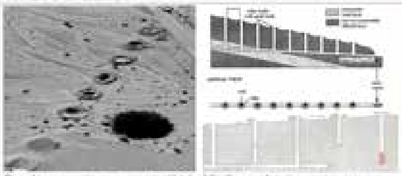


Megacities: *Big Cities, Big Water?*
Water Resource *becomes foundamental for the growing city*

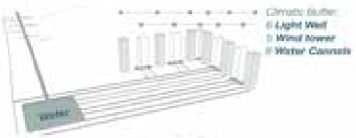
Solution

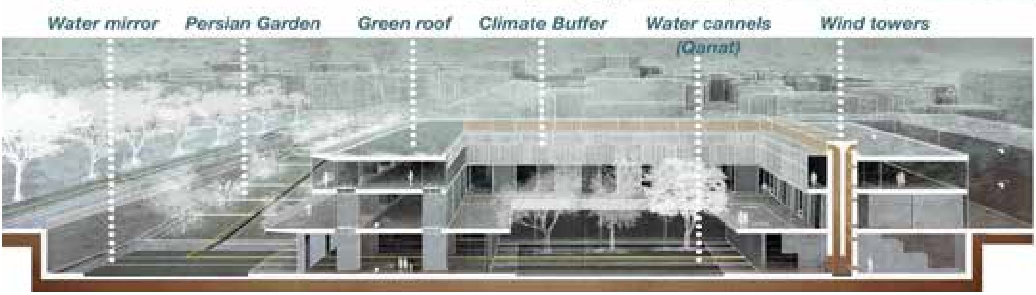
Increase the **sustainable use** *of the* **Ecological network**, *in order to preserve the* **ecosystem** *of the metropolitan landscape*

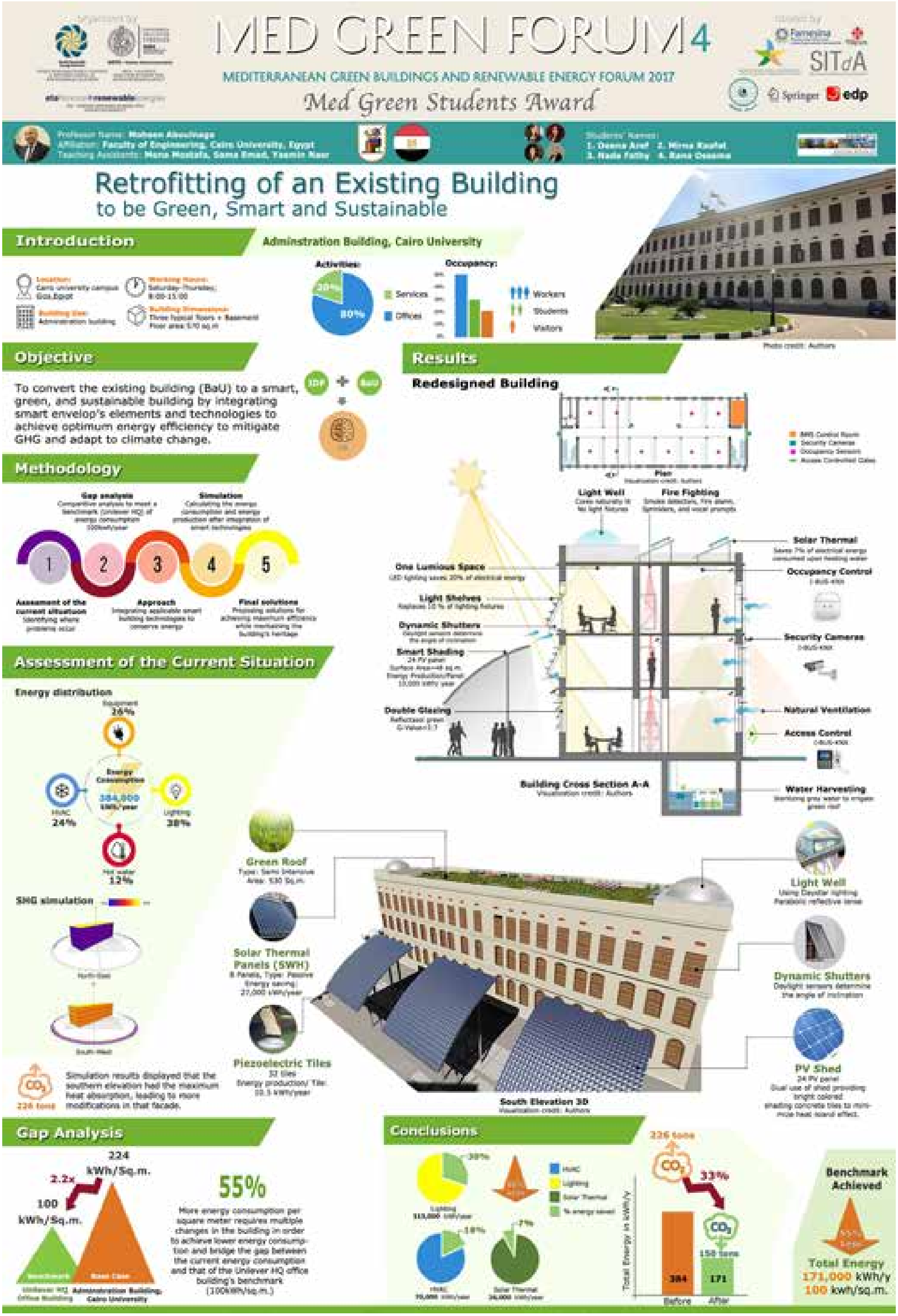
What's a Qanat?



Qanats [illegible]






MED GREEN FORUM 4
MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017
Med Green Students Award
SITdA
Springer
edp
Professor Name: Mohsen Aboulnaga
Affiliation: Faculty of Engineering, Cairo University, Egypt
Teaching Assistants: Mona Mostafa, Sama Emad, Yasmin Nasr
Students' Names:
1. Deena Aref 2. Mirna Raafat
3. Nada Fathy 4. Rana Ossama
Retrofitting of an Existing Building
to be Green, Smart and Sustainable
Introduction
Adminstration Building, Cairo University
Activities:
20%
80%
Services
Offices
Occupancy:
Workers
Students
Visitors
Photo credit: Authors
Objective
To convert the existing building (BaU) to a smart, green, and sustainable building by integrating smart envelop's elements and technologies to achieve optimum energy efficiency to mitigate GHG and adapt to climate change.
IDP
BaU
Methodology
1
2
3
4
5
Assessment of the Current Situation
Energy distribution
26%
Energy Consumption
384,000 kWh/year
HVAC
24%
Lighting
38%
Hot water
12%
SHG simulation
Simulation results displayed that the southern elevation had the maximum heat absorption, leading to more modifications in that facade.
CO_2
226 tons
Results
Redesigned Building
Plan
Light Well
Fire Fighting
Solar Thermal
One Lumious Space
Occupancy Control
Light Shelves
Dynamic Shutters
Security Cameras
Smart Shading
Double Glazing
Natural Ventilation
Access Control
Building Cross Section A-A
Water Harvesting
Green Roof
Solar Thermal Panels (SWH)
Piezoelectric Tiles
Light Well
Dynamic Shutters
PV Shed
South Elevation 3D
Gap Analysis
224 kWh/Sq.m.
2.2x
100 kWh/Sq.m.
55%
More energy consumption per square meter requires multiple changes in the building in order to achieve lower energy consumption and bridge the gap between the current energy consumption and that of the Unilever HQ office building's benchmark (100kWh/sq.m.)
Administration Building, Cairo University
Conclusions
30%
18%
7%
HVAC
Lighting
Solar Thermal
% energy saved
226 tons
CO_2
33%
150 tons
Total Energy in kWh/y
384
171
Before
After
Benchmark Achieved
Total Energy
171,000 kWh/y
100 kwh/sq.m.

MED GREEN FORUM 4

MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017

Med Green Students Award

Professor Name: Prof. Dr Mohsen Aboulnaga
Affiliation: Faculty of Engineering, Cairo University, Egypt
Teaching Assistants: Mona Mostafa, Samaa Emad, Yasmin Nasr
Students' Names: 1. Yousef Adel 2. Belal Ahmed 3. Abdelrahman Ashraf 4. Ahmed Hany 5. Yehia Hany

Retrofitting of an Inefficient Existing Building to be Green, Smart and Sustainable

Department of Architecture Building | CAIRO UNIVERSITY CAMPUS | SEVEN STOREY BUILDING | HIGHER EDUCATIONAL BUILDING | CONSTRUCTION DATE: 1991 | 1750 USERS PER DAY

INTRODUCTION

This building is one of many others that have inefficient energy performance. It contributes to climate change and has negative influence on its environment and users.

OBJECTIVES

1. Retrofit Existing Building to be Smart
2. Integrate Smart Elements & Systems
3. Reduce Energy Consumption
4. Mitigate Carbon Emissions
5. Adapt to Climate Change
6. Achieve Users' Comfort

METHODOLOGY

1 OBSERVATIONS → 2 ANALYSIS → 3 PROBLEMS → 4 SOLUTIONS → 5 SIMULATIONS → 6 CONCLUSIONS

IDENTIFYING PROBLEMS

- ENERGY: High consumption; Non-renewable sources; Non-insulated envelope
- HVAC: High consumption due to high WWR
- ACCESS & SECURITY: No access/ occupancy control
- LIGHTING: Inefficient use
- HEAT ISLAND EFFECT: Dark colors & low reflective materials
- COMMUNICATION: Difficulties in problem tracking

OBSERVATION ANALYSIS

Simulation of the building's performance was run using green building studio and autodesk insight plugin for revit. All images are credited to the authors.

RESULTS
PROPOSED SOLUTIONS

CONCLUSIONS

MED GREEN FORUM 4

MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017

Med Green Students Award

Professor Name: Prof. Dr. Mohsen Aboulnaga
Affiliation: Faculty of Engineering, Cairo University, Egypt

Students name: Doaa Hossam, Mariam Alaa, Norhana Hisham, Shahinda Taher, Nawar Hussein

Developing Smart Buildings for an Efficient Built Environment:

The Case of an Educational Building, Building 12; Cairo University Campus

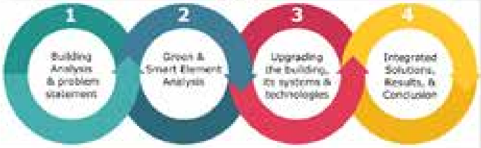
- Sports and Social Club at the Faculty of Engineering Cairo University
- Basement floor +Ground floor +2 floors
- Students, Faculty members, & Outcomers
- Conferences, Events, Seminars
- Conference Hall: Events; Restaurant: 12PM-3PM; Labs: 9AM-3PM; Sports Hall: Events/Exams; Gym: 9AM-2PM

1 Objectives

The project's objective is to retrofit the existing building to be SMART, GREEN, and SUSTAINABLE.

- Energy Efficiency
- Local Material
- Low GHG Emissions
- Smart Integrated Building
- Social Sustainability
- Near Zero Energy Building
- Sustainable and Green Site
- Max. Comfort and Indoor Quality

2 Methodology



3 Building Analysis

Communication
No control room
No monitoring room

Building Envelop
High U-value for wall insulation
Inefficient Glass

Access and Security
No security cameras

Environment
High CO2 emissions

Ventilation
Low natural ventilation
Uncovered HVAC ducts

Lighting
Insufficient natural lighting
Unmanaged lighting fixtures

Heat Island
High solar reflectance materials
High Albedo

Existing systems in the basement floor plan 1/400

Fig1. Northern elevation of the existing building

Fig2. Southern elevation of the existing building

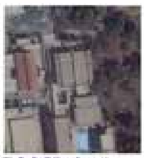
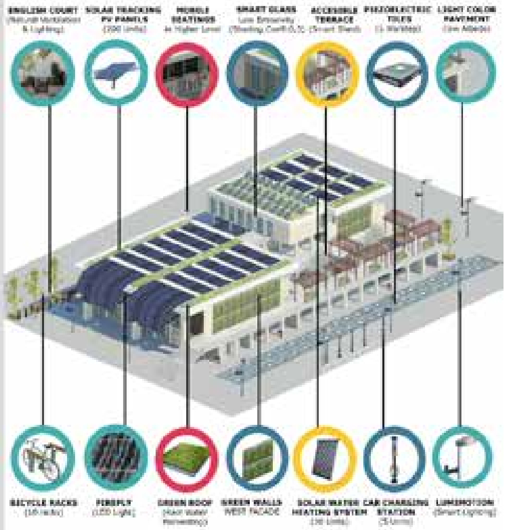


Fig3. Building layout

4 Green & Smart Elements

- 01 Heat Island
- 02 Energy
- 03 Lighting
- 04 HVAC: Green Roof, Thermostats; Heat Sensors, Air Volume Damper
- 05 Communication
- 06 Access & Security

5 Results



6 Green Solutions

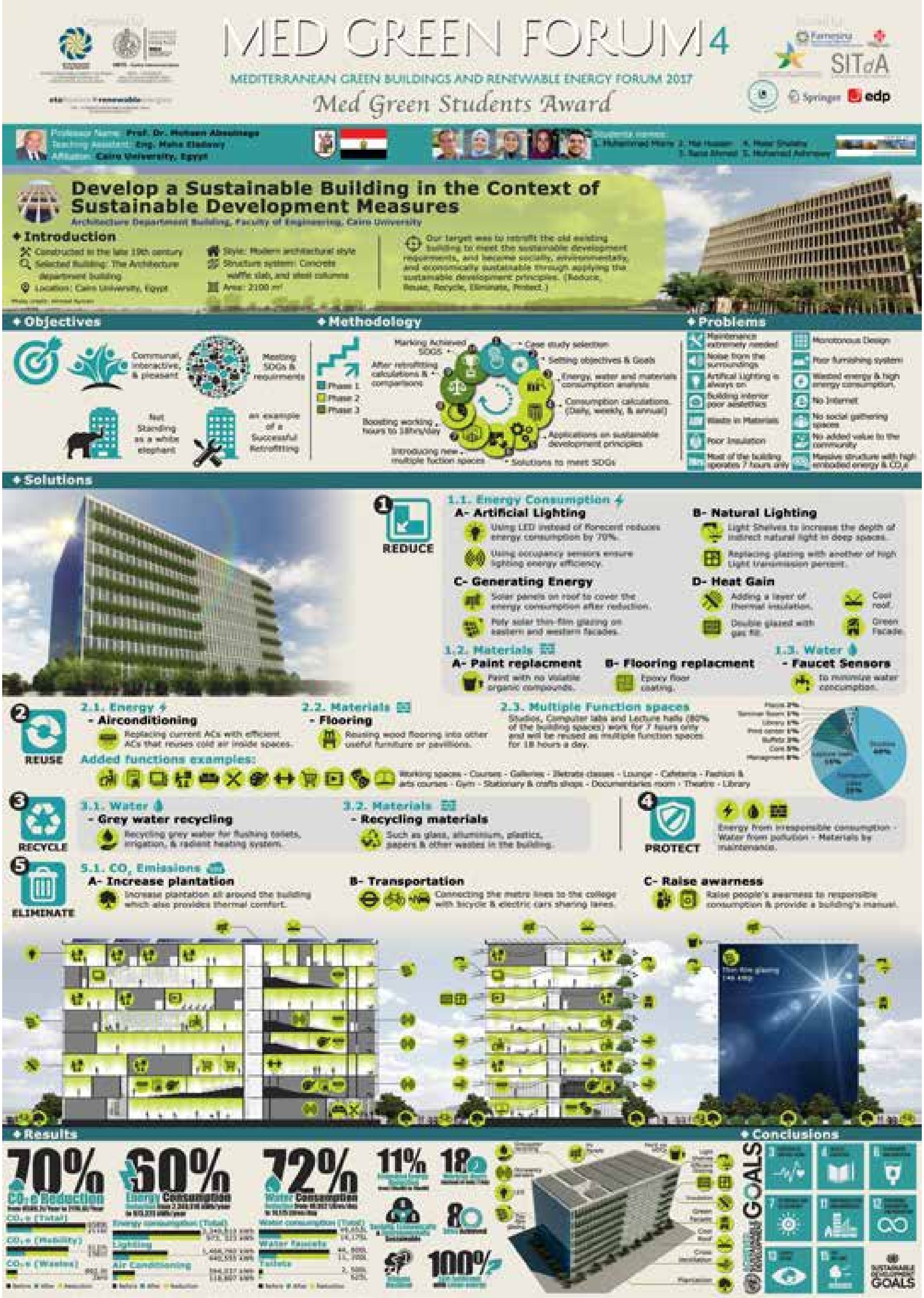
SITE
- Bicycle Lanes
- Site Waste Recycling
- Waste Water Treatment
- Clean Transport

USERS
- Green Awareness

BUILDING
32% Reduction in cooling loads
- Biodiversity
- Insulation
- Green Wall
- Green Roof

7 Conclusions

- Energy Consumption Reduction
- CO_2 Reduction
- Artificial Lighting Reduction
- HVAC Reduction
- Social Sustainability
- SWH
- PV Cell
- Renewable Energy


MED GREEN FORUM 4
MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017
Med Green Students Award
SITdA
Springer
edp
Professor Name: Prof. Dr. Mohsen Aboulnaga
Teaching Assistant: Eng. Maha Eladawy
Affiliation: Cairo University, Egypt
Students names:
Develop a Sustainable Building in the Context of Sustainable Development Measures
Architecture Department Building, Faculty of Engineering, Cairo University
Introduction
Constructed in the late 19th century
Selected Building: The Architecture department building
Location: Cairo University, Egypt
Style: Modern architectural style
Structure system: Concrete waffle slab, and steel columns
Area: 2100 m²
Our target was to retrofit the old existing building to meet the sustainable development requirements, and become socially, environmentally, and economically sustainable through applying the sustainable development principles. (Reduce, Reuse, Recycle, Eliminate, Protect.)
Objectives
Communal, interactive, & pleasant
Meeting SDGs & requirements
Not Standing as a white elephant
an example of a Successful Retrofitting
Methodology
Phase 1
Phase 2
Phase 3
Marking Achieved SDGS
After retrofitting calculations & comparisons
Boosting working hours to 18hrs/day
Introducing new multiple fuction spaces
Case study selection
Setting objectives & Goals
Energy, water and materials consumption analysis
Consumption calculations. (Daily, weekly, & annual)
Applications on sustainable development principles
Solutions to meet SDGs
Problems
Maintenance extremely needed
Noise from the surroundings
Artificial Lighting is always on
Building interior poor aesthetics
Waste in Materials
Poor Insulation
Most of the building operates 7 hours only
Monotonous Design
Poor furnishing system
Wasted energy & high energy consumption
No Internet
No social gathering spaces
No added value to the community
Massive structure with high embodied energy & CO₂
Solutions
1 REDUCE
1.1. Energy Consumption
A- Artificial Lighting
Using LED instead of florecent reduces energy consumption by 70%.
Using occupancy sensors ensure lighting energy efficiency.
B- Natural Lighting
Light Shelves to increase the depth of indirect natural light in deep spaces.
Replacing glazing with another of high Light transmission percent.
C- Generating Energy
Solar panels on roof to cover the energy consumption after reduction.
Poly solar thin-film glazing on eastern and western facades.
D- Heat Gain
Adding a layer of thermal insulation.
Double glazed with gas fill.
Cool roof.
Green Facade.
1.2. Materials
A- Paint replacment
Paint with no Volatile organic compounds.
B- Flooring replacment
Epoxy floor coating.
1.3. Water
- Faucet Sensors
to minimize water consumption.
2 REUSE
2.1. Energy
- Airconditioning
Replacing current ACs with efficient ACs that reuses cold air inside spaces.
2.2. Materials
- Flooring
Reusing wood flooring into other useful furniture or pavilions.
2.3. Multiple Function spaces
Studios, Computer labs and Lecture halls (80% of the building spaces) work for 7 hours only and will be reused as multiple function spaces for 18 hours a day.
Added functions examples:
Working spaces - Courses - Galleries - Illetrate classes - Lounge - Cafeteria - Fashion & arts courses - Gym - Stationary & crafts shops - Documentaries room - Theatre - Library
3 RECYCLE
3.1. Water
- Grey water recycling
Recycling grey water for flushing toilets, irrigation, & radient heating system.
3.2. Materials
- Recycling materials
Such as glass, alluminium, plastics, papers & other wastes in the building.
4 PROTECT
Energy from irresponsible consumption - Water from pollution - Materials by maintenance.
5 ELIMINATE
5.1. CO₂ Emissions
A- Increase plantation
Increase plantation all around the building which also provides thermal comfort.
B- Transportation
Connecting the metro lines to the college with bicycle & electric cars sharing lanes.
C- Raise awarness
Raise people's awarness to responsible consumption & provide a building's manual.
Results
70% CO₂e Reduction
60% Energy Consumption
72% Water Consumption
11%
18
100%
Conclusions
SUSTAINABLE DEVELOPMENT GOALS

MED GREEN FORUM 4

MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017

Med Green Students Award

Professor name: Prof. Dr. Mohsen Aboulnaga
Teaching assistant: Eng. Maha Elmawy
Affiliation: Cairo University, Egypt

Students names: Samar Hafez · Ass Abdelrahman · Doaa Hagazin · Samir Abdelhaleem · Abdulrahman Mahmoud

Developing a sustainable building in the context of sustainable development measures

Introduction

Universities should be models in providing examples of quality and the enhancement of the **environment and society.** In this research we are developing Communication department building in order to make it meets the **sustainable development goals** and not be a **white elephant.**

Communication department building

Source: www.cu.edu.eg

Location
Faculty of Engineering, Cairo University, Cairo, Egypt.

Building type
Educational building

Objectives

Reduce: Energy use; Material consumption

Re-use: Materials; Water; Energy

Recycle: Materials; Water

Protect: Materials; Ecosystem; Land; Energy; Water

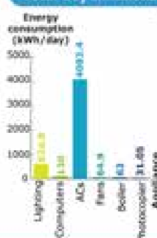
Eliminate: CO_2 emissions; Pollution

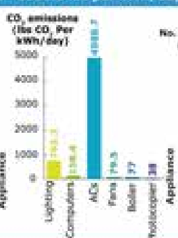
Methodology

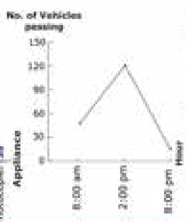
1. Introduction & problem identification
2. Objectives
3. Building analysis & systems
4. Sustainable development solutions
5. Results and conclusions

Assessment of the existing building

Total energy consumption= 4982.49 kWh/day
Total CO_2 emissions= 6088.6 lbs per kWh/day

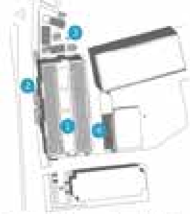






Solutions

1 3D shot showing solutions to meet sustainable development requirements



General layout

2 Bus stop provided

3 Open gallery for students' work

4 Outdoor interactive space

Timeline for suggested redesign

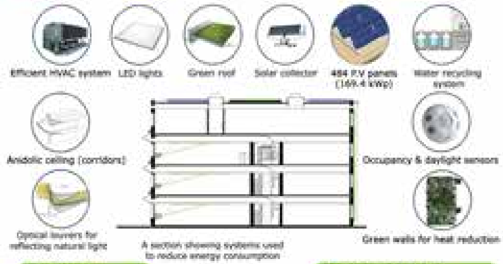
- Lecture halls
  - Group work spaces from 8:00 am to 10:00 pm
  - Literacy classes from 5:00 pm to 7:00 pm
- Third floor
  - Lounge and cafeteria from 8:00 am to 11:00 pm
  - Study zones from 8:00 am to 11:00 pm
- Lecture halls
  - Courses from 3:30 pm to 9:00 pm
  - Startup spaces for fresh graduates from 6:00 pm to 11:00 pm

Lecture hall after redesign

partition added for multi-functions. Replacing desks with others flexible

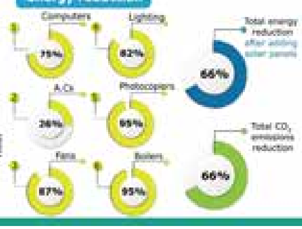
3rd floor after redesign

Cafeteria added for social interaction



Results

Energy reduction



Conclusions

Sustainable development goals achieved

MED GREEN FORUM 4

MEDITERRANEAN GREEN BUILDINGS AND RENEWABLE ENERGY FORUM 2017

Med Green Students Award

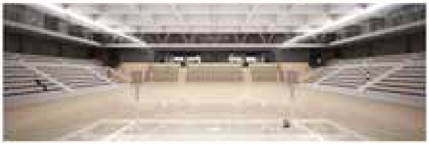
Professor Name: Maria De Santis
Affiliation: University of Florence, School of Architecture

Students name: Giovanni Di Benedetto - Italy

TOPIC 1 | "LUPI SPORT CENTER: Sports Hall renovation project in Santa Croce sull'Arno" | Giovanni Di Benedetto | Master Degree in Architecture | University of Florence

Problem:
an existing Sports Hall with critical bioclimatic, energetic and comfort issues: high costs of technical system, high thermal dispersion in winter, overheating in summer.

Project target:
create a social, economic long-term sustainability adding new collaborating functions to the volleyball association;
fix the existing issues with active and passive bioclimatic strategies;
improve comfort working with levels: new volumes embrace and permeate the existant structure creating visual relations between functions and green areas surrounding.
Formal design mean to make the new sports hall a real landmark.



CONCEPT


1 Partial demolition


2 Stand reconfiguration


3 Services volume


4 Context integration


5 Entrance volume


6 Functions volume


7 Subtraction


8 Green voids

Pictures taken at Villa Strozzi with winners of the award student competition.
© Mohsen Aboulnaga

Biographies

Lucia Ceccherini Nelli

Lucia Ceccherini Nelli PhD Contract Professor and Senior researcher at the University of Florence, Architect from 1988 works at the ABITA Interuniversity research centre. Teacher of Environmental Design at the University of Florence, senior expert in the field of Integration Renewable Energies in Buildings, Dynamic envelopes, Green architecture, Low energy buildings, expert and specialized in sustainable architecture and bioclimatic design. Team leader-committee for the organization of the European Master "ABITA and teacher in Post- graduate courses in NZEB Nearly Zero energy Buildings and energy management.

Marco Sala

Full Professor in Architectural Technology in Florence University, fonder of ABITA research centre and director of the European Master ABITA in Sustainable Architecture. Coordinator of many European research projects. Fonder of the MSA Associates Architecture and Energy Consultants, specialised in bioclimatic architecture, environmental design and sustainable planning, designed many green architectures and consultancies for public administrations as well as national and international companies.

Fernando Recalde

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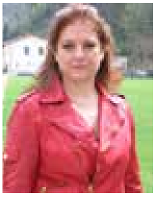

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Finito di stampare per conto di
didapress
Dipartimento di Architettura
Università degli Studi di Firenze
Marzo 2018

The book presents a collection of recent research works that highlight best practice solutions, case studies for the implementation of sustainable architectures and the new approaches to construction and planning of our cities in the Mediterranean area. Emphasis is given on the role of renewable energies integration into architectures and in the development of urban infrastructures to attain a sustainable future. The book is divided into several chapters that intend to be a resume of the current state of knowledge for the benefit of professionals, scientists, students and other interested in the sustainable construction sector in the Mediterranean Area. At the end of the book the results, with the poster presented by many Universities of the International Student Award competition held in Florence at the MED GREEN FORUM in the years 2015 and 2017.

Lucia Ceccherini Nelli, PhD Contract Professor and Senior researcher at the University of Florence, Architect from 1988 works at the ABITA Interuniversity research centre. Teacher of Environmental Design at the University of Florence, senior expert in the field of Integration Renewable Energies in Buildings, Dynamic envelopes, Green architecture, Low energy buildings, expert and specialized in sustainable architecture and bioclimatic design. Team leader-committee for the organization of the European Master "ABITA and teacher in Post- graduate courses in NZEB Nearly Zero energy Buildings and energy management.

ISBN 978-88-3338-024-7

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€ 20,00