Los Angeles Wilshire Center Business Improvement District
AIA Committee on the Environment Visioning Charrette
March 15, 2008

Introduction

The Wilshire Center Business Improvement District of Los Angeles is a Regional Commercial Center per the City's General Plan and includes a dense collection of high-rise office buildings, large hotels, regional shopping complexes, churches, entertainment centers, and both high-rise and low-rise residential buildings. The WCBID is comprised of approximately 12 million square feet of residential, 19.5 million square feet of office, and 1.5 million square feet of retail space.

The WCBID has pledged to reduce Green House Gas (GHG) emissions by two percent per year for the next 40 years, for a total reduction of 80 percent compared to current GHG emission levels. On March 15, 2008 the AIA Los Angeles Committee on the Environment (COTE) convened a visioning charrette to explore strategies for meeting the WCBID goal. The data and calculations herein have been prepared to support the COTE charrette process and to quantify, where possible, the beneficial potential of COTE strategies.

CO_2 Production Benchmark Data

1. LADWP Electrical Power: 1,304 lbs CO_2/MWh (1.3 lbs CO_2/kWh) delivered[1]
2. Vehicle Travel: 1,333 lbs CO_2/1000 miles driven[2]
3. Water: 16.6 lbs CO_2/1000 gallons used, or
   816 lbs CO_2/person per year [3]
4. Food: 9,960 lbs CO_2/person/year[4]

CO_2 Reduction Possibilities (<u>annual basis</u>)

1. On-site Power Generation from Photovoltaics[5]:
   24,800 lbs CO_2/1000 square feet of south facing, vertical array per year
   37,100 lbs CO_2/1000 square feet of south facing, horizontal array per year
   42,100 lbs CO_2/1000 square feet of south facing, tilted array (tilt angle equals Los Angeles Latitude) per year

   The Open Space/Transportation subgroup of the COTE Wilshire Center Cool District Eco Charrette identified a specific and quantifiable strategy that would cover approximately ½ of the 1.7 million square feet existing surface parking with south facing, tilted photovoltaic arrays. This suggestion will reduce CO_2 emissions by **37.8 million pounds per year**. See calculation below.[6]

2. Carbon Storage and Sequestration in trees[7]:
   57 lbs CO_2/tree per year

3. Reduced vehicular travel
   1,333 lbs CO_2/1000 miles driven[8]

4. Building Envelope Improvements: Green Roof and Cool Roofs
   Up to 50 percent savings on air conditioning loads are possible for the space directly below the roof, usually the top story of the building.[9]

5. Building Envelope Improvements: Window Films
   Quantifiable only for specific buildings and situations[10]

6. Reduced Water Use
   16.6 lbs CO_2/1000 gallons used[11]

Evaluation and Prioritization of CO_2 Reduction Strategies

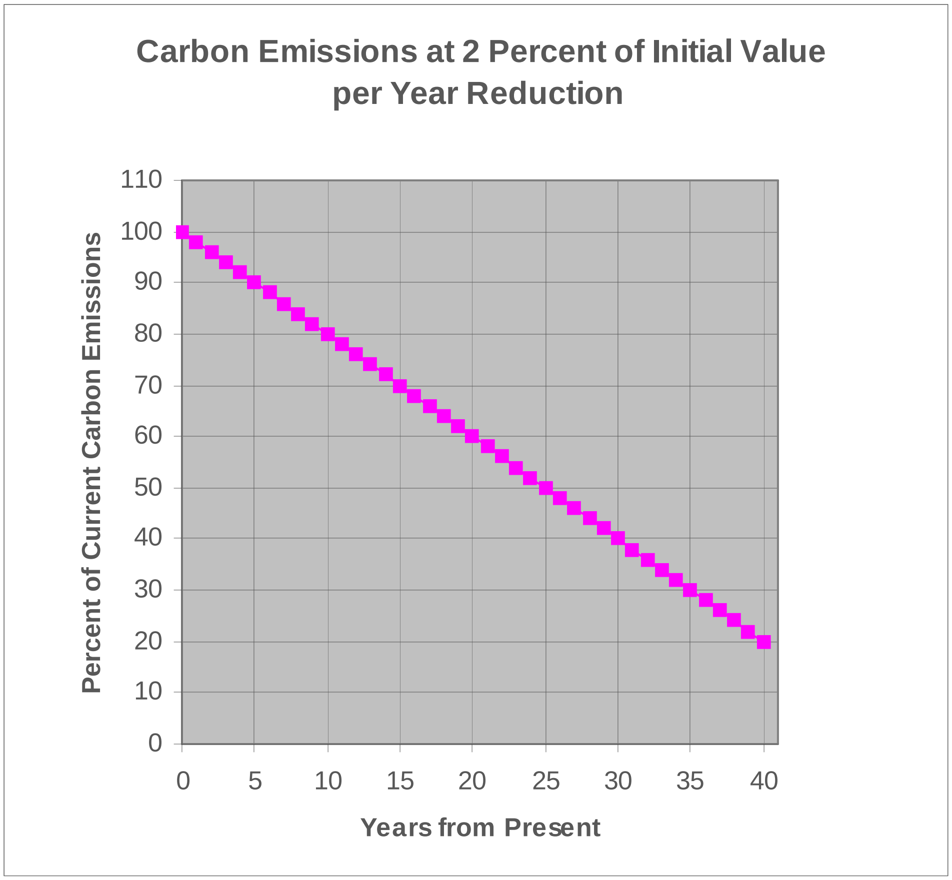
Useful Life

The District's goal of two percent reductions to CO_2 emissions per year for the next 40 years sets an ambitious direction and standard. As a standard the goal can be used to evaluate CO_2 reduction strategies for suitability within the district.

As a way of evaluating strategies that might be candidates for implementation within the District the figure below is included to show the year-by-year trend in carbon emissions if the 2 percent per year goal is achieved. The cumulative reduction over the 40-year period of this effort is 80 percent from current emissions levels.

Because the projects and initiatives that will be considered in the District will have some type of "project life" or "useful life" it is important to evaluate that project against the cumulative reduction needed over its expected useful life. This is mentioned because any project or initiative that does not approach this cumulative reduction target within its expected useful life will become a liability in just a few years because it falls short of what must be accomplished over time.

The figure below can be used to evaluate projects and initiatives based on their expected useful life. For example, if one were to consider replacing an infrastructure component that had a 20-year useful life and a 5-year design and construction period a selection that reduces energy use by about 50 percent would be consistent with the project goal. Any component that does not meet this goal will become a liability within its useful life. Similarly, a component with a 30-year useful life with a 5-year design and construction period should achieve a reduction of 70 percent compared to current emissions levels.



Case Studies and Demonstration Projects to Develop Guidelines
As noted above, some strategies for reducing CO_2 emissions in the District are difficult to quantify because of the many variables that affect building performance and thus possible reductions to CO_2 emission rates. For this reason, and as a means to evaluate and prioritize the effectiveness of different approaches, the District may find it beneficial to select "prototypical" buildings for study. The effort could be focused, for example, on "office towers", "multi-family residential", and perhaps "retail". In each case, the end result could be a set of guidelines that rank renovation or improvement projects in terms of their effectiveness in meeting the District's goal of 2 percent per year reductions to CO_2 emissions.

In addition to collecting meaningful performance and cost data, case studies or demonstration projects could call attention to the District's progress and leadership in reducing CO_2 emissions within the city. Such attention could also result in partial funding for such efforts and increased visibility for the District.

In some instances, the case study or demonstration project might be something that is already built, and simply needs to be evaluated in light of District goals. For example, it may be that one of the District's Owners has already implemented energy conservation measures such as installing new lighting systems, applying window films, upgrading HVAC controls, etc. If such projects have already been implemented, the "case study" effort may be as minimal as researching and reviewing existing utility bills before and after the project, reviewing building floor plans and HVAC drawings, and conducting limited onsite measurements to determine an appropriate metric for use in a guideline.

As an extension of the above idea, case studies in other southern California cities may also bear directly on the District's goals. In these cases, a "paper" research effort may yield valuable information that can be used within the district to set priorities and develop guidelines applicable to the different building types within the District.

Selected strategies that may warrant further research or case study evaluation may include:

- On site wind power generation (gather meteorological data or evaluate existing data)
- Geothermal applications (such as ground coupled heat pumps)
- Solar thermal (solar water heating, convective ventilation via induced draft solar towers, passive solar for space heating, etc.)
- Shared utilities and optimized diversity (district heating or cooling, time-share utility services, etc.)
- Various strategies for HVAC upgrade or downsizing (digital controls, evaporative pre-coolers, economizer cycles, operable windows, convective ventilation, etc.)
- Various strategies for electrical/lighting upgrades or downsizing (compact fluorescent, LED, lighting controls, daylighting, etc.)

The linkage between current Green House Gas emissions and strategies to reduce these emissions should not be lost. If the ongoing work to develop a GHG emissions inventory for the District only results in simple categories such as transportation and buildings, the ability to develop and prioritize reduction strategies will be limited and more research or individual case studies may be needed to assist with development of meaningful GHG reduction strategies, implementation guidelines, and priorities.

On the other hand, if the GHG inventory identifies multiple layers of subcategories it will be much more useful to development of focused strategies and implementation guidelines to reduce CO_2 emissions. As an example, if a total number for building related GHG emissions can be allocated among building types (office, multifamily residential, retail, etc.) more information will be available to COTE and to others working on and prioritizing specific programs to reduce CO_2 emissions. Within each building type, if further allocations are possible (say between lighting, air conditioning, office equipment or appliances, etc.) even more useful information will be available to the District and to those working on CO_2 emissions reduction strategies. Similar advantages would be associated with multiple levels of information within the transportation category…personal vehicles, municipal vehicles, public transit, delivery or commercial vehicles, etc.

References and Notes:

1. Los Angeles Department of Water and Power 2006 Green Power Annual Report http://www.ladwp.com/ladwp/cms/ladwp005196.pdf

2. Based on assumed city driving mileage of 15 miles per gallon and release of 20 lbs of CO_2/gallon fuel. Note that combustion of diesel releases 22.2 lbs CO_2/gallon and gasoline 19.4 lbs CO_2/gallon per the Office of Transportation and Air Quality, *Emissions Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel*, Report # EPA420-F-05-001 (Washington, D.C.: United States Environmental Protection Agency, February 2005).

   According to the State of California Department of Transportation a total of 43,577,950 miles were driven each day within the city of Los Angeles during 2006. See State of California, Department of Transportation, Division of Transportation System Information, *2006 California Public Road Data* (Sacramento, CA: Office of Travel Forecasting and Analysis, Highway Performance Monitoring System Branch, July 2007), Table 6. Available at: http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/hpmspdf/2006PRD.pdf

3. Based on 12,700 kWh per million gallons of water inclusive of energy for supply and conveyance, treatment, distribution, and finally wastewater treatment. See California Energy Commission, *California's Water-Energy Relationship*, Report CEC-700-2005-011-SF (Sacramento, CA: California Energy Commission, November, 2005), Table 1-3. Available at: http://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF

   Carbon Dioxide emissions per kWh were assumed to equal LADWP published data (see 1 above).

   Per capita water consumption in Los Angeles is approximately 135 gallons per day or 49,255 gallons per year. See LADWP Quick Facts 2005-2006. Available at: http://www.ladwpnews.com/go/doc/1475/161220/ The annual carbon footprint associated with water use is thus approximately 816 lbs CO_2/person per year.

4. This estimate is based on a per capita diet of 2500 kcal per day and waste of 500 kcal per day, for a total required food resource of 3000 kcal per day per person.

   Calculation:
   (3000 kcal food/day)(365day/year)(15 kcal fossil fuel/kcal food)(1 gallon diesel/33,000 kcal fossil fuel) = 498 gallon/year
   (498 gallon/year)(20 lbs CO_2/gallon) = 9960 lbs CO_2/year

   The 15 kcal fossil fuel used per kcal food delivered is based on work by Richard Manning and Michael Pollan. See Pollan, Michael. *The Omnivore's Dilemma: A Natural History of Four Meals*, 1st Edition (New York: The Penguin Press, 2006); and Manning, Richard. "The Oil We Eat: Following the Food Chain Back to Iraq." Harper's Magazine, February 2004. Available at: www.harpers.org/archive/2004/02/0079915

5. Based on overall efficiencies of 10 percent, 15 percent, and 17 percent respectively for vertical, horizontal, and tilted photovoltaic arrays. CO_2 reductions are equivalent to LADWP published data for delivered electrical power. Los Angeles area solar insolation assumed to be 5.6 $kWh/m^2/day$ (annual average).

6. 0.5 x 1,700,000 square feet x 42,100 lbs CO_2/1000 square feet/year = 35.785 million lbs/year

   Placement of photovoltaic panels on existing buildings and in other locations was recommended by several subgroups during the charrette but was not quantified. When quantified, CO_2 reductions may be calculated using the benchmark data listed above.

7. Adding urban vegetation was suggested by every COTE subgroup at the March 15, 2008 Eco Charrette (as urban parks, "green" streets, green corridors, and green roofs). The CO_2 reductions possible with these strategies accrue indirectly as shade on nearby buildings, reduced heat island effects, building and rooftop cooling via plant transpiration, and insulating properties of green roofs. Similarly direct CO_2 reductions result from sequestered CO_2 in plant materials. Only the direct affect of sequestered CO_2 allows reasonable quantification at this time.

   Average annual sequestration rates are reported at from 77 to 95 and 48 to 79 lbs per tree in Sacramento and Chicago, respectively. See McPherson, E. Gregory. "Atmospheric Carbon Dioxide Reduction by Sacramento's Urban Forest." Journal of Arboriculture 24(4): July 1998. Available at http://www.fs.fed.us/psw/programs/cufr/products/cufr_26_EM98_9.pdf

   The 57 lbs CO_2/tree per year rate was derived from data presented by milliontreesla.org:
   http://www.milliontreesla.org/mtarticles/milliontreesmtarticles262844646_04192007.pdf

8. The Wilshire Center Business Improvement District identified reduced vehicular travel as a key Wilshire Center Cool District goal. The COTE Eco Charrette recognized the importance of this goal and responded with several strategies for both improving conditions for pedestrian traffic within the District and discouraging vehicular travel. These strategies include lane and street use changes, modification of current parking requirements, encouragement of bicycle and bus transit, etc. While quantification of reduced vehicle miles was not possible, the CO_2 reductions associated with reduced vehicular travel are significant. The rate term of 1,333 lbs CO_2/1000 miles driven is included here as a representative benchmark for reference and future use.

9. Some studies estimate that green roofs can save up to 50 percent from air conditioning costs for the top story of a building. The savings vary based on the type of roof (green vs. cool), the cooling load for the space immediately below the roof, and the outside air temperature. For green roofs additional variables such as soil thickness, plant material, etc. make it difficult to quantify the possible CO_2 reductions in a general fashion.

   The city of Los Angeles has published a resource guide for green roofs and has suggested:

   > "Convincing, quantitative demonstrations of green roof benefits would go a long way towards promoting wider acceptance among developers and building owners and generating opportunities for additional funding sources and incentive programs. Demonstrations of green roof benefits would generate favorable publicity and promote public awareness and acceptance of green roofs. Results of benefit monitoring could also be used to optimize green roof design for the unique characteristics of the Los Angeles environment."

   The District may find it advantageous to work with the city to find funding for such a demonstration project. The reference for the resource guide is: Environmental Affairs Department, *Green Roofs – Cooling Los Angeles* (Los Angeles, CA: Environmental Affairs Department, City of Los Angeles, 2006). Available at: http://www.lacity.org/ead/EADWeb-AQD/Green%20Roofs%20Resource%20Guide%202007.pdf

   Similarly, and especially in residential buildings, attic insulation (in lieu of a green roof) can be effective in reducing or eliminating the need for air conditioning for the top floor (or the entire residence if a single level building).

10. Of all components of a building's envelope, windows represent the largest contribution to cooling loads. Up to 30 percent of a building's cooling load typically originates from solar gain via windows. Many strategies have been developed to minimize solar heat gain associated with windows and include shading (interior and exterior), architectural overhangs, proper selection of window glass and frame components, careful building orientation, application of

window films to existing glazing, and simply reducing window or glazing area. Because solar gain associated with windows and glazing is dependant on so many factors and variables, and because these factors and variables differ from building to building, development of a general CO_2 reduction rate term is not possible at this time.

However, since energy used for building cooling represents a significant source of CO_2 emissions in the District, potential CO_2 reductions associated with building envelope improvements should not be overlooked. Similar to the city's recommendation for demonstration projects for green roofs, the District may find it beneficial to work with the city to find funding for such a demonstration project focused on application of window film, shading, or other modifications to reduce solar gain via windows in existing air conditioned buildings.

11. LADWP has several programs in place to promote water conservation and recycling. See the following:
http://www.ladwpnews.com/posted/1475/waterconservation.161222.pdf
http://www.ladwpnews.com/posted/1475/water_recycling.161223.pdf
http://www.ladwpnews.com/posted/1475/Water_Saving_Strategies_.161225.pdf

    During the COTE Eco Charrette nearly all of the subgroups recognized water conservation and grey water reuse as a possible strategy for reducing CO_2 emissions. In some instances the savings associated with individual appliances can be easily calculated, but because it is difficult to know the existing condition it is thus difficult to quantify an overall net savings for such strategies. Other strategies represented new ideas and were equally difficult to quantify, such as grey water use for irrigation, etc. Nevertheless, these ideas offer real potential for reduced CO_2 emissions and the rate term of 16.6 lbs CO_2/1000 gallons is included here as a representative benchmark for reference and future use.

Please contact Richard Rollins at (925) 932-1303 or by email at richard@rollinscs.com should questions arise regarding any of the above calculations or references.