**Technical Appendix**

**GHG Reductions Assumptions and Calculations – the following sheets contain the assumptions and calculations for the savings in energy for Solar Powered Pivots, Reduction in Energy for Grain Transport and N2O Reduction due to Farm Practices.**

**Table B-1**



**Table B-2 Assumptions for calculations of Amount of Energy Produced by Solar Arrays**

**Estimating Annual Power Generation From Solar Panels**

1. According to the following site:

<https://photovoltaic-software.com/principle-ressources/how-calculate-solar-energy-power-pv-systems>

The global formula to estimate the electricity generated in output of a photovoltaic system is:

E = A \* r \* H \* PR

Where

E = Energy (kWh)

A = Total solar panel Area (m2)

r = solar panel yield or efficiency (%)

H = Annual average solar radiation on tilted panels (shadings not included)

PR = Performance ratio, coefficient for losses (range between 0.5 and 0.9, default value = 0.75)

r is the yield of the solar panel given by the ratio: electrical power (in kWp) of one solar panel divided by the area of one panel.

Example : the solar panel yield of a PV module of 250 Wp with an area of 1.6 m2 is 15.6%.

Be aware that this nominal ratio is given for standard test conditions (STC): radiation=1000 W/m2, cell temperature=25 Celsius degree, Wind speed=1 m/s, AM=1.5.

The unit of the nominal power of the photovoltaic panel in these conditions is called "Watt-peak" (Wp or kWp=1000 Wp or MWp=1000000 Wp).

H is the annual average solar radiation on tilted panels. This is also referred to as PSH.

PR : PR (Performance Ratio) is a very important value to evaluate the quality of a photovoltaic installation because it gives the performance of the installation independently of the orientation, inclination of the panel. It includes all losses due to the site, the technology, and sizing of the system such as:

- Inverter losses (4% to 10 %), Temperature losses (5% to 20%), DC cables losses (1 to 3 %), AC cables losses (1 to 3 %), Shadings 0 % to 80% (specific to each site), Losses at weak radiation 3% to 7%, Losses due to dust, snow... (2%)

Standard PR is 75%, which is what we assume for GHG reductions.

1. A = (12 farms) \* (1.5 acre/farm) \* (4046.9 m^2/acre) = 72844.2 m^2

Assuming 12 farms, each having 1.5-acre solar panel installation.

1. r - Solar panel efficiency of a PV device measures the ability to convert sunlight energy into usable electricity (kilowatt-hours per square foot).

<https://www.energy.gov/eere/solar/solar-performance-and-efficiency>

The following table shows the improvement of efficiency from 1976 to present:

<https://www.nrel.gov/pv/cell-efficiency.html>

The following table indicates most commercial panels having more than 20% efficiency:

<https://www.solar.com/learn/solar-panel-efficiency/>

We use a conservative (lower-level) efficiency of 20% for power estimates here.

1. H or PSH: A peak sun hour is defined as an hour in the day when the intensity of the sunlight reaches an average of 1000 watts/meter². For example, a location that gets 5 PSH (kWh/m²), means that area gets 5 hours of solar power when the average intensity of sunlight is 1000 watts/meter².

For Alabama = 4.5 (from the following link)

<https://8msolar.com/what-is-a-peak-sun-hour-psh/>

Using NERL tool (https://pvwatts.nrel.gov/) for Montgomery, Alabama, we get an average of 5.34 kWh/day. Thus 4.5 kWh/day is a conservative value.

**TOTAL POWER GENERATION FROM SOLAR PANELS:**

**Assumptions and parameters:**

Solar panel area: 1.5 acre/farm

Total number of farms: 12 farms

Average PSH for Alabama: 4.5 kWh/(m^2 day)

Performance ratio: 75%

Average Alabama power CO2 emissions for 2022: 794 lb/MWh = 360.2 kg/MWh

Solar panel efficiency: 20%

1 acre = 4046.9 m^2

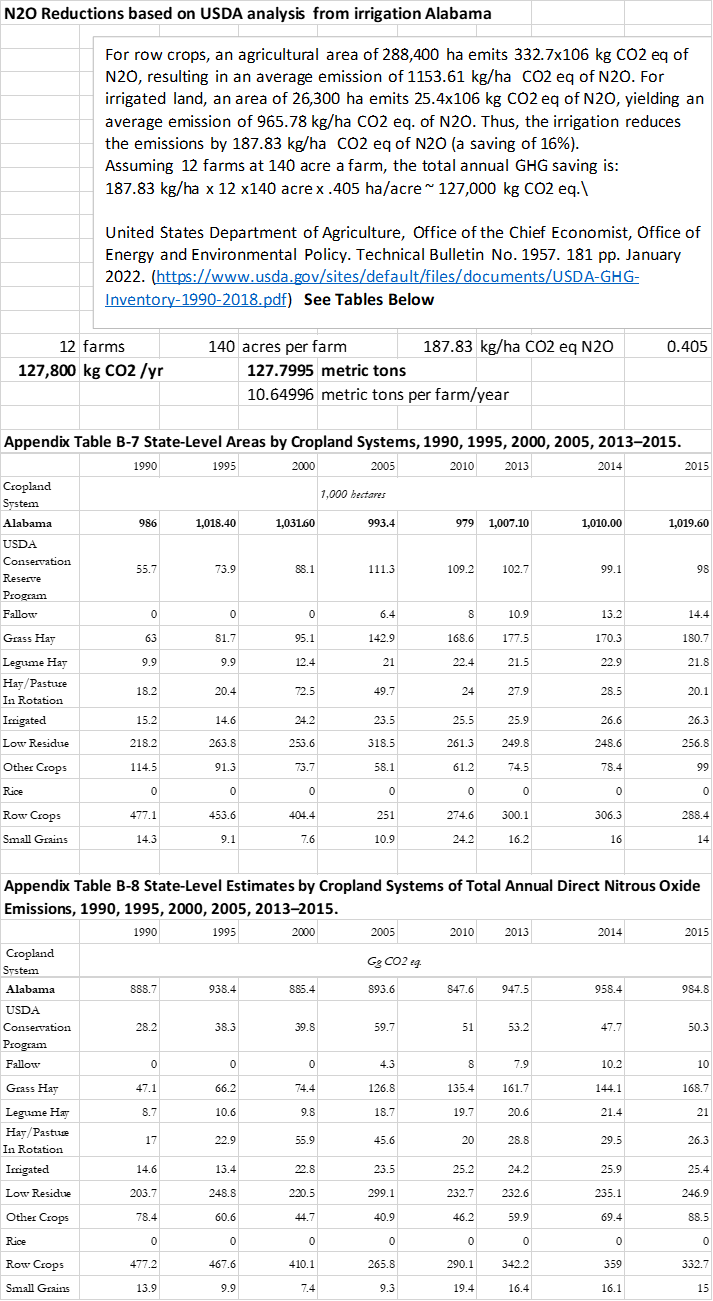
Using E = A \* r \* H \* PR

Total power @75% = (12 farms) \* (1.5 acre/farm) \* (4046.9 m^2/acre) \* (4.5 kWh/m^2/day) \* (365 days/year) \* (0.001 MWh/kWh) \* (0.20) \* (.75) = 17,947.4 MWh/year

**Table B-3 Energy Savings Due to Barge Transport – Shipping of Grain From Midwest Avoided**



**Table B-4 N2O reductions based on irrigation from USDA Alabama Statistics**



**Table B-5 GHG Reduction Calculations for Pivots, Barge Transport and N2O**



**Table B-6 Cumulative GHG Reductions for All Components**

**Table B-7 Summary of Cumulative Emission Reductions**

