VOLUNTARY GUIDELINES AND SUSTAINABLE BUILDING CODE

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Abstract

Research indicates our environment is deteriorating. Buildings account for a large part of the problem, because they consume large amount of raw materials, natural resources and energy; moreover, useful materials are discarded as waste. By rethinking the way buildings are designed, constructed, operated and maintained, building professionals and their clients can slow damage to the environment.

Yet building codes, which powerfully influence every aspect of the design and construction of buildings, ignore resources issues and environmental impacts of resource acquisition or depletion, transportation, manufacturing and disposal after use, as well as embodied energy of materials and their contribution to global climate change. If we truly believe that the preservation of health and safety is the real and legitimate purpose of building codes, then we must achieve sustainable building code, to have buildings that meet present needs without compromising the ability of future generations to meet their needs.

Establishing environmental sustainability as a practical solution to problems communities face is a process requiring social acceptance and understanding. Guidelines that address the aforesaid problems at every phase of a building project are an intermediate step towards sustainable building code: in fact, the guidelines do not require radical changes but ask designers and clients to integrate environmental concerns (i.e. sustainability) into the development of a project. Projects incorporating sustainability must address people's natural resistance to change (undoubtedly sustainability requires thought and added time), and to consider that, by far, the benefits outweigh the costs.

This paper examines the current status of voluntary agreement in Italy in relation to building codes and suggest a preliminary voluntary technical guideline, taking into account that specific tools are needed to support building professionals and clients.

Key words: voluntary guidelines, building code, sustainable building

1. Introduction

Everyone wants a place to live. However, desire for shelter has taken its toll on the planet by depleting the resources to build homes.

Really the construction and use of buildings causes environmental damage at many levels. Thus, for example, carbon dioxide emissions from the consumption of fossil fuels contribute to the global greenhouse effect; tall buildings can produce dangerous winds in the neighbourhood; many buildings suffer from sick building syndrome. These are but three examples from a long list of environmental effects.

Yet building codes, which powerfully influence every aspect of the design and construction of buildings, exclude all of those impacts.

They ignore resources issues, such as where resources come from, how efficiently they are used, or whether they can be reused at the end of their life.

They ignore environmental impacts of resource acquisition or depletion, transportation, manufacturing and disposal after use, as well as embodied energy of materials and their contribution to global climate change.

They are prescriptive and not performance-based, so recycled materials are usually not to be used or simply not regulated.

The issues of sustainable building, however, extend beyond resource issues. They include the toxicity both of processes and materials in buildings. There are economic, social and cultural impacts of building that are quite profound as well.

If we truly believe that the preservation of health and safety is the real and legitimate purpose of building codes, then we must address these larger issues, developing awareness of the real consequences of what codes demand in the design and construction of buildings. Resource issues, often identified as being at the heart of developing sustainable patterns for building and development, should not remain entirely outside the context of building codes and, more important, beyond consideration in the process by which codes are written, modified and enforced.

But we also have to consider that before to write sustainable building codes, a strong voluntary program - accepted by a large portion of the community - to verify green home performance via a set of guidelines, that builders and developers can ascribe to, is required.

A need to develop a process to assess codes on the basis of whether they really preserve or threaten health and safety is illustrated in this paper, as well as the role of voluntary guidelines that may help create better environmental performance of buildings.

2. The voluntary agreement in Italy

The adoption of building typologies and technical-constructive criteria aiming to design energy-efficient buildings and green buildings up to now have been encouraged in Italy using two directions:

- discounts on urbanisation charges or taxes;
- increases of admissible volume[1];
- dispensations to building regulations as regard to the building cubature (conservatories, wall thickness, …).

The voluntary agreement for energy and environmental quality of buildings and open spaces[2], lately developed in Italy by a set of public administration, identifies some general principles about energy, water, material, air, land and plants, as well as reproposes the use of incentives. A few Regions (4) and Municipalities (56), as well as public corporations and professional associations are in favour of the aforesaid voluntary agreement.

This agreement, aiming to encourage and to facilitate the sustainability, as far as the local building regulations (town planning and building code) is concerned, states that:

- all spaces for passive heating systems must be excluded from the calculation of the net available surfaces (for example, the building code of the city of Florence, approved in 1999, states that greenhouses conformed to given prescriptions can be considered as technical volumes[3]);
- building indexes must be set out as the ratio of net available square meter to building square meter;
- roof-gardens and penthouses must be fostered in building design;
- green materials and local energy-efficiency materials must be pushed in building codes;
- building layout for passive cooling - or for barrier to freezing draughtiness – must be used.

The adoption of the voluntary agreement, namely the emendation of building code with distinct rules, involves the overcoming of some obstacles in the current building regulations.

For instance, the adoption of building indexes set out as the ratio of net available square meter to building square meter requires the abrogation of the current settled habits based on the ratio

[1] The town planning variation adopted in 1996 by the Municipality of Faenza allows increases of volume up to 20% for eco-sustainable projects - see the text of the title VIII, downloadable at http://www.racine.ra.it/faenza

[2] Codice concordato di raccomandazioni per la qualità energetico-ambientale degli edifici e spazi aperti, available 9/6/00 at http://ferd.ulysse.it/ambiente/cod_conc.html

dead freight cubic meter to building square meter.

This problem mostly affect the existing building stock and specifically those building typologies of years between '50s and '70s, characterised by inadequate insulating materials, offset with additional fuel consumption.

The problem is very wide because the whole building stock of the second post-war period is interested. With the crisis of this construction technology, the increase of the insulation capacity of the side fabric (walls and roofs), as well as of the single real estate units (floors and partitions) is often hindered by the town planning code in force which not allow further increases of volume, reduction of the separations between buildings or reductions of space between two floors[4].

Also the use of lofts to fit for habitation involves the overcoming of building regulations relative to the net serviceable height and to the inclination of the roofs. Moreover, the national building code about energy conservation[5] is a financing law with incomplete applied ordinance and without tools aimed to verify the energy savings related to the adoption of a specific technology and to compare it with the costs sustained, confining so the whole procedure in a "virtual reality"[6]. To overcome this kind of problem, the production of uniform energy efficiency ratings (as HERS in U.S.A.) would be welcomed.

Italian regions formulate their politics exclusively on financing, favouring especially energy savings (heating systems, thermal insulation). Only few regions (especially Abruzzo, Basilicata and Liguria) fund the technological research in the building sector for energy savings; still less regions (Abruzzo and Lazio) fund professional information and formation.

To remove some of the obstacles interposed by the national building codes, some regions adopted specific laws. Lombardia, for instance, with the law n.25/1995 formulated new rules for the calculation of the building volumes: the thickness of walls for increasing thermal savings more than the minimal one requested by the law must not considered in the volume calculation. Even if this law is anchored to the old parameter of the ratio meter cube empty for full to square meter, nevertheless it is certainly a positive signal achieving an increase of energy savings without using the allowed cubature.

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[3] Rignanese, L. and Lamacchia M. R. (1999): The Need to Revise our Building Codes. In Sharing Knowledge on Sustainable Buildings, Maiellaro, N. ed., La Meridiana

[4] the ratio of meter cube empty for full to square meter and the other parameters used traditionally lacks to guarantee a sustainable architectural quality in existing buildings. It is then necessary a whole revision of the building and town planning code adopted in Italy. See "Il Regolamento edilizio: da strumento rituale a strumento per il governo urbano", Rivista del Consulente Tecnico, n.2/2000

[5] law n.10/1991

[6] Righetti, G. (1995). Comportamento termoigrometrico delle murature: la nuova normativa. In Costruire in Laterizio, n.45/1995, pp. 223-231.

This kind of rule was adopted also by Veneto (regional law n.21/1996), Puglia (r.l. n. 23/1998), Piemonte (r.l. n. 21/1998) and Basilicata (r.l. n. 15/2000).

A rule to fit lofts for habitation was firstly adopted by Lombardia (r.l. n.15/1996) and later by Piemonte (r.l. n.21/1998) and Basilicata (r.l. n.5/1998); a rule to fit basements for habitation was also adopted by Basilicata. Land use reduction is also pursued by these laws.

Unfortunately, regional laws may clash with national building codes[7], therefore wide amendments aiming to facilitate sustainable practices are necessary.

Despite these difficulties, some Municipalities adopted rules aiming to the implementation of the aforesaid voluntary agreement. Guidelines and planning recommendations for efficient energy use and promoting the use of renewable energy sources in existing buildings, in developing urban areas and in new buildings and restructuring ones, were defined, for example, in the Building Code[8] of the city of Florence.

3. A preliminary voluntary technical guideline

Agreements and building code emendations are not enough; next step is the development of voluntary guidelines for sustainable building, aimed to set both general goals for the project and specific parameters for building design, products, systems and siting.

The following sections contain preliminary voluntary guidelines that may help create better environmental performance of housing. The information provided follows the development process so designers, builders and developers may use it in job planning and implementation, taking into account that construction practices vary widely due to climate, local architecture, building codes, available construction materials and clients preferences.

3.1. Pre-Design Issues

Decisions made during pre-design not only set the projection direction, but also must prove cost-effective over the life of the project.

Marketing

By implementing green building practices, homebuyers and communities will begin to stand behind the company’s practices. Typical issues are:

- encourage environmental participation, appealing to the self-image of environmental

[7] The case of Lombardia regional law n.193/2000 is representative: rules about changing of building use has been suspended by the Government because against with town planning standards.

[8] See ‘D’ attached to “Linee guida e raccomandazioni progettuali per l'uso efficiente dell'energia e per la valorizzazione delle fonti energetiche”, downloadable at http://soarisc.comune.firenze.it/comune/regolamenti/edilizio/indice.html

awareness and showing rational-economic benefits through vivid information that is concrete and personalised, but not too complex or technical[9];

- ensure understanding and support of Clients needs;
- strive for ‘smaller is better’ so overall building size and resources necessary for construction and operation are minimised.

Durability

Buildings which are durable, designed and constructed to facilitate reuse and remodelling of the structure help the environment by prolonging the use over the time. Measures to facilitate durability, reuse and remodelling for other purposes include:

- ensure ease of operation and maintenance;
- allow for future expansion and/or adaptive uses with a minimum of demolition and waste (for example, design interior layouts with more open floor plans);
- design and construct buildings in a way to better facilitate ultimate disassembly into useful components that can be reused or easily recycled;
- ensure high flexibility of space design for occupants (for example, use interior non-load bearing partitions of light-gauge materials, designed to be re-configurable, to add flexibility of interior spaces);
- specify very durable materials for structural uses;
- choose recycled or recyclable construction materials, where structurally equivalent or superior to virgin materials;
- renovate an existing building instead of building a new one.

3.2. Site Analysis and Assessment

The purpose of a site analysis is to break down the site into basic parts, to isolate areas and systems requiring protection and identify factors that may require mitigation. Any site analysis should begin with the identification of the prominent features such as geographical latitude, local climate features, solar access, parcel shape and access, existing vegetation, topography, surface and sub-surface geology (technical data).

Infrastructure data (existing utility and transportation infrastructure and capacity), cultural data (historical and archaeological features, incorporation of architectural style, use of compatible building types) and energy resources data (both conventional and renewable) should also analysed, as well as other factors relevant to determining the acceptability of the

[9] for example, demonstrate the benefits of good site design: landscaping adds aesthetic value to the property, mitigates solar gain and noise levels, increases evaporative cooling…

site (for example, prior uses of the site could have resulted in environmental contamination!). Site assessment is a process that examines the data gathered and identified in the site analysis, assigns specific site factors to hierarchies of importance and identifies interactive relationship. Typical guideline issues are:

- select sites in developed area, close to public transportation and amenities to minimise the impact of vehicles;
- select a site that allows use of passive design (such as building orientation and good shading) to reduce the environmental impact;
- design lot contours to help provide good drainage and reduced opportunity for siltation (the use of geographic information system is recommended);
- preserve native vegetation and natural features for low maintenance landscaping and reduced water use (xeriscaping[10]);
- locate the building on the site to minimise environmental impact on vegetation and topography as well as to encourage pedestrian access and pedestrian-oriented uses.

3.3. Building placement

Where the building is placed can have a great influence on the effectiveness of passive design strategies, particularly as they relate to solar radiation and wind.

Landscaping for energy savings

- shading (deciduous trees on the south and east side: in winter sunlight can reach the house to help in heating the building; evergreen trees on the north and west side for the best protection from the setting summer sun and cold winter wind);
- windbreaks (two to three rows of evergreen trees in staggered order);
- vines for shading (when trees are young and not providing much shade);
- arbours (reduce temperature as the air movement can pass through the arbour and be cooled by evaporation at the plant's leaves);
- absorbent and reflective materials;
- native, edible, food-producing and drought tolerant landscaping;
- pervious paving instead of concrete or asphalt paving;
- limited staging area to protect native vegetation.

Orientation

[10] Xeriscape is a trademark term referring to seven basic principles for conserving water and protecting the environment: planning and design; use of well-adapted plants; soil analysis; practical turf areas; use of mulches; appropriate maintenance; efficient irrigation.

- coordinate space functions with site and solar orientation;
- incorporate natural ventilation through channelling of summer breezes;
- design south, east and west shading devices to minimise solar heat gain in hot climate;
- maximise integration of daylighting through use of vertical fenestration, light shelves and building form as well as through translucent-transparent-low interior partitions;
- minimise effects of thermal bridging in walls, roof and window systems;
- design entries with vestibules;
- design roof to accommodate or incorporate PV or thermal solar collectors.

3.4. Building Design

Integrated building design is a cornerstone for developing sustainable buildings, which are efficiently combined systems of coordinated and environmentally sound products, systems and design elements (this integrated approach is well-illustrated in passive solar design strategies, that combine siting, architectural, mechanical and electrical features in a systemic way). The design must use the simplest technology appropriate to the functional need and incorporate passive energy-conserving strategies responsive to the local climate, avoiding use of energy intensive, environmentally damaging, waste producing and/or hazardous materials.

Building simulation for energy performance and quantitative evaluation of day-lighting and lighting technologies integration must be performed. Although the following information is very general, it does serve as a checklist of basic consideration to address once specific site data is obtained.

Natural factors

- Climate: apply natural conditioning techniques to achieve appropriate comfort levels;
- Temperature
- too hot: maximise roof ventilation; use elongated or fractured floor plans to minimise internal heat gain and maximise exposure for ventilation; separate rooms and functions;
- too cool: consolidate functions into most compact configuration; insulate in depth to minimise heat loss; minimise air infiltration; minimise openings not oriented toward sun exposure.
- Sun
- too hot climate: use overhangs to shade walls and openings; use shading devices (louvers, covered porches and trellis with natural vines) to block sun without blocking out breezes and natural light; use lighter-coloured wall and roofing materials to reflect solar radiation; orient broad building surfaces away from the hot late-day western sun (only northern and southern

exposures are easily shaded);

- too cool climate: maximise building exposure and opening facing south (in the northern hemisphere); increase thermal mass and envelope insulation; use darker-coloured building exteriors to absorb solar radiation and promote heat gain.

- Wind can be an asset in hot, humid climates to provide natural ventilation; maximise/minimise exposure to wind through plan orientation and configuration, number and position of wall and roof openings and relationship to grade and vegetation; use wind scoops, thermal chimneys or wind turbines to induce ventilation.

- Moisture

- It is a liability if it comes in the form of humidity in summer (to reduce the discomfort, maximise ventilation, induce air-flow around facilities, vent or move moisture-producing facilities);

- It is an asset by evaporating in hot, dry climates (techniques for evaporative cooling include providing fountains, pools and plants)

Energy

Just as a site has primary natural and cultural resources, it has primary renewable energy resources such as sun, wind and biogas conversion. Energy management must balance justifiable energy demand with appropriate energy supply.

- Energy Awareness: to sustain its own wise use of energy, benefits rather than sacrifices must be demonstrated to its users. By promoting less consumptive lifestyles and demonstrating more sustainable energy alternatives, the demand and supply can more effectively balanced.
- Energy Conservation: Considerable electrical and thermal energy can be saved through facility design in several ways: incorporating strategies appropriate to the local climatic environment; having facilities serving multiple functions; building only the minimum to satisfy the functional requirements; recycling existing facilities. Awareness of the cooling sense of moving air can enhance the user comfort[11].
- Energy Efficiency: Efficient methods, devices and appliances should be employed at the sustainable building to conserve energy; lighting, ventilation and other devices or systems can be controlled with a variety of sensors that reduce electricity consumption significantly. A photocell can control day and night operation; ultrasonic occupancy

[11] Wind chimneys, used in traditional architecture of some countries, serve as a gentle reminder of a cool breeze; the sound of trickling water in a courtyard fountain can impart the perception of coolness; a ceiling fan spinning overhead can provide not only a sensory but also a psychological feeling of a cool breeze).

sensor can operate lighting. Other sensors can control operation of a device by door opening, time of day, timer, noise level and proximity.

- Renewable Energy Resources: Site conditions and available resources as well as energy demand will determine the sources to develop. A broad range of solar technologies exists; low technology systems are readily available to preheat water; medium temperature systems can provide refrigeration. Photovoltaic systems, hydroactive systems, wind generators and biogas use are also to be considered.

Site water

- locate irrigation controller within visual sight of the irrigated area to verify that the sprinkler system is operating properly;
- use different types of sprinklers heads for different watering requirements of vegetation types.

Building water

- Water source: rainfall catchment from the roofs of structures is a recognised option for water supply - a treatment process must be used prior to distribution. Moreover, wastewater can be used for toilet flushing after approved disinfecting.
- Water conservation: separate and use for toilet flushing graywater generated from indoor uses such as laundries, showers and sinks, as well as reclaimed wastewater effluent or runoff from ground surfaces. Water-efficient fixtures and appliances are readily available, including double flush units and waterless toilets. Infrared sensors on toilets, urinals and sinks, faucet bubblers, low-flow showerheads and flow restrictors further reduce water consumption.
- Water storage: gravity storage of any water product should be used wherever possible. As gravity storage tank will be located in an elevated location, visual quality will be important; multiple smaller tanks provide greater flexibility in operation and may be easier to screen than one large tank.
- Water distribution: install dual plumbing lines - one for drinking water and one for lesser quality uses such as toilet flushing. Pipe contents should be colour coded so that cross-connection problems can be prevented.
- Blackwater systems: when possible, treat blackwater from toilet-flushing with on-site systems, taking into account local health regulations.

Equipment

- make-up air hoods;
- reduce loads on cooling system (using heat wheels or heat pipes; incorporating variable

air volumes systems to prevent reheating, recooling and mixing of hot air and cold air streams);
- use thermal storage for off-peak cooling;
- use separate systems to serve areas which operate on widely differing schedules or design conditions;
- use variable speed drives on pumping systems and fans for cooling towers and air handlers;
- use shut off or set back controls when areas are not occupied and controls to turn equipment off when not needed;
- reduce water heating energy cost using condenser heat, waste heat or solar energy;
- design for tenant sub-metering to encourage energy use accountability.

Lighting issues

- specify lumen maintenance, day-lighting and occupancy controls;
- reduce light absorption on surfaces by selecting colours and finishes with high reflectance values;
- use task lighting and low ambient light levels;
- use occupancy sensors in area of low or intermittent use;
- minimise light overlap in exterior lighting schemes.

Recycling

Most citizens favour recycling and consider it a necessary task; the participation level will increase if recycling can be convenient and routine, providing recycling holding area (for example a covered box alongside the building) and/or hazardous material storage and holding cabinets. This can be accomplished in many ways according to the design of the building and type of recycling service.

3.5. Construction Process

The construction process can have a significant impact on environmental resources. Environmental conscious construction practices can markedly reduce site disturbance, the quantity of waste sent to landfills, and the use of natural resources during construction.

Architect and designers must include specific language as well as site utilisation specifications in the contract and construction documents[12] that tells the contractor how to meet requirements and develop monitoring and verification criteria.

[12] see Using Specifications to Reduce Construction Waste available at http://tjcog.dst.nc.us/cdwaste.htm

In fact, the contractor's goal is to build the project for the lowest cost, within the tightest time frame and the highest profit; the contractor is not likely to implement environmental practices unless they involve almost no additional cost, have been required contractually or are economically beneficial to the contractor.

The Contractor must be requested to submit a plan for meeting these specifications, with a special attention to site issues, Indoor Air Quality protection and waste management.

Site issues

In many cases, it is in the contractor's best interest to take actions that curb construction's impact on a site, because such actions can sharply reduce site-restoration costs after project completion; moreover, protecting what is already on the site during excavation and grading will ultimately result in lower landscaping costs. Typical specifications are related to:

- area not to be disturbed and vegetation to be protected[13];
- fencing around site and/or protected area;
- accesses and parking area for deliveries and workers;
- storage and staging areas (not only for building materials, but also for debris and wood's wastage which may be used later for landscaping);
- waste handling and removing;
- site clearing and grading (use reclaimed water for dust control and concrete mixing).

IAQ preservation

The plan should consider the unique circumstances of the project (such as whether it is a new construction or a renovation – with or without building occupants), the planned phasing of activities and the possible impacts of activities on adjacent buildings, the cost and benefits of available options and approaches. The mainly practices are:

- Administrative
- identify potential health hazards and take necessary safety precautions;
- isolate construction sites from occupied areas;
- schedule noxious work during off-hours;
- sequence construction steps to minimise contaminant 'sinks';
- test and inspect for potential contaminants;
- Heating, ventilating and air-conditioning (HVAC) systems
- protect ventilation systems and components;
- pressurise occupied areas or depressurise the construction work area;

[13] specifications must indicate not only the types and locations of vegetation to be protected, but also the methodology for protection.

- flush out occupied areas during off-hours and prior to occupancy;
- Source control practices
- use low-emission products;
- install a temporary local exhaust;
- install localised cleaning and filtration equipment;
- institute sound housekeeping procedures.

Resource efficiency

The builder can reduce waste, increase efficiency and water conservation and reduce consumption of natural resources. The public's wide belief in recycling gives the builder who recycles a positive image with the client. Potential improvements include:

- Reduce waste production
- using products and materials with reduced packaging, and encouraging manufacturers to reuse or recycle their original packaging materials;
- using products and materials with recycled content, as appropriate and consistent with construction plans and specifications, good IAQ practices and health recommendations;
- estimating materials accurately to avoid waste;
- estimating dimensions accurately to minimise cut-off waste;
- reusing building materials and demolition debris on the construction site.
- Recycling construction debris and demolition debris off-site; however, transportation costs and the lack of local companies using recycled resources make recycling of many materials, that are not directly reusable, too expensive to be feasible at the present time.
- Developing overall efficiency guidelines (for example, purchase materials in a manner that minimise waste and unnecessary costs; ensure that storage bins – when used – are not contaminated by foreign materials and that construction materials scheduled to be recycled are, in fact, being separated).

3.6. Final Disposition

Completed buildings represent a considerable amount of embodied energy and embedded resources; deconstructing or demolishing a building may frequently be a last resort, especially if the building exists in a context of historical significance. In any case, environmental benefits could be achieved if developers:

- consider de-constructing existing buildings prior to demolition, and use funds from the sale of recovered materials and components as cost recovery (overall environmental impact of development may be mitigated since old buildings become mines for useful materials);

- increase recycling of construction and demolition materials to reduce environmental impacts on local landfills and to provide feed stocks routed back to useful production.

4. Conclusions

Sustainability does not require a loss in the quality of life, but does require a change both in mind-set and in values towards less consumptive lifestyles. These changes must embrace environmental stewardship, social responsibility and economic viability. Sustainable building design must use an alternative approach to traditional design that incorporates these changes: it must recognise the impacts of every design choice.

Building codes, which powerfully influence every aspect of the design and construction of buildings, ignore resources issues and environmental impacts; our review of local regulations revealed that some efforts were made to put in place some issues.

The process to define a sustainable building code, however, is very difficult, because requires social acceptance and understanding. A first step to reach consensus is represented by the voluntary agreement, recently adopted by a set of local administrations; more practical methods and tools to help improve the environmental performance of buildings are now necessary, such as checklists[14], whole building ratings and evaluations[15], materials standards and guidelines.

The preliminary technical voluntary guideline presented in this paper could be very useful because do not require radical changes but ask designers and clients to integrate environmental concerns into the development of a project. Many of the topics presented can have filled books on their own; the goal here is to provide a quick reference to help building professionals promote sustainable building. Extensions of these preliminary guidelines as well as updates for maintenance and materials will be provided and available both at Sustainable Building Resource (http://www.iris.ba.cnr.it/sustain) and (in Italian language) at Centro Edilizia Sostenibile (http://www.iris.ba.cnr.it/sustain_it).

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[14] For example see Green Building Program – Green Home Checklist, available 20/6/00 at: http://www.ci.austin.tx.us/greenbuilder/checklist.htm

[15] an overview is in Maiellaro, N. (2000): Internet Tools for Sustainable Architecture - Breaking through the Barriers. Proceedings of the Conference TIA 2000, Oxford, U.K.; a study about a building certification for Italy

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