Public Testimony

Terrence L. Chambers, Ph.D., P.E.

Thank you for allowing me to testify to you today. My name is Dr. Terry Chambers. I hold the Mosing Endowed Chair in Mechanical Engineering and serve as the Director of the Energy Efficiency and Sustainable Energy Center at the University of Louisiana at Lafayette. I have been doing solar energy research, education, workforce development, and outreach in Louisiana for 11 years, and have published 24 peer-reviewed scientific papers on that topic. I am the project lead for the 1.1 MW Photovoltaic Applied Research and Testing Lab at UL Lafayette, and I am a registered professional engineer in the State of Louisiana (PE.0029746). Although here as a member of the academic community, my comments do not necessarily represent the position of the University. I am not affiliated with, nor have I received any compensation from any of the parties interested in the outcome of this hearing. The purpose of my appearance is simply to serve as a resource for unbiased, accurate, up-to-date information with regard to solar energy technology, not to recommend or advocate for any particular public policy.

When deployed properly, according to all applicable codes and standards and industry best practices, solar energy is a safe and cost-effective way to provide reliable, low-cost, pollution-free electricity. Nationally and internationally, the solar industry is very mature, and codes and standards have been developed to ensure that solar energy is safe. For example, the National Electric Code (NFPA 70) specifically addresses the proper use and installation of solar energy equipment and requires all solar equipment to be tested and certified by a nationally recognized testing laboratory, such as Underwriter's Laboratory. The plans for any large-scale solar installation must be stamped by the appropriate Louisiana-registered professional engineers certifying that the site layout, drainage plan, electrical design, and structural design will protect the safety, health, and welfare of the public. The permitting authority and the utility generally insist upon third-party inspection and verification before interconnection approval is granted.

I have recently heard many concerns expressed by members of the public, some of which are based on incorrect information, and I would like to address some of those concerns, so that public policy can be based on accurate information. For example, while in use solar power plants do not create toxic run-off that will pollute the groundwater; they do not interfere with medical devices; they do not ruin the land so that it can't be used for farming again, and they will not use enough land to seriously alter the agrarian nature of the state. On the other hand, solar energy has many economic and environmental benefits. For example, solar and wind are now the cheapest form of electrical generation in the U.S., so by implementing solar, utility rates should either stay the same or go down, and low utility rates are most advantageous to our lower-income residents. Parishes can benefit from tax revenue that can be tens or hundreds of times higher than current use, and that tax money can be used to provide additional drainage, police, fire, and other public services. Every year, every acre of a utility-scale solar farm will provide power for approximately 50 homes and provide the CO_2 offset equivalent of planting over 4600 trees.

In terms of solar-related services offered by the University that may be of interest to the community, we have received a grant from the USDA to provide free or low-cost solar energy and energy efficiency audits to qualifying rural businesses and farmers, and if energy saving measures are determined to be cost-effective, there could be USDA funding to help implement the project. We offer tours of our solar facility upon request to interested members of the public, businesses, and public officials, and I am also happy to speak to interested groups upon invitation. We also offer solar energy education for engineers and workforce development courses for those who are desire to become solar energy professionals.

In summary, when implemented properly, solar energy is a safe and cost-effective way to generate pollution-free electricity, and our university offers many solar-related services that may be of interest to the community. Additional information and resources are included in the attached Appendices. Appendix A provides a resource guide related to solar energy in Louisiana, addressing health and safety impacts, land use and farming, property values, and applicable codes and standards. Appendix B provides resources to local governments regarding planning, zoning, permitting, and inspections. If anyone is interested in obtaining more information related to solar energy, my contact information is shown below, and I would be happy to help:

Terrence L. Chambers, Ph.D., P.E.
Donald & Janice Mosing BORSF Endowed Chair in Mechanical Engineering
Director, Energy Efficiency and Sustainable Energy Center
University of Louisiana at Lafayette
PO Box 43678
Lafayette, LA 70504-4170
Office (337) 482-6731
Fax (337) 482-1129
E-mail: terrence.chambers@louisiana.edu
Website: eese.louisiana.edu

Appendix A

Solar Information for Louisiana Residents

Terrence L. Chambers, Ph.D., P.E.

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Energy Efficiency and Sustainable Energy Center
Energy Institute of Louisiana
University of Louisiana at Lafayette

Solar Guidance Documents from Other States

Because members of the public are often concerned about potential solar development in their state, those states have sometimes called upon their universities to provide a summary of answers to common concerns as a resource guide for public officials when making solar-related policy decisions. Two excellent examples are, "Health and Safety Impacts of Solar Photovoltaics," which was written by the North Carolina Clean Energy Technology Center [1], and "Clean Energy Results, Questions and Answers, Ground-Mounted Solar Photovoltaic Systems," created by the Massachusetts Clean Energy Center [2]. In a similar vein, this document attempts to summarize the issues of interest to Louisiana residents related to potential solar energy development.

Health and Safety Impacts of Solar Power Plants

Hazardous Materials

Although solar energy systems do contain small amounts of toxic materials, the issue has been studied intensively and the conclusion is that these materials do not present a danger to public health [3 – 6]. Solar cells are semi-conductors and contain the same type of semi-conductor materials as are used in the computer industry. Unlike computers, however, solar modules are designed to be installed outdoors. Because the semi-conductor would be ruined if exposed to the elements, the solar cell itself is encapsulated between two layers of plastic. In addition, the cells are protected either by a layer of tempered glass on both top and bottom, or by tempered glass on the top and a polymer sheet on the back. As result, the solar cell is completely protected from air and water during normal operation, and as such, rainwater does not wash any toxic materials into the soil. Even if the glass on the solar module is broken, the plastic encapsulant normally still keeps the semi-conductor portion of the modules from being exposed to the elements, thus preventing any harmful materials from escaping. In general, the toxic materials in a solar module will not leach out into the environment unless the solar module is so severely damaged that the encapsulant is compromised, and the cell pieces are fully immersed in water for an extended amount of time. Even then, according to the

International Energy Agency, the concentrations of the toxic materials in the water will remain "several orders of magnitude below regulatory screening thresholds [7]."

End of Life, Recycling, Decommissioning

The situation described above where a defective solar module is immersed in water for a long period of time does not occur during general use, but it could occur if the module were deposited in a landfill at the end of life. Therefore, it is not a recommended practice to place used modules in landfills, and local jurisdictions have the authority to prevent that from happening. Instead, it is recommended to refurbish the modules, if possible, and if not to recycle them at the end of their useful life [8 – 10]. Major module manufacturers and solar industry trade associations have recycling programs [11, 12], and recycling is highly recommended at the end of life.

In general, all components of a solar project can be removed from the property at the end of a solar project and the land can be restored to its original state. The solar modules can be unbolted and recycled. The steel racks that support the solar modules can be removed and either re-purposed or recycled. A decision can be made to either remove the underground PVC conduits that carry the electrical conductors, or to pull the conductors out and leave the conduits in the ground if they are deep enough to not interfere with the next intended purpose for the land. Many of the materials recovered at the decommissioning of a solar farm, including many tons of steel, have an inherent salvage value, making the decommissioning process less costly to the project owner than it would be otherwise. Decommissioning bonds could be considered as a reasonable precaution to take to ensure that neither the landowner nor the local jurisdiction will be left on the hook to decommission a solar power plant if the solar plant owner goes out of business.

O&M – Panel Washing and Vegetation Control

One common concern is that the chemicals used to wash the solar modules will be harmful to the groundwater. Louisiana has enough rain that the modules do not need to be washed very often. In the three years of operation of our solar farm at UL Lafayette, we have only washed the modules once, and that was to initiate a study on the effects of soiling. Washing of the modules was accomplished using tap water run through a deionization filter, a pressure washer, and a brush. No chemicals were needed. If any chemical at all were to be used to wash a solar module it would likely be a mild soap to remove a particularly stubborn bit of soiling.

Utility-scale solar plants typically have grass beneath the modules and between the rows. Vegetation control is primarily accomplished by planting a species of grass that has a limited height, so that it does not shade the solar modules, and then by mowing and weed eating as necessary. It is also possible to run sheep in a solar field to keep the vegetation down and to plant pollinator plants along the vegetative barrier around the solar facility. In general, herbicides are only used at strategic sites, such as along the fence lines and next to the electrical equipment. When an herbicide is used, it is usually a general-use herbicide available over the counter, of the same type used in lawns and parks across the country, rather than a special use herbicide that requires a license.

Hurricanes

Existing local building codes already require all structures, including solar power plants, to be engineered to withstand the design windspeed for each location, as specified by the American Society of Civil Engineers (ASCE). Typical design windspeeds in Louisiana can vary from 110 mph to 140 mph, but solar racks can easily be designed to windspeeds of 150 mph or higher. The National Renewable Energy Lab used maintenance data from 50,000 operational solar energy systems and found that solar plants stand up well to hurricanes and hail [13]. This has been born out by the experience of solar plants in New Jersey and New York during Hurricane Sandy, and by solar plants in the US and Caribbean during Hurricane Mathew, which for the most part survived all of these devastating storms with only minor damage [1].

Electromagnetic Fields (EMF)

Photovoltaic systems do generate both electric and magnetic fields, which are sometimes called EMFs. The type and magnitude of the electric and magnetic fields generated by solar energy equipment is similar to the electric and magnetic fields produced by other electrical equipment that surrounds us every day, including electrical power lines, electrical sub-stations, cell phones, and microwave ovens. Because this is a persistent source of concern, a brief technical explanation seems warranted in order to help the public understand why the electromagnetic fields generated by solar power plants do not represent a unique danger to human health or safety.

The strength of an electric field is proportional to voltage, while the strength of a magnetic field is proportional to current. Both types of electromagnetic fields diminish exponentially with the distance from the source. Electric fields are very easily absorbed and are shielded by anything between a person and the source of the electric field, such as a tree, a fence, or a building. On the other hand, magnetic fields easily pass through most objects, including humans, making magnetic fields the more significant issue with regard to human health. There is also an important distinction between the static magnetic fields produced by DC electricity, and the "power frequency" magnetic fields produced by AC electricity. Static magnetic fields do not induce an electrical current in the human body, but very high current AC electricity does induce a power frequency magnetic field, which could potentially induce an electric current in the human body large enough to cause pain or headaches. Whether this presents a danger to public health has been studied extensively, including by the National Institute of Environmental Health, National Academies of Science, and the World Health Organization [14 - 16]. Following a comprehensive evaluation of this issue, the National Academies of Science concluded:

> "Based on a comprehensive evaluation of published studies relating to the effects of power frequency electric and magnetic fields on cells, tissues, and organisms (including

> humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects [16]."

Exposure limits for public safety have also been established by the IEEE and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [17 - 18]. The typical electrical equipment that we use every day are designed to comply with IEEE and ICNIRP standards.

It is reasonable to ask whether solar power plants present a unique risk to human health, and This question has been asked when other solar projects have been proposed and studies have been performed to answer the question, including by the US Department of Energy [19], which concluded that:

> "…the magnitude of EMF exposure measured at the perimeter of PV installations has been shown to be indistinguishable from background EMF, and is lower than that from many household appliances, such as televisions and refrigerators."

These studies show that the DC voltage generated within the solar field produces a static electric field that will usually be largest at the end of the longest string of modules. The DC current produces a static magnetic field that does not induce a current in the human body. This static EMF is relatively small in magnitude and diminishes dramatically with distance, to the extent that it is "largely indistinguishable from the Earth's natural magnetic field," at a distance of 10 feet [20]. The inverters, AC combiner panels, and transformers in a solar field are the largest sources of power frequency EMF. The power frequency electromagnetic fields in a solar plant are of the same type and magnitude as would be found with traditional electrical equipment, including electrical substations, power lines, and the transformers we see around town and behind our houses. This magnetic field diminishes rapidly with distance and is nearly un-detectable at the fence of a solar facility. A recent peer-reviewed study entitled, "Electromagnetic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities [21]," measured the EMF generated at two commercial solar power plants and concluded:

> "Static magnetic fields were very small compared to exposure limits established by IEEE and ICNIRP. The highest 60-Hz magnetic fields were measured adjacent to transformers and inverters, and radiofrequency fields from 5–100 kHz were associated with the inverters. The fields measured complied in every case with IEEE controlled and ICNIRP occupational exposure limits. In all cases, electric fields were negligible compared to IEEE and ICNIRP limits across the spectrum measured and when compared to the FCC limits (≥0.3 MHz)."

I have personally confirmed this by taking EMF measurements at various locations throughout the University's solar facility and along the fence line. The readings outside the fence were at the ambient levels found throughout town and inside my own home, while the highest readings inside the fence were found beneath a power line that runs alongside the solar field to serve an adjoining neighborhood, but that is not even connected to the solar facility.

I have heard concern expressed about solar facilities potentially interfering with pacemakers. The standards to which Active Implanted Medical Devices (AIMSs) are manufactured requires them to be immune to EMF interference under "reasonable foreseeable" circumstances, which include exposure to EMFs associated with common electrical equipment and power lines, to the extent they are accessible by the general public. As a result, neither the US Food and Drug Administration (FDA) nor the UK's Medicines and Healthcare products Regulatory Agency (MHRA) have ever seen a documented case of a patient having their implanted heart device interfered with by a high-voltage power line [22]. As discussed above, since the EMFs from a solar facility outside the fence are much lower than that of typical power lines, there is no reason to believe that EMFs from a solar facility would interfere with a pacemaker or other AIMS.

<u>Electric Shock and Arc Flash</u>

Solar energy plants are electrical power generation facilities, and as such there is a very real danger from electrical shock and arc flash. For that reason, building codes and the National Electric Codes require that warning signs and tall fences be installed to prevent the general public from inadvertently accessing any electrical equipment that could cause them harm. Qualified electrical technicians and other workers who are specially trained to identify and mitigate these types of hazards and can safely operate and maintain a solar facility.

<u>Fire Hazards</u>

The components that make up a solar field are mostly made of steel, glass and aluminum which are not flammable. In general, therefore, even if the grass underneath a solar array catches fire, the solar modules will not catch fire. On the other hand, an arc flash caused by a loose connector or a frayed wire could potentially generate enough heat to ignite the plastic backsheet, the encapsulant and the insulation on the wires for a solar module, making fire a realistic, although rare, possibility. Recent editions of the National Electric Code, which is published by the National Fire Protection Association, have a special chapter for solar facilities outlining the design requirements to ensure that solar energy systems are designed and installed in a way that will allow firefighters to perform their job safely. Because a solar module will create an electrical potential whenever it is in the sunlight, the NEC requires the installer of a solar energy system to provide an easily identifiable location where firefighters can de-energize the PV system so that they can safely fight a fire at a solar plant. The US Department of Energy has provided millions of dollars to fund the development of specialized training courses for first responders to allow them to learn how do deal with fires in or near solar energy systems. The International Renewable Energy Council (IREC) offers free DOE-sponsored training course entitled, "Solar PV Safety for Firefighters [23]." This course will provide answers to common questions, such as, “Can you spray water on solar panels?” and, “Is a roof top solar array hazardous on a cloudy day?”

Noise

In general, solar farms are very quiet. The largest sources of noise in a solar facility will be the inverters, which emit an audible 60 Hz hum while in operation. Average sound levels at a distance of 10 feet from the inverter face vary over the range of 48 dB to 72 dB [24], which is about the same level of sound from a normal conversation, and it is less than the sound level of a toilet flushing [25]. Also, by way of comparison, OSHA requires employers to implement a hearing conservation program when noise exposure is at or above 85 decibels averaged over eight working hours [26], so in general, the sound levels inside a solar facility are not sufficient to require workers to employ hearing protection. Outside the fence of the solar array, the sound level approaches ambient levels.

Land use and Farming

There are currently somewhere on the order of 7 GW (7,000 MW) of solar projects in Louisiana that have been prospected and submitted to MISO for an interconnection permit. In reality, most of them will never be built for economic reasons. However, if we estimate an average of five acres per MW, and if all 7 GW of solar projects were actually built, they would only use about 35K acres, out of approximately 8M agricultural acres in the state, of which only about half is actually currently being used for farming. This represents less than one half of one percent of all farmlands, so it is unlikely that the proposed solar projects will significantly alter the agrarian nature of our beautiful state, and it seems unlikely that solar farms would create any serious disturbances in the ability of rice mills to receive enough product from nearby farms. Two industry trends will also tend to reduce the amount of land used for solar in the future. One trend is that the efficiency of solar modules has been increasing rapidly over the last twenty years. Another industry trend is to increase the ground coverage ratio in the design of the plant, which simply means that they are tending to put the rows of modules closer together to improve the cost-effectiveness of the projects. Since land use is directly related to module efficiency and ground coverage ratio, future solar farms will require less land to produce the same amount of electricity.

When farmland is used for solar, the land lays fallow for 25 – 35 years with grass planted beneath the solar panels. This may actually improve the quality of the land once it is returned to farmland. Agrivoltaics is a new area of intense study sponsored by the US Department of Energy. Agrivoltaics combine the production of solar energy with and other agricultural activities on the same land. Solar farms have already been successfully combined with farm animals such as sheep as well as certain crops, and a large amount of research activity is currently being devoted to this topic.

Property Values

At the residential scale, researchers at the Lawrence Berkeley National Laboratory performed an "Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California," and found that, "Across a large number of repeat salesmodel specifications and robustness tests, the analysis finds strong evidence that California homes with PV systems have sold for a premium over comparable homes without PV systems [27]."

At the utility scale there is a common perception that utility-scale solar projects will bring down property values, even among appraisers. Researchers at the University of Texas at Austin surveyed land appraisers and found that, "while a majority of survey respondents estimated a value impact of zero, some estimated a negative impact associated with close distances between the home and the facility, and larger facility size. Regardless of these perceptions, geospatial analysis shows that relatively few homes are likely to be impacted [28]."

For the UT-Austin study, it was found that those with a negative opinion had never actually performed a formal appraisal of a solar farm. However, when a study of the potential impact of a specific proposed solar farm at a particular site has been performed by certified appraisers, the results consistently show no negative effect on property values. For example, a State Certified General Appraiser in North Carolina was asked to do a study of the impact of nearby property values of a proposed solar farm and his conclusion was:

> "The matched pair analysis shows no impact in home values due to the adjacency to the solar farm as well as no impact to adjacent vacant residential or agricultural land. The criteria for making downward adjustments on property values such as appearance, noise, odor, and traffic all indicate that a solar farm is a compatible use for rural/residential transition areas [29]."

In a more recent case (2020) of the same type in Virginia [30], a professional appraiser was asked to:

> "…provide our professional opinion on whether the proposed solar farm will have any impact on adjoining property values and whether "the location and character of the use, if developed according to the plan as submitted and approved, will be in harmony with the area in which it is to be located.""

The conclusion in Virginia by a completely different appraisal firm was almost identical to that in North Carolina:

> "Based on my analysis of the neighborhood and properties surrounding the proposed solar site, and my analysis of other existing solar farms in similar locations, it is our professional opinion that the proposed solar electric power plant will not adversely affect the value of adjoining or abutting property.

It is also my professional opinion that the location and character of the solar facility, if developed according to the plan as proposed, will be in harmony with the area in which it is to be located."

Codes and Standards

The DOE SunShot program recently funded a project to create a resource guide for states and municipalities regarding recommended standards and requirements for solar equipment, installation, and licensing and certification [31]. A partial list of the codes and standards that are applicable to solar energy equipment and installations is shown below.

- **Installation Requirements:**
    - National Electrical Code, NFPA 70
    - Must be installed by a qualified person and in accordance with manufacturer's instructions
- **Product Listing**
    - UL 1703: Standard for Safety for Flat-Plate Photovoltaic Modules and Panels
    - UL 1741: Standard for Inverters, Converters and Controllers for Use In Independent Power Systems
    - IEEE 1547 - Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
- **Design Qualification (reliability testing)**
    - IEC 61215: Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval
    - IEC 61646: Thin-Film Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval
- **Performance Measurement**
- ASTM E1036: Standard Test Methods for Electrical Performance of Non-concentrator Terrestrial Photovoltaic Modules and Arrays Using Reference Cells

References

[1] Tommy Cleveland, "Health and Safety Impacts of Solar Photovoltaics," May 2017, White Paper published by the North Carolina Clean Energy Center, Available at: https://nccleantech.ncsu.edu/wp-content/uploads/2019/10/Health-and-Safety-Impacts-of-Solar-Photovoltaics-PV.pdf

[2] Clean Energy Results Questions & Answers Ground-Mounted Solar Photovoltaic Systems, Massachusetts Department of Energy Resources, Massachusetts Department of Environmental Protection, Massachusetts Clean Energy Center, June 2015. Available at: https://www.mass.gov/files/documents/2016/08/rn/solar-pv-guide.pdf

[3] Nover, Jessica, Renate Zapf-Gottwick, Carolin Feifel, Michael Koch, and Juergen H. Werner 2021. "Leaching via Weak Spots in Photovoltaic Modules" Energies 14, no. 3: 692. https://doi.org/10.3390/en14030692. Available at: https://www.mdpi.com/1996-1073/14/3/692

[4] Gao, Qiao, Kirisits, Mary Jo, "The Effect of Photovoltaic Nanomaterial Roofing on Harvested Rainwater Quality," Project Number: University of Texas at Austin, USGS 104b Research Grant Final Report. Available at: https://twri.tamu.edu/media/2021/gao-report.pdf

[5] Vasilis Fthenakis, "Sustainability of photovoltaics: The case for thin-film solar cells," Renewable and Sustainable Energy Reviews, Volume 13, Issue 9, 2009, Pages 2746-2750, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2009.05.001. Available at: https://www.sciencedirect.com/science/article/pii/S1364032109000896

[6] Vasilis M Fthenakis, "Life cycle impact analysis of cadmium in CdTe PV production," Renewable and Sustainable Energy Reviews, Volume 8, Issue 4, 2004, Pages 303-334, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2003.12.001. Available at: https://www.sciencedirect.com/science/article/pii/S1364032103001345

[7] "Human Health Risk Assessment Methods for PV Part 3: Module Disposal Risks 2020," International Energy Agency Photovoltaic Power Systems Programme, Report IEA-PVPS T12-16: 2020. Available at: https://iea-pvps.org/wp-content/uploads/2020/05/PVPS-Task-12_HHRA-PV-Disposal-1.pdf

[8] C.C. Farrell, A.I. Osman, R. Doherty, M. Saad, X. Zhang, A. Murphy, J. Harrison, A.S.M. Vennard, V. Kumaravel, A.H. Al-Muhtaseb, D.W. Rooney, "Technical challenges and opportunities in realising a circular economy for waste photovoltaic modules," Renewable and Sustainable Energy Reviews, Volume 128, 2020, 109911, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2020.109911. Available at: https://www.sciencedirect.com/science/article/pii/S1364032120302021

[9] Heath, G.A., Silverman, T.J., Kempe, M. et al. Research and development priorities for silicon photovoltaic module recycling to support a circular economy. Nat Energy 5, 502–510 (2020). https://doi.org/10.1038/s41560-020-0645-2, Available at: https://www.nature.com/articles/s41560-020-0645-2

[10] Meng Tao, Vasilis Fthenakis, Burcak Ebin, Britt-Marie Steenari, Evelyn Butler, Parikhit Sinha, Richard Corkish, Karsten Wambach, Ethan S. Simon, "Major challenges and opportunities in silicon solar module recycling," Progress in Photovoltaics, 22 July 2020,

https://doi.org/10.1002/pip.3316. Available at: https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3316

[11] “SEIA National PV Recycling Program,” Solar Energy Industries Association Website, Accessed 7-26-2021. https://seia.org/initiatives/seia-national-pv-recycling-program

[12] “Recycling,” First Solar Website, Accessed 7-26-2021, https://www.firstsolar.com/en/Modules/Recycling

[13] D.C. Jordan and S. R. Kurtz, “Reliability and Geographic Trends of 50,000 Photovoltaic Systems in the USA,” Presented at the European Solar Energy Conference and Exhibition, Amsterdam, Netherlands, September 22 – 26, 2014, Available at: https://www.nrel.gov/docs/fy14osti/62801.pdf

[14] EMF Electric and Magnetic Fields Associated with the Use of Electric Power, National Institute of Environmental Health Sciences, National Institutes of Health, sponsored by the NIEHS/DOE EMF RAPID Program, Available at: https://www.niehs.nih.gov/health/materials/electric_and_magnetic_fields_associated_with_the_use_of_electric_power_questions_and_answers_english_508.pdf

[15] World Health Organization. Electromagnetic Fields and Public Health: Exposure to Extremely Low Frequency Fields. June 2007. Accessed July 2021. http://www.who.int/peh-emf/publications/facts/fs322/en/

[16] Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, National Research Council, Possible Health Effects of Exposure to Residential Electric and Magnetic Fields, ISBN: 0-309-55671-6, 384 pages, 6 x 9, (1997) This PDF is available from the National Academies Press at: http://www.nap.edu/catalog/5155.html

[17] International Commission on Non-Ionizing Radiation Protection (ICNIRP): Guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz to 100 kHz). Health Phys. 99(6):818–836 (2010). Available at: https://journals.lww.com/health-physics/Citation/2010/12000/GUIDELINES_FOR_LIMITING_EXPOSURE_TO_TIME_VARYING.26.aspx

[18] IEEE: “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.” New York: Institute of Electrical and Electronic Engineers, IEEE Std. C95.1, 2005. Available at: https://standards.ieee.org/standard/C95_1-2019.html

[19] US DOE Letter from John Lushetsky, Program Manager, U.S. Department of Energy Solar Technologies Program, dated 12 Nov 2009. Available at: https://westbrookfieldsolar.files.wordpress.com/2012/03/us-doe-letter-on-solar-safety.pdf

[20] “Scaling Public Concerns of Electromagnetic Fields Produced by Solar Photovoltaic Arrays,” Good Company, Eugene, OR, available at:

https://www.gusd.net/cms/lib/CA01000648/Centricity/Domain/53/7.%20OR%20EMF%20concerns.pdf

[21] R. A. Tell, H. C. Hooper, G. G. Sias, G. Mezei, P. Hung & R. Kavet ,(2015), "Electromagnetic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities," Journal of Occupational and Environmental Hygiene, 12:11, 795-803, DOI: 10.1080/15459624.2015.1047021, available at: https://www.tandfonline.com/doi/full/10.1080/15459624.2015.1047021

[22] "Real-life experience of interference with Implanted Heart Devices," EMFs.info Website, Accessed 7-26-2021. Available at: https://www.emfs.info/effects/medical-devices/real-life-experience-interference-implanted-heart-devices/

[23] "Solar PV Safety for Firefighters," Interstate Renewable Energy Council (IREC), Albany, NY, Accessed 7-26-2021, https://cleanenergytraining.org/products/solar-pv-safety-for-firefighters#tab-product_tab_contents__20

[24] "Study of Acoustic and EMF Levels from Solar Photovoltaic Projects," Report Prepared for the Massachusetts Clean Energy Center, Boston, MA, by Tech Environmental, Waltham, MA, December 17, 2021, . Available at: https://files.masscec.com/research/StudyAcousticEMFLevelsSolarPhotovoltaicProjects.pdf

[25] Noise Level Chart Website, Accessed 7-26-2021, https://www.noisehelp.com/noise-level-chart.html

[26] "Occupational Noise Exposure," OSHA Website, Accessed 7-26-2021. https://www.osha.gov/noise

[27] Ben Hoen, Ryan Wiser, Peter Cappers and Mark Thayer, An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California, Environmental Energy Technologies Division, Ernest Orlando Laboratory, Lawrence Berkeley National Laboratory, April 2011. Available at: https://eta-publications.lbl.gov/sites/default/files/lbnl-4476e.pdf

[28] Leila Al-Hamoodah, Kavita Koppa, Eugenie Schieve, D. Cale Reeves, Ben Hoen, Joachim Seel and Varun Rai, An Exploration of Property-Value Impacts Near Utility-Scale Solar Installations, Policy Research Project (PRP), LBJ School of Public Affairs, The University of Texas at Austin, May 2018. Available at: https://emp.lbl.gov/sites/default/files/property-value_impacts_near_utility-scale_solar_installations.pdf

[29] Richard C. Kirkland, Jr., MAI, "Oakwood Solar Impact Study," Kirkland Appraisals, LLC, Raleigh North Carolina, February 12, 2016, Available at: https://usesusa.org/wp-content/uploads/2020/02/Solar-Impact-Study.pdf

[30] Christian P. Kaila & Associates, "PROPERTY IMPACT ANALYSIS Of Proposed Maroon Solar Farm Raccoon Ford Road Culpeper County, Virginia," Christian P. Kaila & Associates,

Fredericksburg, VA, Available at: https://www.maroonsolarproject.com/wp-content/uploads/2021/01/Attachment-M-Property-Value-Impact-Study-P1007432.pdf

[31] Beren Argetsinger, Benjamin Inskeep, "Standards and Requirements for Solar Equipment, Installation, and Licensing and Certification - A Guide for States and Municipalities," February 2017, A Report Prepared for the Clean Energy States Alliance with Funding from the DOE SunShot Program, Available at: https://www.cesa.org/wp-content/uploads/Standards-and-Requirements-for-Solar.pdf

Appendix B

Solar Planning Resources for Local Governments

Terrence L. Chambers, Ph.D., P.E.

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Energy Efficiency and Sustainable Energy Center
Energy Institute of Louisiana
University of Louisiana at Lafayette

As an Authority Having Jurisdiction (AHJ), you have many tools that can influence, either positively or negatively, the amount of solar energy development that takes place within your jurisdiction. Some of the most important of these tools include: 1) planning and zoning, and 2) codes, permits, and inspections.

The US Department of Energy funds a program called SolSmart, which provides resources to local governments to help them make their community “solar ready.” The SolSmart program can also provide a national-level designation to any community that takes certain steps to foster the growth of a mature solar market in their jurisdiction. Why is this important?

> “Local governments have tremendous influence over the prospects for solar energy growth. Unnecessary paperwork, red tape, and other burdensome requirements increase costs and discourage solar companies from moving to the area. By streamlining these requirements and taking other steps to encourage solar development, communities become “open for solar business.” And since the solar industry is a leading source of American job creation, attracting solar investment in your community is a great way to promote economic development and new jobs.” [1]

The SolSmart program provides a free toolkit for local governments to guide them through the many issues that can arise when considering solar development, including federal and state policies; stakeholder engagement; planning, zoning, and development; codes, permitting, and inspection; residential issues; utility engagement; community solar; market development and finance; solar development on public facilities and under-utilized land, and resiliency [2]. If the jurisdiction wants to apply for the national SolSmart designation, and if you need technical assistance to work through the process, you can request a free consultation from a SolSmart Advisor [3].

Planning and Zoning

A good solar ordinance will address three primary issues: land use conflicts and synergies; protecting access to solar resources; and encouraging appropriate solar development. The

Great Plains Institute has developed model solar ordinances for five states. What is the value of a model solar ordinance?

> "Model solar ordinances help guide local governments in supporting and encouraging renewable energy development in their communities. Local governments can customize the provided zoning language for all scales of development, from rooftop to utility-scale solar installations. The model language addresses land use conflicts, methods for encouraging solar development, protecting access to solar resources, and solar energy standards [4]."

The model ordinance for Indiana has been recommended as the one most applicable to Louisiana and a good starting point [5]. The model ordinance includes specific language that could be adapted to meet the needs of your jurisdiction.

Another resource is a local non-profit organization called the Center for Planning Excellence (CPEX), located in Baton Rouge [6]. CPEX is a non-profit organization that coordinates urban, rural and regional planning efforts in Louisiana. The CEO of CPEX is Camille Manning-Broome, a member of the Governor's Climate Initiatives Task Force, and an expert on renewable energy planning issues. Her email address is: camille@cpex.org

Codes, Permits and Inspections

As described in the SolSmart toolkit for local governments:

> "Among all the ways local governments can influence solar energy development, the permitting and inspection process is one of the most important. Municipalities and counties often have direct oversight over permitting and inspection. Streamlining this process to facilitate solar energy construction, without compromising safety standards, can dramatically reduce the time and expense for solar installations. Conversely, an unnecessarily cumbersome process can delay installations and increase costs for consumers." [7]

In general, solar installations will need to adhere to the same permitting and inspection requirements as other construction projects. The local jurisdiction has probably already adopted applicable codes for electrical, building, and fire protection for other types of construction (NEC, IBC, NFPA, etc.), and all of these codes now cover solar installations as well.

An AHJ will want to be able to review plans and issue permits for solar development at the residential, commercial, and utility scales. Permits at the utility scale may very well need to be issued after a detailed plan review on a case-by-case basis, but permits for small photovoltaic projects can easily be streamlined through a "simplified permit process." The SolSmart program provides guidelines for local governments to create a standard process to simplify the structural and electrical review of the majority of small PV systems (in general less than 15 kW on a permitted roof). One benefit is that, "By implementing a streamlined and more standardized permitting process, local governments can make installing solar faster, easier, and more affordable for their staff, local residents, businesses, and solar companies."

The Solar America Board for Codes and Standards (SolarABCs) provides a simple "Expedited Permit Process [9], which could very easily be adopted almost without change in most jurisdictions. The process includes a standard permit application with fill-in forms and standardized one-line electrical diagrams.

The National Renewable Energy Lab (NREL) has also recently "launched a collaborative effort with key code officials, authorities having jurisdiction, and the solar industry to develop standardized plan review software that can run compliance checks and process building permit approvals for eligible rooftop solar systems [10]." The Solar Automated Permit Processing software (SolarAPP+), is provided free of cost to city and parish permitting departments. NREL personnel will help the jurisdiction set up the software, and will provide no-cost updates for code revisions and new technology. The software can stand alone or be integrated with existing government software and inspection platforms. Eligible solar applications that comply with all code requirements are approved instantly, while others are returned to the applicant for corrections.

References

[1] https://solsmart.org/how-we-help/what-is-solsmart/

[2] https://solsmart.org/solar-energy-a-toolkit-for-local-governments/

[3] https://solsmart.org/get-started/request-a-consultation/

[4] https://www.betterenergy.org/blog/model-solar-ordinances/

[5] https://www.betterenergy.org/wp-content/uploads/2021/02/IN-Solar-Ordinance-2020_December.pdf

[6] https://www.cpex.org/

[7] https://solsmart.org/solar-energy-a-toolkit-for-local-governments/solar-pv-construction-codes-permitting-and-inspection/

[8] https://solsmart.org/permitting/

[9] http://www.solarabcs.org/about/publications/reports/expedited-permit/index.html

[10] https://solarapp.nrel.gov/