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Reallocating risks and returns to scale up adoption of distributed electricity resources

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HIGHLIGHTS

- We analyze schemes used to induce owners of distributed assets to make them available for electricity generation.
- We show that power purchase agreements used in solar PV "misallocate" electricity price risk to owners/consumers.
- We propose new contracts forms that shift price risk from consumers to parties that are better able to manage it.
- Full-fledged distributed generators are created by unambiguously rewarding owners and de-coupling consumption/ownership.
- We argue that our analysis can be used to assess scale up schemes in other domains of distributed electricity resources.

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ABSTRACT

Deployment of *distributed electricity resources* requires bringing together assets that belong to diverse and geographically diffuse owners. Using the example of distributed solar PV, we analyze the schemes used to encourage/induce owners of distributed assets to make them available for electricity generation. The dominant model in the U.S. is long term power purchase agreements (PPA) offered to owners/consumers by solar developers. We show that these agreements (mis)allocate the electricity price risk to owners/consumers and impose limitations on the scale up of distributed solar. By proper use of financial markets it is possible to shift the electricity price risk from owners/consumers to parties that are better positioned to manage it. The proposed contracts simplify the adoption decision for owners/consumers and can lead to a wider adoption. Removing barriers to scale up requires (i) eliminating the tight coupling between consumers and owners and (ii) rewarding the owners unambiguously for the assets they provide. These necessitate the transformation of the current intermediary firms into full-fledged distributed generators. We discuss the implications of such a transformation and argue that the broad outline of our analysis can be used to assess scale up schemes in other domains of distributed electricity resources as well.

1. Introduction

Feed in tarrifs (FIT) are the most commonly used policies worldwide to promote and stimulate the development of renewable energy sources.[1] These policies, arguably the most direct and supportive of the development of renewable energy, are based on the principle of offering "*guaranteed prices for fix periods of time*" for electricity produced from these sources.[2] In one of the widely used versions of FIT policies, guaranteed prices are supplemented by *guaranteed purchase of the electricity produced.* As a result, these policies shield investments in renewable resources from volatility in the market price of electricity, remove a significant portion of risk through firm purchase commitments, and create a stable and predictable investment environment that can lead to–and has led to–substantial growth and scale up of renewable energy sources. Price and purchase guarantees in these policies are underwritten by electricity rate payers, or more broadly, by tax payers.

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[1] See, e.g., Cory et al. (2009), Mendonça and Sovacool (2009), Couture and Gagnon (2010).

[2] See Couture and Gagnon (2010).

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By contrast, the most prevalent type of policy in the United States is some form of local, state, or federal governmental subsidy. Various states have established Renewable Portfolio Standards (RPS) that set requirement targets for utilities, typically in terms of the percentage of their total energy that must come from renewable sources. Renewable electricity generators, in turn, receive Renewable Energy Credits (RECs) and various tax credits for their investment and for producing electricity. While these subsidies, in general underwritten by tax payers, defray investment and operation costs, they do not provide any price or purchase guarantees and thus provide no guarantees as to the profitability of such investments. As a result, investments under these policies involve considerable *residual investment risk*.

In this paper, we analyze the main economic model that has emerged in the United States for *distributed* solar photovoltaic (PV) generation of electricity in urban and suburban areas and show how it addresses the above mentioned residual investment risk. We discuss the strengths and weaknesses of this model, and suggest alternative schemes that can be used to overcome the weaknesses identified. The example of distributed solar electricity generation is used to highlight the broad outline of an analysis that we believe is also applicable to other domains of distributed electricity resources.

In most, if not all cases, utilizing distributed electricity resources requires some "assets" whose *ownership* is diffuse and distributed. These assets are sometimes *hidden* and/or *idle*, or they are being put to a use other than electricity production[3]; they may not generate economic value for their owners, or they may not even explicitly be recognized as valuable assets. A key step in our analysis is to study the mechanisms that have been developed in order to encourage/induce the owners of these assets to make them available for electricity production. Rewarding the asset holders directly, for example, by leasing their assets, is a straightforward solution that is used in some domains. But, as we explain below, in distributed solar electricity production, the owners of such assets are not unambiguously rewarded and the assets they provide for solar electricity production are not explicitly accounted for.

In each domain of distributed electricity resources, various asset holders act as economic agents whose degree of participation is based on their assessment of the risks and returns associated with their participation. Generation of solar electricity, for example, is premised on the proposition that, over medium term, and taking various governmental subsidies into account, solar electricity will be cheaper than the retail price of electricity. Investing in distributed solar electricity amounts to taking a directional position vis-a-vis this proposition whose validity is anything but certain. The second element of our analysis is to study the current contractual arrangements between providers and consumers in terms of the risks that different parties bear and whether they are best positioned to manage their risks. We show that in the current solar PV contracts investors/intermediaries simply provide homeowners with loan-like instruments and avoid taking any directional position vis-a-vis price uncertainty. *In effect, these contracts synthetically replicate FIT policies with market independent price and purchase guarantees for investors/intermediaries, and remove their residual investment risk.* In this case homeowner/consumers underwrite the price and purchase guarantees and bear the key risk associated with the grid/retail electricity price uncertainty, namely the above residual risk. Homeowners on the other hand are not best positioned to assess and manage this risk. We propose alternative contractual arrangements that shift the risk away from homeowners to those who are better positioned to manage it.

The third component of our analysis is to show that a lack of markets where distributed generators can effectively participate, seriously limits the range of scalable solutions. Current distributed solar electricity contracts primarily focus on those homeowners and consumers who are sufficiently *credit-worthy* to enter into long term power purchase agreements. In the absence of markets where distributed solar electricity generators can effectively participate, solar electricity production opportunities are limited by the availability of *credit-worthy* counter-parties able and willing to commit to purchase the total production over the life of the contract. This requirement is a serious barrier to the scale up of solar electricity production; removing it depends critically on finding alternative market arrangements and regulatory regimes for the sale of distributed solar electricity.

The alternative contracts we propose in order to shift the risk associated with the grid price of electricity away from consumers does not require a major organizational change for current providers of solar electricity contracts but it does require new financing and risk management arrangements through appropriate use of financial markets. On the other hand, we argue that in order to achieve a significant scale up of distributed solar electricity generation we need new and truly distributed generation firms and also substantial changes to current regulations.

2. Distributed photovoltaic (PV) systems

Solar electricity has not yet reached grid price parity.[4] Trends are moving towards parity over the foreseeable future. Technology innovations and large-scale manufacturing have reduced the solar PV module down from \$4/Watt in 2007 to less than \$1/Watt today. Solar installers have gained expertise in site and installation techniques to further reduce the transactions costs. The total installed costs have come down from \$10 in 2007 to \$5 today.[5] To speed up this process and bridge the parity gap, various governmental programs, at federal, state and local levels in the form of subsidies, incentives and tax refunds for production of green electricity have been initiated.[6]

Distributed PV requires two classes of physical assets for solar electricity production: (i) technology assets, namely solar panels, inverters, and monitoring/management systems, and (ii) space/land assets with sufficient solar incidence to host the panels. Given advances in PV technology and large scale manufacturing, technology is no longer a major impediment to scale up. In cities, land is generally a scarce and expensive resource. Rooftops, mostly idle resources with high solar incidence, are natural locations for installing most PV systems; thus, large scale PV electricity production requires having access to a large pool of rooftops. Large scale production of PV electricity also needs large scale investment/financing. Securing land and financing have become the critical bottlenecks to the expansion of PV electricity production.

In addition to these physical assets, to match the time profiles of PV production and consumption, distributed solar PV requires access to the electricity grid. Current net metering regulations permit averaging out the net flows at each location over a specified period of time (e.g. calendar year). This net metering regime

[3] To simplify, we use the term electricity generation or electricity production for cases where electricity is in fact generated, such as solar generated electricity, as well as cases where a more intelligent scheme for matching production and consumption is being used.

[4] There are few exceptions such as some high electricity use customers in California who face top tier prices.

[5] See for example, Barbose et al., (2012).

[6] See, for example, Nemet (2006), Borenstein (2008, 2013), and Branker et al. (2011).