Maximum Solar at the Heart of Urban Forests

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U.S. Department of Energy

September 18th, 2013

About the SunShot Solar Outreach Partnership

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

Follow @ICLEI_USA

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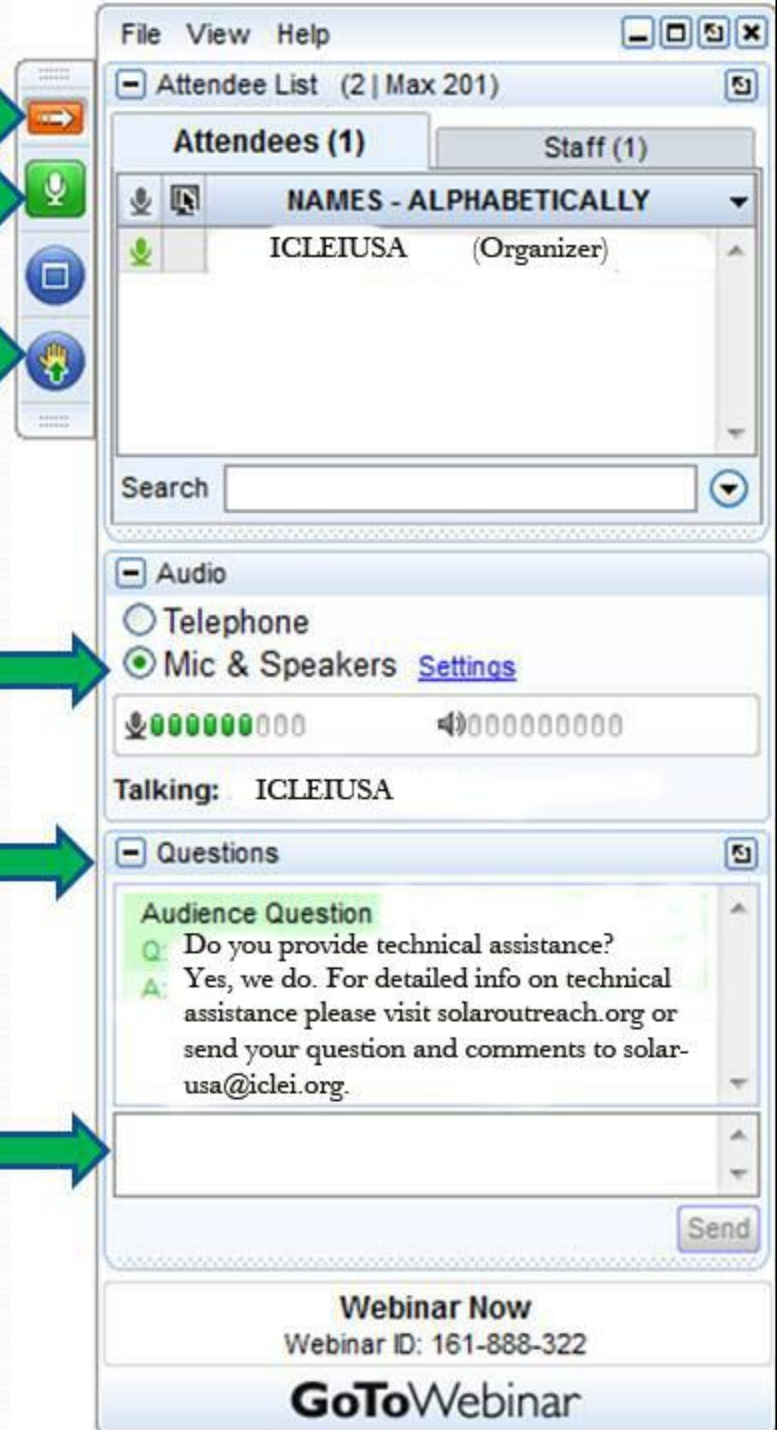

Speakers

- 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

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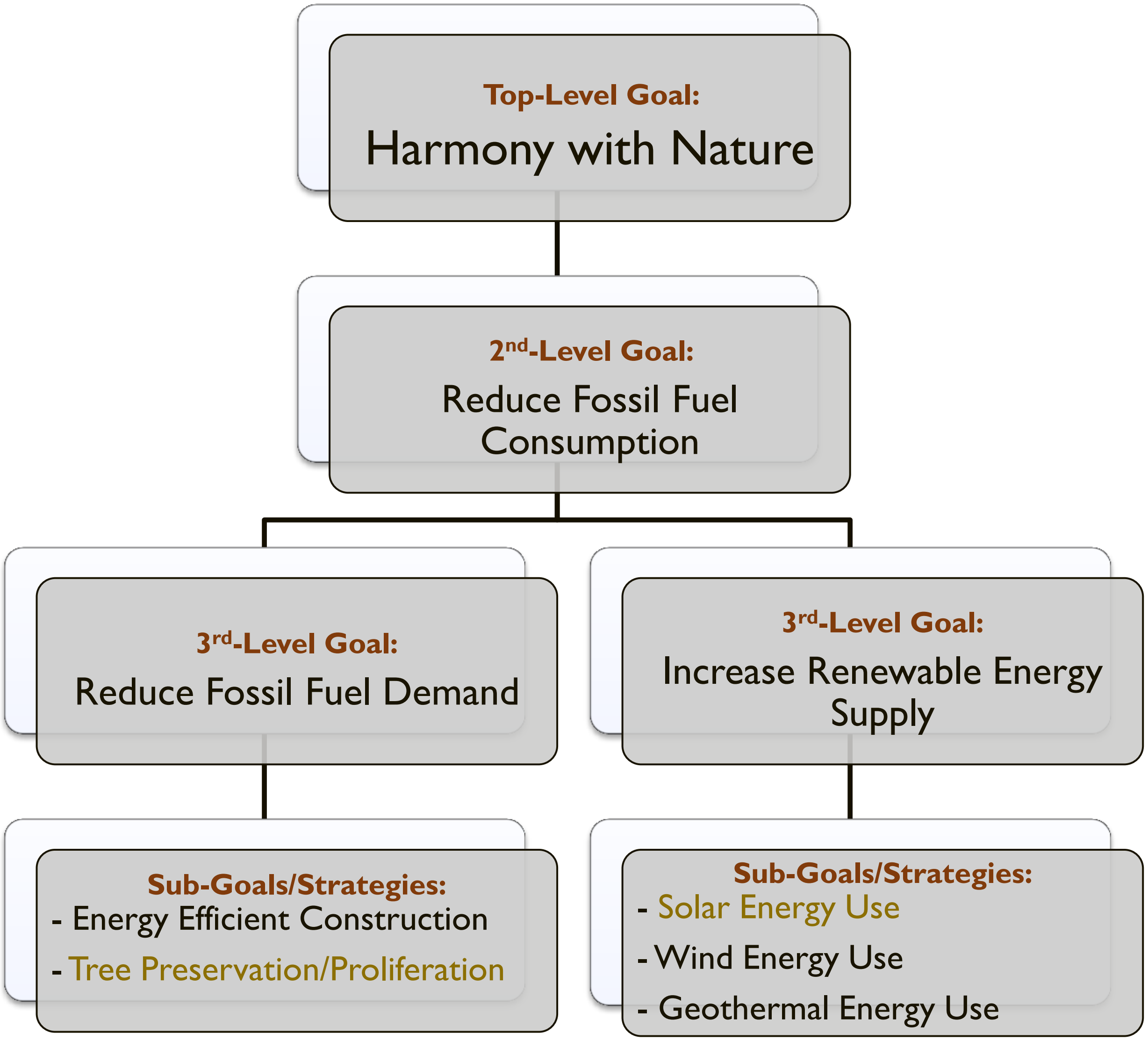
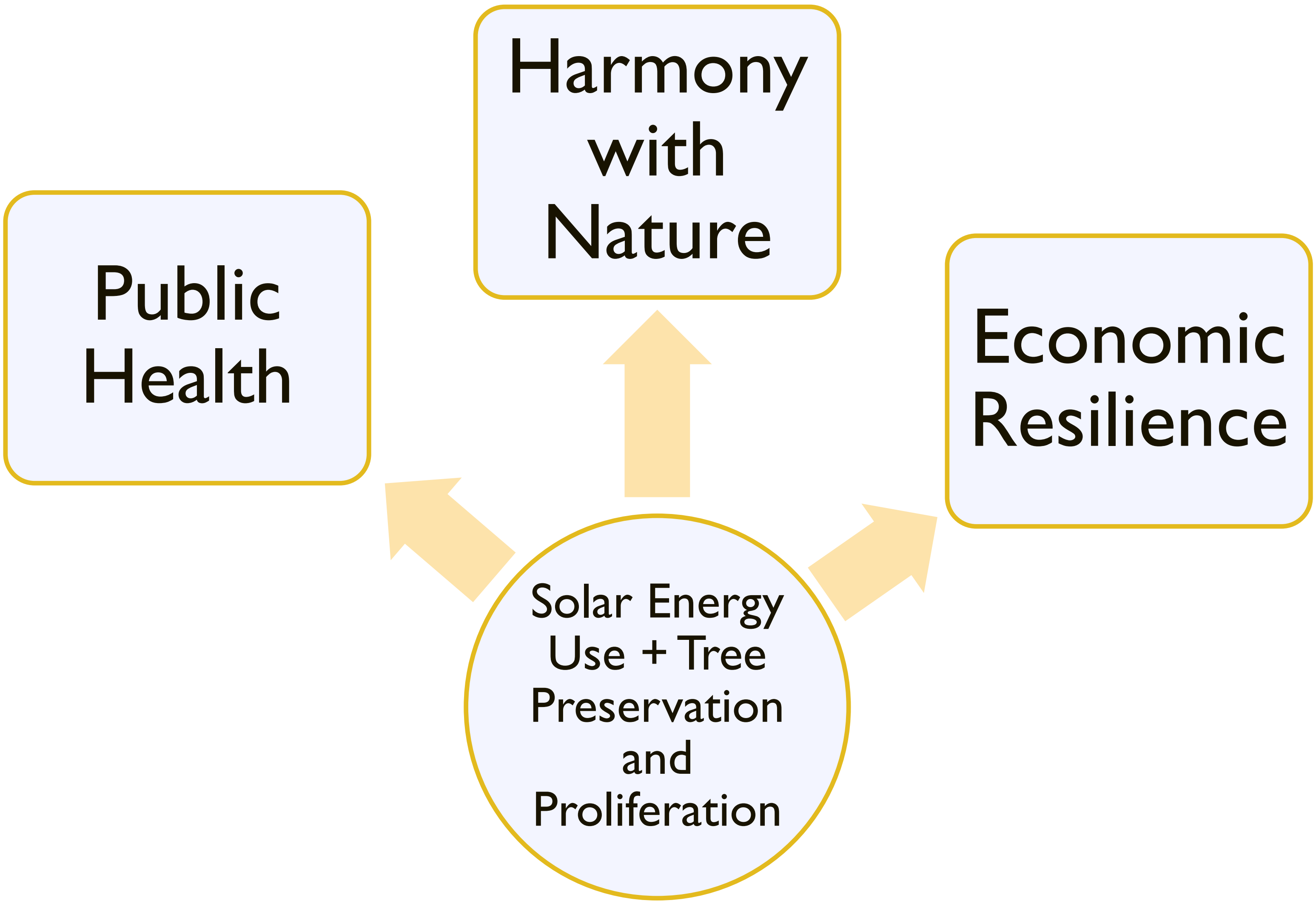
Communities Pursue Multiple Goals

Communities Pursue Multiple Goals

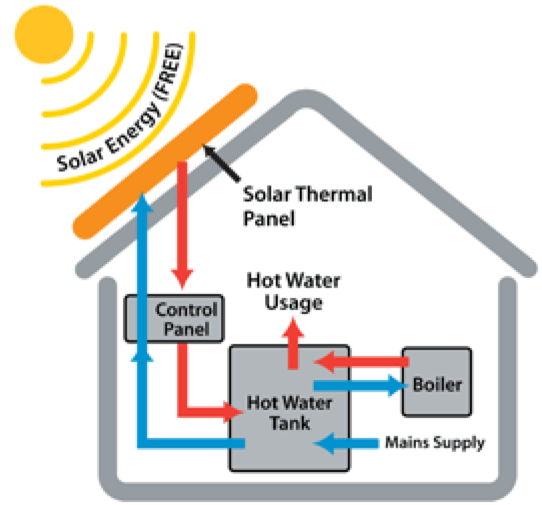


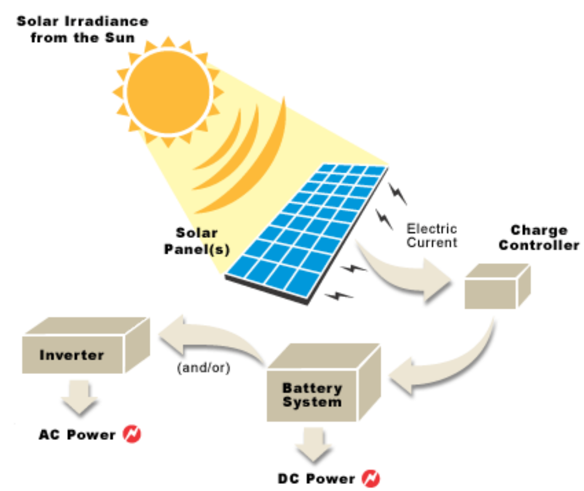
Communities Pursue Multiple Goals



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





Images: Genesis Energy Solutions; Millennium Planet

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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

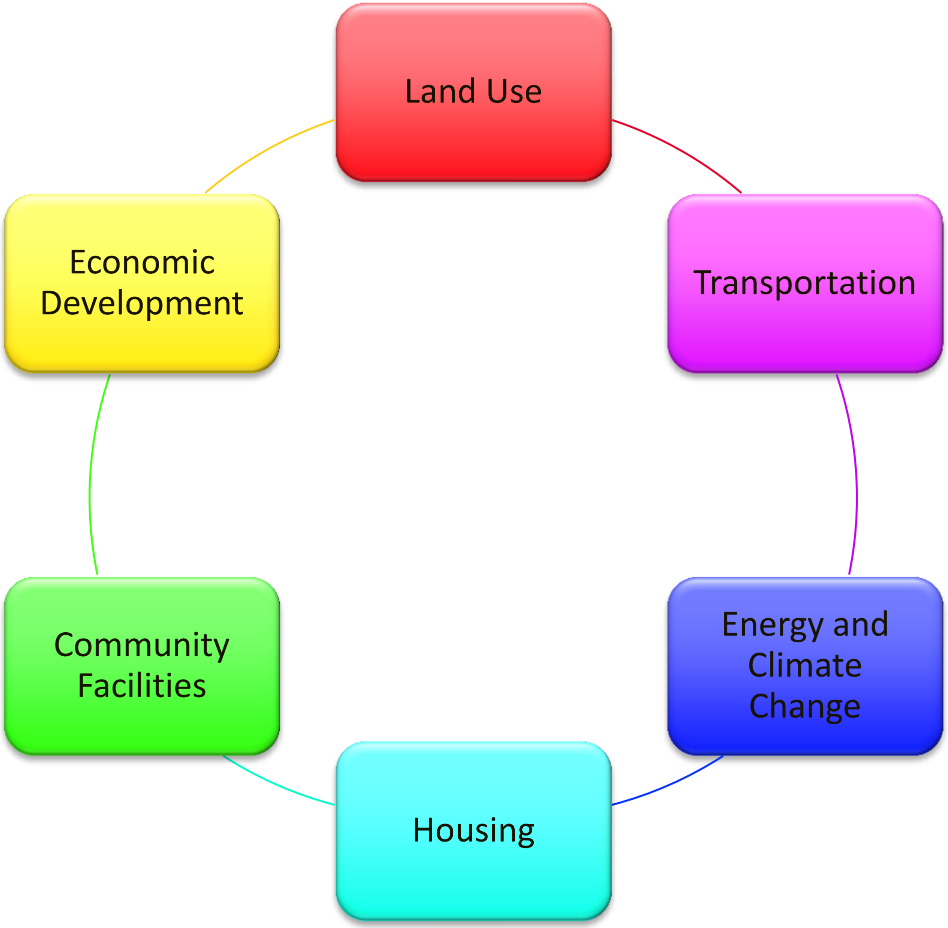
Image: Spacing Toronto

A Planning Perspective

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

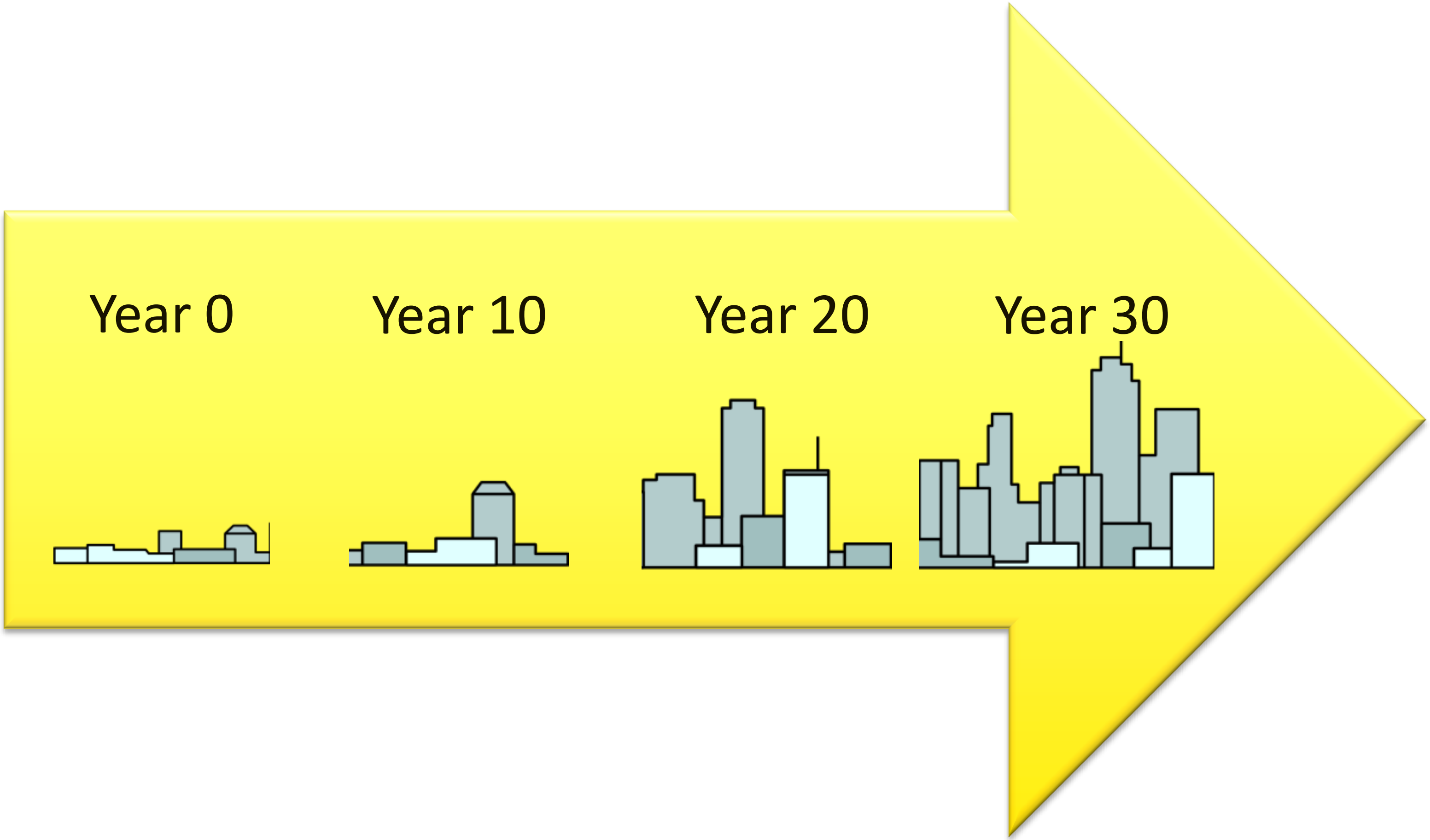
A Planning Perspective

- 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

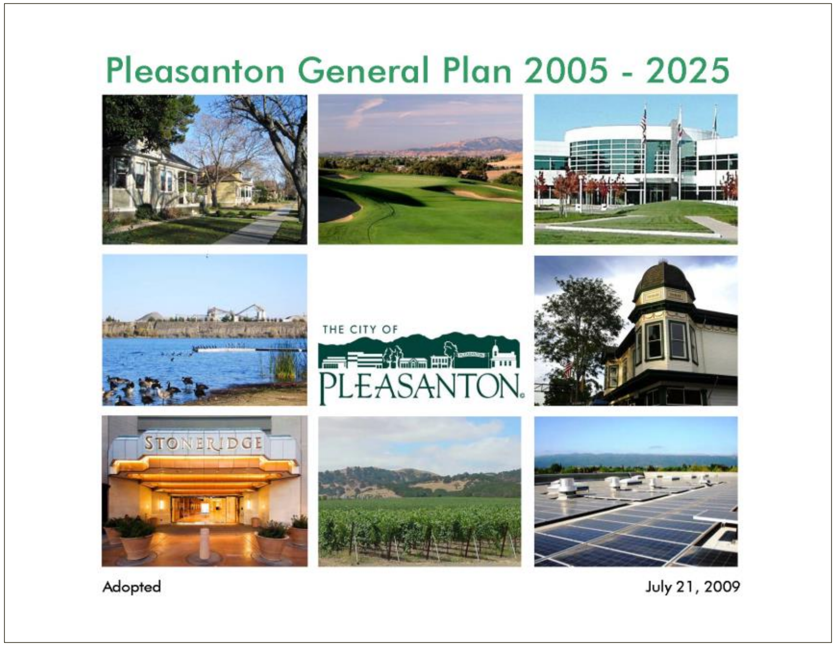
- Local Plans

Communitywide Comprehensive Plan

- **Subarea Plans**
  - Neighborhood Plans
  - Corridor Plans
  - Special District Plans
- **Functional Plans**
  - Green Infrastructure Plan
  - Energy Plan
  - Climate Action Plan

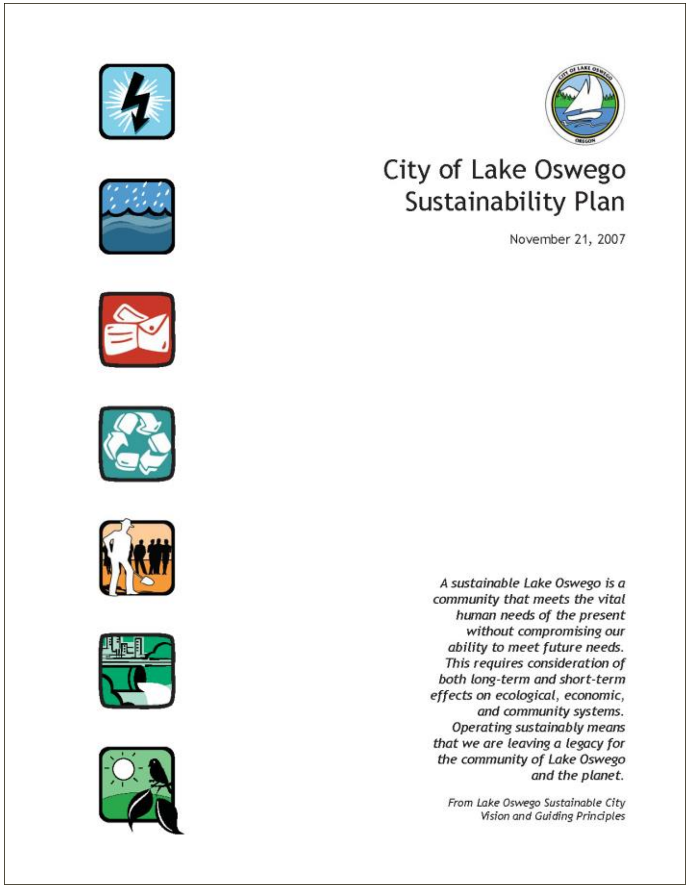
Tools to Minimize Conflicts

- ***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)


City of Lake Oswego
Sustainability Plan

November 21, 2007

A sustainable Lake Oswego is a community that meets the vital human needs of the present without compromising our ability to meet future needs. This requires consideration of both long-term and short-term effects on ecological, economic, and community systems. Operating sustainably means that we are leaving a legacy for the community of Lake Oswego and the planet.

From Lake Oswego Sustainable City Vision and Guiding Principles

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

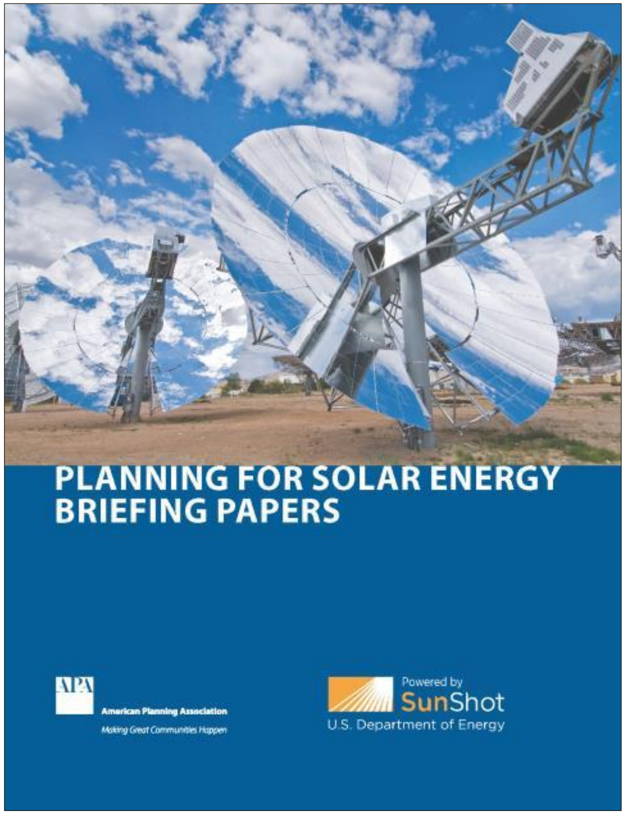
- ***Examples***: Communities that explicitly permit community solar projects:
  - Cleveland Heights, OH (§ 1165.02(i))
  - Baltimore, MD (§ 14-306)
  - Boulder County, CO (§ 4-514.G&L)

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

Solar Energy and Urban Forests: Solutions at Scale

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Overview

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

History

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Spanish grid next to Jeffersonian grid in Los Angeles

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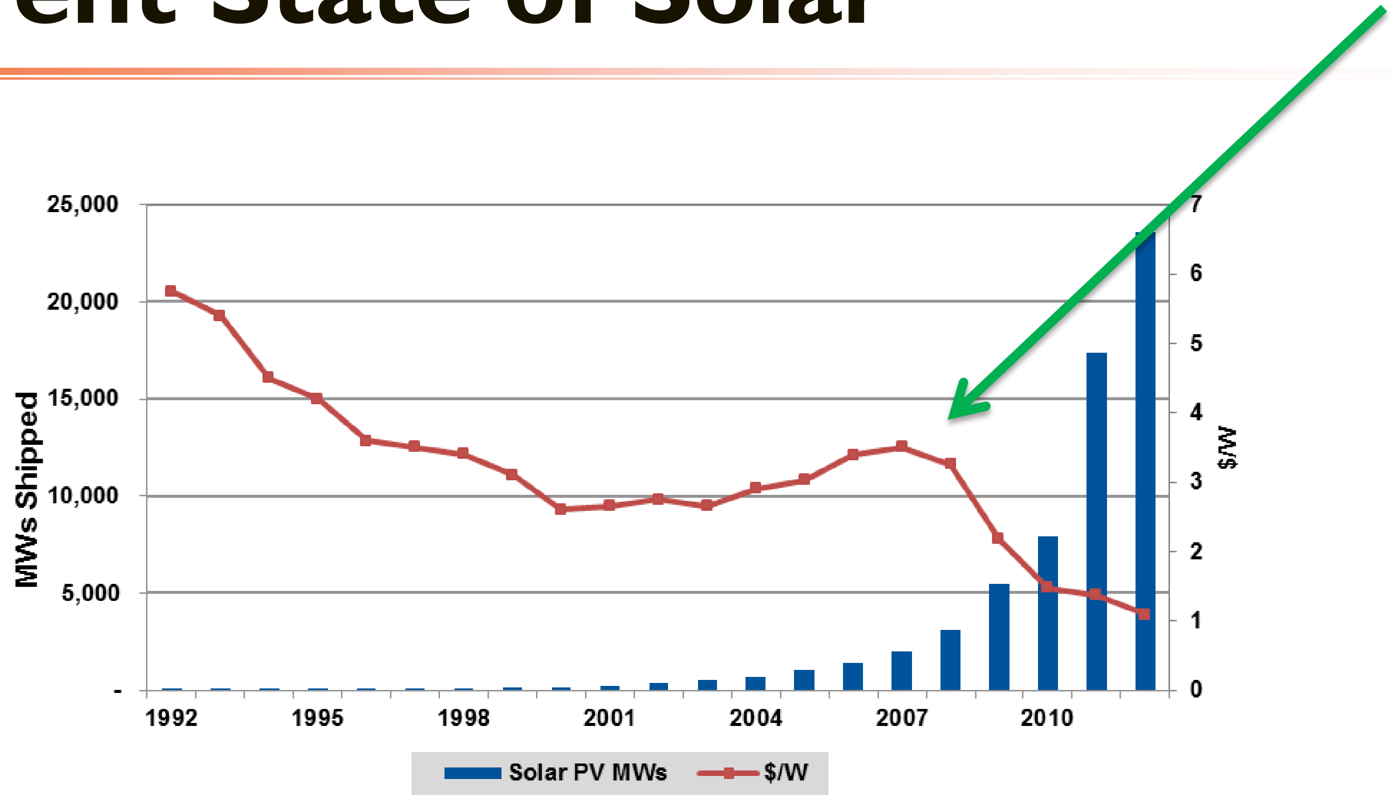
History

- 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

Current State of Solar



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

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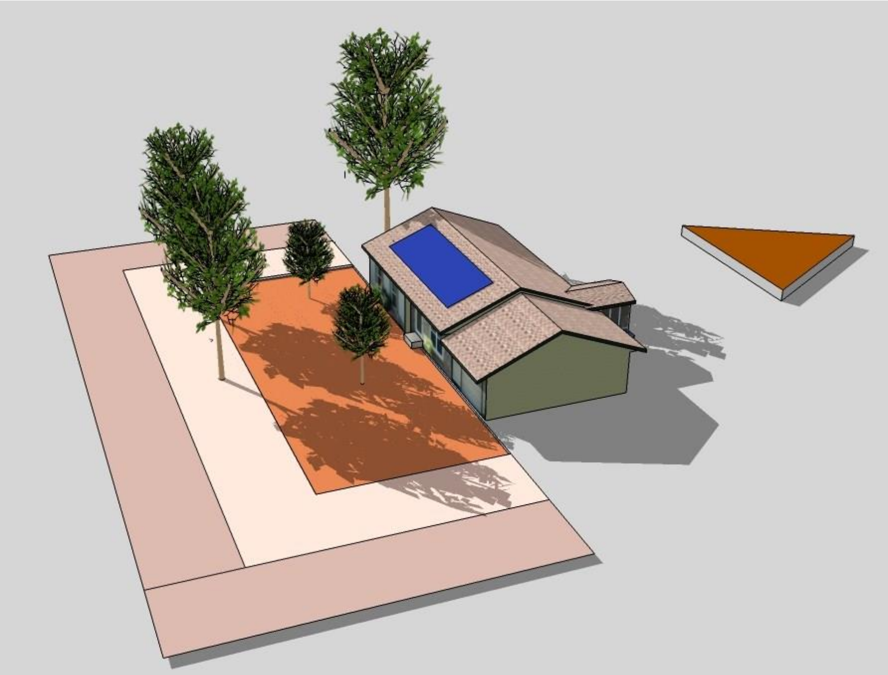
1. Denholm and Margolis, 2008. *Supply Curves for Rooftop Solar PV-Generated Electricity for the United States*. National Renewable Energy Laboratory, Golden, CO, USA.

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

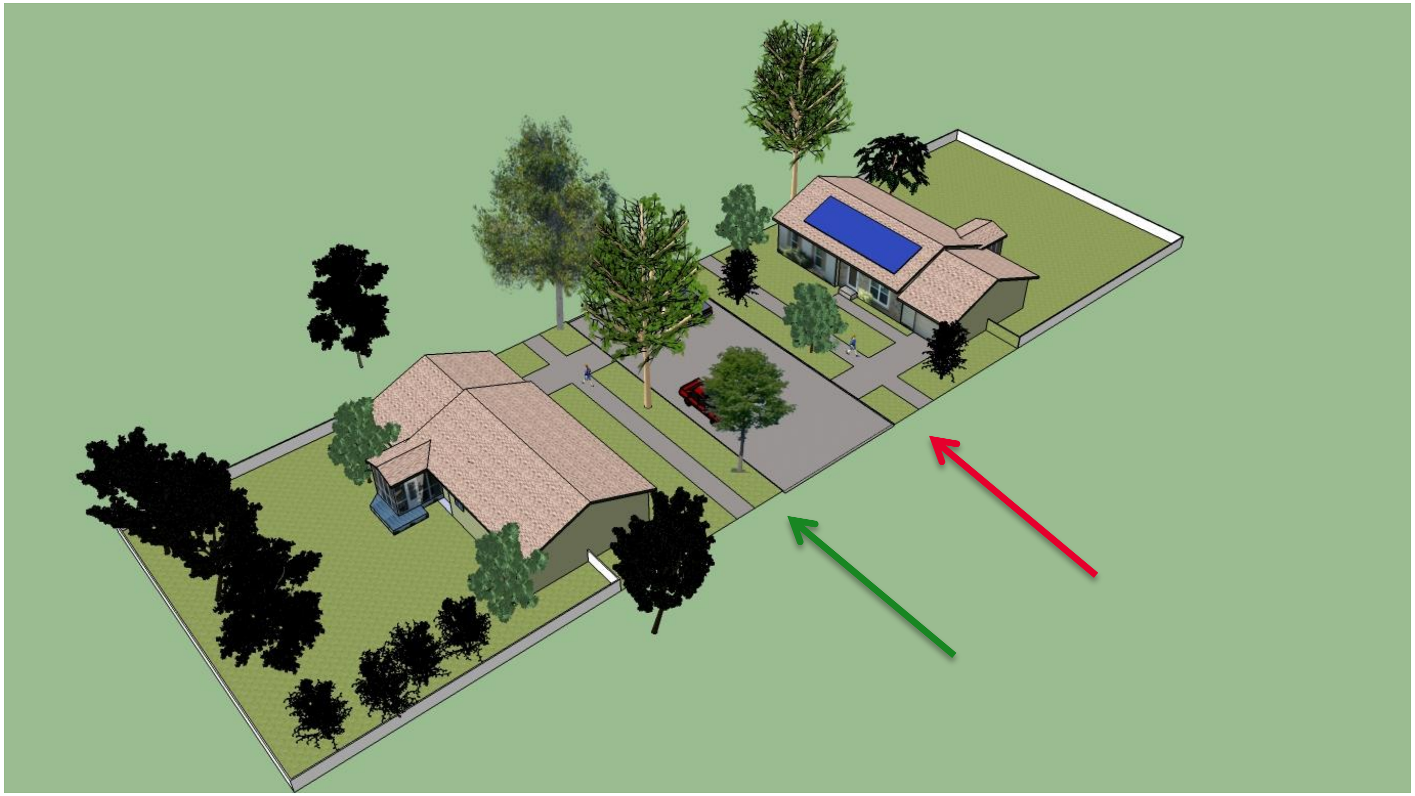
- Parcel-scale



Ordinance, covenant, easement, standard, professional design, guideline, educational material…

Solutions at Scale

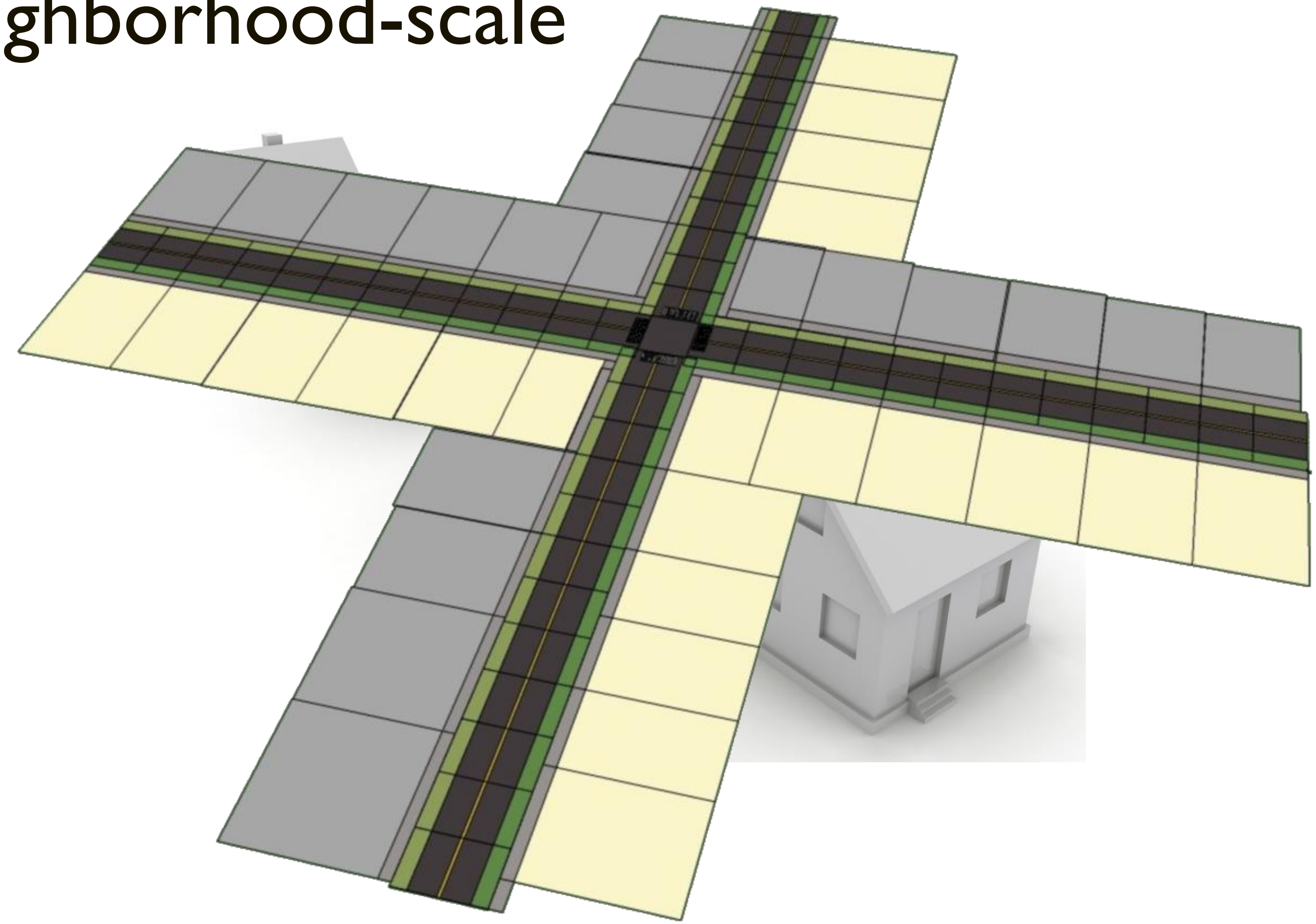
- Street-scale



Ordinance, covenant, easement – post-disaster planning…

Solutions at Scale

- Neighborhood-scale



Ordinance, covenant

All solutions from: Staley, D.C. 2013. Urban Forests and Solar Power Generation: Partners in urban heat island mitigation. *Int.Journ. Low Carbon Technol.* 8:3

Solutions: Permitting

- Many European countries reduce cost by standardizing permitting
- Initial success in US from permit reform, Best Management Practices
  - http://solarcommunities.org/
  - Solar Energy Industry Assn.
  - 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

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September 18, 2013

The Urban Forester's Perspective

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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 via shading

Intersection of public amenities and private property

Denver Housing Authority enters into a power purchasing agreement for 2.513 megawatts installed at 668 sites

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Lessons learned

Public amenity vs. private benefit

Lessons learned

Lessons learned

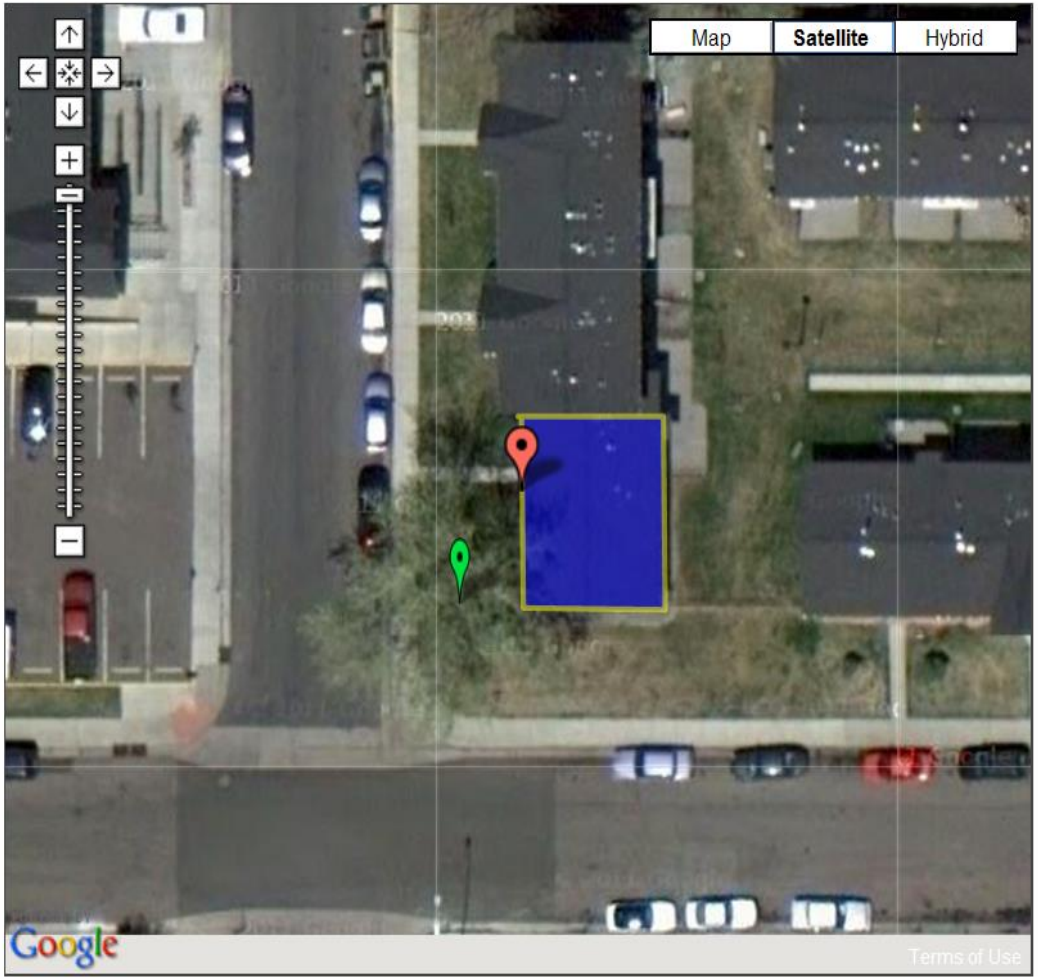
- Specie: silver maple
- DBH: 30”
- Condition: good
- Appraised value: $13,000
- Status: slated for removal
- Removal cost: $592.50

Annual Benefits

- Storm water: 3,294 gallons
- Energy: 69 kWh conserved
  -12 therms
- Atmospheric CO2 reduction:
  1,150 pounds

iTree

Overall Benefit | Storm Water | Energy | Air Quality | CO2 | About Model



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:

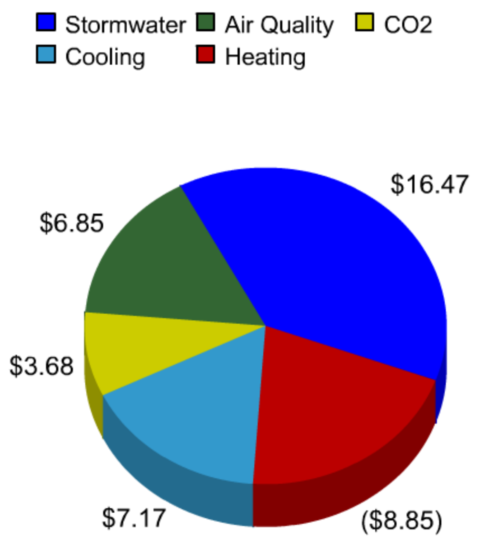
- Shading reduces the amount of heat absorbed and stored by buildings.
- Evapotranspiration converts liquid water to water vapor and cools the air by using solar energy that would otherwise result in heating of the air.
- Tree canopies slow down winds thereby reducing the amount of heat lost from a home, 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.

iTree

Overall Benefit	Storm Water	Energy	Air Quality	CO2	About Model



Breakdown of your tree's benefits

This 30 inch Silver maple provides overall benefits of: $25 every year.

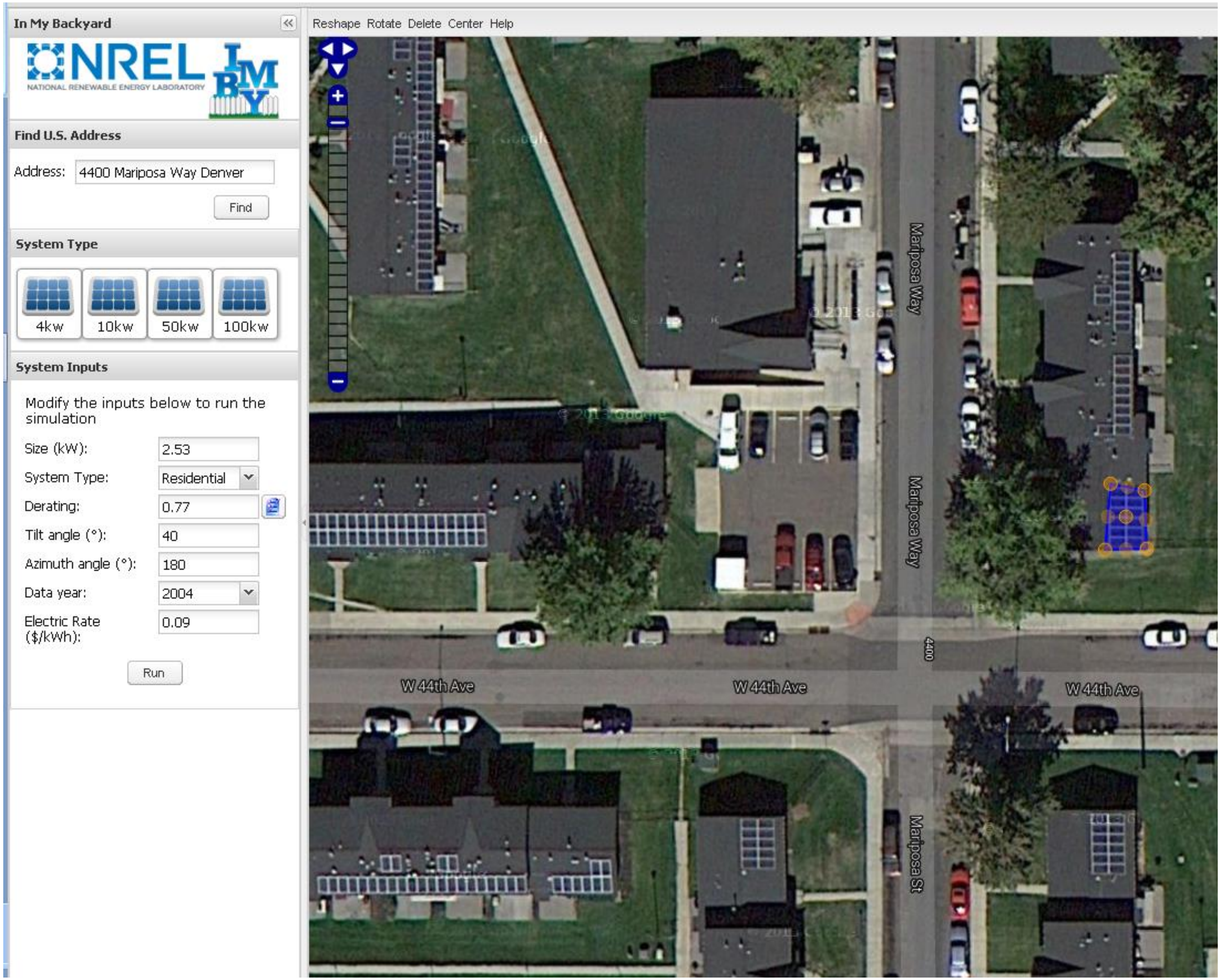
While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure is highly variable and makes precise calculations that much more difficult. Given 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.

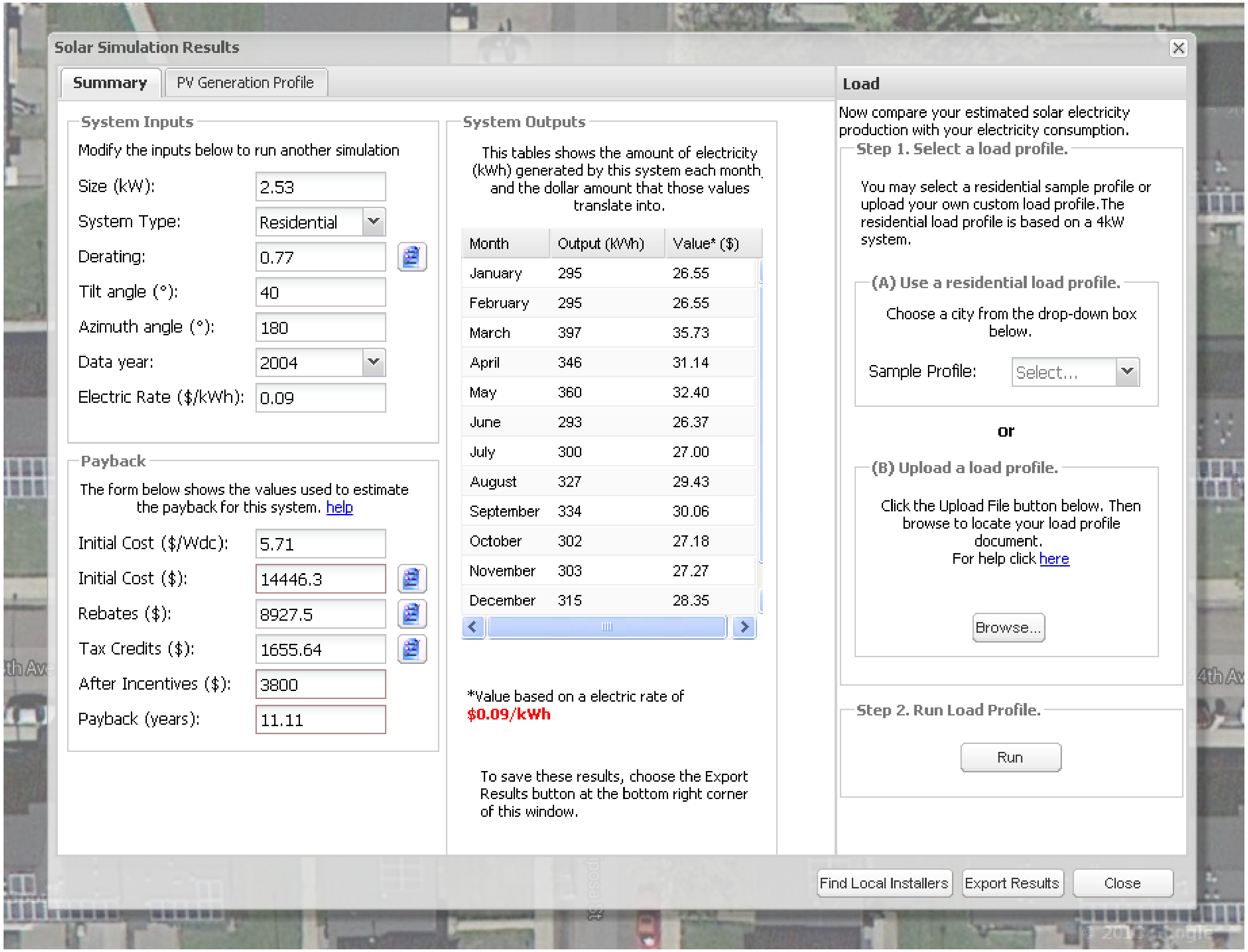
If this tree is cared for and grows to 35 inches, it will provide $24 in annual benefits.

Silver maple
Acer saccharinum

IMBY


In My Backyard
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
IMBY
Find U.S. Address
Address: 4400 Mariposa Way Denver
Find
System Type
4kw
10kw
50kw
100kw
System Inputs
Modify the inputs below to run the simulation
Size (kW): 2.53
System Type: Residential
Derating: 0.77
Tilt angle (°): 40
Azimuth angle (°): 180
Data year: 2004
Electric Rate ($/kWh): 0.09
Run
Reshape Rotate Delete Center Help
Mariposa Way
Mariposa Way
W 44th Ave
W 44th Ave
W 44th Ave
Mariposa St
4400

IMBY


Solar Simulation Results
Summary
PV Generation Profile
System Inputs
Modify the inputs below to run another simulation
Size (kW): 2.53
System Type: Residential
Derating: 0.77
Tilt angle (°): 40
Azimuth angle (°): 180
Data year: 2004
Electric Rate ($/kWh): 0.09
Payback
The form below shows the values used to estimate the payback for this system. help
Initial Cost ($/Wdc): 5.71
Initial Cost ($): 14446.3
Rebates ($): 8927.5
Tax Credits ($): 1655.64
After Incentives ($): 3800
Payback (years): 11.11
System Outputs
This tables shows the amount of electricity (kWh) generated by this system each month and the dollar amount that those values translate into.
Month Output (kWh) Value* ($)
January 295 26.55
February 295 26.55
March 397 35.73
April 346 31.14
May 360 32.40
June 293 26.37
July 300 27.00
August 327 29.43
September 334 30.06
October 302 27.18
November 303 27.27
December 315 28.35
*Value based on a electric rate of $0.09/kWh
To save these results, choose the Export Results button at the bottom right corner of this window.
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 4kW 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
Browse...
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

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