

Paper No: 21PESGM0352



A Machine Learning-Based Method to Estimate Transformer Primary-Side Voltages with Limited Customer-Side AMI Measurements

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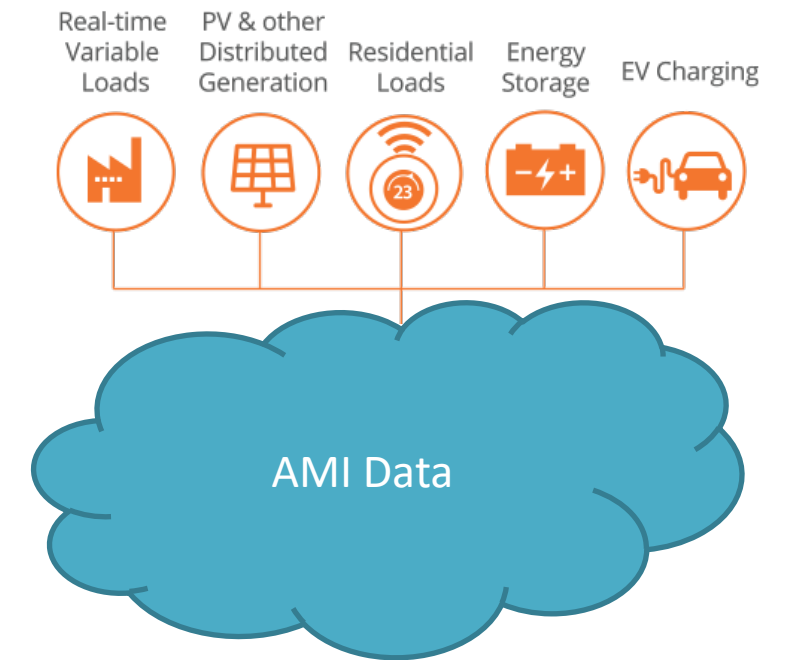
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NREL/PR-5D00-80342

Background

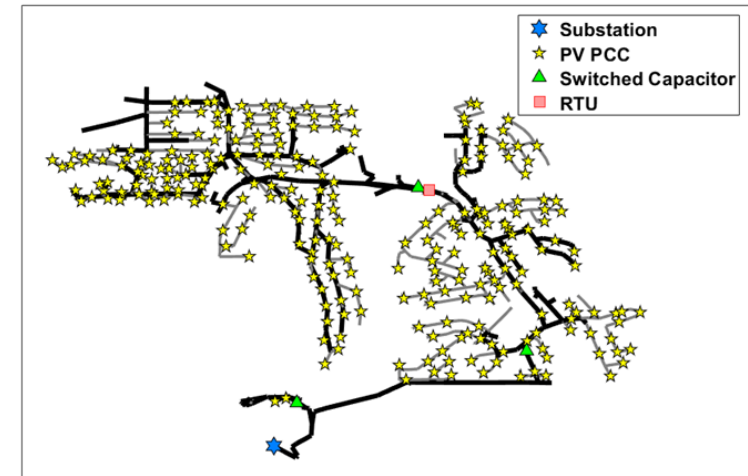
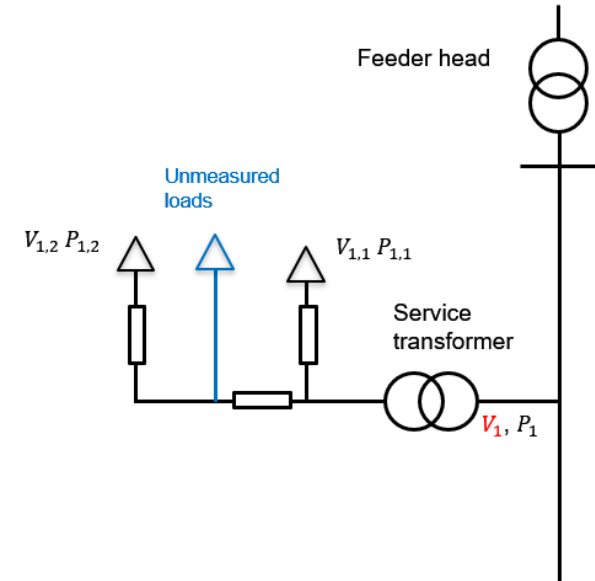
Advanced Metering Infrastructure (AMI) provides a new paradigm for utility planning, operations, and controls.

- Distribution system modeling
- Real-time awareness at the grid-edge
- Processing and visualization of large data sets
- **Developed method for estimating service transformer primary side voltages with limited AMI measurements**



Test System

- **Utility feeder:**
 - 325 service transformers
 - Peak load - ~10 MW
 - Substation LTC, cap banks
- **AMI data :**
 - $V_{1,1}, V_{1,2}$ (5-minute)
 - $P_{1,1}, P_{1,2}, P_1$ (hourly)
- **Random forest machine learning method:**
 - Input: $V_{1,1}, P_{1,1}, V_{1,2}, P_{1,2}, P_1$
 - Output: V_1

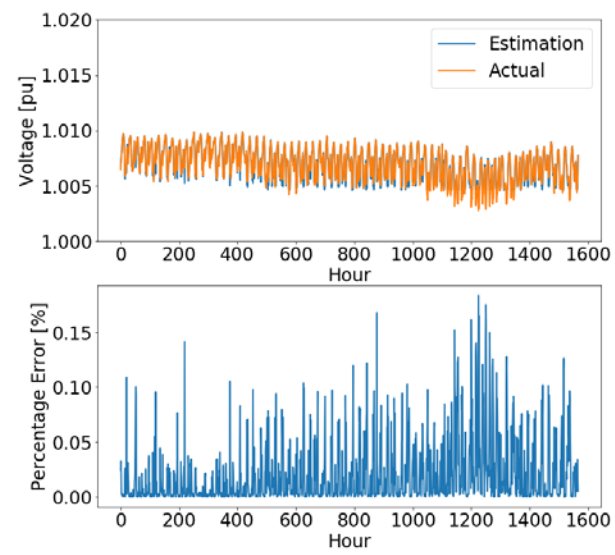


Results

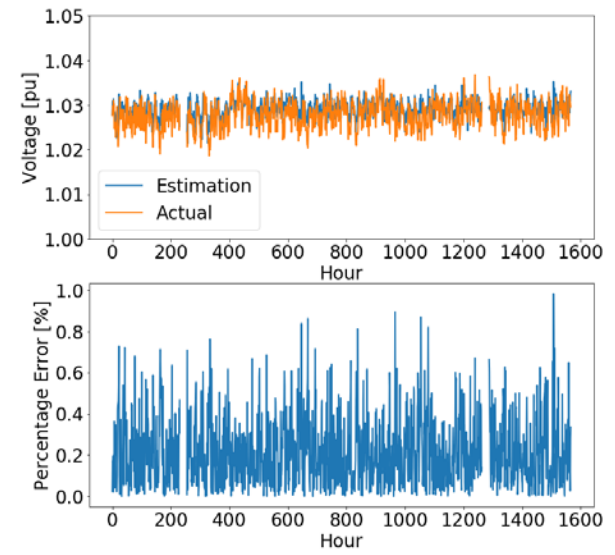
- Test Cases:

		Case 1	Case 2	
			2a	2b
Train	Primary voltage	Simulated	Actual	Simulated
	Secondary voltage	Simulated	Actual	Actual
	Load	Actual	Actual	Actual
Test	Primary voltage	Simulated	Actual	Actual
	Secondary voltage	Simulated	Actual	Actual
	Load	Actual	Actual	Actual

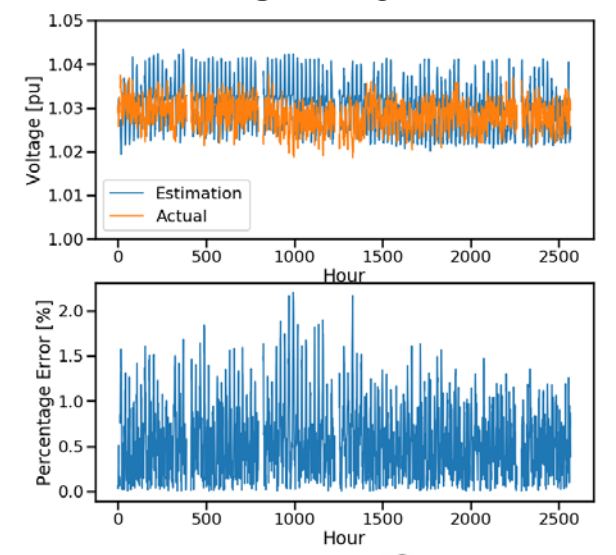
Case 1



Case 2



Case 3



Outcomes

- A machine learning-based approach to estimate the primary network voltages based on the AMI data on the secondary network is proposed
- The estimated primary network voltages can be used by utilities as pseudo-measurements for distribution network planning and control applications
- A software tool developed based on the proposed approach is being deployed at San Diego Gas & Electric utility
- This tool can estimate primary network voltages and identify planning network model inaccuracies leveraging the AMI measurement data

This work is authorized in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy and by Electric Program Investment Charge (EPIC) Program in San Diego Gas & Electric Company under a cooperative research and development agreement (CRADA) # CRD-17-712. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.