

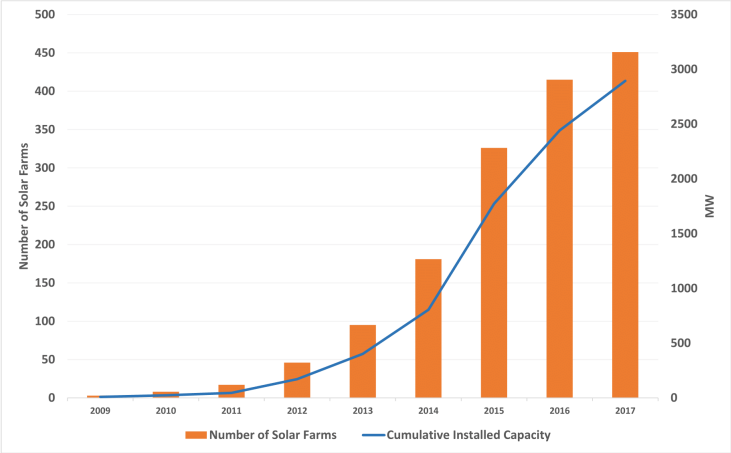
# Solar Farms and Surrounding Property Values: An Empirical Analysis

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# Motivation

## Number of solar farms and cumulative installed capacity by years



## Motivation (cont.)

- Expansion of solar power is an increasingly contentious issue in NC
- Considerable pressure both for and against solar expansion
  - ▶ Proponents: creates jobs, generates tax revenues,...
  - ▶ Opponents: NIMBY (diminishes property values, safety,...)

# Motivation (cont.)

- NC Solar Policy Drivers

- ▶ NC Renewable Energy and Energy Efficiency Portfolio Standards law in 2007
- ▶ NC Renewable Energy Tax Credit
- ▶ Federal Investment Tax Credit
- ▶ 15-year Fixed Price Utility Power Purchase Agreements

- Local opposition

- ▶ The town of Woodland bans solar
- ▶ Three counties impose a moratorium on solar

## Motivation (cont.)

Legal Case: FLS Energy, Inc vs. Robeson County Board of Commissioners

“On 2 November 2015, the Commissioners voted to deny FLS Energy’s conditional use permit request to construct a solar farm. The Commissioners specifically found the solar farm: ...would affect property values within the immediate neighborhood.”

“On 11 March 2016: [The] denial of a conditional use permit may not be based on conclusions which are speculative, sentimental, personal, vague, or merely an excuse to prohibit the requested use.”

# Paper Goal

- To estimate the local impact of solar farms on nearby property values
  - ▶ Hypothesis 1: Negative impact on residential property values
  - ▶ Hypothesis 2: Positive impact on agricultural land values

# Data

- Property Transactions (1997 - 2017)
- Solar Farm Characteristics (2009 - 2017)
- Electricity Transmission Infrastructure
- Land Quality Data
- Other Spatial Data

# Empirical Strategy: Residential Property Analysis

$$\begin{aligned} \ln Price_{itcs} = & \alpha + \beta * \ln Dist_{its} + \gamma * \ln Dist_{its} * MW_s \\ & + \delta * X_{it} + \theta * Z_{it} + \sigma_s + \tau_t + \mu_c + \epsilon_{it} \end{aligned}$$

- House  $i$ , year  $t$ , county  $c$ , solar farm  $s$
- $\ln Price$  - natural log of sale price
- $\ln Dist$  - natural log of distance to the nearest solar farm
- $MW$  - size of a solar farm
- $X$  - house characteristics
- $Z$  - neighborhood characteristics



# Empirical Strategy: Agricultural Land Analysis

- Step 1

$$\begin{aligned} \ln Price\_per\_acre_{itcs} = & \alpha + \beta * \ln Dist\_subst_{its} + \gamma * \ln Dist\_subst_{its} * D_{REPS} \\ & + \delta * X_{it} + \theta * Z_{it} + \tau_t + \mu_c + \epsilon_{it} \end{aligned}$$

- ▶ Land  $i$ , year  $t$ , county  $c$ , substation  $s$
- ▶  $\ln Price\_per\_acre$  - natural log of land sale price per acre
- ▶  $\ln Dist\_subst$  - natural log of distance to the nearest substation
- ▶  $D_{REPS}$  - dummy equals one if land is sold after the REPS act was passed
- ▶  $X$  - land characteristics
- ▶  $Z$  - location characteristics

# Empirical Strategy: Agricultural Land Analysis

- Step 2

$$\begin{aligned} \ln Price\_per\_acre_{itcs} = & \alpha + \beta * \ln Dist\_sub_{its} + \gamma * \ln Dist\_sub_{its} * D_{st} \\ & + \delta * X_{it} + \theta * Z_{it} + \tau_t + \mu_c + \epsilon_{it} \end{aligned}$$

- ▶  $D_{st}$  - dummy equals one if land is sold after solar farm is built

# Results: Residential Property Analysis

Residential house sales over the 2015-2017 period

	Straight line proximity to a nearest solar farm				Street map proximity to a nearest solar farm			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
In distance	0.094*** (0.014)	0.022** (0.011)	0.011 (0.011)	0.022* (0.012)	0.234*** (0.017)	0.030** (0.014)	0.044*** (0.012)	0.029** (0.014)
In distance $\times$ MW	-0.003* (0.001)	0.001 (0.002)	-0.000 (0.000)	0.001 (0.002)	-0.005*** (0.002)	0.002 (0.002)	-0.000 (0.000)	0.002 (0.002)
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year, County, Solar Farm FE	Yes	Yes			Yes	Yes		
Year by County FE			Yes				Yes	
Year by solar FE				Yes				Yes
Adjusted R2	0.247	0.579	0.564	0.586	0.259	0.579	0.564	0.586
Number of observations	14,135	14,135	14,135	14,135	14,135	14,135	14,135	14,135

# Results: Residential Property Analysis

Residential house sales over the 2015-2017 period

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Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
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Year by County FE			Yes				Yes	
Year by solar FE				Yes				Yes
Adjusted R2	0.247	0.579	0.564	0.586	0.259	0.579	0.564	0.586
Number of observations	14,135	14,135	14,135	14,135	14,135	14,135	14,135	14,135

# Results: Residential Property Analysis

Residential house sales over the 1997-2006 period

	Straight line proximity to a nearest solar farm				Street map proximity to a nearest solar farm			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
In distance	0.069***	-0.005	-0.016	-0.014	0.147***	-0.004	-0.005	-0.004
	(0.023)	(0.020)	(0.019)	(0.021)	(0.030)	(0.022)	(0.020)	(0.022)
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year, County, Solar Farm FE	Yes	Yes			Yes	Yes		
Year by County FE			Yes				Yes	
Year by solar FE				Yes				Yes
Adjusted R2	0.241	0.426	0.413	0.450	0.244	0.426	0.413	0.450
Observations	7,765	7,765	7,765	7,765	7,765	7,765	7,765	7,765

# Results: Residential Property Analysis

Residential house sales over the 1997-2006 period

	Straight line proximity to a nearest solar farm				Street map proximity to a nearest solar farm			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
In distance	0.069***	-0.005	-0.016	-0.014	0.147***	-0.004	-0.005	-0.004
	(0.023)	(0.020)	(0.019)	(0.021)	(0.030)	(0.022)	(0.020)	(0.022)
Controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Year, County, Solar Farm FE	Yes	Yes			Yes	Yes		
Year by County FE			Yes				Yes	
Year by solar FE				Yes				Yes
Adjusted R2	0.241	0.426	0.413	0.450	0.244	0.426	0.413	0.450
Observations	7,765	7,765	7,765	7,765	7,765	7,765	7,765	7,765

# Results: Agricultural Land Analysis

Agricultural land sales over 1997-2017 period

Table 6. P., 20.

	Step 1		Step 2
	(1)	(2)	(3)
Ln dist. substation	-0.062 (0.057)	-0.049 (0.065)	-0.039 (0.044)
Ln dist. Substation $\times$ D_2007	-0.008 (0.065)	-0.006 (0.066)	
Ln dist. Substation $\times$ D_st			-0.025*** (0.008)
Controls	No	Yes	Yes
Year FE	Yes	Yes	Yes
County FE	Yes	Yes	Yes

# Conclusion

- Pressure both for and against solar expansion
- Explore the relationship between solar farms and property values
- Suggestive evidence that supports the hypotheses tested in the paper
  - ▶ negative effect on house values
  - ▶ positive effect on agricultural land values
- Lots more work to do



Thank You!

# Map 1: Solar farms by counties

