

# 371: Passive and Low Energy Architecture (PLEA) VS Green Architecture (LEED)

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## Abstract

The paper presents, discusses and analyzes different examples of LEED accredited buildings as well as “Solar Communities” and raises the following questions: Will the new LEED based green building movement enhance bio-climatic and energy conscious architecture? Is bio-climatic architecture still required when new and better materials and HVAC systems have become available? And how should we, as PLEA members, endorse and promote good bio-climatic, passive solar and low energy architecture into the main stream of Green Architecture.

Keywords: green buildings, passive and low energy architecture, bio-climatic architecture

## 1. Introduction

Green Architecture, which involves minimizing the building energy consumption, has recently gained momentum to become the current fashion and the main stream in architectural practice. Although there are today many different Building Grading Systems [1,2,3], the momentum in the USA has been achieved mainly through the Leading in Energy and Environmental Design (LEED) Certification that was established by US Green Building Council (USGBC). For example, the San Francisco AIA announced that “San Francisco is blazing a trail on sustainability as it moves towards enacting the most far-reaching green building legislation in the U.S. This new green building policy builds on the city’s current sustainability initiatives and will be implemented gradually over the next four years, with full implementation in 2012. The green building code will require all new high-rise residential buildings to be certified LEED® Silver, commercial buildings and major renovations over 25,000 square feet to be LEED Gold, and new small- and mid-sized residential to be rated with the Green Point rating system—all leading to a holistic plan for greening the building stock and meeting the city’s climate action goals” [4]. On one hand we witness how the LEED succeeded in triggering a fast expanding trend of architects interested in energy in buildings as supporting the Green Architecture requirements. On the other hand, we observe the very modest achievements of the Passive and Low Energy (PLEA) movement over the past 25 years since its inception in raising the interest of the profession in the subject. In this paper we bring up few critical questions and analyze the technical origin of the apparent triumph of the LEED.

Let me at this point present very briefly the LEED New Construction rating system [2]. Those that are familiar with other green building grading

systems will find that there is much similarity between most of them [1,3].

### LEED Possible Points includes:

**SS- Sustainable Sites 14 Possible Points:** Site Selection, Development Density & Community Connectivity, Alternative Transportation; Public Transportation, Bicycle Storage & Changing Rooms, Low Emitting & Fuel Efficient Vehicles, Parking Capacity. Site Development; Protect or Restore Habitat, Maximize Open Space. Stormwater Design; Quantity and Quality Control, Heat Island Effect and Light Pollution Reduction.

**WE- Water Efficiency 5 Possible Points:** Water Efficient Landscaping, Innovative Wastewater Technologies and Water Use Reduction.

**EA- Energy & Atmosphere 17 Possible Points:** Optimize Energy Performance, On-Site Renewable Energy and Green Power, Enhanced Commissioning and Refrigerant Management, Measurement & Verification.

**MR- Materials & Resources 13 Possible Points:** Building Reuse, Construction Waste Management, Materials Reuse, Recycled Content, Regional Materials, Rapidly Renewable Materials and Certified Wood.

**EQ- Indoor Environmental Quality 15 Possible Points:** Outdoor Air Delivery Monitoring, Increased Ventilation, Construction IAQ Management Plan, Low-Emitting Materials, Indoor Chemical & Pollutant Source Control, Controllability of Systems, Lighting and Thermal Comfort and Daylight & Views.

**ID- Innovation & Design Process 5 Possible Points:** Innovation in Design and LEED Accredited Professional participation in the team.

**Project Totals: 69 Possible Points:** Certified: 26–32 points, Silver 33–38 points. Gold 39–51 points, Platinum 52–69 points.

The LEED New Construction rating system for 2007-2008 allocates 17 out of 69 total available points to Energy and Atmosphere. Out of the 17 points 10 are dedicated to optimizing energy performance, 3 points to On Site Renewable Energy and 1 point to Green Power. Using solar energy for hot water, or active solar energy to heat the building space, or buying Green Power, is awarded twice: once, as it reduces the amount of the total purchased energy and again, as it contributes to the On Site Renewable Energy credit, or to the Green Power credit. The first dilemma to mention is that Passive Solar Energy is not considered as On Site Renewable Energy. Consequently, there is no incentive in LEED for passive solar design. Secondly, the LEED is a simple 'point hunting' approach. This means that although about 25% of the possible points are assigned to energy efficiency (Fig. 1), never the less, in order to achieve LEED Silver, the most common goal, one can get the minimum score required for Silver grade without improving the energy performance of the building at all. The new proposed LEED for 2009 increases the portion of possible points assigned to energy to about 31% (Fig. 2). However, one can still get LEED Silver with no need to save energy, except what is required by the prerequisite. Only when the goal is to obtain LEED Gold or Platinum, one should improve the energy performance of the building. Examining LEED accredited buildings and comparing them with our basic knowledge of good practice of Passive and Low Energy Architecture, one can easily observe design defaults from the point of view of Bio-Climatic and Passive Solar Architecture.

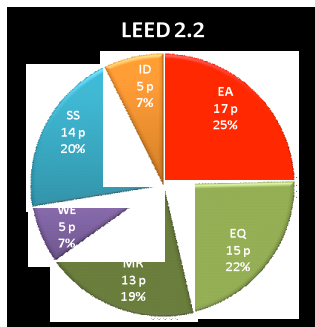


Fig. 1. LEED 2008 - total possible points

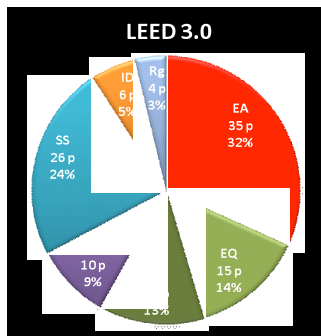


Fig. 2. LEED 2009 – total possible points

## 2. Green Buildings

### 2.1 LBNL Molecular Foundry Laboratory Building – LEED Gold accreditation

The Molecular Foundry research Laboratory, designed by the SmithGroup of San Francisco, and completed in March 2006, is located at LBNL Berkeley. It is the first building in Berkeley to receive a LEED gold certification [5].

The building provides good indoor air quality through low-VOC materials. About 85% of all building construction waste was recycled. Almost all wood used was sustainably harvested as well as rapidly growing renewable materials, such as bamboo flooring. The building six stories minimize its footprint, and more than 50 percent of the site is landscaped with native plants. There exists good access to public transportation, and Berkeley Lab's biodiesel powered shuttle system minimizes car travel around the 100-building campus. Bike racks and showers are also available. An electromagnetic water treatment system on the cooling towers reduces total water consumption and the amount of chemicals released to the atmosphere and the sewer. Indoor air quality elements include carbon dioxide monitoring and control of outside air for ventilation. Among the achievements of the building was minimizing energy consumption and it is one of the most energy efficient buildings at LBNL. By doing all of these the building achieved the 39 points to obtain the LEED Gold accreditation [5]. The points achieved in each category are presented in Fig. 3.

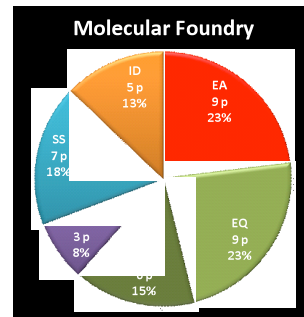


Fig 3. Points achieved by the Molecular Foundry Building to obtained LEED Gold Accreditation

Checking carefully what has been done in order to achieve energy efficiency in the building, one can find that it has to do mainly with the right sizing of the mechanical and electrical systems in the labs, which were originally designed for 25 W/ft<sup>2</sup> and was reduced to 15 W/ft<sup>2</sup>. The electrical system was reduced by 38%, by using efficient T-5 bulbs in lighting systems with bilevel switching and occupancy-based controls. The HVAC system was reduced by about 50%, by limiting the number of air handlers, downsizing the boilers and chillers and by using an energy-efficient elevator. Thus consuming 35% less energy than the national energy standard, as prescribed by ASHRAE 90.1-2004 [6]. Was there any good design from bio-climatic and passive

solar architecture? Let me say that from this point of view not much has been accomplished. The building is elongated along the East West axes and double-pane windows with low-e and a spectrally selective window coating was used and that's all. However, no special elements to achieve passive cooling or heating exist. There are no sunshades to protect the large West facing windows that creates contrast in the main working cubical space and hardly any shading to protect the Eastern and Southern windows (Figures 4,5,6).



Fig 4. Berkeley Lab's Molecular Foundry – West and North Elevations



Fig 5. Berkeley Lab's Molecular Foundry –East and South Elevations



Fig 6. Berkeley Lab's Molecular Foundry –Contrast obtained in main working cubical space from the unshaded West Elevation

## 2.2 San Francisco Federal Building – No LEED approval

The 18-story San Francisco Federal Building is a narrow building, only 65 feet wide, to allow daylight to all offices. The building that can accommodate 2,000 employees features a number of novel design attributes. The narrow floor ensures nearly every worker gets natural light and air, allowing for cross-ventilation. The windows operate by climate sensors. The elevators stop every three floors, forcing federal employees to walk more. The building offers two completely different facades (Figures 7,8,9). On the north side, delicate vertical glass fins serve as brises-soleils, while the translucent windows on the Southern elevation are covered with perforated metal skin that allows transparency and at the same time shade the glass. The windows can be operated from inside, and when they are open, a cool breeze drifts through the space. Beautiful undulating concrete ceilings help channel the air from north to south. The concrete floors and ceilings serve as thermal mass that reduced the temperature swing in winter, and that is cooled in summer during the night by natural ventilation to ensure low temperature during summer days, with no need of air conditioning. The building was designed to be heat and air-conditioning free. Detailed analysis of the natural cross-ventilation airflow pattern, the maximum velocities in the occupied workspace, for fine tuning of the design, was carried on by computer simulations. The building consumes only about 33% of the power of a standard office tower [7].



Fig 7. The San Francisco Federal Building – South Elevation and the restaurant in the front of it



Fig 8. The San Francisco Federal Building – North Elevation with vertical glass fins as brises-soleils





Fig 9. The San Francisco Federal Building – South Elevation with perforated metal skin as horizontal Sunshades

The new Federal Building was expected to be the greenest federal building in the nation's history and the expectation was to obtain LEED platinum. But to an all out surprise it did not pass LEED accreditation at all.

What really happen? The lack of internal climate controls has left some workers too cold and others too hot. While the managers' offices do have heat and air conditioning the other staff felt uncomfortable. On top of it, architect Mayne has stated that federal office workers do not get enough exercise. Therefore, he didn't design a coffee house inside the building, but designed a restaurant across the plaza, which force the people to walk. He also installed elevators in the building that only stop at every third floor. This requires employees to walk up or down one flight that made them unsatisfied. Also, they didn't like to walk to the window to open it manually.

However, this doesn't explain the project's failure to satisfy LEED's scoring system. The reason for that is that when you have no mechanical systems, you can't achieve high score in EA credit 1 for minimizing energy performance, in order to get the 10 points for that credit. This is because the Performance Rating Method is based on appendix G of ASHRAE 90.1-2004, which can't be used for buildings without mechanical systems ([6] Page 169). "Buildings that have no mechanical heating and/or cooling systems, can achieve some credit by modeling fan systems as "cycling" in the Proposed Design versus continuously operated fans in the Baseline Design (ASHRAE Std. 90.1 Table G3/1 No. 4 – Fan Schedules)" (LEED v2.2 Reference manual page 185 [2]). If this is not a paradox, what is? The answer to this is that the systems used for environmental control in the Federal Building are so innovative that they could not be assessed by the LEED grading system. The USGBC, however, claim that LEED is a work-in-progress, and have consented to take the next few months to re-evaluate the Federal Building [8].

### 3. Solar Sustainable Communities

#### 3.1 Home Village in Davis California

Village Homes is an innovative sustainable community on 70 acres in Davis, California, designed and built by developers Michael and

Judy Corbett. It was designed to encourage both the development of a sense of community and the conservation of energy and natural resources. The construction of the village started in 1974. It includes 225 single family homes, 20 apartments and a cooperative house. Business space is included in the community center and an inn was recently completed. There is a comprehensive community center, with pool, meeting and party rooms, and large playing field.

The conservation of energy and natural resources embraces different elements of **Passive and Low Energy Architecture** as well as **Green Architecture** this includes:

**Orientation** - All streets are elongated along east-west axes (Fig. 10) and all lots are oriented north-south to allow passive solar architecture (Fig. 11). This orientation facilitates natural heating and cooling using winter sun for solar heating and shade and night-time ventilation cooling for relief from the summer heat.

**Street Width** - All streets are narrow and curving, and cul-de-sacs. The narrow widths minimize the amount of pavement exposed to sun in the long, hot summers and aid to the thermal comfort by reducing the urban heat island effect. It also reduces stormwater drainage problems, and improves the quality of life by minimizing traffic and noise. The curving lines of the roads force the few cars that venture into the cul-de-sacs to travel slowly.

**Pedestrian/Bike Paths and Common Areas** – There is a system of pedestrian/bike paths, running from the Village Homes through all common areas. Most houses face these common areas rather than the streets, so that emphasis in the village is on pedestrian and bike travel rather than cars.

**Natural Drainage** - The common areas also contain innovative natural drainage system, a network of creek beds, swales, and pond areas that allow rainwater to be absorbed into the ground rather than carried away through storm drains. Besides helping to store moisture in the soil, this system provides a visually interesting backdrop for landscape design.

**Edible Landscaping** – Fruit, nut trees and vineyards form the landscaping in Village Homes.

**Open Land** - In addition to the common areas between homes, Village Homes also includes two big parks, extensive greenbelts with pedestrian/bike paths, two vineyards, several orchards, and two large common gardening areas.



Fig. 10. Home Village in Davis, California

Homes are known for improving comfort and utility bills average about 50-60% of the surrounding developments due to the Passive Solar and Bio-climatic design of the community and houses that incorporate solar design features and solar hot water.



Fig. 11. A Passive Solar House in Davis, California

Although the density is almost double compare with the surrounding areas, the quality of life is much higher. This is reflected in increased home value (a \$10-15 per square foot premium) and much quicker home sales in Village Homes. The community of Village Homes demonstrates that development can work for people and the environment. It also demonstrates that Green Architecture should not replace good Passive and Low Energy Architecture, but can be added on top of it.

### 3.2 Civano in Tucson Arizona

Civano started as the Tucson Solar Village, a small development of 10 solar homes. The governor of Arizona saw the Village and asked its developer, John Wesley Miller, to replicate the community on a larger scale. In 1996 the community came together when the land for the development was purchased. Civano, is an 820-acre traditional neighborhood development designed with the idea to become an example of a sustainable community and to become home to more than 5,000 people. Because Civano is located far away from Tucson's center, it was planned to create a job for every two households, located no more than a five-minute walk from the town center, reducing the need for automobile travel and thereby reducing air pollution. Ideally, Civano will attract businesses engaged in solar power and other renewable resource fields.

The sustainable features for Civano resemble much those of Davis and include:

**Energy conscious design and applying Renewable Energy;** including passive solar designs, solar hot water and photovoltaics (as they become economical) to reduce energy demands by 50%.

**Harvested or reclaimed water** will irrigate xeriscape vegetation and conserve precious potable water while reducing 65% in potable water.

**Solid waste recycling** will reduce landfill use.

**Tree-lined biking and walking paths** throughout the community will reduce auto use and air pollution.

**Narrower streets with shade trees** will help create liveable neighbourhoods and result in a cooler microclimate.

**More efficient lot layouts** will encourage social interaction, and allow conservation of large natural areas for wildlife.

**Applying New Urbanism ideas of mixed land use;** Convenient groceries, offices and parks will allow residents to shop, work and play near home, reducing the costs and side effects of auto dependence by 50%.

**Creating village center** will cluster commercial, cultural and civic activity in the village center to foster a small town feel.

With all these goals Civano was supposed to be a cutting edge example for a better energy and environmentally sound design. Were these goals really achieved?

The Neo-Traditional Community Review shows that the rating obtained by Civano for achieving New Urbanism goals is only 1.71, while any number below 2 means that the design fails to meet objective [<http://demographia.com/db-nu-azcivano.htm>]. As for energy and environment goals, except for the narrow streets, tiny lots, and harvesting and reclaimed water it is not the example we would expect to see. It can't be compared with Davis Home Village, which was designed 20 years before Civano. The houses are not designed for passive solar gain, all have modern air conditioning, and there seemed to be very few homes with solar hot water or photovoltaic panels. The master plan shows that about half of the lots are oriented east and west (Fig. 12). This means that the main glazing of the houses will get the East and West sun in the hot climate of Arizona. On top of it, there were no Southern glazing to get the passive solar energy to heat the building in winter, and most buildings were built from light material' which is bad for the summer. Cooling the thermal mass in the summer nights could reduced the cooling needs.

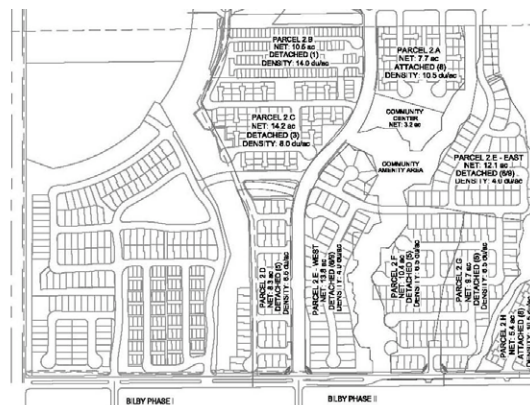


Fig. 12. Plan of Civano I and Civano II

However, it is claimed that the total improvement in energy in Civano I compare with the "baseline", which is Tucson Pre-1996 homes is about 44%, and Civano II is about 47%. This was achieved mainly by improving the mechanical and lighting system, as well as the building insulation

materials and glazing, and seldom by also adding hot water collectors on the roof and one panel of PV (Fig. 13). No need for Bio-climatic design and passive solar architecture was required. As the 2005 Sustainable Energy Standard required that the target annual energy consumption of the building shell and mechanical system and domestic hot water heating will be less than the energy required by the present Tucson/Pima County Model Energy Code by 50% (Sustainable Energy Standard, Chapter 1, Section 101.4.), there is no need to improve the building design, as such an improvement may be achieved mainly by the mechanical systems.



Fig. 13. Hose in Civano II –PV Panel and Solar collector for hot water. No Passive Solar Architecture.

#### 4. Discussions

This paper discusses and analyzes an example of LEED accredited building, as well as a building that failed to gain LEED accreditation. It also examined “Solar Communities”, like Home Village in Davis California that was design in the late 70th as passive solar and sustainable community and is a great success and compared with Civano in Tucson Arizona that was lately designed with no unique Bio-Climatic strategies.

Although one would expect bio-climatic, passive and low energy architecture to glow with the Green Architecture movement, examining carefully the above mentioned buildings and sustainable communities and compare them with our basic knowledge of good practice of Passive and Low Energy Architecture, we might be frustrated. One can easily see that in some way, Bio-Climatic and Passive Solar Architecture was almost abandoned.

Based on the examples discussed the following issues were revealed:

1. Passive Solar Energy is not considered as On Site Renewable Energy. Consequently, there is no incentive in LEED for passive solar design.
2. LEED, as most of the other Green Buildings Rating systems, is a simple ‘point hunting’ approach. In order to achieve LEED Silver, the most common goal, one can get the minimum score required for it without improving the energy performance of the building at all.
3. Energy efficiency in buildings, according to LEED can be achieved only by improving the mechanical, electrical and hot water systems. There is no need to improve the architectural design from bio-climatic and passive solar aspects.

4. If the building is an innovative Bio-climatic design that doesn’t require any mechanical heating or cooling, it can’t be assessed and graded by LEED and hence it can’t achieve Green Building accreditation.

Some questions may arise: Is bio-climatic architecture still required when new and better materials and HVAC systems have become available? And if YES, how should we, as PLEA members, endorse and promote good bio-climatic, passive solar architecture into the main stream of Green Architecture?

#### 5. Conclusion – What to do?

The fact that all energy saving features are put in one basket, and the energy standard are define in such a way that the goals can be achieved with no need for good architectural design, leads to the present situation. First, we should straggle first, that Passive Solar Design will be treated as any other renewable energy, which means, that it will be awarded twice. Second, the Building Code should treat the energy conscious building design separately from the mechanical and the hot water systems. This is because the building is designed to last for at least 50 years, while the mechanical and hot water systems last less than half of it.

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