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Demand-side management by electric utilities in Switzerland: Analyzing its impact on residential electricity demand☆

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ABSTRACT

In this paper, we use panel data from a survey conducted on 30 utilities in Switzerland to estimate the impact of demand-side management (DSM) activity on residential electricity demand. Using the variation in DSM activity within utilities and across utilities over time we identify the impact of DSM programs and find that their presence reduces per customer residential electricity consumption by around 5%. If we consider monetary spending, the effect of a 10% increase in DSM spending causes a 0.14% reduction in per customer residential electricity consumption. The cost of saving a kilowatt hour is around 0.04CHF while the average cost of producing and distributing electricity in Switzerland is around 0.18CHF per kilowatt hour. We conclude that current DSM practices in Switzerland have a statistically significant effect on reducing the demand for residential electricity.

1. Introduction

Increasing energy efficiency in recent years has become a part of the strategy of many industrialized nations to reduce the emissions of greenhouse gases, the leading cause of climate change. However, policies to increase energy efficiency have been promoted since the oil crises of the 1970s. Energy efficiency policies have also been promoted to reduce air pollution from pollutants such as sulfur dioxide, nitrogen oxides, ozone and particulate matter, to improve energy security and to prevent the need for constructing increasingly expensive new power plants. The World Energy Outlook 2009 (International Energy Agency, 2009) and several other studies (Creyts et al., 2007; Granade et al., 2009; Nauclér and Enkvist, 2009) highlight the huge potential of CO_2 reductions from increased end-use energy efficiency. In view of these advantages of energy efficiency, policy instruments that promote the increase in energy efficiency play an important role. Apart from its impact on greenhouse gas emissions, the literature on energy efficiency argues that promoting energy efficiency costs less than building new power plants. There are also

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environmental reasons. Utility companies need to follow a number of environmental regulations. There are emissions control strategies in place and saving energy on the margin will allow the more polluting plants to be removed from producing electricity. Reducing electricity demand also reduces the need to upgrade the transmission and distribution network. Lastly, reducing peak demand combined with reducing energy demand can lead to grid reliability.

The discussion on energy efficiency, and energy policy in general, received an added impetus due to the Fukushima Daiichi nuclear accident on 11 March, 2011 that led to worldwide discussions about the security of nuclear power plants and energy policy issues. Germany imposed a three month moratorium on announced extensions for existing nuclear power plants and shut down 7 of its 17 power plants within days after the accident. Afterwards, the government announced that all existing power plants will be phased out by 2022. Italy had already closed down all its nuclear power plants after the Chernobyl accident, the last in 1990. However, the government planned to construct a new nuclear power plant and it was rejected in a referendum that took place in June 2011, just after the Fukushima incident (Jorant, 2011). In Switzerland, the Federal Council decided to suspend the approvals process for new nuclear reactors and, subsequently, to make the ban on new nuclear reactors permanent. Furthermore, it was decided that the country's five existing nuclear reactors would continue producing electricity until they are gradually phased out with no replacements. The implications of a switch in electricity generation from nuclear to other sources are important for countries like Germany and Switzerland that are heavily reliant on nuclear energy.[1]

Following the decision to phase out nuclear energy, the Swiss Federal Office of Energy (SFOE) developed an energy strategy, the *Energy Strategy 2050*. A part of this strategy sees utilities as key players for reducing electricity consumption due to their direct contact with end-customers. With this in mind the Federal Council had proposed, within the initial package of measures, mandatory efficiency goals at a national level for utilities that sell more than 30 GWh as a way to reduce electricity consumption. The World Energy Outlook (International Energy Agency, 2009) emphasizes the huge potential of energy efficiency (EE) measures which are viewed by many as "low-hanging fruit" due to their low marginal cost.

Promoting energy efficiency is a part of demand-side management efforts that are often undertaken by utilities and the government. Demand-side management (DSM) refers to the *"planning, implementing, and monitoring activities of electric utilities that are designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand"* (Energy Information Administration, 1999). Utility DSM programs began in the late 1970s as a response to the energy crises. They were begun primarily by utilities on the west coast of the USA before gradually spreading to other regions of the USA, as well as to British Columbia, Ontario and other provinces in Canada. In recent years DSM has spread to Australia and several countries in Europe, Latin America and Asia, although DSM efforts outside of North America till the 1990s have been limited (Nadel and Geller, 1996).

The original intention of DSM programs was to change the pattern of electricity demand to modify the load faced by a utility. It has been subsequently modified to take into account the programs undertaken by utilities to promote energy efficiency. DSM, therefore, incorporates energy efficiency, energy conservation, and load management (Carley, 2012). There are various ways in which utilities and federal and local governments carry out these objectives. They include, among others, policies like appliance standards, financial incentive programs, information campaigns and voluntary programs (Gillingham et al., 2006).[2]

While there is a substantial literature on the development of DSM in the US and its impact on electricity demand, little is known about DSM efforts in other countries. There is a lack of systematic analysis of DSM efforts in Switzerland given the importance accorded to energy efficiency in *Energy Strategy 2050*. Therefore, we have two research questions. First, do utility DSM programs in Switzerland have an impact on residential electricity consumption? Second, what is the magnitude of this impact, if any? To answer these two questions we designed and carried out a survey on Swiss electric utilities to obtain data on DSM efforts between 2006 and 2012 and use the variation within utilities over time to identify its impact and magnitude. We also use the econometric results to calculate the cost of saving a kilowatt hour given the effectiveness of the DSM programs. We follow previous studies in identifying the impact of DSM programs by correlating differences in the per household residential electricity consumption with the variation in DSM expenditures within utilities over time. Unlike most studies, we also check the robustness of our approach by using an instrumental variables approach to account for any potential endogeneity problems arising out of measurement errors or simultaneity issues. We also try to attenuate any sample selection issues by using a Heckman-type model in the instrumental variables approach.

This paper contributes to the public policy debate about the degree to which DSM programs can reduce the demand for electricity in the residential sector as well as influence the adoption of energy efficiency measures. While we correlate changes in electricity consumption with changes in spending on DSM programs or with the presence of DSM programs, we can only infer that energy efficiency measures are adopted by households through the impact on the household's electricity consumption. A second major contribution of this paper is that, to our knowledge, this is the first econometric estimation of aggregate DSM efforts in a European country. Another contribution is that we construct a scorecard to measure the energy efficiency activities of individual utilities and correlate changes in the scorecard to changes in the residential electricity consumption. Our scorecard is similar to the state energy efficiency scorecard published by the American Council for an Energy-Efficient Economy that measures the commitment of states in the US to promote energy efficiency.

The structure of the paper is as follows. In the next section, we provide a brief overview of demand-side management efforts in Switzerland. We then describe the existing literature on evaluating DSM activities in Section 3. In Section 4, we provide a description of the survey performed on some Swiss utilities, the construction of an energy efficiency score and the utilities in our survey and their DSM activities. The variables used in our model and their sources are described in Section 5. Our identification strategy and estimating equation are in Section 6 while the results of the econometric estimation are presented in Section 7. We perform some robustness checks in Section 8. Policy implications are discussed in Section 9 while the final section has concluding remarks.

2. DSM in Switzerland

Switzerland is a federal state consisting of 26 cantons and the responsibilities are divided between the federal government, cantonal governments and municipalities. In this institutional context, Swiss energy policy is defined and implemented at all three levels, *viz.* federal, cantonal, and municipal. Moreover, local utilities also play an important role especially for the definition of the implementation of DSM programs. It was only in 1990 that the energy

[1] Almost 40% of Switzerland's electricity in 2011 was produced from nuclear energy. The end-use consumption of electricity was 58.6 TWh of which 30.6% was consumed by households (SFOE, 2013).

[2] For a detailed description of the history of utility-sponsored DSM programs in the US, please refer to Eto (1996), Nadel and Geller (1996), and Nadel (2000).