Conference report: Artificial Intelligence (AI) & Digital Transformation (DX) in Electric Power Summit 2025

I am pleased to share my experience attending the Artificial Intelligence (AI) & Digital Transformation (DX) in Electric Power Summit 2025. Organized by Stanford University and the Electric Power Research Institute (EPRI), the event brought together leading experts, researchers, and industry professionals to discuss cutting-edge advancements in AI and digital transformation within the electric power sector and their applications across different domains including smart electric transportation management at large scale. This report highlights my impressions of the summit and a review of selected research efforts that align with the center's vision of Zero Casualties, Zero Delays, and Zero Environmental Damage.

Notably, the event showcased significant advancements in AI-driven solutions for electric power applications, including topics related to energy optimization, grid resilience, and the impact of the transportation electrification on the grid. These discussions included various challenges, such as improving EV charging paradigms, which is critical to supporting the widespread adoption of electric mobility.

The summit featured an impressive array of keynote talks, panel discussions, and technical sessions covering a wide range of topics- from fundamental optimization research to its real-world applications in power grids. Engaging with fellow participants fostered valuable exchanges of ideas and opened new avenues for interdisciplinary collaboration. Presenting my research, *"Explanatory Analysis and Machine Learning for Electric Vehicles Charging Demand Prediction,"* provided a platform to share insights into the application of comprehensive data analysis and neural networks for quantifying the energy consumption resulting from the use of electric vehicles.

Overall, the summit underscored the importance of collaboration between academia and industry in leveraging AI to address pressing challenges in energy and transportation. In alignment with the summit's focus on digital transformation and sustainability, several works stood out as particularly relevant to advancing the goals of optimizing urban energy systems and transportation networks. One example is Utilidata Karman EV charging analysis project under the Transportation Research Institute at the University of Michigan [1], which analysed EV charging patterns to study the impact on the grid and how to better manage EV demand. Key insights included the following observations:

(1) EV charging caused large and rapid swings in current draw, even after charging session has ended. This inconsistent power draw results inefficient energy consumption, which could lead to overheating lines, power loss and outages.
(2) EV charging lowers local voltage significantly – areas with high concentration of unmanaged EV charging are at risk of more frequent outages
(3) EV charging causes variability in local voltage – the ability to measure these changes with edge computing allows utilities to understand which locations can accommodate EV charging
(4) EV charging lowers power quality by introducing current harmonics generated from the conversion of AC to DC power – low power quality causes equipment degradation and

failure for both utilities and consumers (flickering lights, excessive motor wear and tear, and premature failure of home appliances)

(5) EV charging in the presence of a grid fault showed varied conditions to support voltage recovery.

There is great motivation for industry stakeholders, policymakers, and regulators to support further research into the potential reliability impacts of EV charging, including the value of granular grid edge data and AI models to manage power quality and potential grid upgrade costs.

Another research, "Evaluating the Impact of Multiple DER Aggregators on Wholesale Energy Markets: A Hybrid Mean Field Approach" [2] developed a decentralized, mean-field-based model where aggregators make informed charging and discharging decisions on behalf of the prosumers they manage, guided by locational marginal prices. The algorithm provides cost benefits to consumers by optimizing the use of energy storage and achieve convergence to an Mean-Field Equilibrium. This algorithm can be applied to harness EVs as storage assets within Vehicle-to-Grid framework.

An additional study has developed a PyTorch GPU implementation for contingency-constrained optimal power flow [3], offering speed-up of two orders of magnitude compared to CPU-based commercial solvers. This development is essential to support the reliable operation of grids with increasing level of electric transportation.

Overall, the summit underscored the importance of collaboration between academia and industry in leveraging AI and digital transformation to address pressing challenges in electric grids and to accommodate electrification of transportation within them. It was a rewarding experience that not only enriched my understanding of emerging trends but also provided an opportunity to contribute to the ongoing dialogue shaping the future of smart, sustainable power systems.

Best regards,

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References

[1]https://utilidata.com/api/pdf?fileName=1ec4dbd57ea6f6d6e098feb6155d88a58c659543.pdf

[2] He, Jun, and Andrew L. Liu. "Evaluating the Impact of Multiple DER Aggregators on Wholesale Energy Markets: A Hybrid Mean Field Approach." *arXiv preprint arXiv:2409.00107* (2024).

[3] Degleris, Anthony, Abbas El Gamal, and Ram Rajagopal. "GPU Accelerated Security Constrained Optimal Power Flow." *arXiv preprint arXiv:2410.17203* (2024).