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TO: Summer Shade Solar LLC
 500 Sansome Street, Suite 500
 San Francisco, CA 94111

FROM: Paul Coomes

RE: Estimated economic impact of Summer Shade Solar Project

Executive Summary

Summer Shade Solar, LLC (an affiliate of Candela Renewables, LLC) is developing a photovoltaic solar energy electric generating and battery storage facility with 106 megawatts (MW) generating capacity on about 737 acres of rolling farmland in Metcalfe County, Kentucky. The developer plans to invest approximately \$185 million to develop the site, named *Summer Shade*. This memo provides estimates of the new local economic and fiscal activity expected from the development.

There are two primary economic impacts expected from the project. First, there will be a spike in construction and linked jobs as the site is built out over approximately one year. Using estimates of the construction payroll, I estimate that there will be a total (direct and spinoff) of 276 new jobs in the county in year one, with new labor compensation of \$18.5 million. These estimates are on a county of work basis, not necessarily county of residence. I do not have information about the anticipated extent of local hiring.

The second major economic impact will be the new tax revenues generated annually over the life of the facility. The company has provided me with tax projections related to their capital expenditures. Kentucky state government is projected to receive \$5.1 million over the subsequent three decades. Local jurisdictions, including the school system, the fiscal court, ambulance, extension and libraries, would receive \$6.3 million. Of that, \$3.6 million would go to the county school system. The leased land parcels generated about \$10,000 in property tax revenues for local jurisdictions in 2024. This can be compared to an average of \$208,000 potentially generated per year by the solar project over thirty years from property taxes.

The ongoing annual economic impacts from operating the solar facility involve the positive effects of several operational and maintenance jobs plus the effects of the new lease payments to owners of the land. In Appendix B, these are compared to the negative effects of lost agribusiness activity, revealing net annual gain in jobs and labor income over the operating period. Looking out over three decades, and including the impacts of construction, I estimate there is a net gain of 475 job-years and \$36.0 million in labor income to Metcalfe County. The net gain could be slightly affected if the solar facility owner utilizes sheep to graze around the solar panels, as that agricultural activity would partially mitigate the loss of crop and cattle grazing at the site. However, it would also reduce the need for mechanized mowing and those operations jobs.

Demographic and Economic Characteristics of Metcalfe County

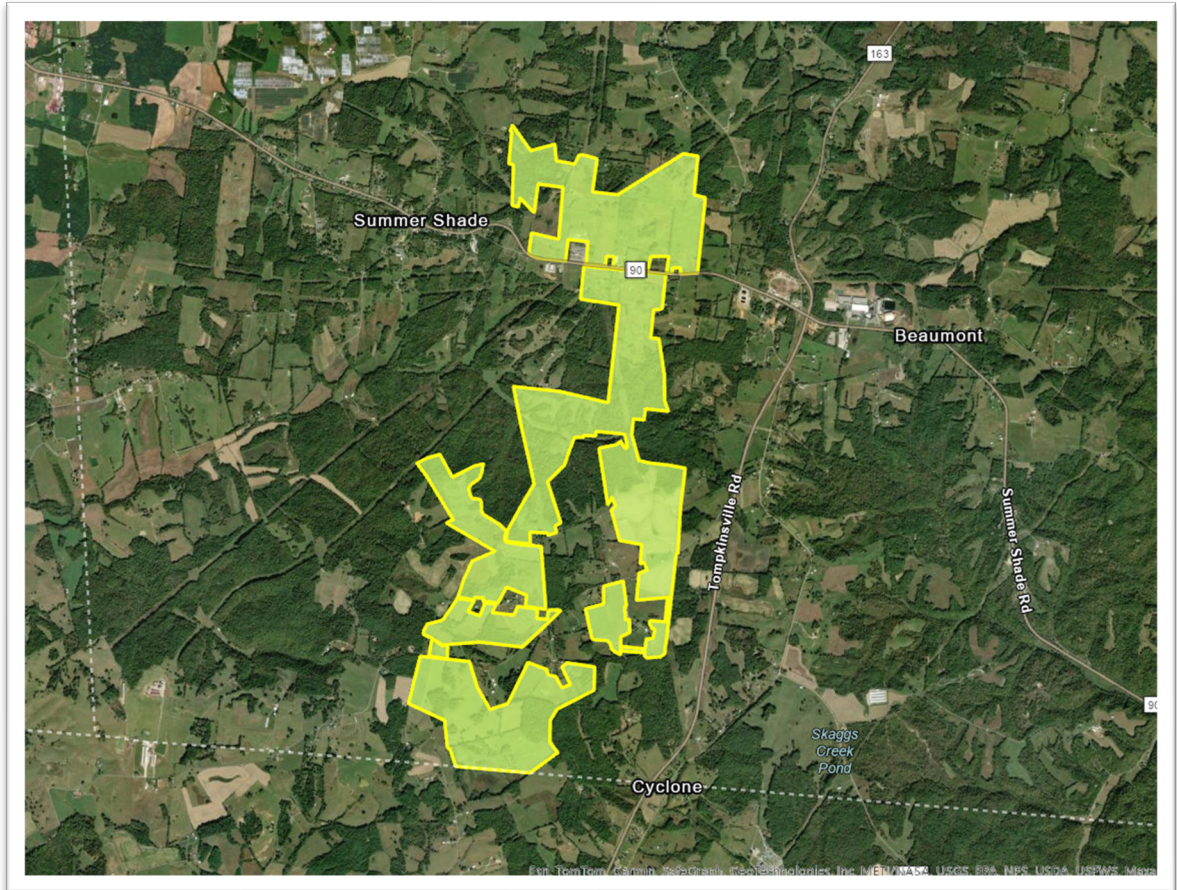
Metcalfe County is located in south central Kentucky, just north of the Tennessee state line. The Summer Shade Solar site is at the south end of Metcalfe County, as shown on Map 1. The red lines indicate the approximate location of the proposed solar facility. It is about 20 miles southeast of Glasgow, the largest city in the region.

Map 1



One can see in Map 2 that the site is rural, mainly rolling farmland and timber. The photovoltaic plant will require 737 acres (“inside the fence”), but a total of 1,535 acres will be leased to accommodate connections and setbacks.

Map 2

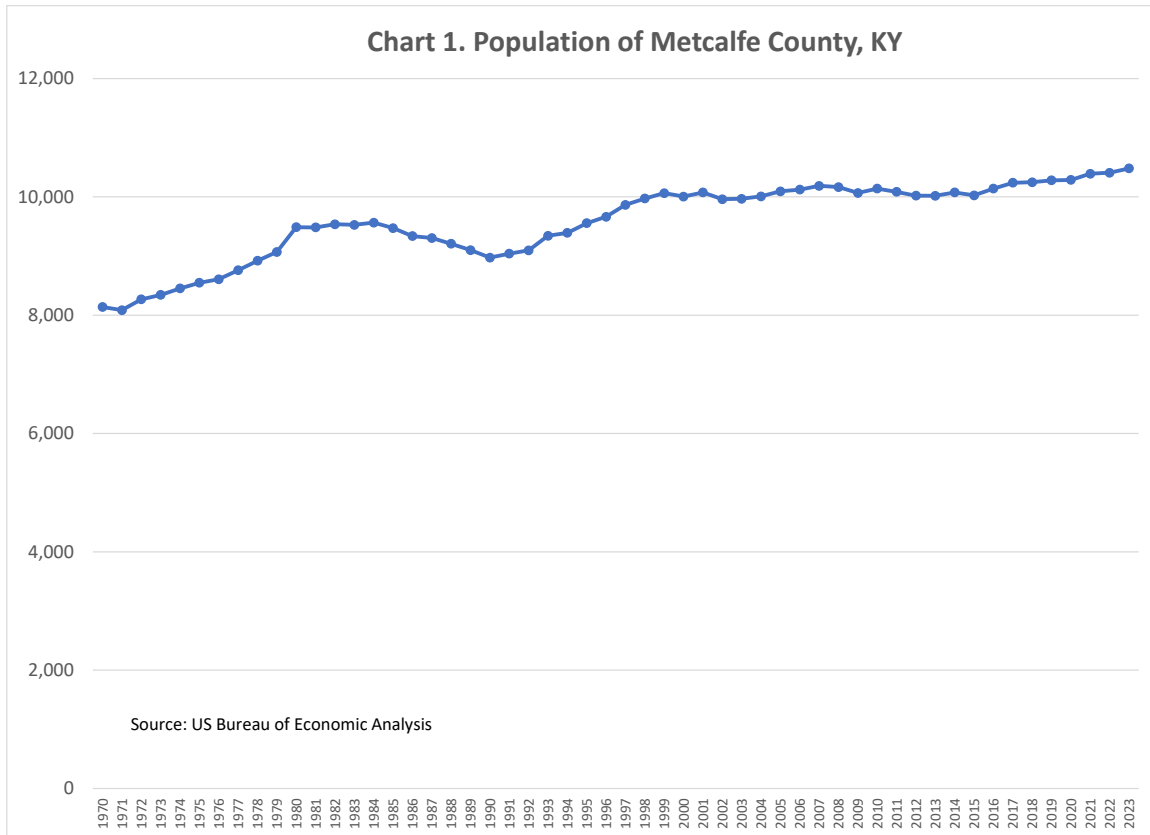


Newly released results from the 2023 American Community Survey¹ provide a nice summary of demographic and economic characteristics of Metcalfe County. Some details are provided in a table in Appendix A. For many of the measures, the county is similar to the state, for example median age, percent veterans, persons per household, and commute times. However, a few things stand out:

- Far fewer adults have a four-year college degree, and a larger percentage of adults are not in the labor force.
- Residents tend to work disproportionately in manufacturing industries around the region, and in production, transportation and construction occupations.

¹ See www.census.gov/programs-surveys/acs/news/data-releases.html

- Median household income was \$48,600, compared to a state average of \$62,400.



Metcalfe County’s population grew fairly rapidly in the 1970s and again in the late 1980s, then was flat in the early 2000s before picking up again over the last decade, and now has around 10,500 residents, as shown in Chart 1. It has grown 29 percent over the period shown (1970 to 2023). Interestingly, this demographic pattern seems uncorrelated with the number of jobs in the county, as is evident in Chart 2. There was a doubling of jobs in the county between 1985 and 1995, accompanied by almost no population growth. Then, as employment dropped perceptibly over the next two decades, the population grew slightly.

The sharp rise and then decline in county employment can be traced to the manufacturing sector. One can see in Chart 3 that the change in manufacturing employment has the same pattern as overall county employment. I have not been able to determine the name of the manufacturing facility that added almost 800 jobs in the mid-1980s, and then shed most of them after a decade. But it clearly was a major driver of the economic fluctuation in the county, as average pay in manufacturing is typically much higher than in other industries, particularly in rural counties.

Chart 2. Wage and Salary Employment, Metcalfe County, KY

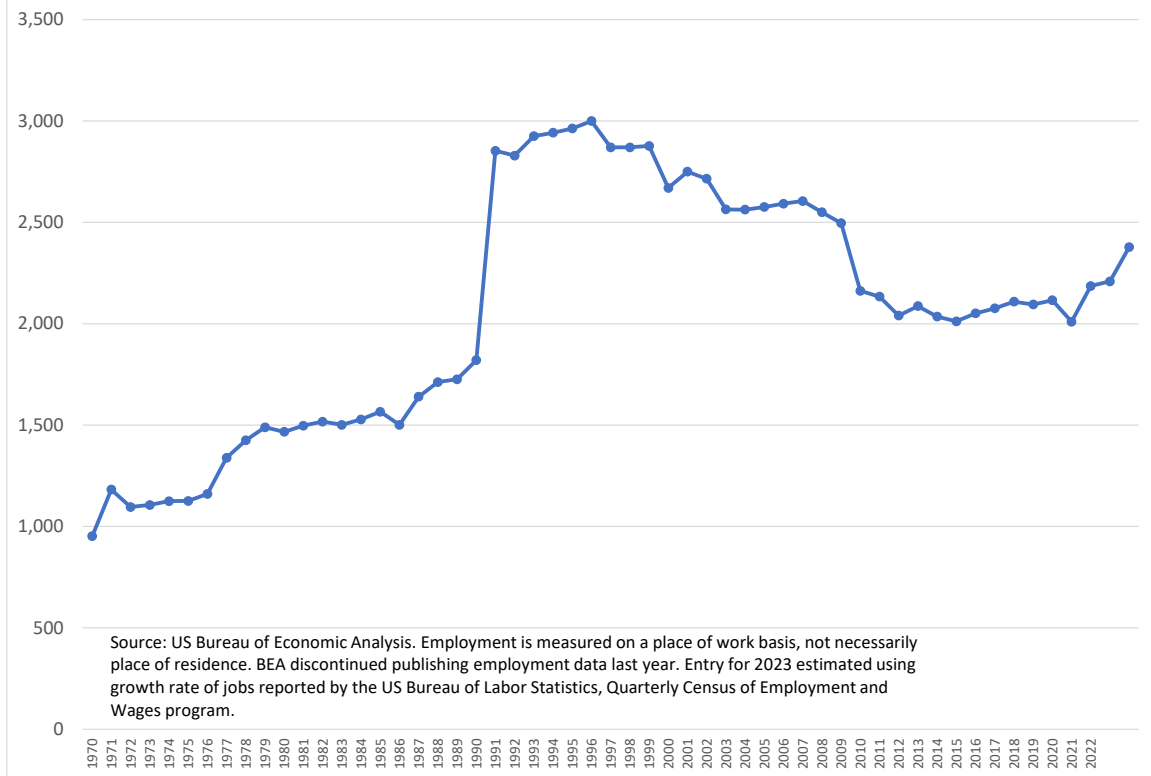
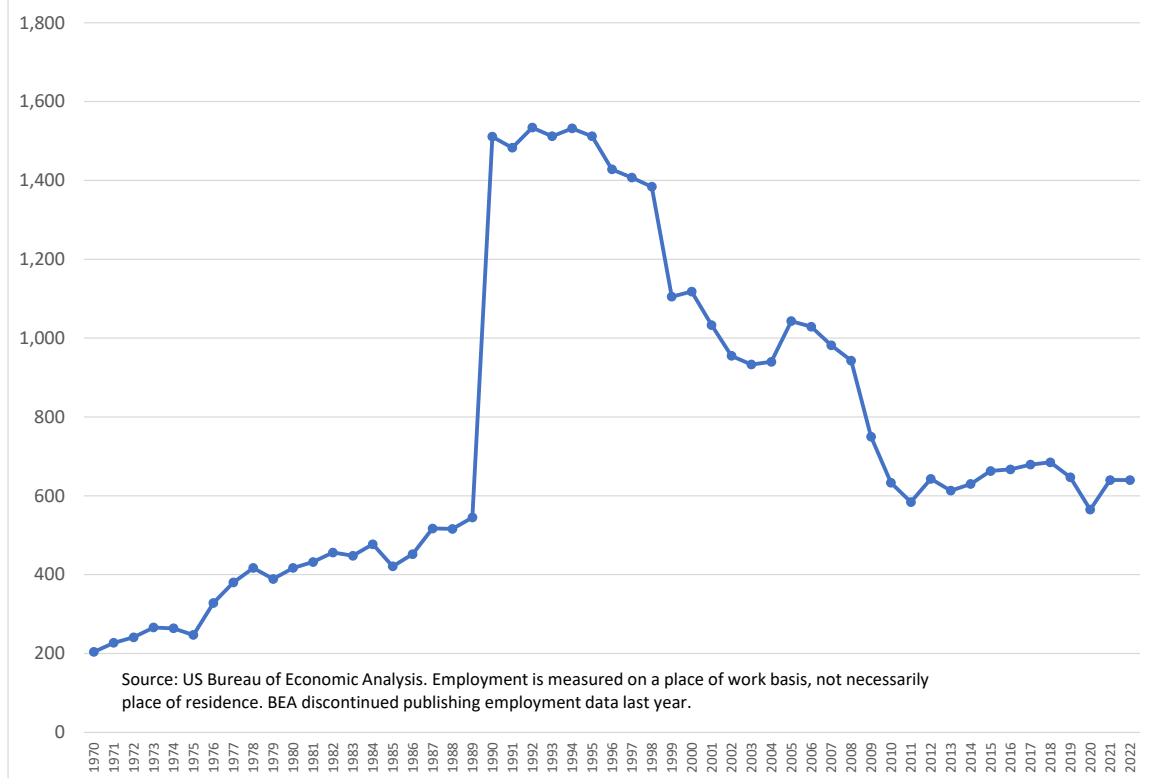


Chart 3. Manufacturing Employment, Metcalfe County, KY



It appears from historical data on personal income that county residents are increasingly dependent on government transfer payments (such as Social Security, Medicare, and Medicaid). It has been the fastest growing component of personal income in Metcalfe County (15 to 44 percent) over the last five-plus decades. The value of those government transfer payments to residents was \$176 million in 2023. By comparison, wages and salaries paid to workers in the county in 2023 were only \$103 million.

Later, I investigate and model linkages among Metcalfe and surrounding counties. A standard way to discover these geographic linkages is to look at county to county commuting patterns. Data on commuting patterns are only published with a long lag, but reveal the historical interchange of workers to and from Metcalfe County. In the latest survey, there were an estimated 2,526 persons working in Metcalfe County (Table 1). Local residents filled 78 percent of the

Table 2. County of Work for Metcalfe County Residents		
	Number	Share of Total
Metcalfe County	1,974	48.5%
Barren County	1,281	31.5%
Warren County	287	7.0%
Hart County	201	4.9%
Monroe County	79	1.9%
Simpson County	42	1.0%
Adair County	40	1.0%
other	209	5.1%
Total workers	4,073	100.0%

Source: US Census Bureau, American Community Survey, Residence County to Workplace County Commuting Flows, 5-Year ACS, 2015-2020.

Table 1. County of Residence for Metcalfe County Workers		
	Number	Share of Total
Metcalfe County	1,974	78.1%
Barren County	243	9.6%
Adair County	131	5.2%
Cumberland County	68	2.7%
Hart County	55	2.2%
Monroe County	29	1.1%
Green County	21	0.8%
other	5	0.2%
Total	2,526	100.0%

Source: US Census Bureau, American Community Survey, Residence County to Workplace County Commuting Flows, 5-Year ACS, 2015-2020.

jobs in the county, and a significant flow of nonresidents commute in from Barren and Adair counties.

Consider now the opposite flow in Table 2, where Metcalfe County residents work. In this survey there were 4,073 working Metcalfe County residents, of which only 49 percent worked in their home county. Clearly, there is a large net outflow of residents to work in surrounding counties, particularly Barren, Warren and Hart

counties. This net outflow shows up in the ‘residence adjustment’ to the personal income of Metcalfe County residents. In 2023, the Bureau of Economic Analysis (BEA) adjustment was \$62 million, representing the net result of Metcalfe residents bringing home income earned in other counties versus residents of other counties earning income in Metcalfe.

Modeling the Economic Impacts

I take a conventional approach to modeling the regional economic impacts, using a customized input-output model of Metcalfe County². I have purchased annual economic data for all 120 Kentucky counties, and use these as needed to construct regional models – of a county, a group of counties, or the whole state. The model has detailed information about the linkages among over 500 potential industries in each regional economy, as well as the relationship between household spending and demand for local retail goods and services due to employee compensation or other forms of income. When there is new industrial activity in a region, the model can predict how much of the supply chain can be met by local businesses and how much the new payroll will result in additional sales (and jobs) by local businesses. For this study, the regional economy will be defined as Metcalfe County or Metcalfe and surrounding counties that are linked economically.

The ratio of the change in total regional economic activity to a change in activity by a local industry is called a multiplier. For example, if a new manufacturing company adds 100 jobs and the county were to ultimately see another 80 jobs due to related spinoff activity, the employment multiplier would be 1.8 (180 total jobs divided by 100 direct jobs). Similar multiplier effects are generated for business output, labor income, and value-added³.

The relevant IMPLAN sector for the construction phase of the solar facility is number 47, “Construction of new power and communication structures”, and I use this to model the initial investment. The employment multiplier for that sector in Metcalfe County is 1.086. This is a very small multiplier, due to the fact that almost all the materials used to assemble a solar farm are made outside the county; thus, there are few inter-industry impacts locally. Moreover, the county is not developed enough to supply all the goods and services demanded by households, and thus the predicted impact of the new construction wages is also relatively small.

There will also be some modest spin-off impacts from ongoing operations. Unfortunately, for the operations phase, the relevant IMPLAN sector, number 37, “Electric Power Generation – Solar”, is empty of data and results for Metcalfe County. This is because

² For documentation of IMPLAN modeling, see <https://implan.com/introduction-to-economic-impact-analysis/>.

³ Value-added is a measure of how much economic activity actually stays in a region. For example, if one purchases a new vehicle for \$40,000 from a local dealership, only a few thousand dollars actually is captured in the county. Business revenues rise by \$40,000, but most of it flows right out to the place where the vehicle was made. Local value-added measures the fraction of the sale that ends up paying workers and owners at the dealership, as well as any local taxes captured as a result of the sale.

there is no history of solar electricity generation and therefore no basic economic data to construct industry relationships. However, the sector has data for the statewide model.

Construction Payroll and Local Economic Impacts

From an economic perspective, the solar project has two phases, construction and operations. The construction phase is expected to last about one year, while the operations phase will last up to four decades. Almost all the employment occurs in the construction phase. The regional economic impacts consist of the direct effects of spending by the developer, and any spinoff impacts due to local purchases of supplies and new spending by households as a result of the increased incomes.

Direct effects

The company expects to invest approximately \$185 million in the solar project. The investment involves permitting, land acquisition, site preparation, solar panel and electrical equipment installation, plus landscaping and security fencing. Summer Shade Solar plans to enter into an Engineering, Procurement, and Construction (EPC) contract for this project, so it is not possible to know precisely how many workers will be employed nor their total compensation. For modeling purposes, I am using an estimate of average employment over a one-year construction phase. The results of a recent California study of six large photovoltaic projects suggests that there will be an average of 254 direct jobs over a twelve-month construction period for this project⁴. This is almost identical to the Candela estimate of 250 construction jobs.

The California study also provides a range of results for construction wages and benefits, as summarized in Table 3. The lowest average annual construction wage reported was \$52,736, and the average wage across the six projects was \$78,002, as shown in the table. California is, of course, a high wage state, with a much higher cost of living than Kentucky. On the other hand, the wage results are from projects developed a decade ago, and there have been large increases in average wages across the US since then.⁵

⁴ A University of California-Berkeley study looked at six large PV projects in California, and summarized the economics. The author finds a ratio of 2.4 FTE construction jobs per MW. Applied to the Summer Shade Solar project's 106 MW one gets 254 direct construction jobs. He also shows the permanent operations jobs per MW, and applied to this project one gets 3.4 FTEs. See page 28 of *Economic and Environmental Benefits of Building Solar in California*, by Peter Philips, November 10, 2014, <https://laborcenter.berkeley.edu/pdf/2014/building-solar-ca14.pdf>

⁵ By contrast, a recent union-oriented report on Ohio solar projects claims temp workers there are only making \$18 to \$20 per hour, implying average annual pay of around \$40,000; See <https://columbusfreepress.com/article/ohio-solar-panel-farms-are-booming-construction-workers-are-being-exploited-make-it-happen>

Table 3. Construction wages and benefits from 2014 Berkeley study			
	Average annual wage	Average annual benefits	Total compensation
CA Valley & Topaz Combined, Low Wage	\$52,736	\$24,104	\$76,840
Average Across Six Solar Projects	\$78,002	\$36,880	\$114,882
Source: https://laborcenter.berkeley.edu/pdf/2014/building-solar-ca14.pdf			

Occupations include construction managers, earth grader operators, panel installers, electricians, and fencers. I searched the federal database on hundreds of occupations to learn how much these workers are likely to earn on the project. There is no listing in the Kentucky data for “Solar Photovoltaic Installer”, but the national average annual wage in 2023 was \$53,149⁶.

Good inferences about other relevant occupations can be gleaned from Table 4. The construction managers are likely to earn over \$100,000, heavy equipment operators and installers over \$53,000, electricians around \$59,000, and fencers \$42,000. The average annual pay for all jobs in Metcalfe County in 2023 was \$49,200⁷. Based on this information, I assume the average annual pay across the construction occupations will be \$50,000, excluding fringe benefits.

Table 4. Kentucky Wages for Related Occupations, 2023				
Occupation (SOC code)	Employment	Hourly Mean Wage	Annual Mean Wage	
Construction Managers(119021)	1,280	\$50.36	\$104,750	
Operating Engineers and Other Construction Equipment Operators(472073)	6,530	\$27.45	\$57,100	
Electricians(472111)	9,620	\$28.18	\$58,610	
Fence Erectors(474031)	260	\$20.19	\$41,980	
Industrial Engineers(172112)	6,020	\$43.76	\$91,010	
Materials Engineers(172131)	500	\$46.99	\$97,740	
Mechanical Engineers(172141)	2,970	\$47.55	\$98,900	
Heating, Air Conditioning, and Refrigeration Mechanics and Installers(499021)	6,500	\$25.90	\$53,870	
Electrical Power-Line Installers and Repairers(499051)	2,870	\$35.72	\$74,300	
Telecommunications Line Installers and Repairers(499052)	900	\$27.19	\$56,560	

Source: US Bureau of Labor Statistics, Occupational Employment Survey,
<https://data.bls.gov/oes/#/geoOcc/Multiple%20occupations%20for%20one%20geographical%20area>

⁶ Source: US Bureau of Labor Statistics, Occupational Employment Survey. For national data on solar photovoltaic installer, see www.bls.gov/oes/current/oes_nat.htm#47-2231 . For Kentucky data, see www.bls.gov/oes/current/oes_ky.htm . County-level data are not available.

⁷ Source: Wages salaries from US Bureau of Economic Analysis (BEA), Table CAINC4; wage and salary employment from US Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

Multiplying the expected number of jobs times the assumed average pay per job yields a direct construction payroll of \$12.7 million. The average fringe benefits, such as employer payments for health insurance, in Kentucky for the construction industry is 18 percent⁸; so, total labor compensation for these jobs is \$15.0 million, or \$59,100 per job.

Total impacts in Metcalf County from construction

The construction phase will have some spin-off effects in Metcalfe County, due to materials and labor purchased locally. The economic impact of local supplies purchased is called the indirect effect, and the impact of new local household spending is called the induced effect. Adding these two effects to the direct effect yields the total effect of a development, and dividing the total effect by the direct effect yields a multiplier. Using the Metcalfe County multipliers for the relevant construction sector, and the direct construction budget, I project there will be a total of 276 new jobs in the county, and new labor compensation of \$18.5 million⁹.

Table 5. Impact of 254 Jobs in Sector 47, Construction of new power and communication structures

Impact Type	Employment	Labor Income	Value Added	Output
Direct	254.0	\$3,503,243	\$5,350,548	\$18,977,692
Indirect	16.4	\$641,573	\$1,198,951	\$3,061,606
Induced	5.4	\$163,699	\$538,100	\$912,819
Total	275.8	\$4,308,515	\$7,087,599	\$22,952,117
implied multiplier	1.086	1.230	1.325	1.209

Source: IMPLAN model of Metcalfe County, using 2023 economic data.

Table 5 illustrates the various impact components across several standard economic measures. These results can be scaled up or down to fit any assumed number of construction jobs¹⁰. Note that both the indirect and induced effects are quite small. The

⁸ BEA provides estimates of both total compensation and total wages by industry for the state. Dividing total construction industry compensation by wages in 2023 yields 1.18.

⁹ IMPLAN data for the county show a much lower average labor income for the direct jobs than I have assumed (\$50,000), so I apply the labor income multiplier (1.230) to the assumed total compensation.

¹⁰ This linear scaling is a feature of IMPLAN and other regional input-output modeling systems. It is reasonable in the case of a photovoltaic solar facility construction project. The feature becomes a problem in cases where an industrial development dramatically changes a local economy, for example, in the case of a large manufacturing plant in rural county. In that case, one could expect complicated

indirect effect is small due to the lack of local suppliers of solar farm materials. The induced effect is even smaller due to the lack of retail and service businesses in the county to absorb the new household income linked to the construction jobs.

Wider regional impacts from construction

Some readers may wonder why I have focused on impacts in Metcalfe County as opposed to more widespread regional impacts. Keep in mind that most federal-state statistical agencies and models measure employment on a place of work basis, as opposed to a place of residence basis. So, all construction workers at the site are counted as Metcalfe County jobs. Nevertheless, clearly there will be some spinoff economic activity in surrounding counties, as supplies are purchased and workers spend their paychecks at retail establishments.

To investigate possible broader regional impacts, I built another IMPLAN model, this time of Metcalfe, Barren and Adair counties, per the commuting patterns results above. The results are slightly larger than that of the Metcalfe-only simulation.

The job multipliers for the solar farm construction phase are 1.086 for Metcalfe alone, and 1.275 for the three-county region, for a net change of 40 total predicted jobs. (Other economic multipliers, such as labor income and business output, are also consistently in that range). I also performed a comparable simulation using a model covering the whole state of Kentucky. That job multiplier for the solar farm is 1.440, slightly higher than that for the three-county region. Based on our impact analysis tools, there are not significant differences in the predicted regional impacts when zooming out to adjacent counties or statewide¹¹. In this case, the economic multipliers are relatively small whether one models one county, three, or 120. This is due primarily to the lack of industrial linkages in the region to the solar industry.

Impact of Ongoing Operations

The California PV study cited above found that a ratio of 31.3 MW per permanent operations job. Applied to the Metcalfe County project, this results in an estimate of 3.4 permanent operational jobs at the site. Using the most conservative California wage and benefit data yields total annual compensation of \$348,000. As mentioned in the above discussion of modeling methods, the IMPLAN sector for solar farm operations is empty of

and nonlinear effects, such as growth in the local population, much higher wage rates, and growth in support industries.

¹¹ For other industrial developments around Kentucky it is common for our models to predict job multipliers of 3, 4, or 5, particularly for complicated manufacturing operations such as motor vehicles and parts.

data. However, the state-level model does show activity in sector 37, Electric Power Generation – Solar. The multipliers for the Kentucky sector are 2.708 for employment and 1.636 for labor income. Applying the state multipliers to the Metcalfe County site yields annual employment of 8.7, with labor compensation of \$569,000. This is a reasonable approach, given that the maintenance activity is by nature local and labor-oriented.

Local Tax Revenues

Metcalfe County and the Commonwealth of Kentucky levy property taxes on real estate and tangible property, and the Commonwealth taxes the value of manufacturing machinery. Table 6 provides the latest published tax rates that are applied countywide. They total about one percent of the assessed value of real estate property, with about one-half of the revenue going to the county public school system. There is one municipal taxing jurisdiction in Metcalfe County – Edmonton - but the project is outside its city boundary and thus would not be subject to those property taxes.

Metcalfe County levies a one percent countywide occupational tax on employee

Table 6. Metcalfe County Property Tax Rates, 2023			
in cents per \$100 valuation			
Jurisdiction	Real Estate	Tangible Personal	Manufacturers' Machinery
Ambulance	5.60	5.60	
Extension	9.90	10.99	
Fiscal Court	8.60	10.00	
Library	11.50	12.77	
Soil Conservation	1.60	0.00	
County Public Schools	51.90	52.20	15.00
State of Kentucky	11.40	45.00	
Total, County-wide	100.50	136.56	15.00
Source: Kentucky Department of Revenue			
https://revenue.ky.gov/News/Publications/Pages/Property-Tax-Rate-Books.aspx			

compensation, as well as a one percent net profits tax on businesses¹². Using my estimate of new labor income in the county due to construction, the county would

¹² See <https://metcalfecounty.ky.gov/Documents/Metcalfe%20OCC%20Online.pdf> and <https://metcalfecounty.ky.gov/Documents/Metcalfe%20NP%20Online.pdf>

receive a one-time boost in occupational taxes of \$185,000. There would also likely be a few thousand new dollars of occupational tax revenue annually from operations. I have no way of projecting profits related to the solar facility operation.

The company has provided me with a property tax projection for their intended investment. Much of the capital expenditures will be for equipment classified as manufacturing machinery, which is taxed at the state level, but not locally. The value of the real estate is enhanced by two factors. The solar project will add fencing and other improvements that increase the land value; and the lease payments to the landowners greatly increase the valuation as compared to its former agricultural use. Kentucky state government is projected to receive \$5.1 million over the subsequent three decades. Local jurisdictions would receive \$6.3 million, of which \$3.6 million would go to the county school system¹³. So, local jurisdictions would receive an average of \$208,000 per year under this projection.

The company may pursue an Industrial Revenue Bond (IRB) for the project through Metcalfe County Fiscal Court. Under an IRB, the County government would actually own the property for the likely 30-40 year life of the bond, and thus the investment is exempt from property taxes. Under the IRB the company makes the debt service payments and the County incurs no financial risk. Moreover, the company would likely make Payments in Lieu of Taxes (PILOT) each year to partially replace the tax revenues that the County would have received. Preliminary projections under the IRB scenario over three decades show \$1.3 million in property taxes going to the state and a \$3.3 million PILOT going to local jurisdictions.

The company also provided me with the parcel numbers of the land leased for the site, and I looked up the 2024 tax bills from the Metcalfe County Sheriff's website. There are 16 land parcels, currently leased at the site, and total taxes paid in 2024 of about \$10,000. According to the Metcalfe County Property Valuation Administrator, the fair cash value of the land is over \$3 million; however, land in agricultural use is taxed at a very low rate. The current property tax revenues can be compared to an average of \$208,000 expected to be generated by the solar project per year over three decades. It should be pointed out that solar projects like this require almost no public services from local government; and because they require so few people to operate do not add students and expenses to the county public school system.

¹³ The ultimate net financial benefit to the schools is more complicated than this. Extra property tax revenues to the County school system would trigger a reduction in state SEEK funding to the district.

Appendix A

Table 7. Demographic and Economic Characteristics of Metcalfe County

	Metcalfe County	State of Kentucky
Number of residents	10,372	4,510,725
Median age	41.9	39.1
Percent white	94.1%	83.7%
Percent of noninstitutionalized population w disability	21.4%	17.7%
Percent foreign-born	1.30%	4.40%
Percent 18 and older veteran	6.2%	6.8%
Percent living in same house as a year ago	82.4%	87.1%
High school attainment rate, population aged 25+	84.3%	88.5%
College attainment rate, population aged 25+	13.1%	27.0%
Number of Households	4,245	1,791,991
Median household income	\$48,572	\$62,417
Persons per household	2.44	2.52
With broadband internet subscription	82.5%	87.2%
Population 16+	8,198	3,605,426
In the labor force	54.4%	59.6%
Employed civilian	51.5%	56.4%
Unemployed	2.9%	2.9%
Armed forces	0.0%	0.4%
Not in labor force	45.6%	40.4%
Median travel time to work (minutes)	23.1	24.0
Civilian employed population 16 years and over	4,218	2,032,890
Management, business, science, and arts occupations	32.0%	37.1%
Service occupations	19.7%	15.4%
Sales and office occupations	10.4%	20.3%
Natural resources, construction, and maintenance occupations	14.6%	8.8%
Production, transportation, and material moving occupations	23.2%	18.4%
Industry		
Agriculture, forestry, fishing and hunting, and mining	1.7%	1.8%
Construction	11.2%	6.3%
Manufacturing	20.7%	14.3%
Wholesale trade	1.8%	2.2%
Retail trade	8.7%	11.8%
Transportation and warehousing, and utilities	3.6%	6.9%
Information	0.3%	1.3%
Finance and insurance, and real estate and rental and leasing	5.8%	5.6%
Professional, scientific, and mgmt, and admin and waste mgmt services	4.1%	9.0%
Educational services, and health care and social assistance	25.1%	24.2%
Arts, entertainment, and recreation, and accommodation and food services	8.9%	8.0%
Other services, except public administration	4.1%	4.5%
Public administration	4.0%	4.2%

Source: US Census Bureau, American Community Survey, 5-year profiles, 2019-2023,
www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/

Appendix B

Measuring the Net Economic Impact of the Change in Land Use

The conversion of agricultural land to a photovoltaic solar energy electric generating and battery storage facility involves both positive and negative economic effects on the regional economy. The negative effects involve the reduction in farming activity, and the linkages that has on local suppliers of seed, feed, fertilizer, equipment and labor, summarized by a reduction in business activity employment and personal income. Many of the positive effects are described in the body of the report, including the one-time construction impacts, the several operations and maintenance jobs at the site, plus the increase in property tax payments to local jurisdictions. But there is also another important positive effect to consider – the impact of the annual lease payments to the farmland owners. This involves not only the actual new income, but also the regional spinoff impacts as the income is spent on goods and services in the local economy.

In this appendix, I attempt to account for all these factors and put them together to measure the net economic impact of the change in land use. No direct accounting-type information is available on actual farm operations at the solar site, but rich data are available on farmland activity at the county level. Using county data on crop yields, livestock production and prices provide a reasonable basis to estimate farm output at the solar site. Annual lease payments to the farmland owners, as provided by the solar developer, provides a fairly precise measure of the new income to the owners. If the lease information is not available, national studies can be used to approximate the rate per acres. Then I use a custom IMPLAN model of the county to predict the linkages of both farm output and new lease income to the local economy.

As context, it is useful to remember that many if not most farmers hold a nonfarm job in a nearby city or industrial site, as often do their spouses. The income from nonfarm work is generally much greater than what they can earn from actual farming, and is how the family is able to pay its bills. Because farming is a seasonal activity, farmers of small and midsize plots can work extra hours during the growing season and hopefully supplement their household incomes. I say hopefully because historical data reveal that net farm income is highly volatile and sometimes negative.

Lost Economic Activity From Farming

1. Determine the solar site's share of county farmland. In most Kentucky contexts, the relevant components are acres harvested of corn for grain, acres harvested

- for soybeans, and inventory of cattle and other livestock. The county totals are published every five years in the Census of Agriculture, with 2022 the latest available¹⁴. Farmland use at the solar site is estimated based on visual inspection, as it is not feasible to do an actual acre by acre survey. The distribution of farmland use at the site will be similar to the county distribution, to the extent the topography and soil quality is similar throughout the county.
2. Obtain the yield per acre and the value per bushel for corn and soybeans from the county tables in the Census of Agriculture. Multiply the site acreage by the yield and value to obtain farm revenues (Output) for the site. A similar calculation can be made for any livestock activity.
 3. Use IMPLAN to simulate the Output loss in the county from the loss of farm activity. IMPLAN has three sectors that usually apply: Oilseed Farming (#1), Grain Farming (#2), and Beef Cattle Ranching and Farming (#11). If needed, there are also sectors for Dairy Cattle (#12), Poultry and Egg (#13), Other Animal Production (pigs and hogs) (#14). IMPLAN will return a statement of the direct, indirect and induced economic impacts in the county from the loss of the farm activity. It also provides a detailed listing of the impacted sectors in the county, such as farm supplies.
 4. Care should be taken at this point to distinguish between Output and Value Added. Output is the total sales, while Value Added measures only the dollars that stick to the county. For example, if farmers purchase \$50,000 of fuel most of those dollars go to the refinery in another county or state. Only the portion used to compensate the local distributor results in lost income in the county. Employment and Labor Income impacts are the most useful for our purposes.

New Income from Leasing Land to Solar Company

1. The solar project developer will have confidential data on the contracted amount they will pay landowners for the use of their land each year. If the company cannot release the lease payments, the only recourse is to estimate them based on studies of other places. According to a recent paper, “More rural areas with high land prices and high solar demand may be in the ballpark of \$1,000 an acre near a substation with capacity. Areas where land price is much lower, and the land doesn’t offer much in the way of agriculture, may drop rent rates to around \$500

¹⁴ The 2022 Census of Agriculture statistics for Kentucky were released in February 2024. See www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_County_Level/Kentucky/

per acre”¹⁵. Below, I use a midpoint estimate of \$750 per acre for the solar site. The lease payments rise over time, but I do not have access to the details of the contracts.

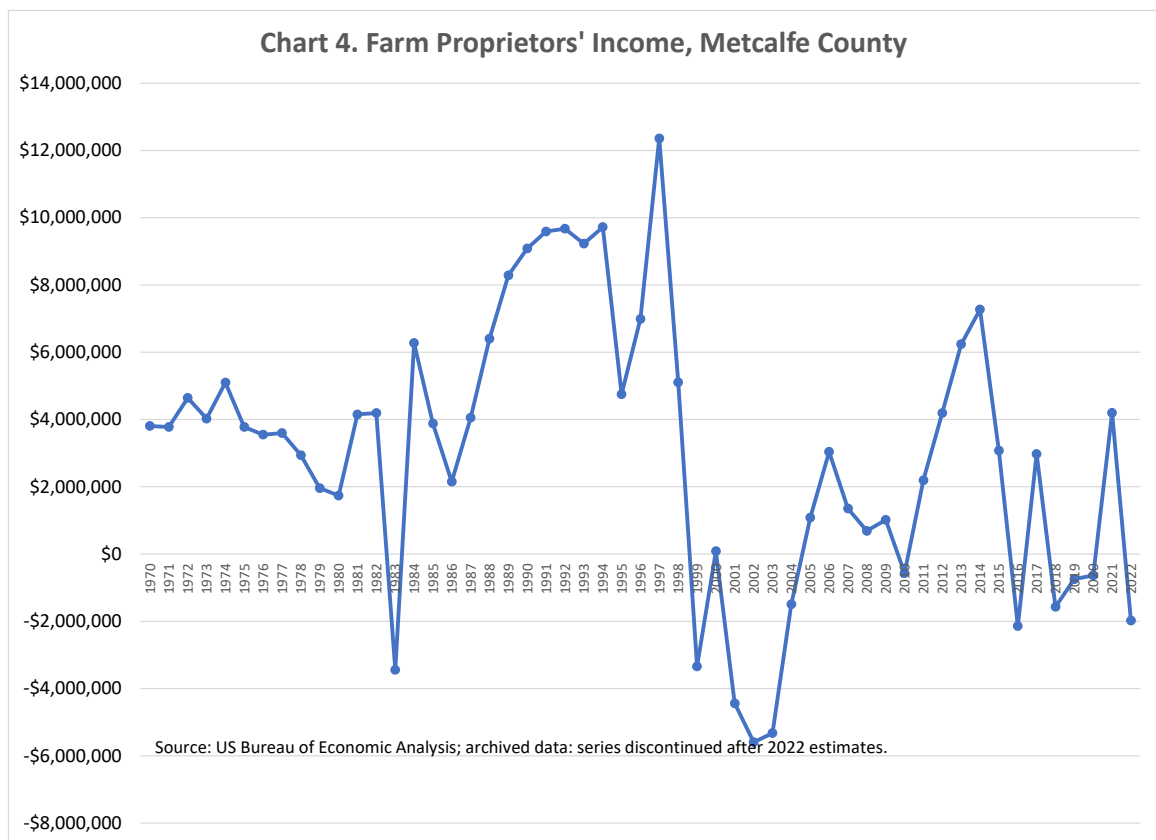
2. To estimate the economic impact of this new income, IMPLAN can be used again. This involves a simulation of new household income and spending, resulting in estimates of the impact on other sectors in the county. Changes to household income have predictable impacts on residential construction, retail sales, health care, insurance, banking, restaurants, entertainment, education and a large range of activities covered by the IMPLAN modeling system. We follow the methods employed in a recent Minnesota study, which allocates one-half the lease payments to net household income and the other half to payments on their real estate mortgage and other debts¹⁶. The more urbanized the county, the greater the portion of household spending that is captured in the county versus imported from other regions. Again, one should distinguish between Output and Value Added, so the focus is on the new dollars that stick to the county.

¹⁵ These sites have good overviews of the factors involved: <https://uslightenergy.com/news/solar-land-lease-rates-how-much-do-solar-companies-pay-to-lease-land/> and www.solarlandlease.com/lease-rates-for-solar-farms-how-valuable-is-my-land

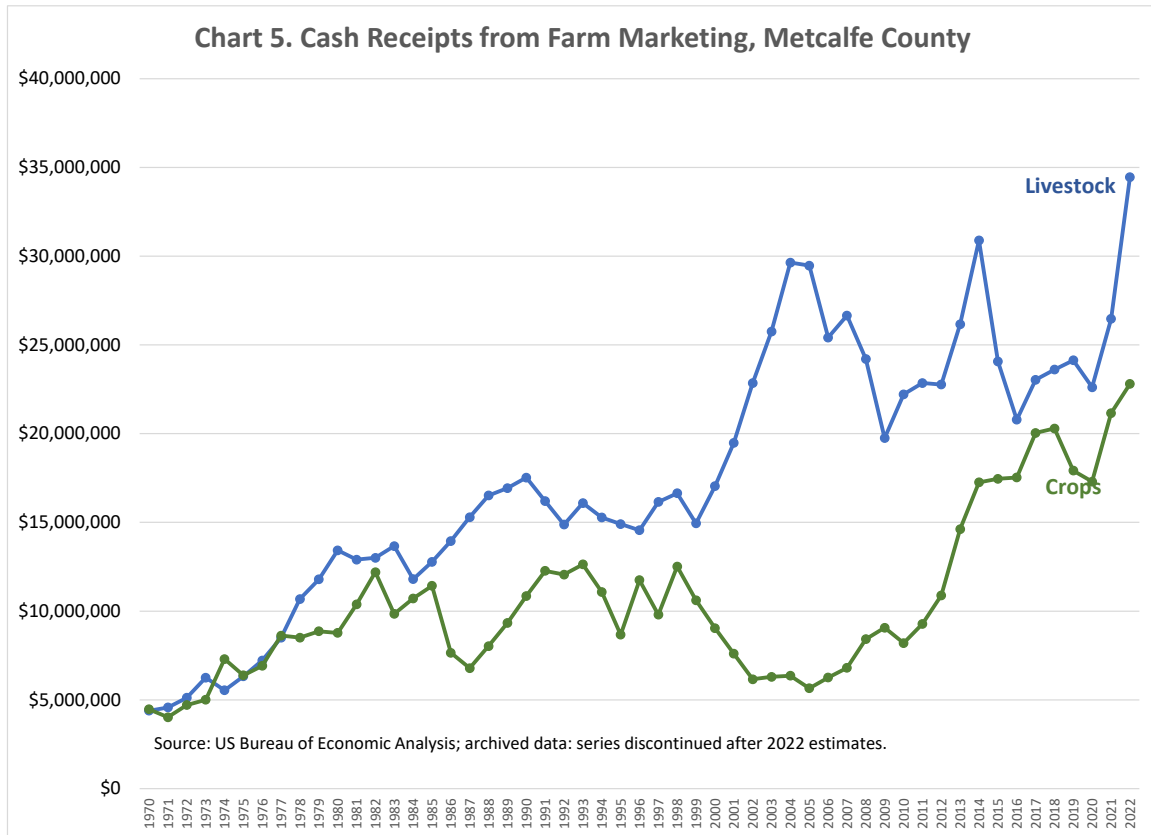
¹⁶ See Economic Impacts of a Proposed Solar Energy Project in Freeborn County, Minnesota, by Brigid Tuck, University of Minnesota Extension, April 2021: <https://conservancy.umn.edu/handle/11299/223053>

Metcalfe County

I now apply the method to the Summer Shade solar site, which is located in Metcalfe County. Before estimating farm income at the site, it is worth looking briefly at agricultural conditions at the county level. The next chart shows net farm proprietors' income over the past five decades. Note the volatility of farm income due to changes in product prices and costs of production. The average over the period shown was \$3.0 million per year (in nominal terms, not adjusted for inflation). Indeed, farm income was negative in five of the last ten years shown in Chart 4.



In Chart 5, we see that livestock revenues have been consistently higher than crop revenues for the last several decades.



A summary of 2022 Census of Agriculture results is provided in Table 8. The solar site accounts for about 0.6 percent of the farmland in Metcalfe County. Cattle, calves, and milk production accounted for most of the livestock activity. Corn, soybeans and tobacco accounted for most of the crop activity

Dividing bushels by acreage, we see that Metcalfe County had an average soybean yield of 48 bushels per acre. For corn, Metcalfe County had a yield of 159 bushels per acre. Soybean revenue per bushel was \$14.07, and corn revenue per bushel was \$6.58. And 49 percent of cattle inventory were sold that year, for an average of \$840 per head.

According to the developer, the site encompasses 737 acres “inside the fence”, with about 800 more surrounding acres also under lease to accommodate connections and setbacks. I do not have precise information about the current specific land use at the site, but according to the developer the primary agricultural activity is pasture and hay for cattle, with some row crops. Most of the area outside the fence is woodland or too hilly to farm, so I focus here on the likely agricultural activity for the 737 acres. To estimate the land use, I applied the Metcalfe County proportions for corn, soybeans and pasture, resulting in 149 acres of corn, 123 acres of soybeans, and 465 acres of pasture. I have

estimated the number of cattle grazing, using the results of a study by the University of Kentucky¹⁷. They find that beef cows need two to four acres of pasture per head, depending on the soil quality and the amount of hay used as feed. Taking the midpoint value of three acres, this implies that the acreage would support about 155 head of cattle.

¹⁷ See “Sacred Cows and Stocking Rates” by Greg Halich, Department of Agribultural Economics, University of Kentucky, July 28, 2020: <https://agecon.ca.uky.edu/sacred-cows-and-stocking-rates>

Table 8. Summary Agricultural Statistics, Metcalfe County, 2022

Farms	799
Land in farms, acres	124,964
Corn for grain, acres	8,459
Corn for grain, bushels	1,348,183
Soybeans, acres	6,964
Soybeans, bushels	335,262
Tobacco, acres	654
Tobacco, pounds	1,024,444
Forage - land used for hay, grass silage, acres	26,346
Forage - land used for hay, grass silage, tons	60,214
Cattle and calves inventory	30,530
Cattle and calves sold	15,020
Milk cows	2,042
Corn, value sold (000)	\$8,872
Soybeans, value sold (000)	\$4,716
Tobacco, value (000)	\$2,455
Cattle and calves sold, market value (000)	\$12,631
Milk from cows (000)	\$10,596
Farm production expenses (000)	\$44,210
Net cash farm income from operations (000)	\$11,285
Farms with net gains	31
Farms with net losses	482
Government payments received (000)	\$1,307
Hired farm labor, workers	470
Hired farm labor (000), payroll	\$2,612

Geographic Area Series, Part 17, February 2024.

www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1_Chapter_2_County_Level/Kentucky/

Applying county-wide yields and prices to the agricultural activity at the site gives us an estimate of the total annual agricultural revenue, as shown in the next table. Total estimated cash receipts are about \$304,000. This estimate loss would be somewhat mitigated should the project owner deploy sheep to graze around the solar panels (in lieu of mechanical mowing). Offsetting employment and income would depend upon the size of the herd.

Table 9. Estimate of Annual Agricultural Revenues at Solar Site	
Corn	\$156,543
Soybeans	\$83,212
Cattle	\$64,109
Total farm revenues	\$303,865

Next, I use IMPLAN to simulate the full economic impact of these revenues on the county. One can see in Table 10 that this agricultural activity is predicted to support four jobs in the county and \$29,000 in labor income.

Table 10. Solar Site Agricultural Loss, Estimated County Impacts				
Impact	Employment	Labor Income	Value Added	Output
Direct	3.2	-\$2,136	\$120,316	\$303,864
Indirect	1.1	\$29,719	\$48,380	\$89,134
Induced	0.0	\$923	\$3,028	\$5,145
Total	4.3	\$28,507	\$171,725	\$398,143

Source: IMPLAN model of Metcalfe County, using 2023 economic data.

These negative farm-related jobs and labor income need to be compared to the positive economic impacts related to the solar farm. Beyond the one-time construction impacts, the solar operation generates two new annual revenue streams – the operation of the solar site and the lease payments to farmland owners.

In the body of the report, I estimated that the operation of the solar farm will support about 8.7 jobs, with labor income of \$536,000 annually. I assume the lease payments are \$750 per acre, implying new household income of \$1,151,250. I simulate this two ways. In Table 11A, I assume that all the lease income is available for household spending, using the income bracket \$70,000 to \$100,000 annually. This results in two jobs and \$62,000 in new labor income in the county. The reader may wonder where the rest of the lease

dollars went. Taxes and savings reduce the amount available for spending. More importantly, in a rural county there are fewer goods and services available locally than in an urban county, and thus the dollars flow out of the county in the form of imports¹⁸. The most impacted sectors in Metcalfe County are child day care services, educational services, hospitals, offices of dentists, offices of physicians, and medical diagnostic labs.

Table 11A. Estimated Annual Impact of Lease Payments

Impact	Employment	Labor Income	Value Added	Output
Direct	0.00	\$0	\$0	\$0
Indirect	0.00	\$0	\$0	\$0
Induced	2.03	\$61,987	\$194,738	\$332,439
Total	2.03	\$61,987	\$194,738	\$332,439

Source: IMPLAN model of Metcalfe County, using 2023 economic data. All lease income simulated as increase in household income.

In Table 11B, the results are based on the assumption that one-half of lease income goes unrestricted to households in the income bracket \$70,000 to \$100,000. The other half is simulated as going to the banking system to pay down real estate mortgage and other debts¹⁹. The results are shown in the accompanying table. I estimate that the lease payments will support 4.5 jobs in Metcalfe County, with labor income of \$148,000. One can see that the estimated impacts are quite low in both cases. I will use the more conservative one, in Table 11A, in the net calculations below.

Table 11B. Estimated Annual Impact of Lease Payments

Impact	Employment	Labor Income	Value Added	Output
Direct	2.56	\$93,443	\$193,158	\$575,625
Indirect	0.81	\$19,476	\$31,933	\$103,079
Induced	1.14	\$34,612	\$109,242	\$186,391
Total	4.51	\$147,531	\$334,333	\$865,095

Source: IMPLAN model of Metcalfe County, using 2023 economic data. Half the lease income treated as new household income; half as new expenditures in the banking system to pay down debts.

¹⁸ By comparison, the same simulation in Jefferson County (Louisville) results in a total of 7.7 jobs, \$495,000 in labor income, value added of \$831,000, and total output of \$1,405,000.

¹⁹ IMPLAN sector 423 "Monetary authorities and depository credit intermediation".

Summarizing, one can see in Table 12 that the negative agricultural impacts are more than offset by the positive impacts from operating the solar site, revealing an annual net gain in jobs and labor income.

Table 12. Estimated Net Annual Metcalfe County Impacts		
	Employment	Labor Income
Farming	-4.3	-\$28,507
Solar operations	9.2	\$568,506
Lease payments to landowners	2.0	\$61,987
Net	6.9	\$601,987

Looking out over three decades (Table 13), and including the impacts of construction, there is a net gain of 475 job -years and \$36.0 million in labor income to the county.

Table 13. Estimated Net Economic Impact Over Three Decades			
	Year 1 Construction	Years 2 through 29, annual average	Cumulative 30 years
Solar-related employment	277.8	11.2	603.1
Solar-related labor income	\$18,538,521	\$630,493	\$36,822,827
Agricultural-related employment	-4.3	-4.3	-128.0
Agricultural-related labor income	-\$28,507	-\$28,507	-\$57,013
Net employment	273.6	6.9	475.1
Net labor income	\$18,510,014	\$601,987	\$35,967,629

Sheep Grazing – A Discussion

The developer has indicated that they plan to introduce a sheep herd to graze around the solar panels, thus replacing some of the lost agribusiness activity from row crops and cattle. These sheep would graze the site and help maintain vegetation and would later be sold for meat and/or wool. Sheep grazing can greatly reduce the cost of mowing around panels and other components, as unlike other animals they only eat the grass and do not tear up equipment. A shepherd would be hired to manage that operation. This section

provides some relevant, though rough, information about the likely economic effects of the sheep activity. However, there would be one other associated effect – a reduction in mechanical mowing, which has already been included in the estimate of operation and maintenance jobs. I do not have sufficient information to breakout the mowing piece from the total operations jobs. Nor do I have information about the likely size of the sheep herd. This analysis of sheep activity is for discussion purposes only.

This substitution of sheep for crops and other agricultural activity at solar sites has been termed “agrivoltaics”, defined by the US Department of Agriculture as

....the combination of solar panels and agricultural production at the same location. Traditionally agrivoltaics referred to systems with crops—typically fruits or vegetables—grown under solar panels, but the term has evolved to include combining solar panels with grazing livestock (mainly sheep) and planting native grasses or pollinator habitat beneath solar panels.”²⁰



There is not much sheep farming in Metcalfe County today, so it is difficult to use current local data to extrapolate the revenues and regional economic impact²¹. However, there is a good literature on the economics of sheep farming that I have tapped to make some

²⁰ www.ers.usda.gov/amber-waves/2024/april/common-ground-for-agriculture-and-solar-energy-federal-funding-supports-research-and-development-in-agrivoltaics/#:~:text=Traditionally%20agrivoltaics%20referred%20to%20systems,pollinator%20habitat%20beneath%20solar%20panels.

²¹ According to the 2022 Census of Agriculture, there was an inventory of 765 sheep and lambs in Metcalfe County, of which 286 were sold, for an average of \$154 each.

reasonable assumptions. According to a recent detailed study by the University of California-Davis²², there are three types of sheep production operations:

The first type can be described as a part-time operation that runs a small number of animals (less than 50) usually a hobby-type enterprise. The second type includes medium-sized operations (75-500 sheep) that are run as a business, but the ranch is supplemented with income from other enterprises or from off-ranch sources. These operations may be meeting a demand for a specialty market, raising purebred breeding stock, or incorporating sheep into a diversified cropping system. The final category applies to large commercial sheep operations (>500 sheep) of varying sizes that may be part of a larger diversified operation with farming and other businesses. Often the ranches in the first and second categories are not profitable as an individual enterprise, while in category three, the ranches are generally a profitable business enterprise.

According to a major farm supply company, 100 sheep need about 30 acres of pasture land²³. Applied to the Summer Shade site, this implies about 2,500 head of sheep. Thus, the operation would be classified as a large commercial operation that is profitable. The results of the California study suggest that the Summer Shade operation would support five herders, earning \$3,445 per month, for a payroll of \$207,000. Gross revenues from the sale of meat and wool, using the study, would be \$840,000. The study does not explicitly calculate net profit to the owner of the flock.

Ideally, we could use the gross revenue assumption to predict the important regional economic impacts with our IMPLAN model of Metcalfe County. But the IMPLAN modeling system has a limitation when it comes to sheep farming. Sheep are counted under Sector 14 “Animal products except cattle and poultry”, but this sector includes hog and pig operations, as well as goats and horses. From the IMPLAN website: “Aggregating different products or services into a single category aggravates this problem. Dairy goats and sheep are lumped with pig farmers into Sector 14 “Animal Production”, yet neither a cheese maker nor a pork producer will view them as substitutable.”²⁴

²² *Sample Costs for Sheep Production*, UC Davis Department of Agriculture and Resource Economics, 2022, 14 pages,

<https://coststudyfiles.ucdavis.edu/uploads/pub/2022/07/07/2022sheepproductionsjvsouth.pdf>

²³ See www.qcsupply.com/blog/product-tips-and-how-tos/goats-vs-sheep.html#:~:text=You%20can%20reasonably%20expect%20to,flock%20to%20keep%20them%20fed.

²⁴ <https://support.implan.com/hc/en-us/articles/115009674588-Regional-Purchase-Coefficients>

In Metcalfe County, Sector 14 is dominated by sheep, though the numbers are very small. The 2022 Census of Agriculture shows inventories of 765 sheep, 106 hogs and pigs, 152 goats, and 119 horses. However, IMPLAN estimates that, while the sector supports 107 jobs, there is a net loss in farm income from this sector. Moreover, IMPLAN predicts no multiplier effects of sales or employment in Sector 14. There is a very small indirect effect from purchases of local supplies, but this is more than offset by the negative induced effect on household income. Thus, using current Metcalfe County data, any economic impact from sheep grazing at the solar site would be limited to the direct employment of shepherds.

Of course, the sheep herd expected at Summer Shade is several times larger than the current herd size in the entire county. Such a large operation would benefit from economies of scale, and thus be much more viable economically.