MILLENNIUM CHALLENGE CORPORATION
UNITED STATES OF AMERICA

Ghana

MCC Learning from Final Impact Evaluation of investments in Line Bifurcation under the ECG Financial and Operational Turnaround Project

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MCC has identified the following programmatic and evaluation lessons based on the Final Report for the Evaluation of Line Bifurcation investments under the ECG Financial and Operational Turnaround (EFOT) Project of the Ghana Power Compact.

PROGRAMMATIC LESSONS

MCC identified the following lessons for the design of future power infrastructure programs:

- ***Harness newer grid measurement technologies in the design, screening, and prioritization of power infrastructure projects.*** While the evaluation did not detect an impact on outages resulting from investments in line bifurcation, the high-resolution data from the GridWatch platform yielded extensive insights into the duration, frequency, and location of outages on the distribution network, while highlighting recurring patterns over time and across low, medium, and high-voltage segments of the local grid. Such granular data on grid performance was not available to MCC during the feasibility and design stages of the Ghana Power Compact, with project teams primarily relying on conventional data sources such as utility data on losses and outages, or targeted load flow analyses. Yet, with the advent of remote sensing platforms that can capture longitudinal grid performance data with relative ease, the design of future power infrastructure investments can be far more robust, leveraging enhanced precision in the analysis of root causes of outages, and even helping to pinpoint the weakest performing portions of the grid down to the feeder level. For instance, analysis from GridWatch data showed that had the worst-performing lines been identified and selected for transformer injections in Accra (instead of comparatively average-performing lines actually targeted), observed impacts on voltage could have been up to 20 percent higher, leading to 14 fewer hours per month of undervoltage experienced by customers. Moreover, deeper analysis of the spatial and temporal patterns of outages could inform the design of highly tailored demand-side interventions to reduce peak load during periods of high demand, when critical components of the grid are most overloaded.

  Going forward, MCC country teams should identify and incorporate newer technology platforms into their due diligence planning, partnering with service providers can integrate outage, voltage, and AC frequency data over time via remote sensing or other modalities going beyond conventional approaches, which typically rely on one-off spot measurements to conduct grid analyses. Such approaches should be enlisted particularly for planned investments in the distribution network of partner countries, with plans for deployment and data collection included in early stages of program development. If installed very early in the process, such analyses can help prioritize investments with greater accuracy by targeting the areas with highest needs. This can also assist in establishing baseline

performance, while improving the rigor of target-setting and overall economic appraisal of program investments.

- ***Further explore the role of voltage quality in mediating consumer outcomes.*** Despite showing a positive impact on voltage quality in targeted project sites, line bifurcation investments did not ultimately lead to observable impacts on customers in terms of the costs associated with poor voltage, such as those resulting from damaged appliances and equipment. Although there are theorized benefits associated with improved voltage stability, it is unclear whether the voltage improvements were of sufficient magnitude to deliver measurable results for consumers – or whether a longer time horizon, with improvements in voltage sustained over time, may be necessary to observe such changes. Another possibility is that the modality by which voltage fluctuations impact customers is not reflected in terms of the number of hours of undervoltage, but via a different mechanism – such as the occurrence of voltage spikes (i.e., sudden large increases above nominal voltage, usually of very short duration). This could entail the need to consider alternate ways of measuring and understanding voltage quality, how it impacts different kinds of electricity customers, and how they insure themselves against damages from voltage fluctuations.

  Based on the evaluation's findings, MCC country teams should continue exploring the impact of poor voltage quality on consumers, supporting analysis of high-resolution (e.g. real-time) voltage data as allowable based on newer strategies for gathering such information. In addition, future analyses should investigate use of alternative metrics for voltage quality, considering the various ways in which unstable voltage may impact users of electricity, as well as working to better characterize the coping strategies adopted by different consumers. Finally, economic appraisals of future power infrastructure programs should be cautious about assumptions on the relative scale and magnitude of benefits associated with improvements in voltage quality until such relationships are better understood.

EVALUATION LESSONS

- ***Evaluations of distribution infrastructure investments may need to be focused on a wider geographic scale to measure and detect reliability impacts.*** Although the evaluation design contained valid treatment and control groups within the districts targeted for line bifurcation investments, these interventions comprised only a portion of the overall suite of infrastructure upgrades completed under the Ghana Power Compact. While the sampled districts received transformer injections into the low-voltage (LV) network, the broader EFOT Project also supported sizable investments into the medium- and high-voltage network, including construction of new primary substations and two major bulk supply points at the interface to the transmission system leading into Greater Accra. Moreover, the evaluation showed that a significant share of outages tended to occur at the medium- and high-voltage

levels within the Accra grid, typically exceeding the extent of outages observed at the LV level, which was the focus for detecting effects via the collection of both survey and GridWatch data for this evaluation[1]. This suggests that to increase the likelihood of detecting impacts on reliability resulting from power infrastructure projects, future evaluations should consider a measurement strategy that captures the totality of MCC investments within the relevant geographic area, treating the LV, MV, and HV segments of the local grid holistically as a 'supply chain' where aggregate outages may arise from faults along multiple sections of the network. Correspondingly, any improvements in reliability achieved by MCC investments would reflect the cumulative new, upgraded, or rehabilitated constituents of the power grid resulting from the program, including all new transformers, substations, and power lines. Evaluation of future power infrastructure projects should therefore explore a design approach that spans an appropriately inclusive geographic (and geometric) scope of the electric grid, in order to facilitate detection of outage improvements at a greater magnitude, while reflecting a fuller extent of outage reductions resulting from project investments. This may require greater reliance on interrupted time series designs in lieu of difference-in-difference or regression discontinuity designs, which are more suited to sampling at a more localized level. However, the high-frequency nature of outage monitoring technology such as that used for the line bifurcation evaluation would enable clearer strategies for identifying reliability improvements over extended time periods, and linking changes to the timing of these changes to the implementation timeline of larger infrastructure assets coming online.

[1] Note that a separate performance evaluation covering the total investments under EFOT is ongoing, with GridWatch devices deployed at a wider scale in Accra to assess results more comprehensively. Final results are expected by 2026.