***GREEN POWER DEMAND in the usa***

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## Overview

## Driven by a concern for the environment and the dependency on foreign oil supplies, many countries are considering renewable energy based electricity as a vital component for reducing greenhouse gas emissions and increasing the security of supply. Besides imposing a minimum RE requirement on providers and/or offering economic incentives to promote green electricity (see Cansino et al., 2010 for a comprehensive review of European incentives), two major mechanisms have been used; one approach is to impose a mandatory fee on all consumers such as the non fossil-fuel obligations (NFFO) in the UK prior to 2002 ( see Grosche and Schroder (2011) for an analysis of the German levy), and a second is to give consumers the option of participating in voluntary green power programs. Green power refers to electricity that is generated from renewable energy sources such as wind, solar, etc. Compared to fossil fuels, these sources emit little or no greenhouse gases, and hence benefit the environment by reducing pollution and harmful emissions.

Starting in the 1990s electricity providers in several countries started offering a green power option. In most cases it takes the form of an energy-based product in which consumers are charged a premium for each kWh consumed to cover the additional cost of generating renewable-based electricity. In a few other cases, consumers are given the option of making a donation to support green electricity, where a minimum fee is sometimes set by the provider. Such contribution-based programs have had limited success in the development of new renewable capacity and in some countries such as in Australia they have been phased out of the national accreditation program due to their limited impact on RE development (Bird *et al*., 2002).

The performance of energy-based green power programs has been mixed. In some countries the programs had to be discontinued, while in others such as in the US they have seen a steady increase during the past two decades. It is therefore of utmost importance that we understand the drivers of green power demand in the US, since by having a more precise knowledge of supply and demand elasticities, the current and future energy needs of consumers are more likely to be met. Also, a better understanding of demand determinants can help guide policymakers, utilities, and marketers in their efforts to expand the green power markets. Price elasticities which measure how sensitive consumers are to changes in premiums, are particularly important in both forecasting and policy-making applications.

In view of the importance of demand elasticities, it is not surprising that there exists a substantial body of research aimed at estimating electricity demand elasticities since the 1950s, starting with the pioneering studies of Houthakker (1951a; 1951b). Much of this work was completed in the late 1970s and early 1980s in response to the 1973 and 1979 oil price shocks. There exist a few studies, however, that estimate green power elasticities most likely due to the lack of data. Since green power programs have not been around for a long time, it is difficult to obtain an adequate data set to perform an econometric estimation. One exception is the study by Mewton and Cacho (2011) who estimate green power elasticities for Australia in a panel data framework. To our knowledge there exists no study that estimates green power demand elasticities for the USA. Given that the US green power markets are the largest in the world with sales of at least 27.8 TWh in 2011 (REN21), this constitutes a big gap in the literature that this study aims to fill.

## Methods

## Using a panel data set comprised of 10 cross sections and 10 annual observations each, we conduct a full-fledged panel data analysis. The data set has been compiled from the annual surveys of green power providers conducted by the National Renewable Energy Laboratory. The dependent variable (y) is green power consumption, while the explanatory variables (x) include the price premium, the number of participants in the program, a dummy variable showing whether the program is accredited or not, and the type of utility.

 where *i*=1….N; *t*=1….T



We will employ the Wansbeek and Kapteyn (1989) method to estimate the variance components. Based on the estimated residual matrix, the dependent and regressor variables are GLS transformed to estimate the regression coefficients. All the standard errors are White-corrected.

## Results

## Preliminary results show that, consistent with economic theory, the price elasticity of green power is negative; when price increases quantity demanded decreases and vice versa. The results reveal that customers are pretty insensitive to price changes; when price increases by 1%, demand decreases by almost 0.02%. This result is not surprising and is similar to the vast majority of those found in the literature in which there is wide consensus that electricity demand is price inelastic (i.e. demand always decreases percentage wise less than the increase in price). One might have expected customers to react more to price changes, however one of the limitations in this study is that we are estimating the price sensitivity of existing customers, who are probably more pro-environmental than the average person. As expected, the elasticity with respect to number of customers is close to 1 (1.2) implying that a 1% increase in households will increase consumption by almost 1%. The coefficient is highly statistically significant. Accreditation seems to be associated with higher consumption and the coefficient is statistically different from zero. Note that the percentage change in consumption due to a dummy variable can be calculated as 100(e^β-1) (Halvorsen and Palmquist, 1980). This implies that getting accredited will have a 33.6% positive impact on consumption. Moreover, the results show that municipal utilities are associated with a 168% higher consumption of green power relative to IOUs, while public and coops are associated with 19.4% and 117%, respectively.

## Conclusions

## This study aims to identify and quantify the determinants of green power demand in the USA. To know where to direct their efforts, green power providers must know what the important determinants of green power demand are. The results are expected to be useful for utilities and policy-makers by helping them understand what the determinants of green power are and which policies can effectively increase consumption. Only one other similar study exists in which Mewton and Cacho (2011) estimate a price elasticity of -0.96, revealing a much higher response to premium changes in Australia than in the USA.

## From a policy perspective there are three issues to consider. When prices are inelastic any increase in price will result in an increase in revenues and any decrease in prices will result in a decrease in the total revenues. However, one must also take into consideration the fact that new customers might sign up when prices go down. This is the effect that is not measured in this study and can be done in a WTP survey. If the extra consumers signing up offset the reduction in Q of the existing customers, then it makes sense for the utility to decrease prices in an effort to increase revenues and hence expand the program. On another front, the results suggest that if policymakers were to make accreditation of the green power program a requirement, demand would be expected to increase substantially.