

# Exploring The American Recovery and Reinvestment Act's Impact on Federal Grant Funding & Renewable Energy Patenting



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# 01

## BACKGROUND & THEORY OF CHANGE






# Motivation For This Research Topic

- Climate change poses a significant threat to our environment and to our well-being (Pörtner *et al.* 2022):
    - Sea level rise
    - Heat waves
    - Wildfires
    - Food supply chains
    - Air quality
    - Migration
- 



# ARRA Background

- American Recovery and Reinvestment Act of 2009
  - Signed into law by President Barack Obama
  - Areas of investment: Infrastructure, education, health, and renewable energy
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# RESEARCH QUESTION

Did federal R&D investments in basic research through the American Recovery and Reinvestment Act (ARRA) lead to an increase in renewable energy technology?



# THEORY OF CHANGE



## INPUTS

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- Hardware, software, lab space used to conduct research
- Research and administrative staff, and their scientific expertise and human capital.

## ACTIVITIES

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- Hiring researchers.
- Collaboration between PIs and Universities or firms.
- Performance of related research.
- Drafting and submission of articles for publication.

## OUTPUTS

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- Unique findings, innovations, and discoveries that result from funded research activities
- Published research articles
- Patent applications

## OUTCOMES

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- Patents related to different types of renewable energy
- New insights into which type of renewable energy is most R&D investment-worthy.

## FINAL OUTCOMES

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- Innovative technologies are further developed, possibly commercialized and brought to market.
- With more people or companies who use these renewable technologies, they will be adopted widely and emissions will decline worldwide.



02

# DATA & EMPIRICAL APPROACH





# DATA & METHODS

## Data:

- CSV files from subsets of Federal Reporter grants & PatentsView databases

ARRA funding was between 2009 to 2013, so we expect patents to lag by several years, but we expect a spike in renewable energy patents going forward. And the lag in patents may have been minimized by the USPTO Green Tech Pilot Program from 2009 to 2012.

## Methods:

- Explore & analyze as separate group entities, compare the time periods of ARRA funding and post-ARRA funding and the results: Grants (2009-2013 vs 2014-2018) and Patents (2012-2016 vs 2017-2018\*)
- After EDA, the most prevalent Renewable Energy (RE) types: Solar, Wind, Biomass & Biofuel, Geothermal
- Use the RE types to filter our data to then identify, measure, and visualize the relationship between grants and patents
- Unsupervised ML: k-means clustering approach on grants
- Topic modeling for more specific patent abstracts

\*Lack of provided patent data beyond 2018

# KEY MEASURES

From 2009-2018:

Filtered on Renewable Energy types: Solar, Wind, Biomass & Biofuel, Geothermal

- Grant dollars per PI for each renewable energy
- Total patents for each specific renewable energy type across time periods

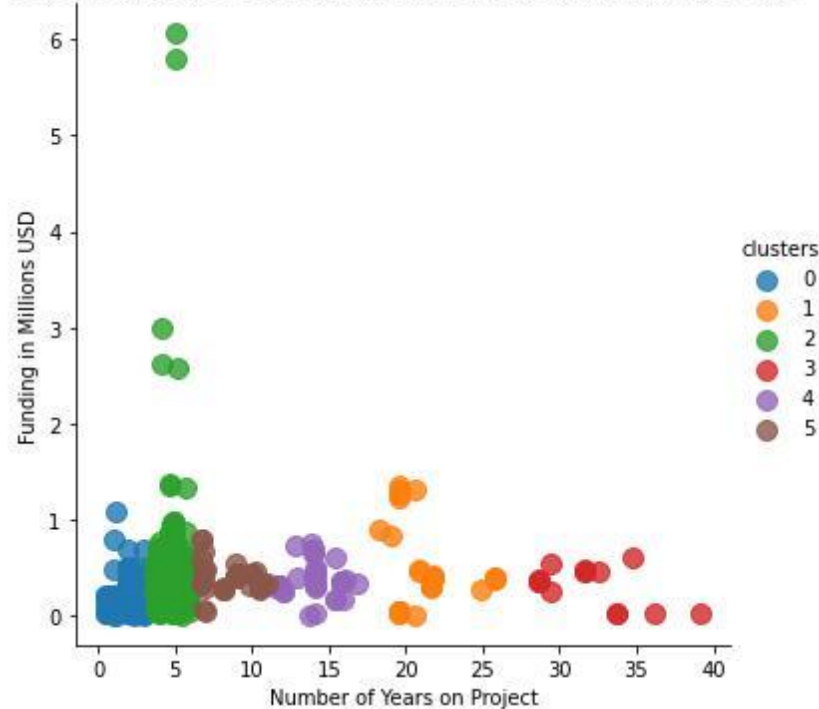
# 03

## RESULTS & ANALYSIS



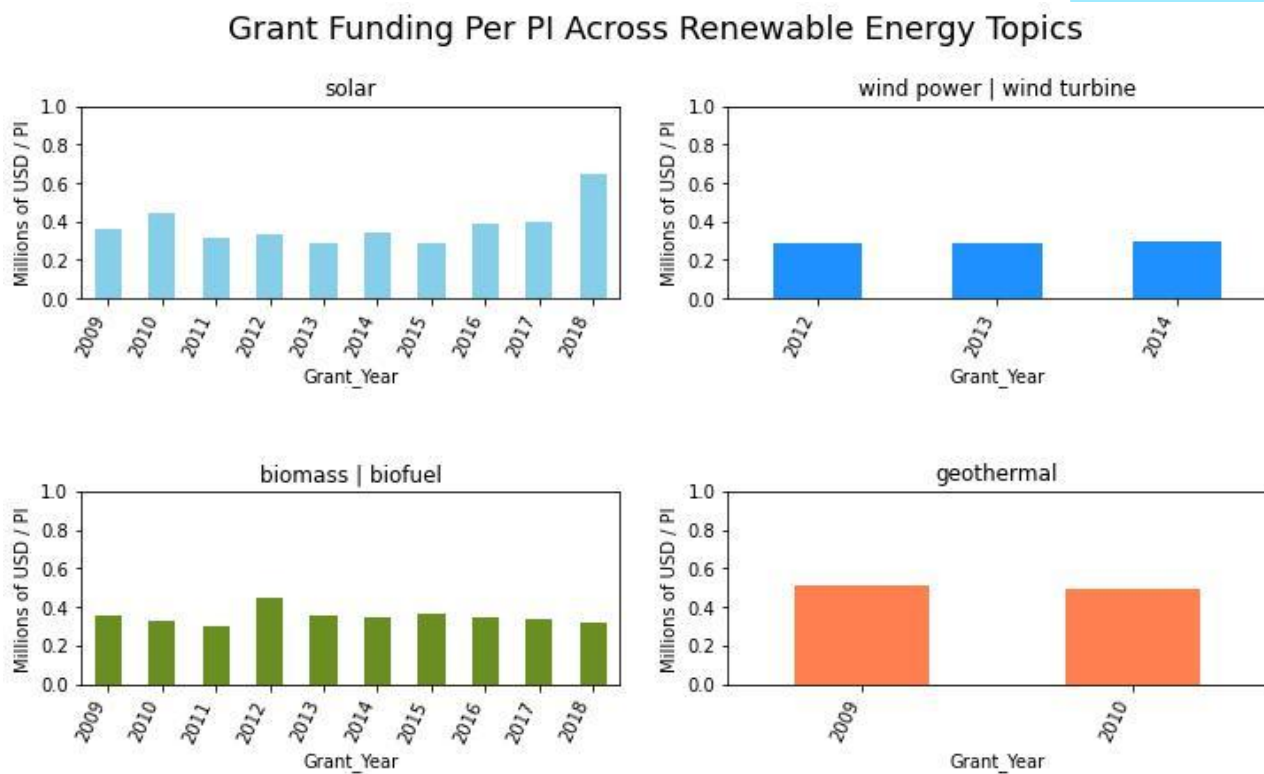
# Most Renewable Energy Projects Last 2.5 to 5 Years

Project Duration vs Funding Amount for Renewable Energy Grants



Source: FedReporter Grants Database

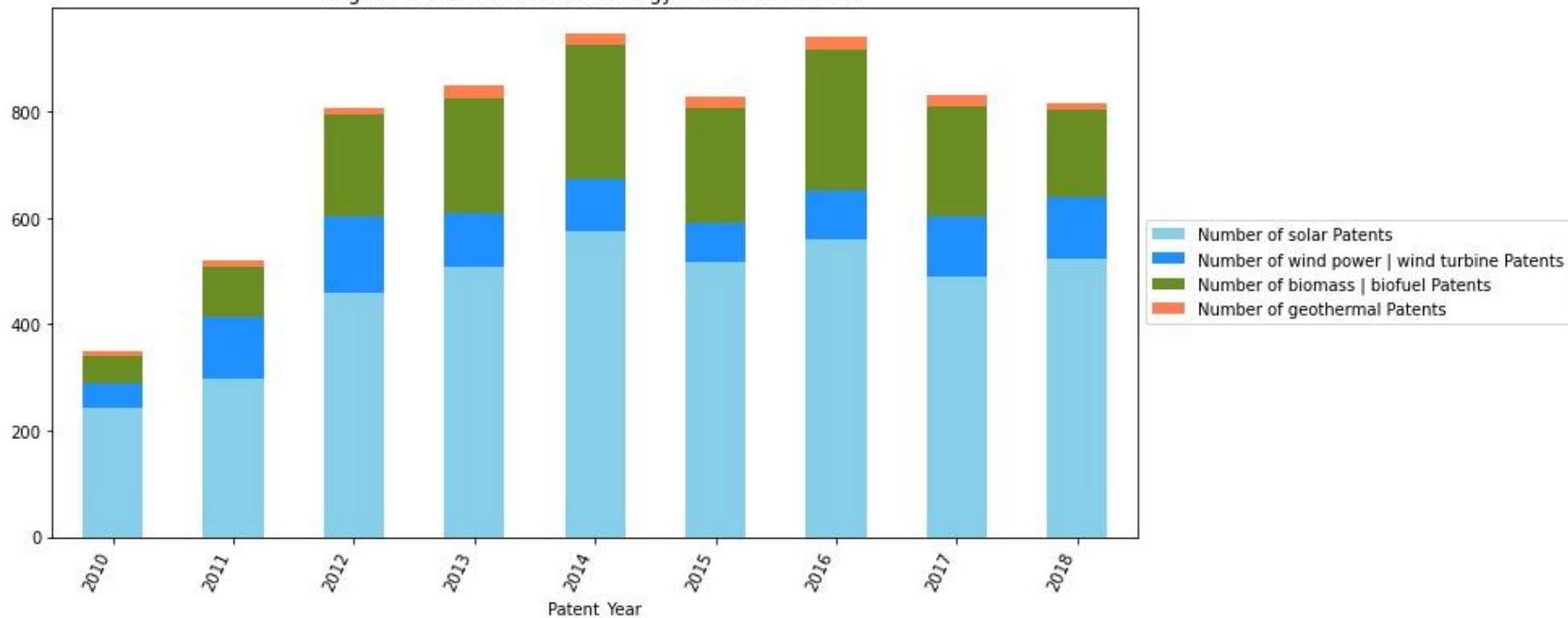
# Solar and Biomass & Biofuel Had The Most Consistent Grant Funding Per PI



Source: FedReporter Grants Database

# Renewable Energy Patents Have Increased 2.5x Since 2010

Segmentation of Renewable Energy Patents 2010-2018



Source: PatentsView Database

## Text Analysis on Patent Abstracts Shows that RE Topics Didn't Change Much After Time Period Comparisons

### After ARRA funding, patent topics:

0 plural, plural of, to, assembl, wind  
1 biomass, and, of, process, in  
2 solar cell, cell, layer, first, second  
3 power, system, may, solar, or

Source: PatentsView Database

### After Post ARRA funding, patent topics:

0 power, wind, turbine, system, wind turbine  
1 biomass, and, to, of, in  
2 cell, solar cell, layer, substrate, metal  
3 first, second, panel, solar, solar panel

Source: PatentsView Database

### Top Pls with Patents in Both Time Periods:

	first_name	last_name	number of patents after ARRA	number of patents after post-ARRA
0	Joseph Broun	Powell	36	17
1	Marshall	Medoff	24	20

Source: PatentsView Database

\*Post ARRA Time Period only used 2017-2018 PatentsView Data



# 04

## CONCLUSION



# Limitations & Biases

1. The uncertainty of the time lag
2. Unable to link the grants and patents records
3. The lack of ranking in both data subjects
4. Systematic lack of data
5. Confidentiality issue with the Department of Energy

# Recommendations For Future Research

1. ARRA as a model? Where to follow ARRA, or where to make adjustments?
2. Conduct cross-sectional analysis between the current sample set and DOE data
3. Explore relationship between grant data from DOE and patent data
4. Linking the data might allow researchers to leverage supervised machine learning methods to predict which grant projects lead to patents
5. Develop some measurements and evaluations rubric to investigate whether renewable energy patents ultimately lead to lower emissions

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# Thanks!

# Questions?



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# REFERENCES

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