Maximum Solar at the Heart of Urban Forests

Powered by SunShot
U.S. Department of Energy

September 18th, 2013
The SunShot Solar Outreach Partnership (SolarOPs) is a U.S. Department of Energy (DOE) program designed to increase the use and integration of solar energy in communities across the US.
Links to SolarOPs and ICLEIUSA:

SunShot Solar Outreach Partnership
www.solaroutreach.org
Follow @SolarOutreach

ICLEI – Local Government For Sustainability USA
www.icleiusa.org
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Type your questions/comments here
Speakers

- Chad Tudenggongbu, ICLEI – Local Governments For Sustainability
- David Morley, Senior Research Associate, Planning Advisory Service Coordinator/Co-editor of Zoning Practice at American Planning Association
- Daniel C. Staley, DCS Consulting Services
- Sara Davis, Program Manager, Office of the City Forester, Parks & Recreation, City and County of Denver
Balancing Solar Energy Use and Tree Preservation Through Local Planning
Communities Pursue Multiple Goals

- Livability
- Harmony with Nature
- Economic Resilience
- Social Equity
- Public Health
- Regional Cooperation
- Authentic Participation

A Sustainable Community
Communities Pursue Multiple Goals

Top-Level Goal: Harmony with Nature

2nd-Level Goal: Reduce Fossil Fuel Consumption

3rd-Level Goal: Reduce Fossil Fuel Demand
- Energy Efficient Construction
- Tree Preservation/Proliferation

3rd-Level Goal: Increase Renewable Energy Supply
- Solar Energy Use
- Wind Energy Use
- Geothermal Energy Use
Communities Pursue Multiple Goals

- Public Health
- Harmony with Nature
- Economic Resilience
- Solar Energy Use + Tree Preservation and Proliferation
A Planning Perspective

- Solar Irradiance as a Local Resource
  - Can be used to produce heat or electricity
  - Using it may affect the use or conservation of other resources
A Planning Perspective

- Trees as Local Resources
  - Can be harvested for wood and by-products
  - Can be preserved or planted for ecosystem services
  - Preserving or planting them may affect the use or conservation of other resources

Image: Spacing Toronto
A Planning Perspective

- There is an inherent (potential) conflict between solar energy use and trees.
A Planning Perspective

- Approach issues comprehensively
A Planning Perspective

- Consider long-term implications
Tools to Minimize Conflicts

- Resource studies/analyses

Energy Innovation Corridor – Minneapolis/St. Paul, MN
Tools to Minimize Conflicts

- Local Plans

Communitywide Comprehensive Plan

Subarea Plans
- Neighborhood Plans
- Corridor Plans
- Special District Plans

Functional Plans
- Green Infrastructure Plan
- Energy Plan
- Climate Action Plan
Tools to Minimize Conflicts

Example: Pleasanton, CA, General Plan

- Policy 4: Program 4.2: Continue to implement parking lot tree planting standards that would substantially cool parking areas and help cool the surrounding environment. Encourage landscaping conducive to solar panels in areas where appropriate.
Tools to Minimize Conflicts

- **Example**: Lake Oswego, OR, Sustainability Plan
  - Proposed Action: Revise Solar Access codes to be more user-friendly and efficient; include public conversation about inherent conflicts between tree protection and solar access protection (as part of green building program)
Tools to Minimize Conflicts

- Development Regulations
  - Subdivision Codes
    - Minimizing conflicts through site design standards
  - Zoning Codes
    - Minimizing conflicts through tree preservation/landscaping and solar access standards
    - Minimizing conflicts through community solar permissions
Tools to Minimize Conflicts

- **Example**: Berkeley, CA, Municipal Code, Chapter 12.45, Solar Access and Views

  The purpose of this chapter is to:
  
  1. Set forth a procedure for the resolution of disputes between private property owners relating to the resolution of sunlight or views lost due to tree growth...

  The objectives of this chapter are:
  
  1. To preserve and promote the aesthetic and practical benefits which trees provide for individuals and the entire community;
  2. To discourage ill-considered harm to or destruction of trees;
  3. To encourage the use of solar energy for heat and light;
  6. To encourage the maintenance of positive relationships within a neighborhood when there is conflict...
Tools to Minimize Conflicts

- **Examples**: Communities that explicitly permit community solar projects:
  - Cleveland Heights, OH (§ 1165.02(i))
  - Baltimore, MD (§ 14-306)
  - Boulder County, CO (§ 4-514.G&L)
Tools to Minimize Conflicts

- Public Engagement/Awareness Strategies
  - Mapping Tools
  - Permitting Assistance
  - Informational Brochures
  - Development Project Consultations
Planning for Solar Energy Briefing Papers

- Solar Community Engagement Strategies for Planners
- Solar Mapping
- Integrating Solar Energy Use into Local Plans
- Integrating Solar Energy Use into Local Development Regulations
- Balancing Solar Energy Use with Potential Competing Interests
- Recycling Land for Solar Energy Development

[www.planning.org/research/solar/]
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9/18/2013
Overview

- History
- Current and Future States of Rooftop Solar Energy Collection
- Solutions at Scale
History

- Long history of "Right to Light"
- Ancient Greeks: purposely planned built environment to receive sunlight
- 4th–6th century Roman empire: Code of Justinian
- Spanish colonization: Laws of the Indies
- British: "Ancient Lights," "Leylandii Law"

Spanish grid next to Jeffersonian grid in Los Angeles
History

- Laws rooted in British Common Law, but no “Right to Light” in USA, Canada
  - Legal precedents
- Hodgepodge of local laws
- Legal protections vary
History

- Trees used in lieu of wall cavity insulation to condition buildings
- 20th century trend away from design solutions for building conditioning
  - From gables, awnings
  - To using energy
  - Built environment durable
Costs plummeting, installations soaring
Current State

- Only 25% of U.S. roofs suitable for solar collection\(^1\)
- Social forces driving installations
  - “Green signaling”
  - Severe weather increasing
  - Energy independence

Future State of Solar

- Several forecasts of solar grid-parity by next decade
- Solar continues technological trend similar to “Moore’s Law” in computing
- More initiatives like California to encourage solar
Solutions at Scale

- Parcel-scale

Ordinance, covenant, easement, standard, professional design, guideline, educational material...
Solutions at Scale

- Street-scale

Ordinance, covenant, easement – post-disaster planning...
Solutions at Scale

- Neighborhood-scale

Ordinance, covenant

Solutions: Permitting

- Many European countries reduce cost by standardizing permitting
- Initial success in US from permit reform, Best Management Practices
  - http://solarcommunities.org/
  - American Planning Assn.
- Aforementioned solutions can fold into permit process, ordinances
Conclusions

- No legal basis for right to light in U.S., Canada
- Tree shade is used to condition the majority of older building envelopes
- Solar power on rooftops will be common soon
- Design paradigms must change to accommodate trees and urban forests
- Arborists and solar industry are good partners for solar-friendly development
The Urban Forester's Perspective
Metro Denver urban forest value

- 10.7 million trees
- Asset value of $13.1 billion
- $551 million in annual environmental services and property value
- 86,370 megawatt savings via shading
Denver Housing Authority enters into a power purchasing agreement for 2.513 megawatts installed at 668 sites
Lessons learned

Public amenity vs. private benefit
Lessons learned
Lessons learned

- **Specie:** silver maple
- **DBH:** 30”
- **Condition:** good
- **Appraised value:** $13,000
- **Status:** slated for removal
- **Removal cost:** $592.50

**Annual Benefits**

- **Storm water:** 3,294 gallons
- **Energy:** 69 kWh conserved
  - 12 therms
- **Atmospheric CO2 reduction:** 1,150 pounds
Your 30 inch Silver maple will conserve 69 Kilowatt-hours of electricity and reduce consumption of heating fuel by (12) therm(s).

Trees modify climate and conserve building energy use in three principal ways:

- Shading reduces the amount of heat absorbed and stored by buildings.
- Evapotranspiration converts liquid water to water vapor and cools the air by using solar energy that would otherwise result in heating of the air.
- Tree canopies slow down winds thereby reducing the amount of heat lost from a home, especially where conductivity is high (e.g., glass windows).

Strategically placed trees can increase home energy efficiency. In summer, trees shading east and west walls keep buildings cooler. In winter, allowing the sun to strike the southern side of a building can warm interior spaces. If southern walls are shaded by dense evergreen trees there may be a resultant increase in winter heating costs.

For more information see the USDA Forest Service’s Community Tree Guide series.
This 30 inch Silver maple provides overall benefits of: $25 every year.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees’ specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations to better understand the environmental and economic value associated with trees and their placement.

Benefits of trees do not account for the costs associated with trees’ long-term care and maintenance.

If this tree is cared for and grows to 35 inches, it will provide $24 in annual benefits.
Solar Simulation Results

**Summary**

- **System Inputs**
  - Size (kW): 2.53
  - System Type: Residential
  - Derating: 0.77
  - Tilt angle (*): 40
  - Azimuth angle (*): 180
  - Data year: 2004
  - Electric Rate ($/kWh): 0.09

- Payback
  - Initial Cost ($/Wp): 5.71
  - Initial Cost ($) 14446.3
  - Rebates ($) 8927.5
  - Tax Credits ($) 1655.64
  - After Incentives ($) 3800
  - Payback (years) 11.11

**System Outputs**

This table shows the amount of electricity (kWh) generated by the system each month and the dollar amount that those values translate into.

<table>
<thead>
<tr>
<th>Month</th>
<th>Output (kWh)</th>
<th>Value ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>296</td>
<td>26.65</td>
</tr>
<tr>
<td>February</td>
<td>295</td>
<td>26.65</td>
</tr>
<tr>
<td>March</td>
<td>397</td>
<td>35.73</td>
</tr>
<tr>
<td>April</td>
<td>346</td>
<td>31.14</td>
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<tr>
<td>May</td>
<td>360</td>
<td>32.40</td>
</tr>
<tr>
<td>June</td>
<td>293</td>
<td>26.37</td>
</tr>
<tr>
<td>July</td>
<td>300</td>
<td>27.00</td>
</tr>
<tr>
<td>August</td>
<td>327</td>
<td>29.43</td>
</tr>
<tr>
<td>September</td>
<td>334</td>
<td>30.06</td>
</tr>
<tr>
<td>October</td>
<td>302</td>
<td>27.16</td>
</tr>
<tr>
<td>November</td>
<td>303</td>
<td>27.27</td>
</tr>
<tr>
<td>December</td>
<td>315</td>
<td>28.35</td>
</tr>
</tbody>
</table>

*Value based on an electric rate of $0.109/kWh

**Load**

Now compare your estimated solar electricity production with your electricity consumption.

- **Step 1.** Select a load profile.
  - You may select a residential sample profile or upload your own custom load profile. The residential load profile is based on a kWh system.
  - **(A)** Use a residential load profile.
    - Choose a city from the drop-down box below.
    - Sample Profile: Select...
    - or
    - **(B)** Upload a load profile.
      - Click the Upload File button below. Then browse to locate your load profile document. For help click here.

**Step 2. Run Load Profile.**

- Run

Find Local Installers Export Results Close
Lessons learned

Tree
- Appraised value: $13,000
- Removal cost: $592.50

Solar collector
- Cost after incentives: $3,800
- Payback: 11.11 years
Lessons learned

Tree
- Appraised value: $21,400
- Removal cost: $711.00

Solar collector
- Cost after incentives: $9,200
- Payback: 5.97 years
Lessons learned

Public amenity vs. private benefit