



Synthetic, Realistic Transmission and Distribution Co-Simulation for Voltage Control Benchmarking

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Texas Power and Energy Conference

February 4, 2021

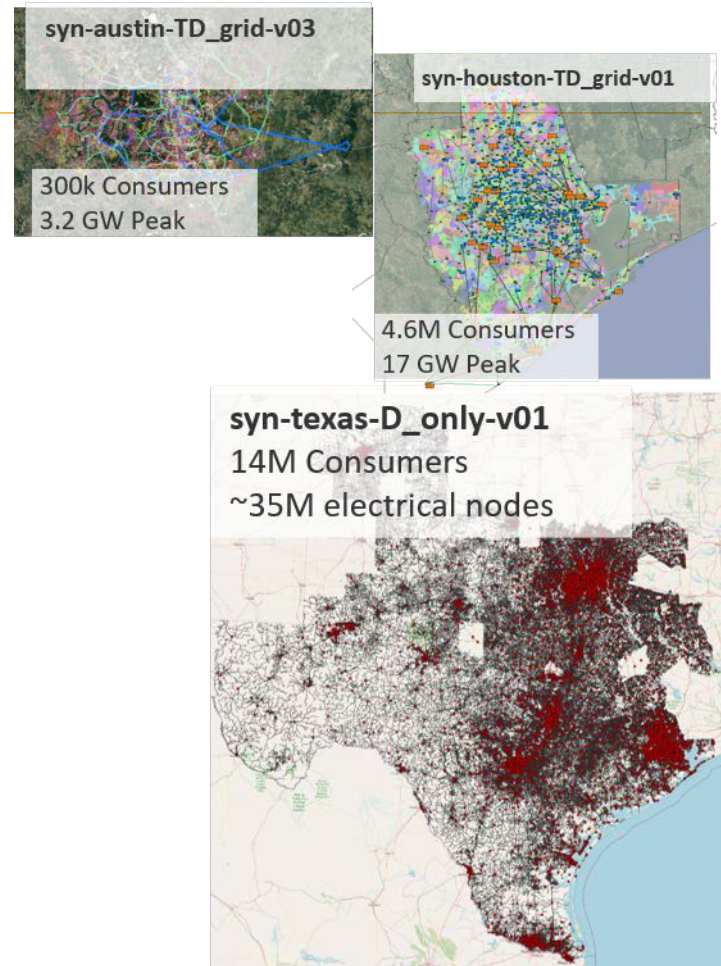
Syn-TX Overview

SMART-DS: Synthetic Models for Advanced, Realistic Testing: Distribution Systems and Scenarios

- Realistic, but not real
- Region-Scale

Co-simulation useful for handling large regions

H. Li et al., "Building Highly Detailed Synthetic Electric Grid Data Sets for Combined Transmission and Distribution Systems," *IEEE Open Access Journal of Power and Energy*, pp. 1–1, 2020,



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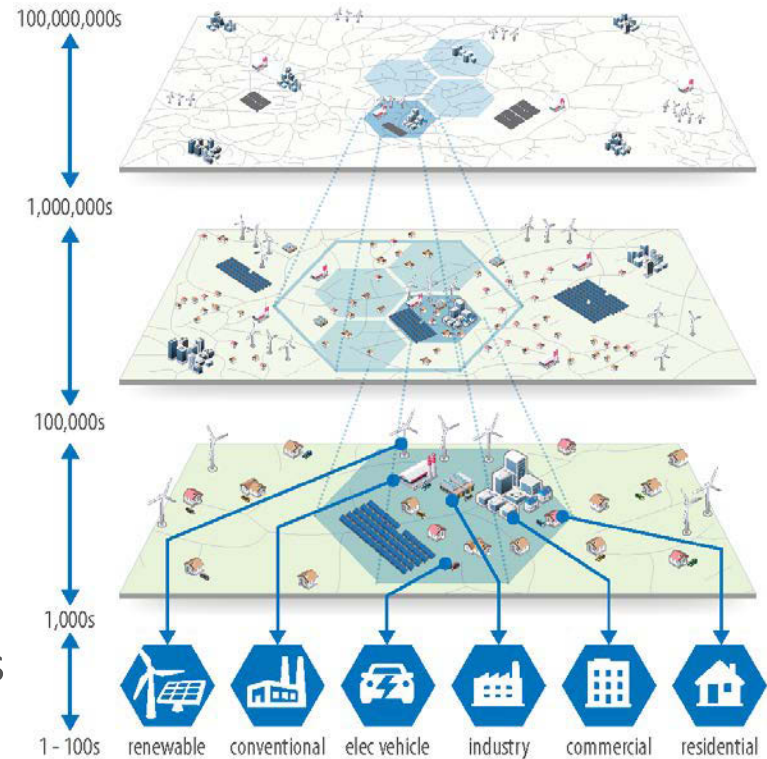
Co-Simulation Background

Transmission and Distribution Needs

- Higher levels of distributed resources
- Computational advancement

Co-Simulation Frameworks

- Use existing models
- Allow communication between models at each timestep
- Creates space for additional controls



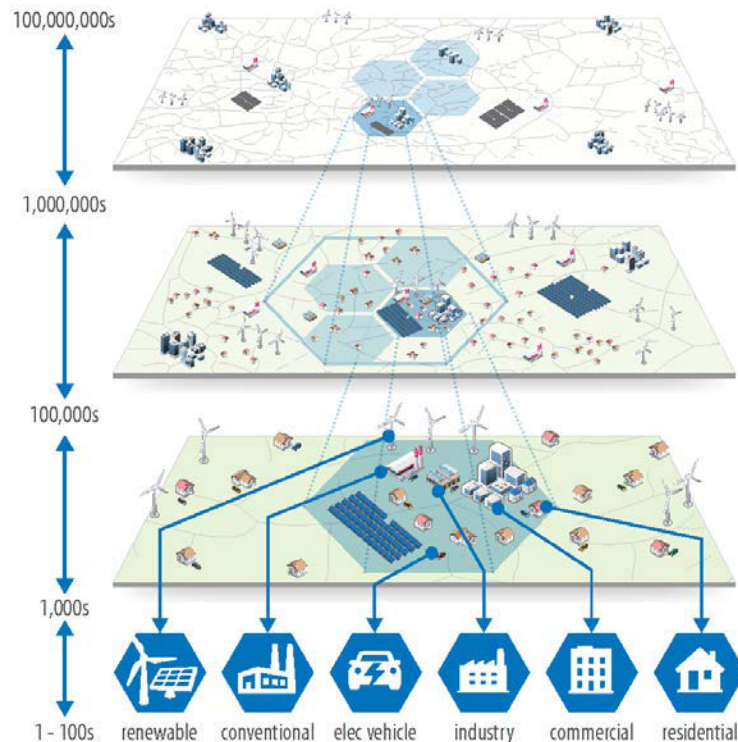
Need for Realistic Simulation

SMART-DS T&D Co-simulation

- Representative
- Repeatable
- At-scale

Many Past Co-Simulation Works

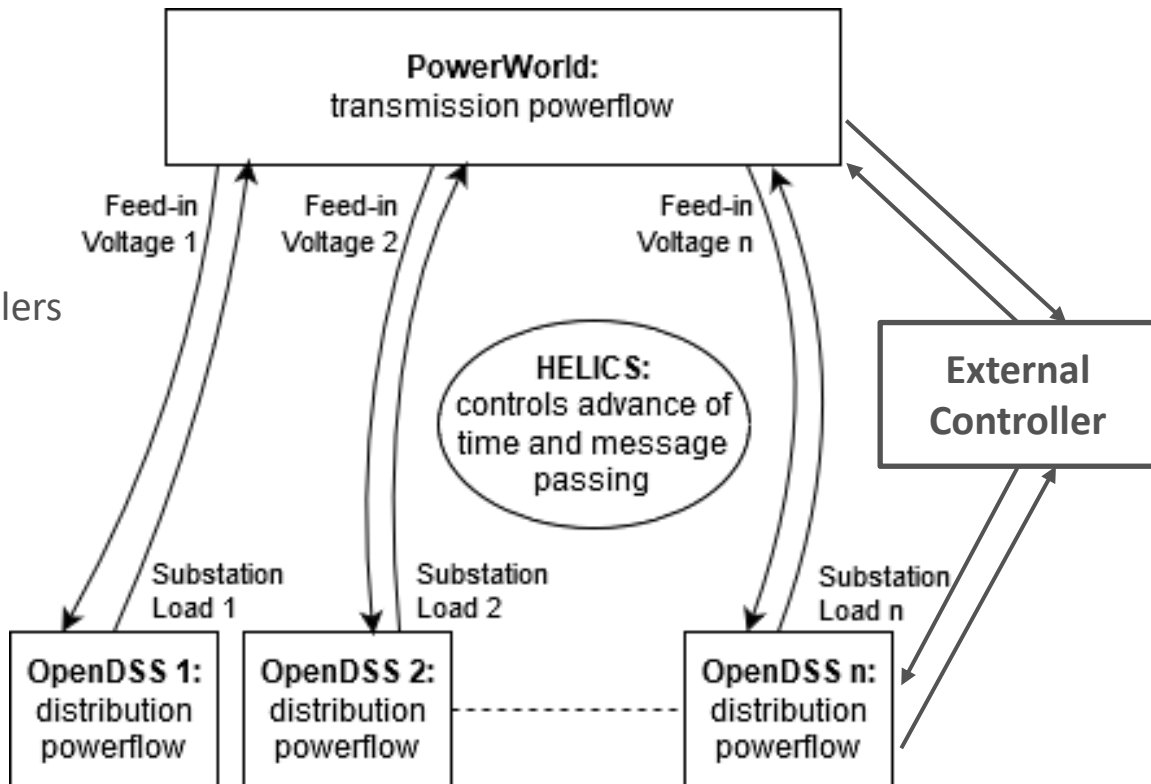
- Use of IEEE Bus models [Huang, Krishnamoorthy]
 - Replicable, but not realistic, scale-up troubles
- Use of models of Real Feeders [Krishnan, Jain]
 - Realistic, but not replicable, not at scale
- Loosely tied [Balasubramaniam, Sadnan]
 - Faster simulation, but convergence not guaranteed



Simulation Setup

Co-Simulation Features

- Message passing
- Time advancement
 - Facilitates co-iteration
- Easier integration with controllers



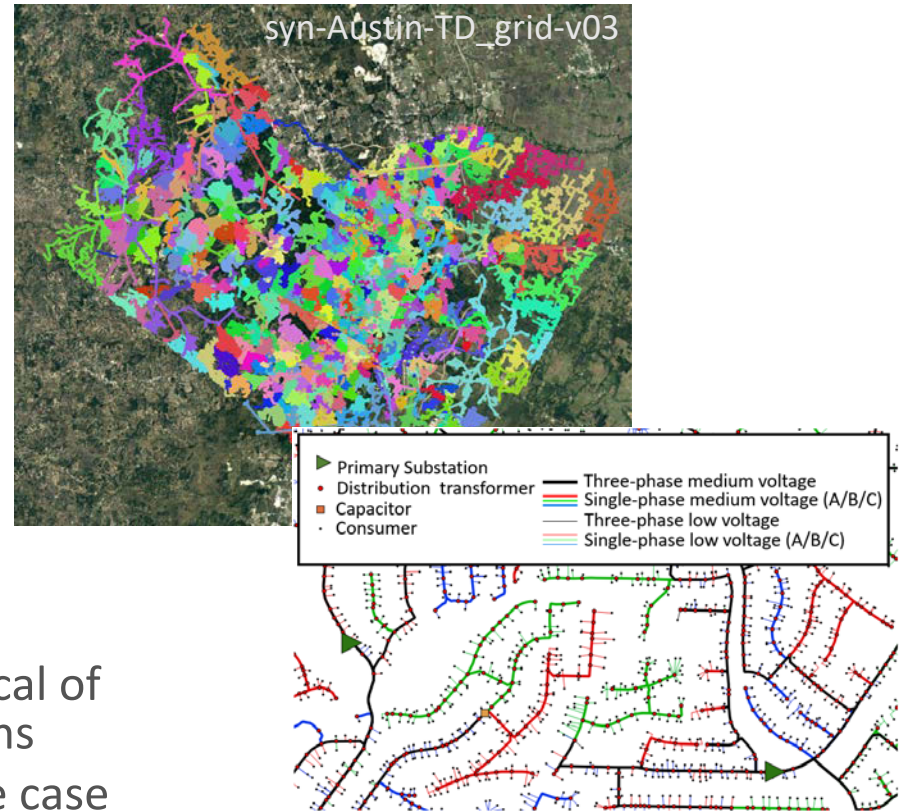
Austin Test Case

Travis County

- 5th largest county in Texas
- 1.274 million people

Synthetic Grid

- 137 transmission buses
 - 230 kV and 69 kV
- 39 transmission level generators
- 128 substation connections to distribution system
- A few loads are higher than typical of region to incite voltage excursions
- Solar and storage overlay for use case exists

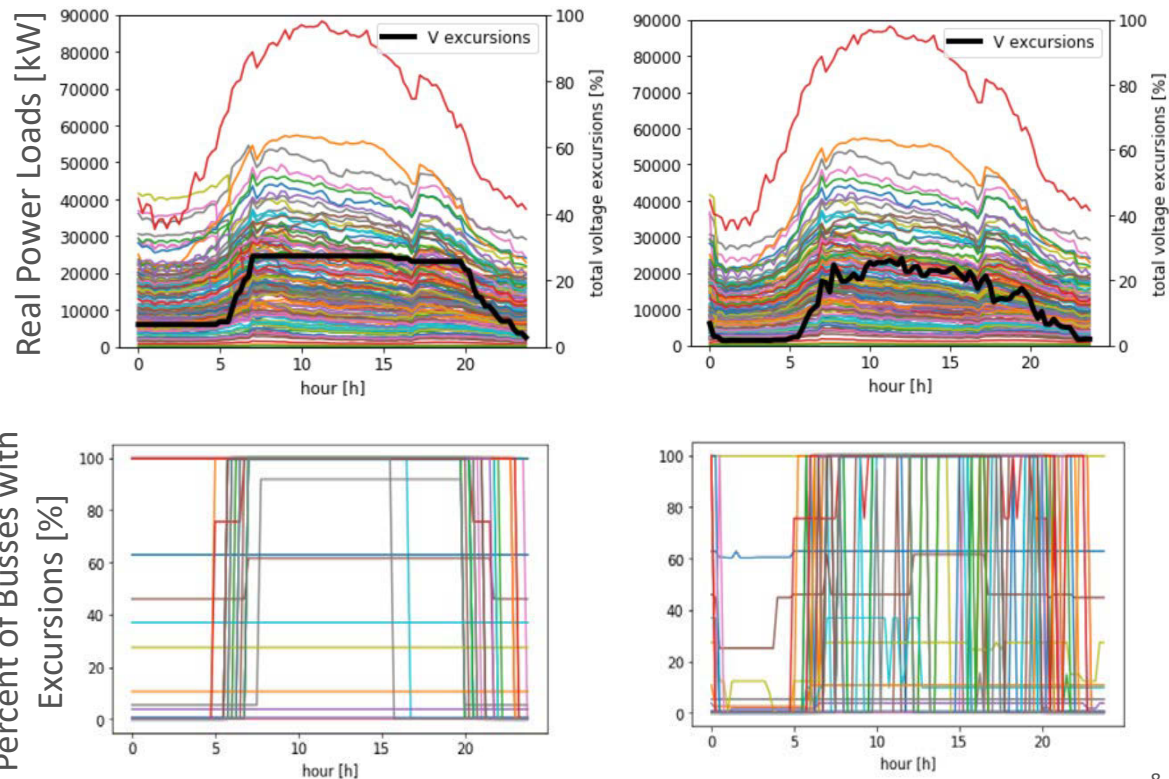


Results

Tightly Coupled T&D Co-Simulation reduces number of modeled voltage excursions 29% as compared with nominal feed-in voltage simulation.

- Excursions reduced during morning
- Voltage is near excursion threshold during mid-day peak for tightly-coupled sim

Nominal Feed-in Voltage vs. Tightly Coupled T&D



Conclusion

Nominal feed-in voltage may not be sufficient for evaluating voltage excursions on distribution systems.

Tightly coupled T&D co-simulation of realistic, but not real power system models should be used to benchmark controls.

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Thank You

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NREL/PR-5D00-78996

This work was authored 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 the U.S. Department of Energy office of Advanced Research Projects Agency – Energy through the GRIDDATA program. A portion of this research was performed using computational resources sponsored by the Department of Energy's Office of Energy Efficiency and Renewable Energy and located at the National Renewable Energy Laboratory. 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.

