ALLEGATO B:

Pubblicazioni periodo luglio 2008 marzo 2009

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Sperimentazione sostenibile: un padiglione in bambù, acciaio e pannelli fotovoltaici

Un progetto sperimentale che coniuga le potenzialità del bambù con la produzione di energia rinnovabile in un involucro che funge da interfaccia energetico-ambientale tra spazio costruito e ambiente naturale.

Il progetto sperimentale del padiglione in bambù acciaio e solare fotovoltaico è il risultato di un lungo periodo di ricerca e nasce dall'interesse maturato negli ultimi anni intorno alle potenzialità d'uso del bambù come materiale da costruzione e alla sempre crescente necessità di ricorrere a forme di produzione energetica da fonti rinnovabili, specie se attraverso tecnologie integrate nell'involucro edilizio.
Già da alcuni anni il gruppo di progettazione Utopie*realizzabili* ha orientato le ricerche e le sperimentazioni architettoniche sull'uso di materiali alternativi "non convenzionali" come il bambù, graminacea dalle ottime prestazioni fisico-meccaniche e con elevatissimi parametri di sostenibilità ambientale, studi evolutisi nel tempo in ricerche progettuali, applicazioni di laboratorio, realizzazione di prototipi sperimentali, oggetti di design e brevetti industriali, fino alla firma di un protocollo di intesa con il Comune di Settimo Torinese e il Laboratorio DICAT della Facoltà di Ingegneria di Genova.
Elemento di grande interesse tecnologico progettuale per il gruppo di progettisti risulta l'involucro edilizio quale interfaccia energetico-ambientale tra spazio costruito e ambiente naturale. Accanto alle strutture in bambù, infatti, il progetto del padiglione si concentra sull'integrazione totale tra struttura portante, sistemi di controventamento, membrana ombreggiante e moduli fotovoltaici in silicio policristallino. Il generatore fotovoltaico integrato nell'involucro ha una potenza

Figura 1. Vista d'insieme della porzione di padiglione con struttura in bamboo-acciaio e vela fotovoltaica montata al Lingotto di Torino in occasione del congresso UIA 2008.

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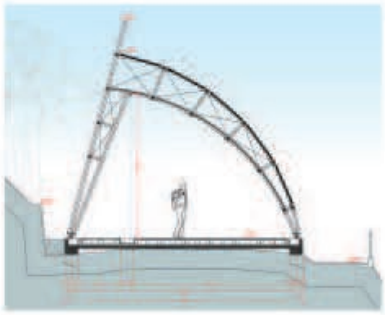
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Figura 2. Vista generale del padiglione Olivetta San Michele (IM), ottobre 2008.

Figura 3. Sezione trasversale.

Figura 4. Dettaglio delle connessioni metalliche e dei morsetti d'acciao Olivetta San Michele (IM), settembre 2008.

Figura 5. Dettaglio della connessione dei pannelli fotovoltaici alla struttura Olivetta San Michele (IM), settembre 2008.

Figura 6. Arelle ombreggianti in bambù Olivetta San Michele (IM), ottobre 2008.

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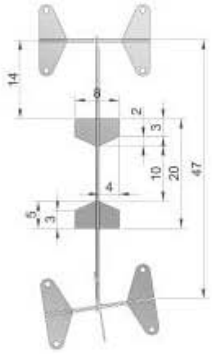
nominale di 7,56 KWp in grado di erogare un'energia che si aggira intorno ai 22500 KW all'anno. L'impianto è stato realizzato dalla società Myenergy che ha curato sia la parte progettuale che quella operativa e di collaudo del generatore.
Il padiglione, dopo la sua prima esposizione al Congresso Mondiale degli Architetti "UIA 2008" tenutosi al Lingotto di Torino nel luglio 2008, è stato definitivamente installato a Olivetta S. Michele, piccolo comune del ponente ligure (Im) ove rimarrà per fornire elettricità al Palazzo Comunale, rendendolo autonomo sotto il profilo energetico.
La costruzione si presenta come una grande "vela fotovoltaica" curva, composta e sorretta da strutture reticolari ad arco rampante realizzate in culmi di bambù disposti in fascio e giunti metallici. La parte retrostante inclinata si sostiene a mezzo di pilastri reticolari di controspinta, sempre in bambù a fascio, rastremati al piede e ancorati a terra, come gli archi, con piastre metalliche studiate ad hoc per trasmettere al meglio gli sforzi al plinto di fondazione. Le sue dimensioni, di ingombro risultano 12 m di lunghezza, 7,5 m di larghezza e 7 m di altezza esterna con quella utile interna massima pari a circa 5 m. L'area di calpestio, 90 m², è costituita da un piano leggermente rialzato e sostenuto da bancali di recupero in legno (nei cui vuoti corrono gli impianti), accessibile a mezzo di scale e rampe e finito con pavimentazione in legno di larice. All'intradosso delle strutture, sul lato sud sotto i moduli fotovoltaici, una pelle in lamelle di bambù omogeneizza la percezione dello spazio interno definendo la volta rampante come superficie vibrante e avvolgente al tempo stesso. Vele in tessuto leggero possono essere issate a piacere tra le campate proteggendo la navata dall'acqua meteorica. Nel periodo estivo lo spazio interno, oltre a godere dell'ombreggiamento dovuto ai moduli fotovoltaici è climatizzato grazie a un velo d'acqua di recupero che, raccolta in vasche all'interno dell'ambiente, viene mantenuta in movimento attraverso un circuito aperto, a cascata. Tutti i sistemi elettrici, compreso l'impianto di illuminazione a LED e le luci del parco limitrofo, risultano completamente alimentati dall'energia prodotta dal generatore fotovoltaico.
Il progetto si pone a metà tra l'attività professionale e il lavoro di ricerca; i due aspetti, che si compenetrano, divengono infatti propedeutici al raggiungimento di alcuni obiettivi specifici come lo sviluppo di tecnologie alternative effettivamente applicabili sul territorio nazionale (il progetto è finanziato da un'amministrazione comunale e configura uno spazio pubblico per esposizioni ed assemblee) riportando tuttavia alla luce l'annoso problema normativo. La mancanza di norme (sia prescrittive sia di consiglio) sul territorio nazionale relative all'impiego di materiali e tecnologie "non convenzionali" e la totale assenza di specifiche certificazioni per l'impiego delle stesse ha costretto i progettisti e i realizzatori a prove di laboratorio sul materiale bambù, sviluppate dal Laboratorio DICAT della Facoltà di Ingegneria di Genova, sotto la supervisione dell'Ing. Stefano Podestà. Tali prove (compressione, trazione, taglio, flessione) operate su un numero considerevole di provini "normalizzati" secondo le uniche norme internazionali esistenti, hanno consentito la caratterizzazione meccanica del materiale *Phyllostachys Viridis Glaucheceus* e un suo razionale impiego, anche a fronte di specifiche verifiche numeriche.
La realizzazione del Prototipo sperimentale ha richiesto l'impiego di circa 350 culmi di bambù italiano della specie *Phyllostachys Viridis Glaucheceus* delle dimensioni di 6 metri utili di fusto (pianta alta circa 10 m), con sezione resistente esterna variabile tra i 60 mm e i 50 mm e spessori di parete non inferiori a 5 mm. A tale proposito è importante sottolineare come dal taglio dei culmi, avvenuto nel novembre 2007, la stessa quantità di piante risulti ricresciuta nel sito di prelievo, con le medesime caratteristiche di altezza e dimensione di chioma.

Figura 7. Particolare del sistema di giunzione e di chiusura dei fasci in bambù.

Figura 8. Dettaglio costruttivo dell'elemento di connessione in acciaio.

Figura 9, 10. Dettaglio costruttivo e particolare dell'attacco a terra.

Figura 11. La piastra di aggancio della struttura alla platea. Olivetta San Michele (IM), ottobre 2008.



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Aspetti progettuali

La progettazione dell'opera rimanda alla grande tradizione delle strutture a fascio in fibra vegetale tipiche delle culture del Sud America, dell'India, del Sud-Est Asiatico e dell'Africa Centrale in cui, come per il padiglione, non sono previste connessioni chiodate o bullonate ma, al contrario, si impiegano esclusivamente sistemi legati in grado di "costringere" alla collaborazione gli elementi del fascio senza determinare punti di discontinuità nelle fibre. Pertanto la progettazione degli elementi portanti e di tutte le parti strutturali del padiglione si è basata sull'impiego di connessioni non forate tra le canne, niente chiodature, bullonature o spinotti passanti tra culmo e culmo, tutto il sistema si basa sulla tensione di serraggio dei lacci di giunzione in cavo d'acciaio, in grado di garantire l'attrito necessario a equilibrare le forze in gioco.
La reinterpretazione in chiave tecnologica contemporanea di sistemi di giunzione tradizionali per le costruzioni in bambù è un elemento fondante del progetto.
I progettisti, convinti della bontà di soluzioni tecniche adottate e raffinate in numerosi secoli di impiego del bambù, hanno di fatto tradotto quel bagaglio di conoscenze in sistemi capaci di:
- riprodurre l'efficienza di sistemi selezionati dalla storia del costruire;
- rispondere a istanze normative legate alla prestazione in opera di componenti edilizi;
- garantire un'agevole e corretta manutenzione.

La progettazione ha previsto metodologie e prassi operative tese a semplificare tempi e azioni di posa degli elementi costruttivi attraverso il ricorso alla modularità, alla reversibilità e allo studio di componenti facilmente gestibili da personale non specializzato.
Il padiglione è stato, altresì, progettato con l'intento di ottimizzare le fasi di trasporto delle strutture realizzate in prefabbricazione, agevolandone la produzione in serie dei loro componenti e una razionale ingegnerizzazione del processo costruttivo, in relazione anche alle esigenze di montaggio e smontaggio sorte in occasione dell'esposizione temporanea avvenuta al Lingotto di Torino.

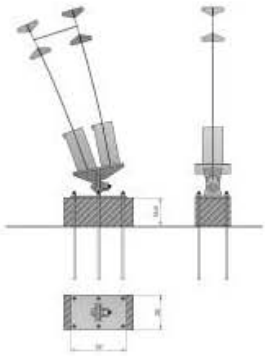
La realizzazione del padiglione ha comportato le seguenti fasi progettuali e operative:
1. progettazione architettonica preliminare definitiva ed esecutiva;
2. progettazione tecnico meccanica e strutturale;
3. interfaccia tecnico progettuale con le aziende fornitrici degli impianti tecnologici (fotovoltaico e altro);
4. realizzazione dei componenti costruttivi in prefabbricazione;
5. assemblaggio in opera delle parti a mezzo di personale specializzato sotto la D.L. di Utopie*realizzabili*;
6. coinvolgimento degli studenti di Architettura attraverso l'organizzazione del workshop "Costruire con il bambù" organizzato presso la facoltà di Architettura del Politecnico di Torino dal Centro di Tecnologia Architettura e Città nei PVS e dal LATEC.

Obiettivi specifici della ricerca progettuale

- Sviluppo di tecnologie sostenibili, anche attraverso l'ibridazione tra prassi costruttive convenzionali e non convenzionali, nella progettazione di spazi pubblici;
- bassissimo impatto ambientale dell'intervento;
- totale ecocompatibilità dell'intervento;
- alta qualità architettonica;
- elevato grado di comfort microclimatica estivo dello spazio progettato;
- costi di investimento altamente competitivi.

La tecnologia

Le architetture in bambù presenti nel panorama mondiale presentano alcune differenze rispetto al progetto del padiglione. In America latina si sono sviluppate nuove tecniche costruttive in edilizia, favorite dal fatto, ad esempio, che la specie *Guadua Angustifolia Kunst* (bambù con caratteristiche fisico-meccaniche particolarmente favorevoli al suo impiego) risulti endemica di alcune regioni. In Colombia, negli ultimi trent'anni, si sono sviluppate costruzioni molto interessanti e ardite: l'architetto Carlos Vergara, ad esempio, ha realizzato a Cali, negli anni Ottanta, la struttura in bambù a pianta quadrata più grande del mondo; Simòn Vélez Considerato ad oggi il massimo esponente mondiale per le costruzioni in bambù, ha realizzato sempre in Sud America spettacolari ville, capannoni, stalle e ponti, e come loro molti altri. Tutti questi progetti si basano tuttavia sull'uso di giunzioni passanti, gettate ad umido con perni che forano i culmi.
Per il progetto del padiglione si è scelto di impiegare bambù locale, coltivato e lavorato nel Nord Italia, in modo da garantire un elevato livello di sostenibilità dell'intero processo costruttivo.
Tale scelta ha influenzato non poco le valutazioni progettuali di dettaglio, sia a livello strutturale, sia a livello di connessione e giunzione dei componenti. Per queste ragioni il sistema costruttivo è stato pensato in modo da utilizzare elementi a fascio capaci di inglobare "stelle" metalliche di connessione, composti da quattro culmi così da migliorare la resistenza generale della struttura e allo stesso tempo garantire una agevole giunzione dei componenti senza forare la parete esterna delle canne. La solidarietà tra i culmi componenti il fascio è garantita da legature metalliche.



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Il sistema tecnologico

Gli elementi portanti sono stati assicurati alle fondazioni per mezzo di piastre inizialmente incernierate, in modo da permetterne l'issaggio, e successivamente trasformate in incastri una volta completata la struttura. Oltre alle piastre di base sono stati progettati elementi metallici che permettono ai fasci di essere connessi tra loro e con le strutture secondarie:

1. "stelle", giunti ad alette forate e saldate perpendicolarmente tra loro, con un'anima in tondino, atte ad essere inserite tra i 4 culmi del fascio;
2. piastra di connessione tra i semiarchi;
3. piastra di connessione dei pilastri a terra;
4. piastra di connessione tra arco e pilastro;
5. morsetto;
6. barra con "stelle" alle estremità.

Le "stelle" hanno la funzione sia di guida ai culmi sia di elemento di aggancio dei tenditori necessario a porre in tensione le croci di S. Andrea in cavi di acciaio (in questo la piccola carpenteria nautica ha dato un forte contributo). È stato necessario dividere in due elementi la struttura del semiarco, per mezzo di una piastra in acciaio collegata ad una barra con alette di inserimento tra i culmi del fascio. Questo sistema permette di realizzare un semiarco completo di 9 m circa di sviluppo esterno, realizzando due elementi di dimensioni ridotte, più maneggevoli e pratici da trasportare.
Il morsetto è forse la parte tecnologica più innovativa del sistema. Esso evita anzi tutto di dover utilizzare perni passanti ovviando al rischio di crak delle canne in corrispondenza di fori e, allo stesso tempo, di garantire una legatura più efficace e duratura di quella realizzata in fibra (naturale o sintetica) infine garantendo una sua successiva e agevole registrazione e manutenzione: due elementi cilindrici in acciaio sono collegati a cavi metallici di 2,5 mm di diametro e grazie viti di serraggio viene garantita la chiusura dei fasci in base alle necessità.

L'attività di cantiere

La realizzazione del padiglione è avvenuta a Olivetta San San Michele (IM) per un periodo di circa sei mesi, durante i quali una parte dell'opera è stata montata ed esposta al Lingotto di Torino, in occasione del Congresso Mondiale degli Architetti (UIA 2008), nella sezione "Off Congress".
L'incarico di esecuzione è stato affidato dal Comune agli architetti Gabriele Casu e Giuseppe [illegible]nzio, con la supervisione dell'architetto Alex Riolfo, progettista dell'opera e direttore dei lavori, e co-progettisti gli architetti Diego Pedemonte e Daniele Di Martino.
Le attività di cantiere si possono descrivere dividendole in 2 fasi: attività svolte in officina, dove è avvenuta la lavorazione, il trattamento e l'assemblaggio dei componenti della struttura; attività di cantiere, dove si è proceduto all'issaggio degli archi e alla realizzazione dei collegamenti orizzontali, dei sistemi di controventamento il montaggio dei pannelli FV e delle opere di finitura e ombreggiamento.
Una volta tagliate e stagionate ai margini del bosco, le canne di bambù sono state trasportate in officina dove hanno subito un ulteriore trattamento di protezione contro gli agenti xilofagi e atmosferici concretizzatosi nell'immersione dei culmi in vasche contenenti una soluzione acquosa di solfato di ferro nella percentuale del 4-5% per almeno 36 ore.
Una volta tolti dalle vasche i culmi sono stati puliti e fiammati con apposito cannello, operazione necessaria a dare al materiale elevata elasticità e resistenza, oltre a migliorarne l'aspetto estetico e la resistenza all'azione degli insetti.
Dopo la fiammatura è stato applicato sui culmi un saturante liquido a base di cere naturali per legno, utile per la protezione da agenti atmosferici e dal fuoco.
In seguito sono state tagliate le canne della dimensione di progetto per i diversi settori degli archi, dei pilastri, per la realizzazione dei puntoni e dei collegamenti orizzontali.
Gli archi sono stati realizzati inserendo i fasci di 4 canne in apposite dime di metallo e mantenendoli in posa per circa 5 giorni. Dopo aver inserito gli elementi metallici necessari ai collegamenti tra gli archi, all'interno dei fasci, i culmi così disposti e curvati sono stati fermati legandoli con morsetti d'acciaio.
Essendo ogni arco suddiviso in 2 parti si è proceduto con la ralizzazione del primo semi-arco sulla dima, unito successivamente al secondo con piastre metalliche. È seguita la costruzione dei puntoni e la posa dei cavi di controventamento paralleli al piano degli archi.
In pratica ogni arco è suddiviso in 6 settori, delimitati dai puntoni, all'interno dei quali vi sono le croci costituite da cavetti metallici.
L'operazione di issaggio delle strutture portanti in situ si è rivelata particolarmente delicata poiché l'area di progetto non ha consentito l'impiego di mezzi meccanici.
Una volta issati gli archi si è provveduto all'inserimento degli elementi di collegamento orizzontale, costituiti da culmi di bambù sempre a fasci di 4, alle cui estremità è stato praticato il taglio cosiddetto a "bocca di pesce", tale da permettere alle singole canne di aderire perfettamente tra loro.
Alla chiusura dei controventamenti ha fatto seguito la posa dei pannelli fotovoltaici, previo l'inserimento di una struttura metallica a croce collegata agli archi a mezzo di molle d'acciaio capaci di garantire l'assorbimento degli sforzi indotti dal vento sulla superficie piana dei moduli fotovoltaici, dissipandone l'energia altrimenti trasmessa alle strutture.

Sustainable Communities, Toward Energy Independence and Carbon Neutral Communities. Clark, Woodrow W.II (Ed.) 2009, Approx. 300 p. 50 illus., Hardcover ISBN: 978-1-4419-0218-4

Sustainable Communities: The Piedmont Region, Settimo Torinese, Italy

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Abstract

This chapter highlights the projects and achievements dealing with renewable energy and agile energy systems for sustainable communities in Italy.

Both the Piedmontese and Settimo Torinese projects, and other parallel projects in Milan are regarded as sustainable communities because of their balance between energy consumption and the environment. Additionally, these projects were not only created out of mere respect for the environment, but to create economic value as well.

This Chapter

1. **Presents new energy paradigms in Northern Italy:**
    1. **Parallel experiences under way: Milano CityLife, Sesto San Giovanni (Falck), Settimo Torinese (Green Tech Park, Laguna Verde)**
    2. **Settimo Torinese: the R&D archipelago Green Tech Park, a new territory for the experimentation on energy innovation in Piedmont, northern Italy**
    3. **The use of sustainable, renewable resources, and the implementation of new technologies and sustainable practices in Settimo Torinese as a sustainable town**
2. **Introduces "Laguna Verde": a new eco-town of the future in Settimo Torinese, from dream to reality**
    1. **Global sustainability, resources and technologies in Laguna Verde, Settimo Torinese**
    2. **Environment/Energy balance in Laguna Verde**

1. Innovative Paradigms for ideas, projects and practices.

Energy production must derive from a dialogue with the environment. This seemingly simple concept implies dramatic cultural leaps when considering the design of urban areas as well as the type and amount of energy consumed. Essentially, everything must be reconsidered including how much energy is consumed in buildings, districts, cities, and the territory as a whole, as well as re-examining technologies employed for production and distribution of goods.

Applying new sustainable paradigms requires technical knowledge and design capabilities able to:

3. Understand varied energy needs of a specific territory

4. Enhance the combination of available resources (wind, sun, water, wastes, biomass, geothermal etc.)

5. Maximize the efficiency of buildings and of the territory as a whole

Settimo Torinese, only a few kilometers for the Piedmont regional capital of Torino was a typical industrial town. Although it has acquired a definite image of its own, it has always been influenced by Milan, its neighbor to the east. Several railroads cross Settimo Torinese, (both new and high speed,) as well as several vehicular thoroughfares such as the recently refurbished Torino-Milano highway. Settimo Torinese is an ideal portal towards Milan and a concrete gateway to new eco-city concepts.

1.b Parallel experiences under way: Milano CityLife, Sesto San Giovanni (Falck), Settimo Torinese (Green Tech Park, Laguna Verde)

CityLife is a project of redevelopment and requalification of the historic district of Fiera di Milano, signed by Pier Paolo Maggiora (Archa)1, Zaha Hadid, Arata Isozaki and Daniel Libeskind according to the guidelines of dialogue in architecture.

CityLife covers more than 250.000 sqms, and is located on one of the main growth thoroughfares of Milano, adjoining one of the most prestigious Milanese institutions, the Fiera. Situated next to several eminent Milanese districts, as well as the ancient network of Navigli waterways. CityLife could eventually prove to be a new city centre for Milan.

A major ambition for Milan is to regain a primary role in design experimentation, formal research and technology innovation. The environmental quality in Milan needs to be improved, which proves to be a remarkable effort. Heavy traffic and air pollution have to be contained in order.

Designing the transformation of the urban areas based upon an ecological strategy is the only feasible treatment. Upon specific analysis, the most significant environmental impacts have been pinpointed in order to devote specific care to them as major environmental targets. The project choices have been carried out with particular care to the following items:

1. Air
2. Water
3. Soil and subsoil
4. Noise and vibrations
5. Car traffic
6. Green system and eco-systems
7. Urban landscape

1 http://www.archiportale.com/progettisti/SchedaProgettista.asp?id=87013

The objective of emission reduction due to car traffic is addressed by optimizing the road network and conditions.

Emission reductions are obtained by containing fossil fuel consumptions, along with other solutions adopted for energy efficiency. The solutions combine a use of materials and technological ideas focusing on building insulation, which will be able to guarantee high light transmittance and low thermal transmittance. The materials have been chosen according to their reusability, with a priority to those materials with limited energy needs in the manufacturing cycle.

The technological choices have been oriented to the utmost degree of energy saving and recovery, among them heat pumps (air and water), methane cogeneration (CHP) systems, and photovoltaic systems.

2. A new district for an important Milanese suburban city: Sesto San Giovanni (formerly Falck steel mill) 2

The requalification of areas in the former Falck steel factory area in Sesto San Giovanni near Milano, is an ambitious new urban plan that will transform the town of Sesto, aimed (in Renzo Piano's project) at operating an "urban resewing" of parts of the town of Sesto San Giovanni so far divided by the railway and by the empty lots of the former Falck and Marelli industrial areas. Greenery is one of the distinctive features of Renzo Piano3's project.

The whole area, receiving a new population of about 15.000, is reclaimed to ensure the highest health standards, with specific attention to eco-sustainability. The area will be provided with an independent energy system adopting a precise strategy based on the use of local resources and the optimization of energy distribution. Groundwater is to be collected and filtered to feed heat pumps, biomasses produced by the Park and solar power will also be used; leaving the existing cogeneration plant to cover peaks of demand. This system of optimization of energy production and distribution plans to use trigeneration plants for the simultaneous production of electricity, as well as heat and air conditioning and tunnels feeding all the blocks along the main streets.

PIANETA4 (belonging to the utility group, Settimo-based ASM) has tightly cooperated with Buro Happold Ltd5 to help create an energy masterplan of the new urban area project by Renzo Piano Building Workshop

2 http://www.risanamentospa.it/upload/nenergiaOtt06.pdf ;
http://www.risanamentospa.it/web/start.asp?idLingua=2

3 http://rpbw.r.ui-pro.com

4 http://www.pianeta.eu/ITA/sesto.html

5 http://www.burohappold.com/bh/home.aspx

(RPBW) and the Physics Nobel Prize recipient Prof. Carlo Rubbia6. The aspects related to urban planning and construction were assessed by Risanamento SpA.

The heart of the old industrial town is to be rebuilt based on a new, sustainable model, in which energies are produced in several sites and in several ways, and distributed by means of a network aimed at balancing demand and offer. The incoming 40,000 inhabitants will have energy consumption per person estimated to be nearly half as much as the other Milano inhabitants. Consequently, the resulting new city is bound to grow more rapidly than elsewhere, because both people and companies will prefer a cleaner, more efficient and cost-effective city to live and work in. The energy masterplan envisions an on-site production of a major quota (more than 75%) of the energy needs (electricity, heating, cooling) by means of high performing, agile, small-scale energy systems, mainly based on the use of locally available renewable resources. The project aims at producing energy by maximizing resources, overall efficiency, and minimizing the environmental impact, noise and emissions.

The design of the overall energy system has been developed on the basis of the following objectives (generating from such keywords as flexibility, independence, modularity and innovation), aimed at developing innovative energy solutions in order to help meet modern standards of efficiency and savings required by law and by international protocols:

1. Minimising the environmental, dimensional, and economic impact of the installations
2. Energy independence and self-sufficiency, but at the same time compatibility and integration with existing neighbouring urban areas infrastructures (cogeneration plant, district heating)
3. Use of all existing resources within the site, both traditional and alternative/renewable
4. Efficiency and effectiveness of energy systems of production, distribution and use of energy
5. Reduction in consumption of fossil fuels and polluting emissions, as well as a commitment to continue researching innovative solutions
6. Flexibility and adaptability to fast-changing technologies

The method and the solutions used to address the above objectives have been as follows:

1. Implementation of good sustainable design principles
2. Efficient use of on-site resources, most notably groundwater
3. Not an exclusive energy solution for the site, rather a flexible mix of systems and scales
4. Groundwater extraction and heat pumps for heating and cooling of buildings
5. Extension of existing district heating system for warm water in buildings
6. New trigeneration energy centres for electricity generation, heating and cooling.
7. Building basement technology-rooms to minimise obtrusive roof mounted plant
8. Good passive design of buildings to reduce energy consumption.
9. Integration of alternative energy and renewable energy systems
10. Sustainable mobility
11. Environmental assessment schemes such as the Italian ITACA or US LEED to measure and score environmental performance for specific buildings.

6 http://nobelprize.org/nobel_prizes/physics/laureates/1984/rubbia-autobio.html

As to energy production, there is no exclusive, single solution for the site, but rather a mix of two or three main primary energy strategies. The energy strategy focuses on combining the most efficient use of existing opportunities (e.g. district heating and the cogeneration plant) with the use of distributed generation systems, mainly trigeneration plants and alternative energies, particularly groundwater coupled with heat pumps. An efficient use of resources will reduce both energy consumption and noxious emissions, the target being to reduce carbon dioxide emissions by 50%, compared to conventional heating, cooling and electrical systems.

Alternative energy systems can be implemented on a small-scale as a demonstration of new technology matched to a specific use, or on a larger-scale integrated into buildings. Solar systems mainly concern conventional solar thermal collectors, high intensity solar thermal collectors and photovoltaic solar cells. Conventional solar thermal collectors can heat water up to 80-100°C for use in sanitary water systems for washing or swimming pool heating. PVs generate electricity to export to the electrical distribution grid to balance demand for street lighting. High intensity solar thermal collectors using parabolic mirrors to intensely focus solar radiation onto oil-filled tubes can heat the oil to very high temperatures (500-600°C), and then generate electricity by means of steam turbines.

Biomass

Focus has been made on energy production out of biomass and organic waste from park maintenance "products" (pruning, chopping): drying and gasification allow for excellent energy recovery, as well as providing a viable solution to the problem of disposing of organic substances. In the longer-term, as the landscape matures, it is possible to take wood off-cuts from trees for use in wood burning boilers to generate hot water for heating, or to be utilized in a gasification or pyrolisis process to produce energy.

Hydrogen

Hydrogen is produced from either water in electrolyser using electricity, or from methane (in natural gas) in a reformer. Fuel cell technology is still developing and its possible applications range from mobility to stationary. An interesting application for the site is to use electricity from PV solar cells to generate "green" hydrogen and oxygen from water in an electrolyser. The oxygen can be used directly for purification of the groundwater, and the hydrogen combined with air, in a fuel cell to regenerate electricity.

Hydrogen will be used to experiment sustainable mobility in the new district of Sesto based on the use of hydrogen as fuel for motor vehicles (SHMS, Sesto Hydrogen Mobility System). The project envisages the creation of filling stations (SHRS Sesto Hydrogen Refuelling Station), and the means of transport7 (buses and scooters like the Torino Environment Park's one) based on fuel cell technology.

7 http://www.iaad.it/eng/gallery/gall_07/FormulaHYSY_gara_eng/index.html
http://www.envipark.com/index.php?option=com_frontpage&Itemid=1

A hydrogen motorcycle and a fuel cell, both conceived and implemented in Piedmont

The objective of the SHRS is to produce fuel (hydrogen) mainly for local public transport. The SHRS are implemented using the state-of-the art production and storage technologies. The supply section in the Falck project includes a 350-bar dispenser for the hydrogen supply of buses.

Hydrogen produced out of water electrolysis, like in two paradigm projects8, was realized by Pianeta in Settimo Torinese in 2005 for an ASM office building and in Cesana for the Winter Olympic Games ("Primo Settimo" and "HighHy", see box below), in tight cooperation with the Regional Government of Piemonte.

8 http://www.pianeta.eu/ITA/primo_settimo.html; http://www.pianeta.eu/ITA/h2006.html

In "Primo Settimo", the first integrated energy plant in Italy designed for the production, storage and use of "green" hydrogen in an office building, the hydrogen power plant is utilized to give Energy to the parking lot of ASM office building.

Electricity is produced by 2 PEM hydrogen fuel cells. Hydrogen is produced during day hours by an alkaline electrolyser (utilizing a green 70 KW Photovoltaic system) able to generate 200-bar hydrogen to be then stored.

The target of Primo Settimo is to store energy produced during day hours by electrolysis transformation into hydrogen, and to utilize it at night hours, in order to light the parking lot. Production and utilization of hydrogen are not contemporary: during the day hydrogen is produced, at night the fuel cells operate. This system was created to generate clean energy for stationary use and, at the same time, to supply hydrogen for future fuel cell vehicles. The system was designed by Pianeta and ASM to also become an open-air laboratory for research activities for innovative technological solutions to be applied to the hydrogen supply chain (production, storage and use), together with Politecnico di Torino Polytechnic University and Regione Piemonte.

"HighHy", a smaller-scale hydrogen stationary energy production plant, was developed by Pianeta and ASM for the 2006 Torino Winter Olympic Games on the same basis as "Primo Settimo", in the "Olympic mountains" of Cesana Torinese.

2.b Settimo Torinese: the R&D archipelago Green Tech Park, a new territory for the experimentation of energy innovation in Piedmont, northern Italy

Piemonte, in northwestern Italy, borders Switzerland to the north, France to the west, the valley of Aosta to the northeast and Lombardia (whose main city is Milano) to the east. To the southeast it borders on Emilia Romagna and Liguria to the south. The Piedmont Government has been investing a lot on the new challenges of clean, sustainable energy. In particular, on 24th May 2008, the President of the Piedmont region, Mercedes Bresso, announced the beginning of the "Piedmontese energy oil independence war", promoting and signing the "manifesto for the petrol energy independence"[9]. Said manifesto, begins with a proposition that states, "in order to reduce energy dependence from fossil fuels, it takes an extraordinary collective, daily commitment", and points out that "Piedmont has decided to accept the challenge by investing on renewable energies, energy saving and on sustainable technologies in order to secure a future to our sons, with a collective commitment of the whole population". In order to concretely become "the Italian ecological engine" a concrete, everyday commitment must be taken by everyone from now to 2020 in order to quickly abide by the EU targets (aimed at maximising production from renewable sources, enhancing energy saving and production of biofuels not derived from food sources but out of cellulose and wood, and dramatically curbing the greenhouse gas emission). The goals pointed out by Regione Piemonte as mandatory ways to achieve the European targets, are listed below:

1. To enhance renewable energy sources and overall energy saving
2. To design houses and workplaces able to self-produce heat and electricity, granting comfort and respect for the environment

9 http://www.regione.piemonte.it/energia/images/stories/dwd/manifesto.pdf

3. To support research and enhance energy savings and self-production
4. To use public means of transport, as well as highly efficient, non-polluting vehicles
5. To support an agricultural production looking after ecological values and the resources locally available
6. Upbringing the younger generations towards a more sober, rational and fair energy culture
7. To give everyone a real chance both to draw on, as well as to input energy by an open and widespread grid network, in which everyone is a producer and a consumer in the meantime.

In Piedmont, particularly in some areas of Torino and in the suburban territory immediately northeast, there are already initiatives and realizations to be accounted for. Projects devoted to innovation and agile energy systems aimed at distributed generation, such as:

-Energy recovery out of biogas in an AMIAT[10] garbage dump in Torino and in a SMAT[11] purifier site (the largest chemical-physical-biological treatment system of waters in Italy).
-Small-scale hydro electrical and PV systems in the Environment Park[12] building
-Medium-sized co-generation plants in Torino, Settimo Torinese and Chivasso as well as district-heating grids, both realized by SEI (ASM Group)
-Medium to big-scale fuel cells production by Siemens[13] in Torino
-Medium-scale fuel cells production by EPS Electro Power Systems[14] near Torino
-PV plant[15] for gas boxes, realized by PIANETA
-Three-generation system with a PV system and microturbines integrating the first plant for production, storage and use of hydrogen in Italy, in Settimo Torinese, realized by PIANETA for ASM Settimo Torinese[16]
-Microturbines, as well as other realizations, mainly in Settimo Torinese.

Within this framework, the Settimo Torinese town administration, a Piedmontese town with a population of 50,000, adjoining Torino and 80 miles from Milano, has been actively and proactively working for at least the last 5 years.

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10 Company for the complete waste treatment, disposal and recovery cycle;
http://www.amiat.it/pagine.cfm?SEZ_ID=23

11 Company leader in the field of integrated water services;
http://www.smatorino.it/area_istituzionale_eng?id=1

12 It provides innovative solutions in the fields of energy/environment;
http://www.envipark.com/index.php?lang=en

13 http://webdoc.siemens.it/CP/PW/ProdottieSoluzioni/PowerGeneration/CelleaCombustibile/default.htm

14 Company for the production of fuel cells running on pure hydrogen, natural gas, LPG and, ethanol, for back-up and stationary use in general. Based in Torino (Italy), it is an established player in the fuel cell systems sector having developed and commercialized the Electro7™ power system. Electro7™ is the first multi-output fuel cell system for business continuity applications and provides 100% clean power with virtually unlimited autonomy. www.electrops.it

15 http://www.pianeta.eu/ITA/sunjump.html

16 http://www.pianeta.eu/ITA/primo_settimo.html

In the suburban area North-East of Torino, an innovative energetic pattern has been developed, actively promoted by Aldo Corgiat Loia[17], Mayor of Settimo Torinese. A pattern arising from experiences and vocations existing in the territory, but not thoroughly structured yet before: the one regarding the renewable sources and the agile energy systems.

The model for the energy innovation network is implemented on a wide suburban area surrounding Torino pivoted on Settimo Torinese. A model developed by Pianeta with many Municipalities, with the Municipality of Settimo Torinese and Mayor Aldo Corgiat Loia as a leader and promoter, called "Green Tech Park". The target of the Green Tech Park is the implementation of new energy paradigms, starting from the territory, local resources, existing cultures and experiences.

The pattern being developed on the wide area is the energy web: a network of sustainable energy paradigms, differentiated by technology and by application, where each and every knot of the network is able (like the internet, peer-to-peer) to be a producer and a user at the same time; all of it on an environmentally-correct background (a new park "Grande Parco 2011" crossing the towns being part of the Clean-Tech Park), and getting more momentum out of its proximity with the Olympic city Torino, a city able to guarantee a proper welcome to possible visitors. The CTP, growing as an "open-air" laboratory and living energy museum.

Energy is seen as a concrete development factor and not as a mere environmental opportunity. An entrepreneurial development, too, and consequently, again, a renewed territorial plan. Energy as an occasion to match the development needs of economy with the environmental sustainability of territory. Energy opportunities are designed and implemented in each and every form on the whole surface of the territory, in the form of an "archipelago-like" technological park (Green Tech Park) characterised by a manifold system of production "isles". In the Green Tech Park a rich open-air catalogue grouping the newest technologies - as far as renewable and new "intelligent" forms of energy are concerned - is experimented and permanently displayed and exhibited, in order to further nurture the "knowledge society". The use of resources locally available must be made on the base of the capacity to integrate different innovative technologies into a network able to guarantee their overall governance and control.

One of the main objectives of the Green Tech Park (CTP) project led by Settimo Torinese on the suburban area, is to create a widespread but consistent and coherent set of sustainable energy realizations based on the integration of different, highly innovative paradigms of energy production, distribution and management.

A set of energy "isles", good practices of energy efficiency and innovation, integrating technologies like, as mere examples:

17 Mayor of Settimo Torinese since 2005, formerly Chairman of the Utility Company ASM Settimo

1. Photovoltaic systems, thermal solar systems
2. Cogeneration (microturbines, natural gas endothermic engines, hydrogen fuel cells)
3. Mini/micro wind systems
4. Ground/water heat pumps
5. Small hydroelectric systems, geothermal systems for electricity
6. Waste/biomass gasifiers
7. Fuel cell-based backup systems, stationary hydrogen plants

2.c The use of sustainable, renewable resources, and the implementation of new technologies and sustainable practices in Settimo Torinese as a sustainable town

Some of the planned, under way, or realized projects in Settimo Torinese are as follows:

8. **Recovery of energy out of fragmented waste treatment, treatment and recovery of energy out of urban solid waste, biogas, organic waste, biomasses, photovoltaic plants (small-scale to big PV plants), heat pumps, small hydro systems, mini wind systems**

9. **New urban blocks and factories designed according to bioarchitectural principles, energy/environmental sustainability**

10. **Low-cost eco-friendly new houses, which use active and passive technology, in order to transform the building into a bioclimatic engine**

11. **Valorisation of public buildings, according to the principles of ecosustainability (bioarchitecture and production plant efficiency)**

12. **New regulatory systems: innovation in the sets of rules concerning the building and planning systems, energy certifications**

In this way, the Municipality of Settimo Torinese is leading other neighbouring Municipalities to follow suit. It is bound to become an incubator of new initiatives (both public and private) and of case histories connected with eco-energies and the eco-sustainability of buildings and of towns: the creation of a new energy culture based on local experiences.

A word must be spared on the project of a new set of rules, being approved by the Municipality of Settimo Torinese and by other neighbouring Municipalities, aimed at enhancing good, ecological, energy-sensible practices: a regulatory document dealing with the requirements necessary for the "eco-energetical" and "bio-energetical" certification of buildings, as well as with incentives to be given out to good realized practices (both active and passive technologies).

PIANETA (see box below), an energy service company based in Settimo, has become a major ingredient of the "sustainability recipe" in Piedmont (in tight cooperation with the Municipalities), the engine for the development of challenging projects aimed at sustainable communities.

PIANETA (www.pianeta.eu) is an all-round energy-saving company, focused on ecosustainability of buildings, districts and cities: energy self-sufficient, cost-effective buildings, districts and cities

As the cook turns to ingredients of the territory, so PIANETA prepares its own energy production systems and passive solutions basing its efforts upon the renewable energy resources that the territory offers.

Pianeta is entirely focused on design, implementation and management of agile energy systems based on global sustainability and all-round efficiency. An energy system is "agile" when it can satisfy several energy needs in different sites, utilizing the resources immediately at hand on-site and the optimized mix of high-efficiency energy technologies. The agile energy systems of Pianeta provide different quantities of energy (from Kws to Mws of electricity, heat and cool) using natural, renewable sources (sun, wind, water, geothermic) locally available. Pianeta's agile energy systems grant self-sufficiency to buildings, housing and commercial estates, industries, new city districts, new cities...and whatever urban area seeking cleaner and more efficient energy solutions. Pianeta produces energy where and when necessary, wastelessly, efficiently, effectively, in the amount needed: a company specially devoted to design, realize and manage small, innovative energy plants as compared to the traditional, big energy plants, integrating the most innovative technologies for the employment of the best, sustainable source to fit in project. Right from the beginning of its existence, Pianeta has contributed to bridge the gap between University labs and the market, in many fields of renewable energies, being the first in Italy, for instance, to design and implement plants for H2 out of renewable resources (Primo Settimo and HighHy, which have contributed to define the Torino 2006 Winter Olympics as "the first hydrogen Olympic Games").

Furthermore, Pianeta has been working on the assumptions that:

1. ***architecture must save natural resources (water), regenerate natural resources (O2), and minimize CO2 production; a building basically mustn't consume energy, it must produce it, utilizing renewable sources (sun, water, wind, motion) and minimizing wastes (to be used themselves as an energy source);***
2. ***the best green, clean energy is the one we neither produce nor use***
3. ***energy efficiency is a synthesis between sustainable production and its sustainable use, and between active and passive technologies***
4. ***the building is a machine that shouldn't consume resources and energy, but rather saves and produces***

1. "Laguna Verde": a new eco-town of the future in Settimo Torinese, from dream to reality

A very important example of a global sustainability project, consistent with (and inside) the Settimo Torinese Green Tech Park, is a new, daring, green-field development district of Settimo Torinese (a new area, a little eco-city – formerly an industrial district in Settimo Torinese – nearly as wide as 1 million sqms in a suburban area of Settimo, some 10.000 fresh inhabitants, University, high tech R&D Companies) called "Laguna Verde" (Green Lagoon).

Innovation, environment sustainability, project and architectural dialogue, are the main elements that make this new urban centrality in Settimo one of the most important requalification projects.

Settimanale Milano — Sole 24 Ore Edilizia e Territorio — 29-SET-2008

Diffusione: n.d. Lettori: n.d. Direttore: Ferruccio de Bortoli da pag. 11

INIZIATIVE Pronto lo studio di fattibilità redatto da Pianeta sull'insediamento di Settimo Torinese

Laguna Verde, obiettivo impatto zero

Il progetto di Maggiora per l'area dismessa consumerà solo l'energia auto-prodotta dagli edifici

Above: some articles on Laguna Verde: main Italian economy daily newspaper "Il sole 24 Ore," Settimo Torinese's Laguna Verde case history and interview with the Mayor of Settimo Torinese Aldo Corgiat Loia, May 2008; "L'Arca", international magazine of architecture, design, and visual communication, an article about Settimo Torinese's Laguna Verde (July/August 2008); "Il Sole 24 Ore", 29 Sept.2008

1. Laguna Verde

Settimo Torinese mayor Aldo Corgiat Loia and architect Pier Paolo Maggiora created the guidelines for Laguna Verde according to his vision of a sustainable community (see Green Park). The design was outlined by Pier Paolo Maggiora's ArchA, along with the cooperation of eminent experts in various fields of sustainability. The challenge being to create a new concept of a town not merely out of an architect's pen, but instead out of a dialogue realized by a heterogeneous yet coherent team of specialists of different topics, bearers of different cultures and experiences.

The sustainable energy project will be characterized by the newest and most innovative technologies for "passive" building performances and energy production, as well as resource savings, water reuse, photovoltaic and microeolic systems, "green" H2 production, and agile energy systems.

The total surface area covers over 815 sqms and, at the end of the operation, will offer 320 sqms of public green space, a 60 sqm "island" for R&D and high education, sports facilities, a swimming pool and a museum (about 55 sqms), as well as a high-level, innovative energy-efficient housing estate.

1.a. Structural Details

The structure itself explains the name Laguna Verde (Green Lagoon). Some compact islands will be developed (16 just for the residential part); they will emerge from a lagoon made of parks and gardens below: a "natural", horizontal level of greenery (integrated with an artificial vertical garden and parking lots with technological plants hidden inside) in continuity with "Tangenziale Verde"[2] ("Green by-pass") north of Torino, a green area extending on several million sqms, with the Torino hill park leading to Superga, and the river Po.

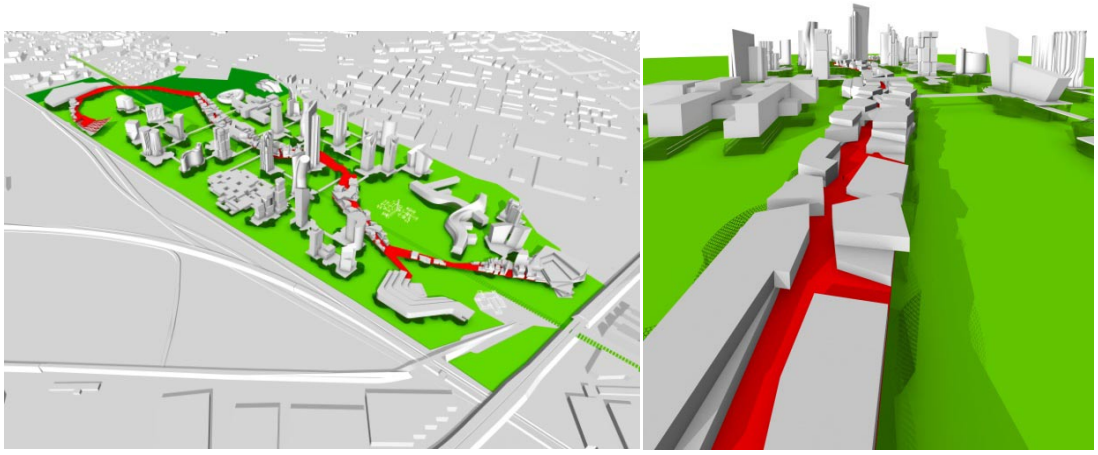
All the buildings will be elevated from the ground and connected and highlighted by a large suspended central avenue fraught with public and private functions so that the existing greenery below can live alongside the structures instead of being interrupted and removed.

The investment will exceed 1.3 billion Euros (net worth of the property),** and is expected to rise another 20-40% thanks to the solutions chosen to obtain the maximum environmental sustainability.

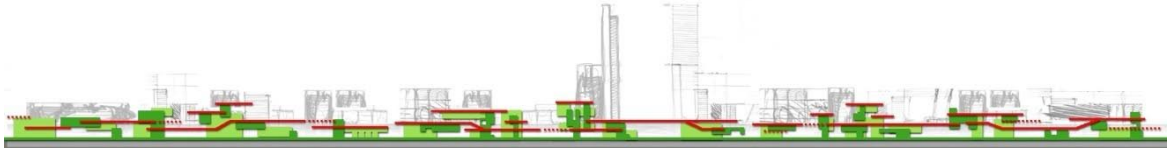
In Settimo Torinese, the Laguna Verde project will transform a significant portion of the city by radically transforming the existing district into a futuristic eco-city. The eco-city will be totally elevated and characterized by tall towers and an overall care for the environment. This is possible thanks to a concrete cooperation between public owners (municipality), and private owners (manufacturers and real estate companies) in the creation of a newly registered company.

Innovations have also taken place on the administrative level as a result of the size of the transformation. Both the municipality and the private enterprises emphasized the their ambition to do so, as a project of this size with such limited time schedule has so far been unparalleled in Italy.

From dream to vision to reality, Laguna Verde in Settimo Torinese is becoming more real every day… Progress is already visible in a big portion of the city thanks to the quick and affective approval by the Settimo Torinese city council.



2. Global Sustainability, Resources, and Technologies in Laguna Verde, Settimo Torinese



Laguna Verde in Settimo Torinese is one of the most ambitious projects of urban renovation, both in terms of volume and conceptual difficulty, in Italy. It is developed on a surface of about 1 sqKm along one of the main Settimo avenues, Via Torino. This area is home to many public and private properties such as a tire production plant, which will be relocated (and is bound to become the most innovative tire production plant in the world) to another district in Settimo Torinese itself.

Laguna Verde was inspired by the principle of Global Sustainability and confirmed a multi-dimensional vision and approach. ArchA experts break down sustainability concepts into 5 main issues that must all interact:

1. Natural-ecological and environmental sustainability-defining the best equilibrium of relationships of natural environmental spaces (as well as resources: water, greenery, soil) with the spaces of human-built artificial environment in order to guarantee a compliment between human and non-human, inner and outer environments.

2. Anthropological/ Cultural sustainability- i.e. the dynamic continuity between culture and habits through well-balanced growth processes and a gradual progressive change. The change is needed in order to define the identity of emerging open cities that are connected with the world while being wisely deep-rooted in their own territory at the same time.

3. Sociological/management sustainability- or the governance of the city in order to favor qualified and highly skilled government practices.

4. Architectural/urban planning sustainability- the quest for a perceptive harmony, overall consistency, ability to recognize, accuracy, and style.

5. Economic/financial sustainability- concerning the necessary investments for the start up as well as all the resources the new city can acquire thanks to its overall attractiveness. The new city will attract investments, enterprise settlements, new services, and the growth of new productive and service activities with the consequent generation of wealth and added value.

Laguna Verde is defined through a pattern of urban structure characterize by a high overall sustainability. The concept designed by Pier Paolo Maggiora and his team of experts, takes up the idea of open source and global architectural dialogue.

The actual structure involves the clustering of built areas of compact blocks. These blocks are essentially islands surfacing in a green lagoon, and that are made up of parks, gardens, and green areas (two thirds of the whole area is available for greening).

In the "public city" sector, it has been planned that a whole "island" should be devoted to University research and higher education.

The research project developed by the Polytechnic University of Torino, Politecnico is certainly one of Laguna Verde's main structural strengths. In terms of architecture and technology, Laguna Verde is a new urban sight into the future. The idea of research derives mainly from recent agreements signed with Pirelli for the development of innovative production technologies for "intelligent tires," and aims to create a Polytechnic Citadel based on keywords like education, research, industry, with the University and Municipality as primary players.

According to the Dean Francesco Profumo of Politecnico of Tornia, "considering the situation of fossil fuels, whose costs can stop rising, it is more and more strategic to focus on R&D and the realization of sustainable processes and products. Accordingly, and important project like Laguna Verde can't be conceived without being based on environmental sustainability and eco-friendliness."

*** deleted next few paragraphs…

The ecological city has to rethink its 3 crucial subsystems: production of goods and services, construction, and mobility. Every subsystem must be able to cooperate with others, so as to utilize its own wastes as active inputs, transforming them into useful inputs for all components of the system. The objective is to give a concrete distinctive sign to the entire Torino metropolitan area characterized by a high relationship density, similar to Milano and Geneva. Laguna Verde physically and conceptually links Torino with Settimo Torinese, as well as Torino with Milano, assigning a new value to the anthropic settlement, a value which is not based on gross floor service or volumetric index of area, but rather on urban and building quality and to correct energy management of the new area, a district meant as a non-energivore, highly efficient organism.

Laguna Verde will use a wide range of renewable sources as a distinctive trait, along with the rational use of energy and an intelligent management of energy demands. An 8/10.000 people district (eco-city) like Laguna Verde, if based on traditional energy habits, can produce as much as 32 tons of CO2 per year, as well as hundreds of tons of pollutants in gaseous, liquid, or solid state on a relatively small territory, Besides the consequences on quality of life, it is possible to directly interrelate such emission levels with public health expenditure, which increases exponentially in urban centers more densely populated.

The design of the Eco-City aims at planning not only the infrastructure/building system, but also the development of enough greenery to act as a "lung" to absorb CO2 and thin dusts.

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Laguna Verde utilizes hydrogen-powered motors for public transport (integrated mini fuel-cell for buses, shuttles, etc.), electricity-powered motors fueled by photovoltaic energy from systems integrated in infrastructures and in vehicles themselves, by “archiwind” systems homogeneously distributed in the eco-city where small-scale aerogenerators are integrated in the means of transport as well as in the streets, in order to obtain a constant balance between produced and demanded energy for mobility; 75% of energy needed for transport is renewable.

The kinetic energy out of motion and pulses produced by the vibrations of vehicles is captured and transformed into electric energy by means of a dense network of dynamo-switching sensors. These are properly distributed on the moving structures, which are able to transmit the captured energy, switch to conversion and rectifying systems and then to the electric grid.

3. Energy Production & Consumption

Every resident in Laguna Verde is a producer of his own needed energy: a little, but valuable engine of the new urban energy economy. The electric grid and the district-heating network play the role of giant accumulators, nurtured by the users themselves; the residents and their building become the main local energy producers. The TS/C (transmitting surface/conditioning) ratio of buildings is thoroughly studied for that climatic zone, with slight adjustments basing on the size of buildings and the use they are zoned for. The shape of buildings arise from their zoned use, their function in the general settlement organism, the natural peculiarities of the surrounding environment as well as, first of all, the climate conditions in that specific area.

1. Every residential/service building-plant system, doesn’t consume more than 25 KWh/sqm/year (PEYD Primary Energy Yearly Demand).

2. Every factory’s building-plant system (excluding productive process energy) doesn’t consume more than 35 KWh/sqm/year (PEYD Primary Energy Yearly Demand).

3. Every residential/service building produces between 25 and 40 KWh/sqm/year of electricity from renewable sources (primarily sun and wind), from treatment of wastes (small scale gasifiers and batch gasifier systems or plasma converters), from small cogeneration and trigeneration, and as far as thermal energy is concerned, latent heat/cool accumulators, etc.).

4. Every residential/service building emits 90% less CO2 and other green house gases, as well as 90% less thin dusts and noxious nano particles.

3.a. Water

At an urban level, a sustainable, eco-friendly management of water aims at eliminating tapping into deep level underground water, in order to preserve the quality and to guarantee its equilibrium. This is a fundamental step towards the reduction of subsidence and the preservation of a water reserve useful for

the supplies. This implies a recourse to the use of surface waters, taking place by restoring and ensuring a minimum vital flow in rivers and in the secondary waterways, a condition to safeguard the water life, as well as to guarantee a refill of the underground waters. As to waterproofing, particular attention has been devoted to compensate the effects of building. Instead of collecting rainwater directly into the sewage system or surface waterways, a design has been created to install a system of catch-basins of rainwater collecting loglines. This is modeled after the natural process of rainwater collection ensuring the regeneration of groundwater. Every residential/service building or factory picks the meteoric water, selects the first rainwater in controlled pools and recovers it for non-drinking uses. The first rainwater undergoes treatments of de-silting and filtering, and is recovered for watering and washing chores; 100% of water used by Laguna Verde is recovered after its use.

Everything in the new eco-city including the shape of residential and service sector building units as well as the development of transport lines etc, arises from the on-site energy flows, in order to eliminate the creation of urban heat islands.

3.c. Wind

The morphology of urban settlements will harness the wind directions inward, pushing towards the points of exploitation.

Small energy systems, aimed at a complete integration and "fusion" into the architectural elements will be employed. For instance, tiny wind turbines in recycled, light and cheap plastic whose diameter is around 25 centimeters are placed in sequence to produce small quantities of electricity which can satisfy the home demand for green, clean energy, at zero cost. Advantages include the fact that such systems get actuated by winds as weak as 2 meters/sec, and keep working for 80% of time. Compared to a traditional alloy mini wind system, the plastic type has an 80-90% lower production cost.

3.c. Solar

In Laguna Verde, new experiments aim at a concrete lowering of the production costs, experimenting some areas photovoltaic silicon-free technologies and relying on new materials and new methods for the production of electricity. In the buildings, new solar technologies will be employed, jointly with traditional silicon-based ones. A 3rd generation of solar cells, completely integrated into the building structures are obtained through print on thin, flexible material of nanoparticles in an alloy of copper, indium, gallium and selenium (CIGS: their efficiency is the same as the silicon ones, but their cost adds up to about a fifth); this technology can take the production cost of electricity as much down as to 99 cents USD. This is less than fossil sources fuels like coal, and of thin films now on-market (whose cost is around 3,55 USD/Watt). Integrated in the "intelligent skins" of the buildings, Laguna Verde will experiment technologies normally used on solar-powered space stations, such as multi-junction solar cells combined with a solar concentrator under the name of CPV. In these kinds of cells, the concentrator is the size of 1 square centimeter and is able to generate the same amount of energy as 500 square centimeters of traditional solar cells. This new technology can greatly reduce the production cost of electricity out of renewables, and is a fundamental step towards the achievement of one of the main objectives of the project "High Performance PV" by the US Department of Energy, that is to say the development of solar cells able to turn more than 33% of the sun energy into electricity.

CPV or XCPV technologies can be completely integrated into the architectural shape. ***They are designed to let the sunlight pass through the connection joint between the modules and between the single concentration cells. In most cases, modules are matched with exchangers, in order to absorb the excess heat. The micro-systems are activated by means of sensors detecting the temperature of the inner face of the modules. When it exceeds 45°C, a junction box actuates micro exchangers in order to lower the temperature within limits and to recover the excess thermal energy. Therefore, by keeping the concentration modules' temperature within the optimal values, it is granted the constant utmost efficiency of the system. Furthermore a "cool" layer gets created, which, along with the dehumidifiers, helps to alleviate the need for air-conditioning.

3.d. Geothermal

Consequently, geothermal systems will use the free, renewable energy available to save up to 70% on heating, cooling, and hot water. Geothermal heat pumps (sometimes referred to as GeoExchange, earth-coupled, ground-source, or water-source heat pumps) have been in use since the late 1940s. Geothermal heat pumps (GHPs) use the constant temperature of the earth as the exchange medium instead of the outside air temperature. This allows the system to reach fairly high efficiencies (300%-600%) on the coldest of winter nights, compared to 175%-250% for air-source heat pumps on cool days. While we normally experience seasonal temperature extremes—from scorching heat in the summer to sub-zero cold in the winter—a few feet below the earth's surface the ground remains at a relatively constant temperature. Depending on latitude, ground temperatures range from 45°F (7°C) to 75°F (21°C). Like a cave, this ground temperature is warmer than the air above it during the winter, and cooler than the air in the summer. The GHP takes advantage of this by exchanging heat with the earth through a ground heat exchanger. As with any heat pump, geothermal and water-source heat pumps are able to heat, cool, and, if so equipped, supply the house with hot water. Some models of geothermal systems are available with two-speed compressors and variable fans for more comfort and energy savings. Compared to air-source heat pumps, they are quieter, last longer, need little maintenance, and do not depend on the temperature of the outside air. A dual-source heat pump combines an air-source heat pump with a geothermal heat pump. These appliances combine the best of both systems. Dual-source heat pumps have higher efficiency ratings than air-source units, but are not as efficient as geothermal units. The main advantage of dual-source systems is that they cost much less to install than a single geothermal unit, and work almost as well.

The building shell, as well as shingles and sunscreening/shading systems, won't play the sole role of skin of the architectural organism, but also that of an energetic interface through the integration of systems for the production and the distribution of energy.

Other Remarks

The town of the future, Laguna Verde eco-city in Settimo Torinese, goes along with natural resources and uses them without abusing them. Laguna Verde is meant to be a living organism. Urban greenery must be read in the new eco-city as an "ecological complement of the building". The areas underneath the buildings are characterized by widespread greenery illuminated by an innovative system of sunlight transport through micro solar tubes. The eco-friendly design approach aims at the improvement of the global

ecological quality by means of actions like microclimatic regulation, integration between natural elements and built elements, as well as the production of work and of eco-friendly economies.

Laguna Verde in Settimo Torinese realizes new inner ecosystems through the creation of horizontal and vertical phyto-purifying areas, which favor biodiversity as well as water recovery, green areas at the foot of Laguna Verde, decorative green vertical areas integrated with intelligent skins in tall buildings, for the creation of passive greenhouses and vertical winter gardens.

Laguna Verde in Settimo Torinese is bound to become the town of recycling and of global sustainability: Laguna Verde, as said, transforms local natural sources (sun, wind, motion, wastes, thermal differential) into electricity, hydrogen, gas and heat, matching active technologies with passive building organisms, so as to make up a self-sufficient, low-emitting, 100% sustainable system.

3.e. Waste Management

Laguna Verde can draw a concrete advantage out of waste as well. Laguna Verde will only produce only 25.000 tons/year of urban solid wastes in residential areas. A recycling/reuse system for urban solid wastes grants a reuse of up to 70% of the waste produced by means of home separators integrated in the building, as well as small-scale systems for the treatment of human waste as well as energy production systems out of all the remaining wastes. It is then possible to produce syngas (and therefore energy out of it) from waste, in every building or block, aiming at the utilization of 100% of unrecyclable wastes.

As the price of oil and other energy resources rise, waste products, normally considered as mere costs and a nuisance, have become a valuable resource that can no longer be ignored. Energy from waste not only reduces our reliance on fossil fuels such as coal, oil, or gas, but it also reduces the amount of land used for landfills. Waste can be economically used to produce heat, electricity and other usable energy forms for industrial and domestic use.

Every district/housing system will be equipped with a mini plant for waste disposal/treatment, whose technology, rather than based solely on incineration, aims at experimenting new energy production processes.

The recovery of energy from waste materials after their gasification is already a well-established technology. The most promising use for waste-produced energy is in the generation of electricity. High-pressure steam can be used to drive a turbine in order to generate electrical power, an efficient and well-proven technique.

The solutions for energy recovery from the syngas, largely depend on the kind of energy needed:

Burn the syngas for heat 95% thermal 0% electricity

Burn the syngas for steam turbine 70% thermal 15% electricity

Engine for electricity 50% thermal 37% electricity

Fuel cell 35% thermal 55% electricity

The amount of energy that can be recovered from waste depends on the type of waste, its moisture degree, and the caloric (BTU) value. For example, a plant with 60 tons of typical MSW (Municipal Solid Waste) per day is capable of producing 1 to 2 megawatts of electricity or 4 to 8 tons per hour of steam. With industrial and bio-waste or oily absorbent waste and tires, which are drier and have a higher caloric value, the value of the recovered energy may be significantly higher.

Compared with traditional incinerators, the energy efficiency is higher (more than double the amount), especially if syngas are utilized in high-performance plants and/or a combined cycle (after treatments to eliminate remaining traces such as dusts, heavy metals, tar), while gas emission is very low.

Conclusion

Sustainability is an objective to be attained, at all costs; not an easy target, but a feasible, realistic one. A parallel, much bigger, twin project with Settimo's Laguna Verde, is about to start in China, arising from similar premises and guidelines as Laguna Verde's, though on a completely different scale: eco-sustainability and dialogue in order to build a new, innovative and livable city of the future, based on its own natural resources.

The project is CAOFEIDIAN[4], located 80 kilometers south of Tangshan. A great endeavor, a major challenge, and a most important step towards the concrete realization of global sustainability in a big city: from Settimo Torinese's Laguna Verde small ECO-TOWN to Tangshan's Caofeidian big Chinese ECO-CITY.

What better opportunity than a new, green-field city like Caofeidian, to conceive the most innovative, 100% ecological, renewable city, conceived starting from its energy needs and the resources of the territory?

A new city of the future, whose challenge (and opportunity) is to derive its energy needs from what the territory can give: wind, sun, tidal movements, sea waves and streams, geothermal, wastes.