

# **Project Part 1: Solar Green Fielding**

**Course:** ECE 592: Utility Scale Solar PV Systems

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# **Content**

## **1. North Carolina**

- 1.1. Search for Land Parcels
- 1.2. Terabase Energy Analysis

## **2. Texas**

- 2.1. Search for Land Parcels
- 2.2. Terabase Energy Analysis

## **3. California**

- 3.1. Search for Land Parcels
- 3.2. Terabase Energy Analysis

## **4. Illinois**

- 4.1. Search for Land Parcels
- 4.2. Terabase Energy Analysis

# 1. North Carolina

## 1.1. Search for Land Parcels

- 1) The analysis initially focused on the **central region**, excluding the western areas with large mountain ranges and the eastern region dominated by hydric soils.
- 2) The assessment was conducted for areas with relatively flat terrain and substations of adequate capacity. However, the presence of steep slopes posed significant challenges during the evaluation process.
- 3) A preliminary analysis was performed using layers that allowed for rapid assessment, including corrosion potential of steel, soil susceptibility, water table depth, and bedrock depth. Due to the irregular shape of parcels in North Carolina, a considerable amount of time was required to identify counties with appropriately sized parcels.
- 4) Based on the findings, **Vance County** was selected as the target area due to its relatively flat terrain, the presence of a substation, and the availability of parcels of suitable sizes.
- 5) Information on **Transmission Lines** (Table 1) and **Substations** (Table 2)

Table 1. Transmission Lines of Vance County

Category	Transmission Line 1	Transmission Line 2
Layer	Premium – Capacity (NC): Discharging Summer Peak	
Name	Castalia to Henderson East	Henderson North to Bullok Solar
Headroom Capacity (MW)	513.1	158.5
Voltage (KV)	230	115
Distance to Nearest Parcel (mi)	0.0	2.62

Table 2. Substations of Vance County

Category	Substation 1	Substation 2
Layer	Premium – Capacity (NC): Discharging Summer Peak	
Name	Henderson East	Henderson North
Headroom Capacity (MW)	532.9	87.1
Voltage (KV)	230	115
Distance to Nearest Parcel (mi)	2.45	0.24

## 6) Zoning Ordinance, Vance County [1]

Table 3. Development Requirements of Vance County

Category	Content
Height	Not exceed 25 ft
Setback	<ul style="list-style-type: none"><li>100 ft from street ways</li><li>50 ft from other property lines</li></ul>
Screening and Fencing	<ul style="list-style-type: none"><li>Minimum 8 ft for structures</li><li>30 ft Vegetative buffer for entire perimeter</li></ul>
Power Transmission Lines	New power lines shall be located underground.
Utility Notification	The owner has been approved by the utility company.

## 7) Information on Land Parcels

Table 4. Information on Land Parcels of Vance County

Category	Content
Lot Area (Acres)	1,606.95
Buildable Area (Acres)	1,107.6
Hydric Soils	Mostly non-hydric
Bedrock Depth	Mostly unknown
Corrosion Potential of Steel	Mostly moderate
Soil Susceptibility to Forest Heaving	Low

## 8) IRA incentives

- **2024 Coal Closure Energy Communities:** Partially adjoins a tract with a coal closure
- **30C Eligible tract through 2029 (2011-2015 NMTC tracts):** Partially
- **30C Eligible tract through 2030 (2011-2015 NMTC tracts)**
- **Low Income Communities (48e):** Census tracts that meet the New Market Tax Credit Program's threshold for Low Income
- **Section 48C Tax Credits:** Partially

## 1.2. Terabase Energy Analysis

- When importing the Buildable Area to Plant Predict, the parcels were fragmented due to the irregular shape of the provided boundary, as illustrated in Figure 1. To ensure accurate simulation execution, a conservative approach was adopted by **manually selecting the Buildable Area boundary**, which was then used to generate the site plan.

- Since it was difficult to obtain an appropriate AC (MW) value when setting the Row Spacing to 7.62 in the simulation, the automatically generated value was used instead. The outcomes of the simulation are presented in Table 5, and Figure 2.



Figure 1. Fragmented buildable area boundary

- **AC Capacity:** 122.85 MW, meeting the project target.
- **Clipping Loss:** -13.52%, caused by a high DC/AC ratio (1.199).
- **Total Grading:** 392,617 bcm, requiring large-scale work due to dense vegetation.
- **Land Use:** 53.8%, reflecting the impact of the densely vegetated site.

Table 5. Terabase Energy Analysis Result

System Characteristics		Plant Characteristics	
Category	Content	Category	Content
Locality	Henderson, NC	Avg Azimuth (°)	180
AC size (MW)	122.85	Avg Row Spacing (m)	7.95
DC size (MW)	147.32	Avg GCR (%)	30
Plant Limit (MW)	Off	Avg DC Array Size (MW)	3.78
# of Arrays	39	Avg AC Array Size (MW)	3.15
DC:AC Ratio	1.1992	-	-
Grid Voltage (kV)	34.5	-	-

2.

GCR	DC/AC	DC (MW)	AC (MW)	Yield (kWh/kWp)	Clipping Loss (%)	Total grading (bcm)	EPC Cost (\$/W)	sLCOE (\$/kWh)	Land Use (%)
0.3	1.199	147.32	122.85	1593.83	-13.52%	392,617	0.9137	0.0691	53.8

Figure 2. Terabase Energy Analysis Result of Vance County

## 2. Texas

### 2.1. Search for Land Parcels

- 1) The initial assessment focused on counties with predominantly flat terrain, a substation with high headroom capacity, and minimal presence of hydric soils.
- 2) Among the counties meeting these criteria, those with significant eligibility for IRA incentives were selected. Special attention was required in land selection due to the presence of wind farms near some substations. As a result, **Wilbarger County** was chosen as the target area.
- 3) Information on **Transmission Lines** (Table 6) and **Substations** (Table 7)

Table 6. Transmission Lines of Wilbarger County

Category	Content
Layer	Premium – Capacity (TX, ERCOT): Discharging Summer Peak Stressed - Branch
Name	Blue Dove Poi to Wellington
Headroom Capacity (MW)	474.5
Voltage (KV)	138
Distance to Nearest Parcel (mi)	0.82

Table 7. Substations of Wilbarger County

Category	Content
Layer	Premium – Capacity (TX, ERCOT): Discharging Summer Peak Stressed - Branch
Name	Blue Summit
Headroom Capacity (MW)	388.5
Voltage (KV)	345
Distance to Nearest Parcel (mi)	1.34

- 4) **No specific solar energy ordinances** were identified in Wilbarger County. A review of solar installation procedures across Texas, conducted by the North Central Texas Council of Governments and the North Texas Renewable Energy Group, indicated that fewer than 20 cities in Texas have dedicated solar-related ordinances [2]. Additionally, Homeowners Associations (HOAs) and Property Owners Associations (POAs) cannot prohibit or restrict a property owner from installing a solar energy device, except

under specific conditions [3]. Therefore, the example template used in the course was applied for this project.

## 5) Information on Land Parcels

Table 8. Information on Land Parcels of Wilbarger County

Category	Content
Lot Area (Acres)	2,383.18
Buildable Area (Acres)	1,820.10
Hydric Soils	Mostly non-hydric, partially 1-25%
Bedrock Depth	Mostly unknown, partially 101-200 cm
Corrosion Potential of Steel	Half high, half moderate
Soil Susceptibility to Forest Heaving	Low

## 6) IRA incentives

- **2024 Coal Closure Energy Communities:** Census tract with a coal closure
- **2024 MSAs/non-MSAs that only meet the FFE Threshold**
- **30C Eligible tract through 2029 (2011-2015 NMTC tracts)**
- **30C Eligible tract through 2030 (2011-2015 NMTC tracts)**
- **Low Income Communities (48e):** Census tracts that meet the New Market Tax Credit Program's threshold for Low Income
- **Section 48C Tax Credits**

## 2.2. Terabase Energy Analysis

- The site plan was analyzed by manually selecting the buildable area boundary, as was done in the case of NC. The summarized results are shown in Table 9 and Figure 3.
- **AC Capacity:** 264.6 MW, meeting the project target.
- **Yield:** 2058.82 kWh/kWp
- **Clipping Loss:** -0.22%, indicating minimal power loss.
- **Total Grading:** 43,346 bcm, requiring relatively low grading work.

Table 9. Terabase Energy Analysis Result

System Characteristics		Plant Characteristics	
Category	Content	Category	Content
Locality	Vernon, TX	Avg Azimuth (°)	180
AC size (MW)	359.10	Avg Row Spacing (m)	7.62
DC size (MW)	394.77	Avg GCR (%)	31.30
Plant Limit (MW)	Off	Avg DC Array Size (MW)	3.46
# of Arrays	114	Avg AC Array Size (MW)	3.15
DC:AC Ratio	1.0993	-	-
Grid Voltage (kV)	34.5	-	-

GCR	DC/AC	DC (MW)	AC (MW)	Yield (kWh/kWp)	Clipping Loss (%)	Total grading (bcm)	EPC Cost (\$/W)	① sLCOE (\$/kWh)	Land Use (%)
0.313	1.064	281.658	264.6	2058.82	-0.22%	43,346	0.7102	0.0417	73.3%

Figure 3. Terabase Energy Analysis Result of Wilbarger County



## 3. California

### 3.1. Search for Land Parcels

- 1) For California, the analysis focused on southern counties where desert areas are predominantly located.
- 2) Multiple solar farms were identified in the southern region of **Kern County**. A high-voltage transmission line and a high-capacity substation were also observed near these solar farms. The specifications of each are presented in Table 10 and Table 11.

Table 10. Transmission Lines of Kern County

Category	Content
Layer	Premium – Capacity (CASIO): Headroom Capacity MW Summer Peak ERIS Branch Discharging - Lines
Name	O'Banion to Olinda
Headroom Capacity (MW)	564.9
Voltage (KV)	230
Distance to Nearest Parcel (mi)	1.74

Table 11. Substations of Kern County

Category	Content
Layer	Premium – Capacity (CASIO): Headroom Capacity MW Summer Peak ERIS Branch Discharging - Lines
Name	Gaskel West Solar farm
Headroom Capacity (MW)	360.3
Voltage (KV)	230
Distance to Nearest Parcel (mi)	1.12

- 3) The area contained numerous vacant plots of land with rectangular divisions, allowing for an expedited review through layered analysis. Ultimately, lands with minimal hydric soils were selected and designated as California parcels.
- 4) One key consideration was the occasional presence of parcels owned by the U.S. government, as shown in Figure 14, which needed to be carefully avoided in the selection process. For this project, efforts were made to select land owned by a single company as much as possible, even if the parcels were not contiguous.

5) While ordinances related to residential solar installations in Kern County were identified [4], **specific regulations regarding ground-mounted solar installations were not found**. Consequently, the buildable area was analyzed based on the course materials.

6) Information on Land Parcels

Table 12. Information on Land Parcels of Kern County

Category	Content
Lot Area (Acres)	1,565.37
Buildable Area (Acres)	1,303.9
Hydric Soils	Mostly non-hydric, partially 1-25%
Bedrock Depth	Mostly unknown
Corrosion Potential of Steel	Mostly high, partially moderate
Soil Susceptibility to Forest Heaving	Low

7) IRA incentives

- **2024 MSAs/non-MSAs that are Energy Communities as of 6/7/24**
- **30C Eligible tract through 2030 (2011-2015 NMTC tracts)**

### 3.2. Terabase Energy Analysis

- The site plan was analyzed by manually selecting the buildable area boundary, as was done in the case of NC. The summarized results are shown in Table 13 and Figure 4.
- **AC Capacity:** 192.15 MW, achieving the project target.
- **Yield:** 2410.95 kWh/kWp
- **Clipping Loss:** -0.45%, indicating minimal power loss in the system.
- **Total Grading:** 148,530 bcm, reflecting a moderate amount of land leveling work.
- **Land Use:** 74.9%, effectively utilizing the available site.

Table 13. Terabase Energy Analysis Result

System Characteristics		Plant Characteristics	
Category	Content	Category	Content
Locality	Lancaster, CA	Avg Azimuth (°)	180
AC size (MW)	192.15	Avg Row Spacing (m)	7.62
DC size (MW)	212.11	Avg GCR (%)	31.30
Plant Limit (MW)	Off	Avg DC Array Size (MW)	3.48
# of Arrays	61	Avg AC Array Size (MW)	3.15
DC:AC Ratio	1.1039	-	-
Grid Voltage (kV)	34.5	-	-

GCR	DC/AC	DC (MW)	AC (MW)	Yield (kWh/kWp)	Clipping Loss (%)	Total grading (bcm)	EPC Cost (\$/W)	sLCOE (\$/kWh)	Land Use (%)
0.313	1.104	212.114	192.15	2410.95	-0.45%	148,530	0.7192	0.036	74.9%

Figure 4. Terabase Energy Analysis Result of Kern County

## 4. Illinois

### 4.1. Search for Land Parcels

- 1) Illinois is predominantly composed of hydric soil. Additionally, a significant amount of time was required to identify parcels that met the conditions for steel corrosion potential and soil susceptibility.
- 2) The areas with the highest potential were located near the river flowing along the left side of Illinois. While several counties, such as Henderson County and Rock Island County, showed promise, only **Rock Island County** satisfied the conditions of having high-capacity substations and high-voltage transmission lines near the parcels.

- 3) Information on Transmission Lines (Table 14) and Substations (Table 15)

Table 14. Transmission Lines of Rock Island County

Category	Content
Layer	Premium – Capacity (IL, MISO): ERIIS Discharging Summer Peak - Branch
Name	TapBus 99033 to Cordova Energy
Headroom Capacity (MW)	276
Voltage (KV)	345
Distance to Nearest Parcel (mi)	0.02

Table 15. Substations of Rock Island County

Category	Content
Layer	Premium – Capacity (IL, MISO): ERIIS Discharging Summer Peak - Branch
Name	Cordova Energy
Headroom Capacity (MW)	310
Voltage (KV)	345
Distance to Nearest Parcel (mi)	0.05

#### 4) Rock Island County Ordinance [5]

Table 16. Development Requirements of Rock Island County

Category	Content
Height Restriction	Maximum 20 ft
Setback Distances	<ul style="list-style-type: none"><li>▪ 150 ft from the nearest point of an occupied community building or a dwelling on nonparticipating property.</li><li>▪ 0 ft from the boundary line of participating property.</li><li>▪ 50 ft from the nearest edge of a public road right-of-way.</li><li>▪ 50 ft from the nearest point on the property line of any nonparticipating property.</li></ul>
Screening Requirements	<ul style="list-style-type: none"><li>▪ Must be at least 6 ft high and no more than 25 ft.</li><li>▪ Vegetative screening may be added along the perimeter to reduce visual impact on nonparticipating properties and public roads.</li></ul>
Utility Connection	If the solar energy facility is connected to the power grid, it must: Provide proof of an offtake agreement with a utility or registration with the Regional Transmission Operator for power sales.

#### 5) Information on Land Parcels

Table 17. Information on Land Parcels of Rock Island County

Category	Content
Lot Area (Acres)	1,004.88
Buildable Area (Acres)	952.4
Hydric Soils	Mostly partially hydric 1-25%
Bedrock Depth	Mostly unknown
Corrosion Potential of Steel	Mostly moderate, partially high
Soil Susceptibility to Forest Heaving	Mostly Low

#### 8) IRA incentives

- **30C Eligible tract through 2030 (2011-2015 NMTC tracts)**

### 4.2. Terabase Energy Analysis

- The site plan was analyzed by manually selecting the buildable area boundary, as was done in the case of NC. The summarized results are shown in Table 18 and Figure 4.
- **AC Capacity:** 144.9 MW, meeting the project's capacity requirements.
- **Yield:** 1773.27 kWh/kWp
- **Clipping Loss:** -0.03%, indicating virtually no power loss.

- **Total Grading:** 42,052 bcm
- **Land Use:** 80.0%, effectively utilizing much of the available land area.

Table 18. Terabase Energy Analysis Result

System Characteristics		Plant Characteristics	
Category	Content	Category	Content
Locality	Cordova, IL	Avg Azimuth (°)	180
AC size (MW)	144.90	Avg Row Spacing (m)	7.62
DC size (MW)	160.75	Avg GCR (%)	31.30
Plant Limit (MW)	Off	Avg DC Array Size (MW)	3.49
# of Arrays	46	Avg AC Array Size (MW)	3.15
DC:AC Ratio	1.1094	-	-
Grid Voltage (kV)	34.5	-	-

GCR	DC/AC	DC (MW)	AC (MW)	Yield (kWh/kWp)	Clipping Loss (%)	Total grading (bcm)	EPC Cost (\$/W)	① sLCOE (\$/kWh)	Land Use (%)
0.313	1.109	160.752	144.9	1773.27	-0.03%	42,052	0.7143	0.0487	80.0%

Figure 4. Terabase Energy Analysis Result of Rock Island County

## References

1. Vance County. (n.d.). Zoning Ordinance. Retrieved February 1, 2025, from <https://www.vancecounty.org/wp-content/uploads/2017/05/Ord.-39-Zoning1.pdf>
2. Go Solar Texas. (n.d.). Solar PV Model Ordinance Guide. Retrieved February 1, 2025, from <https://www.gosolartexas.org/getmedia/4f320710-7d0d-40b7-aaf8-49d18294623c/Solar-PV-Model-Ordinance-Guide.pdf>
3. Sunshine Renewable Solutions. (n.d.). Texas Solar Rights Act. Retrieved February 1, 2025, from <https://sunshinerenewable.com/solar-rights-act/#:~:text=The%20Texas%20Solar%20Rights%20Act&text=According%20to%20Texas%20Property%20Code,device%2C%20except%20under%20specific%20conditions>
4. Kern County. (n.d.). Code of Ordinances. Retrieved February 1, 2025, from [https://library.municode.com/ca/kern\\_county/codes/code\\_of\\_ordinances?nodeId=TIT17BUCO\\_CH17.57SMREROSOENSYREPR](https://library.municode.com/ca/kern_county/codes/code_of_ordinances?nodeId=TIT17BUCO_CH17.57SMREROSOENSYREPR)
5. Rock Island County. (n.d.). Board Agenda Item. Retrieved February 1, 2025, from <https://www.rockislandcountyl.gov/AgendaCenter/ViewFile/Item/1220?fileID=1438>