Local Solar, Local Savings

How to Cut Electricity Costs in Half for Public Schools and Local Governments in Frankfort, Kentucky

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How to Cut Electricity Costs in Half for Public Schools and Local Governments in Frankfort, Kentucky

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This report was produced by *Apogee-Climate & Energy Transitions*. Apogee's mission is to advance the energy transition and solutions to the climate crisis in Kentucky. A program of Earth Tools, Inc., Apogee provides technical assistance, research, and educational services in the public interest.

Apogee, Earth Tools, Inc., and the report's authors have no financial interest in the proposed project and would not be bidders on any RFP's related to this project.

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Executive Summary

Local governments and public schools in Frankfort, Kentucky could reduce their electricity costs by fifty percent and dramatically reduce carbon emissions by developing a collaborative solar project within Franklin County. With the cooperation of their local municipal utility, the Frankfort Plant Board (FPB), a 20 megawatt (MW) solar facility on about 150 acres could supply 100% of the annual electricity needs of these four public agencies, providing combined savings to local taxpayers exceeding $1.2 million per year. Frankfort would join a growing list of cities, such as Louisville, which have committed to using 100% renewable electricity for local government operations. Through this project Frankfort could meet that target within a few years, while greatly reducing energy costs. [1]

This report shows how Kentucky cities like Frankfort, which have locally owned municipal utilities, can greatly reduce costs for local governments and public schools, while making major strides to reduce carbon emissions and improve air quality and public health. The report demonstrates the benefits to the local utility, which would realize significantly reduced peak-demand charges and reduced risks within their wholesale power supply.

Frankfort & Franklin County's public schools & local governments could **save $1.2 million** per year via a collaborative **20 MW solar project.**

Table ES-1 shows the annual energy cost savings available to the City of Frankfort, Franklin County Fiscal Court, Frankfort Independent Schools, and Franklin County Schools, if a 20 MW solar project were developed. Under this proposal, "virtual net metering" would be used to enable the City, County, and public schools to sign solar Power Purchase Agreements (PPA's) with a third-party private solar developer. The developer would finance, develop, own, operate, and maintain the solar facility, with no up-front or maintenance costs for the Project Participants or the FPB. This study estimates the price of the solar PPA to be a fixed rate of 4.5 cents/kWh for a term of 20 to 25 years, a conservative estimate relative to other utility-scale solar projects in Kentucky and the Southeast.

This project would build on the success of the existing solar partnership at Juniper Hill Park, in which the City of Frankfort powers its Pro Shop with a 23 kilowatt solar array that is owned, operated, and maintained by Earth Tools Inc. Using a net metering agreement with the FPB, the City saves about $470 per year. While having similarities to the Juniper Hill demonstration project, the proposed 20 MW project would be much larger and would require additional provisions added to FPB's net metering tariff to enable "virtual" net metering. These provisions would allow a single solar facility's output to serve multiple customers and properties at different locations, off-site from the solar facility. This would allow local governments and schools to take advantage of the economies of scale of building a single large facility capable of serving all of their loads.

Frankfort is uniquely positioned to develop a collaborative solar project because it has a municipal utility with the freedom to set local energy policies for the benefit of local residents. The

[1] www.louisvilleky.gov/government/sustainability/renewable-energy.

FPB is not regulated by the Public Service Commission and has no investors to serve. It exists to serve the Frankfort community, rather than shareholders, and is governed by a board of citizens who are accountable to its customers. This creates the opportunity to consider community-oriented projects that are not possible in other cities. In this time of economic and social crisis, a collaborative solar project is a tangible step the Frankfort community can take towards re-building its local economy and making its public institutions more fiscally secure and resilient.

Table ES-1 – Potential Savings for Frankfort's Public Schools and Local Governments

Estimated Energy Cost Savings from a 20 MW Solar Project Meeting 100% of the Net Annual Electricity Needs for City and County Governments and Public Schools in Frankfort, Kentucky.

	Annual Electricity Use[2]	Solar PV Capacity	Annual Savings
City of Frankfort	13,495,269 kwh	9.32 MW	**$ 600,539**
Franklin County Fiscal Court	2,549,228 kwh	1.76 MW	**$ 113,441**
Frankfort Independent Schools	1,375,715 kwh	0.95 MW	**$ 61,219**
Franklin County Schools	11,408,220 kwh	7.88 MW	**$ 507,666**
	Total Solar Facility Size	**20.0 MW**	
	Total Annual Savings for Local Taxpayers		**$ 1,282,865**

Annual Savings based on FPB retail rate of 8.95 cents/kWh and a solar PPA rate estimated at 4.5 cents/kWh.

Benefits of Expanding Access to Local Solar Energy for Municipalities and Schools

A 20 MW solar facility on the FPB's distribution grid would provide multiple benefits to the local community, the FPB, and its customers. The analysis detailed in this report shows how a locally sited solar facility would significantly reduce the FPB's monthly peak demand charges, providing wholesale power cost savings on the order of $1.8 million per year. In addition, this project offers reduced financial risk, reduced carbon emissions, improved air and water quality, public health benefits, and local economic development.

This comes at an opportune time for the FPB and its wholesale power supplier, the Kentucky Municipal Energy Agency (KYMEA). The KYMEA is currently considering whether to replace 130 MW of coal and natural gas power contracts that are due to expire or be reduced in 2022 and 2023.[3]

[2] Sources for electricity usage data for each agency provided on p.9, footnote 14 of this report.

[3] *Presentation to the Frankfort Plant Board Regarding The KyMEA All Requirements Project Proposed Arrangements for the Supply of All Requirements Service Commencing May 1, 2019,* August 16, 2016, nFront Consulting, p.9. See also *KYMEA Short Term Action Plan Discussion*, December 16, 2020, KYMEA, slideshow, p.22.

By reducing their customer loads, a 20 MW solar project in Frankfort would lessen the need for new power supply commitments. This would reduce financial risk for all members of the KYMEA. Additional benefits for the FPB include reduced exposure to market and transmission price fluctuations, as well as future carbon pricing and environmental regulations, as KYMEA's current portfolio has a heavy carbon footprint.

While the FPB would receive $1.8 million in wholesale power cost savings, its revenue would decline due to reduced kilowatt-hour sales, by about $2.6 million per year. This net revenue reduction of $800,000 would be offset by the multiple other benefits provided by the project, not least of which is the potential value of reduced carbon emissions. With the Federal government's renewed commitment to aggressive action on climate change, a price on carbon has become more likely in coming years. A $40 per ton price on carbon would translate into $932,000 in additional savings to the FPB from the 20MW solar project.[4] Table ES-2 summarizes the multiple other benefits this project would provide to the FPB, its customers, the community, and the wider society.

A review of the FPB's Budget for Fiscal Year 2020 shows a company with strong financial health, in a good position to make choices that will provide long-term benefits to their customers and community. The budget shows the Electric Department earning a margin of $6.7 million in FY2020. FPB cash reserves are projected to grow from $38 million in FY2020 to $68 million by FY2024.[5] In sum, the FPB is financially healthy and has ample revenue to cover its operating costs plus build a significant cash reserve. In light of the FPB's financial position and the overall benefits offered by this project, there are clear reasons to support its development.

Steps to Project Implementation

For a Collaborative Solar Project to succeed, cooperation between local governments, public schools, and the FPB is necessary. The primary steps to implement this project would be:

- The City of Frankfort, Franklin County Fiscal Court, Frankfort Independent Schools, and Franklin County Schools develop an agreement to cooperate on a Collaborative Solar Project.
- The FPB approves a virtual net metering policy for local governments and public schools.
- The City, County, and public schools issue a Request for Proposals (RFP) for a Collaborative Solar Project.

These steps would enable local governments and schools to realize the financial, environmental, and community benefits of using solar energy with no capital investment and no operational or maintenance expenses. The full report explains the methods used to evaluate the benefits of a 20 MW solar project and the policies needed to implement it.

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[4] CO2 emissions reductions based on KYMEA emissions rate as reported in KYMEA document, "September 2, 2020 Community IRP Focus Group Feedback, KYMEA, p. 6," and energy generation from 20 MW solar PV facility. See Footnote 30 for further detail on carbon pricing and CO2 emission reductions.

[5] *Budget and Financial Plan, Fiscal Years Beginning 2019-2020*, Frankfort Plant Board, pp.6-7.

Table ES-2 – Summary of Benefits of a 20MW Solar Project in Franklin County, Kentucky

Including financial savings and other benefits to the utility, its customers, community, and society.

UTILITY & RATEPAYER BENEFITS	
Reducing wholesale power costs.	
Peak Demand & Transmission Cost Savings:	$ 1 million+ per year
Wholesale Energy Cost Savings:	$ 700,000+ per year
Hedging against future carbon pricing.	
Value to FPB of reducing 23,288 tons CO2 per year at $40 per ton:	$932,000 per year[6]
Mitigating financial risk in FPB's wholesale power supply by reducing load and pressure to invest in new coal or gas power contracts.	
Capacity Value for KYMEA of Distributed Solar Generation (approx.):	50%[7]
Reducing exposure to power market price fluctuations and transmission price increases.	
COMMUNITY & SOCIETAL BENEFITS	
Reducing operational costs, stabilizing rates, and increasing financial security for local public agencies.	
City of Frankfort's Savings:	$ 600,539 per year
Franklin County Fiscal Court's Savings:	$ 113,441 per year
Frankfort Independent Schools' Savings:	$ 61,219 per year
Franklin County Schools' Savings:	$ 507,666 per year
Advancing City of Frankfort's commitment to the Mayor's Agreement for Climate Protection.	
Advancing Franklin County and Public Schools' commitments to environmental stewardship.	
Public health benefits of improving air and water quality:	$532,000 to $1,200,000 per year[8]
Reduced CO_2 emissions:	23,288 tons CO_2 per year
Local economic development.	
New investment into Franklin County:	$25 to $35 million[9]
Lease payments to landowners and increasing property tax value at solar sites.	

[6] See Footnote 4.

[7] See discussion of capacity value on p.21 of this report and Footnote 45.

[8] *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report*, US Environmental Protection Agency, July 2019. The range of values cover EPA's low and high-end estimates.

[9] Estimate of the cost to build a 20MW solar facility, based on Bolinger, M., Seel, J., and Robson, D. *Utility Scale Solar: Empirical Trends in Project Technology, Cost, Performance, and PPA Pricing in the United States – 2019 Edition,* December 2019, Lawrence Berkeley National Laboratory, p.18.

Introduction

The City of Frankfort, Franklin County Fiscal Court, Frankfort Independent Schools, and Franklin County Schools could cut their electricity costs in half and reduce carbon emissions from electricity use by up to 100%, by developing a 20 megawatt (MW) collaborative solar project within Franklin County. With the cooperation of their local municipal utility, the Frankfort Plant Board (FPB), a 20 MW solar facility on about 150 acres could supply 100% of the net annual electricity needs of these four public agencies, providing combined savings to local taxpayers exceeding $1.2 million per year.

This report shows how Kentucky cities like Frankfort, which have locally owned municipal utilities, can significantly reduce costs for local governments and public schools while reducing carbon emissions, improving air quality and public health, *and* benefiting the local utility. An analysis of the FPB's historic electricity demand data demonstrates that a local solar facility would reliably reduce monthly peak-demand for the FPB, significantly reducing wholesale power costs for the utility and its customers.

A local 20 MW solar facility would also help the FPB and its power supplier, the Kentucky Municipal Energy Agency (KYMEA), avoid the cost and risk of buying new generation capacity. The KYMEA is currently evaluating their need for additional power supplies to replace 130 MW of coal and natural gas contracts due to expire or be reduced in 2022 and 2023.[10] Frankfort has a window of opportunity to reduce its demand for wholesale power and alleviate KYMEA's need to replace these expiring contracts. By reducing their customer load, a 20 MW local solar project would help the FPB and KYMEA avoid the financial risks of committing to new coal or natural gas contracts.

Furthermore, the Federal government is making a renewed and aggressive commitment to fighting climate change, increasing the likelihood that there will be a price on carbon emissions in the coming years. The next few years are a critical time for reducing the carbon intensity of the FPB and KYMEA's power supplies.

Frankfort is uniquely situated to benefit from a collaborative solar project because it owns a municipal utility which is not regulated by the Public Service Commission, has no investors to serve, and has the freedom to set local energy policies for the benefit of local residents. The FPB exists to serve the Frankfort community, rather than shareholders, and is governed by a board of citizens who are accountable to its customers. This creates the opportunity to consider community-oriented

[10] *Presentation to the Frankfort Plant Board Regarding The KyMEA All Requirements Project Proposed Arrangements for the Supply of All Requirements Service Commencing May 1, 2019,* August 16, 2016, nFront Consulting, p.9. See also *KYMEA Short Term Action Plan Discussion*, December 16, 2020, KYMEA, slideshow, p.22.

projects that are not possible in many other cities. In this time of economic and social crisis, a collaborative solar project is a tangible step the Frankfort community can take towards re-building its local economy and making its public institutions more fiscally secure and resilient. By developing this project, Frankfort would join other cities taking the lead on clean energy, such as Louisville, which has committed to 100% renewable electricity for Metro government by 2030; Cincinnati, which is building an 80 MW solar facility; and Henderson, Kentucky, which is building a 50 MW solar facility.[11]

For a collaborative solar project to succeed, cooperation between local governments, public schools, and the FPB is necessary. The FPB's role would include modifying their existing net metering tariff to enable virtual net metering, so the energy generated by the solar facility can be credited to the accounts of the participating local governments and schools. The virtual net metering tariff would need to allow generators up to 20 MW in capacity to serve municipal governments and public school customers.

A private solar developer would provide the capital to develop the solar facility and would own, operate, and maintain it for the life of the project. The developer would recover their investment through Power Purchase Agreements (PPA's) with the Project Participants (City and County governments and the public schools). Costs to the FPB related to project development, including interconnection studies and infrastructure improvements for the solar facilities, would be paid by the solar developer.

With the FPB's support, this project would allow local governments and schools to cut their electricity costs in half and stabilize their electricity rates for the next 20 years or more, with no up-front costs and no operational or maintenance expenses. The community would see multiple benefits from such a project, including the economic development that would accompany project construction and reduced strain on the budgets of local governments and schools. Important societal benefits would include reduced carbon emissions and improvements to air and water quality and public health. Frankfort would be viewed as a leader in economic and clean energy development, at a time when many companies, such as Apple, GM, Amazon, Walmart, and others are working to achieve net-zero carbon emissions.[12]

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[11] *Cincinnati to Construct Nation's Largest City-Led Solar Project*, November 21, 2019, Office of the Mayor, City of Cincinnati, https://www.cincinnati-oh.gov/mayor/news/cincinnati-to-construct-nation-s-largest-city-led-solar-project/. *Community Energy Announces Agreement with Henderson Municipal Power & Light (HMP&L) Enabling 50 Megawatts of New Solar Power in Western Kentucky,* Businesswire, July 30, 2020, https://www.businesswire.com/news/home/20200730005282/en/Community-Energy-Announces-Agreement-Henderson-Municipal-Power. Louisville's 100% Renewables Commitment: https://louisvilleky.gov/government/sustainability/renewable-energy.

[12] Mandel, K., *Companies Are Making Major Climate Pledges. Here's What They Really Mean*, Huffpost.com, October 7, 2020. See also https://www.wemeanbusinesscoalition.org/.

Project Description:
A Collaborative Solar Project for Frankfort

The City of Frankfort is located in Franklin County and is home to the Kentucky State Capitol. The City and County have separate government agencies and separate school districts, Frankfort Independent Schools and Franklin County Schools. The Frankfort Plant Board (FPB) is the local municipal utility that provides electric, water, telephone, internet, television, and security services to about 21,000 customers in the Frankfort and Franklin County area.[13] The FPB is governed by a board of directors appointed by the Mayor of Frankfort and approved by the Frankfort City Commission.

The City, County, and public schools collectively spend over $2.5 million each year for electricity.[14] This study finds that a 20 megawatt (MW) solar facility could save taxpayers more than $1.2 million dollars each year if virtual net metering were available via the FPB. A 20 MW solar facility, supplying 100% of these agencies' annual electricity needs, would require about 150 acres of land, at one or more sites in Franklin County, and would consist of about 50,000 solar panels.

Virtual net metering would enable the City, County, and school districts to collaborate on a Request for Proposals (RFP) for a private developer to build, own, operate, and maintain the solar facility. Each participating agency would enter a contract with the solar developer to purchase a share of the energy produced by the facility each year. Solar power purchase agreements (PPA's) typically run for 15 to 25 years, with power prices usually fixed for the term of the contract.[15] For the purposes of this study, a solar PPA price of 4.5 cents/kWh was estimated, which would provide a 50% savings compared to the FPB's current municipal retail rate of 8.95 cents/kWh.

> **Virtual net metering** allows a single solar array to serve multiple meters which may be located off-site from the solar array. It also allows multiple customers to share the energy produced by a single solar array and have the energy credited to their individual accounts. **Appendix A** provides more information about virtual net metering.

With virtual net metering, the total energy produced by the solar facility would be allocated to each Project Participant (City, County, school districts) according to their contracted share in the project. The FPB would adjust the Participant's utility bills accordingly, reducing their energy charges

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[13] SAIC, *2013 Cost of Service & Rate Study, Electric Department*, Frankfort Plant Board, Frankfort, Kentucky, May 2013, p. 8.

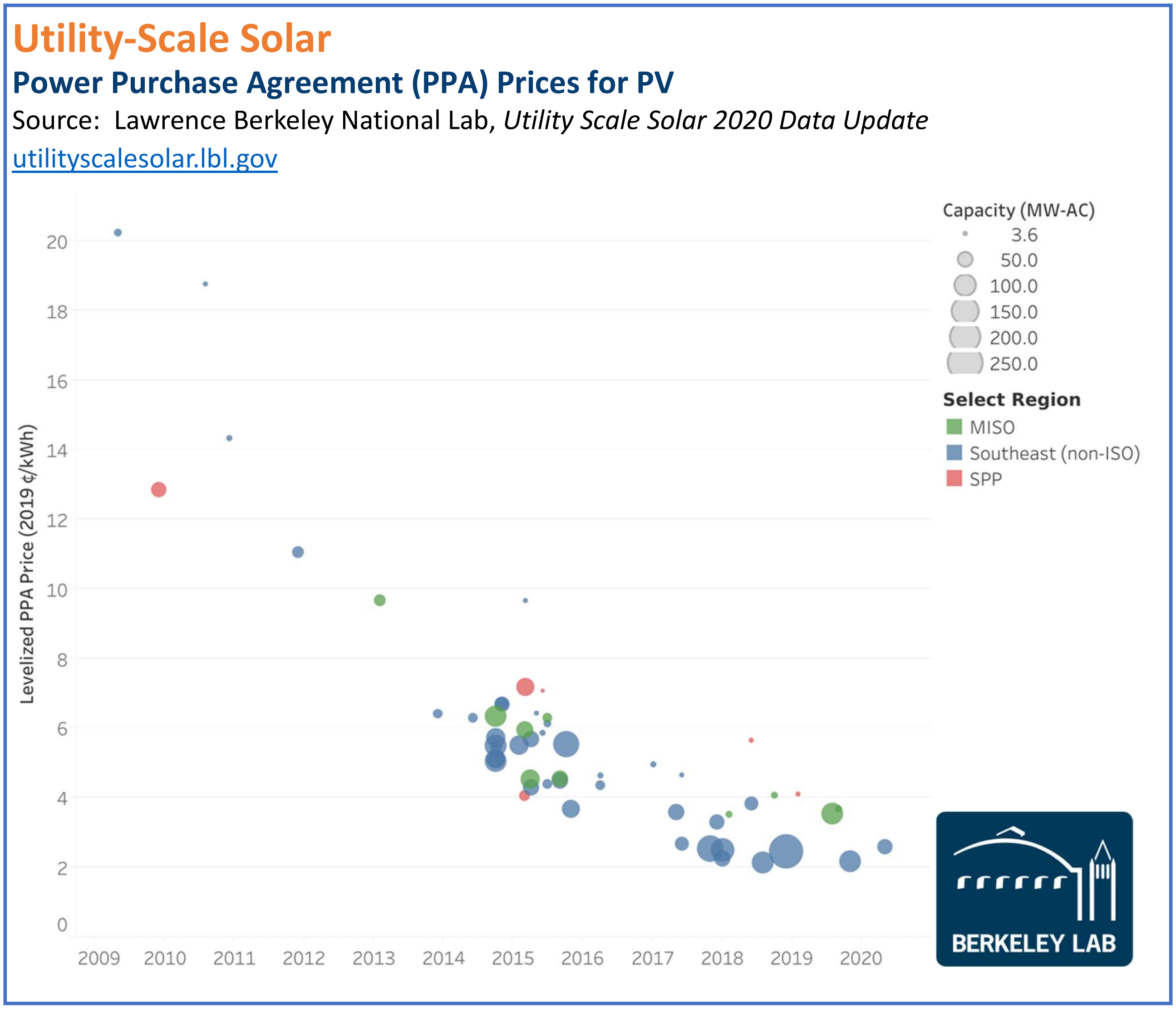
[14] Electricity data sources: City of Frankfort, Excel file of all City meters' usage July 2018 to June 2019. Franklin County, Excel file of all County Buildings' usage, October 2017 to September 2018. No electric data was available for Road Dept. or Sheriff's Office. Frankfort Independent Schools, Excel file of all FIS buildings usage, annual average for July 2015 to July 2017. Franklin County Schools, *FCS Energy Management Program Report, June 2019*, July 2018 to June 2019. Only meters served by the FPB included in the analysis (some County and Public School meters are served by other utilities).

[15] Interstate Renewable Energy Council, *Solar Power Purchase Agreements – A Toolkit for Local Governments*, March 2015, p. 3-1.

on a one-for-one kilowatt-hour (kWh) basis based on how many solar kWh are generated each month. Participants would replace energy priced at the FPB's rate (currently 8.95 cents/kWh) with solar energy priced at the PPA rate (estimated at 4.5 cents/kWh for this study).

The solar PPA price used in this study is based on Lawrence Berkeley National Laboratory's annual review of utility-scale solar trends, which reports that solar "PPA prices have fallen dramatically, in all regions of the country."[16] Figure 1 illustrates how the price of solar energy has fallen by 80% to 90% over the past ten years. Since mid-2017 a majority of solar PPA contracts have been priced below 4 cents/kWh, including in the Southeast, with a number of contracts priced below 3 cents/kWh. Considering that important factors remain unknown about the potential solar project (such as site details and interconnection costs), we selected a somewhat higher PPA price to provide a conservative estimate of cost savings for the City, County, and Schools.

Figure 1



[16] Bolinger, M., Seel, J., and Robson, D. *Utility Scale Solar: Empirical Trends in Project Technology, Cost, Performance, and PPA Pricing in the United States – 2019 Edition,* December 2019, Lawrence Berkeley National Laboratory, p. 36.

This project would build on the success of the existing demonstration project at Juniper Hill Park, in which the City of Frankfort powers its Pro Shop with a 23 kilowatt solar array that is owned, operated, and maintained by Earth Tools, Inc.[17] The City has a net metering agreement with the FPB, which credits the City at the retail rate for all solar energy supplied back to the utility. The City pays Earth Tools for the solar energy produced by the system at a rate below FPB's retail rate, resulting in an annual savings to the City of about $470.[18]

While having similarities to the existing project, the proposed 20 MW project would be much larger and would require additional provisions to be added to FPB's net metering tariff to enable virtual net metering. These provisions would allow a single solar facility to serve multiple customers and multiple meters at different locations off-site from the solar facility. This would enable the City, County, and schools to take advantage of the economies of scale of building a single large facility to serve multiple properties, compared with building numerous solar arrays on multiple buildings to serve their individual loads.

Developing a large solar field to serve local government and schools, using virtual net metering, offers many advantages over solely mounting solar panels on the roofs of public buildings. First, if you combined the roof area of every building owned by the City, County, and schools, it would not be nearly enough to meet all of their electricity needs. The potential savings would be greatly reduced if the project were limited to rooftops and traditional net metering, in which the solar panels are physically connected to the building and meter being served. Second, not all buildings are suitable for mounting solar arrays, whether due to shading, physical condition, or other factors. Third, for this project a large ground-mounted solar field provides economies of scale that offer reduced solar energy costs compared to installing smaller roof-mounted arrays on numerous buildings.

Table 1 shows the annual energy savings that the City, County, and school districts could achieve through a 20 MW solar project if each agency aimed to meet 100% of their current electricity needs with solar energy. The table shows the total annual electricity use for each agency and what their savings would be, assuming a PPA price of 4.5 cents/kWh.

The amount of savings for each agency would depend on the size of the solar facility and their savings target. This study assumes a target of 100% solar based on past electricity usage. If this project is pursued, each agency would decide how much energy to purchase via the solar PPA, based on estimates of their future electricity use.

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[17] 1,000 kilowatts= One Megawatt

[18] Development of this report has been funded by Earth Tools Inc. and its co-author, Andy McDonald, is the Director of the Earth Tools program Apogee-Climate & Energy Transitions.

Table 1 – Potential Savings for Frankfort's Public Schools and Local Governments

Estimated Energy Cost Savings from a 20 MW Solar Project Meeting 100% of the Net Annual Electricity Needs for City and County Governments and Public Schools in Frankfort, Kentucky.[19]

	Annual Electricity Use	Solar PV Capacity	Annual Savings
City of Frankfort	13,495,269 kwh	9.32 MW	**$ 600,539**
Franklin County Fiscal Court	2,549,228 kwh	1.76 MW	**$ 113,441**
Frankfort Independent Schools	1,375,715 kwh	0.95 MW	**$ 61,219**
Franklin County Schools	11,408,220 kwh	7.88 MW	**$ 507,666**
	Total Solar Facility Size	**20.0 MW**	
	Total Annual Savings for Local Taxpayers		**$ 1,282,865**

Annual Savings based on FPB retail rate of 8.95 cents/kWh and a solar PPA rate estimated at 4.5 cents/kWh.

Benefits of Expanding Access to Local Solar Energy for Municipalities and Schools

A local 20 MW solar facility would provide many benefits to the Frankfort community. Municipal utilities exist to serve their communities, rather than shareholders, and are not bound by the same regulations and investor demands that limit access to solar energy in many parts of Kentucky. This freedom can be used to provide valuable benefits for local governments, schools, the community, the utility and its ratepayers, and the wider society.

Benefits to Local Government and Schools

A collaborative solar project would provide local governments and schools with substantial long-term energy cost savings, while stabilizing electricity rates for 20 to 25 years, as shown in Table 2. Locking in low electricity rates for two decades would be of great value to each of the participating agencies. These financial savings are especially important at this time when tax revenue has been greatly reduced by the pandemic and economic crisis. The virtual net metering model with a Power Purchase Agreement enables local governments to achieve these long-term savings with no up-front costs and no operational or maintenance expenses. This also provides access to the Federal Investment Tax Credit (ITC) via the third-party private solar developer. Non-profit entities, such as local governments and schools, are not eligible for the 26% solar tax credit, but a solar PPA allows the developer to pass the tax savings on to their customers via lower pricing.

[19] For electricity data sources, see Footnote 14.

Table 2 - Annual and Cumulative Savings to Project Participants

	Annual Savings	Cumulative Savings over 20 years
City of Frankfort	$ 600,539	$ 12,010,780
Franklin County Fiscal Court	$ 113,441	$ 2,268,820
Frankfort Independent Schools	$ 61,219	$1,224,380
Franklin County Schools	$ 507,666	$ 10,153,320
Total	**$1,282,865**	**$25,657,300**

Savings based on a 20 MW facility with a solar PPA rate of 4.5 cents/kWh, assuming retail electric rates remain unchanged at 8.95 cents/kWh through 2042, each Participant contracting to serve 100% of their net electricity load with solar, and using virtual net metering.

Benefits for the Community

The coronavirus pandemic and economic crisis are challenging us to find new, innovative ways to meet the needs of our communities. Using virtual net metering to develop a local, collaborative solar project would leverage one of Frankfort's unique resources, its municipal utility, to reduce the financial strain on local governments and public schools, freeing up resources for other critical community services. The project would increase local economic development by generating $25 to $35 million of new investment in Franklin County, provide annual lease payments to the landowners where the solar facility is sited, and increase property tax values. Frankfort would stand out as a leader in economic development and clean energy, as many companies are now working to achieve zero carbon emissions and seeking access to renewable energy when siting new facilities.[20] Frankfort could serve as a model of innovation for clean energy development in Kentucky, providing valuable experience that other cities can learn from. It would join the growing number of cities that are now using and developing solar projects to meet their energy needs, such as Cincinnati, which is building a 100 MW solar facility in southeastern Ohio.[21]

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[20] The We Mean Business Coalition includes 1,499 companies that have committed to bold climate action, including companies such as 3M, American Express, and General Mills. www.wemeanbusinesscoalition.org/take-action/.

[21] The City of Cincinnati in 2019 signed a 20 year power purchase agreement for a 100 MW solar facility being developed 40 miles east of the City. City government will use 35 MW of the power and the remaining 65 MW will be made available to City residents via their Electric Aggregation Program. *Cincinnati to Construct Nation's Largest City-Led Solar Project*, November 21, 2019, Office of the Mayor, City of Cincinnati, https://www.cincinnati-oh.gov/mayor/news/cincinnati-to-construct-nation-s-largest-city-led-solar-project/. Pforzheimer, A., Ridlington, E., Sonnega, B., and Searson, E., *Shining Cities 2020: The Top US Cities for Solar Energy*, May 2020, Frontier Group and Environment America Research & Policy Center.

Henderson Municipal Power & Light is a recent example of a small Kentucky city making a major investment in solar power. In July 2020, HMP&L announced a contract with Community Energy for a 50 MW solar facility to be built in Henderson County. As reported in Business Wire, Community Energy's Executive Vice President Joel Thomas said, "We believe solar farms can be more than just a source of low-cost electricity. This solar project will also generate economic growth through new jobs, local spending, long-term tax revenues, and recurring income for the landowners who are hosting the facility. During this time when our country is battling economic headwinds, we are thrilled to partner with HMP&L to put this project on a path to delivering these economic benefits."[22]

Benefits for Society

The urgency of reducing carbon emissions in response to climate change is now widely recognized, with calls for action coming from scientists, churches, corporations, US military leaders, and millions of citizens.[23] A 2018 report from the Intergovernmental Panel on Climate Change warns that global carbon emissions must peak and rapidly decline during this decade if we are to limit the Earth's warming to 1.5°C and minimize the catastrophic harm from climate change. [24] The City of Frankfort is one of over 1,000 cities that have signed the US Mayors Agreement for Climate Protection.[25] A 20 MW solar facility would reduce Franklin County's carbon emissions by 23,288 tons per year.[26] This would be a significant step towards honoring that agreement and a clear sign of leadership on the climate issue.

Extensive research shows that reducing carbon emissions also has direct benefits to public health by reducing other air pollutants from fossil fuels that contribute to asthma, heart disease, respiratory disorders, stroke, and other illnesses.[27] By helping Frankfort reduce its reliance on coal and natural gas, a collaborative solar project would benefit the health of all Kentuckians. The US

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[22] *Community Energy Announces Agreement with Henderson Municipal Power & Light (HMP&L) Enabling 50 Megawatts of New Solar Power in Western Kentucky,* Businesswire, July 30, 2020, https://www.businesswire.com/news/home/20200730005282/en/Community-Energy-Announces-Agreement-Henderson-Municipal-Power

[23] U.S. Department of Defense, *National Security Implications of Climate-Related Risks and a Changing Climate*, July 23, 2015. US Army War College, *Implications of Climate Change for the U.S. Army*, 2019. Citizen's Climate Lobby, *Faith Based Statements on Climate Change*, June 2012. We Mean Business Coalition, https://www.wemeanbusinesscoalition.org/about/. Carlisle, M., *'This Is an Emergency. Our House Is on Fire.' Greta Thunberg Addresses New York's Climate Strike*, Time Magazine, September 20, 2019, https://time.com/5682318/nyc-global-climate-strike/. Easterly, C., *Dozens Participate in Frankfort Climate Change Strike*, State-Journal, September 20, 2019.

[24] Intergovernmental Panel on Climate Change, *Global Warming of 1.5° C: A Special Report*, 2018.

[25] Mayors Climate Protection Center, US Conference of Mayors, https://www.usmayors.org/mayors-climate-protection-center/.

[26] The CO2 emissions rate for the FPB's wholesale power supplier is 1.602 pounds CO2/kWh, according to the KYMEA's "September 2, 2020 Community IRP Focus Group Feedback, KYMEA, p. 6."

[27] Fossil Fuels & Health, Webpage for the Harvard T.H. Chan School of Public Health, C-Change Center for Climate, Health, and the Global Environment https://www.hsph.harvard.edu/c-change/subtopics/fossil-fuels-health/

Environmental Protection Agency has estimated the public health benefits of energy efficiency and renewable energy, based on the type of fuel displaced and the region. For projects in the Southeastern US, solar energy is estimated to provide a benefit ranging from 1.64 cents to 4.15 cents per kWh.[28] For a 20 MW solar facility, this would amount to a public health benefit of $476,813 to $1,206,570. "The goal of these estimates is to create credible and comparable values (i.e., factors) that stakeholders, such as state and local governments, EE/RE project developers, and nongovernmental organizations (NGOs), can use to estimate health benefits of EE/RE projects, programs, and policies."[29]

Municipal Utility and Ratepayers

As detailed in the next section of this report, the FPB would realize significant benefits from a 20 MW solar facility on its distribution grid.

- Reduced peak demand and transmission charges.
- Reduced exposure to power market price fluctuations.
- Reduced exposure to transmission price increases.
- Mitigating financial risk by reducing customer load and KYMEA's need for new wholesale power contracts for natural gas or coal generation.
- Reducing exposure to future regulations on carbon emissions, whether via a carbon tax or by other means. With the Federal government's renewed commitment to aggressive action on climate change, a price on carbon has become likely in the coming years. At $40 per ton, the emissions reductions from this project would have an annual value of about $932,000.[30]

Virtual net metering would allow the FPB to realize these benefits with no investment risk, capital expenditures, or debt financing, since the solar facility would be financed, developed, owned, operated, and maintained by an independent private solar developer. Costs to the FPB related to project development, including interconnection studies and infrastructure improvements for the solar facilities, would be paid by the solar developer.

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[28] *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report*, US Environmental Protection Agency, July 2019, p.3. The EPA analysis used lower and higher estimates for the health impacts of air pollution and evaluated the economic costs under two discount rates, 3% and 7%. This resulted in a range of benefits per kWh.

[29] Ibid, p. 5.

[30] According to the World Bank, the High-Level Commission on Carbon Pricing has identified the range of carbon prices needed to achieve the global temperature goals of the Paris Climate Agreement to be $40 - $80/ton CO2 in 2020 and $50 - $100/ton CO2 by 2030. Source: https://carbonpricingdashboard.worldbank.org/what-carbon-pricing. The oil company BP is one of hundreds of corporations now accounting for an internal price of carbon. BP presently prices carbon at $40 per ton and is forecasting $100 per ton by 2030. As of January 2021 the price of carbon in European markets was about $40 per ton. See Shankleman, J. *Bank of England Tells Banks to Brace for Sky-High Carbon Price*, Bloomberg.com, January 14, 2021.

To calculate the value of the avoided CO2 emissions resulting from the 20 MW solar project:

[(1.602 pounds CO2/kWH) x (29,073,975 kWh/year)] x [1 ton/2000 pounds] x [$40/ton] = $931,530/year

The proposed solar facility would be an example of distributed generation, in which the power source is located on the distribution system, relatively close to the load. This contrasts with central generation, in which a few large power plants transmit power great distances to distant loads. A significant amount of energy is lost in the transmission wires that connect a centralized power generator to the end-user. Having generation located on the distribution grid, close to the end users reduces those line losses and improves the efficiency of the power grid. It can also increase the resilience of the local grid, especially if combined with battery storage. Furthermore, installing generation on the distribution system reduces reliance on the transmission grid and FPB's exposure to transmission price increases.

Assessing the Value to the FPB of a 20 MW Solar Project with Virtual Net Metering

A 20 MW solar project using virtual net metering would reduce FPB's peak demand charges and provide other valuable benefits to the utility. Table 4 provides the results of an analysis of the projected performance of a 20 MW solar project located on the FPB's distribution system.[31] The authors of this report performed seven simulations using local weather data and FPB load data for the seven most recent years for which data was available. The analysis found that a 20 MW solar facility would reliably reduce the FPB's peak demand charges and energy costs, resulting in cost savings approaching $1.8 million per year.

Table 4 - Annual Peak Demand, Transmission, & Energy Cost Savings to FPB from a 20 MW Solar Facility

Simulation Year*	Customer PV Generation (kWh)	NC Demand Reduction (KW)	NC Demand Cost Savings	CP Trans. Cost Savings**	Energy Cost Savings	Total Savings
2010	29,978,940	58,530	$ 911,839	n/a	$ 740,540	**$ 1,652,379**
2012	30,971,174	65,159	$ 1,015,112	n/a	$ 765,050	**$ 1,780,162**
2013	29,067,124	52,626	$ 819,860	n/a	$ 718,016	**$ 1,537,877**
2014	29,513,235	59,124	$ 921,093	n/a	$ 729,036	**$ 1,650,129**
2016	29,916,812	42,316	$ 659,241	n/a	$ 739,005	**$ 1,398,246**
2018	26,982,715	49,050	$ 764,150	n/a	$ 666,527	**$ 1,430,677**
FY20 Load - TMY	29,073,975	57,653	$ 898,176	$ 169,448	$ 718,185	**$ 1,785,809**

**Annual simulations performed using actual load and weather data for the years indicated, plus an "average weather" dataset (the Typical Meteorological Year or TMY), used for Fiscal Year 2020 (FY20). Years 2011, 2015, and 2017 excluded due to missing FPB load data.*

*** FPB's wholesale energy costs include several peak demand charges. "Coincident Peak (CP)" cost savings are only shown for FY20 because CP demand data was unavailable for the other years.*

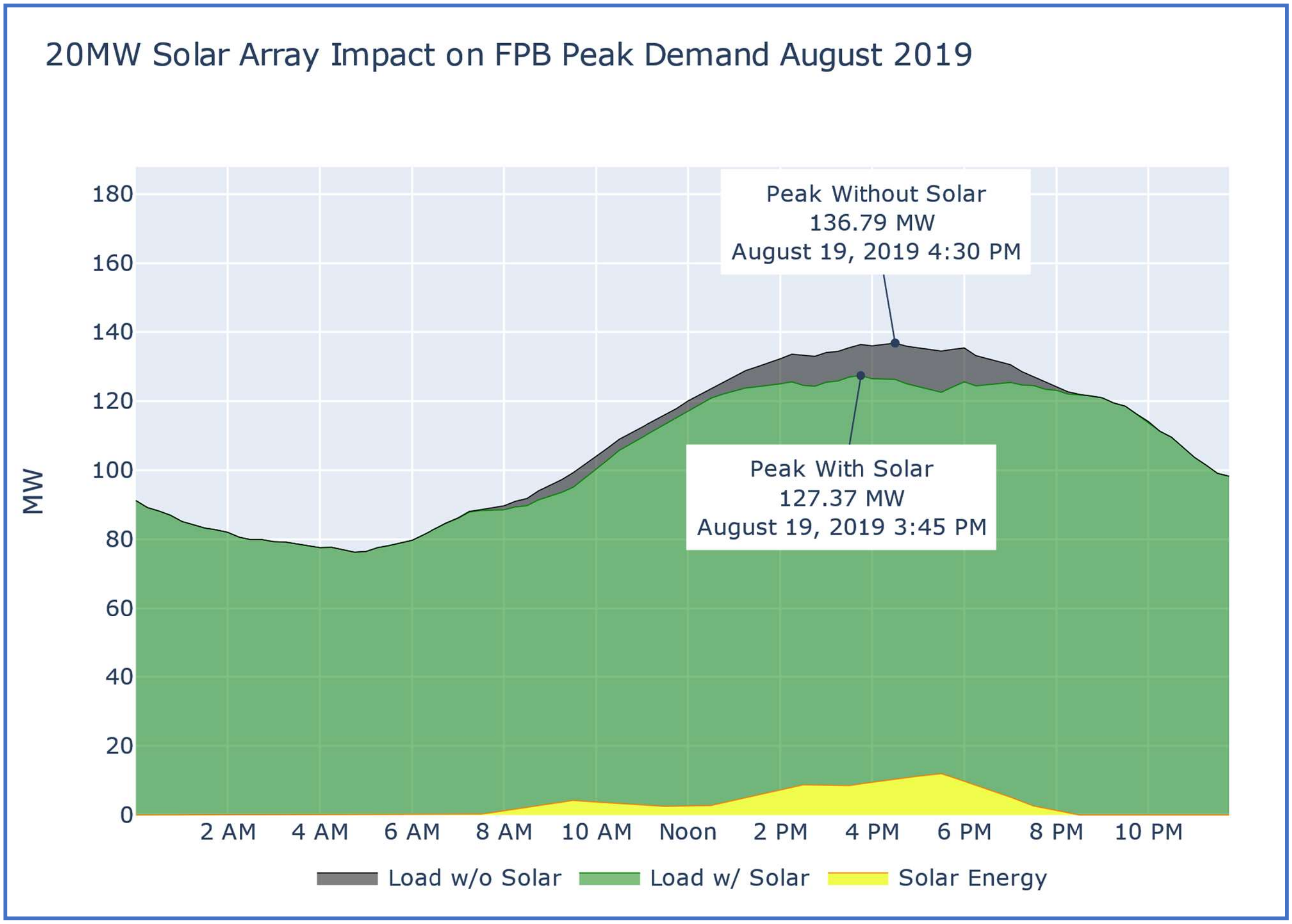
The cost savings in Table 4 are based on FPB's wholesale energy rates from the KYMEA as of July 1, 2020. This includes 'Energy' charges based on kWh usage; 'Non-Coincident (NC) Demand' and 'MISO Transmission' charges based on the highest hourly KW demand each month; and 'Coincident Peak (CP) Demand' charges based on "LGE/KU's transmission system peak hour during the

[31] Simulations were based on a 20 MW dc solar array with a 16 MW ac inverter. See Appendix B for further discussion of the methodology used for the analysis.

monthly billing period."[32] Data for LGE/KU's Coincident Peak hour was only available for Fiscal Year 2020 (July 1, 2019 through June 30, 2020), which is why CP Transmission Cost Savings were only analyzed for FY20.

Figure 2 demonstrates the impact a 20 MW solar facility would have on the FPB's monthly peak demand, using August 2019 as an example. The graph shows how August 2019's peak demand would have been reduced from 136.79 MW to 127.37 MW, saving the FPB $160,965 for that month. Appendix B details the methodology used to analyze FPB's peak demand savings and includes the monthly solar energy production, peak demand savings, and demand curves for FY20.

Figure 2



By allowing the City, County, and public schools to generate their own power, this project would reduce the FPB's kilowatt-hour sales and revenue. Table 5 shows the change to FPB wholesale power costs and the revenue impact of a 20 MW solar project for FY20. Total wholesale power cost savings would be $1,785,809 while FPB revenue would decline by $2,602,121 due to reduced electricity sales. Balancing cost savings and reduced revenue results in a net reduction in FPB revenue of $816,312.

[32] *KYMEA All Requirements Project – Wholesale Power Rate Schedule*, effective July 1, 2020.

However, the reduced revenue would be offset by the multiple other benefits provided by the project, not least of which is the potential value of reduced carbon emissions. A $40 per ton price on carbon (the current price in European markets) would translate into about $932,000 in additional savings to the FPB from a local 20 MW solar project. [33]

Table 5 - Wholesale Power Cost Savings and Revenue Impact to FPB from 20MW Solar Project for Fiscal Year 2020	
Peak Demand (kW) Cost Savings (NC Demand + Transmission) + (CP Transmission)	$ 1,067,624
Wholesale Energy (kWh) Cost Savings	$ 718,185
Total Wholesale Power Cost Savings	$ 1,785,809
Reduced Revenue due to Solar Project	$ (2,602,121)
Net Reduced Revenue (without carbon pricing)	$ (816,312)
Additional Savings if Carbon Pricing Implemented at $40 per ton CO_2	$ 931,530

The impact on FPB revenue needs to be considered in the context of the project's overall benefits and costs, as well as FPB's total revenue requirements. Since 2013, FPB's margin on electricity sales has risen from 1% to 10%, while operations and maintenance (O&M) costs have held steady at 18% and wholesale power costs have declined from 82% to 72% of total revenue.[34] Margin is extra revenue that remains after meeting all of the company's operating costs. It is used "to fund normal capital additions and maintain working capital reserves as well as other obligations to the City," as stated in the FPB *2013 Cost of Service and Rate Study.* [35]

The FY20 budget shows total Electric Department revenue for FY20 equal to $62.5 million, with a margin of $6.7 million. FPB cash reserves are projected to grow from $38 million in FY20 to $68 million by FY24.[36] In sum, the FPB is financially healthy and generates ample revenue to cover its operating costs plus build a significant cash reserve. This places FPB in a good position to make choices that will provide long-term benefits to their customers and community. In light of the FPB's financial position and the overall benefits offered by this project, there are clear reasons for the utility to support its development.

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[33] See Footnote 30.

[34] SAIC, *2013 Cost of Service & Rate Study, Electric Department,* Frankfort Plant Board, Frankfort, Kentucky, p.14; and *Budget and Financial Plan, Fiscal Years Beginning 2019-2020*, Frankfort Plant Board, pp.6-7.

[35] Ibid*,* p.14*.*

[36] *Budget and Financial Plan, Fiscal Years Beginning 2019-2020*, Frankfort Plant Board, pp.6-7.

Table 5 – Summary of Benefits of a 20MW Solar Project in Franklin County, Kentucky
Including financial savings and other benefits to the utility, its customers, community, and society.

UTILITY & RATEPAYER BENEFITS	
Reducing wholesale power costs.	
Peak Demand & Transmission Cost Savings:	$ 1 million+ per year
Wholesale Energy Cost Savings:	$ 700,000+ per year
Hedging against future carbon pricing.	
Value to FPB of reducing 23,288 tons CO2 per year at $40 per ton:	$932,000 per year[37]
Mitigating financial risk in FPB's wholesale power supply by reducing load and pressure to invest in new coal or gas power contracts.	
Capacity Value for KYMEA of Distributed Solar Generation (approx.):	50%[38]
Reducing exposure to power market price fluctuations and transmission price increases.	
COMMUNITY & SOCIETAL BENEFITS	
Reducing operational costs, stabilizing rates, and increasing financial security for local public agencies.	
City of Frankfort's Savings:	$ 600,539 per year
Franklin County Fiscal Court's Savings:	$ 113,441 per year
Frankfort Independent Schools' Savings:	$ 61,219 per year
Franklin County Schools' Savings:	$ 507,666 per year
Advancing City of Frankfort's commitment to the Mayor's Agreement for Climate Protection.	
Advancing Franklin County and Public Schools' commitments to environmental stewardship.	
Public health benefits of improving air and water quality:	$532,000 to $1,200,000 per year[39]
Reduced CO_2 emissions:	23,288 tons CO_2 per year
Local economic development.	
New investment into Franklin County:	$25 to $35 million[40]
Lease payments to landowners and increasing property tax value at solar sites.	

[37] See Footnote 30.
[38] See discussion of the capacity value of solar on p. 21 of this report and Footnote 45.
[39] See Footnote 28.
[40] See Footnote 9.

Benefits to KYMEA Members – The Advantages of Reducing Customer Loads

By reducing customer loads and peak demand, distributed energy resources and demand-side management can alleviate the KYMEA's need to purchase new power supplies, reducing costs and risk for its municipal members and their customers. This report shows how local solar projects on the distribution grid, using virtual net metering, can meaningfully reduce monthly peak demand, reducing wholesale power costs for the local utilities and the need for new capacity for the KYMEA. This is especially relevant at this time because the KYMEA is currently conducting an Integrated Resource Plan (IRP) and evaluating how to serve its customers' future needs.[41] The KYMEA has a 100 MW coal contract due to expire in 2022 and is reducing a natural gas peaking power contract by 30 MW in 2023. Through the IRP process the KYMEA will assess how much of this 130 MW of reduced capacity it needs to replace.[42] As reported in KYMEA board and IRP meetings, the KYMEA has considered additional coal or natural gas generation to replace the expiring contracts and meet projected future needs.[43] However, both coal and natural gas generation carry significant financial risks for the KYMEA's members and their ratepayers.

Solar facilities located in its member communities would help the KYMEA meet its customer load requirements and reduce the need for new capacity. In *A REGULATOR'S GUIDEBOOK: Calculating the Benefits and Costs of Distributed Solar Generation*, Keyes and Rabago state, "DSG [Distributed solar generation] installations are predictable and should be included in utility forecasts of capacity needs, so DSG should be credited with a capacity value upon interconnection."[44] Based on the KYMEA's board meeting reports, the agency uses a capacity value of about 50% for its own Ashwood solar development, a 53.75 MW solar facility being developed in Western Kentucky.[45]

Enabling the KYMEA to avoid new investments in natural gas or coal contracts has significant value to each KYMEA member. Throughout the United States coal generation is becoming increasingly uneconomical. Utilities large and small continue to shut down their coal plants in favor of less-costly alternatives – namely natural gas, wind, solar, battery storage, and demand-side management. While the cost of fueling, operating, and maintaining coal-fired power plants continues

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[41] Buresh, D., *Integrated Resource Planning Schedule*, April 23, 2020, KYMEA, slideshow.
[42] nFront Consulting, *Presentation to the Frankfort Plant Board Regarding The KyMEA All Requirements Project Proposed Arrangements for the Supply of All Requirements Service Commencing May 1, 2019,* August 16, 2016, p.9. See also *KYMEA Short Term Action Plan Discussion*, December 16, 2020, KYMEA, slideshow, p.22.
[43] Buresh, D., *Integrated Resource Planning Schedule*, April 23, 2020, KYMEA, slideshow, pp.7-10.
[44] Keyes, J. and Rabago, K., *A REGULATOR'S GUIDEBOOK: Calculating the Benefits and Costs of Distributed Solar Generation, Interstate Renewable Energy Council, Inc., 2013, p.3.*
[45] Buresh, D., "KYMEA President & CEO Report," *KYMEA Board Packet*, January 28, 2021, slideshow, p.33 of Board Packet.

to rise, the costs for wind and solar have been steeply declining for decades, a trend expected to continue.[46]

We see this trend in Kentucky, where hundreds of MW of coal generation have been retired in the past two years by Owensboro Municipal Utilities and Henderson Power and Light.[47] In Indiana, the "Northern Indiana Public Service Co. (NIPSCO) presented analysis for its 2018 Integrated Resource Plan (IRP), finding it can save customers more than $4 billion over 30 years by moving from 65% coal today to 15% coal in 2023 and eliminating the resource by 2028.... To replace retiring coal, NIPSCO found that a portfolio of solar, storage, wind and demand management is the most cost effective, along with a small amount of market purchases from the Midcontinent ISO."[48]

Natural gas generation, meanwhile, is facing stiff competition from wind, solar, and battery storage, along with the risks of carbon and other environmental regulation. Cheap natural gas has had a major hand in driving coal out of the power market, but market forces and the increasing urgency to reduce carbon emissions places natural gas at a long-term disadvantage relative to wind, solar, and battery storage. This is now leading some utilities to transition directly from coal to renewables plus battery storage, without building any new natural gas generation. Utilities in three states announced such plans in June 2020.[49]

These trends point to significant risks to the KYMEA's members from any new investments in coal or natural gas generation, whether that be new construction or contracts with existing power plants. However, strategies that reduce demand can eliminate the need to purchase additional supplies. For the KYMEA, whose All-Requirements members will be responsible for all investments and contracts made to supply their needs, avoiding new capital investments and contract commitments could represent the least-cost, lowest-risk option. Investor-owned utilities like KU/LG&E earn returns for their shareholders based on their capital investments, even if those investments are not the least-cost option for ratepayers. Municipal utilities, by contrast, exist to serve their customers and have no shareholders driving them to make capital investments. This gives them the freedom to choose demand-side options, like distributed solar generation and net metering, which can reduce costs and risk for local residents and the utility.

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[46] Gimon, E., O'Boyle, M., Clack, C.T.M., and McKee, S., *The Coal Cost Crossover: Economic Viability of Existing Coal Compared to New Local Wind and Solar Resources*, March 2019, Energy Innovation and Vibrant Clean Energy. Wamsted, D., Feaster, S., Cates, K., *US Coal Outlook 2020: Market Trends Pushing Industry Ever Closer to a Reckoning: Competition, Financing, Consolidation, Muni/Co-op Preferences, Export Markets*, March 2020, Institute for Energy Economics and Financial Analysis.

[47] *Integrated Resource Plan Report, Prepared for Henderson Municipal Power & Light*, April 19, 2018, GDS Associates, p. 34. Lawrence, K., *OMU Stops Producing Electricity After 119 Years*, May 30, 2020, Messenger-Inquirer.

[48] Bade, G., *Even in Indiana, New Renewables Are Cheaper Than Existing Coal Plants*, October 25, 2018, Utility Dive.

[49] Wamsted, D., *Utilities Are Now Skipping the Gas 'Bridge' in Transition from Coal to Renewables*, July 1, 2020, Institute for Energy Economics and Financial Analysis, https://ieefa.org/ieefa-u-s-utilities-are-now-skipping-the-gas-bridge-in-transition-from-coal-to-renewables/ .

An Opportunity for All KYMEA Member Communities

Each of the KYMEA's communities have opportunities to develop distributed generation, virtual net metering, and other demand-side management strategies. Reducing utility costs is important for any local government or school and frees up resources for other essential services. The scale of the savings may vary by community, depending on factors such as retail electric rates and energy use, but it is likely that local governments and schools in all KYMEA communities could reduce their utility costs with virtual net metering.

Likewise, each of the KYMEA's All-Requirements members have the potential to reduce their peak demand charges using virtual net metering, as the analysis in this report illustrates. The same analysis performed for Frankfort could be performed for other KYMEA members to determine the potential to reduce peak demand for the utility and energy costs for local governments and public schools.

The KYMEA exists to serve its member communities. As stated in its vision and mission statement: "We shall positively impact our communities as a trusted leader of power supply and energy-related services...Through collaboration and operational excellence, we provide reliable, affordable, and sustainable energy services to the communities we serve."[50] This should encourage KYMEA support for policies that enable local schools and public agencies to reduce their energy costs, carbon emissions, and environmental and public health impacts, while increasing local resilience and economic development. Furthermore, the FPB contract with KYMEA explicitly states, "nothing in this contract shall interfere with a Member's authority to implement demand response, net metering, or energy efficiency programs."[51]

[50] https://www.kymea.org/vision-mission-values/.
[51] *Kentucky Municipal Energy Agency All Requirements Power Sales Contract*, August 2016, Section 2(g), p.9.

Environmental and Community Considerations for Large Solar Projects

Large ground-mounted solar facilities have become increasingly common throughout the United States. There are currently at least nine solar facilities in Kentucky that are 1 MW or larger in size (see Table 4), with numerous larger facilities now in development. This includes an 86 MW facility, which the KYMEA is participating in, planned for Western Kentucky.[52] These facilities can range in size from several acres to thousands of acres. The 20 MW facility proposed in this report would occupy approximately 150 acres. Depending on the available sites, it could be built as two or three smaller facilities on different sites. If multiple sites are used, it is possible that the project could include a roof-mounted system, if a very large, flat roof were available in the right location. We expect that once a Request for Proposals is released, developers will identify potential sites for the project as they prepare their proposals.

Table 4 – Large Solar PV Projects in Kentucky One Megawatt and Larger[53]

Montaplast, Frankfort	1.0 MW
L'Oreal Solar, Florence	1.1 MW
Walton 1 Solar Facility	2.0 MW
Walton 2 Solar Facility	2.0 MW
Bowling Green Solar Project	2.1 MW
Fort Knox Army Base	2.1 MW
Crittenden Solar Facility	2.7 MW
Cooperative Solar One, EKPC, Clark County	8.5 MW
E.W. Brown Solar Project (LG&E/KU), Danville	10.0 MW

As with other forms of development, it is important that solar developers protect agricultural and natural lands, water quality, local ecosystems, and the community. There is a growing body of research and experience with how to develop solar facilities to conserve, enhance, and restore local ecosystems. Pollinator-friendly site development is one strategy in which the solar site is "planted with deep-rooted native flowers and grasses that capture and filter storm water, build topsoil, and provide abundant and healthy food for bees and other insects that provide critical services to our food and agricultural systems."[54] Multiple states have established science-based standards defining what constitutes "pollinator-friendly" solar development and model ordinances are now available.[55]

Solar developments that focus on land conservation can enhance the local ecosystem and adjacent agricultural land throughout the life of the solar project and leave the land in better

[52] https://www.kymea.org/power-resources/ashwood-solar-i/.
[53] *Kentucky Energy Profile - 7th Edition- 2019*, Office of Energy Policy, Kentucky Energy and Environment Cabinet, p. 62. McCaney, K., *Fort Knox Locks Down Energy Independence*, April 2, 2015, https://defensesystems.com/articles/2015/04/02/fort-knox-energy-independence-net-zero.aspx
[54] The Center for Pollinators in Energy, https://fresh-energy.org/beeslovesolar/, accessed June 18, 2020.
[55] Ibid.

condition after 25 years. Integrating agriculture with large solar facilities is gaining popularity, with developers in the Southeast now working with local farmers to raise livestock such as sheep and chickens among the solar panels on these sites. [56] For the Frankfort collaborative solar project, land management requirements can be included within the RFP during the procurement process, to ensure that the community's land preservation and conservation goals are achieved.[57]

Photo courtesy of Trent Hendricks, Cabriejo Ranch, Denmark, Tennessee

[56] Siegner, K., Wentzell, S., Urrutia, M., Mann, W., and Kennan, H., *Maximizing Land Use Benefits From Utility Scale Solar: A Cost-Benefit Analysis of Pollinator Friendly Solar in Minnesota*, December 2019, Yale Center for Business and the Environment. To learn about integrating agriculture with solar developments, see https://regenerativeenergy.org/ and https://www.sunraisedfarms.com/.

[57] Sample ordinance and procurement language for pollinator-friendly solar development can be found at: https://fresh-energy.org/beeslovesolar/sample-ordinance-and-procurement-language/. The Kentucky Resources Council has developed a *Model Solar Zoning Ordinance* to assist localities to adopt provisions to regulate the siting of solar facilities in their communities. It is available at https://www.kyrc.org/our-work/model-ordinances.

Conclusion and Next Steps

The Frankfort community has an opportunity unavailable to most cities in Kentucky – the ability to dramatically reduce operating costs for local governments and schools, while reducing carbon emissions, improving air quality and public health, and increasing economic development and local resilience. Frankfort's municipal electric utility, the FPB, has the power to enact policies that would enable the City of Frankfort, Franklin County Fiscal Court, Frankfort Independent Schools, and Franklin County Schools to invest in a 20 MW solar project to supply up to 100% of the electricity for these four public agencies. The policies to enable this project are straightforward but not available in most parts of Kentucky, due to state regulations and the policies of the state's regulated utilities. Having a municipally owned utility, which is not regulated by the Kentucky Public Service Commission and is governed by local residents, gives Frankfort the opportunity to make a major investment in solar energy and take advantage of the many benefits this would provide.

This report explains how a 20 MW solar facility could supply up to 100% of the electricity needs of local government and public schools in Frankfort and Franklin County, saving local taxpayers over $1.2 million per year. If FPB were to make virtual net metering available, these public agencies could enter into Power Purchase Agreements with a third-party private solar developer. The developer would finance, develop, own, operate, and maintain the solar facility for the duration of the PPA, with no capital costs or debt for the Participating agencies or the FPB.

The proposed solar project would have numerous benefits for the Frankfort community and the FPB. This report provides a detailed analysis of the peak demand savings the project would provide to the FPB, amounting to about $1.8 million in reduced wholesale power costs annually. Although the project would result in reduced revenue for the utility, its ample benefits demonstrate the overall value of the project to the FPB, its customers, and community.

The report also addresses the significance of the project for the FPB's wholesale electricity provider, the KYMEA, and its member municipal utilities. KYMEA's other member communities have the same opportunity that Frankfort has, to reduce energy costs for their local schools and government agencies while reducing peak demand and transmission costs for their municipal utilities.

Further, this report describes how the KYMEA and all of its members can benefit from distributed solar by reducing the need for investments in additional generating capacity. At a time when the KYMEA is actively considering whether to invest in additional coal or natural gas generation, the FPB has a unique window of opportunity to avoid these risks. The report discusses the risks associated with coal and natural gas investments at this time of energy transition, with ever-increasing concerns about the environmental and health impacts of fossil fuels and the rapid decline in the cost of renewable energy and battery storage. Distributed energy resources on its members' systems, such as a 20 MW solar facility in Frankfort, are a low-cost, low-risk alternative to new coal or natural gas contracts.

Next Steps for Project Implementation

- The City of Frankfort, Franklin County Fiscal Court, Franklin County Schools, and Frankfort Independent Schools would develop an agreement to cooperate on a Collaborative Solar Project.
- The FPB would approve a virtual net metering tariff for local governments and public schools.
- The City, County, and public schools would issue a Request for Proposals (RFP) for a Collaborative Solar Project.

Recommendations for the KYMEA and its Member Communities

- The communities served by the KYMEA should evaluate the benefits and feasibility of developing solar projects to serve their local governments and public schools and assess the value of local solar facilities for their local utilities.
- The KYMEA should include analysis of distributed solar generation within their current Integrated Resource Planning process. The load forecasts used by the KYMEA in their IRP should include scenarios that include, at minimum, one 20 MW solar facility in Frankfort, and another scenario including distributed solar facilities in each of KYMEA's other member communities sized to serve the loads for local governments and schools.

Appendix A
Virtual Net Metering
A Tool for Reducing Costs for Local Governments and Public Schools

Net metering is one of the key policies that has provided millions of utility customers throughout the United States the freedom to choose solar energy. Net metering laws and their specific provisions vary from state to state. [58] In Kentucky there are statutes governing net metering which apply to the regulated utilities but not to municipal utilities, which are not regulated by the Kentucky Public Service Commission. The members of the Kentucky Municipal Energy Agency, in particular, are free to offer net metering and define its terms.[59] This creates an opportunity for local communities to enact supportive policies to enable local governments, schools, and other customers to use and benefit from solar energy.[60]

Net metering enables electric customers with a solar PV system to connect their PV system to the utility grid and receive kilowatt-hour (kWh) credits for the solar energy they produce, offsetting their usage from the utility and reducing their utility bills. Net meterer PV systems allow the flow of electricity in both directions, to and from the utility. When it's sunny, the customer can use the solar energy directly, avoiding buying power from the grid. If the PV system produces more energy than the customer needs, the excess flows back to the utility, providing a credit to the customer. Consumption and generation of electricity are traditionally valued at the same rate, the retail rate paid by the customer. At the end of each billing cycle, the customer's account is billed or credited for the net consumption that month.

Under basic net metering, a single solar PV system is physically connected to the utility grid behind a single customer electric meter. "While this arrangement can work well for some electric customers and on-site generation systems (including local government systems), many customer sites that are well-suited for PV installations are not suitable to be net-metered, or vice versa. For instance, a local government may want to offset load in an older building that cannot support the weight of a PV system, or on a building with a roof that will need to be replaced before the life of the PV system has expired. A building with significant electricity load might have too much shading or might not have enough roof space to site a large enough system to significantly offset the on-site electricity consumption.

[58] Barnes, C., *Aggregate Net Metering- Opportunities for Local Governments*, 2013, North Carolina Solar Center, p.4.
[59] *Kentucky Municipal Energy Agency All Requirements Power Sales Contract*, August 2016, section 3(g), p. 9.
[60] Kentucky Public Service Commission, *Staff Opinion 2012-010*, May 18, 2012, p. 1. The opinion identifies Kentucky statute which establishes the PSC's jurisdiction and the exemption from regulation for cities which operate their own electric utility. "…under KRS 278.040(2), "The jurisdiction of the Commission shall extend to all utilities in this state,'' and "The commission shall have exclusive jurisdiction over the regulation of rates and service of utilities . . , ." Under KRS 278.010(3), a "utility" is defined as: 'any person except. . . for purposes of paragraphs (a), (b), (c), (d), and (9 of this subsection, a city, who owns, controls, operates, or manages any facility used or to be used for or in connection with: (a) The generation, production, transmission, or distribution of electricity to or for the public, for compensation, for lights, heat, power, or other uses.'"

Alternatively, the best site for a PV system might be located on a capped landfill, a brownfield, or on undeveloped land where there is currently little or no electricity demand."[61]

Aggregate net metering enables a single PV system to serve multiple meters and buildings, even when they are in different locations, and can make solar energy much more valuable to local governments and schools. For example, where meters can be aggregated for net metering, a city with a large brownfield site that has no electrical load could build a solar array on the brownfield and use the energy generated to offset consumption at several downtown office buildings whose roofs might not be adequate for hosting a solar array. [62]

Virtual net metering goes beyond meter aggregation to allow multiple customers to benefit from a single PV system, and allows the system to be owned by a third party. This enables public agencies to benefit from renewable energy incentives such as the federal Investment Tax Credit. By partnering with a private third-party developer, the developer can claim the tax incentives and pass the savings on to the public agency in the form of lower solar energy prices. Virtual net metering also enables multiple customers to work together to develop a single, larger project, using economies of scale to achieve lower pricing.[63] The laws of Kentucky do not require regulated utilities to provide virtual net metering, but as of 2017 at least 13 other states had policies enabling virtual net metering.[64]

Another significant barrier to public agencies interested in using solar energy are low caps on the size of net metering systems. The state of Kentucky requires utilities to allow net metering up to 45 kilowatts (KW), a threshold that most utilities treat as a cap. Considering that a single high school can require more than 1,000 KW of solar PV to offset all their electrical needs, [65] a 45 KW cap greatly limits the value solar can provide to local governments and schools (as well as many commercial and industrial customers). Of the 40 states that require utilities to provide net metering, about half allow net metering up to one or two megawatts (MW), Massachusetts allows it up to 10 MW, New Mexico authorizes net metering up to 80 MW, and Ohio and New Jersey have no capacity limits. (One MW equals 1,000 KW).[66]

Municipal utilities that have the power to set their own energy policies can use net metering to help local governments and schools reduce costs while meeting environmental, public health, and economic development goals. Removing arbitrary caps on net metering system sizes would enable customers to meet much more of their energy needs with on-site generation. Enabling virtual net metering would allow energy savings at an even larger scale, providing numerous benefits to local governments, schools, and their communities.

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[61] Barnes, *Aggregate Net Metering*, p. 4.
[62] Ibid, p. 5.
[63] Ibid, p. 8.
[64] Cleveland, M., *State Policies for Shared Renewable Energy*, 11-21-2017, National Conference of State Legislatures, https://www.ncsl.org/research/energy/state-policies-for-shared-renewable-energy.aspx. States offering virtual net metering listed under "Legislative Activity" tab.
[65] *Franklin County Schools, Energy Management Package*, June 2019, provides electricity usage for each county school.
[66] *State Net Metering Policies*, NCSL National Conference of State Legislatures, November 20, 2017, https://www.ncsl.org/research/energy/net-metering-policy-overview-and-state-legislative-updates.aspx. North Carolina Clean Energy Technology Center, DSIRE Insight: Net Metering – www.dsireusa.org, June 2020, https://s3.amazonaws.com/ncsolarcen-prod/wp-content/uploads/2020/06/DSIRE_Net_Metering_June2020.pdf.

Appendix B

Methodology for Calculating Peak Demand Savings for the Frankfort Plant Board from a 20 MW Solar Facility

The FPB purchases all of its wholesale power from the Kentucky Municipal Energy Agency (KYMEA), a non-profit wholesale energy supplier created by a group of Kentucky municipal electric utilities in 2015. The FPB's monthly power costs include an energy charge, based on the total number of kilowatt-hours (kWh) used, and demand and transmission charges, based on the monthly peak power demand, measured in kilowatts (KW). The FPB's main meters measure its kilowatt demand in 15-minute intervals and the highest average KW demand during a 60-minute period sets the demand charge for that month.[67] In the summertime, peak demand usually occurs during the late afternoon when temperatures are high and customer air conditioners are running at full load. In the winter, peak demand often occurs in the early morning, when people are getting ready for work, heating up their homes, and taking showers. Many utilities and large commercial customers employ "demand conservation measures" or "peak shaving" strategies to reduce their peak demand and associated costs. For example, many electric cooperatives pay their customers to install devices on their air conditioners to regulate when they operate during times of peak demand.[68]

Solar PV systems located within the FPB's distribution system (whether on rooftops or ground-mounted arrays) can reduce the FPB's peak demand by producing power on sunny afternoons when customer demand is highest. Locally produced solar power reduces the FPB's need to purchase power from their wholesale supplier. When the FPB's peak demand goes down, so do its costs from the KYMEA. While solar power varies with weather conditions, our analysis shows that local solar facilities can reliably reduce the FPB's peak demand, providing substantial cost savings to the utility.

This study used a solar PV simulation model to analyze the effects a local solar facility would have on the FPB's monthly peak demand and wholesale power costs. Solar PV system performance can be reliably modelled using simulation software which accounts for various factors that impact system performance, such as equipment specifications, shading, and solar radiation levels in every hour of every day of the year. Such software is widely used for solar project development and can provide "bankable" results which can be used to secure project financing.[69]

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[67] *Kentucky Municipal Energy Agency All Requirements Project – Wholesale Power Rate Schedule*, Effective July 1, 2020, p.3.

[68] Simple Saver Program, Bluegrass Energy Cooperative, https://bgenergy.com/simplesaver, accessed 6-30-2020.

[69] "Comparison of Bankable Energy Simulation Software Used in the Australian Solar Industry," April 8, 2020, GSES online article, https://www.gses.com.au/comparison-of-bankable-energy-simulation-software-used-in-the-australian-solar-industry/.

For this analysis we used Helioscope PV design software to model the PV system and Energy Toolbase to analyze the impact on the FPB's peak demand. Helioscope has been validated against the real-world performance of operational PV systems and has been found to produce results within +/-1% of the industry-standard simulation program PVSyst.[70] Using weather and solar radiation data specific to Frankfort, Kentucky, we first simulated performance of a 5 MW solar facility in every hour of the year. We then used Energy Toolbase to scale up the PV system to 20 MW and refine the solar production data into 15-minute intervals. We then integrated the solar production data with FPB's actual billing demand to determine the impact of solar generation on the FPB's monthly peak demand.[71]

The PV design used in the base Helioscope model used 13,888 Trina Solar PV modules (model TSM-DE14H (II)360) to produce a 5 MW array. Two Sungrow 2000 watt inverters (model SG2000-MV) were used. This design was scaled up using Energy Toolbase to create a 20MW dc (direct current) array with 16 MW ac (alternating current) inverters. The modelled array was ground-mounted using a single axis tracker with rows running north-south.

Simulations were performed for the seven most recent years for which FPB load data was available. Six simulations used actual weather data for Frankfort for the given year and one simulation was performed using "Typical Meteorological Year" (TMY) weather data. TMY data is based on averaging actual weather readings at a specific location over a span of about 30 years. [72]

The most recent year modelled was Fiscal Year 2020 (July 1, 2019 through June 30, 2020), using TMY weather data. The analysis for all simulations used KYMEA's wholesale power rates in effect as of July 1, 2020 (see Table B-1).[73] Table B-2 shows the monthly peak demand reductions and cost savings for FY2020.

Table B-1 – FPB Wholesale Power Rates from the KYMEA as of July 1, 2020

Demand (Non-coincident peak)	$14.044 per KW
MISO Transmission (Non-coincident peak)	$1.535 per KW
Energy	$0.024702 per kWh
LGE/KU Transmission (Coincident Peak)	$2.7736 per KW

[70] Guittet, Darice L. and Freeman, Janine M., *Validation of Photovoltaic Modeling Tool HelioScope Against Measured Data*, November 2018, National Renewable Energy Laboratory, Technical Report NREL/TP-6A20-72155. See also *Performance Model Evaluation*, October 1, 2013, BEW Engineering, https://help.helioscope.com/article/95-bankability-documents#math.

[71] Energy Toolbase converts Helioscope's hourly interval data into 15-minute interval data with the following process, as stated on the ETB website: "We disaggregate 60-min data down into 15-min intervals using a curve smoothing polynomial regression, which is a widely used statistical process in prediction and forecasting. Note: this process will never create a higher value than the highest value contained in the dataset. This is important when creating 15-minute intervals for kW demand, because we don't want to assume there was a higher kW interval that what was contained in the 60-minute data." https://www.energytoolbase.com/Etb#helpCenter/section/18/topic/1113

[72] Source of annual solar radiation data: National Solar Radiation Database, https://nsrdb.nrel.gov/.

[73] *Kentucky Municipal Energy Agency All Requirements Project – Wholesale Power Rate Schedule*, Effective July 1, 2020. FPB's wholesale energy costs from the KYMEA include Energy charges, based on kWh usage; Non-Coincident (NC) demand and MISO Transmission charges based on "the highest average KW demand during a 60-minute period ending on a clock hour" during a monthly billing period; and Coincident Peak (CP) demand charges based on "LGE/KU's transmission system peak hour during the monthly billing period."

Table B-2 - Monthly Peak Demand, Transmission, & Energy Savings to FPB from 20 MW Solar Project, Using Fiscal Year 2020 Load and TMY Weather Data.

Month	Solar PV Generation (kWh)	Max Demand Before Solar (kW)	Max Demand After Solar (kW)	NC Demand Reduction (KW)	NC Demand + MISO Trans Savings	CP LGE/KU Trans Savings	Energy Savings	FPB TOTAL SAVINGS*
January	1,329,565	114,509	113,591	**918**	$ 14,302	$ 413	$ 32,843	**$ 47,557**
Feb.	1,705,336	112,392	108,363	**4,029**	$ 62,768	$ 14,007	$ 42,125	**$ 118,900**
March	2,405,848	90,216	87,339	**2,877**	$ 44,821	$ -	$ 59,429	**$ 104,250**
April	2,943,262	78,624	73,515	**5,109**	$ 79,593	$ 99	$ 72,704	**$ 152,397**
May	3,409,664	104,126	100,345	**3,781**	$ 58,904	$ 42,258	$ 84,226	**$ 185,388**
June	3,336,649	121,565	110,203	**11,362**	$177,009	$ 29,337	$ 82,422	**$ 288,768**
July	3,445,093	132,451	126,438	**6,013**	$ 93,677	$ 9,815	$ 85,101	**$ 188,593**
August	3,244,030	136,786	127,372	**9,414**	$146,661	$ 14,304	$ 80,134	**$ 241,099**
Sept.	2,612,098	131,040	125,871	**5,169**	$ 80,528	$ 23,267	$ 64,524	**$ 168,319**
October	2,097,826	129,427	121,397	**8,030**	$125,099	$ 34,823	$ 51,820	**$ 211,743**
Nov.	1,414,132	111,485	110,654	**831**	$ 12,946	$ 959	$ 34,932	**$ 48,837**
Dec.	1,130,472	111,989	111,869	**120**	$ 1,869	$ 166	$ 27,925	**$ 29,961**
Total	**29,073,975**	**1,374,610**	**1,316,957**	**57,653**	**$ 898,176**	**$ 169,448**	**$ 718,185**	**$ 1,785,809**

Table B-3 shows the annual results for all seven simulations. We modelled six years using actual weather data to show the impact solar would have had under the actual weather conditions in those years. The FY20 simulation was performed using TMY data because it provides a more accurate projection of future solar PV system performance than data from any one specific year, by smoothing out extremes and showing how a system would operate under average conditions.[74] (The years 2011, 2015, and 2017 were not modelled because FPB billing data was missing for one or more months in each of these years).

Each of these models show the solar PV facility providing the FPB substantial peak demand savings, ranging from 42,316 to 65,159 KW per year. Total wholesale power cost savings would be on the order of $1,750,000 per year. This analysis shows that despite daily and seasonal variability, solar facilities on the distribution grid can provide dependable, significant reductions in peak demand and significant cost savings for the FPB.

These findings point to the value of enabling the City of Frankfort, Franklin County, Frankfort Independent Schools, and Franklin County Schools to use virtual net metering to develop a 20 MW solar facility.

[74] TMY Weather File Primer, Helioscope Help Docs, https://help.helioscope.com/article/59-tmy-weather-file-primer.

Table B-3 - Annual Simulation Results of Peak Demand, Transmission, & Energy Savings to FPB from 20 MW Solar Facility

Simulation Year*	Customer PV Generation (kWh)	NC Demand Reduction (KW)	NC Demand Cost Savings	CP LGE/KU Trans. Cost Savings**	Energy Cost Savings	Total Savings
2010	29,978,940	58,530	$ 911,839	n/a	$ 740,540	**$ 1,652,379**
2012	30,971,174	65,159	$ 1,015,112	n/a	$ 765,050	**$ 1,780,162**
2013	29,067,124	52,626	$ 819,860	n/a	$ 718,016	**$ 1,537,877**
2014	29,513,235	59,124	$ 921,093	n/a	$ 729,036	**$ 1,650,129**
2016	29,916,812	42,316	$ 659,241	n/a	$ 739,005	**$ 1,398,246**
2018	26,982,715	49,050	$ 764,150	n/a	$ 666,527	**$ 1,430,677**
FY19/20 Load - TMY	29,073,975	57,653	$ 898,176	$ 169,448	$ 718,185	**$ 1,785,809**

**Annual simulations performed using actual load and weather data for the years indicated, plus an "average weather" dataset (the Typical Meteorological Year or TMY), used for Fiscal Year2020. Years 2011, 2015, and 2017 excluded due to missing FPB load data.*

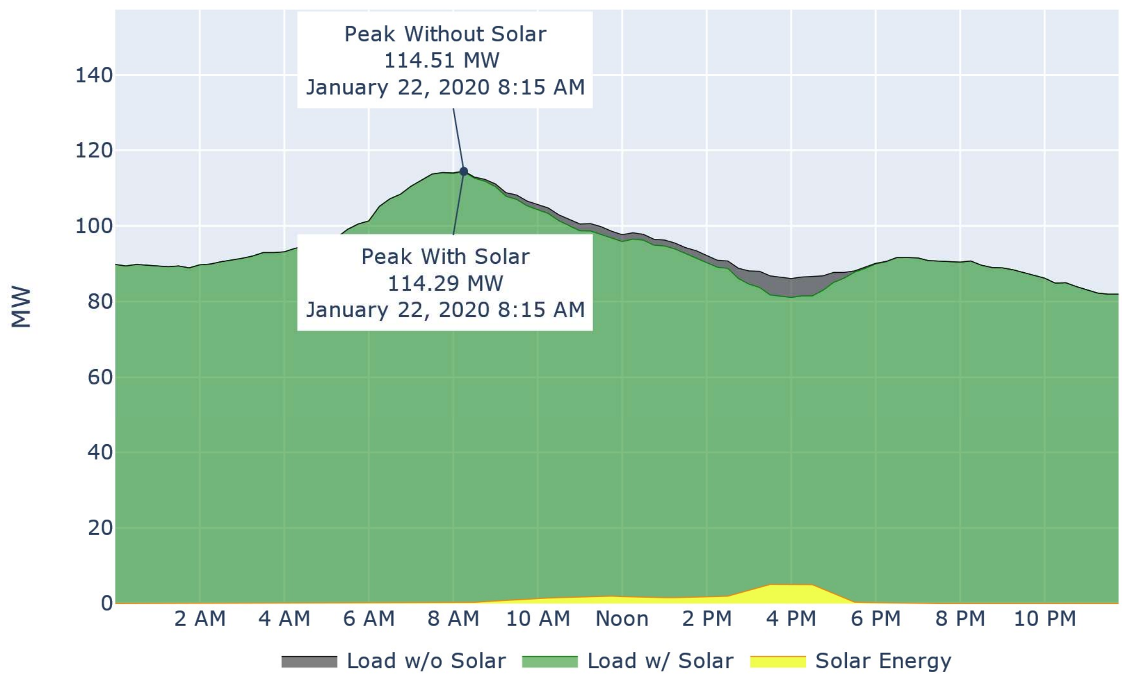
*** FPB's wholesale energy costs include several peak demand charges. "Coincident Peak (CP)" cost savings are only shown for FY19/20 because CP demand data was unavailable for the other years.* [75]

Monthly Peak Demand Curves and Solar Array Impact on FPB Peak Demand

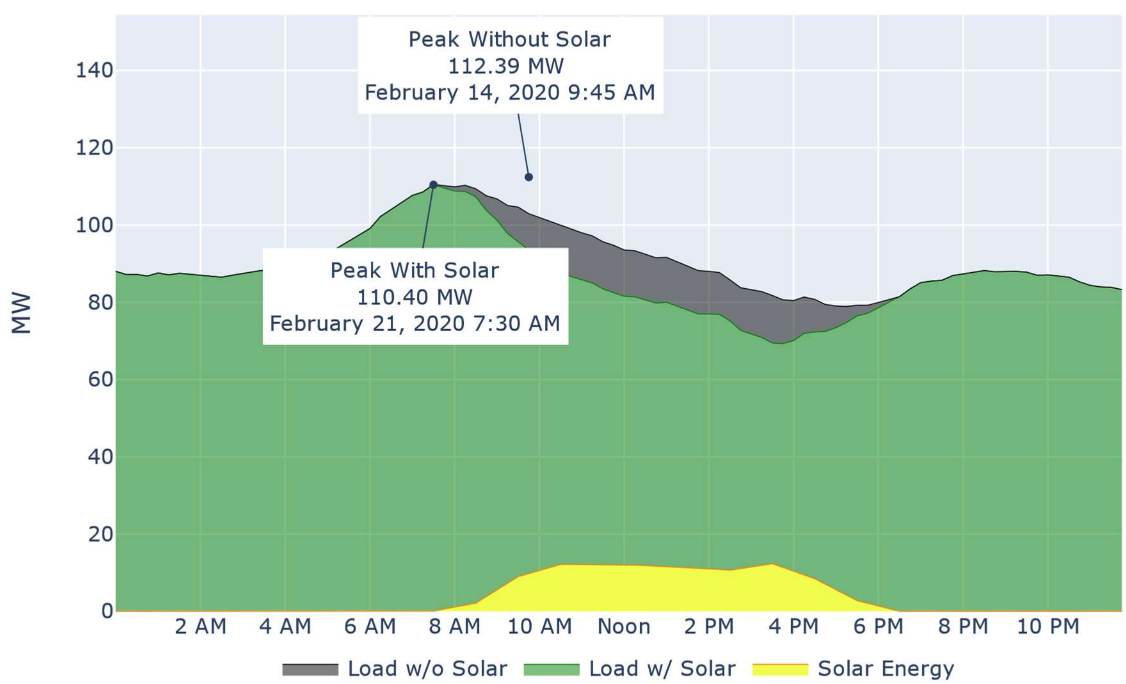
The following graphs show FPB's monthly load curves for Fiscal Year 2020 and the impact on peak demand of a 20 MW solar facility located on the distribution system.

[75] Source of data for LGE/KU's Coincident Peak hour was FPB's monthly invoices from the KYMEA for July 2019 through June 2020. This CP data was only available for FY19/20, which is why CP Transmission Demand Cost Savings were only analyzed for FY19/20.

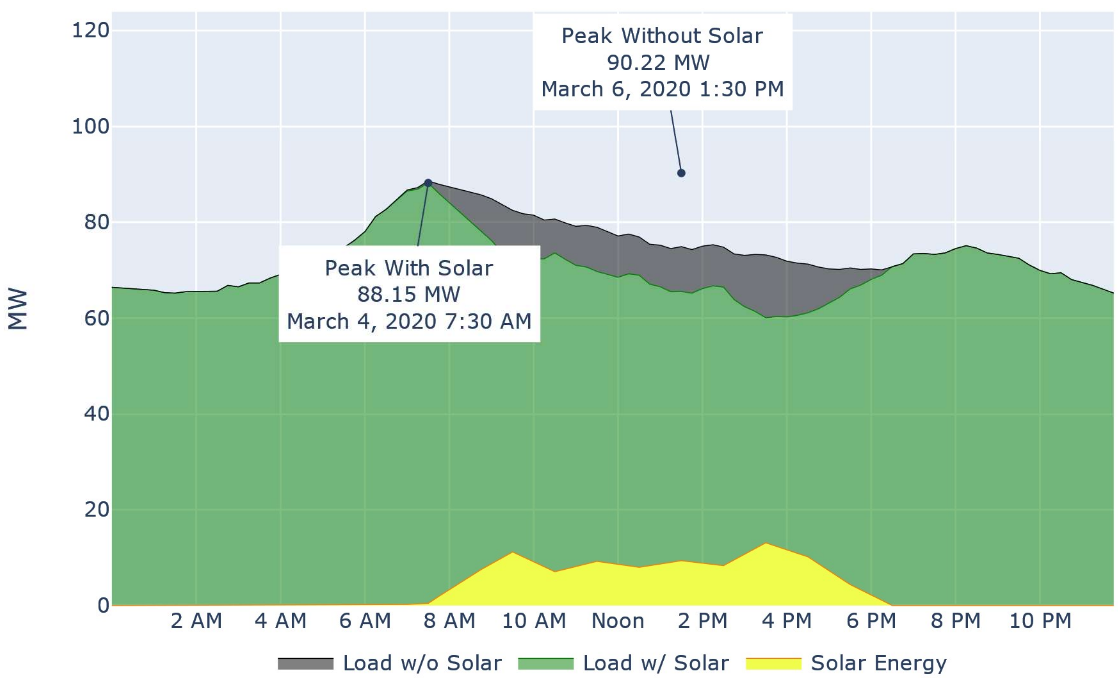
20MW Solar Array Impact on FPB Peak Demand January 2020



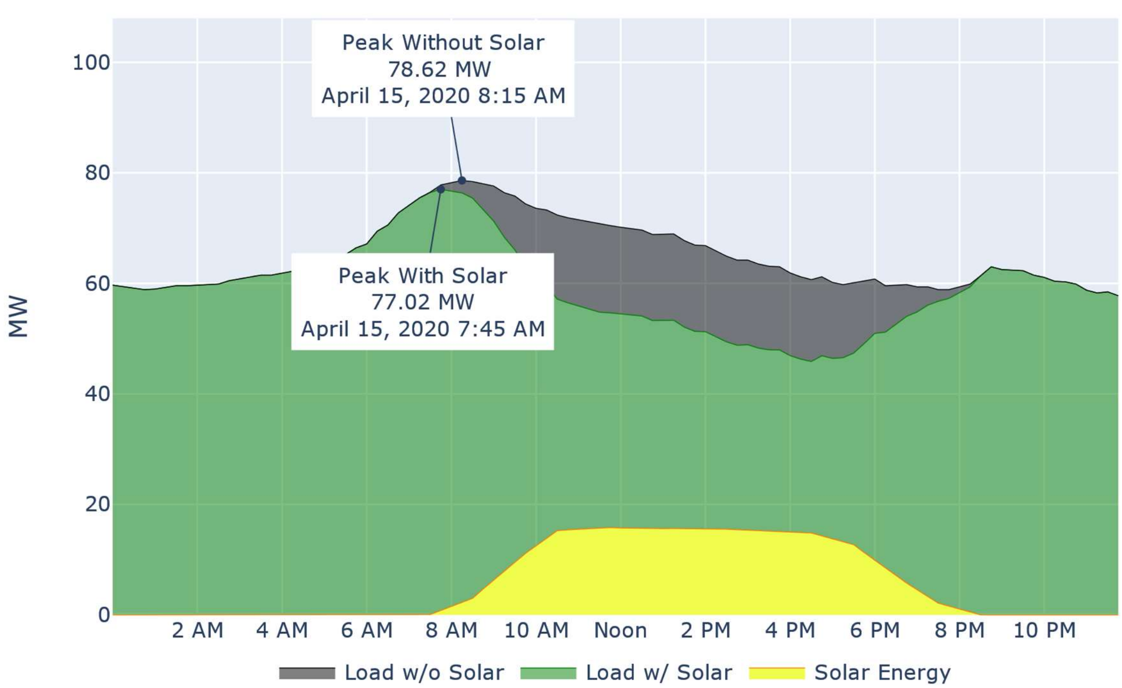
20MW Solar Array Impact on FPB Peak Demand February 2020



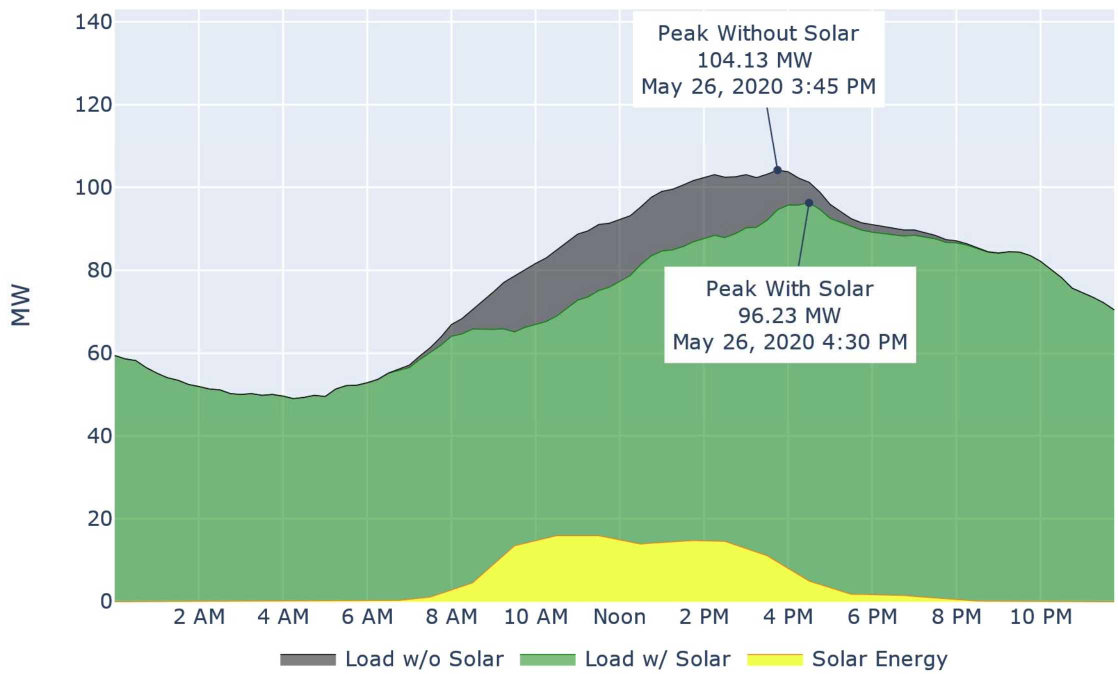
20MW Solar Array Impact on FPB Peak Demand March 2020



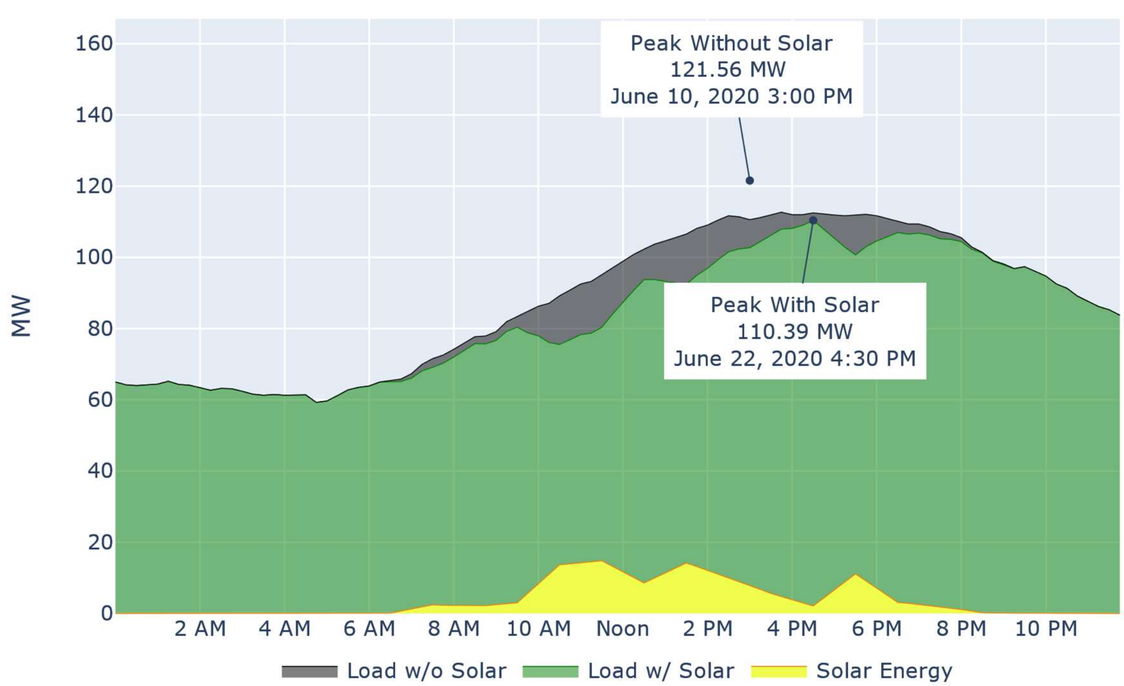
20MW Solar Array Impact on FPB Peak Demand April 2020



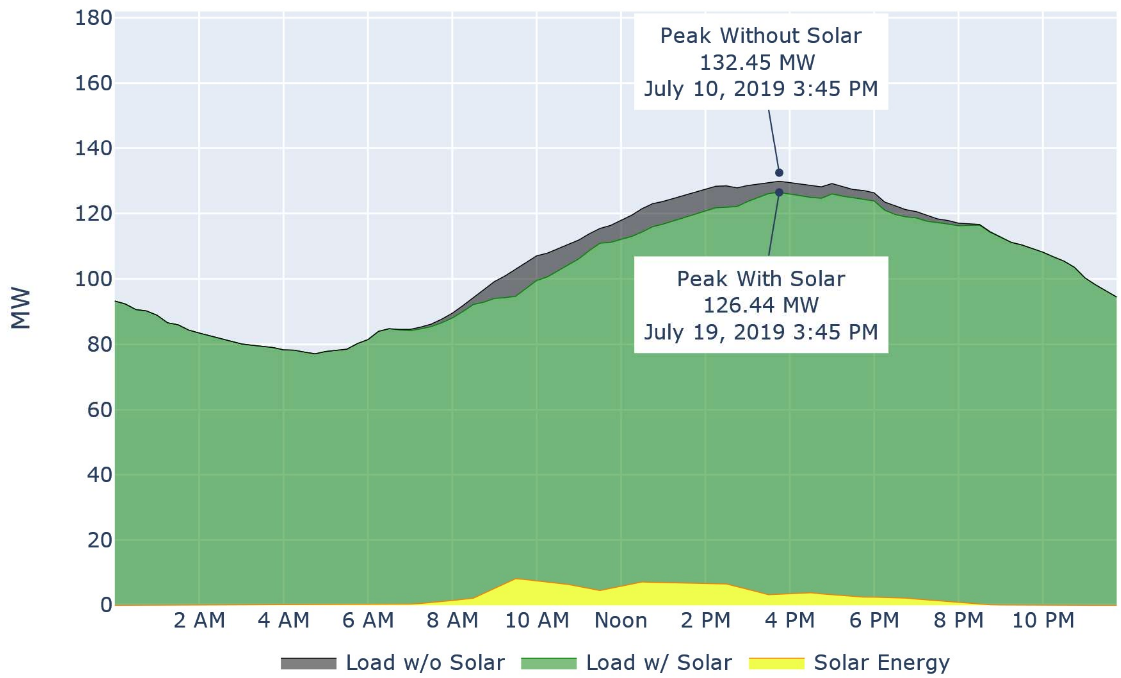
20MW Solar Array Impact on FPB Peak Demand May 2020



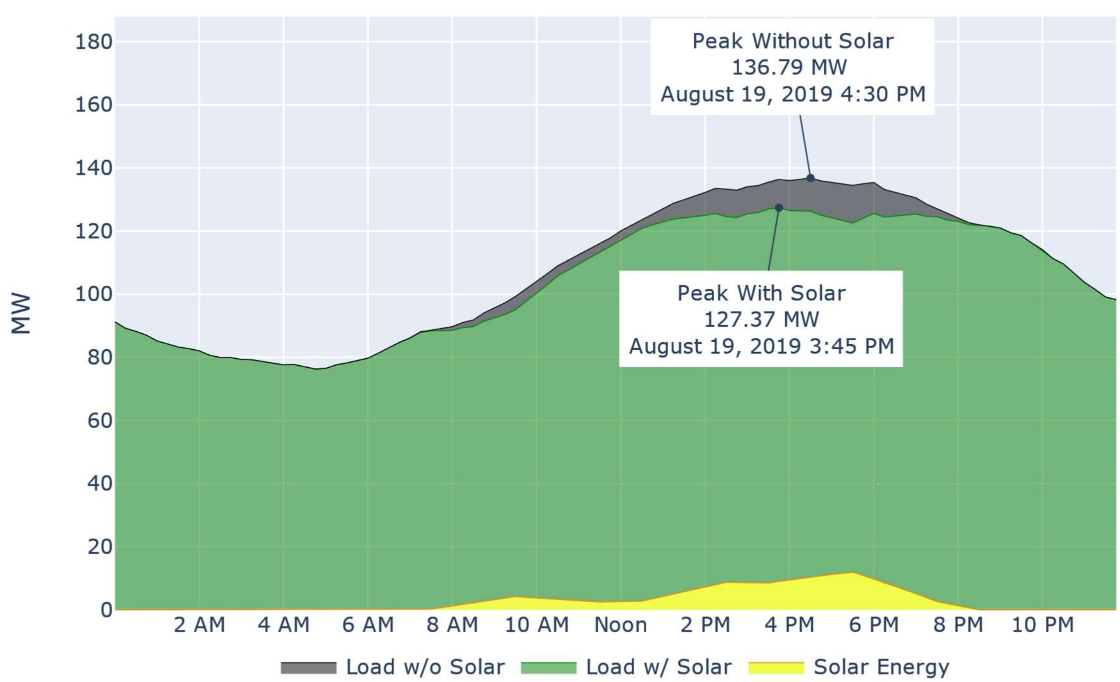
20MW Solar Array Impact on FPB Peak Demand June 2020

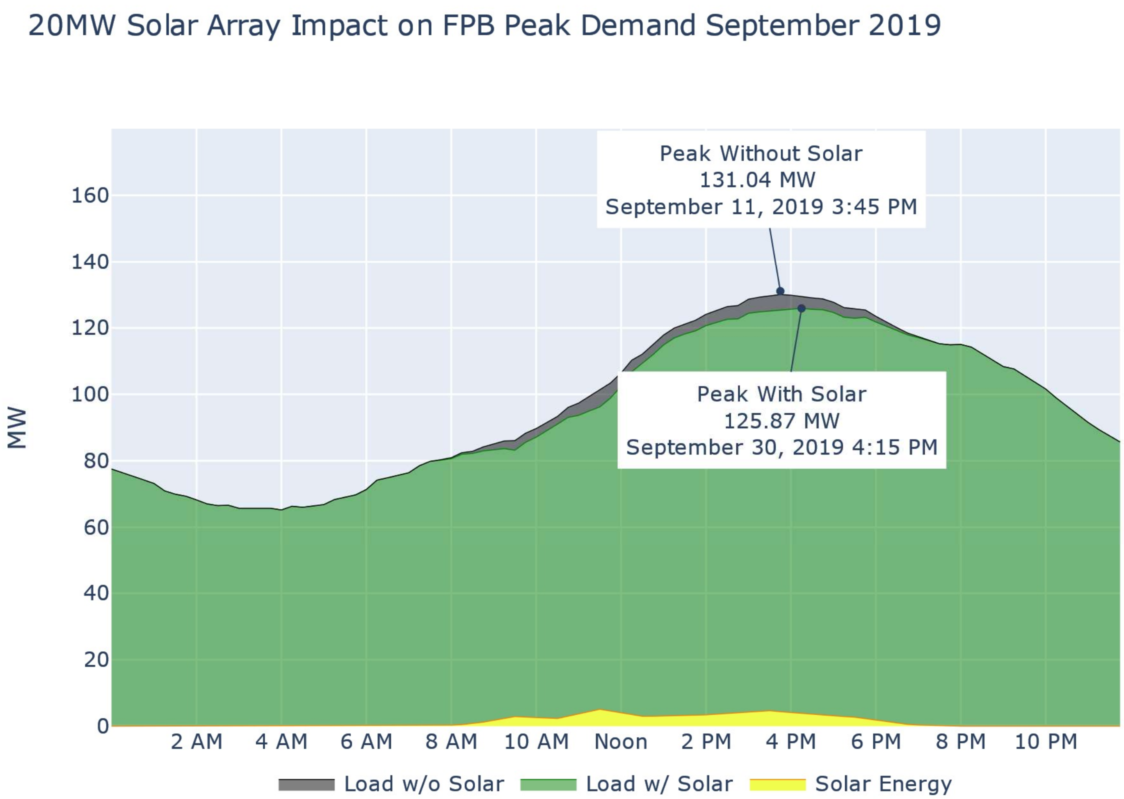


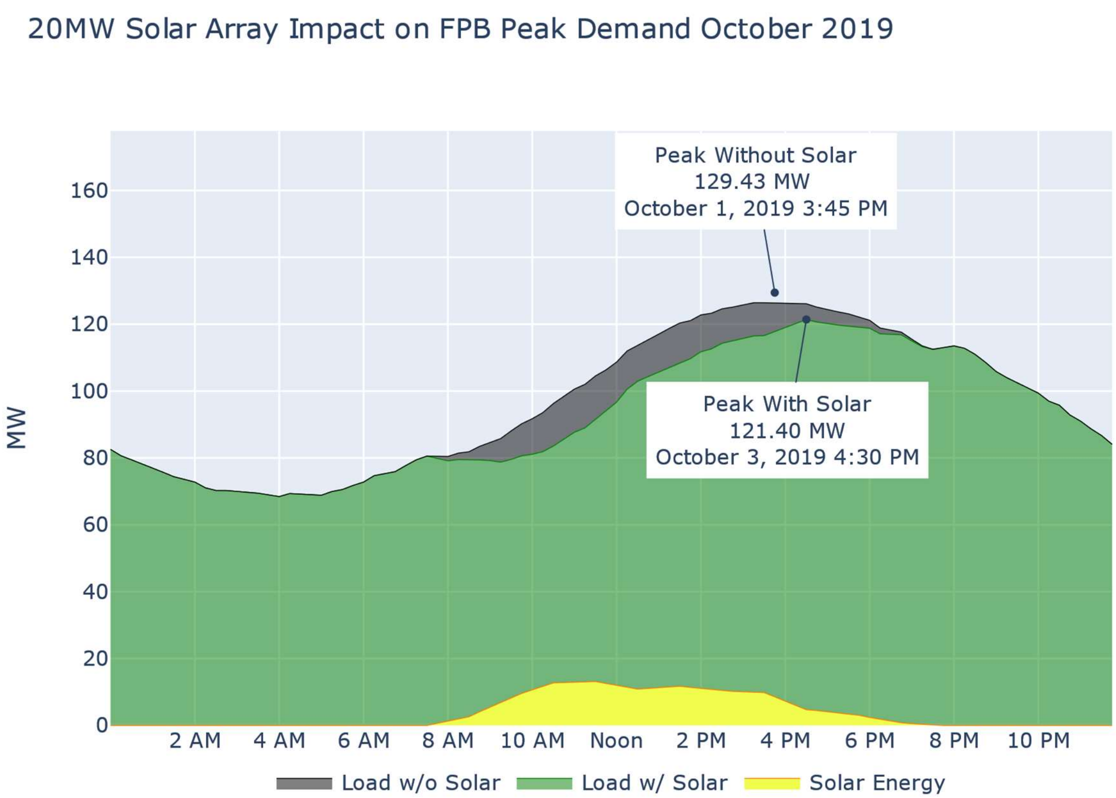
20MW Solar Array Impact on FPB Peak Demand July 2019



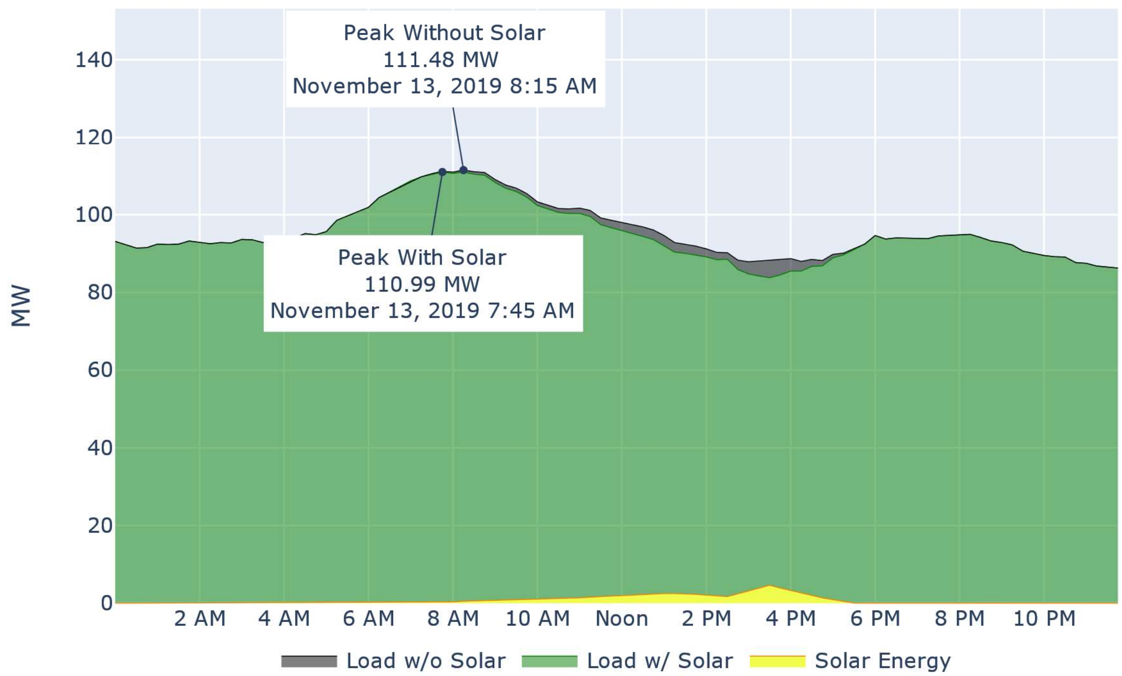
20MW Solar Array Impact on FPB Peak Demand August 2019




20MW Solar Array Impact on FPB Peak Demand September 2019
Peak Without Solar
131.04 MW
September 11, 2019 3:45 PM
Peak With Solar
125.87 MW
September 30, 2019 4:15 PM
MW
160
140
120
100
80
60
40
20
0
2 AM
4 AM
6 AM
8 AM
10 AM
Noon
2 PM
4 PM
6 PM
8 PM
10 PM
Load w/o Solar
Load w/ Solar
Solar Energy


20MW Solar Array Impact on FPB Peak Demand October 2019
Peak Without Solar
129.43 MW
October 1, 2019 3:45 PM
Peak With Solar
121.40 MW
October 3, 2019 4:30 PM
MW
160
140
120
100
80
60
40
20
0
2 AM
4 AM
6 AM
8 AM
10 AM
Noon
2 PM
4 PM
6 PM
8 PM
10 PM
Load w/o Solar
Load w/ Solar
Solar Energy

20MW Solar Array Impact on FPB Peak Demand November 2019



20MW Solar Array Impact on FPB Peak Demand December 2019