The Determinants of On-Farm Renewable Energy Adoption

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Introduction

Renewable energy generation capacity is appearing on more and more farms across the US. In 2007, 10,408 farms reported producing energy from wind turbines, solar panels, or methane digesters (NASS, 2011), but by 2009 this had more than doubled (table 1). Higher energy prices, environmental stewardship, technology early adapters, and favorable policies all likely contribute to this significant increase. For example,

- Renewable portfolio standards have mandated renewable energy production by electricity suppliers in 30 states (including DC) (DESIRE, 2011).
- Forty-three states have adopted net metering policies to encourage electricity consumers to install renewable energy generation (DESIRE, 2011).
- USDA conservation incentive programs offer assistance for the installation of solar and wind technologies for livestock watering systems which reduce streambank erosion.
- Electricity is a critical input in certain types of farming (e.g. poultry farms), thus the recent increases in electricity prices are making on-farm generation more attractive (Bazen and Brown, 2009).
- Due to renewable energy's low carbon footprint this generation method may appeal to farming operations inherently interested in implementing other conservation practices as well.

Technology adoption by farmers has been previously investigated.

- Knowler and Bradshaw (2007) and Daberkow and McBride (2003) conclude that farm and farm household characteristics, farm biophysical characteristics, farm financial/management characteristics are good determinants of adoption.

Data: On-Farm Renewable Energy Production Survey

The 2009 On-Farm Renewable Energy Survey is the first national survey of farm operators to obtain information on renewable energy production (NASS, 2011). The survey provides data about the type, size, cost, incentives and estimated savings of the renewable energy production. This data was merged with the 2007 Census of Agriculture to provide information about the farm operation and primary operator (USDA, 2007).

This new dataset offers new insight into operations with renewable energy generation. For example,

- Solar energy production is the most prevalent form of renewable energy (93% of farms reporting renewable generation capacity have solar panels). Map 1 shows the distribution of these operations across the US.
- Wind is the second most prevalent generation type; with 17% of farms reporting renewable energy generation reporting wind turbines (see Map 2). However, 66% of these farms also report having solar panels (see figure 1).
- Cattle producers are the most frequent farm type to have wind or solar technologies (see figure 2).
- All types of renewable energy producers were more likely to be organic farmers and practice conservation techniques than the average US farmer (see figure 3).

- The amount of land owned by the average renewable energy producer is much more than that for the average US farmer (see figure 3).
- Methane digesters were far less common than either wind or solar (1% of farms), most likely due to being livestock specific and having high installation cost ($1.7 million on average, compared to $32,000 for solar).
- 23% of farms reporting renewable energy production are located in California (see Maps 1 and 2).

Objective and Model

This study examines the determinants of renewable energy (solar and wind) adoption by farmers. We exclude operations with methane digesters because the characteristics of these farms are much different than for all other renewable energy producers (see figure 2).

Our binary-choice model is used to test if there are characteristics which significantly increase the likelihood of operations adopting renewable energy. The logit model is specified as,

$$\text{Prob}(RE_i = 1) = f(FC_i, IC_i, CP_i, State_i)$$

- RE is an indicator variable for the adoption of wind and/or solar generation on the i^{th} farm.
- FC are farm characteristics (acres owned by the operation; value of machinery, farm type, e.g., primarily row crop).
- IC are operator characteristics (a measure of land tenure, how long the farmer has been farming, if the farmer lives on-farm; and if farming is the main occupation for the farmer).
- CP is conservation practice characteristics (if the operation is organic; if the operation uses conservation practices).
- State is a dummy variable for California, the state with the greatest number of renewable energy operations

Discussion

Table 2 presents the results of the logit model.

- Larger farms (in acres) are more likely to produce renewable energy (suggested by figure 2). Wind turbines and solar panels both require and are increasingly useful as operating acres increase.
- The coefficient on the value of machinery is negative suggesting farms with more expensive machinery are less likely to have wind and solar technologies. This is anticipated from the descriptive statistics. Solar producers have an average value of $76,571 for machinery, compared to $88,346 for the census average.
- Row crop farmers are less likely to produce renewable energy (only 1 of 10 types of adopting farms specializes in row crop production).
- The primary operator characteristics influence the likelihood of adoption in the expected ways. Operators with their primary residence on-farm and with farming as their main occupation are more likely to report renewable energy production.

- Organic operations and operations using conservation practices are more likely to have renewable energy generation. This is in agreement with expectations and other literature showing environmental stewardship as a significant indicator of adoption.
- California has the most renewable energy producers, and this is likely a result of favorable policies offering high incentives for adoption. This should be further explored.

Sources

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U.S. Department of Agriculture, National Agricultural Statistics Service (NASS). 2011. On-farm Renewable Energy Production Survey (OFREPS): 2009. Washington DC.

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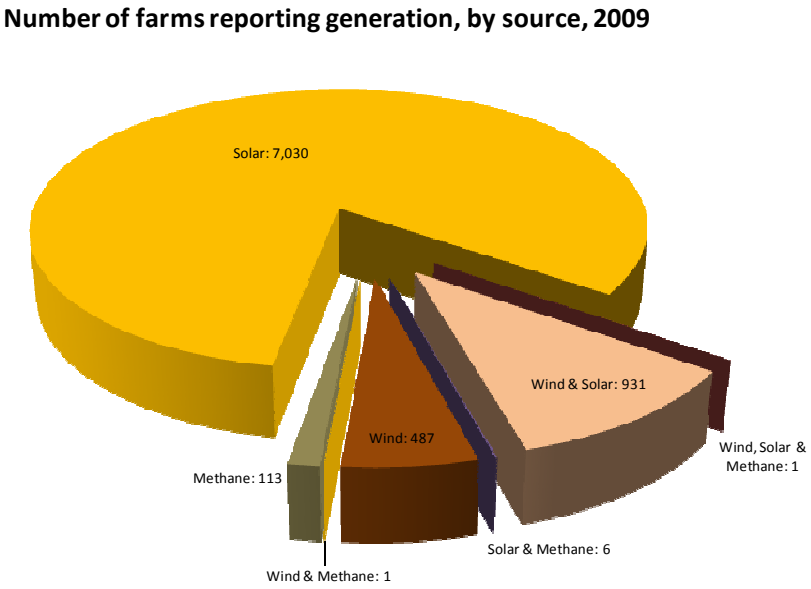
Table 1.

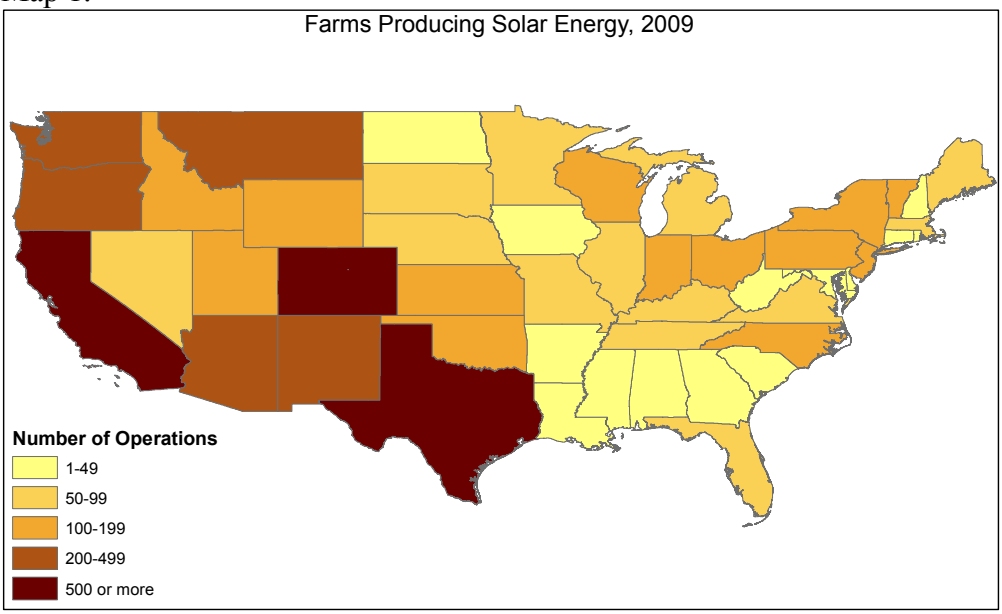
	Farms reporting renewable energy production
2007	10408
2008	17184
2009	25605

Source: 2007: OFRES; 2008 and 2009: ARMS

Figure 1.



Map 1.



Map 2.

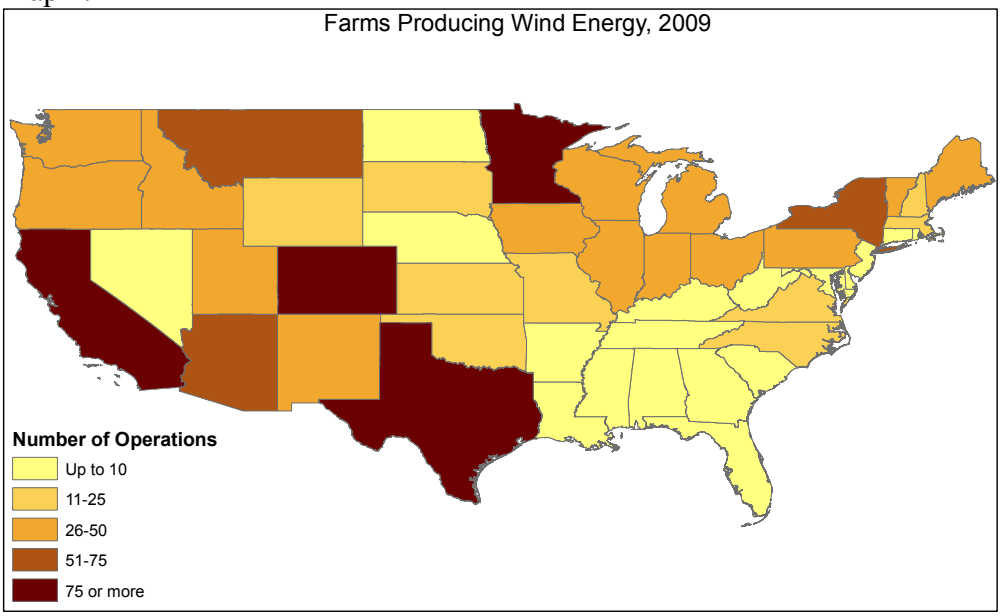


Figure 2.

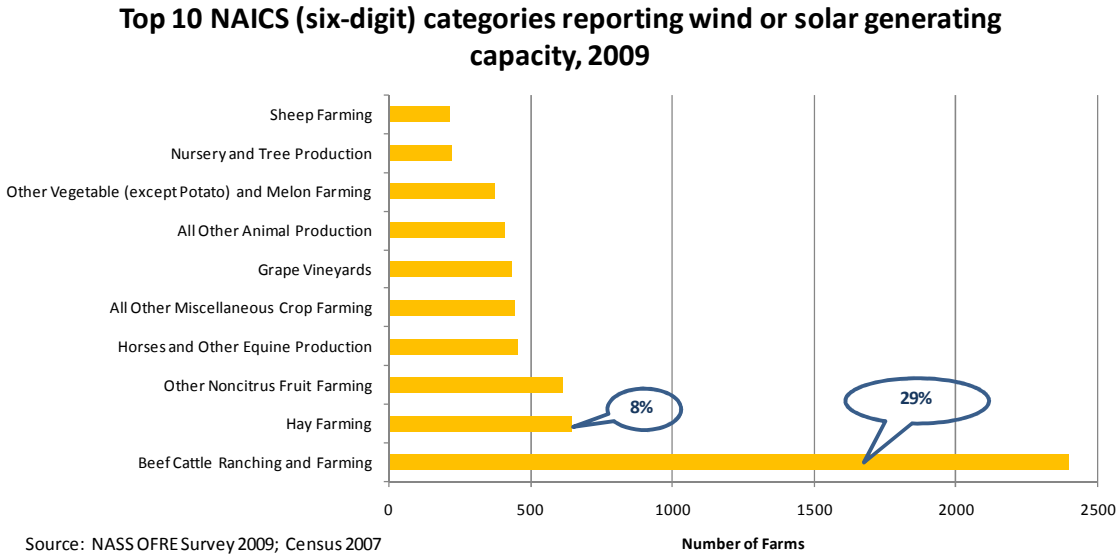


Figure 3.

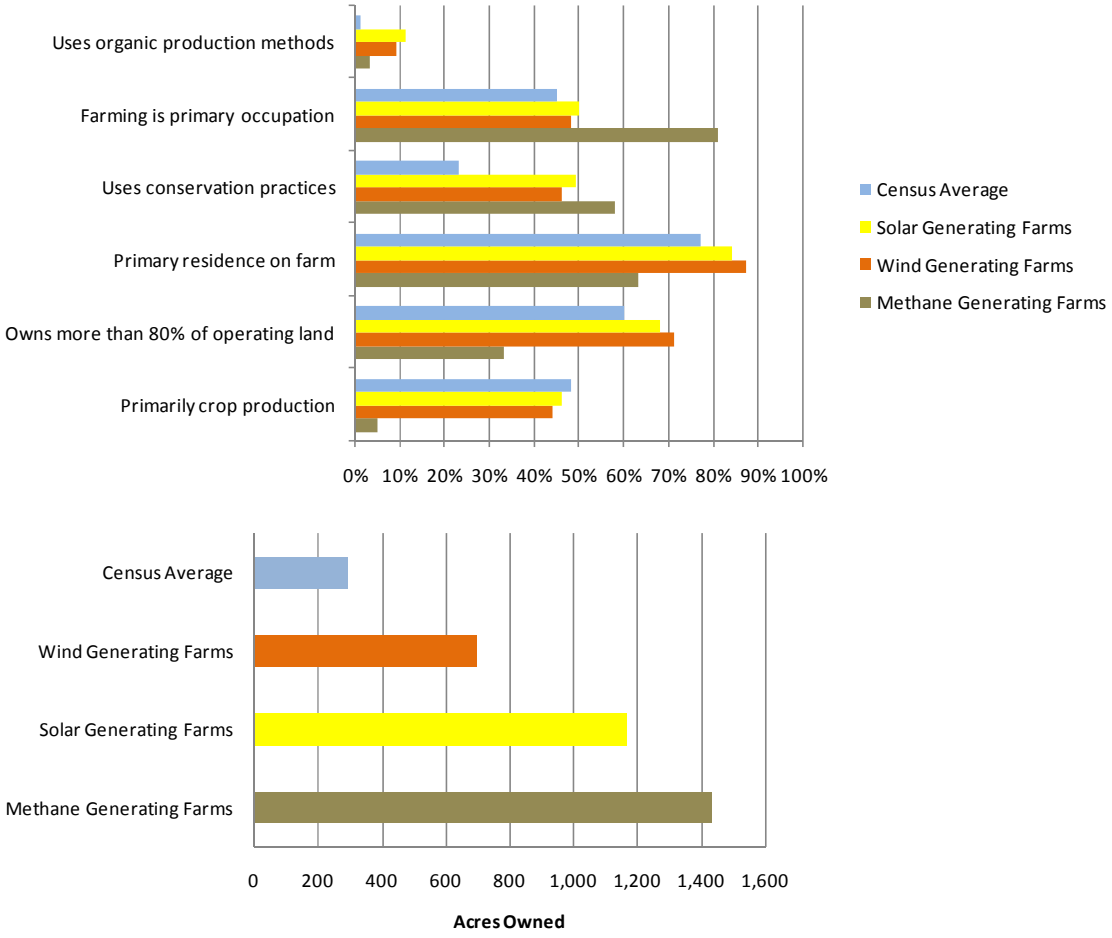


Table 2.

Parameter	Estimate	Standard Error	Pr > ChiSq
Intercept	-6.776	0.052	<.0001
The Amount of Land the Farmer Operates	0.001	1.22E-04	<.0001
The Value of Farm Machinery	-0.001	1.00E-04	<.0001
If the Farmer is Predominately a Crop Farmer	-0.354	0.027	<.0001
If the Farmer Owns 80% of Their Farmland	0.594	0.035	<.0001
If the Farmer Lives On-Farm	0.598	0.038	<.0001
If Farmer Practices Conservation Techniques	1.264	0.026	<.0001
If Farming is Main Occupation	0.192	0.027	<.0001
If Organic Farmer	1.809	0.043	<.0001
California	1.898	0.031	<.0001
The Number of Years the Farmer has been Farming	-0.021	0.001	<.0001