



Machine Learning Applications in Power Distribution System Operation

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Agenda

1. Ning Lu, NC State, “Machine learning based **synthetic data generation**”
2. Valliappan Muthukaruppan, Exelon Corporation, “Smart meter data analysis for **distribution transformer monitoring and sizing**”
3. Xiangqi Zhu, NREL, “Machine learning powered **residential load profiles analysis and DER capacity forecasting**”
4. Avijit Das, PNNL, “ **Optimal Coordination of Distributed Energy Resources Using Deep Deterministic Policy Gradient**”
5. Vassilis Kekatos, Virginia Tech, “Optimal Design of **Volt/VAR Control Rules** using Deep Learning”
6. Nanpeng Yu, UC Riverside, “Learning to Operate an **Electric Vehicle Charging Station**”

Data Needs for ML Algorithm Development

- Valliappan Muthkaruppan (utility): What data we have and who need them? Which algorithm needs what type of data
- Xiangqi Zhu (NREL): if 1-minute data is available, we should have a better way of doing load disaggregation. Very limited high-resolution data, so it is insufficient for developing such applications and algorithms cannot be validated.
- Avijit Das (PNNL): RL relies on data resolution.
- Vassilis Kekatos (Virginia Tech): public available data is very limited we have to use them repetitively.

Logistics

- 5-minute introduction.
- 13 minutes + 2-minute Q&A.
- 20-minute panel discussion.

Utility Data

Smart Meter Data

- **Building level** P, Q, V
- **Resolution:** 15-, 30-, or 60- minute

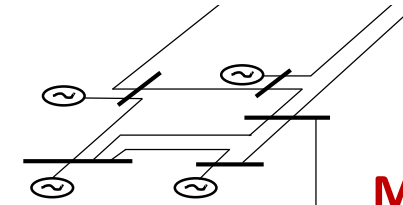
SCADA Data

- **Feeder level** P, Q, V, I
- **Resolution:** 5-minute
- Demand Response events
- CVR events

Customer Information System

- Network connections (i.e., meter-transformer-substation connections)
- Load types

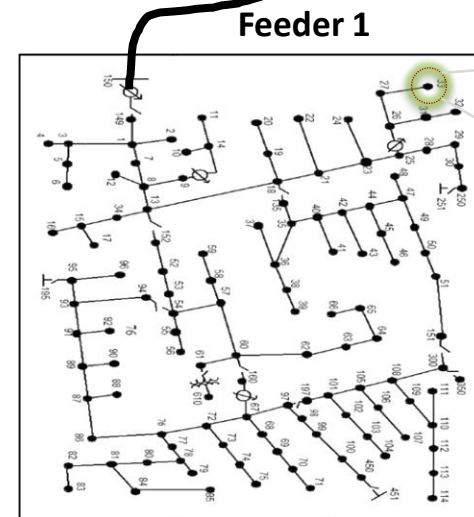
Transmission Network



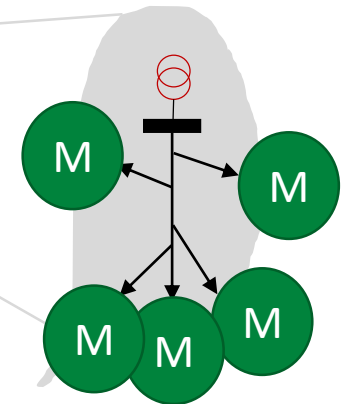
**Municipal/Co-op utilities
Distribution Network**



Substation



Feeder models: showing only distribution transformer locations



GIS map: overlaid with Google map showing meter to transformer connections

Emerging Data Analytic Needs

Use Case 1: Mislabeled meter phase

Use Case 2: Mislabeled transformer-Meter pairing

Causes

- Erroneous entries
- Feeder reconfiguration
- Transformers and meters can be moved to another location
- Labor intensive to maintain the information up-to-date

Use Case 3: Transformer Loading Studies

Use Case 4: Baseline estimation

Use Case 5: Load disaggregation

Use Case 6: EV and PV Integration Analysis

Needs

- Identify high-quality demand response resources
- Understand DER impacts on load curves
- Quantify load reductions by CVR and DR

