Photo by Werner Slocum, NREL 69160

NREL
Transforming ENERGY

Building a Clean Energy Future for the World

Ahmed Zamzam

The 2023 EAP Conference: Energy, Fire, and Changing Landscapes
Sep 21, 2023

NREL at a Glance

3,343 workforce, including:

- 2,482 regular/limited term
- 485 contingent workers
- 183 postdoctoral researchers
- 125 graduate students
- 68 undergraduate students

—as of 12/31/2022

World-class research expertise in:

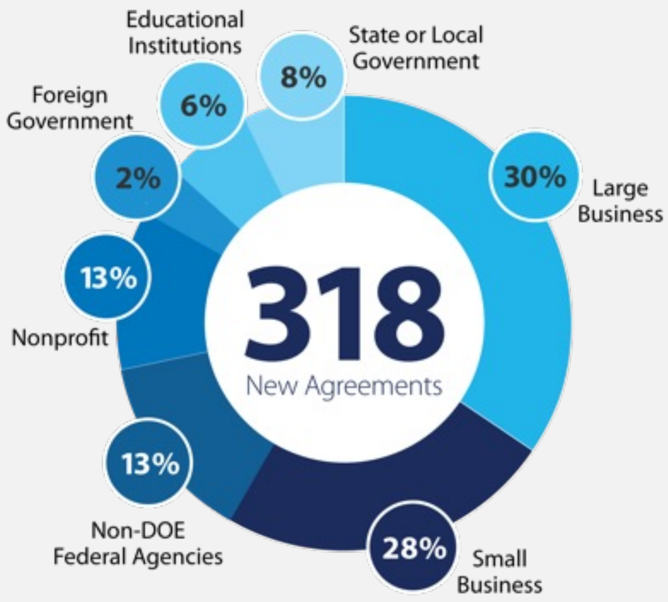
- Renewable Power
- Energy Efficiency
- Sustainable Transportation
- Energy Systems Integration

Partnerships with:

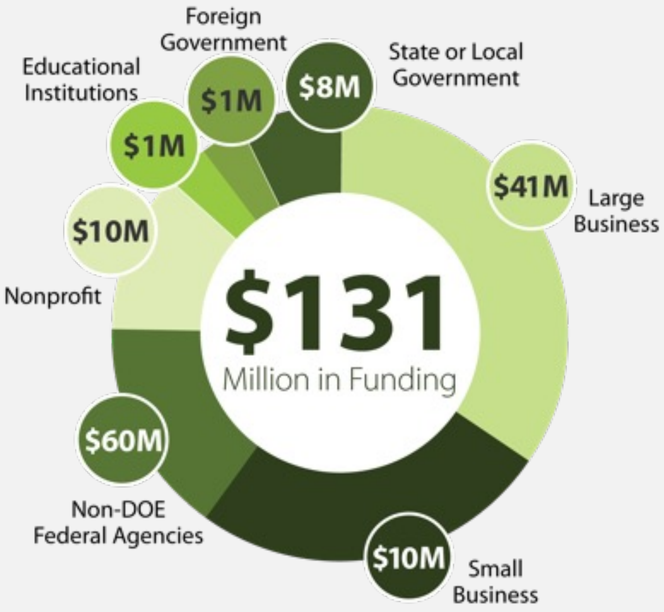
- Industry
- Academia
- Government

3 campuses operate as living laboratories

More Than 1,000 Active Partnerships in FY 2022



Agreements by Business Type



Funding by Business Type

Critical Objectives Address Crisis

Integrated Energy Pathways

Increased use of clean energy sources reduces reliance on fossil fuels, curbing CO_2 emissions and **reducing pollution**

Reduced pollution will **mitigate climate change** and **reduce harm to plants, animals, and their habitats**

Electrons to Molecules

Conversion of waste gases into useful chemicals **reduces pollution such as CO_2**, one of the drivers of **climate change**

Lower pollution levels, reduced drilling for materials and fuels will **benefit organisms and ecosystems**

Circular Economy for Energy Materials

More efficient industrial processes, recycling of materials, and less energy spent on extraction means **less waste and pollution**

Reduced need to mine for materials means **less disruption to biological systems**

Power Systems Engineering Center

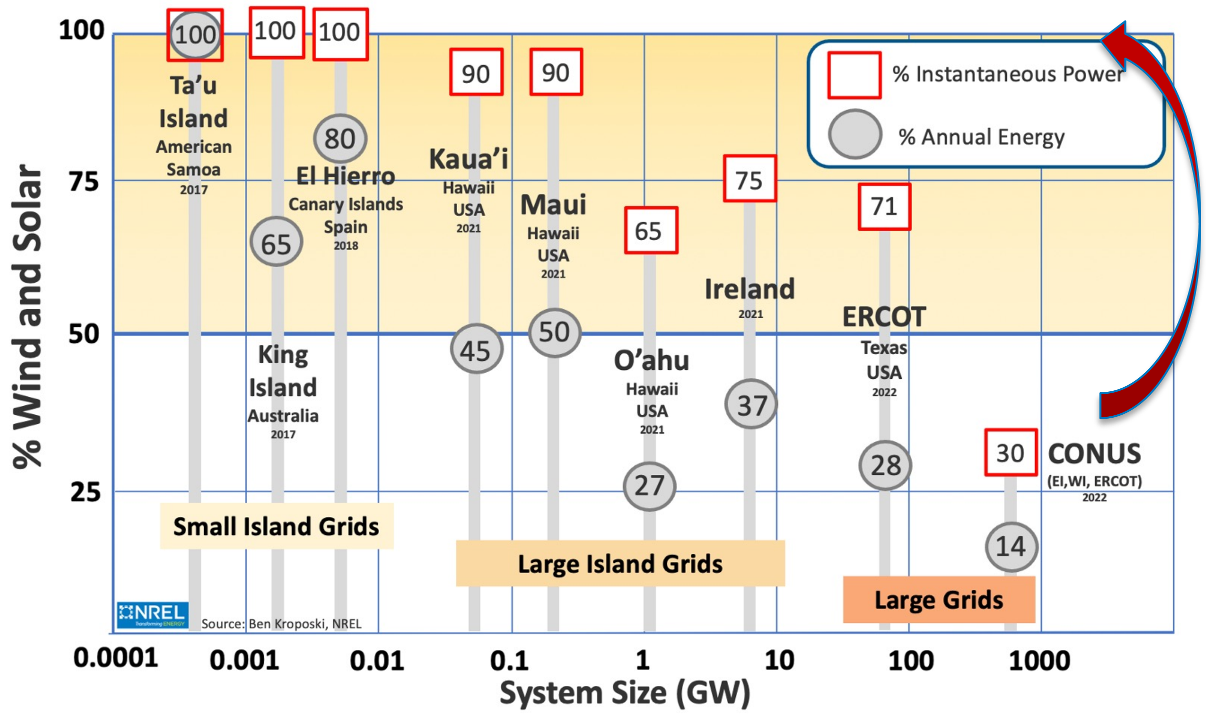
Integrated project portfolio to deliver on the transformation of today's power grid

- **Ultra-High Variable Renewable Energy Grids -** Develop technologies and tools that enable large grids to operate at over 50% annual energy and 100% instantaneous generation from inverter-based, variable renewable energy such as wind and photovoltaics in a resilient, secure, efficient, reliable and affordable manner.

- **Autonomous Energy Grids -** Increase grid operational efficiency, security, and resiliency through foundational science in AI/ML for energy systems, prediction, control and optimization.

- **Transformational Electrification –** Enable electricity to be the foundation of the transition towards a sustainable energy system through integration with transportation, industrial processes, and buildings.

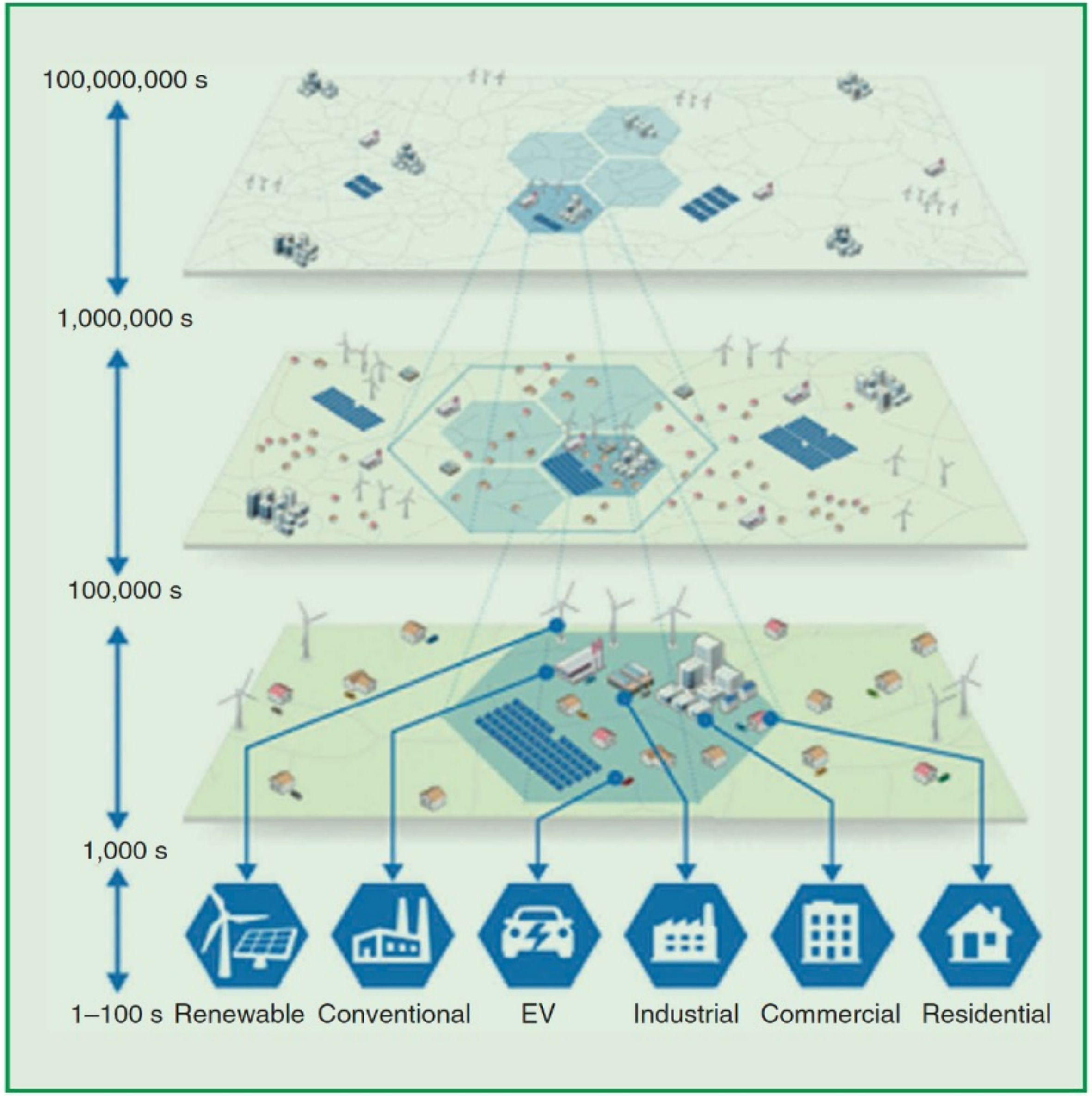
Developing solutions to get large grids to 100% instantaneous and over 50% annual



DynaGrid

Dynamic Microgrids for Large-Scale DER Integration and Electrification

Project Overview

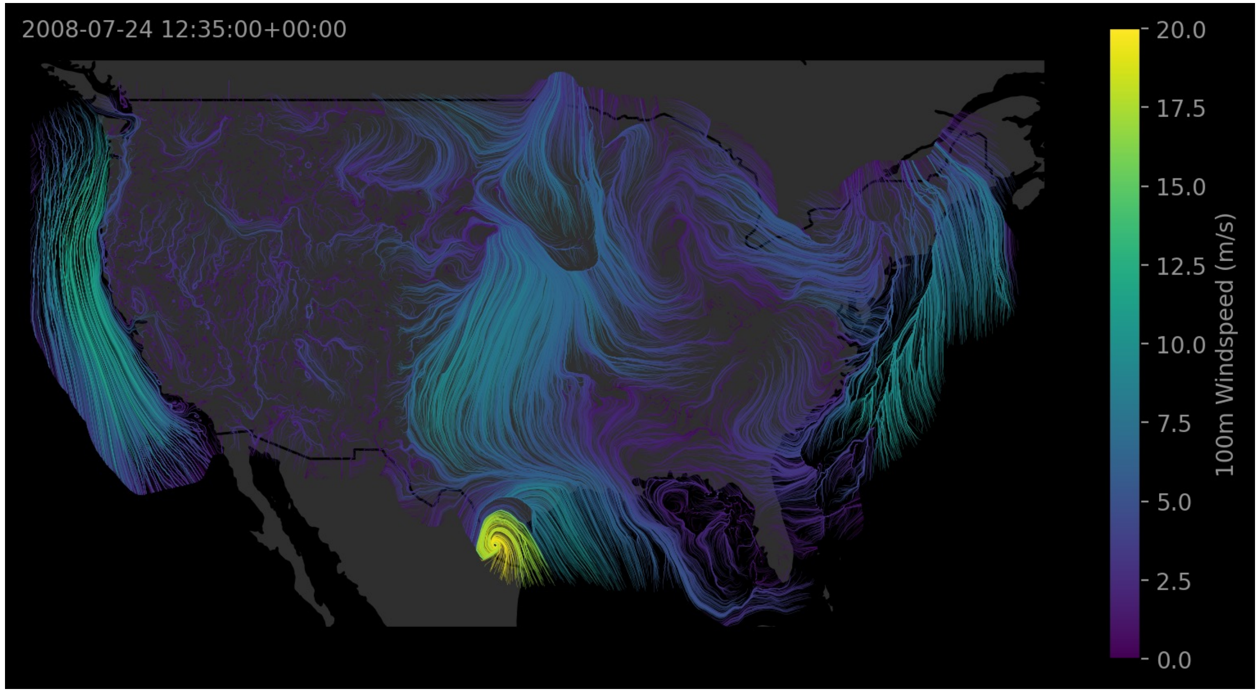


Develop a framework for dynamic formation and operation of networked microgrids.

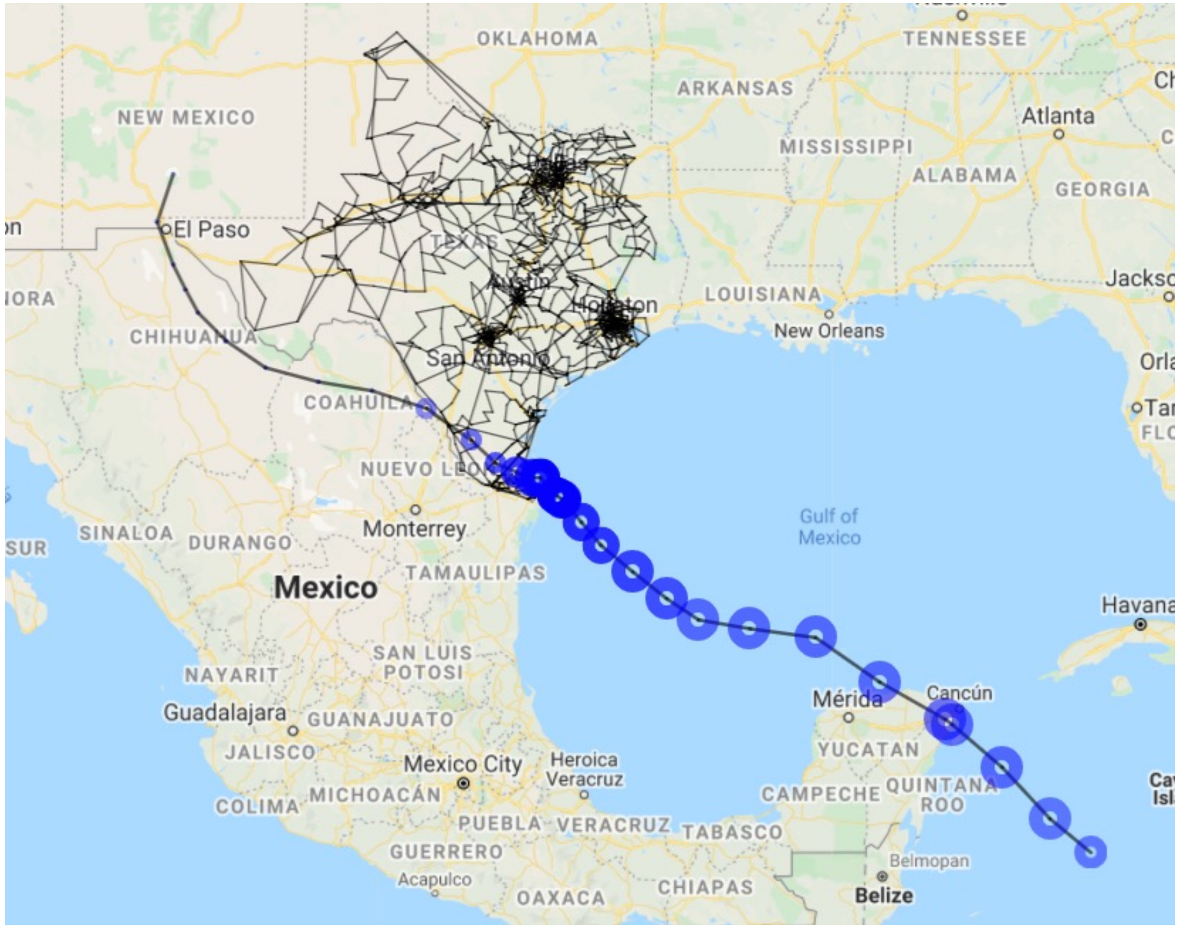
- improve T&D system real-time **resilience**
- integrate and efficiently leverage large amounts of **renewables and DERs**
- allow wide-scale **electrification**
- increase **distributed and decentralized decision making**
- improve **equity and energy justice**

Use Case: Natural Disasters

Example: Hurricane Dolly, TX, 2008



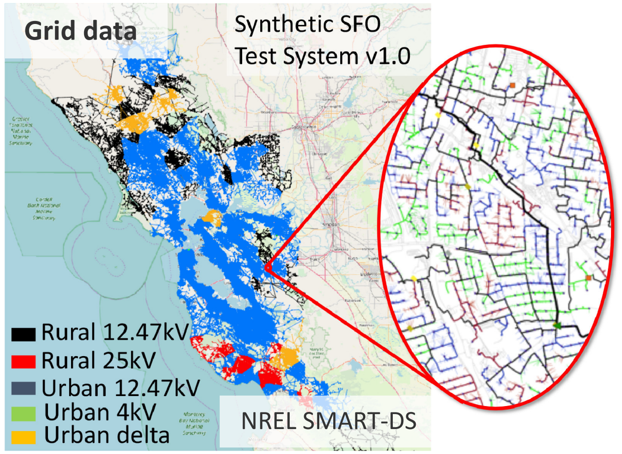
WIND Toolkit wind field at 100m above ground

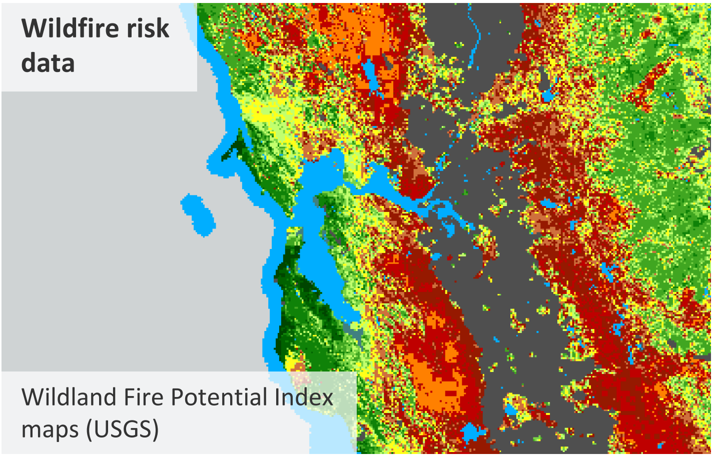


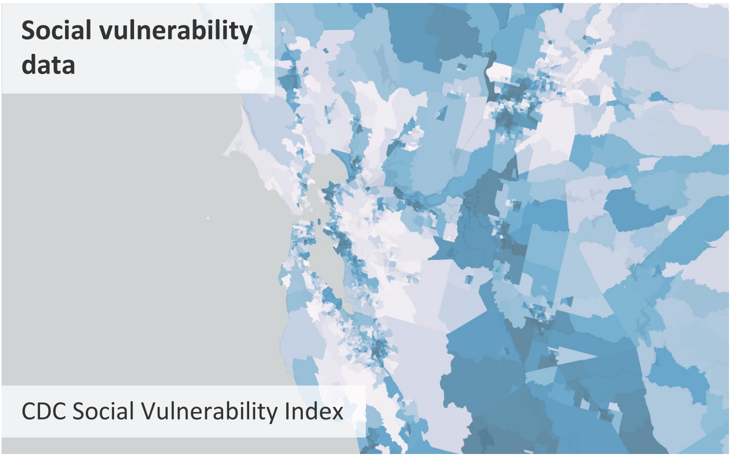
Path and synthetic TAMU 2000-bus transmission grid. Size of the blue circles corresponds to hurricane's radii and their color intensity correspond to maximum wind speed.

Use Case: Wildfire Risk and Energy Justice

Approach: Correlate grid data with wildfire risk and demographic data to demonstrate how DynaGrid operation could mitigate wildfire ignitions from power equipment and promote social equity







Modeling: Start with the optimal switching / load shed problem for microgrid operation (implemented in PowerModelsONM), then modify the objectives to minimize wildfire risk and maximize load delivery, with consideration of two social vulnerability aspects:

1. Vulnerability to power outages
2. Vulnerability to wildfire ignitions

Impact: Promote awareness of energy justice and climate change-induced extreme weather events in the operation of future grids