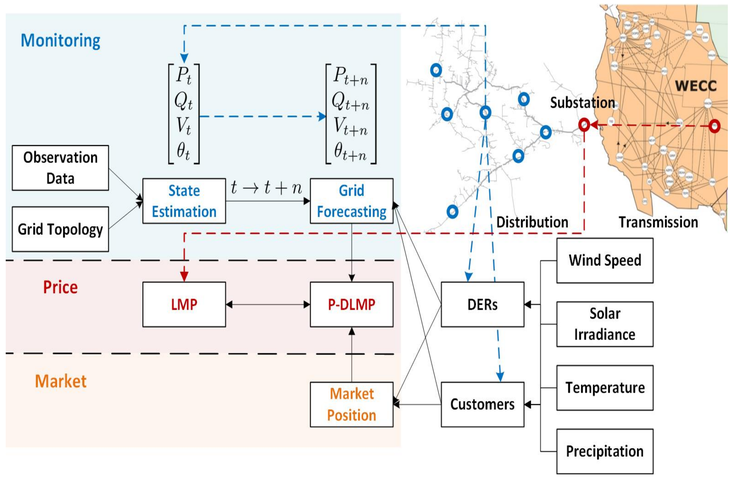
NREL 40 — NATIONAL RENEWABLE ENERGY LABORATORY 1977 – 2017

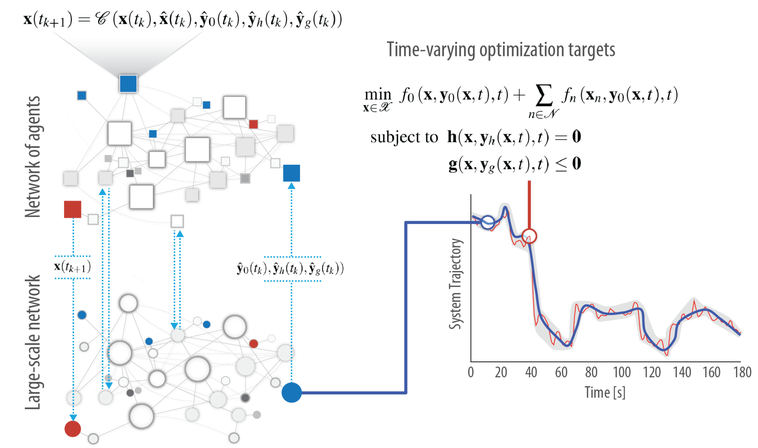
Autonomous Energy Grids

1. Benjamin Kroposki, Emiliano Dall'Anese, Andrey Bernstein, Yingchen Zhang, and Bri-Mathias Hodge, "Autonomous Energy Grids." Preprint NREL/CP-5D00-68712, National Renewable Energy Lab, 2017. https://www.nrel.gov/docs/fy18osti/68712.pdf

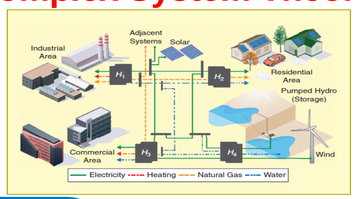


Current frameworks to monitor, control, and optimize large-scale energy systems are becoming increasingly inadequate because of higher levels of distributed energy resources—including variable generation, energy storage, and controllable loads—being deployed into power systems; the data deluge from pervasive metering of energy grids; and the shaping of multi-level ancillary-service markets.[1]

NREL is therefore working to develop autonomous energy grids that are optimized for secure, resilient, and economic operations through advanced science in controls, optimization, big-data analytics, and complex systems.[1]



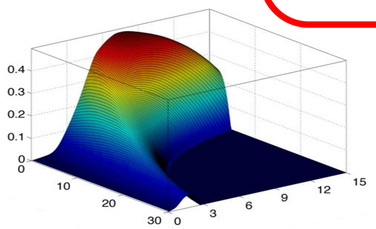
Complex System Theory



Advance core theory in:
- ***Stability of networked nonlinear systems***
- ***Existence and uniqueness of ODE systems***
- ***Nonlinear model predictive control***
- ***Dynamic programming***

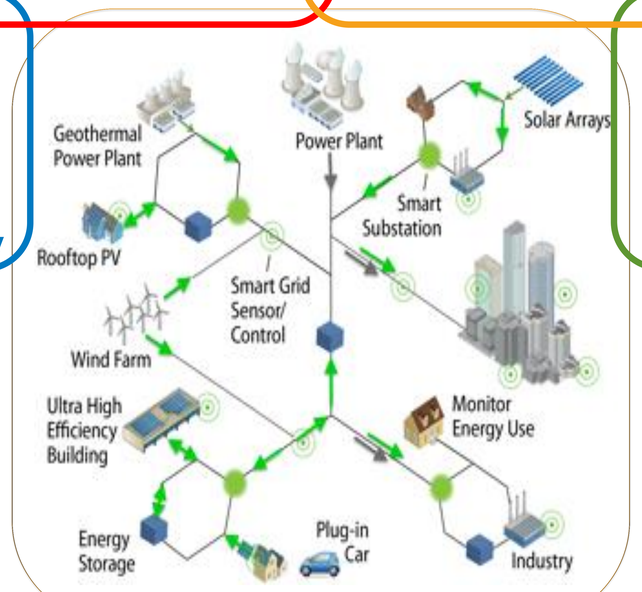
Big-data Analytics

Advance core theory in:
- ***Dynamic regret analysis***
- ***Kernel-based data imputation and prediction***
- ***Graphical models***
- ***Data decompression***

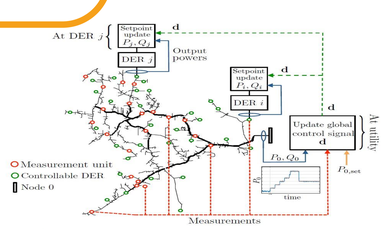


Non-linear Control Theory

- ***Fixed-point methods for nonlinear equations***
- ***Model reduction and approximation***
- ***Uncertainty quantification***
- ***Modeling of coupled infrastructures***
- ***Full time spectrum modeling***



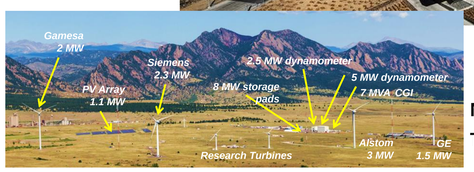
Scalable Energy Cells[1]



Optimization Theory

Advance core theory in:
- ***Dynamic and distributed optimization***
- ***Optimization on manifolds***
- ***Time-varying monotone operators***
- ***Convex relaxation***

Energy Systems Integration Facility



National Wind Technology Center

Our vision is to develop *Autonomous Energy Grids* that are optimized for secure, resilient, and economic operations through advanced science in controls, optimization, big-data analytics and complex systems.[1]

Nation's Premier Megawatt-Scale User Facility

Precise AC/DC Supplies and Loads, Utility Smart Inverters and Storage, Wind Turbines and Dynos, Hydrogen Plant, Supercomputer and 3D Visualization, and World Class Research Staff

NREL is a national laboratory of the U. S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

This work was supported by the U.S. Department of Energy under Contract No. DE-AC36-08GO28308 with the Alliance for Sustainable Energy, LLC.