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ORIGINAL RESEARCH ARTICLE

Examining interconnection and net metering policy for distributed generation in the United States

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Following requirements of the Energy Policy Act of 2005, most U.S. states require utility companies to adopt interconnection and net metering policies, allowing customers to become prosumers who both consume and produce electricity, generating electricity using distributed renewable energy technologies, connecting to the existing electric utility grid and receiving compensation for excess electricity generation. This paper reviews existing interconnection and net metering policies instituted by investor owned utilities (IOUs) across the U.S., specifically focused on policies regulating installations of small scale, residential or Tier 1 (a term used to indicate policies applicable to smaller scale rather than larger scale, although the size at which DG systems are classified as either Tier 1 or higher tiers varies by utility). Publicly available data from each IOU reveal inconsistencies in interconnection and net metering policies, within states and even within individual companies. In addition, accurate information is often unavailable to consumers. Perhaps most importantly, results suggest that compensation for excess distributed generation often lacks transparent articulation in utility policy. The results of this study provide important insight into interconnection and net metering policies for distributed renewable energy generation, as states and utilities continue to modify interconnection and net metering policies in response to increased adoption of distributed renewable energy systems.

Introduction

For more than half a century, scholars have recognized solar energy technologies as a viable source of sustainable electricity generation [1]. There is currently widespread popular support for renewable energy technologies [2,3]. In comparison to the existing reliance on fossil fuel resources as an energy source, renewable energy (RE) technologies offer a diverse suite of benefits, including climate mitigation and health benefits via reduced emissions [4,5] as well as economic benefits [6] and achievement of sustainable development [7].

The cost of RE technologies continues to decline [8]. The levelized cost of electricity (LCOE) from photovoltaic (PV) technology has dropped below the retail rate of electricity throughout much of the U.S. [9]. Further, new methods of financing PV are increasingly becoming more widespread in availability [10–15].

One of the benefits of renewable energy technologies is the possibility for distributed generation (DG, abbreviated here as DG for brevity, but with specific reference to DG from renewable energy sources), where electricity is produced in a decentralized fashion, distributed across diverse sites near the point of consumption. DG can help address the negative environmental externalities associated with conventional fossil fuel-based electricity generation and provide economic benefits [16,17]. Further, accounting for the full cost of energy production through the LCOE, DG is cost competitive when compared to centrally generated electricity [8,9].

DG is also arguably a major benefit to existing electric utilities. While calculating the full costs and benefits of distributed

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renewable energy generation for customers, utilities, and the environment is incredibly complex and highly debated, several studies suggest that DG provides a net benefit to utility companies [18–20]. There are clear environmental benefits to DG [21] and specifically to transitioning to renewable forms of electricity generation as a means of mitigating carbon emissions [22]; there are also potential co-benefits for the security and resiliency of the electrical grid system [23].

Using DG, existing utility customers can become 'prosumers' – both consuming and producing electricity by connecting installed DG connected to the utility grid and feeding excess electricity generation into it. By relying on electricity produced by grid tied prosumers, utilities are less singularly reliant on their own centralized electricity generation to meet customer demand. Thus, both DG prosumers and utility companies can benefit from net metered interconnections. In order to do so, electric utility companies must enable and regulate the process of electrical interconnection between DG and the existing electrical grid. Interconnection and the associated rights and responsibilities of utility companies and prosumers are typically managed through net metering agreements.

In the United States, there are a complex set of policies at multiple scales that shape the economic and practical feasibility of renewable energy technology development, DG, and net metering. The Residential Renewable Energy Tax Credit is a federal tax credit available to help offset the cost of renewable energy system installation. The federal Energy Policy Act of 2005 included a requirement for states to work with electric utilities to establish net metering policies. Yet the United States continues to lack clear and comprehensive federal energy policy for promoting renewable energy technology development, continuing to rely primarily on electricity generated from centralized sources such as fossil fuels and nuclear to meet energy demand [24,25] as well as relying on state level policy [26] as well as local policy [27] to regulate and promote renewable energy technology development.

Many states offer up-front rebate and incentive programs. For example, 38 states have property tax exemptions and 29 states have sales tax exemptions for solar energy technology. However, these policies vary widely by state and have changed, evolved, and dissipated over time. One state level energy policy mechanism is the renewable portfolio standard (RPS), which stipulates that utility companies generate a mandated percentage of their electricity portfolio from RE sources [28–31]. More than half of U.S. states now have established RPS policies. Of these, 22 state RPS policies include specific provisions for DG technology, meaning that states either require a specific portion of the RE come from DG or will count DG toward the RPS requirement. These 'set asides' for DG have a measurable impact on adoption [32].

An RPS with these provisions can help promote DG by allowing utilities to include customer-generated RE from small scale solar photovoltaic (PV), microhydro or wind energy technologies as part of their portfolio. One specific aspect of policy guiding DG-utility grid interconnection is net metering, which provides a means of accounting for and compensating DG generation. Utilizing interconnection and net metering, customers can produce electricity and offset part or all of their own electricity demand while staying connected to the utility grid and relying on grid power when necessary. Net metering certainly can take place without a state level RPS established, but RPS is one policy that can promote the need for effective net metering so that DG installing prosumers produce electricity that counts toward utility compliance with RPS goals.

Net metering is a simple accounting system for compensating prosumers for electricity contributed to the grid. Net metering is a system by which prosumers are credited for electricity they produce in excess of what they use; net metering can also be referred to as a net feed-in tariff and is distinct from a from a gross feed-in tariff system, where DG adopters are given credit for all electricity generation. Net metering can provide prosumers with long-term savings in overall utility expenditures while also contributing to reduced fossil fuel reliance and carbon emissions from a utility's total energy portfolio [33,34]. Although there is no federal RPS in the United States, federal regulation does require states to establish a net metering policy. However, there are currently seven U.S. states with no specific net metering policy, and utility compensation for electricity generated by customers varies widely [35,36].

Net metering is one means of shifting the utility business model to support sustainable energy sources, arguably a necessary step for a sustainable energy future [37–39]. Some argue that the value of DG outweighs the costs of net metering even without considering environmental externalities and other indirect benefits of renewable energy generation technologies [40–44]. Yet net metering is currently governed by a host of complexities and complications. These include how much credit is given by utilities for excess generation from prosumers (either retail rates – what the prosumer pays the utility for electricity – or some other rate, either greater than retail as a form of subsidy incentive or, as is more often the case in the U.S., some lesser than retail rate), how the prosumer is reimbursed for excess generation (through credits or payment), and how and how often net metered accounts are settled (some options include annual settling of accounts, annual expiration of excess credits, or indefinite rollover of credits).

The requirements of the Energy Policy Act of 2005 stipulate that states establish regulatory regimes to guide utility policy regarding interconnection of DG. However, as this study demonstrates, state level policy implementation often results in inconsistent policies across electric utilities. In some states, utility companies are choosing to interpret RPS requirements and interconnection regulations as allowing them to prevent additional net metering among their customers, effectively disallowing them from becoming prosumers (this is the case with the largest IOU operating in the service territory where the authors' reside). This interpretation of state level policy is just one indication of the complex relationships among federal regulations, state level policy implementation, and utility interpretations and practices that actually shape the experience of residential electricity customers. While competition among IOUs to offer the most lucrative net metering policies for potential prosumers may exist in unregulated electric utility markets, most U.S. electric customers are locked in to whatever guidelines their existing electric utility establishes for interconnection and net metering of DG, and these guidelines are often based in interpretations and implementation decisions at the utility rather than state level.

Net metered DG changes the profitability and ratepayer revenue generation of electric utilities, which have been structured based on centralized generation and guaranteed rates of return. Recent