# Hamilton Steimer Capstone Project:
## Evaluating Contaminated Lands for Solar PV with Georgia Case Study

July 28th, 2020

# Outcome objectives:

- Improve the RE-Powering dataset
- Evaluate Georgia's contaminated lands for renewable energy generation
- Provide an in-depth analysis of one specific site – City of Tifton Landfill
- Discuss what types of polices other states are using that Georgia should consider

# DRAWDOWN GA

Georgia Tech | University of Georgia | Emory University | the Ray C. Anderson Foundation


# EPA's RE-Powering America's Land Initiative

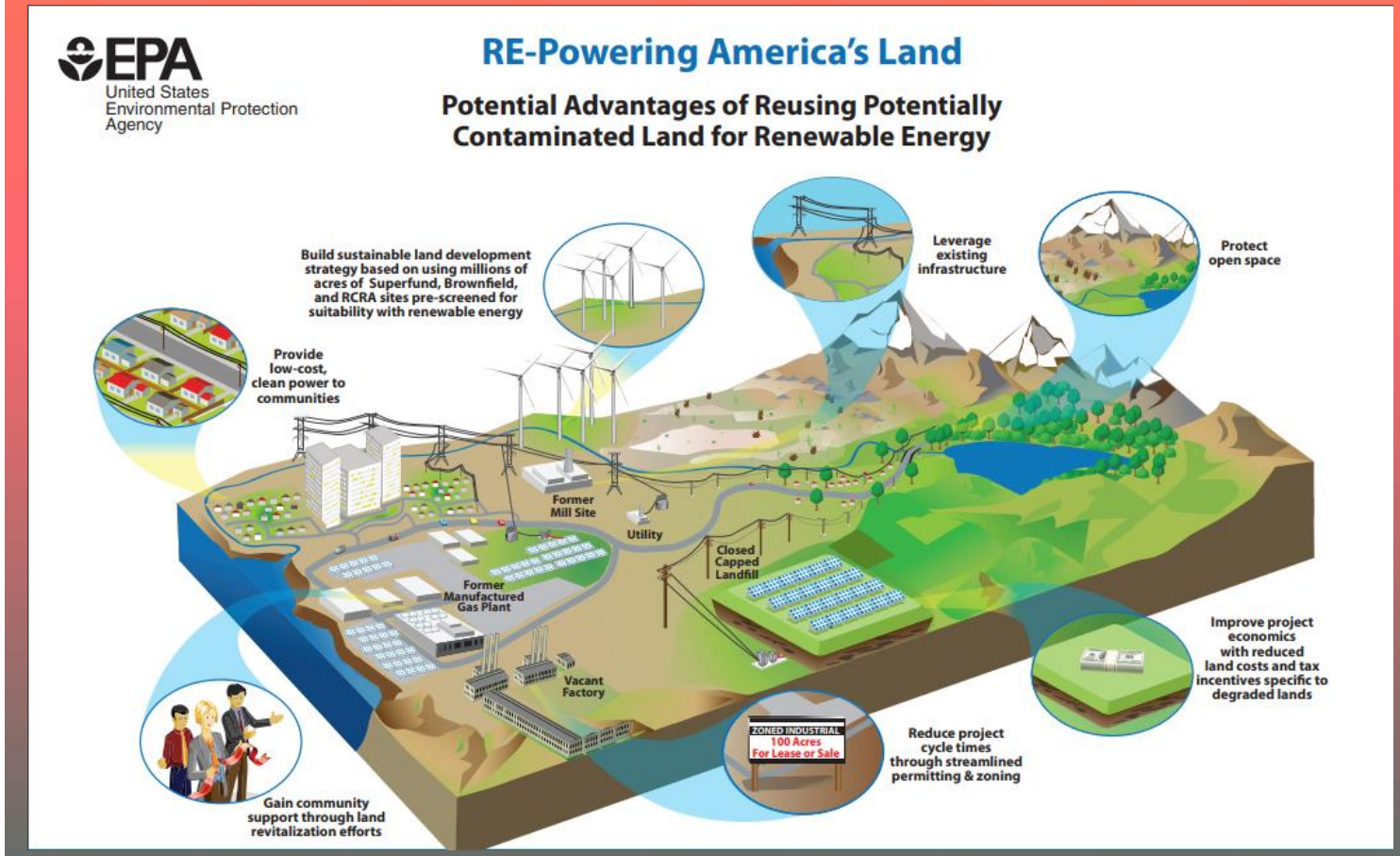
Created to encourage the transformation of contaminated lands into productive renewable energy sites

Provides resources to communities, developers, or anyone interested in reusing these sites for clean energy production

Has currently identified and assessed over 130,000 sites across the country for the renewable energy potential

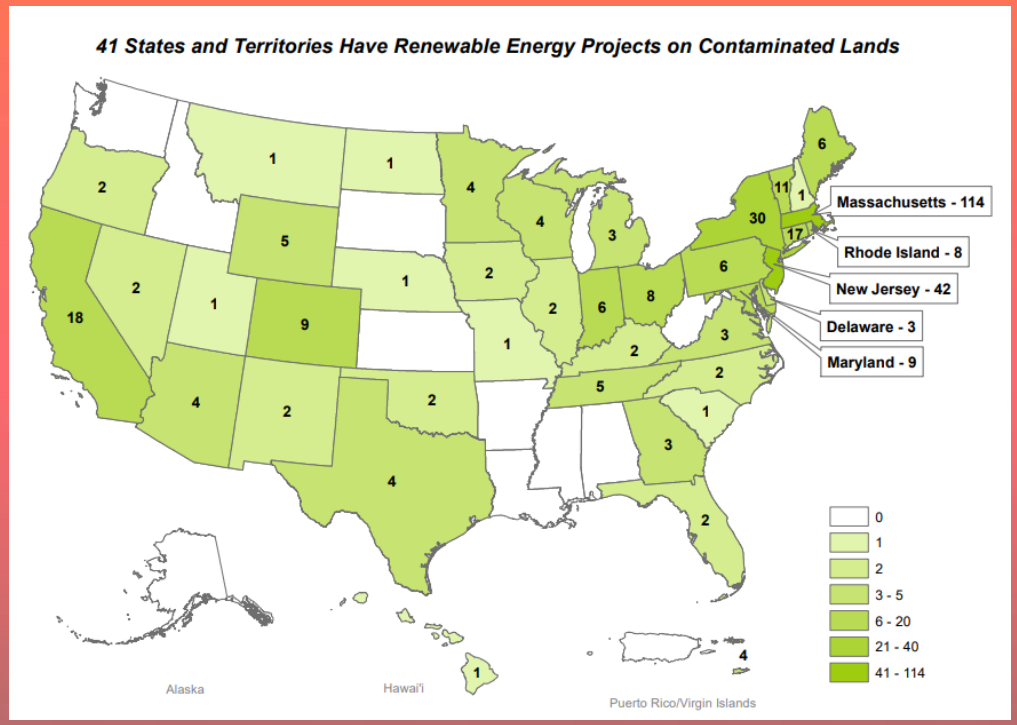
# Why use contaminated lands for renewable energy?

- Environmental benefits
- Low-cost electricity
- New jobs
- Increased tax revenues
- Improved project economics
- Potential project incentives



# Progress Around the Country

- Property Tax Exclusion for Solar Energy Systems (CA)
- Solar and CHP Sales Tax Exemption (FL)
- Renewable Energy and Energy Efficiency Portfolio Standard (NC)
- Solar Easements & Rights Laws (MA)




- **352 projects on 327 different sites**
- **Cumulative capacity of 1,710.2 MW**
- **91% of installations are solar PV**
- **64% of installations are on former landfills**
- **Massachusetts is number one**

# Adder Values

| Location Based Adders | |
|---|---|
| **Type** | **Adder Value ($/kWh)** |
| Agricultural | $0.06 |
| Building Mounted | $0.02 |
| Brownfield | $0.03 |
| Floating Solar | $0.03 |
| Landfill | $0.04 |
| Solar Canopy | $0.06 |

| Off-taker Based Adders | |
|---|---|
| **Type** | **Adder Value ($/kWh)** |
| Community Shared Solar (CSS) | $0.05 |
| Low Income Property Owner | $0.03 |
| Low Income CSS | $0.06 |
| Public Entity | $0.02 |

| Energy Storage Adder | |
|---|---|
| **Type** | **Adder Value ($/kWh)** |
| Storage + PV | Variable |

| Solar Tracking Adder | |
|---|---|
| **Type** | **Adder Value ($/kWh)** |
| Solar Tracking | $0.01 |

- 3,200 MW declining block tariff program
- Provides Fixed Compensation Rates to qualifying projects
- 20-year term for projects over 25 kW
- 4 categories of compensation adders

# Solar Massachusetts Renewable Target (SMART) Program

# Issues with RE-Powering Database

No map of location's counted acreage

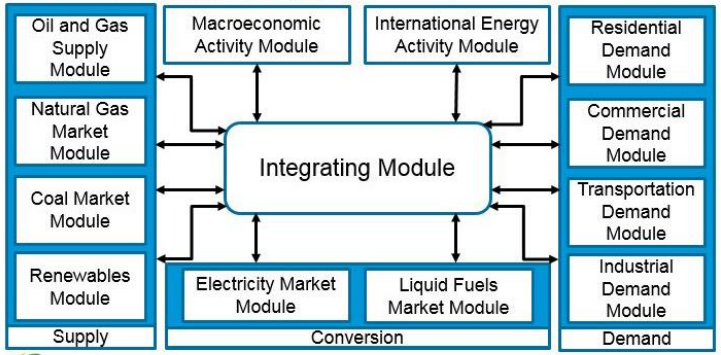
No terrain slope analysis

Questionable PV capacity density estimate

No financial information provided for considered sites


NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Figure 1. National Energy Modeling System




eia Source: U.S. Energy Information Administration, Office of Energy Analysis

# City of Tifton Landfill – 445 Mitchell Store Road

RE-Powering lists acreage as 62.8 acres but property records suggest the landfill may be 337.19 acres large

Eligible acres = 59.7 acres

With 8 acres/MW metric = 7.46 MW solar facility

Fixed-tilt with angle of 20 degrees

Panel efficiency of 19.1%

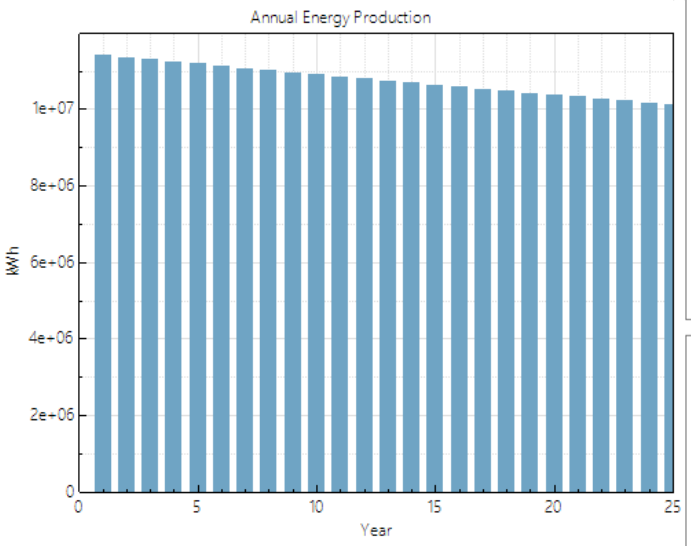
SAM executes based on location irradiation data, system size and type, design costs, incentives, financial parameters

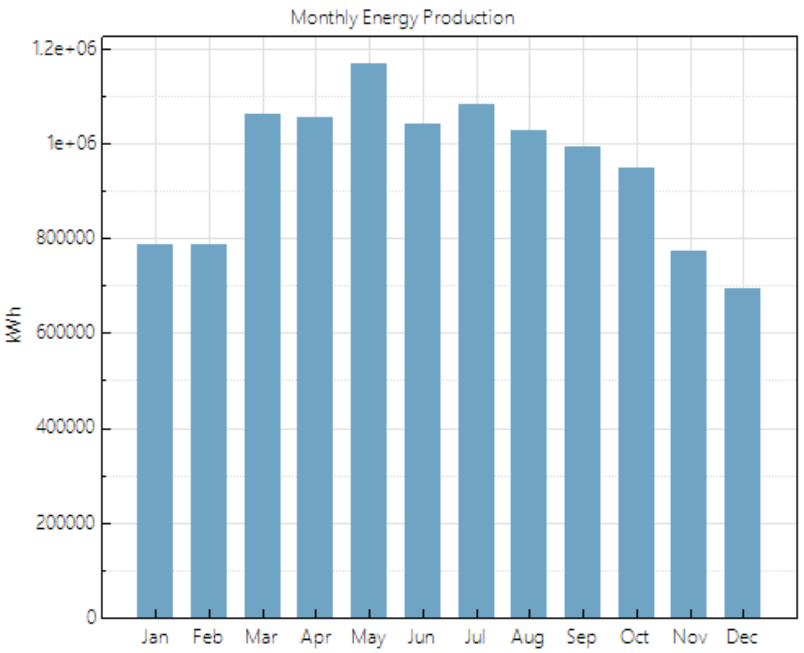
# SAM Results

System costs
- Total installed cost - $13,352,184
- Grid interconnection - $3,309,652
- Cost per capacity - $1.79/Wdc

Energy production
- 11,408,784 kWh in Year 1
- Over 268 million kWh by end of life (17.5% capacity)
- If at 22% capacity – 338,661,840 kWh

NPV
- $-2,265,919
- 22% capacity would greatly improve the NPV




**Direct Capital Costs**

| | | | | | | |
|---|---|---|---|---|---|---|
| Module | 1 units | 7,460.0 kWdc/unit | 7,460.0 kWdc | 0.43 | $/Wdc | $ 3,207,800.00 |
| Inverter | 1 units | 5,485.3 kWac/unit | 5,485.3 kWac | 0.07 | $/Wdc | $ 522,200.00 |

| | $ | | $/Wdc | | |
|---|---|---|---|---|---|
| Balance of system equipment | 0.00 | | 0.32 | | $ 2,387,200.00 |
| Installation labor | 0.00 | + | 0.15 | = | $ 1,119,000.00 |
| Installer margin and overhead | 0.00 | | 0.10 | | $ 746,000.00 |
| | | | | Subtotal | $ 7,982,200.00 |

**Contingency**

Contingency 3 % of subtotal $ 239,466.00

**Total direct cost** $ 8,221,666.00

**Indirect Capital Costs**

| | % of direct cost | | $/Wdc | | $ | | |
|---|---|---|---|---|---|---|---|
| Permitting and environmental studies | 0 | | 0.03 | | 0.00 | | $ 223,800.00 |
| Engineering and developer overhead | 0 | + | 0.15 | + | 0.00 | = | $ 1,119,000.00 |
| Grid interconnection | 0 | | 0.00 | | 3,309,652.00 | | $ 3,309,652.00 |

**Land Costs**

| | | | | | | |
|---|---|---|---|---|---|---|
| Land purchase | 0 | + | 0.00 | + | 0.00 | = $ 0.00 |
| Land prep. & transmission | 0 | | 0.02 | | 0.00 | $ 149,200.00 |

**Sales Tax**

s tax basis, percent of direct cost 100 % Sales tax rate 4.0 % $ 328,866.63

**Total indirect cost** $ 5,130,518.50

**st**

talled cost is the sum of the direct and indirect costs. Note
ıot include any financing costs from the Financial
›age.

**Total installed cost** $ 13,352,184.00

Total installed cost per capacity $ 1.79/Wdc

**ıintenance Costs**

| | First year cost | | Escalation rate (above inflation) |
|---|---|---|---|
| Fixed annual cost | 0 | $/yr | 0 % |
| ‹ed cost by capacity | 13 | $/kW-yr | 0 % |
| ɛ cost by generation | 0 | $/MWh | 0 % |

In Value mode, SAM applies both inflation and escalation to the first year cost to calculate out-year costs. In Schedule mode, neither inflation nor escalation applies. See Help for details.

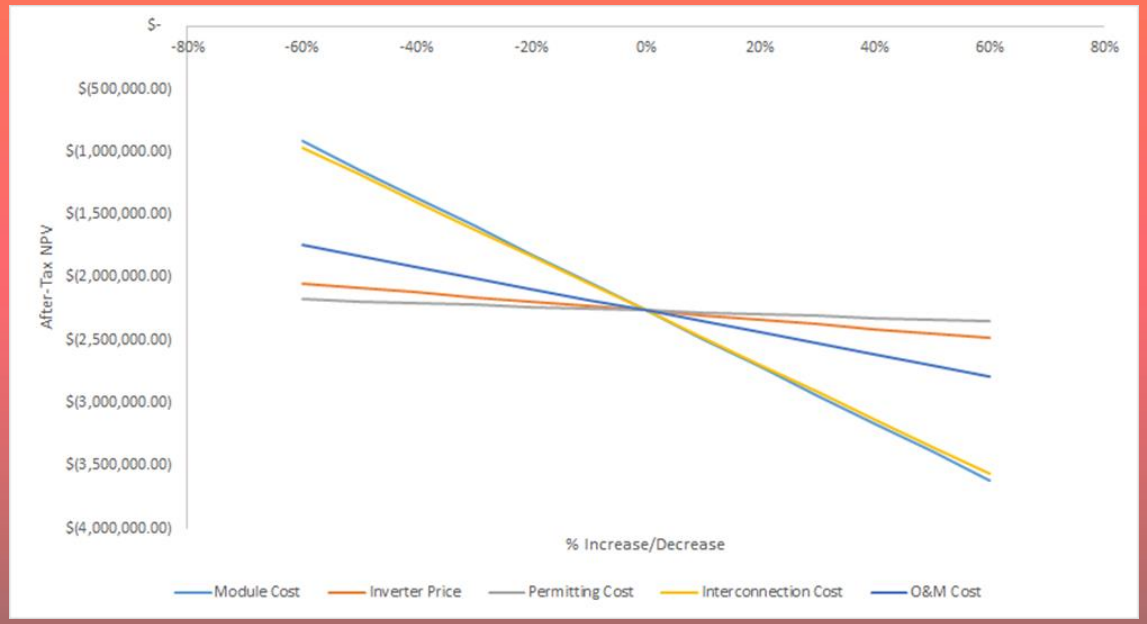
| Year | Energy Produced (kWh) | GA Electricity Carbon Intensity (kg/kWh) | CO2 Reduction (kg) |
|---|---|---|---|
| 1 | | 0.4629 | |
| 2 | 11,408,800.00 | 0.4558 | 5,200,584.82 |
| 3 | 11,351,700.00 | 0.4388 | 4,980,881.54 |
| 4 | 11,295,000.00 | 0.4551 | 5,139,811.68 |
| 5 | 11,238,500.00 | 0.4751 | 5,339,443.50 |
| 6 | 11,182,300.00 | 0.4836 | 5,407,737.80 |
| 7 | 11,126,400.00 | 0.4832 | 5,376,546.27 |
| 8 | 11,070,800.00 | 0.4791 | 5,304,007.79 |
| 9 | 11,015,400.00 | 0.4783 | 5,269,175.53 |
| 10 | 10,960,300.00 | 0.4915 | 5,387,474.88 |
| 11 | 10,905,500.00 | 0.4668 | 5,090,761.60 |
| 12 | 10,851,000.00 | 0.4650 | 5,045,404.54 |
| 13 | 10,796,800.00 | 0.4432 | 4,785,270.07 |
| 14 | 10,742,800.00 | 0.4466 | 4,798,112.92 |
| 15 | 10,689,100.00 | 0.4436 | 4,741,291.53 |
| 16 | 10,635,600.00 | 0.4404 | 4,683,767.02 |
| 17 | 10,582,400.00 | 0.4356 | 4,610,118.51 |
| 18 | 10,529,500.00 | 0.4198 | 4,420,151.67 |
| 19 | 10,476,900.00 | 0.4213 | 4,413,805.61 |
| 20 | 10,424,500.00 | 0.4353 | 4,537,875.42 |
| 21 | 10,372,400.00 | 0.4385 | 4,548,713.62 |
| 22 | 10,320,500.00 | 0.4374 | 4,514,507.16 |
| 23 | 10,268,900.00 | 0.4368 | 4,485,125.10 |
| 24 | 10,217,600.00 | 0.4495 | 4,592,816.67 |
| 25 | 10,166,500.00 | 0.4351 | 4,423,724.85 |
| 26 | 10,115,600.00 | 0.4281 | 4,329,988.88 |
| | | Total CO2 Reduction: | 121,427,098.99 |

| | 2.50% | | 3% | | 5% | |
|---|---|---|---|---|---|---|
| Year | 2007 $ | 2020 $ | 2007 $ | 2020 $ | 2007 $ | 2020 $ |
| 2020 | 62 | 79 | 42 | 53 | 12 | 15 |
| 2021 | 63 | 80 | 42 | 53 | 12 | 15 |
| 2022 | 64 | 81 | 43 | 55 | 13 | 17 |
| 2023 | 65 | 83 | 44 | 56 | 13 | 17 |
| 2024 | 66 | 84 | 45 | 57 | 13 | 17 |
| 2025 | 68 | 86 | 46 | 58 | 14 | 18 |
| 2026 | 69 | 88 | 47 | 60 | 14 | 18 |
| 2027 | 70 | 89 | 48 | 61 | 15 | 19 |
| 2028 | 71 | 90 | 49 | 62 | 15 | 19 |
| 2029 | 72 | 91 | 49 | 62 | 15 | 19 |
| 2030 | 73 | 93 | 50 | 64 | 16 | 20 |
| 2031 | 74 | 94 | 51 | 65 | 16 | 20 |
| 2032 | 75 | 95 | 52 | 66 | 17 | 22 |
| 2033 | 76 | 97 | 53 | 67 | 17 | 22 |
| 2034 | 77 | 98 | 53 | 67 | 18 | 23 |
| 2035 | 78 | 99 | 55 | 70 | 18 | 23 |
| 2036 | 79 | 100 | 56 | 71 | 19 | 24 |
| 2037 | 81 | 103 | 57 | 72 | 19 | 24 |
| 2038 | 82 | 104 | 58 | 74 | 20 | 25 |
| 2039 | 83 | 105 | 59 | 75 | 20 | 25 |
| 2040 | 84 | 107 | 60 | 76 | 21 | 27 |
| 2041 | 85 | 108 | 61 | 77 | 21 | 27 |
| 2042 | 86 | 109 | 61 | 77 | 22 | 28 |
| 2043 | 87 | 110 | 62 | 79 | 22 | 28 |
| 2044 | 88 | 112 | 63 | 80 | 23 | 29 |
| 2045 | 89 | 113 | 64 | 81 | 23 | 29 |
| 2046 | 90 | 114 | 65 | 83 | 24 | 30 |
| 2047 | 92 | 117 | 66 | 84 | 24 | 30 |
| 2048 | 93 | 118 | 67 | 85 | 25 | 32 |
| 2049 | 94 | 119 | 68 | 86 | 25 | 32 |
| 2050 | 95 | 121 | 69 | 88 | 26 | 33 |

| | | | 2.50% | |
|---|---|---|---|---|
| Year | Project CO2 Emissions Reduction (Mt) | 2020 $ | Monetized Benefits | Discounted Benefits |
| 2021 | 5201 | 80 | $ 416,047 | $ 416,046.79 |
| 2022 | 4981 | 81 | $ 403,451 | $ 393,611.13 |
| 2023 | 5140 | 83 | $ 426,604 | $ 406,048.18 |
| 2024 | 5339 | 84 | $ 448,513 | $ 416,489.14 |
| 2025 | 5408 | 86 | $ 465,065 | $ 421,326.35 |
| 2026 | 5377 | 88 | $ 473,136 | $ 418,183.35 |
| 2027 | 5304 | 89 | $ 472,057 | $ 407,053.01 |
| 2028 | 5269 | 90 | $ 474,226 | $ 398,949.68 |
| 2029 | 5387 | 91 | $ 490,260 | $ 402,379.39 |
| 2030 | 5091 | 93 | $ 473,441 | $ 379,097.50 |
| 2031 | 5045 | 94 | $ 474,268 | $ 370,497.42 |
| 2032 | 4785 | 95 | $ 454,601 | $ 346,471.52 |
| 2033 | 4798 | 97 | $ 465,417 | $ 346,063.51 |
| 2034 | 4741 | 98 | $ 464,647 | $ 337,064.09 |
| 2035 | 4684 | 99 | $ 463,693 | $ 328,168.10 |
| 2036 | 4610 | 100 | $ 461,012 | $ 318,312.80 |
| 2037 | 4420 | 103 | $ 455,276 | $ 306,685.01 |
| 2038 | 4414 | 104 | $ 459,036 | $ 301,676.05 |
| 2039 | 4538 | 105 | $ 476,477 | $ 305,500.76 |
| 2040 | 4549 | 107 | $ 486,712 | $ 304,452.07 |
| 2041 | 4515 | 108 | $ 487,567 | $ 297,547.83 |
| 2042 | 4485 | 109 | $ 488,879 | $ 291,071.64 |
| 2043 | 4593 | 110 | $ 505,210 | $ 293,458.54 |
| 2044 | 4424 | 112 | $ 495,457 | $ 280,774.22 |
| 2045 | 4330 | 113 | $ 489,289 | $ 270,515.69 |
| | | | Summed: | $ 8,757,444 |

# Calculating and Monetizing Environmental Benefits

# Parametric Analysis





Things to Note:

- 17.5% capacity factor makes the economics of the system appear less favorable
- Interconnection and module costs are the most influential system costs
- Electricity prices and Federal ITC are the most important financial parameters

# Closing Points

- My improved dataset better identifies eligible contaminated sites for clean energy projects
- I have found the energy production potential and environmental benefits for the eligible sites in the dataset
- The City of Tifton Landfill seems like a risky option for a new solar facility, but it could be improved given the right incentives
- SAM suggests what types of policies can improve project's NPV (tax exemptions, improved ITC, production-based incentives)
- The Georgia legislature, PSC, and local communities can better support clean energy projects in the state

## What if the SMART Program was done in Georgia?

| Run | pbi_sta_amount ($/kWh) | pbi_sta_escal (%/year) | pbi_sta_term (years) | project_return_aftertax_npv ($) |
|---|---|---|---|---|
| 1 | 0.106645 | 0.83 | 20 | $ 5,824,570.00 |
| 2 | 0.04 | 0.83 | 20 | $ 768,632.00 |
| 3 | 0.146645 | 0.83 | 20 | $ 8,859,120.00 |
| 4 | 0 | 0 | 0 | $ (2,265,920.00) |