IMPROVED REGULATORY APPROACHES FOR THE REMUNERATION OF ELECTRICITY DISTRIBUTION UTILITIES WITH HIGH PENETRATIONS OF DISTRIBUTED ENERGY RESOURCES

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Executive Summary

The proliferation of rooftop solar power and other distributed energy resources, or DERs, (including distributed generation and storage, demand response, and electric vehicles) is now actively transforming the delivery of electricity services and the use and management of distribution systems in many jurisdictions. Distributed generation and storage introduce bidirectional power flows and, at significant penetration levels, entail profound changes to the real-time operation of distribution systems. Widespread electric vehicle adoption could likewise necessitate new network investments and may enable new "vehicle to grid" services. Advanced metering, time-varying rates, and energy management systems have the potential to make electricity loads more responsive to economic and operational signals than ever before. Efficient price signals, new control systems, and/or novel market actors are necessary to manage and coordinate each of these DERs and their associated services. These emerging technologies constitute a set of important new users of distribution systems, potential new competitors for the delivery of electricity services to end-users, and possible suppliers of services to distribution companies seeking to harness DER capabilities to avoid network investments or improve system performance.

This ongoing transformation of the power sector presents new challenges for the regulation of electricity distribution utilities and strains both cost of service/rate of return and incentive/performance-based approaches to the remuneration of distribution utilities. In particular, regulators face heightened uncertainty regarding the way DERs will change the use of distribution networks and impact efficient network costs. That uncertainty also puts the regulator at an informational disadvantage. On the front lines of the evolving power sector, distribution utilities interface regularly with customers and equipment vendors and are likely to know far more about emerging technologies and the evolving use of the grid than their regulators. This information asymmetry exacerbates existing temptations for utilities to engage in strategic behavior to increase their allowed remuneration.

New solutions are thus needed to regulate the distribution utilities of the future. Regulators need forward-looking tools to overcome information asymmetries and identify the impacts of DERs on the cost of building, operating, and maintaining distribution networks. In addition, regulators need remuneration mechanisms that incentivize utilities to not only accommodate distributed

resources as new network users but also to harness the new capabilities DERs may provide to reduce system costs and improve performance. Finally, regulators need to manage the heightened uncertainty they now face while preserving incentives for utilities to be more efficient and safeguarding the regulatory compact that prudently-managed regulated firms shall remain financeable.

This paper proposes a new process that equips regulators with the tools they need to establish the allowed revenues of distribution utilities in the uncertain future ahead. This method involves a novel combination of four state-of-the-art regulatory tools.

First, an engineering-based reference network model (RNM) is employed to generate a forward-looking benchmark of efficient network expenditures. The RNM designs an efficient distribution network that can accommodate expected growth of DERs and produces an estimate of efficient network expenditures. In short, the RNM helps the regulator "peer into the future," reducing both information asymmetry and uncertainty.

Second, a menu of profit-sharing regulatory contracts creates strong incentives for utilities to pursue cost-saving efficiencies while managing uncertainty by sharing risks between the utility and ratepayers. In addition, if designed correctly, the menu of contracts will preserve "incentive compatibility"—that is, firms will always be better off when they provide regulators with accurate forecasts of their expected costs. This feature further reduces information asymmetries and helps the regulator establish an accurate revenue baseline.

Third, a fixed share "fast money/slow money" approach to capitalizing expenditures equalizes incentives for savings in both capital expenditures (CAPEX) and operational expenditures (OPEX) so that utilities will, for example, pursue cost-effective active system management or "non-wires" solutions.

Finally, the paper proposes novel automatic adjustment mechanisms, or "delta factors," which can be used to adjust allowed revenues after the fact to accommodate inevitable errors in the original forecast of network uses (i.e. load growth or DER penetration) used to establish the utility's allowed revenues. As the paper demonstrates, these delta factors are an effective tool to accommodate the heightened uncertainty regulators now face regarding the evolution uses of distribution networks. Using delta factors also improves regulatory certainty by reducing the risk that the revenue determination will need to be re-opened during the regulatory period. Finally, these delta factors align incentives for the utility to connect and serve new DERs by ensuring cost recovery even if DER penetration grows more rapidly than expected.

This paper simulates a realistic, large-scale urban distribution network to demonstrate, step-by-step, the practical implementation of this novel regulatory process and illustrate the advantages for the economic regulation of electricity distribution utilities under increasing penetration of distributed energy resources.