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How Effective Are Renewable Portfolio Standards?

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INTRODUCTION

In efforts to mitigate the impacts of climate change and reduce greenhouse gas emissions, many states have implemented policies to encourage development of renewable energy infrastructure. One common approach is establishing a Renewable Portfolio Standard (RPS) which mandates that a certain percentage of a state's energy comes from renewable resources. **This project aims to investigate the efficacy of RPS for encouraging development of utility-scale (capacity greater than 1 megawatt) solar photovoltaic (PV) facilities.**

METHODS

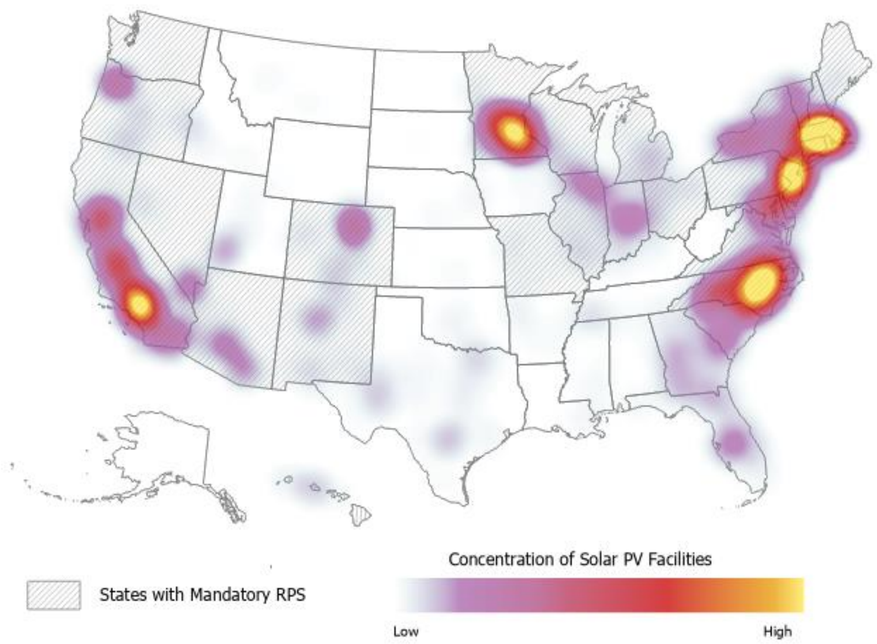
- Analysis was based on two shapefiles (point and polygon) containing locations and attribute data about utility-scale solar PV facilities
- Spatial joins were used to summarize points and polygons by state
- Point locations were normalized by land area (facilities per square mile)
- Polygons were normalized as a percentage of state land area (percent of land developed for solar)
- Renewable energy goals as mandated by state RPS were derived from state policy publications and represented as a percentage
- **Spearman's Rho correlation tests were used to evaluate the relationship between percent renewable energy goals and (1) solar facilities per square mile, and (2) percent land area developed for solar**
- **Two-sample t-test was used to compare the difference in means between Group 1 (states without mandatory RPS) and Group 2 (mandatory RPS) for both (1) average number of solar facilities per square mile, and (2) average percent land area developed for solar**

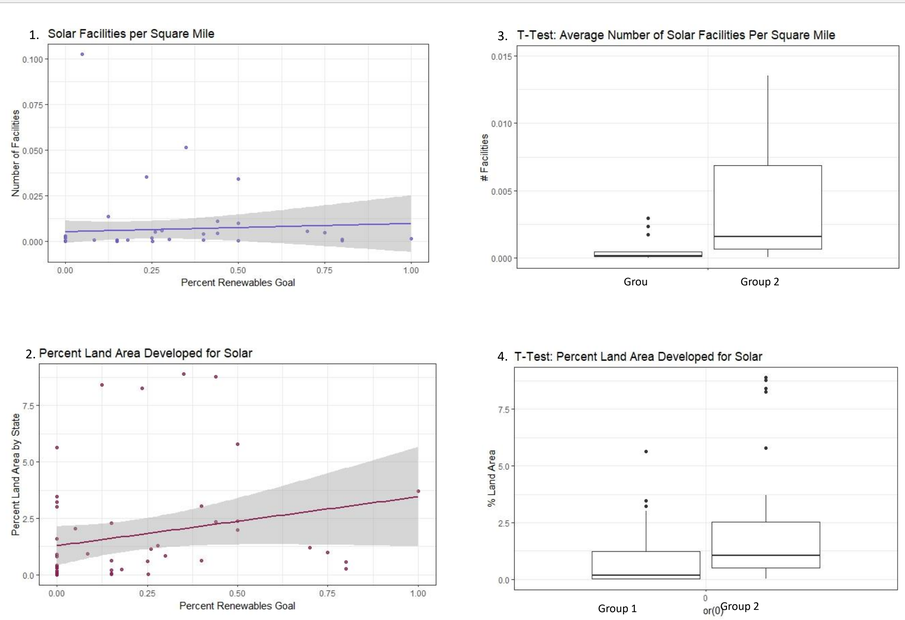
Table 1. Data Sources

Solar PV Facilities Point Shapefile	US Energy Information Administration, 2022
Solar PV Facilities Polygon Shapefile	USGS Geosciences Center for Environmental Change, 2022
State Boundaries	US Census Bureau, 2019
State Renewable Energy Goals	RPS plans as published by individual state legislatures

Software Used: ArcGIS Pro V2.9.5; R V4.2.1

Snapshot: Utility-Scale Solar in the United States





RESULTS

Results of statistical analyses are shown in Figures 1-4 (bottom center) and in Table 2 below.

Group 1: States with voluntary or no RPS (*n = 23)*
Group 2: States with mandatory RPS (*n = 27)*

Table 2. Statistical Analysis Results

		Number of Facilities per Square Mile	Percent Land Area Developed for Solar
Spearman's Rank Correlation Rho (Figures 1, 2)	Coefficient	0.5969	0.4557
	P-value	< 0.0000	0.0010
2-Sample T-Test (Figures 3, 4)	Mean		
	Group 1	0.0005	0.9848
	Group 2	0.1061	2.3384
	P-value	0.02179	0.0375

CONCLUSION

- Higher renewable energy goals mandated by RPS are strongly associated with both a greater number of solar facilities per square mile and total percentage of land area developed for solar
- States with mandatory RPS have statistically significant greater average number of solar facilities per square mile and total percentage of land area developed for solar
- **These findings indicate that mandatory RPS are an effective policy mechanism that can encourage development of utility-scale solar facilities**

LIMITATIONS

- Renewable energy goals have timelines that vary by state; the closest year to present (2022) was used but depending on state timelines this may not accurately reflect the current state of renewables in each state (for example, target timelines vary from 2020, 2025, 2050, etc.)
- Normalization of facility point locations and polygons is necessary for statistical analyses but introduces some error/uncertainty by assuming facilities are evenly distributed across space
- The point and polygon shapefiles are estimated to encompass approximately 95% of all utility-scale solar facilities in the US, but are not exhaustive and do not include facilities currently under construction
- This project considers only solar PV and does not attempt to evaluate the effectiveness of RPS for other renewable energy sources