Leveraging AMI for DER Interconnection and Model Validation

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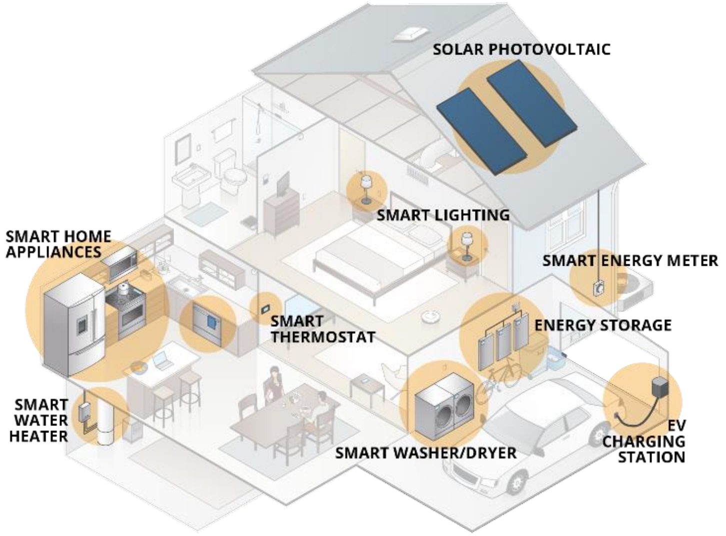
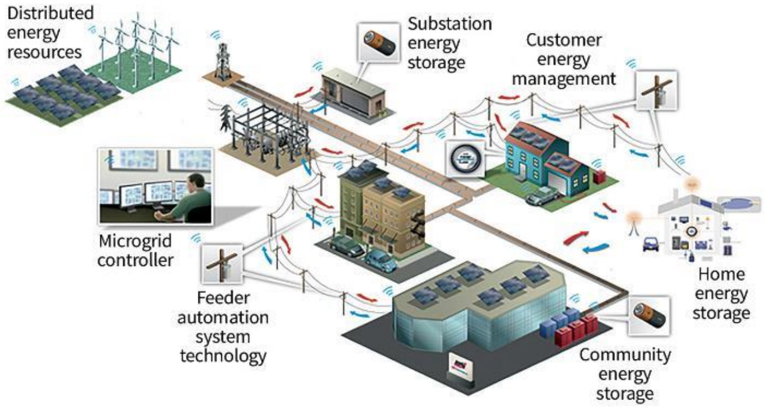
Introduction

- DER integration is reliant on 1) data, 2) power system models, and 3) software tools for planning or implementing controls
- Recent additions of Advanced Metering Infrastructure (AMI), or smart meters, provide measurements of each customer’s power consumption and possibly other quantities, such as voltage and reactive power
  - Brings new opportunities and new challenges
- The distribution system is getting more complicated with the proliferation of distributed energy resources (DER), and new control strategies – electric vehicles, rooftop PV, energy storage, microgrids, etc.
- Power Systems—and specifically distribution systems— are a perfect application for Machine Learning due to their complexity and large amounts of data





What is the General Problem?

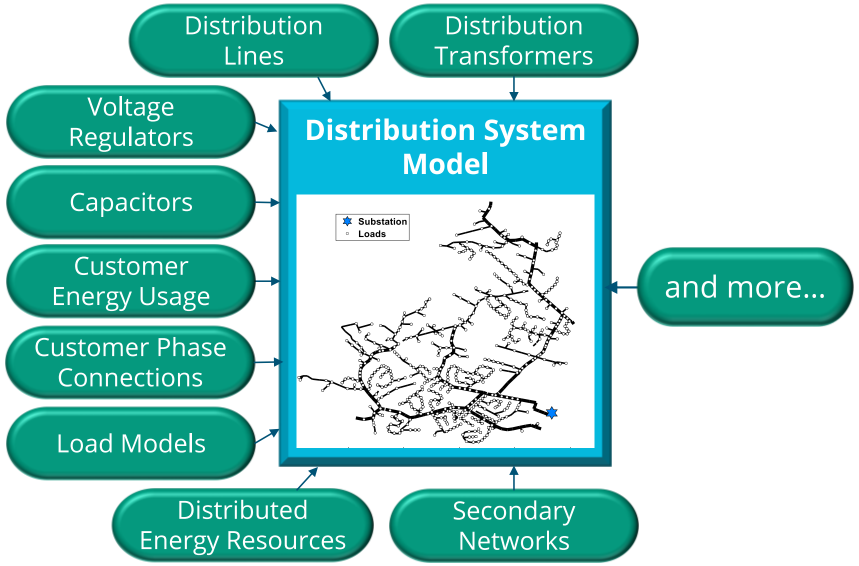
DER integration is reliant on 1) data and 2) power system models, both of which can contain errors and challenges

- System measurements include streaming and historical data from sensors like SCADA, AMI, and PMU
  - Data quality issues such as missing data
  - Challenges in storing and accessing big data (many utilities have not updated their database structures, which makes data queries incredibly slow)
- Power system models have a large number of parameters such as line lengths, transformer impedances, and governor settings
  - Challenging to exactly match all the values that are in the field
  - Errors due to manual data entry or unknown estimated values is common

Need – Models that provide a more granular understanding of the distribution system and substantially increase the precision and accuracy of planning and operation tools

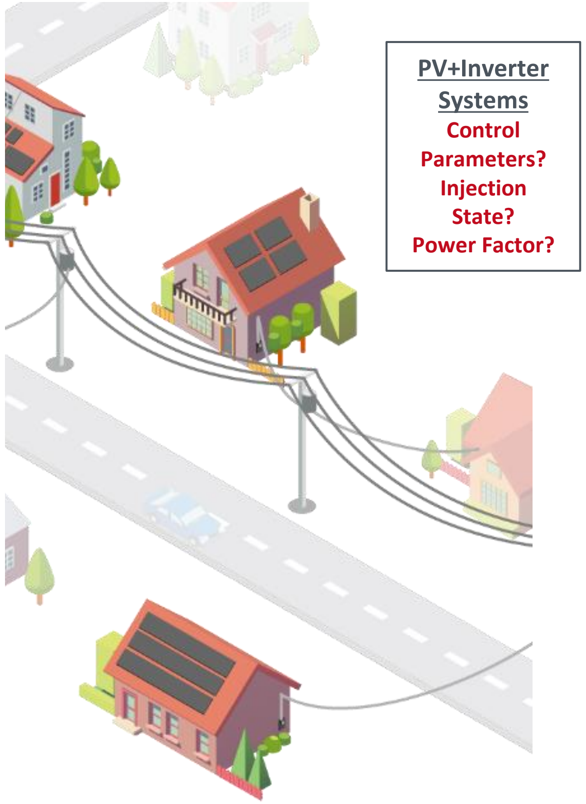
Data Quality Issues:

- ❖ Measurement Interval and Time Synchronization
- ❖ Measurement Type (instantaneous vs. average)
- ❖ Meter Resolution (decimals)
- ❖ Measurement Noise
- ❖ Missing Data
- ❖ Erroneous Data
- ❖ Calibration or Installation Errors



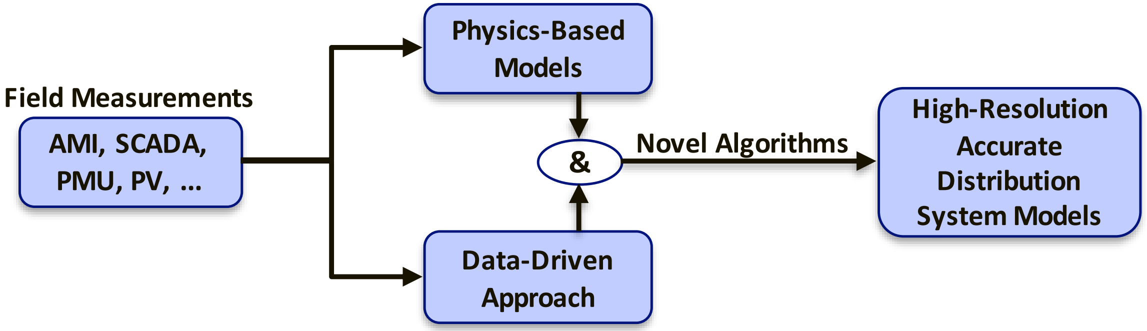
Challenges to Overcome

- Keeping grid models up-to-date is difficult as the grid is continually changing due to maintenance, DER interconnections, equipment upgrades, and new smart grid technologies and controls
- DER is being installed at an incredible rate, but it may vary from the interconnection plan - not interconnected, project delayed, changed size, shading issues, gradual soiling, or module/string failures.
  - Information for existing DER systems may not be known (DC power rating, tilt, or azimuth) and settings like power factor, volt-var, and ride-throughs may change
- Automated DER interconnection screening tools have uncertainty, and generating hosting capacity maps is time-consuming and computationally intensive, so they may not be updated very often.



How do we overcome this obstacle?

- For improved DER interconnection planning and control, we need new tools that will incorporate data into the physics-based models, to detect modeling errors and calibrate parameters
- Data-driven methods can be used to detect events and system changes, allowing the models to dynamically adapt and automatically update based on system conditions
- Solar disaggregation methods can separate the PV from the load measurements. Machine learning can detect if there is PV, along with size, tilt, azimuth, and identify advanced inverter control parameters, behavior, and dynamic response characteristics, including any mis-operations that are different than planned
- Development of data-driven hosting capacity maps can make DER integration less reliant on power system models



Benefits and Impacts

Conventional Methods

- Manual data entry – compiling records of installations, upgrades, and maintenance over decades
- Prone to errors – unlogged or erroneous maintenance reports or entry into the model
- Little validation with measurements
- Often out of date with a list of changes to add to the model

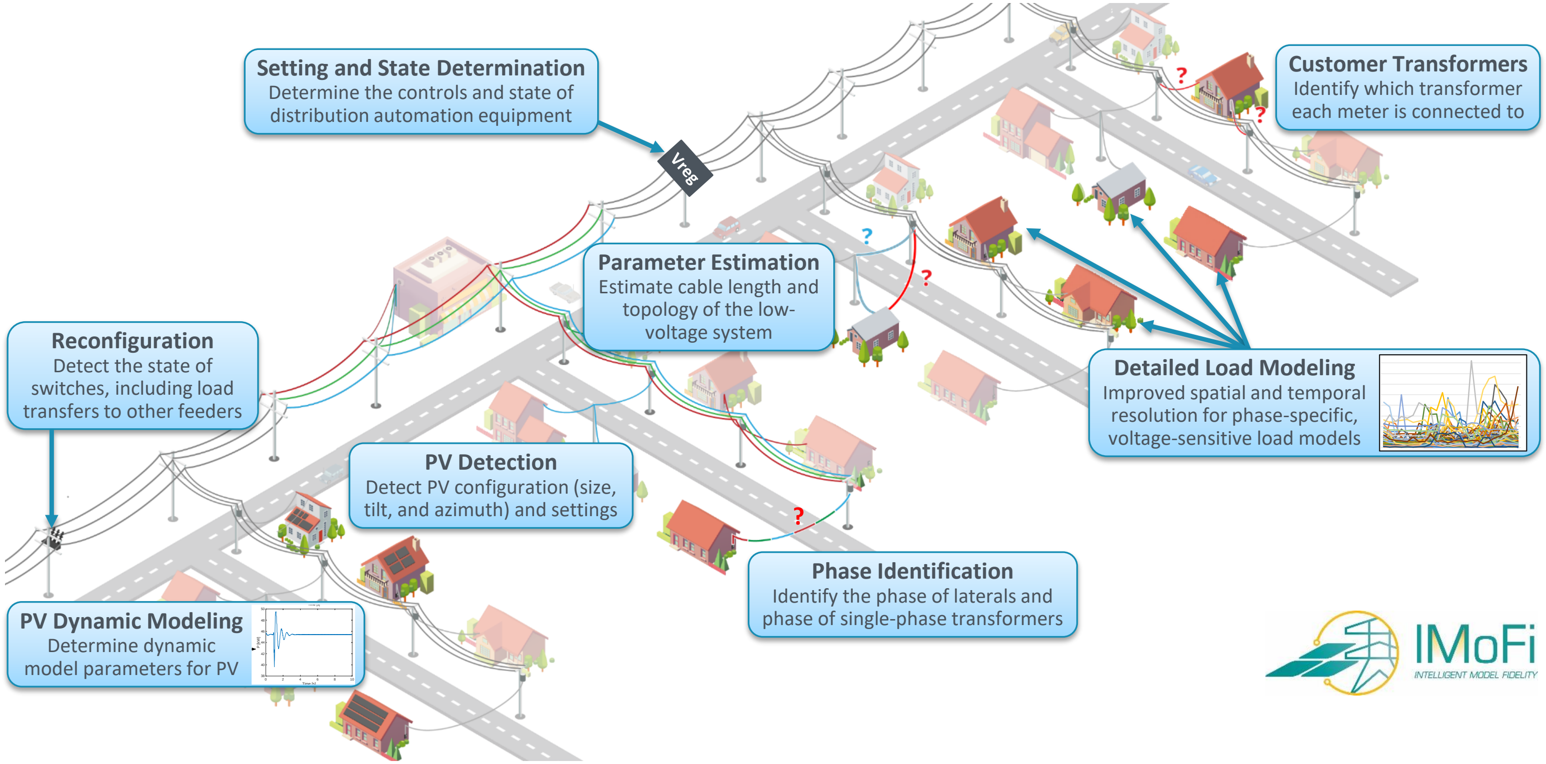
Physics-Based Data-Driven Modeling

- Leveraging AMI data and other grid edge sensing to derive and validate system models
- High accuracy and fidelity – a reproduction faithful to the original
- Granular and high resolution, multi-phase model down to the low-voltage system
- Model dynamically adapts and automatically updates based on system conditions

Conclusions

Regarding advancing grid planning and operations in a high DER future, a critical obstacle to collectively overcome is model accuracy and data management.

Solution: Automation and data-driven algorithms combined with physics-based modeling



Questions?

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