HOME

Tools for energy balance analysis concerning building production cycle

Arianna Dongiovanni
SiTI - Istituto Superiore sui Sistemi Territoriali per l'Innovazione (Italy)

Torino, May 25, 2007

International Workshop
Energy Management Systems

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She is graduated at Politecnico di Torino in Engineering for Environment and Territory on 2004. She was employed at Sistemi per la Meteorologia e l'Ambiente, working on design on new technology machineries for environment monitoring. Since 2005, she joined to SITI (Research Institute for Innovation on Territory System). Her main activities are setting on innovative technologies for territorial planning and cooperation in the drafting of Management Plans for UNESCO sites.

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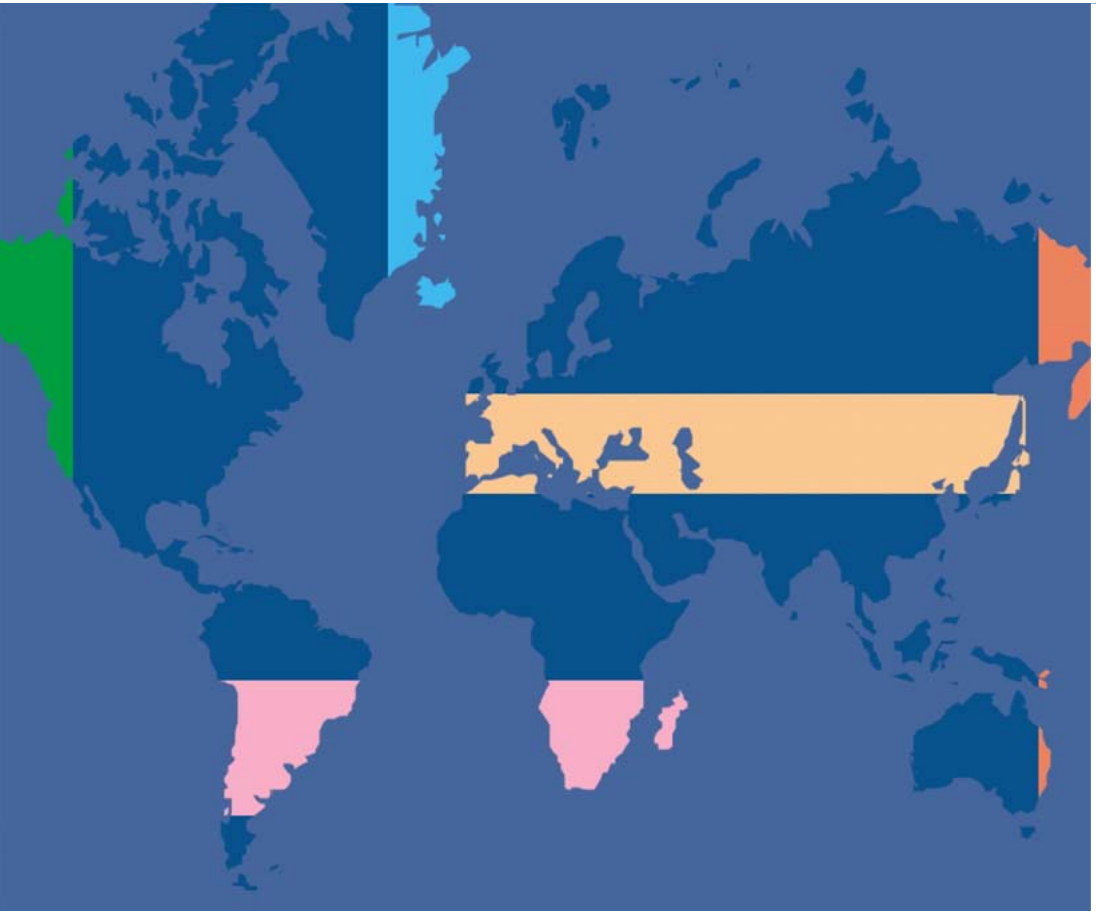

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SiTI (Higher Institute On Territorial Systems for Innovation)- is a not-for-profit organisation, set up in 2002 by the Politecnico di Torino and the Compagnia di San Paolo in order to produce research and higher education on innovation sustainability and socio-economic growth.

The Institute is a permanent organization of the Compagnia di San Paolo.

The research activity, highly interdisciplinary, is carried out mainly by professors and researchers of the various Departments of the Politecnico.

SiTI is an integrator of competences and bridges the gap between innovation and territory.

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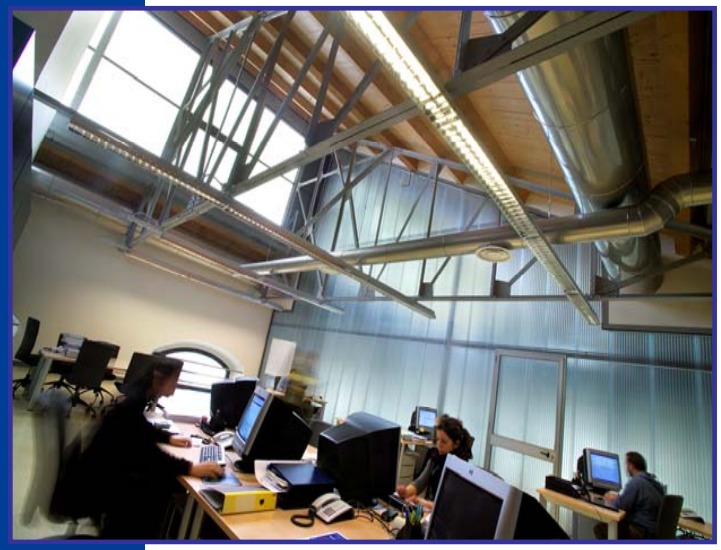
The applied research is focused on highly strategic and innovative projects supporting economic development, environmental safeguarding, valorisation of the environment, architecture and cultural patrimony, and their fields of application, sustainability and quality of life and it aims at the development of methodologies for the solution of actual problems. The knowledge and experiences thus acquired are made available to the community.



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SiTI's research activities are focused on six theme areas:

Case study 1: ATC real estate

Formulation of a procedure aimed at improving the monitoring of Energy, Structural and Maintenance issues concerning ATC(*) real estate

GOALS

Assess the conservation state of a sample (constituted by 50 buildings)

Constitute a computerized implementable database

Give guidelines concerning periodic upkeep plans

STRUCTURE

ENERGY ANALYSIS

SHELL ANALYSIS

UPKEEP ANALYSIS

BUILDING PROFILE

DENER
Department of Energetics

Prof. Marco Filippi
Prof. Stefano Corgnati

Summary paper

DATI GENERALI

IDENTIFICATIVO SOPRALLUOGO

Squadra | Scheda n. | Data rilievo (giorno mese anno)

IDENTIFICATIVO EDIFICIO

Comune: TORINO | Istat Com.
Quartiere | Edificio
Complesso | n° di edifici | esam.
Via: via Arquata
n° civico | interno | Lettera
Riferimenti catastali
Foglio | Particella

FOTO

DESCRIZIONE EDIFICIO

n° di piani totali | Altezza di gronda (m)
piani fuoriterra | Sup. media lorda di piano (m^2)
H. media di piano (m) | Tipologia del tetto

ETA' DELLA COSTRUZIONE - INTERVENTI PASSATI

Classi di età		Inteventi		
Prima del ' 19	A	nessuno	0	Classe di età di costruzione
19 - ' 45	B	ampliamento	1	
46 - ' 60	C	sopraelevazione	2	Classe di età ultimo intervento
61 - ' 71	D	ristrutturazione	3	
72 - ' 75	E	risanimento	4	Tipo ultimo intervento
76 - ' 80	F	rip. antisismica	5	
dopo ' 80	G	mancanza dati	6	Priorità miglioramento antisismico

PRIORITA' DI INTERVENTO: PRIORITA' 1 | PRIORITA' 2 | PRIORITA' 3

(*)ATC= Agenzia Territoriale per la Casa, Territorial Housing Agency

Energy analysis

Gathering of geometric and material data concerning the buildings

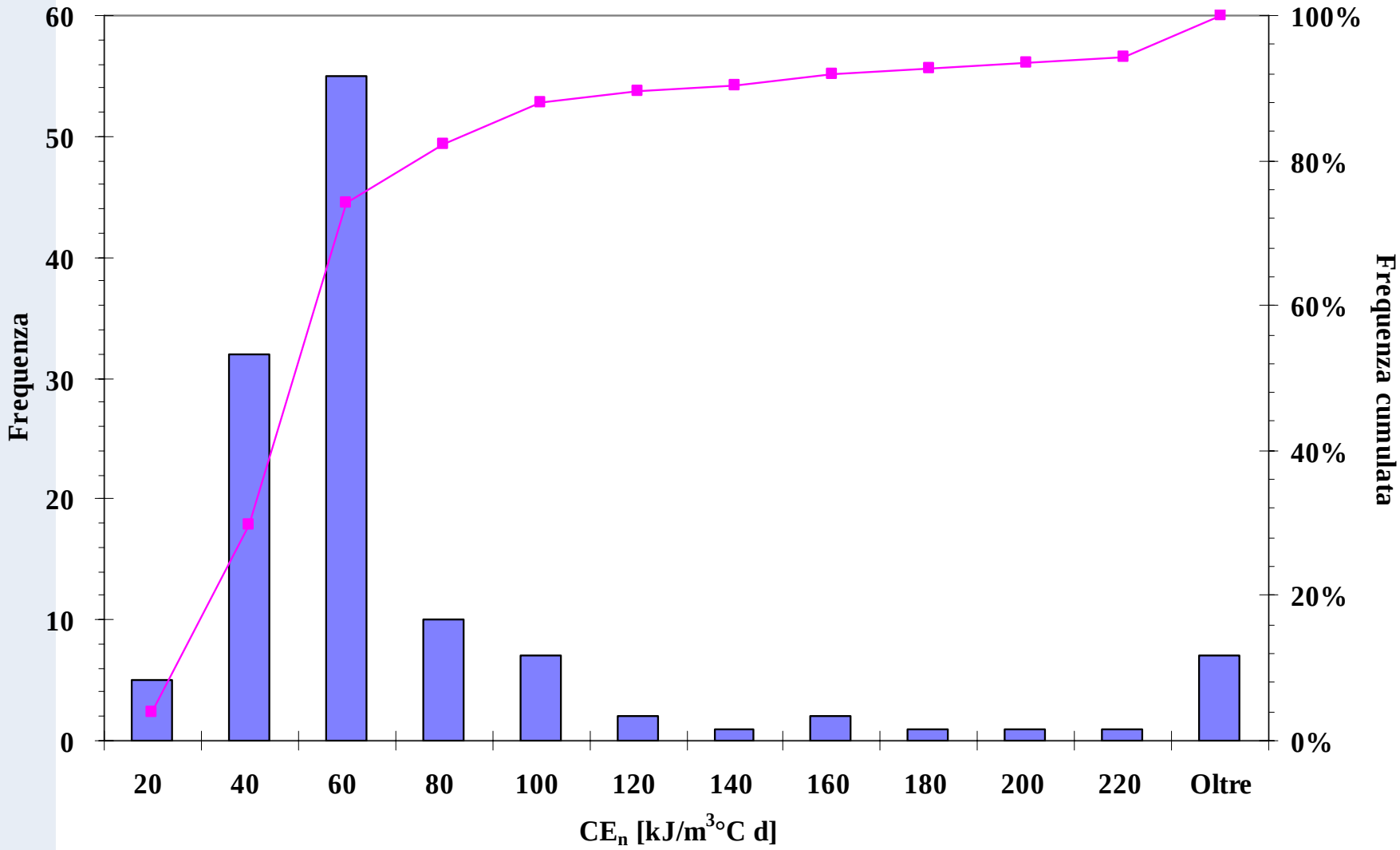
Collecting of data concerning energy and water consumptions

Data processing and calculation of indexes aimed at assessing the energy efficiency of the buildings

PRIORITA' DI INTERVENTO									
STRUTTURE	5			2,5			0		
MANUTENZIONE	2	1	0	2	1	0	2	1	0
ENERGIA 3	10	9	8	7,5	6,5	5,5	5	4	3
ENERGIA 2	9	8	7	6,5	5,5	4,5	4	3	2
ENERGIA 1	8	7	6	5,5	4,5	3,5	3	2	1
ENERGIA 0	7	6	5	4,5	3,5	2,5	2	1	0

Distribution frequency of normalized consumption of primary energy

[Natural gas heated buildings, season 2002/03]



Results

The sample of buildings examined has a **1,7 W/m²K** average **global thermal transmittance** of the shell, with a 0,5 W/m²K standard deviation

The **normalized energy need** (NEF) averages **72 kJ/m3GG**, with a 20 kJ/m³GG standard deviation

The **theoretical consumptions** average 157 kWh/m²y, with a 45 kWh/m²y standard deviation

The **real consumptions** average (M) **94 kWh/m²y**, with a 22 kWh/m²y standard deviation (D); certification classes are:

- A class, buildings with less than 65 kWh/m²y (<M-D) needs, 38% of sample
- B class, buildings whose needs stay between 65 and 115 kWh/m²y, 43% of sample
- C class, buildings with more than 115 kWh/m²y (>M+D) needs, 19% of sample

The daily consumption of **drinkable water per-person** averages **224 l** (about 60 l of which for warm sanitary water, with 64 litres per-day per-person standard deviation)

Conclusions

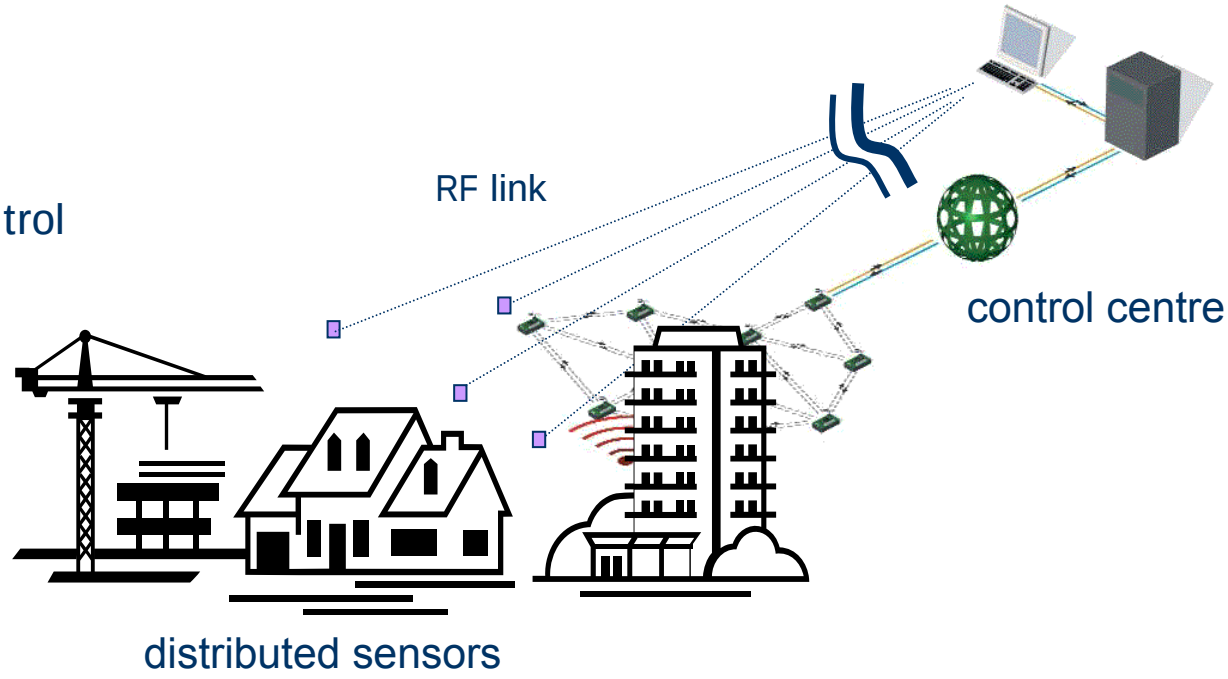
The research allowed to deepen the knowledge concerning a sample of buildings representative of the ATC real estate, through an approach that can be extended to all buildings. The monitoring method developed allows to give a picture of the building conditions, and also to suggest some projects to be carried on, acting as a decision support tool for the drawing up of periodic upkeep plans.

Monitoring of indoor Safety&Energy efficiency

To monitor indoor safety and indoor environmental parameters (including temperature and humidity) the use of wireless sensor networks (wsn) equipped with specific sensors can be very useful.

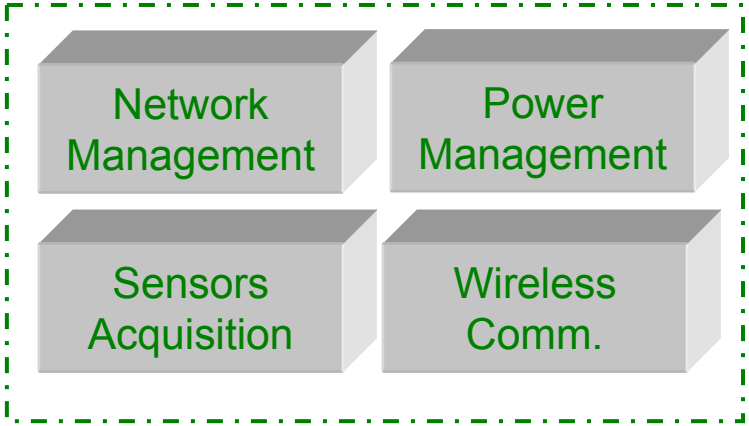
The wsn are easily deployable, low-cost and can gather data concerning the behavioral users' profiles (quite relevant to understand how to manage indoor heating and cooling.

Wsn are at the basis of building intelligence and enable the use of ICT control centres for an integrated management of all installations.

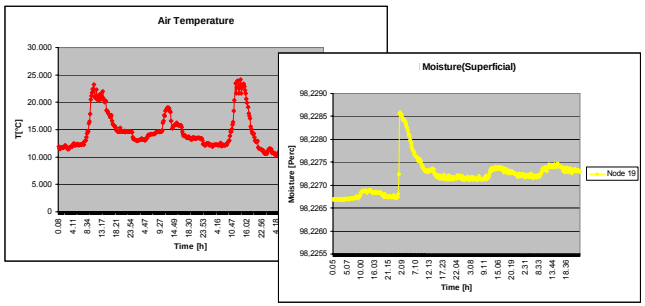


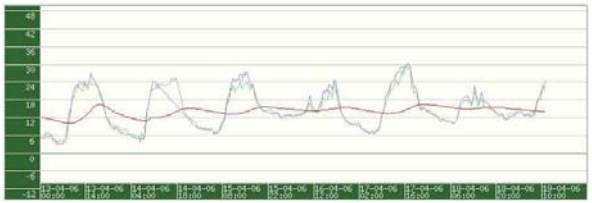
Indoor Safety&Energy efficiency

Indoor wsn networks can be deployed also to enable tests about the performances of new construction and insulating materials.



In fact, on-line continuous monitoring of indoor, outdoor and interface parameters makes available significant and representative data of the "on-field" characteristics of building infrastructures (including the effect of living behaviour of people in the buildings).





In a word, buildings are integrated systems, and wireless monitoring systems enable a better global understanding of the energy balances.

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BATTERFLAI sistema

Case study 3: Energy studies concerning environmentally compatible buildings

Basis of the experimentation

The system uses environmentally compatible and respectful of nature materials. One of its peculiarity is the use of huge vertical and zenithal windows.

The houses are quick-to-build and produce a low impact on the environment.

Main features

- External gardening
- External sunshade
- Airy roof
- Steel pillars
- Green roof
- Inner roller shades
- Glass front
- Steel and lamellar wood beams
- Use of photovoltaic panels
- Plasterboard and plasterboard-covered-with-stones walls
- Inner floor made of wood
- Geothermal systems for heating
- Utilization of rainwater

Low coefficients of environmental impact

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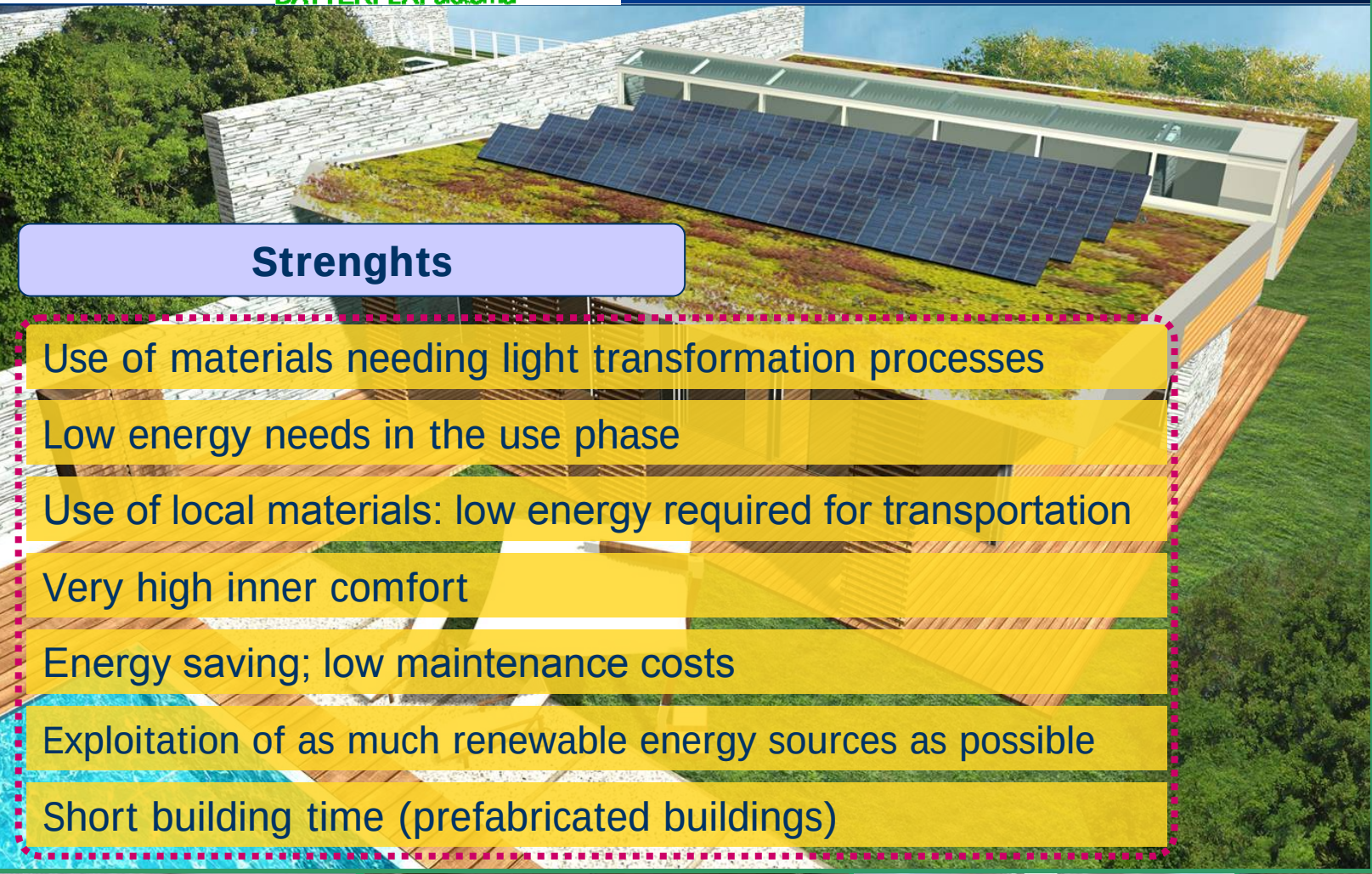
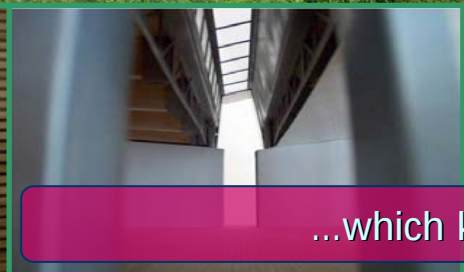
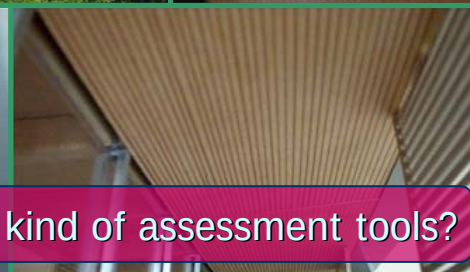
BATTERFLAI sistema™



Strenghts

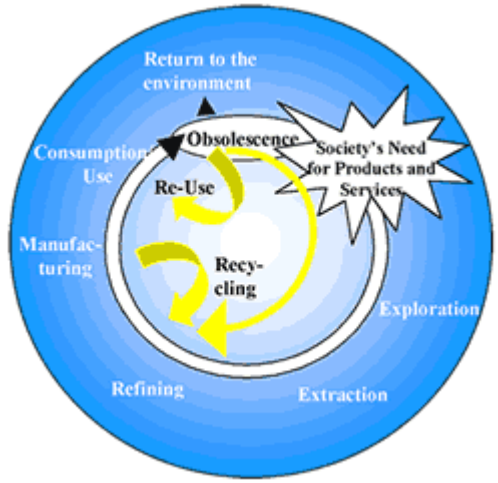
- Use of materials needing light transformation processes
- Low energy needs in the use phase
- Use of local materials: low energy required for transportation
- Very high inner comfort
- Energy saving; low maintenance costs
- Exploitation of as much renewable energy sources as possible
- Short building time (prefabricated buildings)





...which kind of assessment tools?

A life cycle assessment (also known as life cycle analysis, life cycle inventory, ecobalance, cradle-to-grave-analysis, well-to-wheel analysis, and dust-to-dust energy cost) is the assessment of the environmental impact of a given product or service throughout its lifespan.



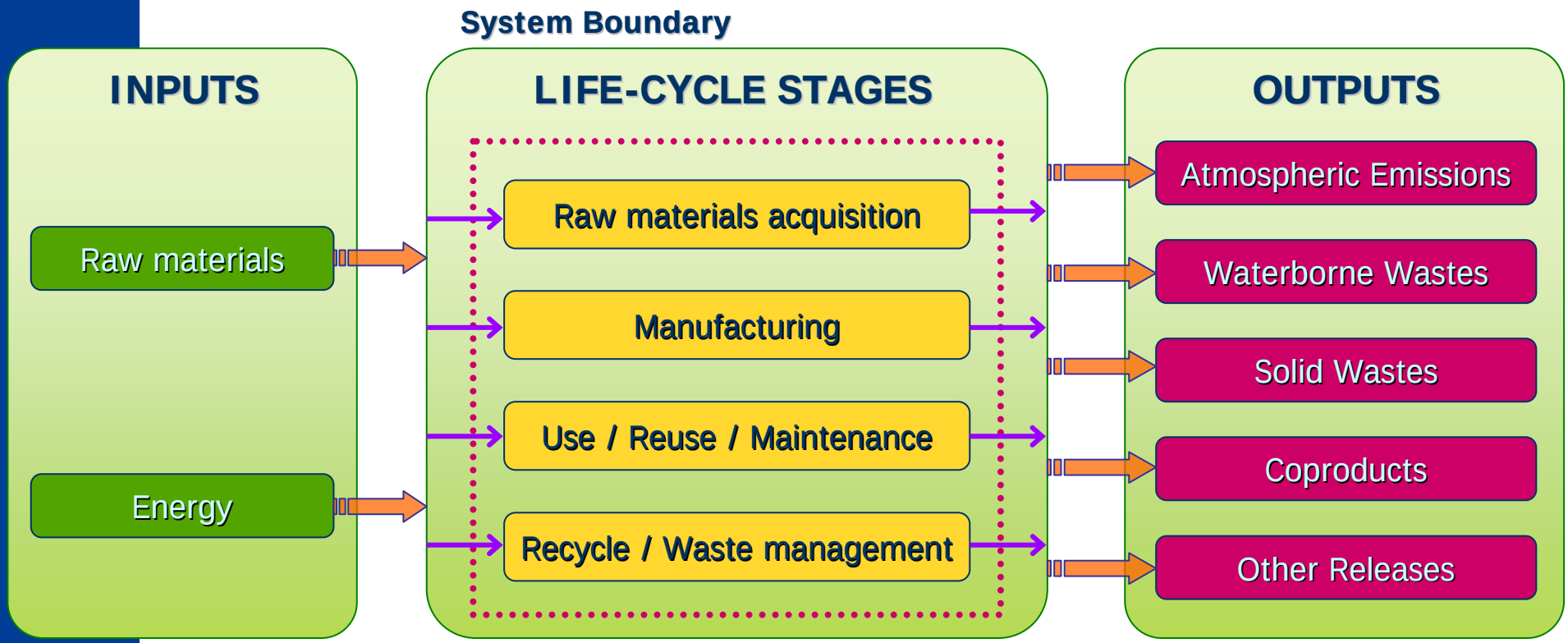
Life Cycle Initiative

The goal of LCA is to compare the environmental performance of products and services, to be able to choose the least burdensome one. The term 'life cycle' refers to the notion that a fair, holistic assessment requires the assessment of:

- raw material production;
- manufacture;
- distribution;
- use;
- disposal

including all intervening transportation steps. This is the life cycle of the product.

Stages of the product – Life Cycle (*)



Impact Categories

- Human health toxicity (occupational/public, acute/chronic)
- Landfill space use
- Water eutrophication
- Aesthetics (odor)
- Photochemical smog
- Resource consumption (renewable & non-renewable)
- Energy use
- Global warming
- Acidification
- Water use
- Local air quality (PM_{10} & Ozone)
- Ecotoxicity (aquatic & terrestrial)
- Local water quality (BOD, TSS, pH)

(*) Source: U.S. EPA




waste waste waste waste

MINING → MANUFACTURING → USE → DISPOSAL

Indirect / Direct Energy (*)

- ✓ the energy request for digger used in lithoid material extraction for concrete production
- ✓ the energy request for a chain saw in raw timber material purchasing
- ✓ …

- ✓ the energy request for industrial processes aimed at manufacturig products/assembling by-products
- ✓ the energy needed during the transport of finished product
- ✓ …

- ✓ for instance, for a complex product, like a building, this is the energy consumed within the home including heating, lighting, cooking…

- ✓ the energy needed during the transport of waste material to the landfill or to the treatment plant
- ✓ the energy request for the treatment and recycling plant

[1] *Indirect Energy:* energy needed in the process of energy and materials (used in the working process) production
[2] *Direct Energy:* energy needed in working process

LCA – Life Cycle Assessment

LCA studies analyze the environmental aspects and potential impacts throughout a product's life cycle (e.g., cradle-to-grave) from raw material acquisition through production, use and disposal (ISO).

The main goal of life cycle thinking is to reduce resource use and emissions from/to the environment as well as to improve the social performance in various stages of a product's life.

In this way, companies can achieve cleaner products and processes, a competitive advantage in the marketplace, and an improved platform to meet the needs of a changing business climate.

Definition

A life cycle of a product ("cradle to grave") begins with raw materials production and extends to manufacture, use, transport, and disposition.

LCA is "a technique for assessing the environmental aspects and potential impacts associated with a product, process, or system by":

- Setting goals and scope of study
- Compiling an inventory of inputs / outputs
- Evaluating potential impacts of those
- Interpreting result of the inventory and impact assessment in context of study objectives
- Suggesting improvements for future benefit.

IS0 14040-14043 is considered the LCA standard

Possible application of LCA

During the **decision making process** → in fact LCA can direct the operators and researchers towards the more sustainable/preferred investment solution under an environmental point of view

As a good support in the implementation of **Environmental Management Systems** and to evaluate environmental performances of products

To **compare existing products with planned alternatives**. For instance, LCA could be used with success in the field of building and urban development as a tool to compare different types of structures. During the design phase the results gathered from the analysis could be useful, for example, in the choice of materials and solution with the best environmental performances.

In particular, for an Institute like SiTI, the main application of this methodology is as an internal tool for **research, development and design**.

Future developments – 2
Exploiting energy efficiency potentials: white certificates

Building restructuring and **maintenance** implies an increase in energy efficiency, that can be seen as a cluster of many **Localized Virtuous Activities** (**LVA**), that are "*too little and scattered*" to be known, declared and gathered.

The result is that the overall sum of all these LVAs corresponds to a "relevant" increase in energy efficiency, but no means exists to use it to create value.

It seems therefore useful to develop GIS-based methodological approaches and technical procedures for a good census of all LVAs.

These implies the creation of innovative mechanisms to involve all Stakeholders (owners, builders, installation specialists, maintenance companies, designers, consultants, etc.) along the entire information supply chain, in order to stimulate the voluntary population of data bases.

The calculation of energy efficiency improvements is to be made, enabling the conversion of LVAs into Energy Efficiency Bonds (Titoli di Efficienza Energetica – TEE), with the final generation of **WHITE CERTIFICATES**.

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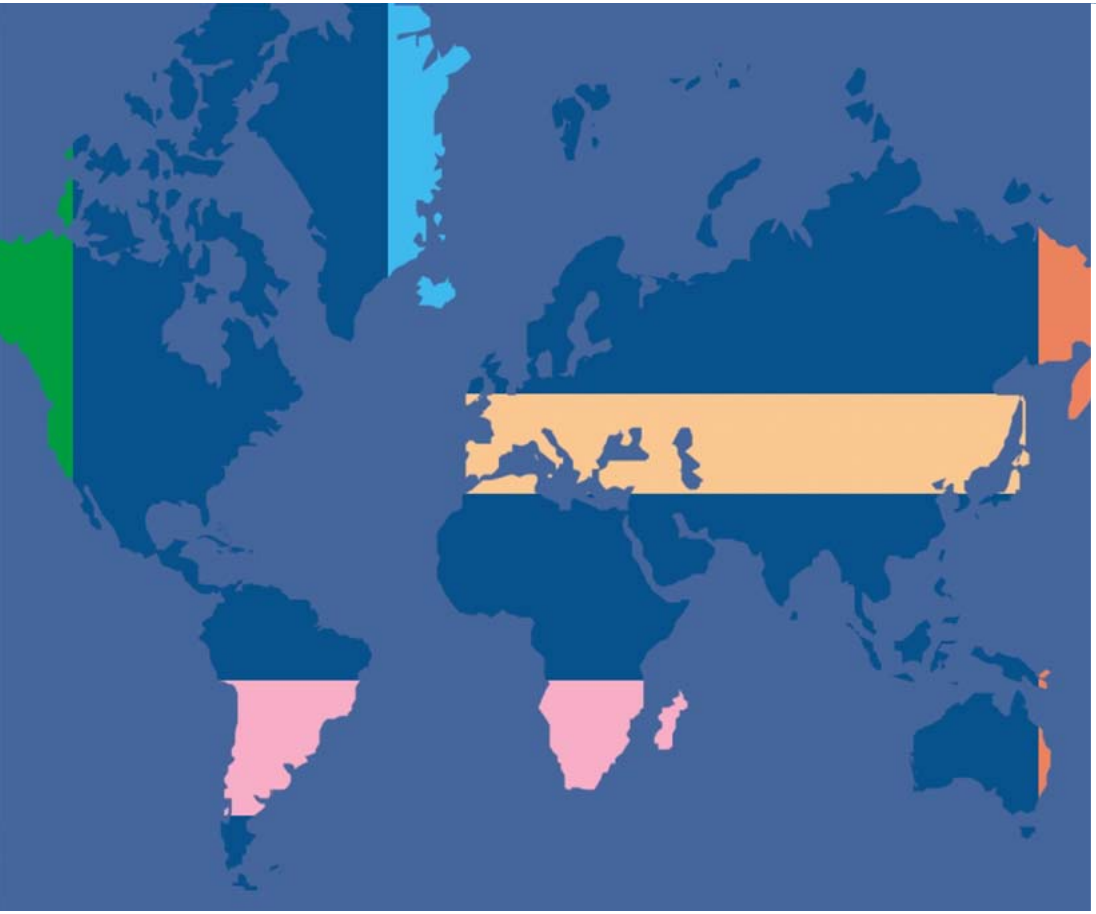

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