

# ***MANAGING RELIABILITY IN A DISTRIBUTED ELECTRICITY SECTOR VIA INSURANCES: INSIGHTS FROM AN AGENT-BASED MODEL***

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## **Overview**

High penetration of new distributed energy technologies would call for a different way to manage reliability in the power sector. In the most extreme case, the consumer would produce all the power their home needs and store it until the time of consumption, effectively by-passing the utility. The issue of electricity security for self-sufficient households would still remain because these technologies can eventually fail due to technical or weather conditions, or be subject to spikes in demand which installed capacity will not be able to meet. An option could be to draw power from the grid when this happen, but this behaviour could eventually constitute an existential threat for utilities. In response to these concerns, we test in this paper the creation of a risk market that enables reliability preferences to be internalized through the use of insurances. We propose the utility can offer last resort power – an insurance-- to energy self-sufficient households to protect them against the prospect of a blackout. The overarching idea is that instead of selling commoditized kilowatt-hours, consumers would pay for guaranteed services..

## **Methods**

We investigate the extent to which contracts for insurance can converge into a theoretical optimal contract defined by the households' energy budget, a risk aversion attitude, expected loss (or excess demand). The nature of this optimal contract is explored in a static (one-shot) version of the insurance model where the supplier possesses full and complete information about households. This static model is then extended into a dynamic framework, with further relaxation of assumptions.

The dynamic model explores a repeated game, where households are allowed to renew or switch contracts after a certain number of periods. In this model, we restrict the information that utilities have on households, and instead of customized contracts, offer a menu of contracts to choose from which can be updated after a fixed number of periods. Both households and firms are allowed to “learn” over time and update their choices and offerings respectively. The impact of the dynamic model is examined with an Agent Based Model (ABM), and we examine how the perception of risks and losses impact the price of insurance and potential revenues of utilities, when the supplier moves from perfect information and instead second guesses the household's characteristics with a menu of contracts that allows the households to self-select the contract that maximizes their utility.

## **Results**

We find that a stable market can exist, where prices converge to a long run equilibrium, and the distribution of choices made by households become stationary. Our results suggest that the creation of this market improves welfare as consumers transfer some of the inherent risk to the utility, possibly reducing over investments in installed capacity. Our simulations show that, on average, out of those households who would otherwise have had to go dark, between 1 to 15% are able to fully cover their excess energy needs through insurance. From those households who would otherwise go dark, between 50 to 70% are budget constrained, would still be able to partially cover their excess energy needs.

## **Conclusions**

In central electricity systems, planners invest in capacity higher than the peak load in order to have reserve margins that can deliver almost perfect coverage, as they can spread this cost among all customers. Being on the “safe- side”

may have been justifiable when technology options were limited and the underlying assumption was that blackouts have an infinite value. In a distributed dominated power system, however, this approach seems unnecessarily expensive and unfair, as all customers pay in equal terms regardless of their risk preferences. It would also be self-defeating as utilities would no longer be able to spread the costs because defect the grid leading to a death spiral.

To deal with security of supply in this context, we test in this paper the creation of a risk market that enables reliability preferences to be internalized through the use of insurances. We find it is more efficient for households to transfer the “last mile” of risk to the utility than bearing the disutility of a blackout. We find that, in terms of the ex-ante internalization, an insurance might be able to work as a surrogate regulation mechanism to increase prevention and precaution, and that the actors ensure a stable workable market.

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