LANDSCAPE TOOL SERIES

MULTI-BENEFITS OF LANDSCAPE TRANSFORMATION

ENERGY AND GREENHOUSE GASES

Introduction

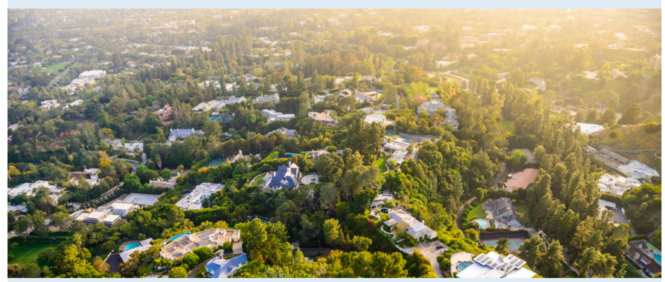
Maintaining landscapes requires energy, which results in releases of greenhouse gases (GHGs). Mowing lawns is fuel-intensive, and the decomposition of green waste, like grass clippings, releases GHGs. The California Air Resources Board (CARB) found that the population of lawn equipment with small engines exceeds the number of light-duty passenger cars by 3 million (16.7 million vs. 13.7 million respectively), and further, running a lawn mower for an hour is the equivalent of driving 300 miles. Collectively, the use of this equipment results in over 50 tons per day of smog forming emissions, and by 2031, CARB estimates that emissions from small engines will be more than double that of passenger cars (CARB 2017).

In addition to direct energy used for maintaining landscapes, energy is required to pump, treat, and deliver water to landscapes. This is often referred to as the "energy intensity of water," or the energy to pump, treat, and deliver a specific volume of water. For example, the Pacific Institute found energy intensities for four Sacramento County water agencies to range between 300 to 700 kWh/AF (Heberger 2013). Therefore, saving water saves energy. Spang et al. 2018 found that during the 2015 drought, energy savings in California were 11% higher for state-wide water conservation measures compared to all energy efficiency programs run by Investor Owned Utilities during that time.

Landscapes that integrate the watershed approach in both design and maintenance can have a significantly smaller carbon footprint than traditional landscapes. They require less inputs (i.e. water, fuel, and fertilizer), reduce the amount of methane-producing green waste from entering landfills, and they can also cool the air. For example, the City of Santa Monica demonstrated water savings of 83% and green waste reduction of 56% over the course of 9 years for a sustainably designed landscape in comparison to a traditional turf-dominant landscape. Maintenance hours were also reduced by 68% and included discontinued use of lawn mowers. The Alliance for Water Efficiency conducted a survey of more than a dozen agency landscape transformation programs and found a 7% to 39% reduction in outdoor irrigation (AWE 2019). Other indirect energy benefits include:

- rain gardens, bioswales and permeable pavements that help retain and infiltrate stormwater to reduce the need for onsite stormwater pumping;
- carbon sequestration by woody perennial shrubs and trees that help offset GHG emissions;
- vegetative cover that reduces summertime air temperatures and in turn the energy demand for indoor cooling (Dimoudi and Nikolopoulou 2003); and,
- GHG emission reductions can help businesses achieve their sustainability or corporate stewardship goals (Cooley et al. 2019).

Trees



Landscape trees can help reduce peak household energy demand.

Urban trees are responsible for creating microclimates and help to significantly reduce summertime air temperatures. By shading buildings trees help reduce the solar heat gain on windows, walls and roofs and they transpire moisture into the air to help increase latent cooling (Dimoudi and Nikolopoulou 2003). In the summer of 1992 Akbari et al. discovered that shade trees at two Sacramento homes generated a 30% reduction in cooling energy. Additionally, peak energy demand was also reduced by 0.6 and 0.8 kW per household. In a later study Akbari et al. 2001 found that for most hot cities in the U.S. shading a building can save between $5 and $25 per 100m^2 of roof area annually.

Tools

The Pacific Institute developed the River-Friendly Landscaping Calculator, to assess emissions for various landscape designs in Sacramento county by accounting for five maintenance activities: (1) irrigation water treatment and delivery, (2) fertilizer applications, (3) lawn mower usage, (4) green waste transportation and disposal, and (5) green waste biodegradation in landfills (Heberger 2013).

- River-Friendly Landscaping Tool:
  - Comprehensive tool but values restricted to Sacramento County
  - Open source format allows for adaptation to other regions
  - Includes energy embedded in water, but no carbon sequestration
  - Formulas for converting electricity type to GHG emissions
  - Outputs: Annual GHG emission in pounds of carbon dioxide equivalents

Climate Positive Design developed a free web-based calculator in 2019 that analyses the carbon footprint of commercial landscape projects and estimates the number of years until carbon neutrality. A Climate Positive Design Scorecard reports back the total embedded carbon from materials, carbon sequestered by plants, operational carbon from maintenance, and time in years to achieve carbon neutrality.

- Pathfinder Landscape Carbon Calculator:
  - Practical for large commercial landscapes
  - Impacts assessed for a 50-year lifespan
  - Outputs: reported in pounds of carbon dioxide equivalents

Additional Considerations

Typically, landscape energy consumption and GHG emissions are associated with water usage and maintenance and rarely account for energy use attributed to installation and materials. Thus, an energy life cycle assessment of landscapes would more accurately reflect energy consumption over their projected lifetimes. Further, the lack of data on carbon sequestration for specific plant types (except for turf and trees) including perennial low water use varieties, limits a comprehensive analysis of this benefit.

In order to accurately calculate energy savings from landscapes one must rely on site-specific conditions, these include:

- Energy intensities of regional and local water supplies
- Irrigation water requirement (IWR) per hydrozone (IWR is a factor of reference evapotranspiration, plant factor, landscape area and irrigation efficiency)
- Recommended maintenance practices per region (i.e. irrigation and mowing frequencies, fuel used for energy consuming activities, fertilizer applications, mulch dressing)
- Green waste disposal and/or composting

Primary Resources

Akbari, Hashem, Dan M. Kurn, Sarah E. Bretz, and James W. Hanford. 1997. "Peak power and cooling energy savings of shade trees." Heat Island Project. *Energy and Buildings*. 25: 139-148

Akbari, Hashem, M. Pomerantz, H. Taha. 2001. "Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas." *Solar Energy*. 70 (3): 295-310

Alliance for Water Efficiency. 2019. Landscape Transformation: Assessment of Water Utility Programs and Market Readiness Evaluation.

https://www.allianceforwaterefficiency.org/impact/our-work/assessment-water-utility-programs-and-market-readiness-evaluation

California Air Resources Board. 2017. Small Engine Fact Sheet. https://ww2.arb.ca.gov/our-work/programs/small-off-road-engines-sore

City of Santa Monica. 2013. Sustainable Landscape Case Study: garden/garden a comparison of native and traditional gardens in Santa Monica. https://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Landscape/garden-garden-2013.pdf

Climate Positive Design. 2019. Pathfinder Landscape Carbon Calculator. http://app.climatepositivedesign.com/

Cooley, Heather, Anne Thebo, Cora Kammeyer, Sonali Abraham, Charles Gardiner and Martha Davis. 2019. *Sustainable Landscapes on Commercial and Industrial Properties in Santa Ana River Watershed*. Oakland, Calif.: Pacific Institute. https://pacinst.org/wp-content/uploads/2019/02/Pacific-Institute_Sustainable-Landscapes-in-the-Santa-Ana-River-Watershed_Feb-2019.pdf

County of Sacramento. 2013. River-Friendly Landscaping Benefits Calculator. https://www.riverfriendly.com/

Dimoudi and Nikolopoulou. 2003. "Vegetation in the urban environment: microclimate analysis and benefits." *Energy and Buildings*. 35: 69-76.

The U.S. EPA. 2018. Emissions and Generation Resource Integrated Database (eGRID). https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

Pierce Jones. 2010. Handout: Land Development, Landscaping and Greenhouse Gas Emissions. University of Florida, Program for Resource Efficient Communities.

Matthew Heberger. 2013. "Technical Document: River Friendly Landscaping Emissions Calculator." Prepared by the Pacific Institute for the County of Sacramento. Updated September 2013.

McPherson, Greg. 2007. Urban Tree Planting and Greenhouse Gas Reductions. Arborist News. June 2007, 32-34.

Spang, Edward S., et al. 2018. "The estimated impact of California's urban water conservation mandate on electricity consumption and greenhouse gas emissions." Environ. Res. Lett. 13 014016, https://iopscience.iop.org/article/10.1088/1748-9326/aa9b89/pdf

Other Energy Calculators for Water Management:

The Pacific Institute and Dr. Bob Wilkinson. 2012. Water-Energy Simulator (WESim). https://pacinst.org/publication/wesim/

The Climate Registry. 2019. Water-Energy GHG Metrics: Guidance for Water Managers in Southern California, Version 2.0 (WEG 2.0). https://www.theclimateregistry.org/

CALIFORNIA WATER EFFICIENCY PARTNERSHIP
A Chapter of the Alliance *for* Water Efficiency

901 F Street, Ste 225 | Sacramento, CA 95814
P 916-552-5885 | W CALWEP.ORG