Autonomous Energy Systems at NREL

Ben Kroposki

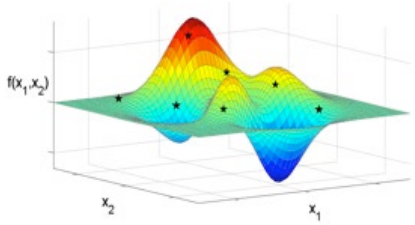
AES Workshop

July 14, 2022

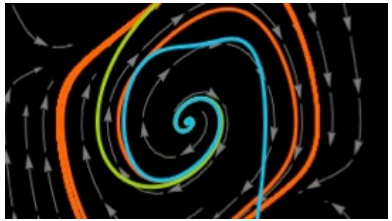
AES Capabilities Summary

Algorithms and tools development for

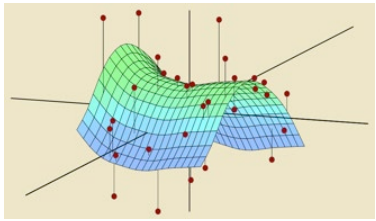
optimization



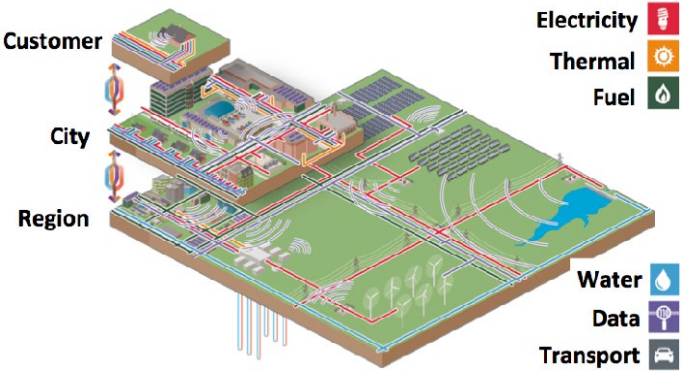
control



estimation/prediction



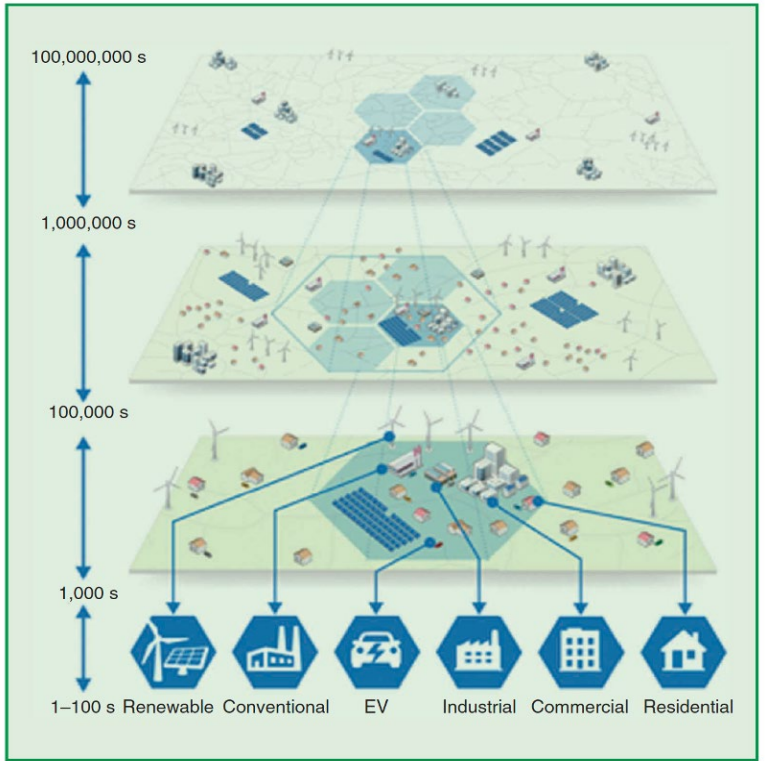
with applications to **highly distributed energy systems integration problems**



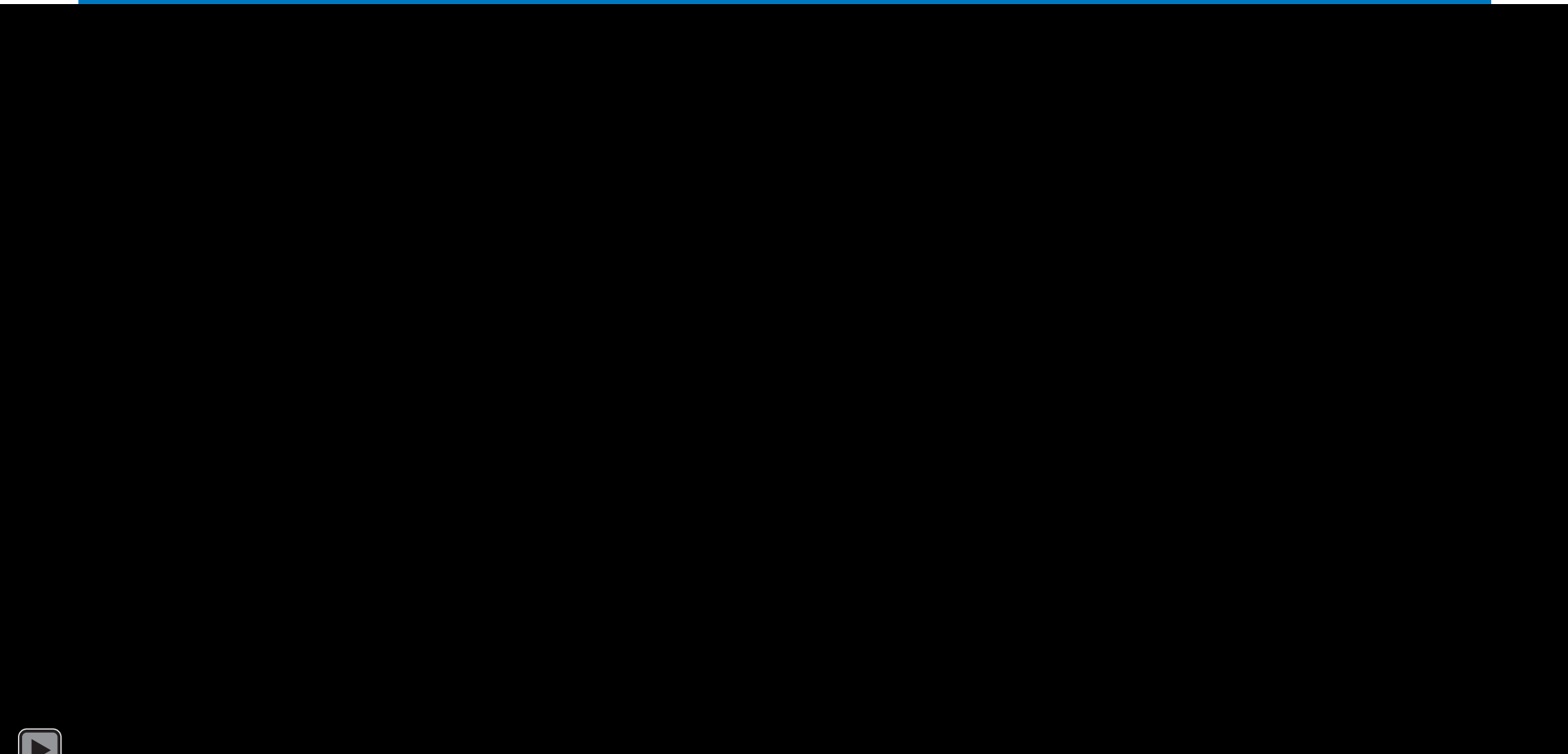
Distributed Optimization and Control

Hierarchical-distributed optimization

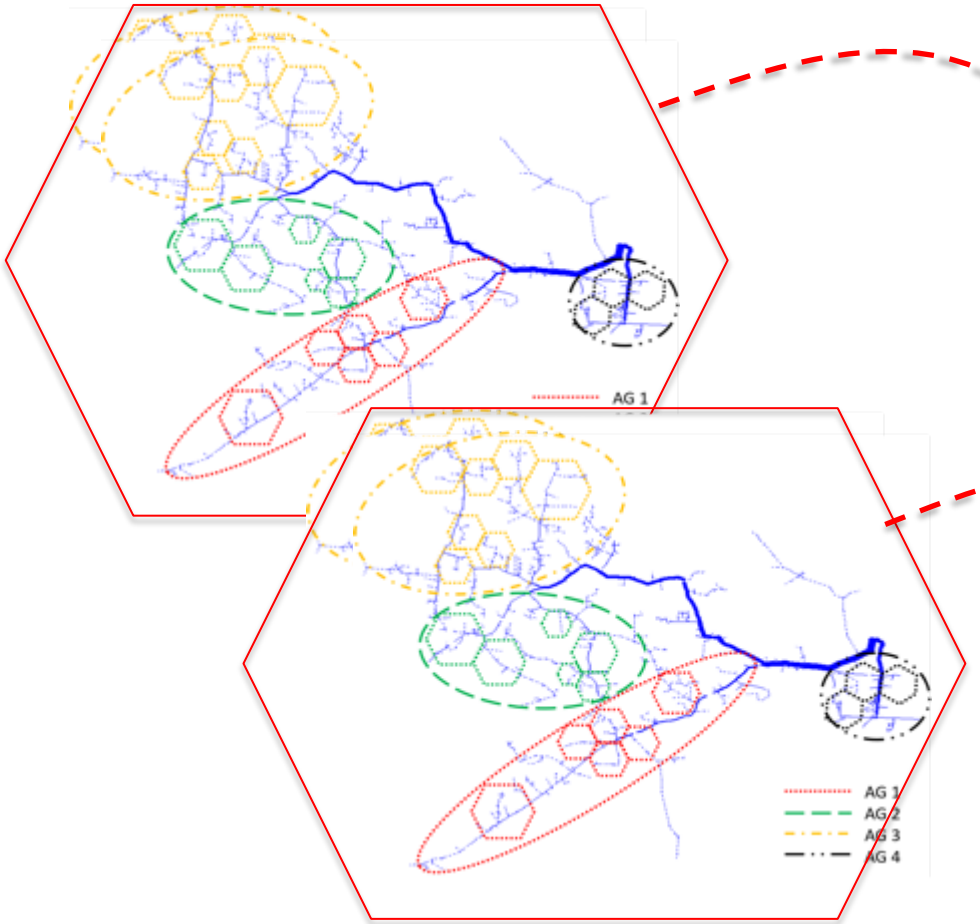
- **Motivation:** Fast solutions for large distribution networks w/o losing optimality
- **Methodology:** Multi-level algorithms that exploit the network problem structure and improve the computational efficiency
- **Results and Impact:**
  - >10-time “free” speed improvement
  - Enabling 1-second/iteration online OPF solving for large networks
  - **Capability of handling solutions for million-node systems**

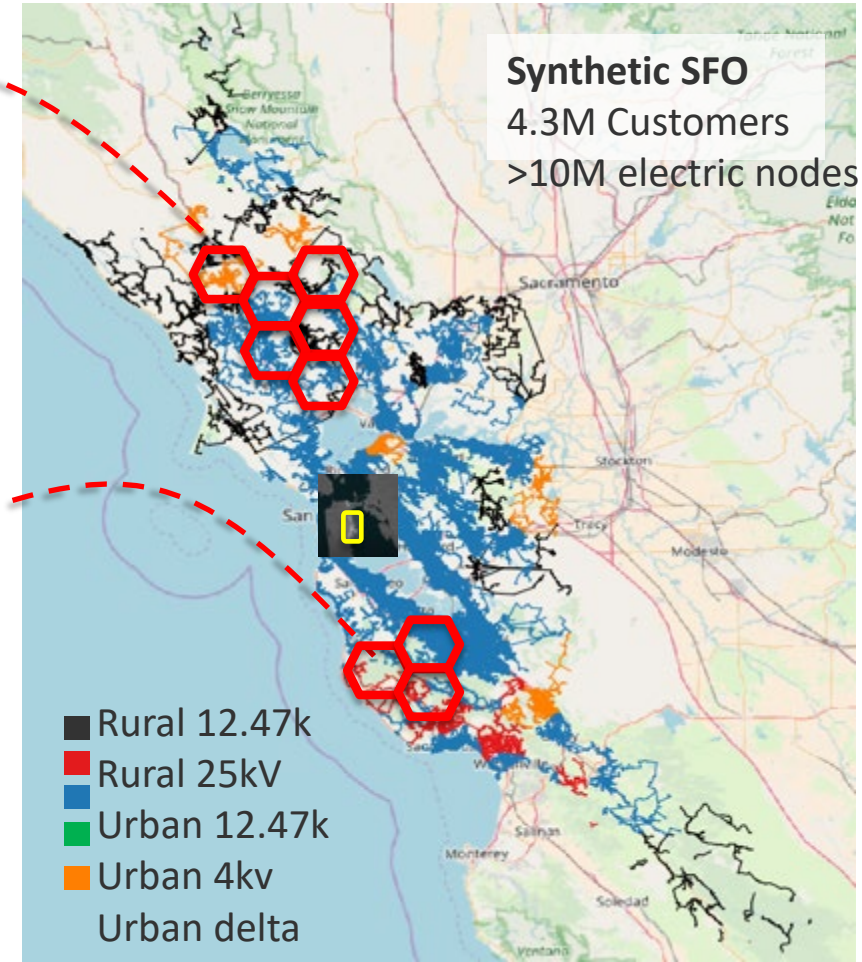


Application – Distributed Control of Wind Farms

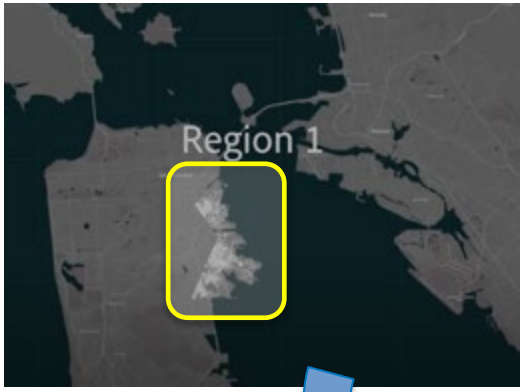


Pulling it all together….





Bay Area Simulations



PV Generation

Building Loads

Electric Vehicles and Charging Station

Completed ARPA-E NODES: Large-Scale PHIL Experiment

- Demonstrated **distributed control of 100 operating devices** (inverter, storage, EVs, loads) in ESIF
- Largest number of Power Hardware-in-the-Loop (PHIL) devices in a single experiment
- Innovative distributed controls (several patents and looking to license algorithms)
- Several new research papers on innovative controls

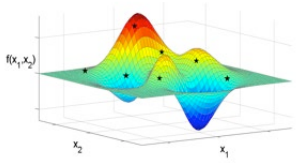
arpa·e

CHANGING WHAT'S POSSIBLE

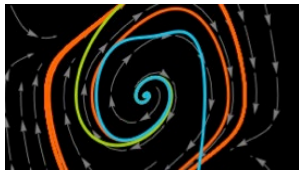
Network Optimized Distributed Energy Systems (NODES)

AES Summary

optimization



control



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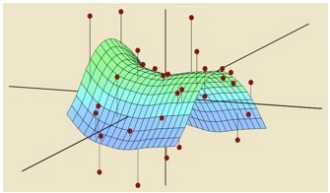

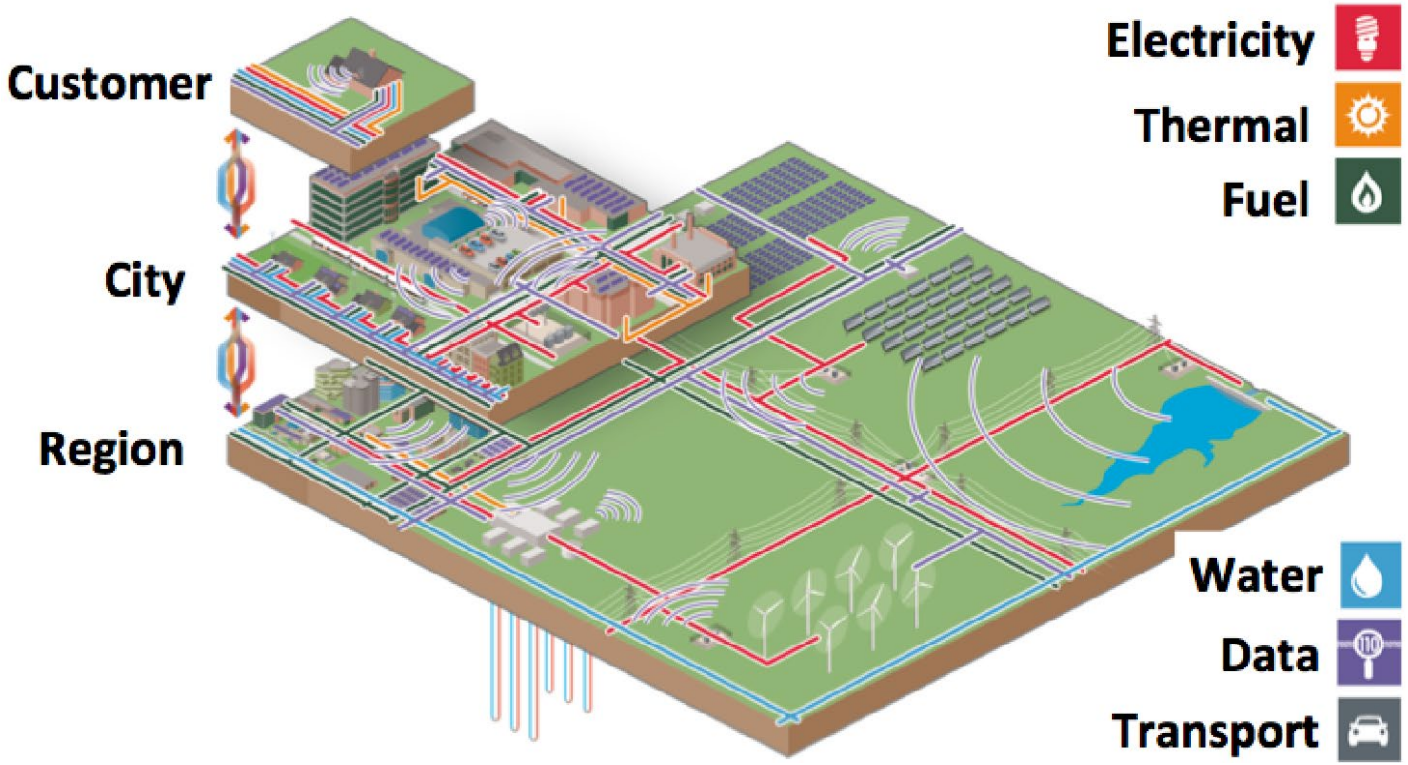

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Thank you

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