Agrivoltaics in Energy Contracts with Landowners

Economics, land use, and best practices considerations

Oklahoma Senate Interim Study – September 2, 2025

Dr. Shannon L. Ferrell | OSU Department of Agricultural Economics
Holli Hendrick | OSU School of Global Studies

FERGUSON COLLEGE OF AGRICULTURE

Understanding solar land use in Oklahoma

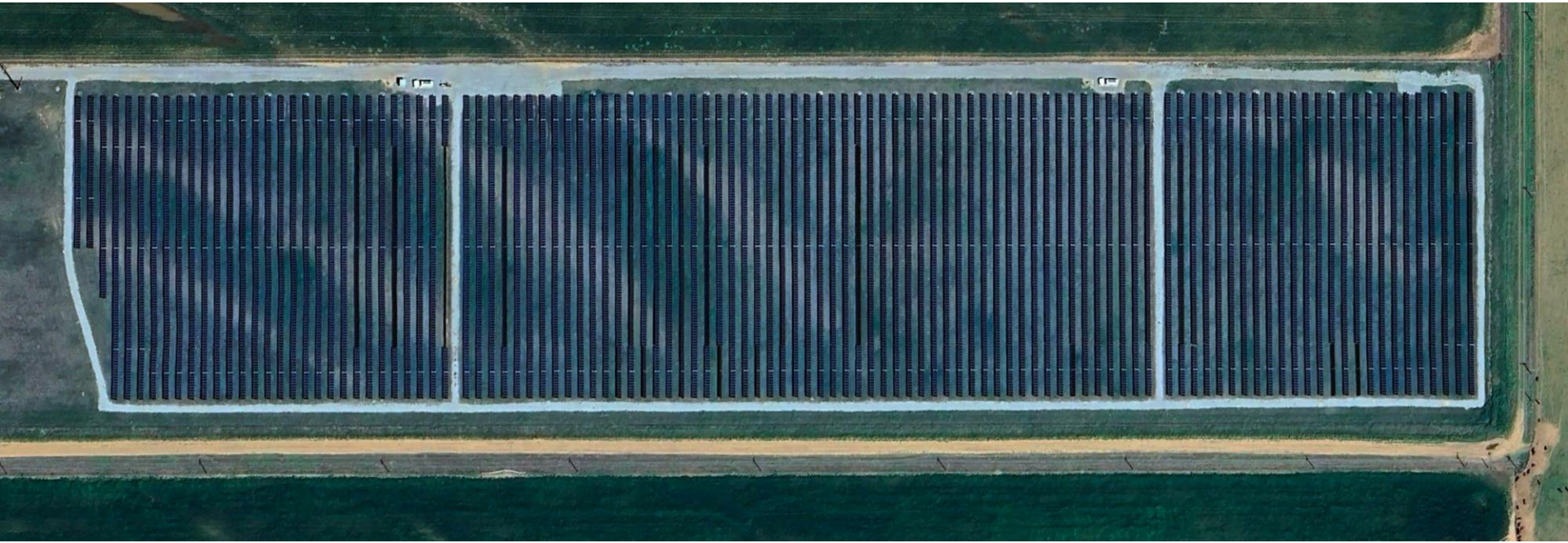


Image source: Google Earth

Total field area: 156.88 ac

Source: Measurements from Google Earth, author's analysis

Total field area: 156.88 ac
Total obstructed area: 3.85 ac
Use ratio: 2.46%

Source: Measurements from Google Earth, author's analysis

Image analysis of the Hinton Solar Project

Total field area: 18.04 ac
Total obstructed area: 9.73 ac
Use ratio: 53.95%

Image source: Google Earth

A sample of Oklahoma's utility-scale solar projects

Project	Year Online	Capacity (MW)	Average row spacing (ft)	Total fence line area (ac)	PV arrays (ac)	Roads (ac)	Total land occupied (ac)	Open area (ac)	Use ratio	Gross land use (ac/MW)
Hinton	2017	3.0	7.6	18.04	7.94	1.80	9.73	8.31	53.95%	6.01
Covington	2018	10.0	30.2	72.82	18.55	1.91	20.46	55.93	28.10%	7.28
Pine Ridge	2017	3.0	9.1	19.24	6.83	1.66	8.50	10.74	44.16%	6.41
Cyril	2017	5.0	7.5	41.16	11.18	2.31	13.49	27.67	32.77%	8.23
Tuttle	2017	4.0	7.8	33.90	9.88	1.83	11.71	22.18	34.56%	8.47
								Average	38.71%	7.28

Source: Measurements from Google Earth, author's analysis

Land use requirements for PV projects in the U.S.

≈ 5 to 10 ac / MW capacity

Source: SEIA

Total solar land use potential in Oklahoma

Total solar PV capacity in OK Southwest Power Pool (SPP) Queue	**3,877 megawatts (MW)**
Average land use per megawatt in Oklahoma	**7.28 acres/MW**
Total land use for all solar PV capacity in OK SPP Queue	**28,236 acres or 44.12 mi^2**
Total Oklahoma agricultural land area	**58,750 mi^2**
Proportion of Oklahoma agricultural land area needed to build all solar PV capacity in the OK SPP Queue	**0.08%**

Source: Measurements from Google Earth, author's analysis, USDA land use data

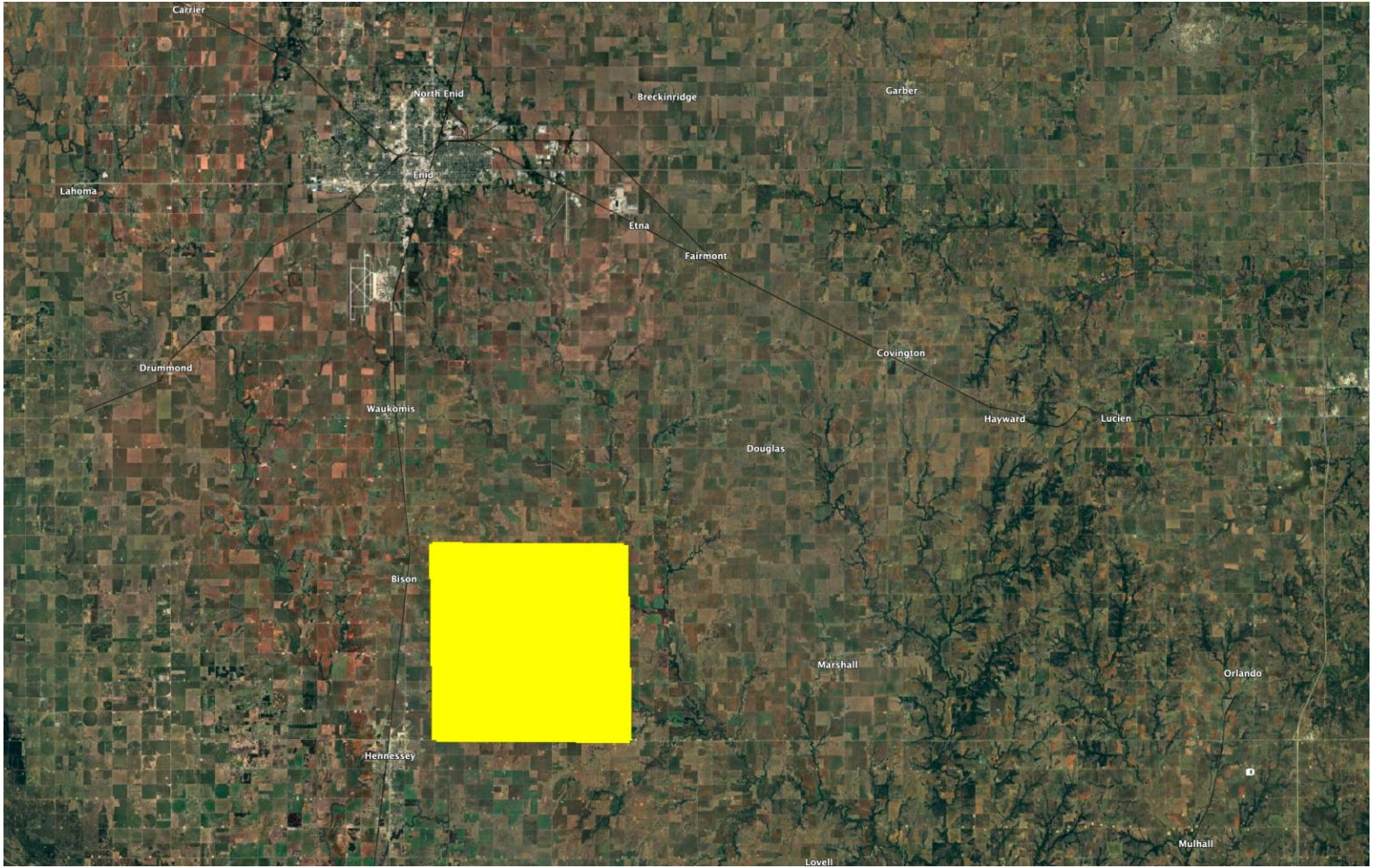


Image source: Google Earth

Total solar potential economic impact

All projects in OK SPP Queue

Total solar PV capacity in OK Southwest Power Pool (SPP) Queue	**3,877 megawatts (MW)**
Total cumulative landowner payments	**$1,150,350,000**
Total ad valorem property revenues	**$2,126,813,308**
Total Oklahoma cumulative economic impact	**$11,229,287,193**

Source: Ferrell, McNabb, Palczynsky, & Hendrick (2025)

Farm-level income impacts of conversion from agricultural production to solar production (per acre)

	Per-acre solar lease rate	
Crop	Baseline (no payment)	$750.00
Winter wheat/cow-calf	($28.96)	$778.96
Corn	($12.78)	$762.78
Soybeans	$69.99	$680.01
Grain sorghum	($41.30)	$791.30
Canola	($92.41)	$842.41
Cotton	$58.70	$961.30
Bermuda hay	$109.56	$640.44
Alfalfa hay	$322.57	$427.43

Source: OSU Enterprise Budgets updated with commodity and input prices as of 8/29/2025; partial budget analysis by author

Income impacts of conversion from agricultural production to solar production (per acre)

	Per-acre solar lease rate			
Crop	Baseline (no payment)	$500.00	$750.00	$1,000.00
Winter wheat/cow-calf	($28.96)	$528.96	$778.96	$1,028.96
Corn	($12.78)	$512.78	$762.78	$1,012.78
Soybeans	$69.99	$430.01	$680.01	$930.01
Grain sorghum	($41.30)	$541.30	$791.30	$1,041.30
Canola	($92.41)	$592.41	$842.41	$1,092.41
Cotton	$58.70	$441.30	$961.30	$941.30
Bermuda hay	$109.56	$390.44	$640.44	$890.44
Alfalfa hay	$322.57	$177.43	$427.43	$667.43

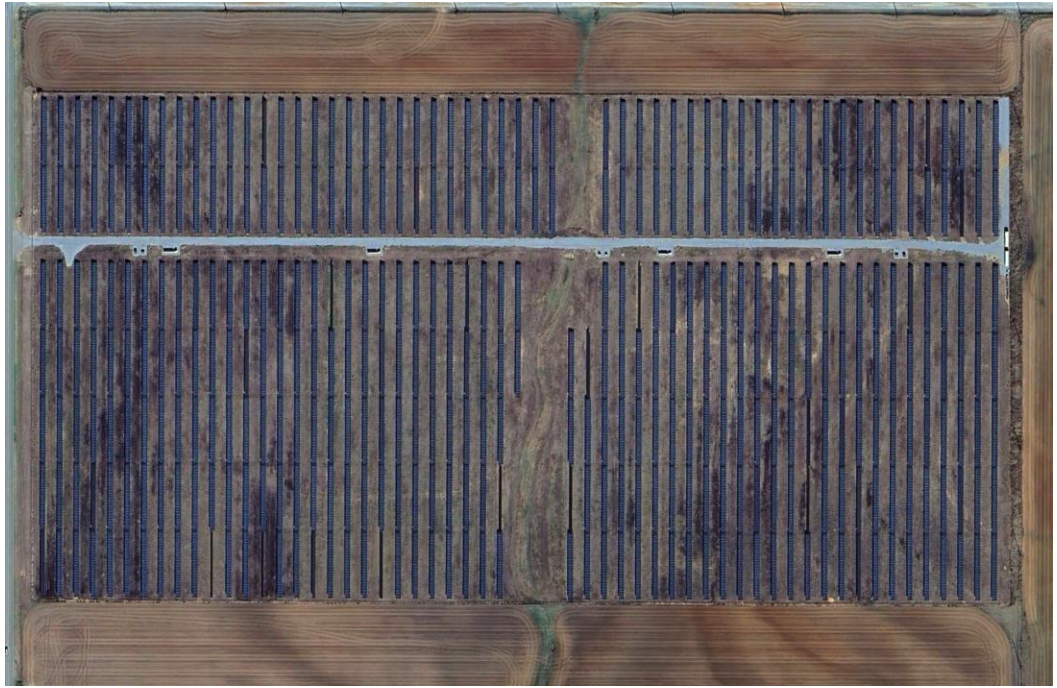
Source: OSU Enterprise Budgets updated with commodity and udget analysis by author

Farm-level income impacts of conversion from agricultural production to solar production (quarter-section)

	Per-acre solar lease rate			
Crop	Baseline (no payment)	$500.00	$750.00	$1,000.00
Winter wheat/cow-calf	($4,633.60)	$84,633.60	$124,633.60	$164,633.60
Corn	($2,044.80)	$82,044.80	$122,044.80	$162,044.80
Soybeans	$11,198.40	$68,801.60	$108,801.60	$148,801.60
Grain sorghum	($6,608.00)	$86,608.00	$126,608.00	$166,608.00
Canola	($14,785.60)	$94,785.60	$134,785.60	$174,785.60
Cotton	$9,392.00	$70,608.00	$153,808.00	$150,608.00
Bermuda hay	$17,529.60	$62,470.40	$102,470.40	$142,470.40
Alfalfa hay	$51,611.20	$28,388.80	$68,388.80	$106,788.80

Source: OSU Enterprise Budgets updated with commodity and input prices as of 8/29/2025; partial budget analysis by author

An example of row spacing with the Covington Solar Project



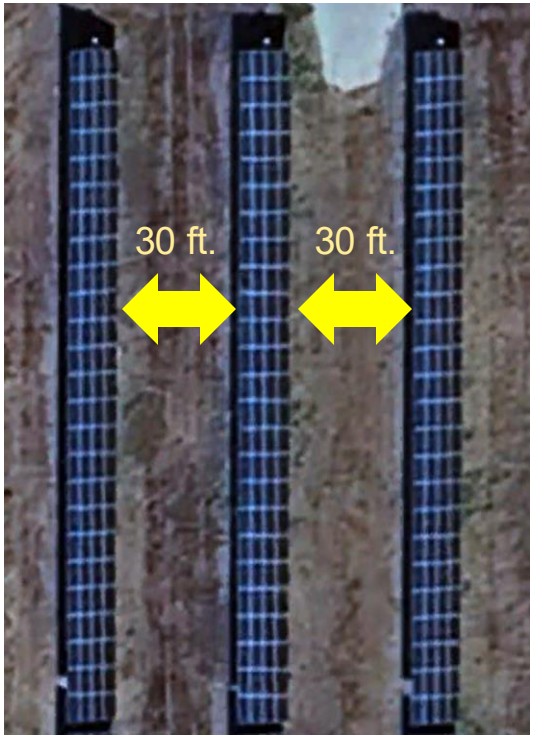


Image source: Google Earth

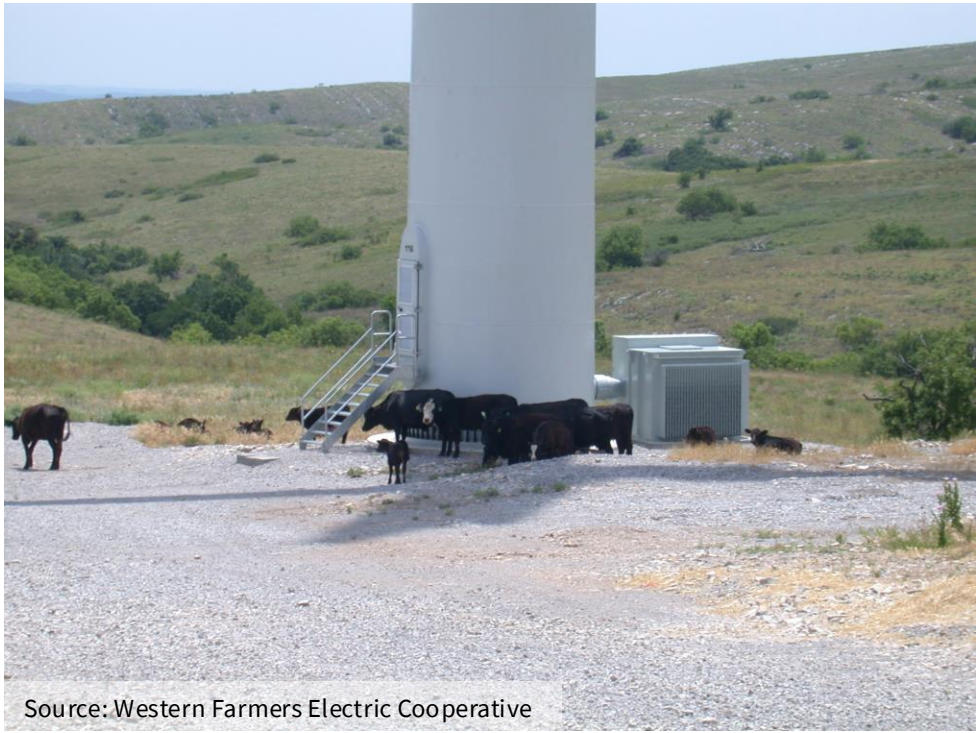
An example of row spacing with the Covington Solar Project

Current row spacing	**30 feet**
Minimum row spacing for cultivation	**60 feet**
Current Covington Solar Project fence line area	**72.82 acres**
Covington Solar Project fence line area with 60 ft. row spacing	**124.6 acres (1.71x)**
Covington Solar Project fence line area with 120 ft. row spacing	**690.8 acres (9.49x)**

Source: Measurements from Google Earth, author's analysis

Sheep and solar

Livestock and turbines



Source: Western Farmers Electric Cooperative

Image source: Google Earth

Image source: University of Minnesota Cooperative Extension

Separate Land Use on 2 Hectare Cropland

1 hectare

1 hectare

100% wheat + 100% solar electricity = 100% wheat
100% solar electricity

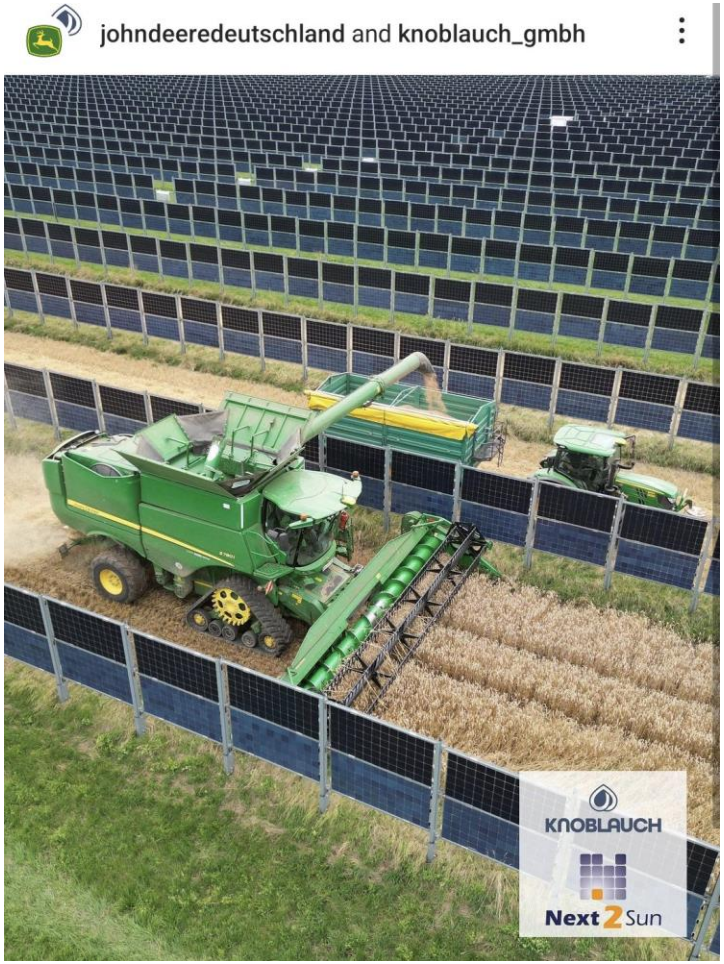
Combined Land Use on 2 Hectare Cropland: Efficiency increases over 60%

1 hectare

1 hectare

80% wheat
80% solar electricity + 80% wheat
80% solar electricity = 160% wheat
160% solar electricity

Image source: Pfaltzgraf Farms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The Top 5 questions to ask about energy leases

1. How will your current uses of the property be affected by the project?
2. How long will agreement last?
3. What are your obligations under the agreement?
4. How will you be compensated?
5. What happens when the project ends?

What are your obligations under the agreement?

- General: Commitment to use commercially reasonable efforts and communication to coordinate agricultural and solar operations without material interference to the other
- Indemnity
  - For developer: against damage to project equipment and interference with maintenance and operations
  - For producer: against negligent injury to livestock and/or crops
  - Indemnification for both against actions of 3rd parties
- Production practices
  - Restricted use of pesticides impacting livestock / crops / pollinators
  - 24 hours advance notification to producer of any operations requiring removal of livestock
  - 24 hours advance notification to project operator of ag operations potentially impacting solar production

Collocated agricultural use language

1. Lessor may use areas not occupied by Project Equipment (“Project Equipment” shall include, but is not limited to, photovoltaic panels, mounting racks and frames, electrical transmission lines, inverter systems, supervisory control and data acquisition systems, and access roads) for the grazing of livestock and/or the production of agronomic or horticultural crops (“agricultural activities”) provided that such agricultural activities shall not materially interfere with the normal operations of the Project.

Collocated agricultural use language

2. Lessor and Lessee will use commercially reasonable efforts to develop a mutually agreed set of operating procedures to coordinate the use of the Property for Agricultural Production and Project Operations with the intent to minimize the extent to which Agricultural Production and Project Operations interfere with each other.

Collocated agricultural use language

3. Such operating procedures shall include requirements for:
   a) Sufficient notice (not less than 24 hours except in the case of an emergency condition posing risk of physical harm and/or material economic damage to a party) to the other party of any activities that might interfere with the other party's operations and/or that might require corrective actions.
   b) Consultation among the parties with respect to the application of any herbicides, pesticides, or other chemicals that might impair Agricultural Activities or that could materially reduce the production capacity of the Project Equipment.
   c) Delineation and/or marking of any areas where Project Equipment located below grade is not buried below the depth that might be reached by agricultural production equipment.
   d) Temporary removal of any livestock prior to any project operations that pose a material threat of injury to livestock or circumstances in which the presence of livestock could pose a risk of harm to project personnel.
   e) Immediate notification to the other party of any damage to Project Equipment, livestock, and/or crops as soon as a party has actual knowledge of such damage.
   f) Indemnification for material damage caused to the Project Equipment, livestock, or crops caused by the other party or by parties acting on behalf of Lessor or Lessee.

Collocated agricultural use language

4. Both parties shall maintain a policy of commercial liability insurance with a coverage limit of $X and naming the other party as a named insured, the coverage of which shall include those forms of damage that party could reasonably foresee being caused by its operations to the counterparty.

What happens when the project ends?

- Specify decommissioning requirements
  - Disassembly and removal of equipment
  - Restoration of grades and soils
  - Replacement of vegetation
  - Restoration of any conservation structures if needed
- Financial security is critical to enforce obligations

Conclusions

- Solar production land use is more concentrated than wind production, but not as concentrated as previously thought.
- Even at complete buildout of all planned solar projects, Oklahoma would lose less than one tenth of one percent of its agricultural land.
- Solar lease revenues more than offset lost revenues from agricultural production across all common Oklahoma production systems and solar lease ranges; this is critical given current commodity prices.
- Collocation of solar and agricultural production systems is possible but requires careful coordination between the parties to avoid interference with each other.

Shanon L. Ferrell, J.D., M.S.

Department of Agricultural Economics

O | 405.744.9815
C | 405.742.2575
E | shannon.l.ferrell@okstate.edu
532 Agriculture Hall, OSU
Stillwater, OK 74078

agecon.okstate.edu