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SOLAR ANN ARBOR

A PLAN FOR ACTION

CITY OF ANN ARBOR MICHIGAN — FOUNDED 1824 — INCORPORATED 1851

Prepared by Project Consultants:

CLEAN ENERGY Coalition

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ABOUT THE U.S. DEPARTMENT OF ENERGY'S SOLAR AMERICA CITIES PARTNERSHIP

The U.S. Department of Energy Solar America Cities partnership supports 25 U.S. cities committed to making solar a mainstream energy source. DOE provides financial and technical assistance to expand innovative efforts to accelerate the adoption of solar energy technologies. Cities, the nation's centers of electricity consumption, are uniquely positioned to reduce global climate change, strengthen America's energy independence, and improve air quality by converting to solar energy sources. From installing solar on city facilities to updating zoning codes and permitting processes to providing financial incentives, Solar America Cities demonstrate comprehensive, city-wide approaches that encourage and facilitate solar as a viable energy solution for residents and businesses. Visit Solar America cities online at www.solaramericacities.energy.gov.

ABOUT THE ANN ARBOR SOLAR CITIES PARTNERSHIP

The Ann Arbor Solar Cities Partnership (SCP) is an extensive collaboration between nearly two-dozen organizations, formed to implement the Solar America Cities project. Partners include the City of Ann Arbor Energy Office, Clean Energy Coalition, Great Lakes Renewable Energy Association, Ann Arbor Hands-On Museum, Ann Arbor Office of Community Development, City of Ann Arbor Office of Emergency Management, University of Michigan's Memorial Phoenix Energy Institute, NextEnergy, Ann Arbor Downtown Development Authority, Ann Arbor District Library, Pfizer, Ecology Center, Ann Arbor Energy Commission, Washtenaw County Government, DTE Energy, State of Michigan Energy Office, Michigan Economic Development Corporation, Michigan Department of Environmental Quality, Michigan Governor Jennifer Granholm, United Solar Ovonics, and the University of Michigan Taubman College of Architecture & Urban Planning.

SOLAR AMERICA CITIES™

Energy—Ann Arbor Putting It Together

CITY OF ANN ARBOR MICHIGAN

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Goals and Objectives

The Ann Arbor Solar Plan will build on the success of the Ann Arbor Energy Plan and Mayor Hieftje's Green Energy Challenge to prepare Ann Arbor for a sustainable energy future. Through implementing this plan, Ann Arbor will serve as a model for other communities looking to solar energy as an answer to rising energy costs, unstable energy supplies, stagnating local economies, and the negative environmental impacts of nonrenewable energy sources.

The Ann Arbor Solar Cities Partnership (SCP) is an extensive collaboration between nearly two-dozen organizations formed to apply for the U.S. Department of Energy Solar America Cities initiative. Ann Arbor was selected as a Solar America City in 2007. The project supports the Mayor and City Council's Green Energy Challenge goals of providing 20 percent of the community's energy needs from renewable sources and installing 5,000 solar roofs, while working toward the Department of Energy's Solar Program goal of making solar-generated electricity cost-competitive with conventional forms of electricity, all by 2015.

Solar Plan development began by conducting local market research to identify local benefits of and barriers to adopting solar technology. This was followed by an extensive literature review of more than 120 documents. Best practices were identified for each topic area and compared to local resources and practices. Finally, recommendations for Ann Arbor were designed based on this process. These recommendations are the heart of the Plan, and are intended to be used by city officials to reduce any barriers to solar energy growth, help craft solar-friendly incentives, and to introduce progressive solar policies.

Benefits of and Barriers to Solar

Understanding the benefits of using solar energy and barriers to its widespread adoption can guide policy and decision makers in focusing solar education and policy changes to be most effective. The benefits described in this Plan include:

- Environmental Benefits
- Public Health
- Job Creation
- Energy Security
- Economic Benefits
- Reliability

Significant barriers identified include:

- Regulations and Permitting
- Cost
- Financing
- Siting and Aesthetic Issues
- Lack of Solar Knowledge

Ann Arbor has many resources and programs that can address these barriers and promote the benefits of solar energy, which are described fully in *Section 3: The City of Ann Arbor*.

Best Practices

The following strategies, measures and inspiring ideas have been identified to overcome barriers to increasing the adoption of solar energy technologies. Recommendations have been made to fill in the gap between best practices and actual practices.

Rules, Regulations, and Policies

A. **Public Benefits Funds -** Public benefits funds (PBFs) provide resources for renewable energy, energy efficiency, and low-income programs and projects. Direct incentives and financing made available from these funds continue to spur the growth of the renewable energy market. While generally a state-level program, municipalities with authority over their electric utility can establish a PBF by adding a flat monthly fee or surcharge to the electricity consumed by their customers

B. **Permitting, Codes, and Standards** - The process of obtaining permits and approvals for solar photovoltaic and solar hot water systems has been cited by solar customers and solar installers as a significant barrier to implementing projects. Best practices include enough inspection and reference standards to guarantee system performance and safety while not imposing overly burdensome or unreasonable procedures. Two specific practices that have proven helpful are expedited permitting and reduced/waived permit fees.

C. **Interconnection Standards** - Having different regulations based on the size of the system can prevent burdensome rules from applying to small installations. The Interstate Renewable Energy Council (IREC) has a list of model interconnection procedures that are comprehensive but not overly restrictive.

D. **Net Metering** - Renewable energy systems that are grid-connected can feed electricity back to the grid when a customer's energy generation exceeds their demand, growing the production of renewable energy. To encourage solar, net metering should allow for large system size limits, allow credits to carry over, have reasonable fees, and allow for meter aggregation.

E. **Solar Access Laws** - In order to utilize the sun for solar energy, it is essential for the property to have access to sunlight, as well as have the right to install solar systems. Solar access can be protected through solar easements, which protect access to sunlight, and solar rights, which prohibit restrictions on the installation of solar systems.

F. **Building Energy Codes** - Adding strong efficiency and renewable requirements to state building codes is a powerful tool governments can use to decrease energy use, increase renewable energy use, and reduce carbon emissions. Government facilities should be required to meet energy and greenbuilding standards.

G. **Solar Set-Asides in Renewable Portfolio Standards** - A Renewable Portfolio Standard (RPS), which requires a utility to produce a percentage of their energy generation or energy sales from renewable energy sources, should be designed to incentivize solar energy and customer-sited distributed generation. In the case of solar energy, this can include a solar set-aside.

H. **Support Laws Incentivizing or Requiring Community Ownership** - Laws encouraging community or local ownership of renewable energy help keep the revenues from and control of projects in the community. Almost any type of financial or production incentive can require local ownership as a condition of receiving the benefit, or it can be mandate its utilities implement special tariffs to facilitate the purchase of these projects.

Financial Incentives

A. **Direct Cash Incentives** - Direct incentives, whether provided by a state, utility, or a municipality, play an important role in encouraging solar installations before the technology is cost competitive with conventional forms of energy. Direct cash incentives for solar may take a variety of forms, including rebates, buydowns, grants, and production-based incentives like feed-in tariffs. Feed-in tariffs, which require energy suppliers to buy electricity produced from renewable resources at a fixed price per kilowatt-hour, have proven to be a very successful incentive in other parts of the world.

B. **Low-Interest Loan Programs -** Low-interest loan programs can help ease many of the upfront costs associated with installing a solar system. While state-supported loan programs are generally utilized for projects in the non-residential sector, local and utility-run programs are aimed for residential projects. Many municipalities and counties secure favorable rates for projects by partnering with a local bank or community economic development organization. Some municipalities have also provided interest rate buy-downs to support solar projects.

C. **Income/Investment Tax Credits -** Tax credits can serve as a critical incentive for building owners to adopt solar technology when public benefit or direct funding sources for renewable energy projects are not available. While tax credits have generally been made available through state policies and programs, municipalities that collect income tax can implement similar strategies to encourage solar and other renewable energy projects. Tax credits can be extended to organizations without a tax liability, like schools, nonprofits, and government facilities.

D. **Property Tax Incentives -** Property tax incentives provide exemptions, abatements, credits, or special assessments that mitigate or eliminate the increase in assessed value of a property (for tax purposes) attributable to a solar energy installation. The goal of property tax incentives is to bring the cost of owning a solar energy system in line with using conventional heating and cooling systems. These are helpful in areas where property tax rates are high.

E. **Property Tax Financing Districts/Property Assessed Clean Energy Program -** The initial investment needed to install a photovoltaic or solar hot water system remains a barrier for solar adoption. Under a Property Assessed Clean Energy Program, the cost of a solar energy system is rolled into the homeowner's property taxes. Funding for projects comes from a bond or loan fund created by the municipality that is eventually paid back through the tax assessments described above. This is valuable because much of the upfront cost is eliminated; funding approval is not based on a property owner's credit history; a well-secured municipal bond or loan provides lower interest rates; and tax assessments are transferable between owners.

Training, Education and Research

A. **Training and Certification for Installers -** As installers are increasingly in high demand, the need for training programs and quality standards increases. In addition to traditional credentials, such as Professional Engineer and Electrician Licensure or Certification, solar specific certification such as that provided by the North American Board of Certified Energy Practitioners (NABCEP) is also available and should be encouraged.

B. **Green Collar Jobs and Solar Workforce Development -** Green jobs are defined as blue-collar jobs with a "green" element, relating to careers and jobs associated with energy efficiency, weatherization, remediation/abatement, and renewable energy. Green Collar Jobs are also often focused on low income and minority populations for training and career development. Several cities across the United States have taken the lead on this and policy can easily be modeled on these efforts.

C. **Training for Code Officials and Inspectors -** Because solar installations remain unusual, code officials and inspectors often need additional training so they can ensure installations are safe and meet code requirements, and also so they do not unnecessarily slow down projects.

Since the building code is set at the state level, ideally this training would be a statewide effort.

Outreach and Marketing

A. **Use Effective Marketing Techniques in all Outreach Programs -** Many solar-related public education and outreach programs are not as effective as they could be because education by itself rarely prompts people to act. In order to effectively encourage solar adoption, campaigns need to address the barriers and strengthen the benefits of adopting solar energy systems, and use effective methodologies. One such approach, community-based social marketing, uses behavior change tools that have been proven to be effective such as public commitments, social norms, and incentives. An effective program would conduct a pilot first, revise the program, roll it out, and then evaluate it to determine its impact.

B. **Conduct Marketing & Outreach Campaign -** As there are many myths about solar and it is a new technology to many people, conducting an effective marketing campaign would facilitate solar adoption. A comprehensive marketing and outreach campaign that intends to dispel solar myths and assist residents and businesses in installing solar would include: one easy to remember comprehensive website; targeted distribution of informational brochures for residents and businesses; regular informational workshops; a solar ambassador program; and a customer assistance program.

C. **Create Visible Demonstration Projects -** Demonstration projects can increase visibility and community awareness of solar energy. Effective demonstrations are in highly visible locations and accessible to the public. The display or printed information should clearly address barriers to solar adoption and give clear information about how to go about installing a system. The energy saved and environmental benefits of these projects can be put online in a highly visible website for public access.

Recommendations

The following actions are recommended to increase the use and viability of solar in Ann Arbor. As recommendations are implemented, the best practice examples summarized above can be used as reference models. The recommendations are described in detail in Chapter 5 of this Plan along with a description of why and how, and are summarized here:

Recommendation 1: Commit to a Solar Plan Implementation Process

Create a clear plan to prioritize recommendations, including creating a timeline, assigning responsibilities, and planning for follow up.

Recommendation 2: Design Municipal Solar Financial Incentives

Design municipal incentives that encourage homeowner and business installation of solar energy, working in concert with developing Ann Arbor finance programs, DTE incentives and Michigan Saves. As many effective incentives are created at the state level and by utilities, Ann Arbor should advocate for best practices at these levels.

Recommendation 3: Simplify Solar Permitting

Unwieldy permit processes have been identified as a significant barrier to solar. Taking steps to improve and expedite the permitting process and to train city inspectors can increase the speed and ease of solar project installation.

Recommendation 4: Advocate for State-Level Policy Changes

Facilitating solar adoption requires more than local law changes and programs. Advocating for changes at the state level will facilitate solar adoption in Ann Arbor and in other municipalities.

Recommendation 5: Integrate Solar into City Infrastructure and Culture

Integrate solar installations and education into municipal culture and city culture. Each of the various city agencies, authorities and departments can creatively implement the use of solar energy in different ways, and support non-municipal efforts.

Recommendation 6: Consider Solar Access Laws & Robust Building Energy Codes

Solar access laws guarantee residents and businesses access to available solar resources. On the local level, ordinances serve a very important role in guaranteeing a legal right to access. Building energy codes can guarantee desired levels of energy performance, greenbuilding, and renewable energy.

Recommendation 7: Create Solar Outreach Campaign

Implement a two-phase solar outreach and marketing campaign, using community-based social marketing principles. Evaluate each aspect to be sure that it: a) Demonstrably increases interest in solar; b) Gives concrete information about next steps; c) Demonstrably increases the number of people installing solar.

Recommendation 8: Support Solar Workforce Development & Green Jobs

Ann Arbor policies and action can support programs that help develop the solar workforce and green jobs training availability in this region, catalyzing increased employment in green industries, and increasing Ann Arbor's leadership in the renewable energy field.

Conclusions

As part of the community of Solar Cities, Ann Arbor can easily draw from some inspiring strategies and programs that have already been proven in other communities. Focusing efforts in this way is a logical first step, and reduces risks, implementation time and learning curves. This approach has been utilized in the development of this plan. Beyond the implementation of these eight recommendations, new and innovative practices should be explored. Ann Arbor, for example, has broken new ground with the installation of LED streetlights - how can it lead the way to a city powered by solar?

PART 1:
SOLAR PLAN & RECOMMENDATIONS

1. INTRODUCTION

LOCAL EXAMPLE: FIRE DEPARTMENT HEADQUARTERS

This solar thermal system on top of the Fire Department Headquarters in downtown Ann Arbor was installed with the help of a $6,000 grant from the Michigan Energy Office. The fire station system is expected to provide about half of the station's hot water needs and will cover its cost in about six years. An exhibit, located inside the Hands on Museum, tracks and monitors the temperature of the hot water entering and leaving the panels, and explains how the system works.

1.1 About this Solar Plan

This plan is designed to prepare Ann Arbor for a sustainable energy future. With this plan, Ann Arbor has the potential to serve as a model for other communities looking to solar energy as an answer to rising energy costs, unstable energy supplies, stagnating local economies, and the negative environmental impacts of fossil fuel energy.

A. Solar Plan Technologies

The technologies considered in this Plan broadly include any use of the sun as an energy source. These technologies include:

- Passive solar: using the heat from the sun to heat buildings
- Daylighting: using the light from the sun to illuminate buildings
- Solar Thermal: using the heat from the sun to heat air or water for space or water heating
- Photovoltaics: converting the light from the sun to generate electricity
- Concentrating Solar Power: concentrating the heat from the sun to produce steam, which can be used for heating or generating electricity

This diversity of solar energy technologies offers opportunities for solar energy to supplement or substitute for other non-renewable fuels that are used to heat buildings, generate electricity, or even power transportation.

B. Solar Plan Development Process

The process for developing this Plan began with local market research that identified local barriers and benefits to adopting solar. Next, an extensive literature review located more than 127 documents, which were evaluated and integrated into this Plan. From this research, best practices were identified for each topic area, such as financial incentives, technology, codes and so on.

Areas of success and areas needing improvement were identified by comparing Ann Arbor with each best practice topic area. Finally, recommendations for Ann Arbor were made where areas of improvement were found. These recommendations are the heart of the plan, and are designed to reduce barriers to solar adoption, to design solar-friendly incentives, and to outline other progressive solar policies.

1.2 About the Solar America Initiative

Initiated in 2006, the Solar America Initiative (SAI) was created by the U.S. Department of Energy (DOE) to promote the development of advanced solar energy technologies. These advanced technologies will allow solar energy to play a larger role in the U.S. energy supply and economy. The goal is that in 2015, electricity generated by photovoltaics will be cost-competitive with nonrenewable electricity sources. The following chart illustrates the reduction in solar energy costs—and subsequent increase in installations—through 2020.

To achieve these goals, research and development activities must work hand-in-hand with market transformation projects. Maintained through partnerships between industry professionals, universities, state governments, federal agencies, and non-governmental agencies, these activities and projects will boost the U.S. economy and solar industry, increase

energy security with a diversified national electricity portfolio, and reduce the environmental impact from nonrenewable power generation.

A. Solar America Cities

In 2007 and 2008, the U.S. Department of Energy awarded twenty-five U.S. cities a total of $4.9 million in federal funds through the Solar America Cities (SAC) program to tackle the goals set forth by the Solar America Initiative. The U.S. Department of Energy also provided on-site technical and policy assistance as part of the program. The technologies supported by the program include photovoltaics, concentrating solar power, and solar thermal.

These 25 cities have committed to expedite their adaptation of solar energy technologies and have developed a unique collaboration for early adaptation of solar technologies. The resulting partnerships are intended to transform the energy market at the local level and serve as case studies for other communities. These partnerships will work to integrate solar energy technologies into local energy planning, remove solar energy market barriers, and promote solar technology among residents and businesses through outreach and incentives. Selected cities will also work to review and amend regulations and practices that discourage or prohibit the use of renewable

Market Sector	Current U.S. Market Price Range (¢/kWh)	Cost (¢/kWh) Benchmark 2005	Cost (¢/kWh) Target 2010	Cost (¢/kWh) Target 2015
Residential	5.8-16.7	23-32	13-18	8-10
Commercial	5.4-15.0	16-22	9-12	6-8
Utility	4.0-7.6	13-22	10-15	5-7

energy systems. Ann Arbor was selected as a SAC partner in 2007.

B. Ann Arbor Solar Cities Partnership

The Ann Arbor Solar Cities Partnership (SCP) is an extensive collaboration between nearly two-dozen organizations, formed to implement the Solar America Cities project. The project supports the Mayor and City Council's Green Energy Challenge goal of providing 20 percent of the community's energy needs from renewable sources and installing 5,000 solar roofs while working toward SAI's goal of making solar-generated electricity cost-competitive with conventional forms of electricity. Both of these goals have a targeted completion date of 2015. Major partners include:

City of Ann Arbor Energy Office, Project Administrator – The City of Ann Arbor Energy Office is responsible for project administration, including submitting all necessary reports and invoices. With its long-standing commitment to renewable energy projects, the City of Ann Arbor Energy Office has continued to offer their administrative, financial, and technical support to achieve the goals set forth by the SCP.

Clean Energy Coalition, Project Contractor – Clean Energy Coalition, a 501(c)3 nonprofit, is contracted with the Ann Arbor Energy Office to develop the Ann Arbor Solar Plan as well as implementing and managing several key projects developed.

Great Lakes Renewable Energy Association, Project Contractor – Great Lakes Renewable Energy Association, a 501(c)3 nonprofit, is contracted with the Ann Arbor Energy Office to provide technical training as well as assistance with statewide outreach and state and local policy development.

Ann Arbor Hands-On Museum, Project Contractor – The Hands-On Museum is a nonprofit organization that is dedicated to science, math and technology with than 250 interactive exhibits. The museum is contracted to provide interactive, traveling, educational solar exhibits.

Other program partners include: Ann Arbor Office of Community Development, City of Ann Arbor Office of Emergency Management, University of Michigan's Memorial Phoenix Energy Institute, NextEnergy, Ann Arbor Downtown Development Authority, Ann Arbor District Library, Pfizer, Ecology Center, Ann Arbor Energy Commission, Washtenaw County Government, DTE Energy, State of Michigan Energy Office, Michigan Economic Development Corporation, Michigan Department of Environmental Quality, Michigan Governor Jennifer Granholm, United Solar Ovonics, and the University of Michigan Taubman College of Architecture & Urban Planning.

2. SOLAR ENERGY: BENEFITS AND BARRIERS

LOCAL EXAMPLE: LESLIE SCIENCE & NATURE CENTER

Two equally sized 2.5 kW photovoltaic arrays provide electricity to the Leslie Science & Nature Center's energy-efficient classroom building, while the nearby Critter House uses any excess electricity. Forty First Solar modules are rack mounted on the left (west end) and twenty Uni-solar modules are adhered directly to the standing seam roof on the right (east end). Each array feeds its own grid-tied inverter. The photovoltaic systems were generously funded by First Solar and United Solar. Two solar thermal panels provide domestic hot water, and south-facing glass and mass walls capture passive solar energy for space heat.

2.1 Benefits of Solar Energy

Much of the world today depends on fossil fuels to meet their energy demands. However, there are only so many gallons of oil, trainloads of coal, and cubic feet of natural gas in our planet, and so a system based on nonrenewable energy cannot operate indefinitely. Increasingly, countries are turning to cleaner renewable energy sources to meet their needs. Solar energy is one of the most sustainable ways of generating energy and electricity today. Not only is electric power from solar panels free from greenhouse gas emissions, it's also an infinite resource.[1]

A study by the National Renewable Energy Laboratory found that only 0.5 percent of western lands would have to be used to produce twice the energy consumed in 16 states (excluding Alaska) of the Western Governors' Association (WGA) using existing solar technology. This energy could be produced indefinitely and with no air emissions.[2]

A. Environmental Benefits

There are major environmental impacts attributed to electricity generation from non-renewable fuels. Emission of pollutants into the atmosphere (particulates, Sulfur Dioxide (SOx), Nitrogen Oxide (NOx), Carbon Dioxide (CO_2), and others) has a grave impact on public health, water and crops. These negative externalities also impact many delicate ecosystems such as forests and fisheries. By using solar energy, considerable amounts of greenhouse polluting gasses are avoided. Using solar host water heating saves 80 percent of the greenhouse gas emissions of a conventional system.[3]

The average American home uses more than 11,000 kWh of electricity every year, resulting in the emission of 23,122 lbs of CO_2 per year from burning coal. For example, if the state of California alone were to harness solar power to satisfy just its residential energy needs, the impact would be the same as taking almost 20 million cars off the road.[4] PV systems also require 1/100th of the water that is required for conventional power.

B. Public Health

Risk of workplace injury and death among energy workers is a hidden cost of energy production, known as an externality of energy. Externalities of energy production include adverse effects on human health caused by pollution, sometimes resulting in death among workers in the energy sector. According to a commentary by Medical College of Wisconsin researchers, in Milwaukee, the human health risk associated with traditional fossil fuels, such as coal, oil, and natural gas is higher than renewable energy sources such as wind, solar, and biomass.[5] Wind and solar energy appear to offer less risk of workplace injury and death than traditional fossil fuel industries, as the dangerous energy extraction phase is minimized or eliminated in wind or solar energy production.

Health impacts related to coal-powered plants are alarming. Particulate pollution from the plants is estimated to have the following impacts on people in the United States:

Health Effect	Incidence
Premature Death	23,600
Heart Attacks	38,200
Asthma Attacks	554,000
Hospital Admissions	21,850
Emergency Room Visits	26,000
Lost Work Days	3,186,000

Coal plants are responsible for 65 percent of the air emissions of mercury, a dangerous neurotoxin. Mercury exposure is estimated to put between 300,000 and 600,000 children at risk of neurological and developmental impairments. Finally, coal-fired plants are responsible for 40 percent of climate-changing greenhouse gas emissions in the United States. Worldwide, climate change is already estimated to be causing 150,000 deaths annually.[6]

C. Job Creation

Job creation is a major benefit of solar energy, including new local industries, products, and markets, and particularly local employment for installation and servicing. Because much of this new work is at the point of installation (installers, retailers and service engineers) local economies receive an extra boost. Based on industry information, ten jobs are created per megawatt (MW) of photovoltaics (PV) during production and 33 jobs per MW during installation. Wholesaling of the systems and indirect supply (primarily in manufacturing) each create three to four jobs per MW. Finally, research and development adds another 102 jobs per MW.[7]

In 2006, the German PV industry alone employed 35,000 people. Such an impact on the national job market would be impressive for any source of energy. Currently, there are more jobs in the German PV sector than in the nuclear industry. Michigan is expected to add 1,000 jobs in the solar industry over the next 5 years, according to Jill Babcock of the Michigan Economic Development Corporation.[8] If a standard of 20 percent renewable energy by 2020 is established, employment in the industry would be increased by 4,900 jobs in Michigan and 185,000 jobs nationally.[9]

According to the Political Economy Research Institute in Massachusetts, roughly $150 billion per year can be generated in new clean-energy investments in the United States over the next decade. This estimated $150 billion in annual new spending includes government funding but is notably dominated by private-sector investments. This sustained expansion in clean-energy investments can generate a net increase of about 1.7 million jobs. This expansion in job opportunities can continue as long as the economy maintains a commitment to clean-energy investments in the $150 billion per year range. If clean-energy investments expand still faster, overall job creation will increase correspondingly. These job gains would be enough—on their own—to reduce the unemployment rate in today's economy by about one full percentage point, even after taking into full account the inevitable job losses in conventional fossil fuel sectors of the U.S. economy as they contract.[10]

D. Energy Security

The United States depends on affordable, reliable energy sources. This can be undermined by dependence on unreliable trading partners and related security risks, among other variables. Because the U.S. imports 31 percent of its energy, and because centralized power plants and grid systems are vulnerable to power outages and natural disasters, solar energy provides more security by:

- Distributing energy that is produced locally with available local resources.
- Generating power that can be transported in portable systems to a disaster site, or anywhere where there is a crippling or dangerous grid power outage.
- Substituting electricity for imported oil for transportation.
- Reducing the risk associated with possible attacks on nuclear power plants or radioactive materials used in nuclear power plants.

E. Economic Benefits

According to the Renewable Energy Policy Network, global PV market growth has shown exponential growth in recent years. Installed PV systems around the globe totaled approximately 16 GW, which represents a six-fold increase since 2004.[11] Despite this rapid growth, photovoltaics still account for only a small percentage of global electricity generation. One of the primary reasons for limited diffusion of photovoltaics is the high cost, particularly for grid-connected systems.[12] Even with a 40 percent drop in solar module prices, and assuming installation costs remain roughly unchanged, installed solar PV power would cost, on a per kWh basis, some eight times as much as coal-fired electricity.[13] However, capital costs have declined significantly since the 1970s from $30-35 per watt to $4-5 per watt today, and are expected to continue declining.[14]

While capital cost is a common denominator for making energy investments, there are four additional economic considerations that favor photovoltaics over nonrenewable electricity generation:[15]

- First, solar PV power, while not generally cost competitive with "base load" grid-tied electricity, is in many regions cost competitive with "peak load" power, which is turned on when power demand reaches the highest point during the day. Peak load power is the most expensive type of electricity for utilities to produce and usually occurs at, or overlaps partially with, the hottest time of the day when the sun shines brightest and power consumption is at its highest. Solar power is the ideal strategy for meeting peak electricity demand.
- Second, decentralized energy systems eliminate the need for expensive, inefficient and resource-intensive transmission and distribution (T&D) infrastructure. Not only are network losses experienced in T&D estimated to range between eight and nine percent, but the construction of every 100 km of power lines of a 500-kV grid project requires 5,000 tons of steel, 2,000 tons of aluminum and 7,000 cubic meters of cement. While the need for expensive T&D capital outlays cannot be eliminated in each and every case, stand-alone distributed PV systems are a highly economical choice in remote rural areas that lack grid access.
- Third, the simultaneous use of solar panels for applications other than power generation can improve its economics. For instance, the installation of rooftop solar panels can reduce a building's air conditioning load by shading the roof. There are also building-integrated photovoltaic (BIPV) applications, where the PV panels are not installed on top of the facade of a building, but *as* the facade of the building, eliminating the need for conventional building materials and allowing the PV panels to be included in the mortgage.
- Finally, the modular nature of solar PV means that it can be installed in stages, panel by panel, or solar farm by solar farm, allowing electricity production to begin shortly after construction commences but before it is finished, thus greatly enhancing the economics of solar power. This is in contrast to large centralized power plants, which take years to build and cannot generate power until construction is complete. The opportunity cost associated with the lag time between beginning construction and generating electricity in large-scale fossil fuel plants is rarely taken into account in the economic analysis when comparing relative costs of different energy options. The generation capacity of solar systems is scalable and more likely to match demand, reducing instances of overcapacity and inefficiency that is now being experienced in the coal power sector.

PV systems also promote economic security through their relatively short supply chains, which reduce transportation and infrastructure build out, improve environmental and economic performance, and maximize benefits to the local economy. With distributed solar, the energy supply chain is virtually nonexistent (see figure below).[16]

F. Reliability

Solar energy is also benefits a city's energy portfolio by improving reliability. For both power companies and their customers, PV has the advantage of relatively quick and modular deployment, which can offset investments in new centralized generation and strengthen the electric grid, particularly toward the end of the distribution line. Variations in solar resources (e.g. diurnal cycles, cloudiness, etc.) are well understood and fairly predictable. Since power is generated close to the point of use, such distributed generation can reduce transmission loss, improve service reliability for customers, and limit maximum demand.[17] Moreover, technological advances in energy storage along with sun tracking and shade mitigation are extending the use of solar power throughout the day. The result is that the lifecycle costs for solar power are more certain than for centralized fossil fuel plants, whose fuel costs remain subject to market forces. Taken together, these benefits demonstrate that solar energy is among the most predictable and reliable energy generation technologies available today.

2.2 Barriers to Growing Solar

A. Regulations and Permitting

With building, zoning, and historic regulations that vary by municipality, builders and architects sometimes find it difficult to become involved in a solar energy market. The challenge of understanding these different regulations can prevent builders from integrating solar technology in their projects or building owners from requesting solar. Getting approvals and permits is sometimes challenging because of a lack of knowledge in building code departments and differences in approval requirements between different departments.

Moreover, some homeowner associations have restrictive covenants limiting visible solar or wind installations. Others require approval to install them, which adds a lack of certainty to the project and can be difficult to receive due to concerns about aesthetics and lack of uniformity across the subdivision or condominium.

Historic district regulations also often limit the ability to install solar. For instance, Ann Arbor is home to about 1,850 properties in 14 historic districts that add additional requirements to the installation of solar energy.

B. Cost - Economic Considerations, Cost, and Return-On-Investment

Photovoltaic Systems

Cost is one of the principal barriers to widespread renewable energy development and solar energy in particular. While the costs for solar PV systems have decreased, without incentives the price is still higher than non-renewably produced electricity.[18] While a homeowner can recoup a great deal of the installed cost over the life of the system, the California Energy Commission estimated in 2004 that the price of a residential system still needed to be cut in half in order for a homeowner to break even.[19]

Economic considerations for PV systems are complex, due to the variety of systems and possible configurations. Some contributing factors include:

- Cost of grid connection
- Cost of power from the grid
- Life-cycle cost of system components and maintenance
- Financing costs
- Savings from avoided service interruptions, or in lieu of building elements (i.e. roofing)
- Savings from offsetting peak demand charges
- Availability of income from Renewable Energy Certificates

PV systems have not achieved widespread use primarily because of cost issues. Reducing costs can be achieved by technological improvements, government incentives, or by increasing manufacturing scale.

The cost of solar has decreased as production has increased, but production costs are still high relative to other electricity sources. [20] A variety of studies of the PV market in Japan and Europe have found that production costs decrease between 75 to 85 percent for every doubling of cumulative production.[21]

Material development continues to bring costs down. Thin films, for example, have already achieved this by manufacturing panels from cadmium-telluride, amorphous-silicon, or copper-indium-gallium-deselenide rather than crystalline silicon.

Options for incentives are discussed under the *Financial Incentives* section of this Plan. It would take 74 years for several recent local installations to pay back their initial installation cost through energy savings at current electric prices. Since most components of solar systems are expected to last 15-20 years, these systems will not currently earn back their initial cost during their lifespan, without incentives or an increase in the cost of conventional electricity.

The existing costs and income described above represent a worst-case scenario. Factors that improve the payback period include incentives, higher grid electricity costs, the sale of RECs (Renewable Energy Certificates), and installations that are offsetting higher electricity rates during daytime hours (known as peak demand charges).

Currently, several federal, state, and utility incentives that are available improve the payback period of solar PV. For a more detailed description of currently available incentives, see Chapter 8, Federal and State Incentives and Resources.

Solar Hot Water

Market analysis of solar hot water systems has shown that installation costs still exceed the level needed for widespread implementation. Studies have indicated that a price between $1,000-$1,500 (1998 prices) would attract homeowners to the technology, but current pricing in our area runs $6,000 - $9,000. [22]

C. Financing

While the overall cost itself can be a barrier, being able to finance solar energy systems is also a challenge. Since a solar installation has fairly predictable future costs, many experts assert that solar technology is – in the long run – more financially viable than currently thought.[23] With the current banking climate, private loans are more difficult to obtain.

D. Siting and Aesthetic Issues

Early solar installations from the 1970s were often long on enthusiasm and short on aesthetics. Installers often insisted on implementing the ideal angle,

PV Costs Without Incentives

Project Name	Location	Size (KW)	Annual kWh Produced	$ Value of kWh	System Cost	Solar Product Description	Simple Payback (yrs)
Joshua Barclay (residential)	Whitmore Lake, MI	3.2	5500	$605	$44,000	Sanyo HIT-200 - tracking	72.7
Al Compaan (residential)	Toledo, OH	4.3	6000	$660	$45,000	First Solar Thin Film	68.2
Oakland University	Rochester, MI	10	10000	$1,100	$109,200	Unisolar thin film shingles	99.3
University of Michigan Dana Building	Ann Arbor, MI	33	36000	$3,960	$300,000	Unisolar Thin Film, Kyocera Multi-Crystalline	75.8
Oberlin College	Oberlin, OH	60	51400	$5,654	$385,788	BP Microcrystalline	68.2
TOTAL		**110.5**	**108900**	**$11,979**	**$883,988**		**73.8**

Average $/KW = $7,999.89
Average kWh/KW = 985.52
Electricity($/KW) rate= 0.11

to the detriment of the roof form of many homes. It has been shown that using a less than ideal angle such as 10 percent (still on a south facing roof slope) would reduce efficiency by less than 5 percent for a thin-film PV product.[24] Some installers are still focused on the ideal solar gain and do not balance it with aesthetic issues.

Other siting issues include building ownership (business and residential rentals utilities are often paid for by tenants instead of landlords) and the fact that some buildings do not have enough solar access to make a solar energy system viable.

E. Lack of Solar Knowledge

Another significant barrier to solar energy use is a lack of understanding about how viable solar energy is currently and in the future as costs for other types of energy increase. In Michigan, it is widely believed that we do not get enough sun to be able to effectively employ solar technology.

In addition, many residents and businesses are not aware of current financial incentives, and mistakenly believe solar has a longer payback period than it actually does. Another concern voiced by residents is that solar energy systems might negatively impact property values, or be considered unattractive and not a good fit for the neighborhood.

It has been shown that using a less than ideal angle such as 10 percent (still on a south facing roof slope) would reduce efficiency by less than 5 percent for a thin-film PV product.

3. THE CITY OF ANN ARBOR

LOCAL EXAMPLE: ANN ARBOR FARMERS MARKET

As part of the Solar America Cities matching funds, the Downtown Development Authority funded the solar photovoltaic demonstration project at the Farmers Market, a 10KW system comprised of 156 panels that includes an educational display funded by the State of Michigan Energy Office.

The city of Ann Arbor is located in southeast Michigan about 40 miles west of Detroit, with a population of Ann Arbor was 113,521.[25] A total of 17,252 acres make up Ann Arbor, which is about 27 square miles. Ann Arbor is the major city in Washtenaw county and is home to the University of Michigan and its University Hospital System. In addition to the university, there are 8,000 businesses and 47,000 homes in Ann Arbor. More than 51% of Ann Arbor residents are renters, and many businesses rent their space as well.

3.1 Energy Profile

The Ann Arbor community spends $309 million on energy annually, divided between: $87 million for natural gas, $119 million for transportation, and $103 million for electricity . This breaks down as 8 billion cubic feet of natural gas, 50 million gallons of transportation fuels, and 1.5 billion kilowatt hours of electricity. Most of this energy comes from fossil fuels with a fraction from nuclear and a smaller fraction from renewables. The average household in Ann Arbor spent $5,000 on energy in 2006, split about evenly between home and transportation; this is up two-thirds since 2002..

> The Barton Dam generates 5,700-megawatt hours of electricity per year.

A. Electricity

The city of Ann Arbor receives its electricity from DTE Energy, an investor-owned utility, while a significant percentage of the electricity used by the University of Michigan is generated in its own natural gas burning Central Power Plant. The average household consumption of electricity is 13,162 kWh per year, slightly more than the US average of 12,810. Over 75% of DTE-generated electricity comes from coal, and 18% comes from nuclear. In the US, 51.8% of electricity generated comes from coal and 19.9% from nuclear; thus, Ann Arbor receives significantly more of its energy from coal. The US uses 7.2% of power from hydroelectric stations and 2.2% from other renewables, while DTE generates just 0.1% of its power from dams and 1.3% from other renewables, mostly landfill gas. All coal used by DTE comes from outside the state of Michigan.

B. Natural Gas

Most natural gas in Ann Arbor is used for heating, though some is also used for transportation and for electricity generation at the University of Michigan's Central Power Plant. Natural gas consumption in Ann Arbor increased from 7.6 million thousand cubic feet to 8.0 million cubic feet between 1990 and 2000.[27] Despite the cold climate of Ann Arbor, the average citizen of the city consumes less than the average US citizen: 70,570 cubic feet as opposed to 80,575. 54% of natural gas in Ann Arbor is consumed by residential users, commercial users consumed 33% and the university another 11%. Though City of Ann Arbor municipal operations actually used less natural gas in 2006-2007 than it did in 2002-2003, the total cost was significantly higher due to increased commodity prices.

C. Renewable Energy

Renewable energy makes up a growing share of Ann Arbor's energy supply. Though subject to some fluctuation, the Barton Dam generates around 5,700-megawatt hours of electricity per year. Ann Arbor's landfill gas project provides enough natural gas to produce another 5,400 megawatts hours annually, though the supply of gas is depleting over time. Smaller projects like the solar PV at the Farmer's Market and Leslie Science Center also contribute renewable power to the city. In July of 2009, the U.S. EPA announced that Ann Arbor is among the top 20 cities in the United States for on-site renewable energy generation:

> *The City of Ann Arbor is generating nearly 9 million kilowatt-hours (kWh) of biogas, hydro, and solar power annually, equivalent to 20*

percent of its electricity use. By producing green power on site, the city demonstrates a proactive choice and a leading commitment to switch away from traditional sources of electricity generation and support cleaner renewable energy alternatives.[28]

D. Solar Potential

A recent study done as part of the Solar America Cities project confirms the viability of solar for many residences in Ann Arbor. In 2008, a group of University of Michigan students working with Recycle Ann Arbor's EnHouse used aerial photographs to analyze the solar potential of single-family houses in Ann Arbor. Their study concluded that of 22,000 houses studied, 86 percent had adequate solar access for solar thermal systems – 33 percent had great solar access and 53 percent had good solar access.

3.2 Energy Related Programs and Activities

Ann Arbor is fortunate to have existing resources that can be built upon to increase solar energy use in Ann Arbor. There is a strong governmental commitment to renewable energy and energy efficiency, an active and interested community, and solar expertise within the region.

A. Local Governmental Resources

City of Ann Arbor - Energy Commission

Ann Arbor is home to the Energy Commission, one of the only local government Energy Commissions (or groups of appointed officials dedicated to energy) in the country. The Energy Commission, created in 1980, has developed a comprehensive energy plan for the City - identifying strategies for reducing energy consumption and utilizing renewable energy in the transportation and commercial/residential building sectors. The first energy plan was developed in 1981 and updated in 1994; today, sections continue to be updated.

The role of the Energy Commission is to oversee City policies where energy efficiency and renewable energy should be addressed and advise City Council; create periodic public reports and recommendations on means of improving municipal and community energy efficiency and renewable energy; prepare, adopt, amend, and transmit to City Council plans identifying municipal and community-based energy efficiency, renewable energy and other production projects; research, formulate, and oversee community education programs; and identify and make recommendations regarding energy project financing options. The monthly commission meetings are open to the public, broadcast on public access television, and previous meetings can be viewed on the city's website.

City of Ann Arbor - Energy Office

In 1985, City Council created the position of Energy Coordinator (now named Energy Programs Manager) that had been recommended by the 1981 Energy Plan. The Ann Arbor Energy Office has managed projects and programs, developed information and resources and provided expert advice to help the city reduce its energy use and move toward a sustainable future.

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Ann Arbor's innovative Municipal Energy Fund invests in energy efficiency and renewable energy projects (including solar) at city facilities. Since 1999 the Energy Fund has invested $588,000 in these projects and saved the City of Ann Arbor over $705,000 in energy savings alone.

Ann Arbor's Energy Programs Manager is currently assisted by a Program Assistant and one intern. Future plans include adding an additional staff person focused on outreach and education, funded through the federal Energy Efficiency Community Block Grants. As a result of the Energy Office's programs, the city has realized a net savings to-date of $33,000 per month (2006 dollars).

City of Ann Arbor - Renewable Energy Goals
In a speech to City Council on September 19, 2005, Mayor Hieftje issued a Green Energy Challenge, calling for Ann Arbor to use 20 percent green energy by 2010 for municipal operations and by 2015 for the whole city. After the Energy Commission reported to Council that 20 percent could be achieved early, Mayor Hieftje raised the goal for municipal operations to 30 percent by 2010. On May 1, 2006, City Council unanimously passed a resolution to formally adopt these goals. As part of the Mayor's Energy Challenge, City Council passed a resolution setting a goal of 5,000 Solar Roofs in Ann Arbor by 2015. The Energy Commission anticipates that many of these solar installations will be solar hot water systems, with more solar electric systems appearing as the program grows.

Downtown Development Authority
Ann Arbor's Downtown Development Authority (DDA) has been strongly supportive of energy efficiency and solar energy projects in Ann Arbor's downtown district.

In support of the City's Green Energy Challenge and the DDA's goal to encourage a more sustainable downtown, the DDA created the Downtown Energy Saving Grant Program in 2008. The program provides a free energy audit of a downtown building or business space for qualified applicants. If the building owner or tenant goes forward with installing recommended improvements, the DDA then will provide half of the cost of the improvements, up to $20,000.

In addition, the DDA has been supportive of solar energy projects downtown. In 2009 the DDA installed twenty-five solar parking meters on Main, Liberty and State streets as the first test phase before replacing all of downtown's 1,500 parking meters. The DDA hopes to eventually swap out the vast majority of downtown's parking meters with 175 solar-powered meter stations (One meter station can cover about half a dozen parking spaces.) The solar-powered parking meters come equipped with a solar panel that enables them to remain entirely off the grid. As part of the Solar America Cities matching funds, the Downtown Development Authority also funded the solar photovoltaic demonstration project at the Farmers Market, a 10 kW system comprised of 156 panels that includes an educational display funded by the State of Michigan Energy Office.

B. Solar, Renewable Energy, & Energy Efficiency Products and Service Providers

There are numerous energy-related service providers in Michigan and the Ann Arbor region. Service areas include home and commercial energy auditing, renewable energy installation, engineering, and more. Energy Efficiency and Solar related products are also available. For products and services that have been identified while writing this Plan, refer to the *Local Resource Directory* found in the Appendix.

The solar industry and manufacturing is also well established in Michigan and is described in Chapter 6 under *Solar in Michigan*.

C. Education and Training Resources

Increasing the level of training in solar technologies is a service that local nonprofits as well as area universities and colleges provide. The following organizations offer installer training, and/or education related to renewable energy.

Great Lakes Renewable Energy Association (GLREA)
On a regional level, Great Lakes Renewable Energy Association (GLREA) offers two training programs related to solar. Both offer a certification:

> Apprentice Program
> *The apprentice workshop is a 5-day program combining classroom sessions with field experience to introduce the participant to distributed generation technologies and interconnection issues. The seminar includes 2 or 3 days of field experience with installation practices and procedures. The workshop is designed for individuals beginning a career as a PV system integrator, an electrical or mechanical engineer or a professional in the building construction industry. The program will provide the successful graduate with the experience and reference materials needed to advance a career in the distributed micro generation profession.*
>
> Systems Integrator Certification
> *This two-day program in a classroom setting is for experienced individuals in the utility industry, building and engineering professions, state and local inspection agencies, electrical contracting and current practitioners in the renewable energy or distributed generation field.*

GLREA
GREAT LAKES RENEWABLE ENERGY ASSOCIATION

The organization reports that interest in the classes has recently "exploded." This training is recognized in Michigan, Illinois and Ohio. GLREA is also a project partner for the Solar America Cities project in Ann Arbor.

The University of Michigan
The University of Michigan is of obvious importance for the city, and as a knowledge and research center, it already plays a vital role in the development of solar projects. Even though the University is a research-based institution and does not offer hands-on training, several University-sponsored activities support the goal of solar education in Ann Arbor. These include:

- The **Michigan Solar Car Team** (a 501c3 non-profit and an entirely student-run organization) finished the 2009 World Solar Challenge in third place.
- The **Michigan Memorial Phoenix Energy Institute (MMPEI)** is a major institute within the University and operates under a mission to "*chart the path to a secure, affordable and sustainable energy future by applying our strengths in public policy, economics, business and social sciences to lay the foundation for successful implementation of our scientific and technological achievements."* The research areas of the Institute include: energy policy, economics and societal impact, carbon neu-

Michigan Solar Car. Source: Michigan Solar Car Team.

tral electricity sources, energy storage and utilization, and transportation and fuels. The Institute includes outreach programs that can assist solar projects in Ann Arbor.

- The **Center for Sustainable Systems (CSS)** is a research-based group that focuses on interdisciplinary projects utilizing life cycle analysis and other research tools. CSS has published projects related to solar and other renewable energy sources.
- The **School of Natural Resources** and **Ross School of Business** have demonstrated interest in energy efficiency and renewable energy. The **Ross School Community Consulting Club** has provided invaluable research and input into this Plan and other Solar America Cities related activities (see Acknowledgements). Additionally, the **Erb Institute** within the Ross School of Business is focused on global sustainable enterprise. Additional courses and research projects have taken place within the **College of Engineering**, which offers several solar-related courses, and competes in other solar competitions, and the **College of Architecture and Urban Planning,** which competes in the **Solar Decathalon.**

Washtenaw Community College
Washtenaw Community College offers an Associates Degree in Sustainable Technologies in HVACR (Heating, Ventilation, Air-Conditioning and Refrigeration), that prepares graduates to become certified in Green Energy Awareness, a program sponsored by the Green Mechanical Council.

Oakland Community College
Located in Royal Oak, MI, Oakland Community College offers an Associates degree in Environmental Systems Technology with 4 options in energy management, including a special interest option that provides customized curricula. Additionally, a 28-credit certificate and a 12-hour Certificate of Achievement in Renewable Energies and Sustainable Living are available. Courses span all the renewable energy technologies plus Sustainable Business Practices, Sustainable Design and Sales, and Marketing and Entrepreneurship for Sustainability. OCC is also part of the Consortium for Education for Renewable Energies Technology (www.ceret.us), which allows them to offer online courses. The courses developed at OCC helped create national curriculum models with the support from the U.S. Department of Energy and the National Science Foundation.

Macomb Community College (Warren)
The Renewable Energy Technology Program at MCC complements other programs offered at the College and provides the knowledge and skill required for positions involving the integration of renewable energy applications.

Detroit Joint Electrical Apprenticeship Training Center (Warren, MI)
For members of the IBEW (International Brotherhood of Electrical Workers) union, Photovoltaic Systems Courses and Photovoltaic Seminars are taught which include detailed training and instruction. The training center is also a NABCEP (North American Board of Certified Energy Practitioners) approved provider. Ann Arbor's own Local 252 is an additional resource for bolstering journeyman and apprenticeship opportunities for solar PV deployment.

IBEW Training, Detroit. Source: GLREA.

University of Toledo
Located only 52 miles directly south of Ann Arbor, the University of Toledo offers a photovoltaic-specific program at the Wright Center for Photovoltaics Innovation and Commercialization. While the program is primarily focused on further developing PV technology through research, a portion of the program is dedicated to the commercialization of PV technology.

Owens Community College (Ohio)
Owens Community College is a NABCEP approved provider and offers a course in "Photovoltaic Principles and Applications," a five day training program that includes hands-on and classroom activities.

Contact and other information related to these programs can be found in the *Local Resource Directory* found in the Appendix.

D. K-12 Educational Expertise

A variety of Ann Arbor area nonprofits have the capability of providing renewable energy education to children at the K-12 educational level:

- **Leslie Science & Nature Center.** The Leslie Science and Nature Center is a not-for-profit organization whose mission is to provide youth with educational experiences that foster understanding, appreciation, excitement and respect for the natural environment and that also generate responsible environmental stewardship. The Center offers programs for children of all ages that can include education about the Nature House, a solar-powered green building that showcases green energy systems, building techniques, and recycled materials.
- **MiSo House at Matthaei Botanical Gardens.** The Michigan Solar House (MiSo) is the work of an interdisciplinary team of architecture students and faculty for the 2005 Solar Decathlon in Washington, D.C. The Michigan Solar House is made from earth-friendly materials and seeks to create an affordable and customizable home that produces a surplus of renewable energy that will effectively redefine comfortable living in a manner feasible for generations into the future.
- **Energy Works Michigan** is a partnership between Recycle Ann Arbor, The Ecology Center and Conservation Services Group to work with the State of Michigan to administer the Michigan Renewable Schools Program (MRSP). Through the MRSP, Energy Works will visit Michigan schools over two years to perform site analysis and design, coordinate, and implement 20 small-scale solar/wind installations, along with three larger wind systems. Energy Works will develop an associated educational program aligned with school curricula to teach students, faculty, staff and the general public about renewable energy to promote a clean energy future.
- **Creative Change Educational Solutions** is a nonprofit organization focused on sustainability education. Based in southeast Michigan, Creative Change works regionally and collaborates nationally with schools, universities, research institutions and sustainability leaders in multiple sectors. The organization's staff and board include practicing teachers, university educators, and content experts from science, business, and public policy fields.

> There are a variety of nonprofits that work in the field of environmental advocacy and education that could be potential partners in any solar energy outreach and education plan.

E. General Solar Education Resources

Several area nonprofits work significantly in the area of energy efficiency and renewable energy education:

- **The Great Lakes Renewable Energy Association (GLREA)** is a non-profit organization that educates, advocates, promotes, and publicly demonstrates renewable energy technologies. The mission of GLREA is to increase the mainstream use of renewable energy technologies and sustainable energy practices.
- **Recycle Ann Arbor (RAA)** offers a variety of recycling programs and home energy audits. RAA also has the Environmental House Energy & Green Building Resource Center (EnHouse), a comprehensive resource and touring facility dedicated to furthering the causes of green building, energy efficiency and renewable energy. In 2008, Michigan Public Service Commission awarded $50,000 to RAA to provide home energy assessments to Ann Arbor homes and offer access to energy improvement loans based on the findings.
- **Clean Energy Coalition (CEC)** is a non-profit, non-partisan organization dedicated to promoting clean energy technologies as a way to create healthier, energy independent communities. CEC works in the areas of clean transportation, building efficiency, and community-supported energy.

In addition, there are a variety of nonprofits that work at least partially in the field of environmental advocacy and education that could be potential partners in any solar energy outreach and education plan. These include Growing Hope, the Ecology Center, Clean Water Action, Project Grow, Hands on Museum, Legacy Land Conservancy, Matthaei Botanical Gardens, Michigan Interfaith Power and Light, National Wildlife Federation –Great Lakes Natural Resource Center, Sierra Club Huron Valley Chapter, Slow Food Huron Valley, Think Local First, Transition Ann Arbor, and Huron River Watershed Council.

Ann Arbor is fortunate to have a community that is interested in renewable energy. DTE Energy's GreenCurrents program has been very successful in this community, and home energy auditing companies/nonprofits report that demand for home audits exceeds supply, indicating a strong interest in renewable energy.

A variety of green events throughout the year provide opportunities for outreach, including the Mayor's Green Fair, the Ann Arbor Earth Day Festival, and events held by local environmental nonprofits such as Ecology Center.

F. Energy Tools

As part of the Solar America Cities project, the City of Ann Arbor received technical assistance for five solar site assessments. The assessments were summarized in *U.S. Department of Energy 2007 Solar America City: City of Ann Arbor, Michigan, Solar Energy Site Assessments and Training*. This document can be found in the appendix of this Solar Plan, and can also be downloaded from the City of Ann Arbor's

Hands on Museum Display about the solar thermal system on the Ann Arbor Fire Department Headquarters. Source: City of Ann Arbor.

website. Following recommendations outlined in this report, a site assessment would consider all the factors listed described above, and utilize assessment tools such as the Solemetric SunEye ® or Solar Pathfinder ®. An economic analysis follows the site visit and is described in the following section. Jason Bing, of Energy Works Michigan was trained in Solar Site Assessments.

City of Ann Arbor residents can enter their address to assess their property's solar access and estimated solar energy production on the City's website: www2.a2gov.org/Mypropertyinformation/address.asp.

G. Existing Solar Installations

Several inspiring private and public installations, many of which are publicly accessible, demonstrate the local viability of solar energy technology. These installations are illustrated and described throughout this Plan:

- Ann Arbor Farmers Market – 10 kW Solar Photovoltaic System
- Leslie Science & Nature Center – 5 kW Solar Photovoltaic, 2 Solar Thermal Panels, and Passive Solar Elements.
- Buhr Park, Veteran's Park, and Fuller Park – Solar Pool Heating Systems
- Fire Department Headquarters – Solar Hot Water System
- Downtown – Solar Photovoltaic Powered parking meters
- DTE – 28 kW Solar Photovoltaic System
- Matthaei Botanical Gardens – MiSo House - 6 kW Solar Photovoltaic, Evacuated Tube Solar Thermal System.
- University of Michigan Dana Building – 33 kW Solar Photovoltaic System
- Washtenaw County – 10 kW Solar Photovoltaic system

Several future solar installations are planned for Ann Arbor that could contribute to solar visibility and education:

- Washtenaw County is planning a 12 kW solar energy demonstration project on their property as part of their Energy Efficiency Community Block Grant funding. A site has not been chosen as of December 2009.
- Through Solar America Cities, the Ann Arbor Hands on Museum is creating several mobile solar energy exhibits that will be used for educational purposes.
- With the assistance of the Solar America Cities grant, XSeed Energy Community Power Project launched in late November 2009. XSeed Energy will be developing a highly visible initial solar installation in the Ann Arbor community, utilizing funding from community donations and grants. Proceeds from financial incentives and donations will be recycled back into a 'Solar Bank' to fund ongoing solar installations, seeding projects across Ann Arbor.

4. BEST PRACTICE RESEARCH

LOCAL EXAMPLE: UNIVERSITY OF MICHIGAN DANA BUILDING

The School of Natural Resources and Environment added solar panels to the Dana Building during a major Gold-LEED renovation project. The solar rooftop system is made up of a 30 kW PV array with both Uni-Solar thin-film panels and Kyocera multi-crystalline modules. A display inside the building reports the amount of energy being produced and used. The building's passive solar system includes a 4,000-square-foot atrium skylight designed to provide daylight to the building, while shades on the south side of the skylight help keep the building cool during the summer.

This summary of best practice research is intended to detail strategies, measures and inspiring ideas that have been identified to overcome barriers to adopting solar. Within each topic area best practices are given, followed by concrete examples of these practices. Michigan and Ann Arbor's use of these practices is described next. For recommendations that grow out of the gap between best practices and actual practices, see Chapter 5: Recommended Strategies and Incentives for Ann Arbor.

Two key references were used extensively in the development of this section. *Solar Powering Your Community: A Guide for Local Governments,* released in July of 2009 by the U.S. Department of Energy, is an essential compilation of ideas and practices from the Solar America Cities, and beyond. Additionally, an online resource called the *Database of State Incentives for Renewables and Efficiency (DSIRE)* is a detailed and very useful database that provides excellent, up-to-date information on policy and incentives across the country. This database, as the name implies, covers all forms of renewable energy and energy efficiency. The database recently introduced a solar-specific section called DSIRE SOLAR, which simplifies the process of identifying those policies and incentives that are the topic of this Plan.

Best practices are divided into several areas: International best practices; domestic regulations and policies; financial incentives; training, education and research; and domestic outreach and marketing.

4.1 International Best Practices

Outside of the United States, programs and regulations have successfully encouraged the advancement and adoption of solar energy, both for solar-generated electricity and solar hot water heating. Solar initiatives, as well as other renewable energy and environmental initiatives, have provided a significant boost for solar use in Germany, Spain, China, Japan, and Canada. The successful programs combine progressive policies, incentives, and outreach campaigns.

The incentive that has resulted in the most dramatic advancement of solar in several locations is the feed-in-tariff.

A. Germany

Though Germany receives an average of only 1,528 hours of sunshine a year – just one third of total daylight hours – it has emerged as a leader in solar energy generation.[29] A Feed-in Tariff Law designed "to level the playing field for renewables" was created in 1990. While the law has been hugely successful in expanding the use of renewable energy in Germany, it has benefited wind power more than solar.[30] In 1993, the *1,000-Daecher-Programme* – or 1,000 Roofs Program – was created to offer investment aid of 60-70 percent of the cost of solar panels, and was expanded to a 100,000 roofs program in 1999, offering low-interest loans for solar installations. In 2000, the Renewable Energy Law was passed, which guaranteed solar providers a rate of about 50.6 Eurocents/kWh for new installations, declining 5 percent a year. In 2008, solar energy added only 1 euro a month to the average German home's electric bill.[31] More than 40,000 people work in the growing German photovoltaic industry, in large part to government programs that have allowed solar to succeed.[32]

In addition to photovoltaics, Germany has also supported solar water heating with the Market Stimulation program of 1999 which subsidized 1.05 Euros per square meter of solar water heating systems for systems up to 200 square meters.[33] These subsidies helped double the collection area of solar water heating between 2002 and 2006.

German policies at the state level have also contributed to the growth of solar power. Freiburg, a city in southwest Germany similar in size to Ann Arbor with a population of 205,000 people, created the SolarRegion program in 1986, which has helped the city and surrounding region become a solar leader. The Freiburg SolarRegion includes programs that range from financial incentives to community education to a solar information desk. By 2006 Freiburg was producing 8.6 MW of solar and had 12,000 square meters of solar thermal heating.[34] The Vauban district was built in Freiburg as a sustainable model district and includes 50 solar houses that will produce more energy than they consume.

B. Spain

Spain, like Germany, has combined national and local solar programs with great success. In 2008 Spain set a goal of 3,000 megawatts of solar capacity by 2010 (12 percent of their total electricity), and by mid-2009 they had reached this goal.[35] An ambitious Feed-in Tariff facilitated this success. Spain's Feed-in Tariff scheme provided price certainties that were needed to create a solar market while remaining flexible enough to adapt over time.[36] Since 1998 Spain has used a Feed-in Tariff system that gives consumers a choice between paying a fixed premium on top of the market price for electricity or paying a fixed total price.

> The city of Barcelona's 2000 Solar Thermal Ordinance requires residential and commercial buildings to generate 60 percent of their hot water from solar.

In addition to solar generated electricity, Spain excels in solar water heating. In 2006, Spain adopted legislation requiring new and remodeled homes to utilize solar water heaters that generate 30-70 percent of their hot water.[37] The city of Barcelona led the way for this with its Solar Thermal Ordinance (STO) in 2000. Barcelona's solar ordinance, which was Europe's first, requires residential and commercial buildings to generate 60 percent of their hot water from solar. It also includes training courses for professionals and information for consumers and the media. In 2006, Barcelona strengthened their STO; it now saves 25,000 MWh a year in energy that would have been used heating water. The city of Barcelona also runs Porta Porta, or Door to Door, an education campaign to work with communities and ensure that equipment is properly functioning.

C. China

China is currently the world's top producer of photovoltaic cells. It had only 147 MW of solar capacity installed at the end of 2008 but has set a 2020 goal of producing 1800 MW.[38] China currently exports 98 percent of the photovoltaic cells they produce. China recently started subsidizing some solar modules on buildings 50 kW at up to $3 per watt, and there will be additional incentives for solar energy for schools and hospitals.

Though China has only recently begun to support solar electricity, solar water heating has a long history in China. At the end of 2006, China had 90 million square meters of installed capacity of solar water heating, 60 percent of the global solar collector area.[39] Similar to Spain, solar hot water systems are compulsory in Hainan Province and Shenzhen City on new and rebuilt residential buildings of twelve stories or less.

Shanghai also has its own system of new regulations, called the Program of Exploiting and Using Solar Energy. Shanghai's Program calls for solar water heating systems and solar air conditioning with a goal of 2.5 million square meters of collection area by 2010. Underlying these local measures are the set of norms that the Ministry of Construction has issued to standardize design and construction of solar hot water systems. The norms must be followed nationwide, but specific locales can adopt additions to them. China is already the largest market in the world for solar water heaters with 10 percent of the water heating market.[40]

D. Japan

Japan, like Michigan, faces a dearth of conventional energy resources. The Japanese government, in turn, has been supportive of renewable energy advancements. One key feature of solar power in Japan is that distributed rather than centralized generation has been favored.[41] Ninety percent of Japan's PV installations are in grid-connected small residential systems. Two major Japanese home building firms offer photovoltaic systems in their newly built houses. The success of photovoltaics in Japan is due in part to making integration easy and not highly site specific. Housing companies and developers have strategic alliances with solar companies that make integration easy. Utilizing solar technologies in mass-fabricated units new projects have helped increase the use of solar energy.

The Japanese government offers capital cost subsidies to make solar energy affordable and realistic, similar to Germany's 100,000 roofs program.[42] Additionally, the national legislature adopted renewable portfolio standards for Japan in 2002.

E. Canada

Throughout Canada, renewable energy products can get sales tax exemptions, a simple measure that can tilt the scales towards additional use. In early 2009, the province of Ontario passed a sweeping new energy bill, the Green Energy and Green Economy Act. By 2015, this act will create 6,000 MW of conservation, 10,000 MW of new installed renewable energy, and achieve a 30 percent reduction in natural gas consumption. A Feed-in Tariff has been established, and community-based projects will be eligible to receive a graduated incentive, based on the percentage of local ownership, of up to 1¢/kWh in addition to the standard FIT rates. A new Renewable Energy Facilitation Office has been established as a one-window access point for information on renewable energy project requirements within the Ministry of Energy and Infrastructure, and environmental approvals process for renewable energy projects have been streamlined, integrating municipal planning, environmental assessment, certificates of approval, and a variety of other approvals and licenses.

4.2 Domestic: Rules, Regulations, and Policies

A. Public Benefits Funds

Public benefits funds (PBFs) provide resources for renewable energy, energy efficiency, and low-income programs and projects. Direct incentives and financing made available from these funds continue to spur the growth of the renewable energy market. While generally a state-level program, municipalities with authority over their electric utility can establish a PBF by adding a flat monthly fee or surcharge to the electricity consumed by their customers (e.g., 0.2 cents/kWh).

Best Practice Examples

Portland, Oregon: Oregon's 1999 electric-utility restructuring legislation required Pacific Power and Portland General Electric (PGE) to collect a 3 percent public-purpose charge from their customers to support renewable energy and energy efficiency projects, currently administered by the Energy Trust of Oregon, an independent non-profit organization. Of the funds collected by the electric utilities, 56.7 percent must be allocated towards energy efficiency programs and 17.1 percent to renewables. The Energy Trust's renewable energy programs include financial incentives for small-scale and utility-scale projects that generate energy from solar, wind, hydro, biomass and geothermal resources.

Local Practices

In Michigan, a statewide PBF was enacted in June 2000 through the Customer Choice and Electricity Reliability Act. This act authorizes the creation of the Low-Income and Energy Efficiency Fund (LIEEF). The purpose of the LIEEF is to assist low-income customers with conservation and energy efficiency measures to lower their energy use and energy bills and provide shut-off protection.

Some renewable-energy projects - including wind turbines, photovoltaic (PV) systems, anaerobic digesters and other biomass projects - have received funding from the LIEFF.

B. Permitting, Codes, and Standards

The process of obtaining permits and approvals for solar photovoltaic and solar hot water systems has been cited by solar customers and solar installers as a significant barrier to implementing projects. Because these types of systems are not yet commonly installed and inspected, permits and inspection processes vary greatly. Best practices represent enough inspection and reference standards to guarantee system performance and safety, while not imposing overly burdensome or unreasonable procedures. An excellent study on this topic, entitled *Taking the Red Tape Out of Green Power*, presents a set of such recommendations:

1. Exempt roof top systems from building height limitations.
2. Allow "over the counter" building permits for standard roof mounted PV systems that do not exceed the roof support capabilities of a structure meeting minimum building code requirements.
3. Do not restrict systems based on aesthetic grounds.
4. Coordinate permitting procedures with nearby jurisdictions.
5. Base permitting requirements on IEEE 1547 and UL 1741
6. Provide Training to educate building and electrical inspectors about solar technology and installations.
7. Adopt flat permit fees or fee waivers (rather than value-based fees) for systems.

The Vote Solar Initiative has developed a model city ordinance that sets in motion actions to remove these barriers. It can be found in the Appendix of this Plan.

Training for code officials and inspectors has also been emphasized as a nationwide and local need. For more information about training inspectors, see the *Training, Education, and Research* sections of this Plan.

The Solar America Board of Codes and Standards (Solar ABCs) was formed to assist in improving solar related codes and standards. Their ongoing work is expected to be valuable for ongoing code related issues.

Expedited Permitting

Once inspectors have been trained in codes and issues related to Solar PV systems, an expedited permit process will allow standard, residential scale systems to be permitted quickly and easily. The *Solar ABCs* has recently released a report entitled "Expedited Permit Process for PV Systems," which offers a set of well developed processes to implement the expedited process, and the organization will publish updates to the forms that can be downloaded from their website.[43]

Reduced or Waived Permit Fees

Reducing any barrier, including financial, to obtaining needed permits will encourage systems to be installed. When governments have implemented these policies, it indicates to the public that solar is welcome and encouraged. Waiving fees would be ideal from this perspective, but other options include fixed fees that are not based on the value of the systems. In that case, a detailed study by Pace University Law School recommends the following fee guidelines for PV systems:

Small systems (4 kW and less): $75-$200
Large systems (4-10 kW): $150-$400
Above 10 kW (10 kW and above): $15-$40 per kW

Best Practice Examples

Portland, Oregon: Streamlined permitting process; fees for residential systems are less than $100.

Tucson, Arizona: Provides a Solar Permit Fee Credit up to $1,000 for qualified solar energy systems.

San Jose, California: Offers an "over-the-counter" expedited permitting process for solar PV installations that meet certain criteria.

Local Practices

No statewide initiatives exist on expedited permitting or permit fees. Ann Arbor received training on expedited permitting for PV systems by the Interstate Renewable Energy Council (IREC), but has not yet implemented an expedited process. Height limitation revisions are in progress.

C. Interconnection Standards

Interconnection standards are critical for regulating the way energy-generating systems connect to the utility grid. The standards detail the technical, legal, and procedural requirements that both customers and utilities must follow when connecting a PV system to the utility grid. State regulatory bodies typically determine interconnection standards, and more than 37 states have some regulations.

Most importantly, the standards are recommended to have different regulations based on the size of the system, in order to prevent burdensome rules from applying to small installations.

IREC developed a model interconnection standard that is regarded as reasonable procedure while not unreasonably restricting renewable energy installations. IREC recommends the following: [44]

1. All utilities, both municipal and investor-owned, should be subject to the standard.
2. All utility customer types - such as residential, commercial and industrial - are eligible to interconnect.
3. Three or four separate levels of review based on system size and complexity.
4. No limits should be given to system capacity.
5. Minimize application costs.
6. Adopt enforceable and reasonable timelines for procedures.
7. Use a standard form of agreement.
8. Establish a clear, transparent process for reviewing the technical aspects of an installation.
9. Eliminate requirement for external disconnect on small, inverter-based systems.
10. Eliminate requirement for liability insurance (above and beyond the coverage in a typical property owner's insurance policy) Utilities should not require the customer to cover the utility on insurance.
11. Allow interconnection to secondary distribution networks within reasonable limits.
12. Establish a means of clear communication between local code officials and the local utility to expedite the inspection and interconnection process.

Best Practice Examples

Virginia: Is currently considered the best standard in the nation. There are two standards given, one for net-metered installations and another for systems that are not net-metered. Unique to Virginia is a dispute resolution process through the state authority.

New Jersey: Has standards that include an expedited process for small systems, a standard agreement is used, and no disconnect switch is required.

Local Practices

Michigan adopted interconnection standards first in 2003, and then revised them in 2008. The Michigan standards contain many of the elements of the IREC recommendations, although they remain less than ideal. For instance, there is a requirement for a redundant external disconnect switch, and a requirement for additional insurance.

D. Net Metering

Renewable energy systems that are grid-connected can feed electricity back to the grid when a customer's energy generation exceeds their demand, growing the production of renewable energy. Net Metering is the billing arrangement, by which customers realize savings from their systems, where 1-kWh generated by the customer has the exact same value as 1-kWh consumed by the customer. Currently, more than 40 states (including Michigan) and the District of Columbia have net metering regulations. While some of these are very effective at encouraging renewable energy systems, some are less effective. According to the U. S. DOE's guide *Elements of a Sustainable Solar City* and the Network for New Energy Choice's *Freeing the Grid: Best and Worst Practices in State Net Metering Policies and Interconnection Standards*, states and municipalities should adopt the following net metering standards:

1. Allow for large system size limits to cover large commercial and industrial customers' loads, up to 2 MW
2. Net metering should be required of all types of utilities, and eligibility should apply to all customer classes;
3. Aggregated limits for all net-metered systems in a utility's service territory should be high (ideally 5% or unlimited);
4. A net excess generation (NEG) credit should be applied to the end of a customer's billing cycle at the utility's full retail rate and carried forward to the customer's next bill until the customer leaves the utility's system;
5. Systems should be required to adopt fair, safe, and reasonable interconnection standards;
6. Application fees should not be required by utilities;
7. Utilities should not be permitted to excise additional charges and fees or require that a customer change to a different tariff;
8. A customer should retain ownership of all self-generated renewable-energy credits (RECs);
9. Different facilities owned by the same person or entity should be permitted to aggregate their meters.

In addition, an emerging best practice is to allow for neighborhood meter aggregation for facilities owned by more than one person or entity. This "community net metering" or "neighborhood net metering" allows for the joint ownership of a solar energy system by different customers.

<u>*Best Practice Examples*</u>

Colorado: Allows net metering for systems sized up to 120 percent of the customer's average annual consumption for all customers of investor-owned utilities. There is no stated limit on the aggregate net metering capacity in Colorado. Any net excess electricity generated by a customer during a billing period is carried forward to the customer's next bill as a full kWh credit. At the end of a 12-month period, the utility purchases any remaining excess electricity from the customer at a rate lower than the retail rate. Alternately, customers can choose to rollover the net excess generation credits indefinitely.

Massachusetts: Massachusetts allows "neighborhood net metering" for neighborhood-based facilities that are: "(i) owned by, or serves the energy needs of, a group of 10 or more residential customers that reside in a single neighborhood and is served by a single distribution company; and (ii) is located within the same neighborhood as the customers that own or are served by the facility. The neighborhood facility may also serve additional cus-

> An emerging best practice is to allow for neighborhood meter aggregation for facilities owned by more than one person or entity.

tomers (including commercial) as long as the base requirements are met. All net-metered facilities must be behind a customer's meter, but only a minimal amount of load located on-site is required."[45] These facilities may be up to 2 MW in size.

Local Practices

Michigan's net metering law has some, but not all, of the best practices. True net metering applies to systems 20 kW and under. The following aspects of Michigan's net metering law do not follow best practices:

- The combined interconnection/net metering application is $100.
- True net metering standards only apply to systems below 20 kW.
- The system is currently capped so that net metering will not be required as the size of the program reaches 1 percent of the electric provider's previous year system peak in MW instead of the recommended 5 percent.
- Net metering standards say that utilities shall limit each applicant to generation capacity designed to meet the customer's electric needs, not allowing customers to receive credit for electricity generated above their average yearly use.
- There is no provision for neighborhood/community net metering.

E. Solar Access Laws

In order to utilize the sun for solar energy, it is essential for the property to have access to sunlight, as well as have the right to install solar systems. Solar access can be protected through *solar easements*, which protect access to sunlight, and *solar rights*, which prohibit restrictions on the installation of solar systems. Solar access is protected in over 34 states and several local municipalities.

Solar Easements

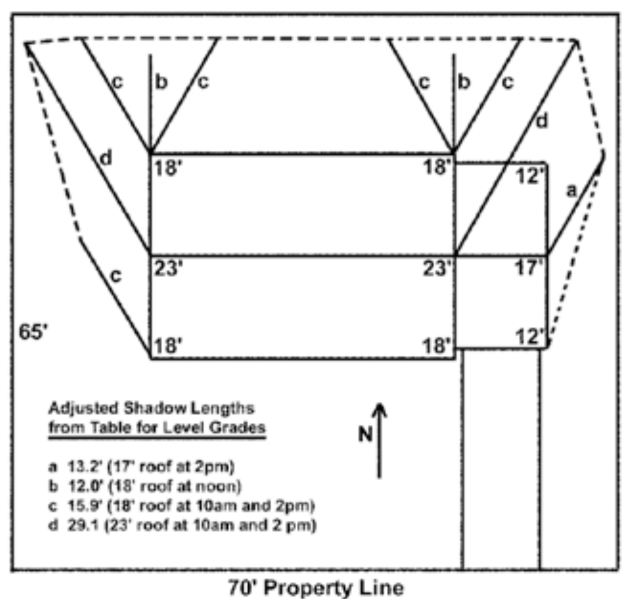
Under a solar easement, a property owner would be protected by allowing access to sunlight, including across property lines. For example, a neighbor would be prevented from building a structure or planting landscape that would interfere with access to sunlight. Solar easements are limited in effectiveness because they are usually voluntary and are not guaranteed by an agreement.

Solar Access Permits

A Solar access permit is a way that a local government can automatically grant a solar easement when a property owner receives a permit to install a solar energy system. Local governments can design the amount of solar access that is protected by specifying certain setbacks.

Solar Rights

Solar systems can be restricted by neighborhood covenants or bylaws, local government ordinances, and building codes. Solar rights are designed to prohibit restrictions such as these. At least twelve states have passed some form of legislation protecting solar rights, but incomplete provisions have led to legal action and installation delays.



Best Practice Examples
Boulder, Colorado: Established an ordinance to protect solar access for residential properties. The law guarantees access to sunlight by limiting the amount of shade from buildings and landscape. The Boulder ordinance is included in the Appendix of this Plan.

Ashland, Oregon: Created an ordinance that establishes "solar setbacks" to ensure shadows from building would not exceed certain limitations depending on the zone the property is located in. To gain protection from shadows caused by landscape, property owners can apply for a solar access permit.

Madison, Wisconsin: Amended statutes that prohibited solar energy systems in Historic Districts.

Local Practices
There is currently no statewide or local solar access protection, and there are no clear guidelines for integrating solar energy systems into Ann Arbor's historic districts.

F. Building Energy Codes

Because buildings use such a significant portion of energy, and because passive solar design or solar installations are often related directly to buildings, building codes play an essential role in the way buildings are created. Adding strong efficiency and renewable requirements to local and state building codes is a powerful tool governments can use to decrease energy use, increase renewable energy use, and reduce carbon emissions. These codes are also opportunities to tie together the bigger energy and environmental picture of efficiency, renewable energy and greenbuilding.

One step taken in many states and localities is to require that government facilities meet energy and greenbuilding standards. A state, county or city can require that new construction or major remodeling meet certification requirements of greenbuilding programs, such as LEED (Leadership in Energy and Environmental Design) or Green Globes. The higher status LEED certifications, for example, require both efficiency and renewable energy. Another option is to require that new home construction be made "solar-ready" so that a homeowner can add a system later at a greatly reduced cost.

The code requirements can encompass government-owned facilities, but can also be extended to privately owned residential, commercial, and industrial facilities as well.

Best Practice Examples
Boulder, Colorado: Requires all residential and commercial buildings to meet city-defined greenbuilding criteria. New construction must be 30-75 percent more energy efficient than the 2006 International Energy Conservation and Insulation Code (IECC), major renovations must achieve a Home Energy Rating System (HERS) score of 70-100 (15-50 percent over IECC), and residential permit applications for new construction or major renovation must obtain an energy audit and meet greenbuilding criteria.

State of California: Established greenbuilding standards that apply not only to government facilities, but all residential and commercial buildings. The extended standards are currently voluntary, but are expected to be mandatory by 2011. In addition, California law requires that solar equipment be installed on all state-owned buildings (if feasible), and 4 megawatts of solar have been installed on government buildings as of 2008.

Tucson, Arizona: Requires all new residences to be solar-ready.

Local Practices
The state of Michigan set the goal of a 25 percent reduction in grid-based electricity state purchases by 2015, compared to 2002 levels. Additionally, the state requires the purchase of energy efficient equipment when possible, requires buildings to qualify for

Energy Star® designation, and study the feasibility of gaining LEED certification. For residential energy code, the 2003 IRC, with reference to the 2004 IECC supplement is mandatory statewide. For commercial buildings, ASHRAE/IESNA 90.1-1999 is mandatory statewide.

Ann Arbor cannot require that private projects exceed the state energy codes because of Michigan State law, but the city has a long-running efficiency program for city facilities. Ann Arbor has set renewable energy goals for city-owned facilities of 30 percent by 2010, and 20 percent for the entire Ann Arbor Community by 2015. *Chapter 3* details city-based energy programs, voluntary commercial and residential energy auditing, and more.

G. Solar Set-Asides in Renewable Portfolio Standards

A Renewable Portfolio Standard (RPS) requires a utility to produce a percentage of their energy generation or energy sales from renewable energy sources. A number of states have designed their RPS to augment promising technologies that currently cost more, typically solar energy and customer-sited distributed generation. In the case of solar energy, this can include a credit multiplier, which gives favored technologies additional credits toward meeting the RPS, or a set-aside (sometimes referred to as a carve-out). While credit multipliers effectively incentivize solar, they can result in less renewable energy being generated overall if a .

If a municipality hopes to institute such a requirement, they may decide to work directly with their state government to encourage a statewide RPS. If a municipality has authorization to do so, however, they may adopt their own RPS to support renewable energy and local green jobs initiatives. Currently, 26 states (including Michigan) and the District of Columbia have established an RPS.

Best Practice Examples

Austin, Texas: In December 2003, Austin city council approved Austin Energy's 10 year strategic plan, which included a 20 percent RPS by 2020. The plan also contains a commitment to develop 15 megawatts of solar generating capacity by 2007, increasing to 100 megawatts by 2020. To help achieve the solar generation requirement, the utility established a rebate program for PV systems. In February 2007, the city increased the overall RPS requirement to 30 percent by 2020 as part of the mayor's climate protection plan; the solar requirement remained unchanged at 100 MW by 2020.

State of New Jersey: New Jersey's renewable portfolio standard (RPS) -- one of the most aggressive in the United States -- requires each supplier/provider serving retail customers in the state to produce 22.5 percent of the electricity it sells from qualifying renewables by 2021. The New Jersey Board of Public Utilities (BPU) made extensive revisions to the RPS in April 2006, significantly increasing the required percentages of renewable energy, as well as the required separate percentage of solar electricity. By year 2021, 2.12 percent solar electricity is required.

Local Practices

Michigan's RPS, established with Public Act 295 of 2008, requires that state investor-owned utilities, alternative retail suppliers, electric cooperatives,

Solar hot water system on the top of the VA Hospital. Source: City of Ann Arbor.

and municipal electric utilities generate at least 10 percent of their retail electricity sales from renewable energy sources by 2015. Under this act, electricity derived from biomass, solar, solar thermal, wind, geothermal, municipal solid waste (MSW), landfill gas, existing traditional hydroelectric, and tidal, wave, and water currents are all eligible renewables.

The RPS contains a series of bonus credits, termed Michigan Incentive Renewable Energy Credits, for each MWh of electricity generated by certain types of systems. These credits act in addition to the single credit that a facility receives for producing 1 MWh of electricity. One bonus credit is for solar - electricity produced using solar power receives an additional 2 credits per MWh.

Additional obligations have been put into place for Michigan's two largest investor-owned utilities, DTE Energy and Consumers Energy. DTE Energy, which serves the Ann Arbor region, must build or purchase 300 megawatts of new renewable energy by 2013 and 600 megawatts by 2015. Consumers Energy must build or purchase 200 megawatts of new renewable energy by 2013 and 500 megawatts by 2015.

Ann Arbor has set goals for renewable energy production for municipal related energy use and for the city as a whole. Currently the goal is 30 percent by 2010 for municipal operations and 20 percent for Ann Arbor by 2015. The goal does not contain a specific solar set-aside, which can be considered as an option, although this type of strategy is usually implemented by municipally owned utilities. For more information on the Ann Arbor goals, see Chapter 3.

H. Support Laws Incentivizing or Requiring Community Ownership

Laws encouraging community or local ownership of renewable energy help keep the revenues from and control of projects in the community. High upfront cost often keeps ownership of large renewable energy projects in the hands of large non-local companies. Local ownership can facilitate local job growth in the renewable energy sector and keep project revenues in the community. Almost any type of financial or production incentive can require local ownership as a condition of receiving the benefit. A state seeking to promote the profitability of community renewable energy projects without having to appropriate large amounts of state funds for direct subsidies may mandate that its utilities implement special tariffs to facilitate the purchase of these projects.

Best Practice Examples

Minnesota: Under the Community-Based Energy Development (C-BED) Tariff, each public utility in Minnesota is required to file with the state Public Utilities Commission (PUC) to create a 20-year power purchase agreement (PPA) for community-owned renewable energy projects.

In order for a project to be considered community-based and eligible for C-BED tariffs, the following must occur:

- 51% of the revenues from the power purchase agreement must flow to Minnesota-based owners and other local entities.
- No single wind project investor can own more than 15 percent of a project consisting of two or more wind turbine, except for local governments which may be the sole owners of community-based projects.
- All owners of property traversed by transmission lines serving the project must be given the opportunity to invest.
- The project must have a resolution of support adopted by the county board of each county in which the project is located—or by the tribal council if a project is located within a reservation.

Local Practices
Currently there are no laws or regulation incentivizing or requiring local ownership of renewable energy programs, although periodically legislation has been introduced into the Michigan House in support of this goal. It has not yet been passed into law.

4.3 Domestic: Financial Incentives

A. Direct Cash Incentives

Direct incentives, whether provided by a state, utility, or a municipality, play an important role in encouraging solar installations before the technology is cost competitive with conventional forms of energy. These incentives can drive up the demand for solar, decreasing a solar system's unit price. Direct cash incentives for solar may take a variety of forms, including rebates, buydowns, grants, and production-based incentives like feed-in-tariffs. While rebates are generally provided after a solar installation is made, upfront rebates – based on a solar system's expected performance– are increasing in popularity. These upfront rebates ease the large financial burden while installing a solar system and allow more homeowners and businesses to invest in solar technology. Feed-in tariffs require energy suppliers to buy electricity produced from renewable resources at a fixed price per kilowatt-hour, usually over a fixed time period, and have proven to be a very successful incentive in other parts of the world.

According to the U. S. DOE, funding for direct incentives should be generous and long-term while decreasing as the solar market matures. These reductions should not be made on an arbitrary timetable; rather, they should be based on aggregate capacity of installed solar systems.[46] Applications for direct incentives should be clear and concise to avoid confusion and avoid potential applicants from becoming discouraged from applying.

To keep program costs down and allow more revenue to be put directly into incentive funding, a cost-effective quality control system should be put in place. This control system should aim to protect consumers while assuring proper system performance. Common requirements include equipment specification, design guidelines, installations made only by certified installers, and performance-based incentives.[47] A program evaluation process should be created to aggregate program use, energy savings, and energy production as well as analyze all program costs. When program changes are deemed necessary – either through regular evaluation or during the program's management – flexibility should be allowed to employ such changes.

Best Practice Examples
State of California: California offers expected performance-based buydowns for systems under 50 kW at \$2.50/W AC for residential and commercial systems and \$3.25/W AC for government entities and non-profits (adjusted based on expected performance). They also offer performance-based incentives (PBI) for systems 50 kW and larger at \$0.39/kWh for the first five years for taxable entities, and \$0.50/kWh for the first five years for government entities and nonprofits. These incentive levels decline as the aggregate capacity of PV installations increases. One year after the program was started in 2007, over 125 MW of PV capacity was installed.

San Francisco, California: The City and County of San Francisco, through the San Francisco Public Utilities Commission (SFPUC), are providing rebates to residents and businesses who install PV systems one kW or larger on their properties. It is funded with \$3 million from the SFPUC renewable energy fund, which was previously just used for solar installations on city buildings, which comes from the sale of power generated by a dam. Different incentive levels are available and dependent on the property's designation as a residential, commercial, low-income residential, or non-profit owned and operated. Basic residential systems are eligible for rebates of \$1,000. Additional incentives are available for: installations performed by a local installer ($1,000); lower-income participants ($3,500); and for systems installed by individuals trained through the city's workforce development system ($3,500). Commercial and non-residential buildings owned by a non-profit, or occupied by a non-profit and owned by government entities receive a capacity-based incentive of $1,500 per kW. Multi-unit residential buildings that are operated by a non-profit may receive $4,500 per kW up to a maximum of $100,000. Marin County also provides similar incentives to residents through the Marin County Sustainability Team, including $500 for a photovoltaic system, $300 for a solar hot water heater, and $200 for a solar pool heater.

Gainesville, Florida: Gainesville Regional Utilities, a municipal utility in Florida, initiated a feed-in tariff in March 2009 for solar PV systems. Modeled after Germany's FIT, the utility is purchasing energy from PV systems at fixed rates for a period of 20 years. The fixed rate for the life of the contract starts at $0.32/kWh for contracts executed in 2009 and 2010 and decreases over time. This program was enthusiastically received - days before the FIT was officially launched - they had received enough completed applications to meet their first-year target of 4 MW. Reviews of the program have determined that additional rigor in reviewing initial applications would have increased the program's efficacy.[48]

Solar PV. Source: National Renewable Energy Laboratory.

Massachusetts: In addition to base incentives, Massachusetts offers additional incentives to encourage "high-value" solar applications. In 2009 the added residential incentives include systems using components made in-state, and installations installed either on a home of moderate value or by a household with moderate income. Additional incentives are available for public buildings and Green schools.

Local Practices

There is currently no statewide incentive. Several large utilities offer incentives – Consumer's Energy offers a 2 MW feed-in tariff that has a waiting list, while DTE Energy is currently offering direct incentives for solar energy systems that are 20 kW and under, through their SolarCurrents program.

B. Low-Interest Loan Programs

Low-interest loan programs can help ease many of the upfront costs associated with installing a solar system. While repayment schedules vary by project, a repayment term of seven to ten years is typical. While state-supported loan programs are generally utilized for projects in the non-residential sector, local and utility-run programs are aimed for residential projects. Many municipalities and counties secure favorable rates for projects by partnering with a local bank or community economic development organization. Some municipalities have also provided interest rate buy-downs to support solar projects.

Best Practices

Aspen, Colorado: A partnership between the Community Office for Resources Efficiency (CORE) and the Community Bank of Colorado provides Aspen residents and businesses with a zero-interest loan for financing photovoltaic or solar hot water systems. Interest rates have not been completely removed for this project; instead, CORE pays the interest. Typical loan terms are five years.

Ashland, Oregon: Homeowners can switch their electric water heaters with solar water heaters with a zero-interest loan (or cash rebate) provided by the city. The loan can be paid back as part of a homeowner's monthly utility bill. Potential program participants are provides site evaluations, consumer education, solar system information, and the contact information of qualified contractors.

Wisconsin: Residential and small business customers of Wisconsin Public Power's member utilities are able to secure low-interest loans for solar hot water systems and solar space heating systems (for buildings that primarily use electricity as a heating source), PV systems up to 20 kW, or repairs to existing solar systems. Loans between $2,500 and $20,000 are available at a 1.99 percent interest rate for three to ten years.

Local Practices

Michigan currently has several low-interest loan programs, including the Property Improvement Program and Small Business Pollution Prevention Loan. See Chapter 8 for further details on these programs.

C. Income/Investment Tax Credits

Tax credits can serve as a critical incentive for building owners to adopt solar technology when public benefit or direct funding sources for renewable energy projects are not available. Currently, more than a dozen states provide income or investment tax credits to encourage renewable energy projects. While tax credits have generally been made available through state policies and programs, municipalities that collect income tax can implement similar strategies to encourage solar and other renewable energy projects.

Unfortunately, tax credits do little to encourage renewable energy projects for those without a tax liability, like schools, nonprofits, and government facilities. Some states have found ways around this by extending tax benefits to non-taxable entities. In Oregon, for example, business energy tax credits can be transferred – once a project is completed – in exchange for cash. The value of this sum is based on the current net price of the tax credit. This system allows those with or without tax liabilities to transfer their tax credit to a business or individual with a tax liability.

Best Practices

Arizona: Solar projects in Arizona can be financed and installed by a third-party organization with a tax liability on the facility of a tax-exempt organization. The financier is able to claim the tax credit on behalf of the tax-exempt organization and sell the electricity through a power-purchase agreement. This arrangement is becoming more popular since it allows municipalities to install solar systems on their own facilities without the upfront costs.

Local Practices

Currently there are no state or municipal level investment tax credits.

D. Property Tax Incentives

Property tax incentives provide exemptions, abatements, credits, or special assessments that mitigate or eliminate the increase in assessed value of a property (for tax purposes) attributable to a solar energy installation. The goal of property tax incentives is to bring the cost of owning a solar energy system in line with using conventional heating and cooling systems, or drawing electricity from the utility grid. Generally, these exemptions exclude the added value of solar energy equipment in the valuation of the property for taxation purposes.

While property tax incentives reduce the cost of solar system ownership, these savings alone are not likely to stimulate significant solar development. These exemptions, however, are helpful in areas where property tax rates are high.

Best Practices

Connecticut: Provides a property tax exemption for renewable energy that generate electricity for private residential use (single-family homes or multi-family dwellings limited to four units). In addition, any passive or active solar water or space heating system or geothermal energy resource is exempt from property taxes, regardless of the type of facility the system serves. Such assessments are in effect for the first 15 years following construction or addition to a building.

Harford County, Maryland: Currently offers a credit against real property taxes imposed on residential or non-residential buildings that use solar or geothermal devices for heating, cooling, or generating electricity for on-site consumption. The credit amount is equal to one year of total real property taxes or $2,500, whichever is less. A one-time application must be submitted to the Harford County Director of Administration prior to the taxable year for which the credit is sought.

Local Practices

The State of Michigan offers personal property tax exemptions for commercial and industrial installations. Installations must be certified by NextEnergy to be eligible. There are no exemptions for residential installations currently offered.

E. Property Tax Financing Districts/Property Assessed Clean Energy Program

Even with the incentives and subsidies previously mentioned in this section, the initial investment needed to install a photovoltaic or solar hot water system remains a barrier for solar adoption. To combat this, a unique solution has been developed by the City of Berkeley, California. Here, residents are able to roll the cost of a solar energy system into the long-term assessment on their property taxes.

Under this system, both residential and commercial property tax owners are able to pay for energy efficiency and solar system installations. Funding for projects are made through a bond or loan fund created by the municipality that is eventually paid back through the tax assessments described above. Property owners can finance their systems for as long as 20 years, prompting more homeowners to consider investing in energy efficiency improvements or renewable energy installations.

For many reasons, property tax financing is especially helpful for property owners:

- Much of the upfront cost is eliminated;
- Funding approval is not based on a property owner's credit history or the property's equity since a tax on the property is voluntary;
- A well-secured municipal bond or loan provides lower interest rates;
- Tax assessments are transferable between owners. If the property is transferred or sold, the new owners will pay the remaining tax obligation.

Best Practices

Berkeley, California: Berkeley's Financing Initiative for Renewable and Solar Technology (FIRST) is a solar financing program operating in the City of Berkeley. It provides property owners an opportunity to borrow money from the City's Sustainable Energy Financing District to install solar photovoltaic electric systems and allow the cost to be repaid over 20 years through an annual special tax on their property tax bill. More information can be found in the *Guide to Energy Efficiency & Renewable Energy Financing Districts for Local Governments.*[49]

Local Practices

Ann Arbor is currently in the process of designing and implementing a property tax financing program modeled in part on Berkeley's FIRST program.

4.4 Domestic: Training, Education, and Research

A. Training and Certification for Installers

Installer training is an essential consideration for solar related projects. As installers are increasingly in high demand, the need for training programs and quality standards expands. If the general public is to gain confidence in solar, then shoddy workmanship, unsafe installations, erroneous claims, and expensive systems not performing to their optimal level cannot be acceptable.

On a national level, a number of high quality training centers and programs exist, including:

- Florida Solar Energy Center
- Solar Energy International
- Midwest Renewable Energy Association
- Great Lakes Renewable Energy Association *(Ann Arbor Solar America Cities Partner)*
- Solar Living Institute

It is expected that workforce needs will continue to outstrip training opportunities, so new programs will be necessary. The Interstate Renewable Energy Council (IREC) has recently released specific recommendations for new programs in its report entitled *Renewable Energy Training, Best Practices and Recommended Guidelines.*

In addition to traditional credentials, such as Professional Engineer and Electrician Licensure or Certification, solar specific certification is also available. The North American Board of Certified Energy Practitioners (NABCEP) is widely recognized as an exemplary certification. For solar installers, certifications are available for solar photovoltaic and solar thermal systems. These certifications are recognized for their rigorous standards and emphasis on safe, ethical business practices and workmanship standards. Additionally, NABCEP offers an entry-level certificate of knowledge for solar photovoltaics.

To become certified and maintain certification, the applicant must:

- Be at least 18 years of age
- Meet prerequisites of related experience and/or education
- Complete an application form documenting requirements
- Sign and agree to uphold a code of ethics
- Pay application and exam fees
- Pass a written exam
- Complete continuing education and installation requirements within the three-year certification period in order to be recertified.

Best Practice Examples

New York State: New York State Energy Research and Development Authority (NYSERDA) has taken an active role in training and workforce development activities. They have helped train 35 installers by working with the Florida Solar Energy Center, and the Interstate Renewable Energy Council. NYSERDA has also provided study assistance to 70 installers preparing to take the NABCEP exam. The New York program also gives priority to programs that have been accredited by the Institute for Sustainable Power (ISP).

Solar Richmond Training. Source: Solar Richmond.

Local Practices

No training programs for NABCEP exist in Michigan and only seven installers in the State are certified. Great Lakes Renewable Energy Association and the Detroit IBEW union provide Solar Installer training – see Chapter 3 and the Appendix for more information.

B. Green Collar Jobs and Solar Workforce Development

Green Jobs are defined as blue-collar jobs with a "green" element, relating to careers and jobs associated with energy efficiency, weatherization, remediation/abatement, and renewable energy. Green Jobs are also often focused on low income and minority populations for training and career development. Several cities across the nation have taken the lead on this and policy can easily be modeled on these efforts. Several case study programs are outlined in *Green Collar Jobs in America's Cities: Building Pathways out of Poverty and Careers in the Clean Energy Economy.* This report and other policy recommendations are authored by Green For All, a leading nonprofit organization concerned with Green Jobs. Another recent report by this organization was recently released that outlines opportunities for Green Job development associated with the American Recovery and Reinvestment Act, *Bringing Home the Green Recovery*.

Best Practice Examples

Richmond, California: Solar Richmond is an innovative program in California that provides low cost and free solar system installation to low-income homeowners while also training low-income residents from the community to work as installers.

Solar Hot Water Training Video. Source: Florida Solar Energy Center.

Multnomah County, Oregon: This county linked green-collar jobs goals into a Request for Proposals (RFP) for Oregon's largest solar installation in 2007. The RFP language is included in the Appendix of this Plan.

Los Angeles, California: Partnered with the Los Angeles Unified School District and the International Brotherhood of Electrical Workers (IBEW) to fund training for low-income residents at the East Los Angeles Skills Center.

Local Practices

The State of Michigan launched the Green Jobs Initiative in 2008 as part of the No Worker Left Behind program. Although no solar related programs are listed as part of this program, a number of Green Jobs programs have emerged. Detroiters Working for Environmental Justice and Focus: HOPE are two examples in Detroit.

No Green Jobs programs are currently offered in the Ann Arbor area. For area educational resources refer to the Appendix of this Plan.

C. Training for Code Officials and Inspectors

Because solar installations remain unusual in Michigan, code officials and inspectors often need additional training so they can ensure installations are safe, prompt, and meet code requirements. As solar projects and retrofits become more common, guidelines and training will be necessary. Since building codes are set at the state level, ideally this training would be a statewide effort. Several programs are available that address the needs of officials and inspectors, including:

- Florida Solar Energy Center
- North Carolina Solar Center
- New Mexico State University

For photovoltaic systems, detailed recommendations are made for inspectors in *Inspector Guidelines for PV Systems*.[50] These guidelines seek to create a reasonable process for both permitting and inspection phases of photovoltaic projects.

For Solar Hot Water systems, the Florida Solar Energy Center offers a free online training video for code officials.[51] The video includes an introduction to the various system types, as well as citing all the numerous code sections that apply to the systems.

The Interstate Renewable Energy Council (IREC) offers training in both photovoltaic and solar hot water systems for code officials.

Best Practice Examples
Salt Lake City, Utah: Solar Salt Lake's Leadership Team coordinated two training sessions for code inspectors in 2008 that attracted hundreds of participants.

New Orleans, Louisiana: A solar code trainer was invited by the city of New Orleans to train city code officials, plan reviewers, building and electrical inspectors, local solar installers, and utility personnel in solar PV and National Electrical Code (NEC).

Local Practices
Code officials in Ann Arbor received code-official training by IREC in expedited permitting processes, which included some general code related training.

4.5 Domestic: Outreach and Marketing

A. Use Effective Marketing Techniques in all Outreach Programs

Many solar initiatives have a public education and outreach component. The goal of these initiatives is to let people in the community know about the value of solar thermal and solar photovoltaic systems, and encourage them to install these systems. These outreach efforts, however, are often not as effective as they could be since education by itself rarely prompts people to act. In order to effectively encourage solar adoption, campaigns need to address the barriers and strengthen the benefits of adopting solar energy systems. Community-based social marketing is one approach that has proved effective in encouraging environmentally positive behaviors. A community-based social marketing approach to increasing solar energy adoption would have the following aspects/steps:[52]

1. Community members should be divided into target audiences that can be reached in different ways and with different messages. The most effective groups to start with are at the intersection of:
    - **Probability:** These community members have a high probability of installing a solar energy system because they are already familiar with renewable energy systems or because they are very supportive of green energy. They would not face any limits on installation such as homeowner association or historic district limitations.
    - **Impact:** The participation of this group would have a high impact since they would be able to install a decent sized system on their property or business. Additionally, they are well known and well respected in their community and thus their installation would have a high likelihood of encouraging other installations.
2. Outreach and marketing efforts should focus on decreasing barriers and increasing benefits of solar adoption. Not all barriers can be addressed by giving people information about the value of solar. For instance, common solar energy barriers are financial (overall cost, high upfront cost), perceived social norm (the look of PV panels is not acceptable, a belief that it would negatively affect property values), and lack of knowledge (cost is higher than it actually is, belief that solar

isn't viable in Michigan, not knowing the steps to going about installing a solar energy system).

3. The outreach and marketing strategy should be developed using behavior change tools that have been proven effective through academic and case study. Some effective tools that are relevant to solar adoption campaigns include:
   - **Public commitment:** Making a public commitment to a behavior - whether it is to colleagues or family, or by putting a sticker on one's car - can increase participation since people are reluctant to contradict a commitment they have made. Commitments to adopting a specific environmental behavior should be public, durable, and voluntary.
   - **Social norms:** Social norms play a major role in deciding what is deemed acceptable and what is not. Solar panels are often highly visible, which not all environmentally friendly behaviors are. In some communities this would be a positive aspect of having panels; in others it would be a negative. To enhance interest in panels in areas where it would be a positive social norm, a campaign could increase the visibility of solar panels by promoting visible panel installations and by providing materials like bumper stickers and yard signs to call attention to installed panels. In communities where panels are not a positive norm, outreach efforts should emphasize the many types of solar panels that are not highly visible as well as the possibility of locating installations behind a building. Other social norm strategies include recruiting respected community leaders to install a solar energy system, and encourage the members of their social networks install their own solar energy systems.
   - **Effective communication strategies:** A variety of techniques such as using vivid communication and speaking to the barriers and benefits of an action can make communication with an audience more effective. For instance, research indicates that people respond more positively to the message that installing a solar energy system will prevent the loss of $800 a year rather than stating that installing a solar energy system will save $800 a year.
   - **Incentives:** Effective incentives are paired with the behavior change when a choice is made – for example, an up-front reimbursement for a PV system. Feed-in-tariffs also provide an ongoing monetary incentive that is obvious each time that a customer pays their utility bills. Non-monetary forms of incentives (such as public recognition) can also be very effective.
4. **Piloting:** Once a program has been designed, piloting will help determine if it will be effective. It can help compare one approach with another, and tweak the program details to make it more effective. Without this step, the program budget may be spent on a program that does not achieve its intended results.
5. **Evaluation:** Finally, the project's impact should be measured. How effective was it? What would have made it more effective?

Best Practice Examples
Canada: Although this example is not from a *solar* marketing campaign, it illustrates the potential of a community-based social marketing campaign. Natural Resources Canada, as part of the Public Education and Outreach (PEO) Issue Table's project, evaluated barriers to participation by individuals in greenhouse gas reduction activities.[53] Research discovered that the barriers and benefits to having people check their tire inflation were different than the ones they had assumed. Because of this research, the campaign was geared toward emphasizing the benefits of safety and reducing tire wear rather than emphasizing environmental benefits. Researchers developed strategies to overcome identified barriers such as not remembering or not knowing how to check tire pressure by showing drivers how to check their tire pressure, providing a free tire gauge, and

asking drivers for a commitment to check their tire inflation when receiving an oil change.

Local Practices
No solar outreach campaigns specifically using community-based social marketing have been conducted in this area.

B. Conduct Marketing & Outreach Campaign

An effective marketing campaign should facilitate solar adoption while addressing the many myths and uncertainties about solar energy systems.

A comprehensive marketing and outreach campaign that intends to dispel solar myths and assist residents and businesses in installing solar should include:

- A single easy-to-remember website for a community that lists comprehensive, up to date information about solar energy systems and local solar installers.
- Creation and targeted distribution of informational brochures for residents and businesses and including an insert that lists up-to-date incentives.
- Regularly held informational workshops. Presenters should be able to speak in non-technical language about how solar energy systems work, recommend types of systems appropriate for various uses, be able to give an honest assessment about payback times for different types of systems, and provide a list of installers and next steps. Attendees should be contacted after the workshop in order assist them in moving past barriers to installing solar.
- Creating a solar ambassador program. These solar advocates could give presentations to the public or in their own neighborhoods and walk people through the installation of solar energy systems. These ambassadors could also coordinate bulk-purchasing programs like 1 Block off the Grid if appropriate.
- Creating a customer assistance program that directs potential solar buyers to one point person or organization that residents and businesses can contact for solar advice. The program could also include free solar site analysis.

Best Practice Examples
San Francisco, California: The San Francisco Department of Environment and the Pacific Gas and Electric Corporation have partnered to develop a solar training program for neighborhood "solar champions." These volunteers are trained on how to give a basic solar presentation that includes basic PV information, incentives, and ownership options.

Portland, Oregon: The city's Bureau of Planning and Sustainability created the Solar Now! campaign to provide outreach and education about the benefits of solar energy. The campaign includes free monthly workshops, educational brochures, an easy-to-remember informational website and toll-free number. They also offer on-site presentations at workplaces, and have conducted an advertising campaign.

Local Practices
The Great Lakes Renewable Energy Association offers a free Go Solar program that explains the costs and benefits of purchasing a renewable energy system, and brings building owners together to make a collaborative purchase of solar electric and/or solar hot water systems.

xseed ENERGY
Ann Arbor's Community Power Project

C. Create Visible Demonstration Projects

Demonstration projects can increase visibility and community awareness of solar energy. Effective demonstrations are in highly visible locations and accessible by the public. Educational opportunities associated with demonstration projects include kiosks, school and public tours, and printed materials. If the goal of the project is to encourage the public to install solar on their own residence or business, then the display or printed portion should clearly address barriers to this goal and give clear information about how to go about installing a system.

The energy saved and environmental benefits of visible demonstration projects should be included online for public access.

Best Practice Examples

Knoxville, Tennessee: The City of Knoxville is creating several demonstration projects. One new PV system on the city's transit center will feature a real-time display for the electricity produced by the system and additional information. An educational exhibit on an existing array at a nature center will highlight various types of solar technologies, and provide a step-by-step guide for navigating the installation process.

Local Practices

Ann Arbor has several demonstration projects, some of which have educational materials or displays. None of these demonstration projects are geared specifically toward moving viewers from learning about solar to installing it on their own residence or business.

5. RECOMMENDED STRATEGIES FOR ANN ARBOR

LOCAL EXAMPLE: SUNDRAGON

The outdoor pools at Buhr Park, Veteran's Park, and Fuller Park have had solar hot water systems for over 20 years. These systems have each saved the city about $4,500 per year, in addition to offsetting greenhouse gas emissions. A public art installation called the "Sundragon" was added in 2003 at the Fuller Park installation. The project sought to demonstrate renewable energy, in this case solar pool heating, in a unique and very "hands-on" way to promote creative and innovative ways to think about energy use. Through this demonstration the City of Ann Arbor intends for owners of swimming pools to become more aware of the value and feasibility of using solar energy to heat their pools.

The heart of the Ann Arbor Solar Plan can be found in the following recommendations. As a municipality, Ann Arbor is presented with many opportunities for increasing the use of solar in the community. This includes a role for the city to model best practices "in-house," but there is also a role to be played in facilitating and assisting Ann Arbor citizens and businesses in implementing solar energy systems, and working to change state policy.

When implementing the recommendations, the previous chapters of best practice research and other information should be referred for model programs and more information. Relevant chapters are referenced within each recommendation. Additionally, the U.S. Department of Energy publication *Solar Powering Your Community: A Guide for Local Governments* and the *DSIRE* solar database *(www.dsireusa.org/solar)* are invaluable resources for implementing changes.

On February 4th, 2010, 25 Ann Arbor Solar Cities Partnership members met to discuss a draft of this plan. Participants discussed each recommendation and prioritized its importance. The outcomes of this discussion and prioritization have been incorporated into the recommendations. A follow-up Solar Cities Financial Incentives meeting held in March further prioritized financial measures that are available or could be offered at the local, state, federal, and utility level [See Appendix E].

1. **Commit to a solar plan implementation process**
2. **Design Municipal Solar Financial Incentives**
3. **Simplify Solar Permitting**
4. **Advocate for State-Level Policy Changes**
5. **Integrate Solar into City Infrastructure & Culture**
6. **Consider Solar Access Laws & Robust Building Energy Codes**
7. **Create a Solar Outreach Campaign**
8. **Support Solar Workforce Development & Green Jobs**

Recommendation 1:
Commit to a solar plan implementation process

Create a clear process to prioritize recommendations including creating a timeline, assigning responsibilities, and planning for follow up.

WHY: The 1981 Ann Arbor Energy Plan listed several recommendations that are similar to the ones included in this report, including improving solar access laws and providing training to code officials. Creating a plan does not ensure recommendations are put into place. Therefore, designing an effective implementation process will increase the likelihood that these recommendations are put into place in a timely, thoughtful manner.

HOW:

- *Prioritize recommendations.* Determine which recommendations are most important to focus on in 2010, and which are more important later. Set phases for implementation, and chart the full implementation pipeline for each recommendation. For example, some items will require city council actions or legal review, while others will require additional funding.
- *Set timelines, responsibilities, and a budget for action.* Have one key person responsible for coordinating implementation activities. Follow up and measure success on a regular basis. Having regular reporting on and discussion of implementation activities as a regular agenda item on the Energy Commission agenda will help keep the implementation process moving forward.
- *Hold regular advisory meetings.* An advisory committee comprised of the solar community constituents should meet quarterly or semi-annually to review solar goals, progress, and priorities. The group should include city commissions, industry, advocacy group leaders, the Downtown Development Authority, the Ann Arbor Transportation Authority, Michigan Public Service Commission Renewable Energy Program, Michigan Energy Office, and other interested stakeholders.

Recommendation 2:

Design Municipal Solar Financial Incentives

Design municipal incentives that encourage residential and business installation of solar energy systems. Work in concert with the developing Ann Arbor Property Assessed Clean Energy program, DTE Energy incentives and the Michigan Saves program to maximize financial assistance. As most incentives are created at the state level and by utilities, advocating for best practices at these levels will also be an important strategy to encourage adoption of effective incentives.

WHY: Upfront and ongoing financial incentives have proved to be one of the most effective ways to encourage quick solar energy adoption.

HOW:

- *Promote and expand Property Assessed Clean Energy Program (PACE).* Build upon Ann Arbor's PACE program, expanding eligibility, available funds, and maximizing community education opportunities **[see 4.3 e]**.
- *Advocate for state level policy change.* Strengthening the Renewable Portfolio Standard and offering incentives such as feed-in tariffs are two particularly effective ways to increase solar adoption [**see Recommendation 4**].
- *Offer an incentive for installation of solar hot water or solar PV systems.* Specifically incentivize types of installations that meet multiple goals, including the use of local products and installers, installations on energy efficient buildings, and the utilization of green jobs program trainees. Specific types of installation locations can also be incentivized, including nonprofits that are not eligible for federal tax credits, and low-income housing **[see 4.3 a]**.
- *Add solar to property tax exemption.* Exempt solar thermal and solar PV from property taxes in Ann Arbor **[see 4.3 d]**.
- *Continue exploring the viability of creating a municipal utility.* As a municipal utility would have the authority to implement innovative incentives like feed-in tariffs, an Ann Arbor municipal utility would be most able to aggressively pursue Ann Arbor's renewable energy goals.

  See Appendix E: Financial Incentive Priorities for more information.

Recommendation 3:

Simplify Solar Permitting

Unwieldy permit processes have been identified as a significant barrier for solar adoption. Taking steps to improve and expedite the permitting process and to train city inspectors can increase the speed and ease of solar project installation.

WHY: Codes, standards and permitting govern the safety and reliability of both PV and solar thermal systems. The goal of these improvements is to help create a reasonable approach that strikes a balance between necessary regulations and reasonable processes, while incentivizing solar energy systems by streamlining approval processes.

HOW:

- *Streamline permitting*. Introduce the Permit Streamlining resolution created by Vote Solar (see Appendix for resolution) **[See 4.2 b]**.
- *Expedite permitting*. Implement an expedited permitting process for small scale, residential PV installations based on Expedited Permit Process for PV Systems produced by Solar ABCs **[see 4.2 b]**.
- *Reduce other solar permitting barriers*. Implement other recommendations outlined in "Taking the Red Tape out of Green Power," **[see 4.2 b]** including:
  - Do not restrict systems based on aesthetic grounds.
  - Coordinate permitting procedures with nearby jurisdictions.
  - Base permitting requirements on IEEE 1547 and UL 1741.
  - Adopt flat permit fees or fee waivers (rather than value-based fees) for systems.
- *Provide training to City inspectors*. The following recommended references for this training can be used to model the program:
  - "Inspector Guidelines for PV Systems", Brooks Engineering
  - Training Video for Inspection of Solar Water Heating Systems (Florida Solar Energy Center - www.fsec.ucf.edu) **[see 4.4 c]**.
- *Require high quality systems*. Require that solar water heating systems used are certified by SRCC and all PV system components meet the "Go Solar California" program requirements.

Recommendation 4:

Advocate for State-Level Policy Changes

Facilitating solar adoption requires more than local law changes and programs. Advocating for changes at the state level will help facilitate solar adoption in Ann Arbor and in other municipalities.

WHY: State-level policies have a major impact on local capacities. For example, in Richmond, California - a city with a slightly smaller population than Ann Arbor - at least 5 MW of solar energy have been installed. This is more than 5 times the amount installed in the entire state of Michigan. This impressive achievement is in due to local municipal practices that build upon excellent statewide incentives and policies.

HOW:

- *Participate in a state level solar policy group.* Work with the Michigan Public Service Commission Renewable Energy Program Solar Working Group or another group with similar goals. This would ally Ann Arbor with other communities to achieve state-level solar friendly initiatives.
- *Improve interconnection standards.* Three ways to do this are by introducing a standard form of agreement, removing the requirement for a redundant external disconnect switch, and removing the requirement for additional insurance **[see 4.2 c]**.
- *Promote solar access laws.* Support state-level solar access laws, such as Solar Rights, which can prohibit restrictive local covenants **[see 4.2 e]**.
- *Strengthen building-energy codes.* Support state-level building-energy code improvements and the ability for local codes to exceed state standards **[see 4.2 f]**.
- *Strengthen financial incentives.* Advocate for adding residential alternative energy systems to the property tax exemption or authorize a refundable income tax credit for renewable energy systems.
- *Strengthen Renewable Portfolio Standard.* Advocate for a strengthened Renewable Portfolio Standard, including promoting solar set-asides and feed-in tariffs **[see 4.2 g]**.
- *Enact legislation encouraging community ownership of larger solar projects.* Two important laws include: 1) allowing for "neighborhood net metering," which would aggregate neighborhood meters for facilities owned by more than one person or entity; and 2) instituting a Community-Based Energy Development (C-BED) Tariff, where each public utility is required create a 20-year power purchase agreement (PPA) for community-owned renewable energy projects **[see 4.2 h]**.

Recommendation 5:

Integrate Solar into City Infrastructure & Culture

Integrate solar installations and education into municipal culture. Each of the various city agencies, authorities and departments can creatively implement the use of solar in different ways.

WHY: The public will see and learn about solar through different gateways. The city will maximize the use of solar through integration with all the various possible applications.

HOW:

- *Continue to lead by example.* Continue installing renewable installations at the municipal level. Set new goals as previous targets are reached. Set a solar-specific goal for municipal energy. Publicize these installations by publishing information online and by installing easy to read, comprehensive educational displays.
- *Make solar integral to energy, climate and environmental planning.* This integrated approach includes prioritizing energy strategies, such as energy efficiency, and involves policy development that considers the potential of each energy related improvement and how it relates to other approaches.
- *Require all city-owned installations be sub-metered and have Data Acquisition Systems.* Publicize this information online in real-time **[see 7.8]**.
- *Integrate solar into high-visibility projects.* Some potential high-visibility projects could include:
  - Requiring or encouraging solar in public art commissions
  - Integrating solar into bus stops
  - Purchasing solar-powered trash compactors
  - Purchasing solar powered street and pedestrian lighting
  - Developing a municipal and/or public solar-powered vehicle charging stations **[see 7.5]**.
- *Include discussion of solar plan recommendations in relevant venues.* Integrate implementation goals into discussions with Environmental Commission, Inter-Commission Meetings, Greenbelt Program planning and wherever relevant.
- *Support non-municipal solar related initiatives.* XSeed Energy is one initiative that resulted from this plan which aims to demonstrate the viability and relevance of solar energy systems by installing visible community supported solar projects. Continue to support and partner with this initiative and other nonprofit and educational initiatives **[see 3.3]**.

Recommendation 6:

Consider Solar Access Laws & Robust Building Energy Codes

Solar access laws guarantee residents and businesses access to available solar resources. On the local level, ordinances serve a very important role in guaranteeing a legal right to access. Building energy codes can guarantee desired levels of energy performance, green-building, renewable energy, and more.

WHY: Ordinances, laws and unconsidered development can severely compromise the ability to utilize solar resources. All buildings are subject to code compliance, so introducing new, robust energy codes can drive new investments in renewable energy and energy efficiency. Not addressing these laws has led to unnecessary litigation in other states and municipalities.

HOW:

- *Eliminate solar access restrictions.* Assess and identify any solar access restrictions from historic district laws, covenants, planning and zoning codes or other municipal codes. Building height restrictions and aesthetic requirements are examples to evaluate **[SEE 4.2 E]**.
- *Design solar access laws.* Laws in Boulder, Colorado or Ashland, Oregon are particularly good examples, included in the appendix of this plan. These laws are often have more requirements in residential areas, and fewer in commercial or downtown areas as to not impede density **[SEE 4.2 E]**.
- *Create a solar access permit.* Utilize a solar access permit to automatically create a solar easement when a building owner applies for a solar permit **[SEE 4.2 E]**.
- *Require energy audits.* Energy audits can be required for commercial and residential buildings, either at the time of sale (Austin, Texas), or at the time of construction / major remodel (Boulder, Colorado). These audits can include solar site assessment, among other energy strategies **[SEE 4.2 F]**.
- *Create comprehensive building energy codes that facilitate solar energy systems.* Advocate for the State of Michigan to allow local building codes to exceed the state requirements. Model building energy codes on solar and eco-friendly code examples that facilitate solar, require green building criteria, and include high energy efficiency standards. Two examples are Boulder, Colorado and the State of California. Options include: greenbuilding, solar hot water, renewable energy generation, and energy efficiency **[SEE 4.2 F]**.

Recommendation 7:
Create a Solar Outreach Campaign

Implement a two-phase solar outreach and marketing campaign, using community-based social marketing principles. Evaluate each aspect to be sure that it: a) Demonstrably increases interest in installing solar energy systems; b) Answers common solar energy questions while providing concrete information about next steps needed to install solar; and c) Demonstrably increases the number of people installing solar energy systems.

WHY: As new solar and energy programs, incentives and other resources are developed, the public needs to be informed about their availability. An effective campaign can increase awareness of solar energy, demonstrate the viability of solar in Michigan, inform the public about various resources that are available, and noticeably increase solar adoption.

HOW:

Phase 1: Set the groundwork:

- *Create an easy-to-remember website* (e.g. AnnArborSolar.com; SolarAnnArbor.org). Promote and ask local environmental and community groups to link to the website **[SEE 4.5 B]**.
- *Distribute informational brochures for residents and businesses.* Distribute brochures with an insert listing current incentives to key locations, including online.
- *Designate and publicize a specific point person and organization/municipal agency to answer questions.* This person/group should give unbiased advice about installing solar energy systems and walk interested residents and people through the installation process.
- *Build upon existing solar installations.* Add a link to the website recommended above and specifically gear display information to go beyond solar education to address misbeliefs and encourage solar adoption. Add educational displays to existing installations that do not have information **[SEE 4.5 C]**.

Phase 2: Carry out a comprehensive outreach campaign:

- *Hold regular informational workshops.* Workshops should cover how to evaluate a site's potential for solar energy and provide an overview of types of systems, costs, payback periods, and sources of installation assistance **[SEE 4.5 B]**.
- *Create an outreach and marketing program through neighborhoods.* Work through neighborhood associations to talk to residents and create an effective outreach campaign.
- *Create a solar ambassador program.* Train and facilitate the outreach of solar educators, focusing on well-known community leaders. These educators could also be a point person for facilitating bulk-purchasing programs as requested.

Recommendation 8:

Support Solar Workforce Development & Green Jobs

Ann Arbor policies and action can support programs that help develop the solar workforce and green jobs training availability in this region, catalyzing increased employment in green industries, and increasing Ann Arbor's leadership in the renewable energy field.

WHY: Growing the number of qualified solar installers is key to growing solar energy in Ann Arbor. Focusing training on Green Jobs is one effective way to encourage the participation of low-income and minority populations in the renewable energy field. Green Jobs career tracks include energy efficiency, weatherization, and solar installation. Several cities across the nation have taken the lead on this and policy can easily be modeled on these efforts.

HOW:

- *Survey existing Green Jobs training programs.* Encourage new solar training programs within existing workforce development landscape. Programs identified in this Plan are included in the Local Resources section of the Appendix. Once workforce development programs include solar, incentives can be designed to encourage the use of program graduates.
- *Create partnerships.* Partner with the Detroit IBEW solar training program, the only NABCEP-recognized program in the area, and other stakeholders. This is similar to the approach taken by the City of Los Angeles' Water and Power Department. This partnership can involve training of low-income residents, and utilize trainees on municipal or other Ann Arbor installations.
- *Provide scholarships.* These can be offered to local installers or trainees to gain NABCEP certification, as the New York State Energy Research and Development Authority has done **[see 4.4 b]**.
- *Require Green Jobs criteria.* These criteria can be included as part of city-created Requests for Proposals, similar to Multnomah County, Oregon (RFP language is provided in the Appendix). This can include energy and weatherization activities in addition to solar **[see 4.4 b]**.

PART 2:
SUPPORTING INFORMATION

6. NATIONAL & STATE ENERGY TRENDS

LOCAL EXAMPLE: DOWNTOWN PARKING METERS

In 2009 the Downtown Development Authority installed twenty-five solar-powered parking meters on Main, Liberty and State streets as the first test phase before replacing all of downtown's 1,500 parking meters. The DDA hopes to eventually swap out the vast majority of downtown's parking meters with 175 solar-powered meter stations (One meter station can cover about half a dozen parking spaces.) The solar-powered parking meters come equipped with a solar panel that enables them to remain entirely off the grid.

6.1 Energy Use and Policy in the United States

A. Historic Overview

Historically, the United States utilized wood - and later coal - as its primary sources of energy. By the middle of the 20th century, petroleum-derived energy had exceeded all other sources. Despite growth in other energy markets, such as natural gas, hydroelectric power, and nuclear electric power, petroleum remains our main source of energy, accounting for almost 40 percent of the energy utilized in the United States.

Self-sufficient in its energy needs until the late 1950s, the United States began to import energy to meet its rising consumption. These imports have generally grown over the last 50 years, only decreasing for a handful of years from the oil price shocks of the late 1970s and early 1980s. Currently, net imported energy accounts for approximately 29 percent of all energy consumed in the United States.

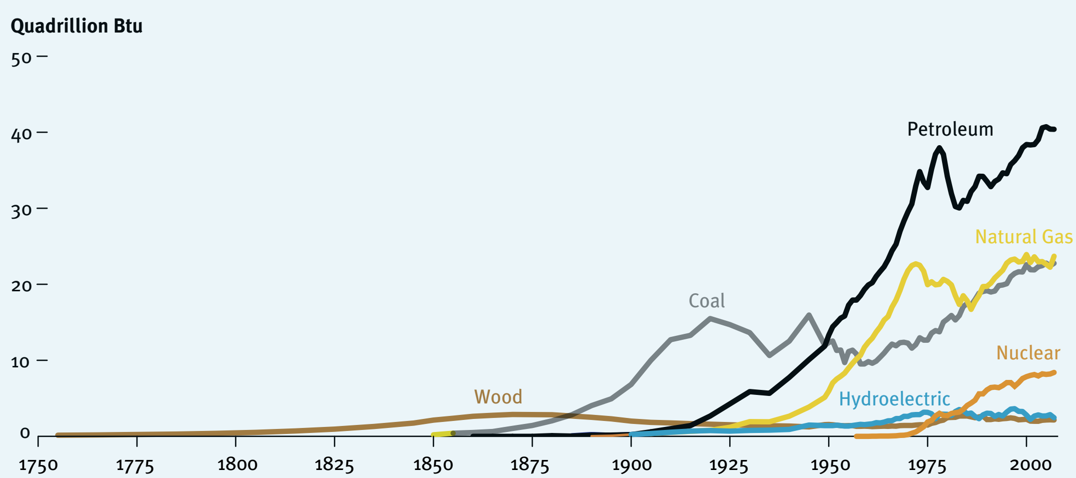
B. Current Energy Use

Currently, the United States consumes just over 100 quadrillion Btu of energy of all kinds annually. In their *High Economic Growth Case Projections for 2009*, the Energy Information Agency of the U.S. Department of Energy predicts that U.S. total primary energy consumption to grow from 100 quadrillion Btu in 2006 to 123.4 Quadrillion Btu in 2030.[1] Worldwide, total primary energy consumption is predicted to grow from 510.5 quadrillion Btu to 733.4 quadrillion Btu during the same time period.

Of total U.S. energy consumed in 2008, 24 percent was in the form of natural gas, as compared to 37 percent from petroleum and 22 percent from coal.[2] Only seven percent of energy used in the United States was derived from renewable sources, the vast majority of which is hydroelectric power collected by dams.

The United States is the largest consumer of energy in categories across the board. Of the 16,378 billion kWh of electricity consumed around the world in 2006, the U.S. consumed 3,816 billion kWh, or 23.3

U.S. Primary Energy By Source



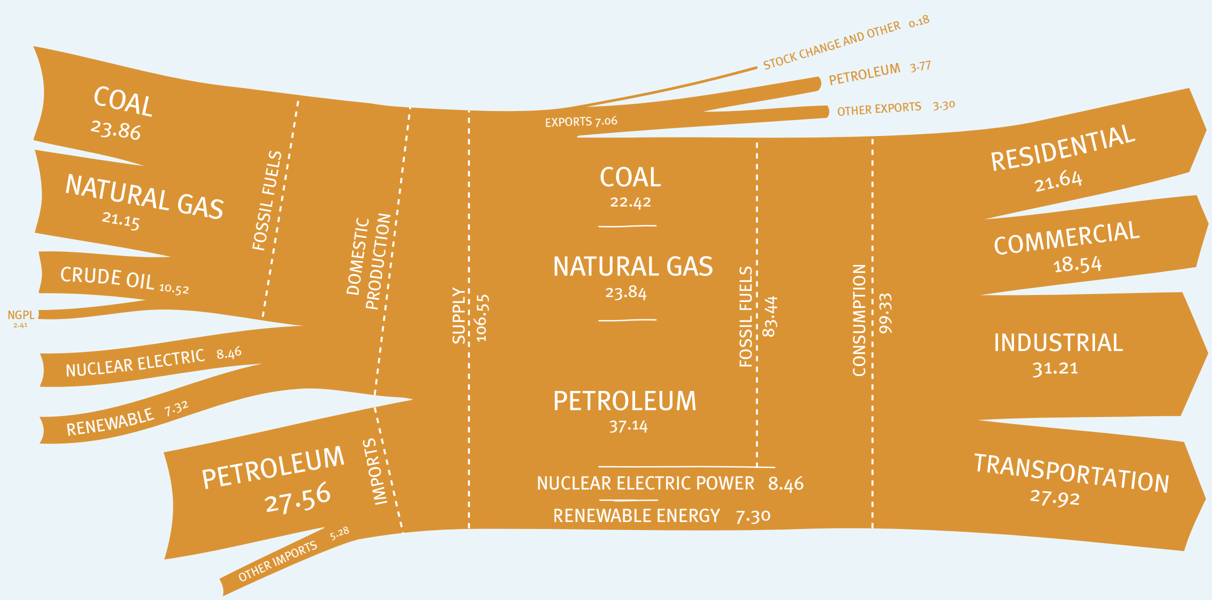
Source: Annual Energy Review 2008, Energy Information Administration percent.[3] By comparison, all of Europe – which has over twice the population of the United States - consumed 3,232 billion kWh that year. About 40 percent of energy used in the U.S. is classified as electric power, the largest single category. The other categories, in descending order, are transportation at 29 percent, followed by industrial and residential and commercial[4]. Natural gas fits in prominently in three out of four categories for electrical power generation and as heating.

C. Problems Associated with Fossil Fuels and Nuclear Energy

Despite their predominance and our reliance on them, the use of fossil fuels (oil, coal, and natural gas) comes at a heavy cost in terms of human and ecological health and political instability. One of the major disadvantages of fossil fuels is their finite quantity – they are "non-renewable." Additionally, issues with fossil fuels include:

- *Peak Oil:* Multiple sources estimate that global production of oil has is close to or has already reached its maximum rate of extraction, and so future extraction will dramatically decline and become more costly until it is depleted.
- *Human Health:* The extraction, transport, byproducts and waste from the use of fossil fuels creates harmful pollution that is dangerous to human health in many ways and causes thousands of premature deaths every year. [5]
- *Ecological Effects:* Both the extraction and use of fossil fuels have negative impacts on the natural environment. For example, oil spills can be devastating to marine life, and coal mining can negatively affect the water, soil, and wildlife near the mining operation.
- *Environmental Justice:* Pollution and other negative outcomes from fossil fuel use are disproportionately impacting economically and racially disadvantaged communities. For example, an advisory committee to the U.S. Civil

U.S. Energy Flow, 2008
(Quadrillion Btu)



Source: Adapted from Annual Energy Review 2008, Energy Information Administration

Rights Commission found that the infamous "Cancer Alley" petrochemical region of Louisiana has disproportionately affected minority groups.[6]

- *Climate Change:* The burning of fossil fuels is a principal source of greenhouse gas emissions, such as carbon dioxide, and are changing the delicate balance of the entire earth and all its inhabitants. The changes in sea levels and weather patterns could prove catastrophic if no actions are taken to dramatically reduce greenhouse gas emissions.[7]
- *Energy Security:* Because most of the oil we use is imported, we rely on relationships with countries that have oil resources. These countries may not have interests compatible with those of the United States, and relying on other countries leaves us vulnerable to economic shocks caused by supply disruption and increasing prices.

Nuclear Power has a different set of issues. In contrast to fossil fuel, the actual energy production produces no air emissions, and is not considered scarce. The nuclear process, however, results in highly toxic, cancer-causing and radioactive waste that has to be stored for thousands of years.

D. Renewable Energy

In contrast to fossil fuel and nuclear power, renewable energy offers fewer problems and more benefits. Renewable forms of energy include wind, geothermal, hydroelectric, and solar. All forms of renewable energy are, by definition, not likely to run out. Each type of technology does have an environmental impact, as the materials to make a wind turbine or solar panel have been mined, processed, and transported. These impacts, however, are dramatically less harmful than fossil and nuclear power. Once installed, these technologies produce no emissions and no harmful waste products. The major disadvantage of some renewable energy is its intermittent quality, due to the natural processes it relies on. Several methods have been developed to compensate for this, including storage of various types, smart grids, and more. Benefits and barriers associated specifically with solar are detailed in Chapter 2 of this Plan.

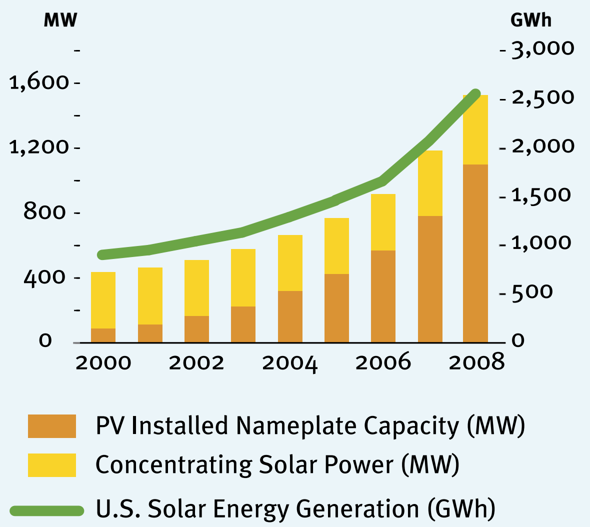
Renewable Energy is experiencing a major upsurge on a global scale. Some key findings of the *Renewable Energy Data Book*, recently published by the U.S. Department of Energy, include:[8]

- Although renewable energy (excluding hydropower) is a relatively small portion of total energy supply both globally and in the United States, renewable energy installations as a whole have nearly tripled between 2000 and 2008.
- Including hydropower, renewable energy represented more than nine percent of the total energy generated in the United States in 2008 and seven percent of energy used.
- In the U.S., growth in wind and solar PV sectors signify an ongoing shift in the composition of our electricity supply. In 2008, cumulative wind capacity increased by 51 percent and cumulative solar PV capacity grew 44 percent from the previous year.
- Worldwide, wind energy is the fastest growing renewable energy technology. Between 2000 and 2008, wind energy generation worldwide increased by a factor of almost seven. The United States experienced even more dramatic growth, as installed wind energy capacity increased almost ten times between 2000 and 2008.

6.2 Solar Resource Potential

Solar radiation is so essential to the Earth's ecology that life as we know it would cease without its reliable glow. As the center of our solar system, the Sun sends massive amounts of energy to Earth. This energy supports life and can be converted to forms of energy that are useful to humans. The sun's energy that reaches the Earth's surface amounts to 100,000 terawatts (TW) and represents more than 6,000 times the current global consumption of primary energy.[9] The energy from the sun is free and available to all living things on Earth.

U.S. Installed Solar Energy



Source: Adapted from "2008 Renewable Energy Data Book," U.S. Department of Energy, Energy Efficiency and Renewable Energy

As with other renewable energy strategies, solar technologies depend on the local availability of solar resources. According to the Union of Concerned Scientists:

> *The technical potential of U.S. solar power is huge. PV panels installed on less than 1 percent of the U.S. land area could generate the equivalent of the country's entire annual electricity needs, as could Concentrating Solar Plants covering a 100-square-mile area.*[10]

An intelligent, regional approach to solar energy development would lead to massive developments primarily in the southwest United States. The use of solar in Michigan, however, is still recommended within a portfolio of other renewable technologies. Despite its climate and northern location, Ann Arbor has very strong solar potential. About half of the days in Ann Arbor are classified as either "clear" or partly cloudy with the other half classified as "cloudy." Ann Arbor receives more than enough insolation (a measure of solar radiation) to make solar a viable energy option. Southeast Michigan's average solar insolation of 4.29 kWh/m^2.[11] Germany, for example, has been very successful with solar energy despite insolation levels similar or lower than Michigan's. Munich averages 2.98 kWh/m^2 per day while Hamburg has just 2.52/m^2 per day.

On a regional and local level, understanding the amount of solar resources available is contingent on the local climate, such as cloud cover, and on the geographic location. On a specific site, access to solar radiation is also limited by shading from trees and buildings; all are important factors when designing and selecting systems.

A. Policy

Federal energy subsidies and policies mirror current U.S. production and consumption trends. For example, an analysis by the Environmental Law Institute of recent subsidies revealed a major trend to support fossil fuels over renewable forms of energy.[12]

The 2008 election shifted energy policy toward support of renewable energy. Among the policies enacted to date, the American Recovery Act is the most significant with $80 billion worth of investment into clean energy. According to the White House, the following allocations have been made:

- $11 billion for a bigger, better, and smarter grid that will move renewable energy from rural production sites to cities. $40 million has been allocated for smart meters to be deployed in American homes.
- $5 billion for low-income residential weatherization projects.
- $4.5 billion to "green" federal buildings and cut federal energy bills, saving taxpayers billions of dollars.

- $6.3 billion for state and local renewable energy and energy efficiency efforts.
- $600 million in green jobs training programs – $100 million to expand line worker training programs and $500 million for green workforce training.
- $2 billion in competitive grants to develop the next generation of batteries to store energy.

Additionally, other policies include:

- Increasing, for the first time in more than a decade, the car and truck fuel economy standards for Model Year 2011. This will save drivers money and spur companies to develop more innovative products.
- The President issued a memorandum to the U.S. Department of Energy to implement more aggressive efficiency standards for common household appliances, such as dishwashers and refrigerators. Through this step, over the next three decades, we'll save twice the amount of energy produced by all the coal-fired power plants in America in any given year.[13]

6.3 Energy Use and Policy in Michigan

Ten million people live in Michigan, about 3.3 percent of the U.S. population. In 2008, Michigan used 3.6 percent of the natural gas consumed in the U.S., but just 3.0 percent of the total energy consumed.[14] Seventy-eight percent of homes in Michigan are heated with natural gas.

Petroleum serves as the largest source of energy use for Michigan residents and businesses, but only slightly – natural gas and coal account for nearly as much in Michigan energy consumption. This consumption is met mostly through imports: 97 percent of the petroleum consumed, 80 percent of the natural gas used, and 100 percent of the coal and nuclear fuel used is imported from other states and nations. When considering expenditures, energy imports account for approximately 70 cents of every dollar spent for energy by Michigan residents and businesses. In 2007, this accounted for a total of $27 billion spent on imported energy.[15]

In 2007, 38.5 million tons of coal was burned. One hundred percent of the coal used in Michigan is imported (mostly from Wyoming and Montana) at an estimated cost of $1.36 billion.[16]

Of the electricity that is consumed in Michigan, 60 percent comes from coal-burning power plants, 26 percent is derived from Michigan's three nuclear power plants, ten percent is supplied from natural gas-fired generation, and four percent is provided by hydroelectric and renewable energy.[17]

According to the *Michigan Energy Appraisal* prepared by Michigan's Department of Energy, Labor, & Economic Growth (DELEG), Michigan has "significant potential for energy from renewable resources, particularly from: biomass; liquid fuels from agricultural and forestry feedstock; wind, generally near the Great Lakes shorelines and in the Thumb region; and solar."[18]

Additionally, the State has enacted several policies that encourage the use and expansion of clean energy:

- In October 2008, Michigan passed a Renewable Portfolio Standard (Public Act 295), that requires electric utilities and suppliers to generate ten percent of their retail sales from renewable energy sources by 2015. Specifically, DTE Energy is required to produce 300 MW of new renewables by 2013 and 600 MW by 2015. While not as aggressive as other states, this important step brings Michigan into the company of states that promote renewable energy.
- Net metering is another program that has helped encourage renewable energy, since it allows customers to sell back or get credit for electricity they generate using renewable energy. These incentives and policies are described

in detail in *Federal and State Incentives and Resources.*

- Michigan legislators have also been introducing new legislation. In late 2009, there were eight pending bills related to Energy Policy, three for net metering, and seven for residential renewable energy tax credits.

6.4 Energy Prices

The average price of natural gas for residential use in the United States in 2008 was $13.68 per thousand cubic feet.[19] This price is double the price of natural gas just ten years ago.[20] With the price of natural gas rising and the supply limited, solar power - for both electrical generation and heating - is becoming more and more financially attractive.

Unlike the price of natural gas, the price of electricity in the United States has remained steady over the last decade; the price has actually fallen over several decades. The average price of electricity in the U.S. for residential use is just over eight cents per kWh, which is down from a high of 11 cents in the early 1980s.[21]

The average residential price of electricity in Michigan is just slightly below the national average, averaging 10.09 cents per kWh in September 2009.[22] The price of natural gas for residential use, however, was lower in Michigan than the national average; it was $11.82 per thousand Btu in 2008, nearly two dollars less than the nationwide average of $13.68.[23]

Natural gas prices are predicted by the Energy Information Agency to increase in the next twenty years, particularly after 2020.[24] During this period the number of natural gas-fired power plants is expected to increase as it becomes more difficult and costly to site and build coal-fired plants. In 2030, the price of natural gas is predicted to be $19.01 per thousand cubic feet. Domestic natural gas production is predicted to increase in the next 20 years, particularly production from unconventional sources such as tight gas sand formations; natural gas imports are actually expected to decline over this period.[25]

Though electricity prices have not risen as much as natural gas prices have, the Energy Information Agency predicts electricity prices to rise to about ten cents per kWh in 2030, not accounting for inflation.[26] Total residential electrical use is expected to rise only slightly between 2009 and 2030, though larger gains are expected in the commercial, industrial, and transportation sectors.

During this period, the price of solar energy will continue to fall, especially in comparison to other fuel types. In fact, the Energy Information Agency predicts national grid-connected solar photovoltaic installations to rise from 50 MW of capacity in 2009 to 380 MW in 2030.[27]

6.5 Solar Energy in the United States

Generally, solar installations in the U.S. have comprised of customized solar installations for on- or off-grid applications. The solar market, however, is quickly growing, due mostly to rising energy prices, a desire to reduce dependence on imported fossil fuels, and a greater interest in sustainability. Electricity generation from solar has tripled over the last ten years - 2,662 GWh and 62,000 new solar thermal and electric installations were completed throughout the United States in 2008.[28]

California saw the largest increase in photovoltaic system installations, capturing 62 percent of new installations in 2008. During this time, the capacity of California's installed PV systems nearly doubled to 179 MW. Ten other states saw similar trends, raising the U.S. grid-connected solar capacity in 2008 to a total of 289.8 MW (an increase of nearly 81 percent from 2007). Of this recent growth, however, 82 percent was concentrated to only four states: California, New Jersey, Nevada, and Colorado.

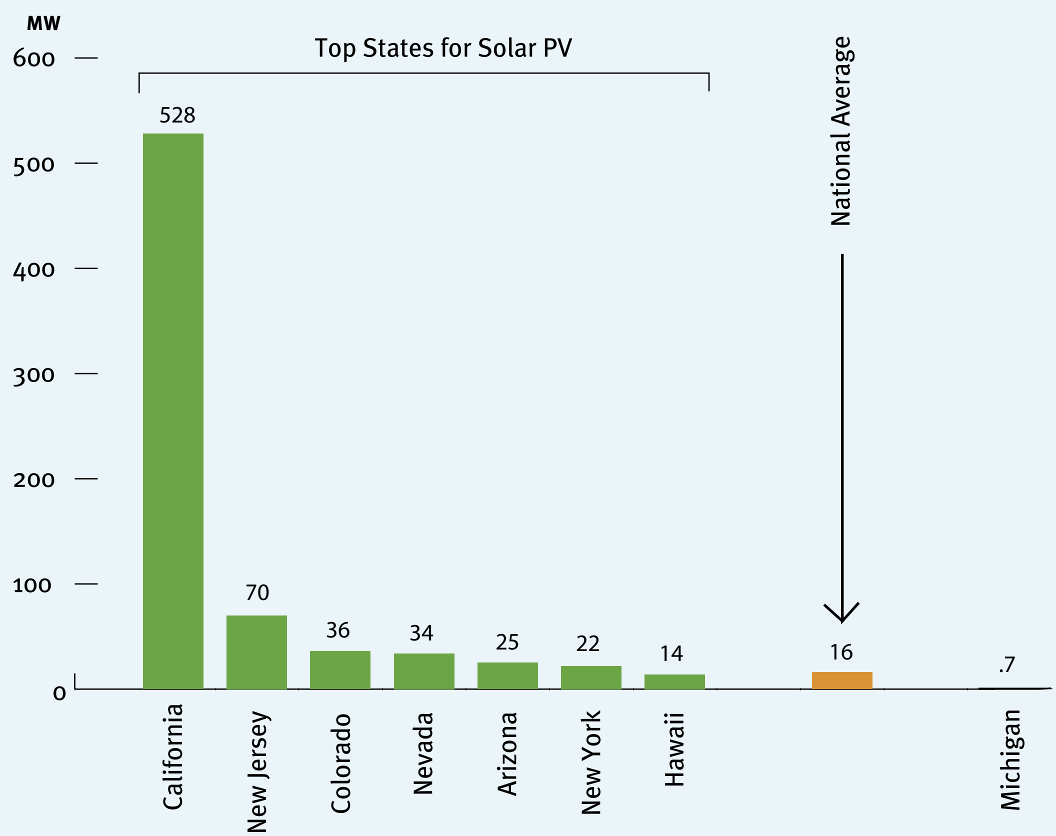
Solar hot water installations have also boomed – total installations in the contiguous 48 states quadrupled from 2005 to 2008.

Both of these tremendous growths are largely attributed to the financial incentives offered for new adoptions of the technology, including:

- An increase in the federal investment tax credit for commercial taxpayers in 2006.
- The establishment of a residential tax credit in 2006.
- Strong state incentives that support solar.
- Renewable portfolio standards that include specific solar requirements.

Approximately two-thirds of the total capacity for all grid-connected photovoltaic systems is derived from non-residential installations. 'Non-residential' installations include placement on government buildings, commercial buildings, utility installations, and military installations. Since federal incentives tend to be more generous for commercial installations, there are more non-residential installations with a larger average size and capacity. Approximately 19,000 grid-connected PV systems were installed in 2008. Of these, 90 percent were for residential use. Since the average non-residential system, however, is ten times the size of a residential system, the total capacity of non-residential systems is much greater.

Installed Solar PV Capacity State Comparison



Created with data from: "2008 Renewable Energy Data Book," U.S. Department of Energy, Energy Efficiency and Renewable Energy

The average size of both residential and non-residential photovoltaic installations has also increased. Over the last decade, the average size of a grid-connected residential system grew by 2.5 kW – from 2.2 kW in 1998 to over 4.7 kW in 2008. The average size of a grid-connected non-residential system grew by nearly 55 kW – from 12 kW in 1998 to 67 kW in 2008.

Nearly all large and many medium-sized non-residential installations are made possible through a power purchase agreement (PPA). A financier owns the solar installation and receives all applicable tax benefits and incentives. This third party then leases or sells the system to the building or site owner.

Utility companies increased their solar installations in 2008, raising their solar capacity to eight percent of all grid-connected systems. Large system installations – in both utility and non-residential systems – grew faster than any other sector. Thirty percent of the capacities of all PV systems installed in 2008 are from systems larger than 500 kW.

According to the Interstate Renewable Energy Council (IREC), activity in the solar electric market has more to do with incentives and policies than with the availability of solar resources. The states with the most grid-connected PV systems all have financial incentives available and/or solar mandates in their Renewable Portfolio Standards (RPS). Most solar installations around the United States have been "inspired" by income tax credits and state, local, or federal incentives. Examples of state and local incentives are discussed in the *Financial Incentives* section of this Plan.

Renewable Portfolio Standards have been instrumental in building the solar market in Colorado. Amendment 37 – passed by voters in 2005 – created a requirement that 0.4 percent of retail electricity sales must be derived from solar sources. The legislature eventually doubled this requirement, helping to grow grid-connected capacity in all of Colorado to 21.7 MW in 2008 – the third largest in the nation. Several large solar installations have resulted from Nevada's RPS, which currently has a solar carve-out of 1.5 percent of all electricity by 2025. In fact, Nevada is home to two of the largest solar installations in the U.S. – the 12.6 MW plant in Boulder and the 14 MW plant at Nellis Air Force Base. Nevada's RPS also led to the 2007 opening of a 64 MW solar thermal electric plant.

6.6 Solar Energy in Michigan

While Michigan has not been a leading state for solar installations, many independent and grant assisted projects have been installed. Local initiatives, such as Solar Ypsi and the installation on the Leslie Science & Nature Center, have brought awareness and visible public installations.

The State of Michigan's Bureau of Energy Systems estimates that 734 kW of photovoltaics have been installed statewide as of 2008. In the near future, solar is expected to increase dramatically in Michigan as utilities meet the requirements of the Renewable Portfolio Standard. DTE Energy, the state's largest utility, plans to install 15 MW of utility-owned solar. The utility will encourage 5 MW of customer-owned solar energy systems through their SolarCurrents program, which is described in detail in the *Financial Incentives* portion of this Plan. When installed, this would represent a 27-fold increase from Michigan's current capacity.

If implemented, other new progressive policies on the local, state, and federal levels will also have a direct impact on solar in Michigan. If solar PV, for example, was installed on seven percent of rooftops in Michigan, it could produce 38,000 GWh per year, or one third of the electricity used in 2005.[29]

Michigan's rich industrial and manufacturing tradition, significant scientific and research communities, and because it has one of the largest natural deposits of silicon in North America, solar research and manufacturing has rooted itself in Michigan.

The Michigan Economic Development Corporation (MEDC) is actively recruiting potential new firms by using industry recruitment and support incentives that the state has passed. The following are some major Michigan businesses involved in solar photovoltaics, according to the MEDC:

- **Clairvoyant Energy -** Clairvoyant Energy Solar Panel Manufacturing Inc. plans to invest $856 million (over four phases) at the former Ford Wixom Assembly Plant to manufacture solar panels. The project is expected to create over 750 direct jobs over the next five years in addition to nearly 4,600 indirect jobs.
- **United Solar Ovonic -** United Solar Ovonic is the world leader in thin-film solar technology and the manufacturer of thin-film electric modules and laminates distributed globally under the Uni-Solar brand. United Solar Ovonic has four of the largest thin-film PV laminate plants in the world here. They had planned on building a fifth facility in Battle Creek, but have put off these plans because of the economic downturn.
- **Hemlock Semiconductor -** Hemlock Semiconductor Corporation is the world's leading producer of hyper-pure polycrystalline silicon for the semiconductor and solar power industries. Based in Saginaw County, this subsidiary of Dow Corning has begun production at its new polysilicon facility that will nearly double its output of polycrystalline silicon (polysilicon). The new facility is part of a $1.5 billion expansion at its Hemlock site, bringing the company's annual capacity to approximately 19,000 metric tons by the end of 2008, making it the largest single polysilicon facility in the world.
- **Evergreen Solar -** Evergreen has developed state-the-art manufacturing featuring their String Ribbon wafer technology. Marlborough, Mass-based Evergreen Solar is building a $55.2 million plant in Midland's Eastwick Industrial Park to create string for the company's technology.

Other PV related companies with some tie to Michigan include:

- PrimeStar Solar
- Dow Corning Solar Solutions
- KUKA
- Nextek
- Patriot Solar Group

There are also at least five solar thermal companies located in Michigan, including:

- BTF, Limited (Fennville)
- EVOSOLAR (Warren)
- Great Lake Electric (Stevensville)
- Power Panel, Inc. (Detroit)
- Sunsiaray Solar Manufacturing (Davison)

Contact information for the above companies can be found in the *Local Resource Directory* in the appendix of this Plan.

7. SOLAR TECHNOLOGY OVERVIEW

LOCAL EXAMPLE: MISO HOUSE

The Michigan Solar House (MiSo) is the work of an interdisciplinary team of architecture students and faculty for the 2005 Solar Decathlon in Washington, D.C. The Michigan Solar house is made from earth-friendly materials and seeks to: "create an affordable and customizable home which produces a surplus of renewable energy that will effectively redefine comfortable living in a manner feasible for generations into the future."

The sun's free energy can be converted into a number of different uses using a variety of different technologies. The following describes an overview of currently viable solar technologies.

7.1 Passive Solar and Daylight

Passive solar refers to the conversion of solar energy into useful energy without the use of active mechanical systems such as pumps or fans. Typically, solar energy is used to heat air or water in order to heat or cool spaces or cook food. Passive solar buildings are carefully designed and oriented to maximize the use of this radiation and a number of techniques have been employed to accomplish this. For example, window openings should face south, walls are designed to absorb and slowly release heat, and overhangs are used to shade openings during the summer. Passive solar techniques use solar energy both directly and indirectly. These types of techniques have been used by different cultures for thousands of years. Passive solar can usually provide 60% of an efficient home's heating needs.

While much of this report is focused on advanced technology, it should not be forgotten that basic technology is often the most beneficial, easiest to implement, and offers the most rapid return on investment. Another such "solar" technology is the humble clothesline. If all 113,271 Ann Arbor residents wash 2 loads of laundry per week (226,542 loads), then 906,168 kWh would be saved every week, for a total of 47,120,736 kWh per year by switching to line-dried systems.[30]

Similarly, the presence of daylight has been proven to enhance productivity, well-being, and health. Well-designed buildings utilize natural daylight to the great benefit of the occupants. Daylight also can offset or eliminate the need for artificial light, which is predominantly powered by non-renewable sources.

Among all solar technologies, passive solar and daylight are the most cost-effective and direct ways to utilize solar energy. If they are considered in building designs, the upfront cost is the same or only slightly higher than a conventional building. The energy savings and social and environmental benefits are ongoing.

7.2 Solar Thermal

Solar thermal refers to the use of solar energy to heat a medium such as air or water. This heated air or water can then be used for hot water or space heating, for example. Common applications associated with solar thermal include water heating for domestic hot water and for swimming pools. Solar thermal applications for space heating are not as common as photovoltaic systems, even though this is a good use for solar, especially in heating dominated climates like Michigan.

Among all solar technologies, passive solar and daylight are the most cost-effective and direct ways to utilize solar energy.

A. Solar Water Heating Systems

The 1970s saw a huge rise in the solar water heating industry as systems were encouraged by tax incentives and the energy conscious era surrounding the decade's oil crisis. While this trend ended during the 1980s when federal incentives ended, solar water heating systems have continued to be refined and installed and have remain among the most viable active solar technologies.

B. SWH Certification

Because of the rapid market expansion in the 1970s, a need for uniform standards developed. In 1980, the Solar Rating and Certification Corporation (SRCC) was formed to rate and certify solar water heating systems. Certified systems ensure a level of efficiency and quality that did not exist in the 1970s. SRCC's uniform testing procedures include tests for durability, reliability, safety, and operation. Other factors, such as maintenance and service, are also evaluated. The SRCC rating uses standard testing procedures to determine a performance rating for the various collectors and systems.

C. Solar Water Heating

There are a number of system types and possible configurations of solar hot water systems. **Flat Plate Collectors** are typically insulated, weatherproof shallow boxes that contain a metal absorber plate under a glass or plastic cover. **Unglazed Collectors** are similar, can be made of metal or plastic, but have no cover or enclosure. **Integral Collector-Storage Systems**, or "batch" systems, are comprised of black tanks or tubes in an insulated and glazed box. Water is circulated through these collectors and then into the conventional water heater (because water is circulated to the outside, they are not recommended for freezing climates). **Evacuated-tube Collectors** are made of a series of parallel transparent glass tubes. Each tube contains a glass outer tube and metal absorber tube attached to a fin.

The collectors can then be utilized in conjunction with active or passive circulation systems. Active systems pump water or a non-freezing heat transfer fluid between the solar collector and a storage tank. For our climate, which reaches freezing temperatures, non-freezing fluids or a drainback system (where the collector is emptied of water when the system is not running) should be used. The most common type of system used in Michigan is a closed-loop, active system. In such a system the collector heats an anti-freeze type solution, which is circulated to a storage tank where the heat is transferred to water inside the tank. The instant or tank type gas-fired hot water heater then draws from the solar-heated water tank when hot water is required. This way, because of seasonal variations, the conventional system can make up part or all of the energy required to heat the water. The solar system can be thought of as a pre-

Evacuated Tube Solar Water Heating. Source: NREL Photo Exchange.

heat system or the conventional water heater as a backup for the solar system. Typically, a conventional system will be required in Michigan's winter months. In Michigan's summer months, however, the solar hot water system will provide all of the necessary water heating. Unglazed collectors are typically used for swimming pool applications and glazed collectors for domestic hot water.[31] Passive systems are generally more reliable than active systems because they have fewer moving parts, but they can freeze in cold climates like Michigan. Owners should be made aware that service will be required during the lifespan of their systems and moving parts such as pumps and valves should be checked. The addition of an audible alarm that will sound when no hot water is being produced will reduce system downtime. Because many systems are tied to conventional hot water systems, owners would not necessarily realize that the solar system is not working.[32]

D. Solar Space Heating

As previously discussed, the most effective way to utilize solar in a heating dominated climate is to design buildings in a way to utilize the solar radiation effectively for heating. This is more easily accomplished during the initial building design and construction or during a major remodel. Some retrofit options, however, are available. Often these systems use a collector to heat air that is then distributed using fans to the spaces that require heat, much like a forced air furnace. Solar air collectors can also be used in a hybrid system to heat both air and water for space and domestic hot water heating purposes.

7.3 Solar Photovoltaic Systems

A solar photovoltaic (PV) system produces electricity through a direct conversion of solar radiation, primarily from sunlight. The effect was discovered in 1839 by Henri Becquerel, but has only reached a noticeable level of practical application since 1980.[33] This technology is currently very viable, but the cost and intermittent nature of sunlight remain the main barriers to widespread implementation. PV technology continues to improve at a remarkable pace.

From a policy perspective, previous U.S. Department of Energy initiatives and others in partnership with solar companies have helped reduce the cost of PV-generated electricity from $5 per watt down to its current cost of $.25-.50 per watt. Several other government efforts, including the Solar America Cities Initiative, are continuing this effort.[34]

A. PV Technology

Photovoltaic cells, the smallest electricity-producing element in a PV system, create an electric current when light strikes the cell, turning electrons loose. The electric current flows in direct proportion to the amount of sunlight present. The more recent generation of PV collector materials, including thin-film (amorphous silicon) and polycrystalline technology (thin-film polycrystalline), offer higher efficiency and can be integrated into buildings more easily than the older, large crystal silicon wafer elements. Crystal silicon, however, is less expensive, hardier, more reliable, and long-lived. Newer technology is less stable and has a shorter lifespan.[35] The latest generation of PV is called organic photovoltaics (OPV). Like the thin film products, OPV is thin, flexible, and is manufactured in a process similar to printing. The technology is not yet as efficient as thin film, but offers interesting promise because of its ability to generate energy in low-light conditions, and because of its potential to reduce production cost. [36] The thin film products offer additional aesthetic and cost benefits because they can be "building integrated." Building integrated PV is part of a building material, usually roofing or glazing, and does not appear to be added to the structure in the same way as separate panels do. Building integrated roofing related PV is available in asphalt shingle, metal roof, and roll roofing modules. PV glass modules are available for walls, roofs, or skylights and can be fused with different colors of translucent plastic. Building integrated systems also offer the cost advantage by combining the cost of a roofing or facade material with the PV.

PV cells are assembled into PV modules (a module could be 2' x 4', for example), and PV modules are assembled into PV arrays. The arrays can be mounted on a building or the ground and can be stationary or can mechanically track the sun. Modules should face south and be angled to meet the sun's rays. For Southeast Michigan, the ideal angle is 42°.

PV arrays can be grid-connected grid ("grid-tied") or perform independently as a stand-alone system ("stand-alone"). Stand-alone systems are most practical for remote or unattended locations. For example, stand-alone systems can power sign lighting, lighthouses, navigational aides, isolated residences, and so on. Stand-alone systems can be directly connected to another system (e.g., a water pump), can be used to charge batteries, or can be used in conjunction with a fuel-powered generator.

Batteries used with stand-alone systems store excess electricity produced by the PV panels and have the advantage of delivering usable electricity during periods when the sun is not shining. When a system cannot be grid-tied, batteries are an important characteristic for residential applications where most electricity is demanded in the evening.

In a grid-tied system, the system is attached to the utility grid and so a utility agreement must be reached (see *Net Metering* and *Interconnection Standards*). These systems can use either one or two meters. In the one-meter example, the meter turns both directions, and so the customer is credited for generated electricity and billed only for excess electricity supply by the utility. In the two-meter example, one meter reads the PV generated electricity and the other meter reads the electricity supplied by the utility.

PV generates electricity in direct current (DC). With stand-alone systems, this current may or may not require an inverter to change the current to alternating current (AC), the type of current commonly used in building electrical systems. In a grid-tied system, however, an inverter that produces utility grade alternating current is required.

Finally, other components of PV systems should be considered for system design, safety, operation, and cost. These other components include charge controllers, inverters, blocking diodes, lighting arresters, grounding systems, and more. All the system components other than the PV modules are known as "balance of system" and contribute a considerable impact on the systems cost and performance.

B. PV Equipment Quality

Photovoltaics are complicated devices in a rapidly expanding marketplace, so care should be taken in selecting systems that meet basic quality standards. Usual measures of careful purchasing apply, such as warrantee and company track record. Additional care, however, should be taken to verify that equipment has undergone specific testing procedures. A valuable reference for equipment standards is the California Solar Initiative/Go Solar California program, the most successful state-run program in the nation. The program maintains lists of equipment that meets basic standards. Equipment eligible for the program includes PV modules, inverters, and meters (see www.gosolarcalifornia.org for details).

The California program relies on reputable testing and certification processes. Underwriters Laboratory (UL) is one such well-known listing program. Standards and testing procedures are intended to ensure a product's safety and performance characteristics. The primary reference standards used in the California program are:

- UL 1703 (PV modules)
- ANSI C12.1 (meters)
- UL 1741 (for inverters)

Additional discussion of these standards and others can be found in the *Codes, Standards, and Permitting* section of this Plan.

7.4 Concentrating Solar Power

Concentrating Solar Power (CSP) works by concentrating sunlight to heat a fluid that drives a turbine to generate electricity, as well as heat. CSP is typically used for utility-scale plants, and use parabolic mirrors to focus radiation or heliostats (slightly curved mirrors) to reflect sunlight into a tower. Different variations of the technology include parabolic troughs, power towers, and linear fresnel systems. CSP projects offer excellent potential - up to 7,000 gigawatts (GW) in the Southwest United States, which is the prime location for this technology.[37] Worldwide, there are approximately 9,000 MW of CSP projects under contract, with developments focused in areas that offer the very high levels solar radiation. [38]

7.5 Other Solar Products & Strategies

Well-designed urban environments include public spaces and landscapes for citizens to enjoy. Elements of these spaces include street furnishings, lighting, signage, and more. Products and strategies that integrate solar are becoming available and could signify Ann Arbor's commitment to both renewable energy and quality urban life. The public visibility of these products and strategies is an important factor to consider alongside other solar benefits.

A. Bus Stops

Solar-powered bus stops using organic PV have recently been installed in San Francisco that provide energy for signage, lighting, and a Wi-Fi system. These stops include LED information about bus route and arrival times.

B. Street Lighting

Street lighting is often a significant portion of the municipal power budgets, and so efficiency and renewable energy are serious considerations. Several street lighting systems are available or emerging that utilize PV technology for electricity. An exemplary design has been installed in Vienna, Austria that uses solar power as well as considers lamp efficiency, light pollution reduction, and a reduction in overall light levels using a design-oriented approach.

Solar Tree street lighting. Designed by Ross Lovegrove, Installed at Museum of Contemporary Art, Vienna.

C. Trash Collection

BigBelly® is a solar-powered trash collection system that reduces maintenance costs by compacting trash

and alerting staff only when the system is full. It also can work in conjunction with a recycling system. BigBelly® systems have been installed in Philadelphia, Boston, Banff, Canada, and several universities, including the University of Michigan.

D. Vehicle Charging

Solar vehicle charging can integrate solar energy systems into city operations or public parking facilities. For plug-in vehicles, these charging stations could provide a clean electricity source while meeting the City's renewable energy goals. Chicago has recently implemented such a system for electric fleet vehicles.

E. Public Art

Commissioning public art projects contributes greatly to a city's aesthetic and cultural value. Several innovative and inspiring installations have been created that incorporate renewable energy, including solar. *Solar Collector*, designed by Gorbet Design, was commissioned in Waterloo, Canada and is a solar-powered interactive moving light sculpture. For any municipality promoting solar, incorporating solar into public art can be made a requirement of the project. Ann Arbor has already incorporated this strategy with the *Sun Dragon*, a public art commission that enhanced the Fuller Pool solar hot water system.

7.6 Solar Site Assessment

Potential sites for solar installations should be carefully analyzed because a number of factors contribute to the viability of the installation. For photovoltaic installations, applicable criteria includes available roof area, roof age, shading factors, electrical interconnection access, conduit routing, facility consumption, electrical meter location, potential inverter and disconnect mounting locations, structural roof issues, and more.

Ideally, solar systems should be designed to face south, be located in areas with very little or no shading, and be tilted to 42°. Other factors, however, should be considered and include aesthetics, seasonal usage, and existing roof orientations. Balancing the various factors is possible because a minor change in angle or orientation results in only a slight reduction in energy production.

An excellent preliminary web-based analysis tool from the National Renewable Energy Laboratory called IMBY (In My Back Yard, at www.nrel.gov/eis/imby) has been developed and is designed for both PV and wind applications. Using interactive maps, IMBY can quickly estimate the size, output and cost of a system. A system's cost and payback is tied to DSIRE's database, so available state and federal incentives are included in the calculation.

7.7 Modeling and Economic Analysis

In addition to evaluating a site, other planning tools are available to model systems for both accurate performance and economics. A number of trustworthy and free resources are available to complete this process:

RETScreen International - Created by Natural Resources Canada, the software includes comprehensive analysis of a number of renewable energy and energy efficiency strategies. (www.retscreen.net)

Solar Advisor Model - Created by the National Renewable Energy Laboratory in conjunction with Sandia National Laboratory and the U.S. Department of Energy, this resource only analyzes solar photovoltaic systems. (www.nrel.gov/analysis/sam)

PV Watts - Created by the National Renewable Energy Laboratory, this is an online analysis tool for PV systems. (www.pvwatts.org)

Solar-Estimate.org - A user-friendly online analysis tool originally created by the California Energy Commission can analyze a number of system types, including both PV and solar hot water. (www.solarestimate.org)

7.8 System Metering and Data Acquisition

For all PV systems, measuring the output and recording a system's performance data can help demonstrate the viability of solar energy. Net metering installations with two utility-owned meters will provide some data. A single, utility-owned meter is desirable for economic reasons so solar generated electricity can be submetered with a privately-owned system. Generated electricity – along with weather data - can be logged for analysis using a data acquisition system. Ideally, for municipal installations, this data should be made available to the public.

Area PV installations that offer real-time information to the public include Solar Ypsilanti, the Leslie Science & Nature Center, and the Ann Arbor Farmers Market installation. The Ypsilanti system is a custom software program that is made available free from the program's website, the Leslie Science & Nature Center uses the PowerDash system, and the Ann Arbor Farmers Market uses Sunny Portal Software. Several other user-friendly and detailed systems are widely used across the US, including the Building Dashboard® from Lucid Design Group and Fat Spaniel Technologies.

Sub metering and data logging is also available for solar hot water installations and is highly encouraged.

Solar system monitoring can be part of a larger Building Management System (BMS) that is often developed for energy management practice in commercial buildings. Sensors, monitors, and meters used with these systems can also tie into solar installations.

7.9 Environmental and Social Impact of Solar

A Life Cycle Assessment (LCA) involves analyzing the true environmental and social costs of products and services by examining its entire lifecycle. For example, this type of analysis would consider the energy, pollution, and social costs of extracting raw materials, processing them into useful forms, shipping and distributing them, disposing of them at the end of their life, and more.

Economic concerns typically dominate the discussion about the value of solar technology, and for good reason. Life cycle considerations should be considered alongside social and economic considerations, especially as a way to quantify the environmental benefits of solar energy systems. These considerations will also become more important as the United States begins to regulate carbon dioxide emissions. Because of the negative environmental and health impacts of our existing electricity sources, solar is often lauded for what it offsets in terms of pollution and fossil fuels. Since manufacturing solar energy systems takes up both energy and produces pollution, do they pay back their environmental debt?

According to a 2004 study of the 60 kW array installed at Oberlin College, the system will recover its energy and carbon dioxide expended in the creation, shipping, and installation of the system in 7.3 and 3.7 years, respectively.[39] The Oberlin study also demonstrated that the environmental paybacks are shorter than the financial paybacks of the system. Similarly, a comprehensive LCA conducted for the University of Michigan's 30 kW installation at the School of Natural Resources and Environment concluded that the energy payback period will be 5.5 years and noted large decreases in pollution and health impacts as compared to the predominantly fossil-fueled electricity that supplies the school.[40] Other studies have concluded that large-scale installations have been calculating payback energy in less than one year, assuming average U.S. solar conditions.[41]

Environmental paybacks are shorter than financial paybacks of solar energy systems.

8. FEDERAL & STATE RESOURCES AND INCENTIVES

LOCAL EXAMPLE: WASHTENAW COUNTY PHOTOVOLTAIC ARRAY

Washtenaw County installed a 10 kW Solar Photovoltaics array in 2004, funded by a grant received from the State of Michigan Energy Office. The installation offers the County valuable educational opportunities to help its residents become more award of renewable energy. The Solar PV system generates 3-5% of the County's 705 N. Zeeb Road building's total annual energy use, resulting in an annual savings of approximately $1,000 to $1,500 for the county each year, and reduction of 16,000-24,000 pounds of carbon dioxide.

A variety of federal, state, and utility incentives are available to facilitate solar thermal and solar photovoltaic systems. To find an up-to-date list, visit www.dsireusa.org/solar. The major incentives are summarized below.

8.1 Federal

Business Energy Investment Tax Credit (ITC) - The ITC is equal to 30 percent of solar expenditures with no maximum credit. Eligible solar energy technologies includes equipment that uses solar energy to generate electricity, to heat or cool (or provide hot water for use in) a structure, or to provide solar process heat. Passive solar systems and solar pool-heating systems are not eligible.

Renewable Energy Grants – This grant allows taxable entities to receive a grant from the U.S. Treasury Department for new solar installations instead of the business energy investment tax credit (ITC). The same technologies are eligible for this grant as are eligible for the ITC and the grant would also cover 30 percent of the installation costs.

Modified Accelerated Cost-Recovery System (MACRS) - Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain technologies through depreciation deductions. The 5-year schedule for most types of solar, geothermal, and wind properties have been in place since 1986.

Residential Renewable Energy Tax Credit – This 30 percent tax credit for residential systems is available for solar electric systems placed in service after 12/31/2008 and before December 31, 2016. The home served by the system does not have to be the taxpayer's principal residence.

A variety of incentives for local governments are also available, including Renewable Energy Production Incentives, Qualified Energy Conservation Bonds, and Clean Renewable Energy Bonds (CREBs).

8.2 State

Alternative Energy Personal Property Tax Exemption - Commercial and industrial buildings are eligible for this property tax exemption. New photovoltaic systems are included as long as they have not been previously subject to tax exemption and are certified by NextEnergy. This incentive is set to expire at the end of 2012.

Renewable Energy Renaissance Zones (RERZ) – These zones offer increased benefits for renewable energy generation. Commercial, industrial, and local government facilities located within one of the designated 15 zones are eligible for exemption from the Michigan Business Tax, state education tax, personal and real property taxes, or local income taxes where applicable. Tax abatements can be utilized for 15 years with an incremental phase out of 25 percent over the last three years. Ann Arbor does not fall within a RERZ.

Public Benefits Funds - The State of Michigan under the Michigan Public Service Commission created the Low-Income Energy Efficiency Fund (LIEEF) as a public benefit fund. The primary purpose in creating the fund is to assist low-income populations with shutoff protection and promote energy efficiency in all customer classes. While the majority of the fund is provided for low-income residents and for energy efficiency, renewable energy projects have been supported through grants. For more information on Public Benefits Funds, see Chapter 8.

MSHDA Property Improvement Program - The Michigan State Housing Development Authority (MSHDA) offers low interest loans to homeowners who earn less than $65,000-$74,750 a year. The loan applies to owner-occupied homes and can be used for a variety of improvement projects, including energy efficiency, solar and wind installations.[42]

DEQ Small Business Pollution Prevention Loans - Through a local lender, Michigan businesses can apply for a Small Business Pollution Prevention Loan through the Environmental Science and Services Division of the Department of Environmental Quality (DEQ). The loan is intended to offset pollution through conservation-oriented improvements such as equipment, process improvements, water conservation, energy conservation, and agricultural energy production. Renewable energy generating equipment may also be eligible. The loan is intended for small businesses (500 people or less) and has a maximum loan amount of $400,000 at five percent or less.[43]

Michigan Saves – The Michigan Saves program is currently being developed under the Michigan Public Service Commission. It is based on the Pay-As-You-Save system, a market-based method designed to eliminate upfront costs and debt associated with installing energy efficiency and renewable energy improvements. The system is organized so that equipment and improvements are paid for on-bill by energy savings generated by the efficiency work or renewable energy installation.[44]

8.3 Utility

DTE Energy – DTE Energy is currently running the SolarCurrents program which offers a $2.40 per watt (installed capacity) up-front payment in return for selling Renewable Energy Credits (REC) back to DTE Energy. Participants also receive $.11 per kWh during the life of the 20-year agreement. Residential and commercial interconnected systems of 20 kW or less are eligible.

8.4 Example Incentive Calculation

Based on information gathered from area installations and current incentives offered, the following calculation provides an example of the cost of a residential-scale installation with available incentives. The initial system costs are greatly reduced by both the federal residential renewable energy tax credit and the DTE Energy incentive. The overall payback period is calculated to be about 16 years, although it should be noted that the actual payback time will likely be less than this given rising energy costs and the conservative production numbers listed in this example.

System Size (kW)	3.00
Installation Cost ($/kW)	$9,000
Production kWh/yr per kW	1,100
Upfront REC Payment from DTE Energy ($/W)	$2.40
Ongoing REC Payment from DTE Energy ($/kWh)	$0.11
Estimated Cost of Purchased Electricity ($/kWh)	$0.11
Tax Credit (% of upfront cost)	30%

Total Installation Cost ($)	$27,000
Federal Tax Credit ($)	-$8,100
DTE Upfront Incentive ($)	-$7,200
FINAL COST ($)	**$11,700**
ANNUAL PRODUCTION (kWh)	3,300
ANNUAL DTE REC payment ($)	$363
ANNUAL Electricity Savings ($)	$363
ADJUSTED PAYBACK PERIOD (yrs)	16.1
Total REC Payments & Electricity Savings Over 20 Years	**$14,520**
Total Savings Over 20 Years	**$2,820**

A calculation for a business would be similar to this example given that the federal tax incentive is also 30 percent of the upfront cost and DTE Energy's payments would be identical. For nonprofit and government entities without tax liability, the cost would be higher given the ineligibility for federal tax credits.

APPENDICES

APPENDIX A: Sample Statutes, Ordinances, RFPs and Other Language
APPENDIX B: Local Resource Directory
APPENDIX C: Reference Codes and Standards for PV and Solar Thermal
APPENDIX D: Summary of Michigan Interconnection Standard
APPENDIX E: List of Financial Incentive Priorities

Appendix A: Sample Statutes, Ordinances, RFPs and Other Language

1. Green Jobs Criteria

2007 MULTNOMAH COUNTY, OREGON, REQUEST FOR PROPOSAL:

C. Socioeconomic Considerations – (M/W/ESB) Participation and Green Jobs (10 Points)
1. M/W/ESB Participation. The Proposal shall include a separate section that describes utilization of Minority, Women and Emerging Small Business (M/W/ESB) firms for the Project and past experience in promoting M/W/ESB participation on previous Projects. Include subcontracting information from example Projects in the last two years.

- a. Specify a description of services performed and/or goods provided by M/W/ESB firms. Include the dollar amount paid and indicate the percentage of the Project awarded to each M/W/ESB firm
- b. Identify contact information for all M/W/ESB contractors proposed for the Project and utilized on past Projects referenced. Include company name, point of contact with title, phone number, location and address of
- c. Indicate whether actual final payments and percentages were different than award and the reason for such changes.
- d. Provide a detailed outreach plan for obtaining the maximum utilization of M/W/ESB organizations for the Proposer Team member firms. This plan shall become a part of the contract.

2. Green Jobs: This Project may provide an opportunity for low-income individuals to receive job training in renewable power and ultimately provide a "pathway out of poverty." The Proposal shall include a separate section addressing the Proposer's commitment to working with apprenticeship programs or other workforce development programs that cater to low-income individuals, including but not limited to: at-risk youth, recently returning veterans, formerly incarcerated, adjudicated, nonviolent offenders, or other underserved sectors of the workforce within areas of high poverty. The Proposal should include examples of specific actions that will be taken, such as: creating specific employment and training opportunities for individuals in families with income less than 200 percent of the poverty threshold (as determined by the Bureau of the Census) or a self-sufficiency standard for the local area.

3. Evaluation Criteria: The County will evaluate this Proposal Element as follows: It will consider the Proposer's M/W/ESB outreach done for the Project as well as the Proposer's history of M/W/ESB outreach and participation on previous Projects. The County will also consider the specific commitments and actions proposed to create job opportunities for low-income individuals.

2. Solar Access Laws

CITY OF GAINESVILLE, FLORIDA

§30-254. Permits for tree removal.
(e) Permit approval criteria. Removal or relocation of regulated trees shall be approved by the city manager or designee upon a finding that the trees pose a safety hazard; have been weakened by disease, age, storm, fire or other injury; or prevent the reasonable development of the site, including the installation of solar energy equipment. Regulated trees shall not be removed, damaged or relocated for the purpose of locating utility lines and connections unless no reasonably practical alternative as determined by the city manager or designee is available.

CITY OF BOULDER, COLORADO

9-9-17 Solar Access.
(a) Purpose: Solar heating and cooling of buildings, solar heated hot water, and solar generated elec-

tricity can provide a significant contribution to the city's energy supply. It is the purpose of this section to regulate structures and vegetation on property, including city-owned and controlled property, to the extent necessary to ensure access to solar energy, by reasonably regulating the interests of neighboring property holders within the city.

(b) Applicability of Section:

- (1) Private Property: All private property is subject to this section.
- (2) Development Approval: No proposed development permit may be approved for any structure that would violate the basic solar access provided by this section unless the object or structure is exempt or an exception is granted by the city manager or the BOZA for such purpose.
- (3) Government Property: Governmental organizations not under the jurisdiction of the city may elect to enjoy the benefits of solar access under this section if they also consent in a written agreement with the city to be bound by its restrictions.
- (4) City Property: Property owned or possessed by the city is subject to, and enjoys the benefits of this section. The city may submit applications, make objections, and may take actions that are afforded to any other person subject to the provisions of this section.

(c) Solar Access Areas Established: Three solar access areas are hereby established: SA Area I, SA Area II, and SA Area III. The purpose of dividing the city into solar access areas is to provide maximum solar access protection for each area of the city consistent with planned densities, topography, and lot configurations and orientations.

- (1) Solar Access Area I (RR-1, RR-2, RE, RL-1, and MH): SA Area I is designed to protect solar access principally for south yards, south walls, and rooftops in areas where, because of planned density, topography, or lot configurations or orientations, the preponderance of lots therein currently enjoy such access and where solar access of this nature would not unduly restrict permissible development. SA Area I includes all property in RR-1, RR-2, RE, RL-1, and MH zoning districts.
- (2) Solar Access Area II (RL-2, RM, MU-1, MU-3, RMX, RH-1, RH-2, RH-3, RH-4, RH-5, and I): SA Area II is designed to protect solar access principally for rooftops in areas where, because of planned density, topography, or lot configuration or orientation, the preponderance of lots therein currently enjoy such access and where solar access of this nature would not unduly restrict permissible development. SA Area II includes all property in RL-2, RM, MU-1, MU-3, RMX, RH, and I zoning districts.
- (3) Solar Access Area III - Permits - Other Zoning Districts: SA Area III includes areas where, because of planned densities, topography, or lot configurations or orientations, uniform solar access protection for south yards and walls or for rooftops may unduly restrict permissible development. Solar access protection in SA Area III is provided through permits. SA Area III initially includes property in all zoning districts other than those set forth in paragraph (c)(1) or (c)(2) of this section.

(d) Basic Solar Access Protection:

- (1) Solar Fence: A solar fence is hereby hypothesized for each lot located in SA Area I and SA Area II. Each solar fence completely encloses the lot in question, and its foundation is contiguous with the lot lines. Such fence is vertical, opaque, and lacks any thickness.
    - (A) No person shall erect an object or structure on any other lot that would shade a protected lot in SA Area I to a greater degree than the lot would be shaded by a solar fence twelve feet in height, between two hours before and two hours after local solar noon on a clear winter solstice day.

- (B) No person shall erect an object or structure on any other lot that would shade a protected lot in SA Area II to a greater degree than the lot would be shaded by a solar fence twenty-five feet in height, between two hours before and two hours after local solar noon on a clear winter solstice day.
- (C) Solar fences are not hypothesized for lots located in SA Area III. Solar access protection in SA Area III is available under this section only through permits, as hereinafter provided.

- (2) Height: Unless prohibited by another section of this title, nothing in this section prevents a structure in SA Area III from being erected up to a height of thirty-five feet if located within the allowed building envelope. However, unless an exception is granted pursuant to subsection (f) of this section, no such structure may exceed thirty-five feet in height if any such excess height would cause the structure to violate, or to increase the degree of violation of, the basic solar access protection provided for any lot in SA Area I or SA Area II.
  - (A) Nothing in this section shall be deemed to prevent the principal building on a lot in SA Area I or II from being erected within the building envelope up to the height of the solar fence in the area in which the structure is located.
  - (B) Each application for a development permit for a building of a height greater than allowed by this subsection shall:
    - (i) Include a graphic representation showing the shadows that would be cast by the proposed structure between two hours before and two hours after local solar noon on a clear winter solstice day;
    - (ii) The solar fences on all lots that the shadows would touch;
    - (iii) All possible obstructions of solar access protected by permit; and
    - (iv) Provide additional information as may be required by the city manager.
- (3) Insubstantial Breaches and Existing Structures: Insubstantial breaches of the basic solar access protection or of the protection provided by a solar access permit are exempt from the application of this section. A structure in existence on the date of establishment of an applicable solar access area, or structures and vegetation in existence on the date of issuance of an applicable solar access permit, are exempt from the application of this section. For purposes of this section, structures are deemed to be in existence on the date of issuance of a development permit authorizing its construction.
- (4) Temporary Solar Obstructions: Unavoidable temporary obstructions of protected solar access necessitated by construction activities or other necessary and lawful purposes are exempt to the extent that they do not exceed ten days in any three month period and thirty days in any year.
- (5) Solar Analysis: When a solar analysis is required for any review process, it shall be prepared in compliance with the methods described in materials provided by the city manager.

(e) Amendment of Solar Access Areas:

- (1) Purpose: The planning board may amend solar access areas on its own motion or on petition of any person with a property interest in the subject area. A petitioner shall submit a list to the planning board of the names and addresses of all owners of property within and adjacent to the subject area and within one hundred feet to the north and sixty feet to the east and west of the subject area.

- (2) Public Hearing and Notice Required: Before amending a solar access area, the planning board shall conduct a public hearing on the proposal. The board shall provide notice for the hearing pursuant to the requirements of section 9-4-3, "Public Notice Requirements," B.R.C. 1981.
- (3) Review Criteria: A solar access area may be amended only after the planning board determines that one or more of the following conditions applies to the subject area:
  - (A) The subject area was established as a particular solar access area in error, and as currently established it is inconsistent with the purposes of the solar access areas;
  - (B) Permissible land uses and densities in the subject area are changing or should change to such a degree that it is in the public interest to amend the solar access area for the area; or
  - (C) Experience with application of this ordinance has demonstrated that:

    (i) The level of solar access protection available in the subject area can be increased without significant interference with surrounding property; or
    (ii) Application of the ordinance has unreasonable interference with use and enjoyment of real property in the subject area.
- (4) Impact of Changes: When any area is amended from SA Area I to another solar access area or from SA Area II to SA Area III, any solar access beneficiary whose solar access is affected by such change may apply for a permit to provide solar access protection to any solar energy system installed and in use on the date the change becomes effective.

(f) Exceptions:

- (1) Purpose: Any person desiring to erect an object or structure or increase or add to any object or structure, in such a manner as to interfere with the basic solar access protection, may apply for an exception.
- (2) Application Requirements: An applicant for an exception shall pay the application fee prescribed by subsection 4-20-33(b), B.R.C. 1981, and apply on a form furnished by the city manager that includes, without limitation:
  - (A) The applicant's name and address, the owner's name and address, and a legal description of the lot for which an exception is sought;
  - (B) Survey plats or other accurate drawings showing lot lines, structures, solar systems, dimensions and topography as necessary to establish the reduction of basic solar access protection expected on each lot that would be affected by the exception, together with a graphic representation of the shadows that would be cast by the proposed structure during the period from two hours before to two hours after local solar noon on a clear winter solstice day. The requirements of this subparagraph may be modified by the city manager, depending upon the nature of the exception sought;
  - (C) A list of all lots that may be affected by the exception, including the names and addresses of all owners of such lots;
  - (D) A statement and supporting information describing the reasons that less intrusive alternatives, if any, to the action that would be allowed by the exception cannot or should not be implemented; and
  - (E) A statement certifying that the proposed structure would not obstruct solar access protected by permit.
- (3) Public Notice: The city manager shall provide public notice pursuant to section 9-4-3, "Public Notice Requirements," B.R.C. 1981.

- (4) City Manager Action: The city manager may grant an exception of this section following the public notification period if:
  - (A) The applicant presents the manager with an affidavit of each owner of each affected lot declaring that such owner is familiar with the application and the effect the exception would have on the owner's lot, and that the owner has no objection to the granting of the exception, and
  - (B) The manager determines that the application complies with the requirements in paragraph (f)(2) of this section, and
  - (C) The manager finds that each of the requirements of paragraph (f)(6) of this section has been met.
- (5) Appeal of City Manager's Decision: The city manager's decision may be appealed to the BOZA pursuant to the procedures of section 9-4-4, "Appeals, Call-Ups and Public Hearings," B.R.C. 1981. Public notification of the hearing shall be provided pursuant to section 9-4-3, "Public Notice Requirements," B.R.C. 1981. The sign posted shall remain posted until the conclusion of the hearing.
- (6) Review Criteria: In order to grant an exception, the approving authority must find that each of the following requirements has been met:
  - (A) Because of basic solar access protection requirements and the land use regulations:

    (i) Reasonable use cannot otherwise be made of the lot for which the exception is requested;
    (ii) The part of the adjoining lot or lots that the proposed structure would shade is inherently unsuitable as a site for a solar energy system; or
    (iii) Any shading would not significantly reduce the solar potential of the protected lot; and
    (iv) Such situations have not been created by the applicant;
- (B) Except for actions under subparagraphs (f)(6)(D), (f)(6)(E), and (f)(6)(F) of this section, the exception would be the minimal action that would afford relief in an economically feasible manner;

(C) The exception would cause the least interference possible with basic solar access protection for other lots;
(D) If the proposed structure is located in a historic district designated by the city council according to section 9-11-2, "City Council May Designate or Amend Landmarks and Historic Districts," B.R.C. 1981, and if it conformed with the requirements of this section, its roof design would be incompatible with the character of the development in the historic district;
(E) If part of a proposed roof which is to be reconstructed or added to would be incompatible with the design of the remaining parts of the existing roof so as to detract materially from the character of the structure, provided that the roof otherwise conformed with the requirements of this section;
(F) If the proposed interference with basic solar access protection would be due to a solar energy system to be installed, such system could not be feasibly located elsewhere on the applicant's lot;
(G) If an existing solar system would be shaded as a result of the exception, the beneficiary of that system would nevertheless still be able to make reasonable use of it for its intended purpose;
(H) The exception would not cause more than an insubstantial breach of solar access protected by permit as defined in paragraph (d)(3) of this section; and
(I) All other requirements for the issuance of an exception have been met. The applicant

bears the burden of proof with respect to all issues of fact.

- (7) Conditions of Approval: The approving authority may grant exceptions subject to such terms and conditions as the authority finds just and equitable to assist persons whose protected solar access is diminished by the exception. Such terms and conditions may include a requirement that the applicant for an exception take actions to remove obstructions or otherwise increase solar access for any person whose protected solar access is adversely affected by granting the exception.
- (8) Planning Board: Notwithstanding any other provisions of this subsection, if the applicant has a development application submitted for review that is to be heard by the planning board and that would require an exception, the planning board shall act in place of the BOZA, with authority to grant exceptions concurrent with other actions on the application, pursuant to the procedures and criteria of this section.

(g) Solar Siting:

- (1) Siting Requirements: For purposes of insuring the potential for utilization of solar energy in the city, all planned unit developments and subdivisions shall be designed and constructed in compliance with the following solar siting requirements:
  - (A) All residential units in Solar Access Areas I, II, and III have a roof surface that meets all of the following criteria:
    - (i) Is oriented within thirty degrees of a true east-west direction;
    - (ii) Is flat or not sloped towards true north;
    - (iii) Is physically and structurally capable of supporting at least seventy-five square feet of un-shaded solar collectors for each individual dwelling unit in the building; and
    - (iv) Has unimpeded solar access under either the provisions of this section or through easements, covenants, or other private agreements among affected landowners that the city manager finds are adequate to protect continued solar access for such roof surface;
  - (B) Each residential unit in Solar Access Area I has an exterior wall surface that meets all of the following criteria:
    - (i) Is oriented within thirty degrees of a true east-west direction;
    - (ii) Is located on the southernmost side of the unit; and
    - (iii) Is immediately adjacent to a heated space;
  - (C) Each nonresidential building with an anticipated hot water demand of one thousand or more gallons a day has a roof surface that meets all of the following criteria:
    - (i) Is flat or oriented within thirty degrees of a true east-west direction;
    - (ii) Is physically and structurally capable of supporting a solar collector or collectors capable of providing at least one-half of the anticipated hot water needs of the building; and
    - (iii) Has unimpeded solar access under either the provisions of this section or through easements, covenants, or other private agreements among affected landowners that the city manager finds are adequate to protect continued solar access for such roof surface;
- (2) Waivers: Upon request of any applicant for a building permit or a subdivision or planned unit development approval, the approving authority may waive such of the requirements of this paragraph as it deems appropriate if it finds that any of the following criteria are met:

- (A) Any structure or structures subject to the requirements of this paragraph are designed and intended to be unheated;
- (B) Topographic features, land slope, shading by objects, structures, or vegetation outside the control of the applicant, or the nature of surrounding development or circulation patterns when combined with the requirements of this paragraph:
  - (i) Makes use of solar energy not feasible in some or all of the structures to be erected;
  - (ii) Will result in a substantial decrease in the density of land use in the subdivision or planned unit development;
  - (iii) Will result in an increase in transportation or other energy use that substantially outweighs the potential for increased solar energy use created by adherence to these requirements; or
  - (iv) Will be inconsistent with the floodplain management requirements of section 9-3-2, "Floodplains," B.R.C. 1981;
- (C) Substantial planning, design, or other preliminary expenditures have been incurred by the applicant prior to July 1, 1982, and adherence to the standards of this paragraph would work an undue hardship on the applicant; or
- (D) The applicant's proposal incorporates the following additional energy resource and conservation option points in excess of the requirements of subsection 10-5.5-2-(y), "Resource Conservation – Green Points," B.R.C. 1981:
  - (i) 2 points - to qualify for a waiver of the requirement of subparagraph (g)(1)(A) of this section;
  - (ii) 3 points - to qualify for a waiver of the requirement of subparagraph (g)(1)(B) of this section; and
  - (iii) The city manager finds that adequate protection for any solar energy systems to be installed is provided either under the provisions of this section, or through covenants, easements, or other agreements among affected landowners.

(h) Solar Access Permits:

- (1) Purpose of Solar Access Permit: In order to promote opportunities for the use of solar energy and where basic solar access protection established by this section is inadequate to protect potential solar energy users, or to insure maximum utilization of solar energy resources consistent with reasonable use of surrounding property, persons may obtain permits under this section. Beneficial use is the limit and measure of any right conferred by permit and no permit shall restrict use of other property beyond the extent reasonable to insure efficient and economical beneficial use of solar energy by the permittee. Further, no permit shall restrict the reasonable use and enjoyment of adjacent properties.
- (2) Eligibility Standards: Any owner or possessor of property who has installed a solar energy system or who intends to install such a system within a year from the date of application may apply for a permit if:
  - (A) The lot for which a permit is requested is included in SA Area III;
  - (B) The system that has been or will be installed is capable of applying to beneficial use substantial amounts of solar energy outside the hours of the day during which basic protection is provided for under this section;
  - (C) A solar energy system is in existence on the lot or is planned to be built within a year and the lot is changed from SA Area I to an-

other solar access area or is changed from SA Area II to SA AREA III, resulting in a diminution or elimination of protection previously afforded the user or potential user of the solar energy system;

  - (D) A new structure is built on a lot in SA Area I or SA Area II after the effective date of this section whose locations renders the basic solar access protection inadequate, and the structure could not reasonably have been constructed at a location where it would have substantially benefited from the basic solar access protection provided by this section; or
  - (E) The applicant demonstrates that there are substantial technical, legal, or economic factors that render it infeasible to collect a reasonable amount of solar energy by utilizing the basic solar access protection available under this section without a permit. Such factors include, without limitation, structural characteristics of the applicant's building that limit possibilities for economical retrofit of a solar energy system or shading by objects, structures, or vegetation that are beyond the applicant's control and are exempt from the requirements of this section.
- (3) Application Requirements: An applicant for a permit shall pay the fee prescribed by subsection 4-20-33(a), B.R.C. 1981, and complete an application in writing on a form furnished by the city manager that includes, without limitation:
  - (A) The applicant's name and address, the owner's name and address, and a legal description of the lot where the solar energy system is located or will be located;
  - (B) A statement by the applicant that the solar energy system is already installed or that the applicant intends to install such a system on the lot within one year of the issuance of the permit;
  - (C) A description of the existing or proposed size and location of the system, its orientation with respect to south, and its elevation and orientation from the horizontal;
  - (D) A statement describing the beneficial use to which solar energy is or will be applied and certifying the energy capacity of the system in BTUs or BTU equivalents and its reasonable life expectancy;
  - (E) A statement and accurate drawings describing the access protection desired beyond the basic solar access protection provided by this section, specifying the hours of the day, seasons of the year, and locations on the applicant's lot for which protection is desired;
  - (F) A description of all existing vegetation, objects, and structures wherever located that will or may in the future shade the solar energy system, together with a map or drawing showing their location to the extent possible;
  - (G) Information showing that the applicant has done everything reasonable in designing and locating the system so as to minimize the impact it will have on use and development on nearby land;
  - (H) Survey plats or other accurate drawings showing lot lines, dimensions, and topography of the lot on which the solar energy system is or will be located and all surrounding properties that are intended to be subject to the permit; and
  - (I) A list of all lots that may be affected by the permit, including the names and addresses of all owners of such lots.
- (4) Public Notice: The city manager shall provide public notification pursuant to the require-

ments of section 9-4-3, "Public Notice Requirements," B.R.C. 1981.

- (5) Permit Issuance: The city manager shall issue a solar access permit and may impose additional conditions or restrictions as the manager deems appropriate if the application complies with the requirements of paragraph (h)(7) of this section.
- (6) Appeal of City Manager's Decision: The city manager's decision may be appealed to the BOZA pursuant to the procedures of section 9-4-4, "Appeals, Call-Ups and Public Hearings," B.R.C. 1981. Public notification of the hearing shall be provided pursuant to section 9-4-3, "Public Notice Requirements," B.R.C. 1981.
- (7) Permit Requirements: In order to issue a permit, the approving authority must find that each of the following requirements has been met:
  - (A) The applicant meets at least one of the eligibility standards of paragraph (h)(2) of this section;
  - (B) The applicant has done everything reasonable in designing and locating the proposed solar energy system to minimize the impact it will have on use and development of nearby land. However, the fact that an alternate design or site may be more expensive does not necessarily establish that the applicant's failure to select that alternate design or site is reasonable. In making this finding, the board or the city manager may consider whether the additional cost of alternative, less intrusive sites or solar energy systems, if any, would exceed the difference between the adverse effects, if any, imposed on other lots by the proposed site and solar energy system and the adverse effects, if any, that would be imposed on other lots by alternative sites or solar energy systems;
  - (C) Issuance of the permit is consistent with reasonable use and enjoyment of nearby land, excluding landscaping considerations. Issuance of the permit will be presumed not to be consistent with reasonable use and enjoyment of nearby land if issuance would prevent any affected property owner from erecting, consistent with legal requirements, a structure of a size, character, and usefulness reasonably typical of those in existence on similar lots subject to the same zoning requirements located within one-fifth mile of the lot in question. However, nothing in this subsection prohibits issuance of a permit only because it would impose requirements on a neighboring lot owner that are more restrictive than the height or setback requirements that would otherwise apply, if reasonable use and enjoyment of such lot is preserved; and
  - (D) Issuance of the permit is consistent with reasonable landscaping of nearby land. In determining consistency, the board shall consider the need for any additional landscaping in the future, including any energy conservation value that such landscaping may have.
- (8) Conditions of Approval: The board may grant permits subject to such terms and conditions as it finds just and equitable.
- (9) Records: The city manager shall maintain complete records of all permits that have been issued and shall make them readily available for public inspection.
- (10) Expiration of Permit: A solar access permit expires if:
  - (A) A functioning system is not installed within a year after the issuance of the permit;
  - (B) The solar energy system protected by the permit has not functioned to fulfill its

intended purpose for a continuous period of two or more years; or

- (C) The term established under paragraph (h)(11) of this section expires.

- (11) Term of Solar Energy System: The city manager or the BOZA shall specify the term of each solar access permit, which shall be for the reasonable life expectancy of the particular solar energy system, as determined by the manager or the board. At the expiration of a permit, it may be renewed in the same manner as new permits are issued.
- (12) Renewal of Permit: If no functioning solar energy system is installed within a year of the issuance of the permit, the city manager may grant a renewal of up to one additional year to the holder of the expired permit if the permittee demonstrates that the permittee has exercised due diligence in attempting to install the system.
- (13) Enforcement: A solar access permit is enforceable by the beneficiary, if and only if the beneficiary has properly recorded the permit in the real property records of the Boulder County Clerk and Recorder with respect to each affected lot in such a manner that it could be detected through customary title search.
  - (A) On sale, lease, or transfer of the lot on which the protected solar system is located, the right to enforce its terms passes to the beneficial user of the system.
  - (B) No property owner shall be requested to remedy vegetative shading unless a protected solar system is installed and functioning.
- (14) Impacts of Vegetation on an Issued Permit: Upon application of a beneficiary to the BOZA, vegetative shading may be remedied to the extent necessary to comply with the terms specified in a solar access permit. However, no vegetation in the ground and growing at the time the permit application is filed may be ordered removed or trimmed. After notice to at least the beneficiary and the vegetation owner, the board shall hold a hearing and, based on evidence submitted by any interested party, may issue any necessary order and specify the time in which actions thereunder must be performed. Absent unusual circumstances, the cost of remedying shading from vegetation not in the ground and growing at the time the permit application is filed shall be borne by the vegetation owner. If an owner or possessor of real property who receives an order to remedy vegetative shading fails to comply within the specified time, the city manager may order the condition remedied and charge the actual cost thereof to the person to whom the order is directed, who shall pay the bill. If any person fails or refuses to pay when due any charge imposed under this subsection, the manager may, in addition to taking other collection remedies, certify due and unpaid charges to the Boulder County Treasurer for collection as provided in section 2-2-12, "City Manager May Certify Taxes, Charges, and Assessments to County Treasurer for Collection," B.R.C. 1981.

(i) Authority to Issue Regulations: The city manager and the BOZA are each authorized to adopt rules and regulations necessary in order to interpret or implement the provisions of this section that each administers.

Ordinance Nos. 7484 (2006); 7522 (2007); 7535 (2007); 7568 (2007); 7655 (2009)

3. Permit Streamlining

ORDINANCE NO. ________

AN ORDINANCE OF THE CITY OF _________________, STREAMLING AND IMPROVING SOLAR PERMITTING AS FOUND IN __________ OF THE ___________ MUNICIPAL CODE.

The City Council of the City of _________ does ordain as follows:

SECTION 1. PURPOSE. The purpose of this ordinance is to promote the deployment of clean, local renewable energy in our city by removing unnecessary barriers to installing small-scale solar energy systems (15 kilowatts and under). This ordinance directs the building department, and other agencies with solar permitting authority to streamline the solar permitting process by updating provisions of _____________ of the City of ____________ Municipal Code related to residential photovoltaic and solar thermal system permit fees.

SECTION 2. FAIR FLAT FEES. A flat-fee that reflects the time needed for city staff to review and issue a permit (three hour average for a trained permitting agent) shall be used to determine permitting fees for standard small-scale PV systems. A value-based method shall not be used.

SECTION 3. STANDARDIZED PERMIT REQUIREMENTS. Standard permitting requirements shall be used to make the process clear and transparent for applicants. Guidelines shall be obtained from the Solar American Board for Codes and Standards' (Solar ABC) "Expedited Permit Process for PV Systems" report.

SECTION 4. OVER-THE-COUNTER ISSUANCE: Issuing of permits shall be same day or "over- the-counter" for standard small-scale PV systems that meet the Solar ABC expedited permit process criteria.

SECTION 5. ELECTRONIC PERMIT MATERIALS. Permit fees and process shall be easily accessible via the city's website so applicants can review and prepare materials in advance.

SECTION 6. TRAIN PERMITTING STAFF. Building department staff shall be trained to review small-scale PV permits and perform standard fire department checks to reduce time and cost. One or half-day workshops shall be developed and made available to relevant staff.

SECTION 7. REMOVE EXCESSIVE REVIEWS. Building department staff shall identify and remove reviews that do little to validate the safe and efficient operation of a proposed PV system (i.e.: plan checks with aesthetic criteria).

SECTION 8. REDUCE INSPECTION APPOINTMENT WINDOWS. Time windows for permit inspection appointments should be at or below two hours.

EFFECTIVE DATE AND NOTICE. This ordinance shall take effect thirty (30) days after its adoption. Within fifteen (15) days of its adoption, this ordinance shall be published at least once in a newspaper of general circulation published and circulated in the City of _____________.

PASSED AND ADOPTED by the City Council of the _________ this ___ day of ____ 20__ by the following roll call vote:

AYES: _____________ NOES: _____________ ABSENT: _____________ ABSTAIN: _____________

____

(Name), Mayor

ATTEST: ___________________________

Appendix B: Local Resource Directory

1. Government

Michigan Public Service Commission
Julie Baldwin (Interconnection)
Michigan Public Service Commission
Operations & Wholesale Markets Division
P.O. Box 30221
Lansing, MI 48909
517-241-6115
baldwinj2@michigan.gov
http://www.michigan.gov/customergeneration

2. Solar Installers

City Creations, Inc.
17170 hubbell avenue
Detroit, mi 48235
Contact: Mr. Page
313-345-3567
http://www.citycreationsinc.com

Great Lake Solar
1428 Blue Heron Dr.
HIghland, MI 48357
Contact: Lary Bannasch
248-895-1141
http://www.greatlakesolar.com

GREEN ENERGY SMART SOLUTIONS
P.O Box 871684
Canton, MI 48187
Contact: Mariela Romero
734-446-6939
http://www.greenenergysmartsolutions.com

MECHANICAL ENERGY SYSTEMS
8130 Canton Center Rd.
Canton, MI 48187
Contact: Joe Napolitano
800-BY-SOLAR
http://www.by-solar.com

MICHIGAN SOLAR & WIND POWER SOLUTIONS
509 Sherbrooke
Commerce Township, MI 48382
Contact: Mark Hagerty
248-520-2474
http://www.michigansolarsolutions.com

PDC
10617 McCabe Road
Brighton, Mi 48116
Contact: George Groat
810-231-8331
http://powerdistributioncenter.com

PHASE LOGIC INC.
3089 E, Bristol Rd. Ste 1C
Burton, MI 48529
Contact: Randall MacDonald
810-743-1688

PROJECT 8 INDUSTRIES, INC.
707 Homewild Avenue, #3
Jackson, MI 49201
Contact: Leonard Gates
517-414-6074

RENEWABLE ENERGY SOLUTIONS, LLC
17700 Garvey
Chelsea, MI 48118
734-649-1777

SELF RELIANT ENERGY COMPANY
10192 Sargent Road
Fowlerville, MI 48836
Contact: Thomas Reinke
313-295-9326

SUR ENERGY, LLC
734-913-9944
Contact: John Wakeman
http://www.sur.biz

SOLAR WORKS LLC
8895 Kearney Road
Whitmore Lake, MI 48189
Contact: Damon Dotson
517-404-8803
http://www.solarworksllc.com

3. Solar Data

Data Acquisition Systems
Contact: Dave Strenski
c/o Ypsilanti Food Co-Op
312 North River Street
Ypsilanti, MI 48198

4. PV Industry & Manufacturers

United Solar Ovonic (Uni-solar)
World Headquarters
Energy Conversion Devices, Inc. (ECD)
2956 Waterview Drive
Rochester Hills, MI 48309
248.293.0440
info@uni-solar.com

Hemlock Semiconductor Corporation
12334 Geddes Road
PO Box 80
Hemlock, Michigan 48626
989-642-5201

Evergreen Solar (Headquarters in Massachusets)
Evergreen Solar – Midland Manufacturing Facility
2820 Schuette Road
Midland, MI 48642

PrimeStar Solar (Headquarters in Colorado)
Michigan Equipment Center
8155 Cook St.
Montague, MI 49437-1512
Phone: 231-894-2769

Dow Corning Solar Solutions
Kuka
Nextek
Patriot Solar Group

5. Solar Thermal & Other

BTF, Ltd.
P.O. Box 409
Fennville, MI 49408 USA
269-236-6179
info@btfsolar.com
www.btfsolar.com

Evosolar
7243 Miller Drive
Warren,MI 48092 USA
586-268-1220
adam.stier@jomar.com
www.jomar.com

Great Lake Electric LLC
5744 Cleveland Avenue
Stevensville, MI 49127 USA
269-408-8276
zheng_zhang@gl-electric.com
www.gl-electric.com

Power Panel Inc.
461 Burroughs
Detroit, MI 48202 USA
248-917-8257
cgsgarth@sbcglobal.net
www.powerpanel.com

Sunsiaray Solar Manufacturing, Inc.
4414 Washburn Rd.
Davison, MI 48423-8006
810-653-3502
sunsiaray46@earthlink.net
www.sunsiaray.com

6. Solar Retail

Mechanical Energy Systems
8130 Canton Center Road
Canton, MI 48187
Contact: Joe Napolitano
800-BY-SOLAR
http://www.by-solar.com

Energy Outlet
44 East Cross St.
Ypsilanti, MI
Contact: Deb Heed
888-818-0987 x 705
http://www.cec-mi.org

7. Training and Education

University of Michigan – Erb Institute
http://www.erb.umich.edu/About/
MMPEI
http://www.energy.umich.edu/index.html
(Contact: mmpei@umich.edu)

SOLAR CAR
http://solarcar.engin.umich.edu/

SOLAR DECTHLON
http://www.misohouse.org/

CENTER FOR SUSTAINABLE SYSTEMS
http://css.snre.umich.edu/

University of Toledo
Wright Center for Photovoltaics Innovation and Commercialization (PVIC) consists of a world-class science and technology platform in the State of Ohio employing second and third generation Photovoltaics materials tailored primarily for applications in clean electricity generation. Three primary locations of the Center are: The University of Toledo, The Ohio State University, and Bowling Green State University.

PVIC was created in January 2007 with $18.6 M in support from the Ohio Department of Development, along with matching contributions of $30 M from federal agencies, universities, and industrial partners.

Co-Director of PVIC

Norm Stevens P.E. - The University of Toledo
Department of Physics and Astronomy
Research and Technology Complex 1
2600 Dorr Street, Suite 2100B
Toledo, Ohio 43607
Norman.Stevens@utoledo.edu
419.530.3846

Washtenaw Community College
No in-house programs are currently offered related to solar, but this institution hosts training offered by GLREA. For updates on possible future programs, contact Dale Petty, Phone: 734-677-5108

Ferris State University
Ferris State University, and United Association (UA), has developed the Green Awareness Certification Program. This 2-day certification course addresses high performance mechanical systems in buildings, and covers Green mechanical terminology, concepts, products and systems. The Green Awareness Program is excellent for HVAC technicians, facilities maintenance personnel, plumbers, electricians, energy managers, service contractors, boiler contractors, general contractors, and students. Ferris State University and HVAC Excellence grant certification jointly.

OHIO – Toledo
Owens Community College (NABCEP approved provider)
Tracy Road
P.O. Box 10,000
Toledo, OH 43699-1947
Contact/Instructor(s): Joe Peschel, John Witte
e-mail: joseph_peschel@owens.edu
567-661-7163

www.owens.edu
Photovoltaic Principles and Applications
Training Program: This 5 day training program for PV installers/integrators includes classroom and hands-on workshop. The course covers the basics in electricity, the characteristics of PV systems and theory and includes system sizing and construction, codes and standards, siting and design, battery safety, interconnection safety, troubleshooting, and maintenance. The workshop will include the design and installation of a grid-tied PV system. Installation practices of project management, adapting mechanical and electrical design, and system commissioning will also be discussed. Various inverters, PV modules, batteries and data information systems will be installed and operated.

Oakland Community College
Debra G. Rowe

dgrowe@oaklandcc.edu / 248-246-2553

- AET-2010 Solar & Other Renewable Energy Systems
- AET-2400 Energy Management
- AET-2424 Independent Research/Auto Bldg Systems
- PSY-2510 Introduction to Psychology
- PSY-2630 Psychology of Organizational Behavior

University of Toledo
Kenneth E. Dobson is currently director of the Division of Community and Economic Development, director of the Clean and Green Building Resource Laboratory, director of Capacity-Building in Emerging Applied Building and Construction Technologies, Workforce Technology Preparedness and adjunct associate professor at The University of Toledo in Toledo, Ohio.
419.530.3280 (office)
kenneth.dobson@utoledo.edu
kenjackboo1@yahoo.com

Oberlin College
David Orr
Oberlin College
440-775-8312
David.Orr@oberlin.edu

MICHIGAN - Warren

Detroit JATC (NABCEP approved provider)
2277 E. 11 Mile Road, Suite 1
Warren, Michigan 48092
Thomas W. Bowes
tomb@det-ejatc.org
586-751-6600

Photovoltaic Systems (course) Photovoltaic Seminar (workshop)
Note: These are journeyman level training courses that will be offered only to persons with 4+ years' electrical experience. Courses cover loads, site surveys, system sizing, inverter and string sizing, support systems, module testing, mounting, cabling, grounding, hardware, combiner boxes, string OCPD, utility requirements, net metering, commissioning, data acquisition, electrical code, and safety.

NABCEP is the organization that does solar PV certification. http://www.nabcep.org/

Northwestern Michigan College has a PV training program where you take the NABCEP test at the end of a week of training.
http://www.nmc.edu/ees/energycenter/

Some links to community college alternative energy training:

Henry Ford Community College

https://my.hfcc.edu/site_manager/catalog_manager/programs/view_program.asp?id=3823&view=s&showprinticon=y&__utma=1.36512470449033 26700.1240589285.1240589285.1240589285.1&__utmb=1.1.10.1240589285&__utmc=1&__utmx=-&__utmz=1.1240589285.1.1.utmcsr=google|utmccn=(organic)|utmcmd=organic|utmctr=henry percent20ford percent20community percent20alternative percent20energy&__utmv=-&__utmk=932657

Lansing Community College
http://www.lcc.edu/energy/

Macomb Community College
http://www.macomb.edu/Current+Students/Educational+Offerings/Associate+Degrees/Program+Descriptions/RenewEnergyTech.htm

Oakland Community College
http://www.oaklandcc.edu/EST/

Appendix C: Reference Codes and Standards for PV and Solar Thermal

Because PV installations are electrical systems, they fall under the National Electrical Code (NEC), also known as NFPA 70 (The National Fire Protection Association creates the code). NEC Article 690 is dedicated to Solar Photovoltaic Systems, and IEEE 1547 as well as UL 1741 are key standards. Other codes and standards that may be applied to PV systems include:

- IEC 61194 Ed. 1.0 b:1992 – Characteristic Parameters of Stand Alone Photovoltaic Systems
- IEC 61727 Ed. 1.0 b:1995 – Photovoltaic Systems – Characteristic of the Utility Interface
- IEC 611215-1993 – Chrystalline Silicon Terrestrial Photovoltaic Modules – Design Qualification and Type Approval
- IEC 61173 Ed. 1.0 b:1992 – Overvoltage Protection for Photovoltaic Power Generating Systems
- IEC 61277 Ed. 1.0 B:1995 – Terrestrial Photovoltaic Power Generating Systems – General and Guide
- IEC 61702 Ed. 1.0 b:1995 Rating of Direct Coupled Photovoltaic Pumping Systems.
- IEEE 929-2000 – Recommended Practice for Utility Interface of Photovoltaic Systems
- IEEE 1013-2000 – Recommended Practice for Sizing Lead-Acid Batteries for Photovoltaic Systems
- IEEE 937-2000 – Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems
- IEEE 1144-1996 – Recommended Practice for Sizing Nickel-Cadmium Batteries for Photvoltaic Systems
- IEEE 1145-1999 – Recommended Practice for Installation and Maintenance of Nickel- Cadmium Batteries for Photovoltaic Systems

- UL 1703-2002 – Standard for Flat-Plate Photovoltaic Modules and Panels
- UL 1741-1999 – Standard for Inverters, Converters, and Controllers for Use in Independent Power Systems.

For Solar Hot Water systems, several sections of the Michigan Plumbing Code (based on the International Plumbing Code) and the Michigan Mechanical Code, and for some systems the electrical codes will also apply. In the Michigan Mechanical Code, Chapter 14 is dedicated to Solar Systems. The indoor portion of the system is similar to a conventional hot water system, and so inspectors will have some familiarity. The Florida Solar Energy Center has created training videos1 for inspectors, also a resource for plan checking and permitting, as it describes systems, and cites specific code sections with a logical explanation.

For both PV and SHW systems, similar building and zoning codes will apply, for example to ensure systems are attached to roofs that are structurally capable of supporting them.

Appendix D: Summary of Michigan Interconnection Standard

The Michigan Public Service Commission (PSC) first adopted interconnection standards for distributed generation (DG) in September 2003. The original standards provided for 5 levels of interconnection with cutoffs at 30 kilowatts (kW), 150 kW, 750 kW, and 2 megawatts (MW), but left many details of the interconnection process up to the utilities. In October 2008 Michigan enacted Public Act 295, creating a renewable portfolio standard (RPS) and authorizing the development of a mandatory, statewide net-metering program. In May 2009, the PSC issued an order formally adopting new net metering rules and revised interconnection rules to implement P.A. 295 of 2008.

The revised rules are somewhat similar to the version adopted in 2003, but offer improved detail and customer protections in some areas. Certain aspects of the newly adopted rules apply only to net metered systems, but the rules generally apply to all distributed generation. Michigan utilities have until August 3, 2009 to submit proposed interconnection procedures and forms for approval by the PSC. The revised rules provide for the following interconnection categories:

- Certified, inverter-based systems of 20 kW or less;
- Systems greater than 20 kW but not more than 150 kW;
- Systems greater than 150 kW in capacity, but not more than 750 kW;
- Systems greater than 750 kW in capacity, but not more than 2 (MW); and
- Systems greater than 2 MW

Certified systems are defined as those that use equipment certified by a nationally recognized testing laboratory to IEEE 1547.1 testing standards and in compliance with UL 1741. Utilities have some leeway in how they evaluate requests in that the rules are generally silent on the appropriate technical screens, engineering, and operational requirements for different categories of interconnection request. However, the rules do offer customer-generators the following protections against unreasonable requirements.

Additional insurance requirements are prohibited for category 1 & 2 projects and utilities may not require the customer to name the utility as an additional insured party. Category 3-5 projects are required to have general liability insurance of at least $1 million.

Application and review fees are subject to PSC approval and Category 1 fees are limited in total to an application fee of $75.

The rules contain specific time lines for the processing and review of interconnection requests for different categories of system.

Utilities must designate and maintain points of contact for initial information requests and must designate a point of contact for each interconnection applicant to address inquiries about technical issues and the status of interconnection requests.

Disputes may be resolved through the PSC and technical disputes may be put before a panel of independent experts. Utilities are responsible for reasonable expenses incurred by the expert panel in their investigation.

Utilities must provide standardized interconnection applications and agreements to customers, with a simplified version for Category 1 requests.

Customer-generators are not required to install an external disconnect switch, although the PSC declined to prohibit utilities from making such a requirement. Utilities are generally prohibited from establishing additional fees; requiring additional equipment or insurance; or making other requirements not specifically authorized by the standard rules.

Source: DSIRE (www.dsireusa.org), November 2009.

Appendix E: Financial Incentive Priorities

A Solar Cities Team meeting in March of 2010 further identified several measures available or requiring action at the local, state, federal, and utility level.

LOCAL INCENTIVES

Local incentives include both aggregated purchasing, low-interest financing, and direct financial incentives. Establishing a Property Assessed Clean Energy (PACE) financing program should be a top priority for Ann Arbor, along with finding a means to offer direct financial incentives. A renewable energy millage or a local carbon tax (such as in Boulder, Colorado) should be considered as possible funding sources for direct incentives. Other local opportunities to incentivize solar include financial backing for community supported solar programs, such as XSeed Energy, and other ways of aggregating purchasing or creating solar buying pools. Strengthening partnerships with Washtenaw County, local banks and credit unions, and leveraging emerging DTE solar programs were also identified as important local priorities.

STATE & FEDERAL INCENTIVES

Ann Arbor should advocate for and promote the local use of: state rebates, Michigan SAVES statewide energy financing initiative, virtual and neighborhood net metering, Community Based Energy Development (CBED), having a solar "carve-out" in the state renewable portfolio standard (RPS), and providing refundable tax credits. Advocating for the continuance of federal investment tax credits (ITC) and production tax credits (PTC), as well as taking advantage of Clean Renewable Energy Bonds (CREBs) and Qualified Energy Conservation Bonds (QECBs) will help enable larger scale solar deployment opportunities in Ann Arbor.

UTILITY INCENTIVES

Not running its own municipal utility means a limited ability to influence utility incentive offerings. While Ann Arbor continues to explore the viability of establishing a municipal utility, the City should also help promote incentives available from DTE. Incentives under DTE's SolarCurrents™ program have the potential to enable moderate to large solar-powered systems, and encouraging the utility to further expand their incentives can further broaden local solar deployment. Consumers cannot easily understand the wide variety of government and non-government solar incentives. Therefore, it is important to work with DTE to educate residents and business owners on the range of utility and government incentives to better guide consumers and demystify the process of installing and reaping the benefits of solar power.

Part 1 Notes

1 U.S. Department of Energy and EPRI. Renewable Energy Technology Characterization, Topical Report TR-109496, December 1997, p. 5-4.

2 National Renewable Energy Laboratory. "Fuel From The Sky: Solar Power's Potential For Western Energy Supply," Report SR-550-32160, July 2002, p. 95.

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