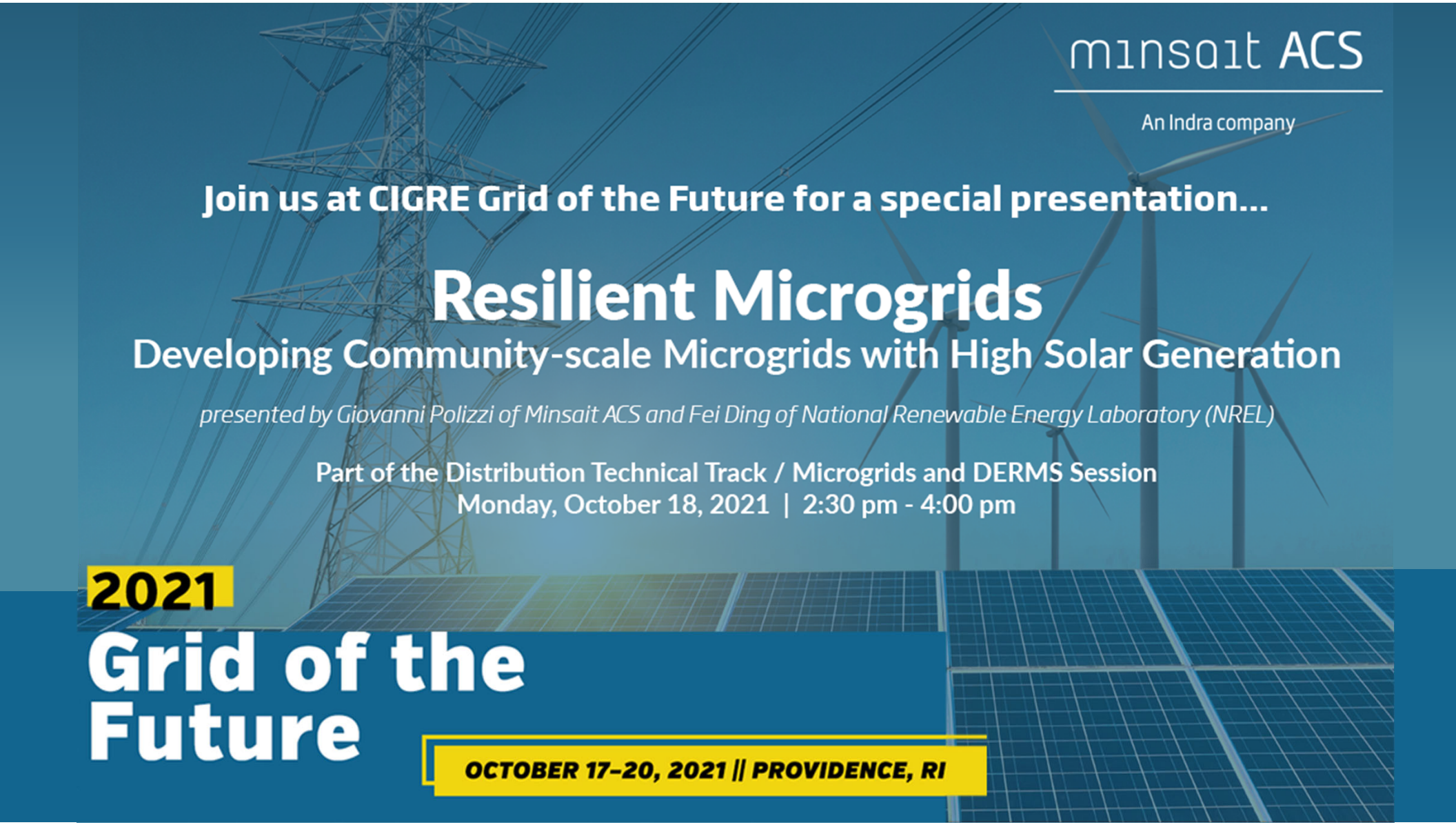

minsait ACS
An Indra company
Join us at CIGRE Grid of the Future for a special presentation...
Resilient Microgrids
Developing Community-scale Microgrids with High Solar Generation
presented by Giovanni Polizzi of Minsait ACS and Fei Ding of National Renewable Energy Laboratory (NREL)
Part of the Distribution Technical Track / Microgrids and DERMS Session
Monday, October 18, 2021 | 2:30 pm - 4:00 pm
2021
Grid of the Future
OCTOBER 17–20, 2021 || PROVIDENCE, RI

Introduction

We would like to share with you a project that we are involved in with an electric utility in Colorado

We will discuss the partners involved, technology used and the details of the project

You will then be able to appreciate the expected benefits of this innovation project for your organization.

Lastly, we will answer questions

Project Goal

Create a distributed control microgrid using clean energy to tackle power issues relating to extreme events like storms, wind, snow, etc.

REORG

Resilience and Stability **Or**iented Cellular **G**rid Formation and Optimizations for Communities with Solar PVs and Mobile Energy Storage

Partners

Funds

SOLAR ENERGY TECHNOLOGIES OFFICE
U.S. Department Of Energy

R&D

NREL Transforming ENERGY

MISSISSIPPI STATE UNIVERSITY

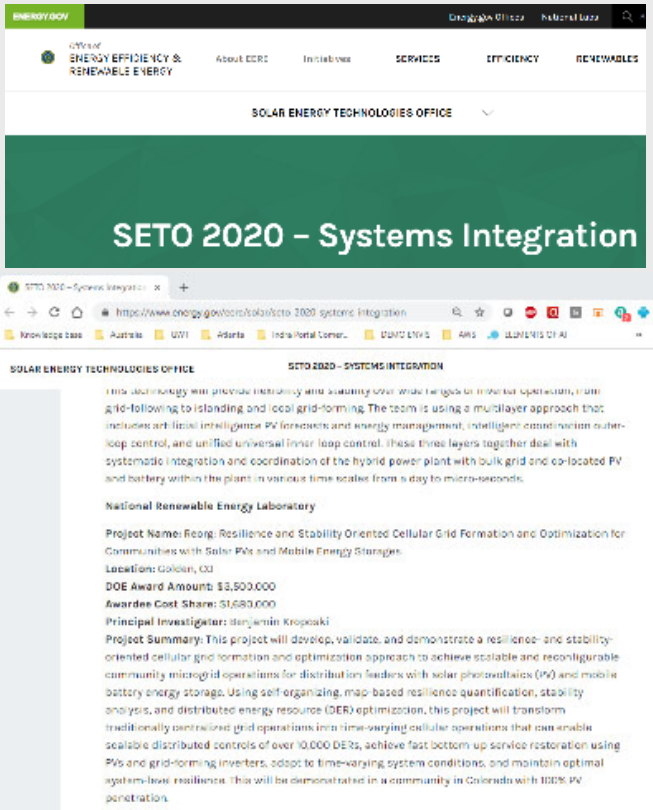
Technology Platform

minsait ACS
An Indra company

Grid, Testbed

NRECA America's Electric Cooperatives

HOLY CROSS ENERGY EST. 1939



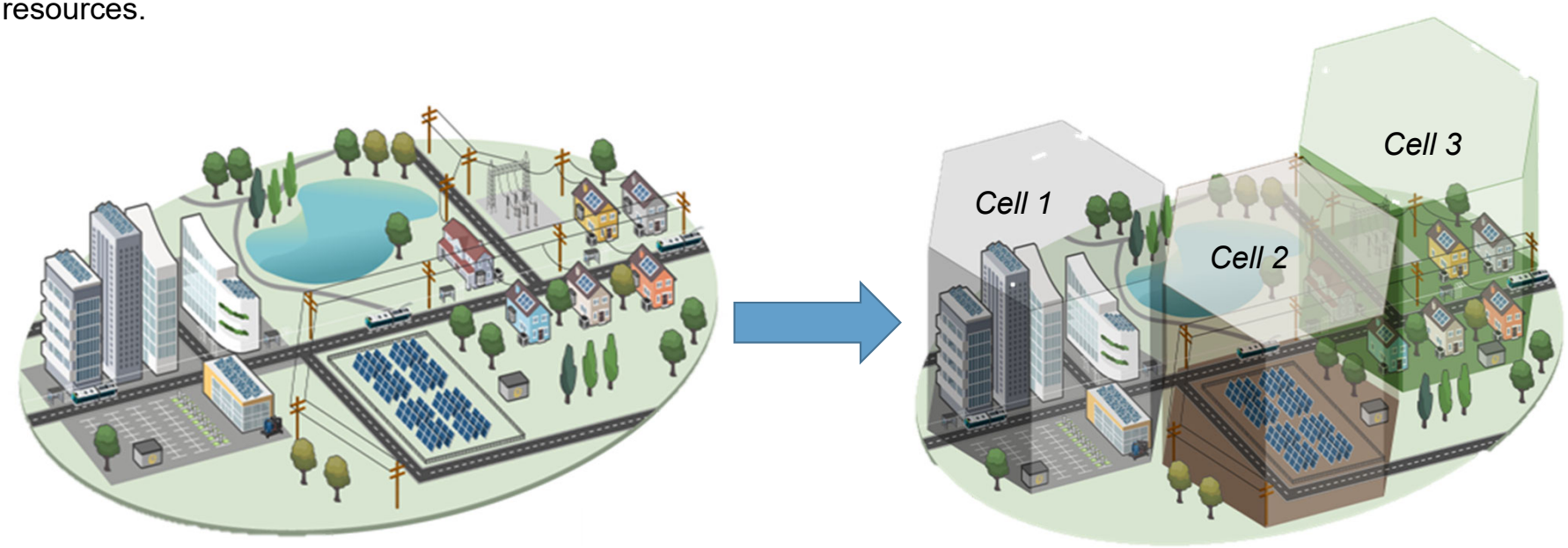
https://www.energy.gov/eere/solar/seto-2020-systems-integration

Project Scope

Organize the distribution system into community microgrids using **dynamically** *reconfigurable cells*

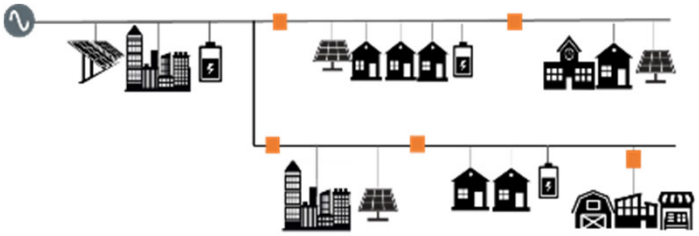
Cell: group of interconnected PVs, BESSs, and buildings that makes up the smallest subset of the grid capable of operating independently using its own resources.

- Operations for a more resilient grid are run by stable cell-based microgrids.
- Cells and their coordination, adapt to time-varying system conditions.



Project Scope

The typical configuration of urban areas allows for the definition of *cells* (or **self-sustained microgrids**), linked by normally-closed switching devices.



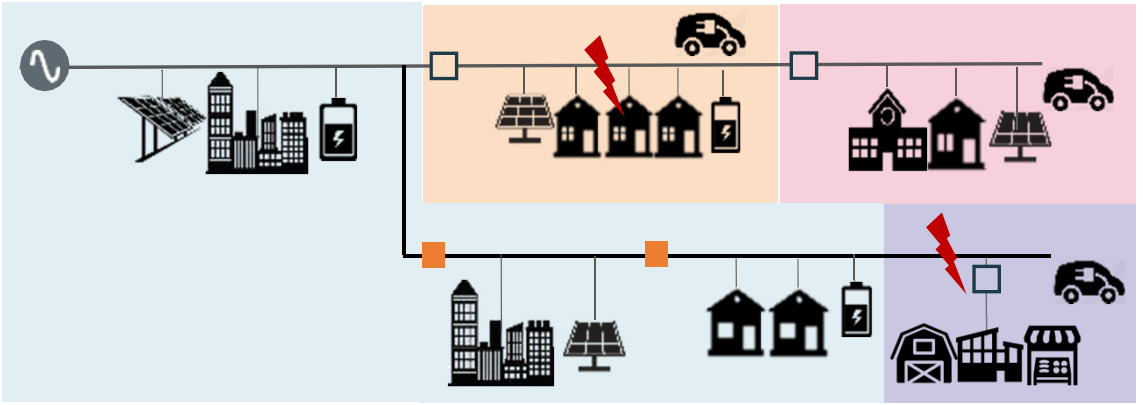
normally-closed switching devices

opened switching devices

Energy Storage on-wheels

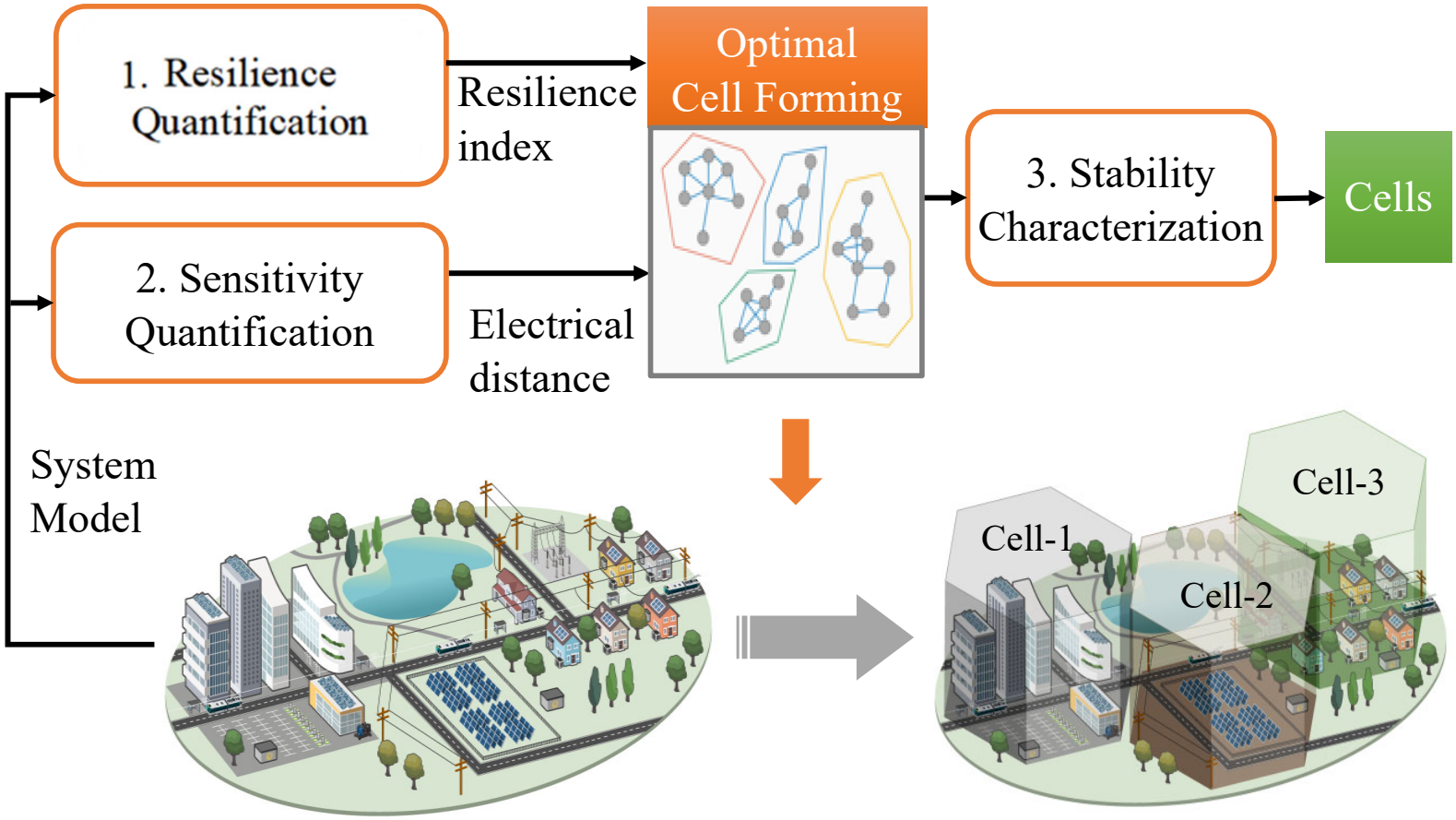
fault / damages

Cells are **automatically** configured according to location of outages



Load/Generation is calculated through algorithm for optimal resilience

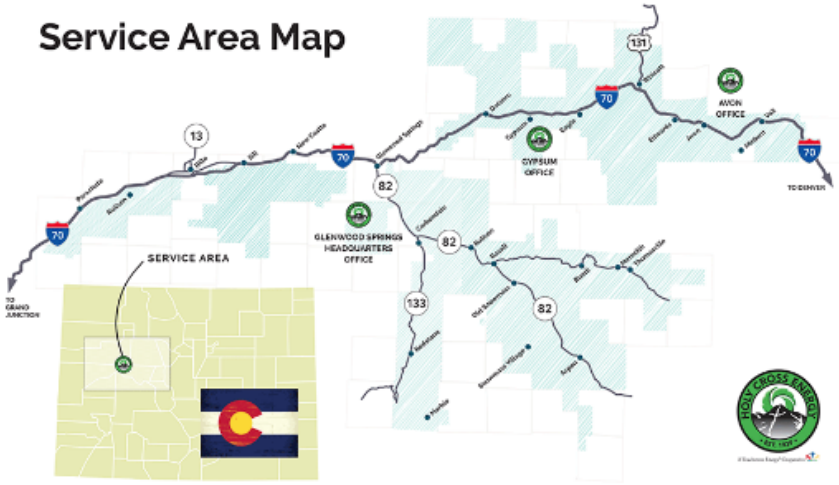
Project overview



Holy Cross Energy Layout

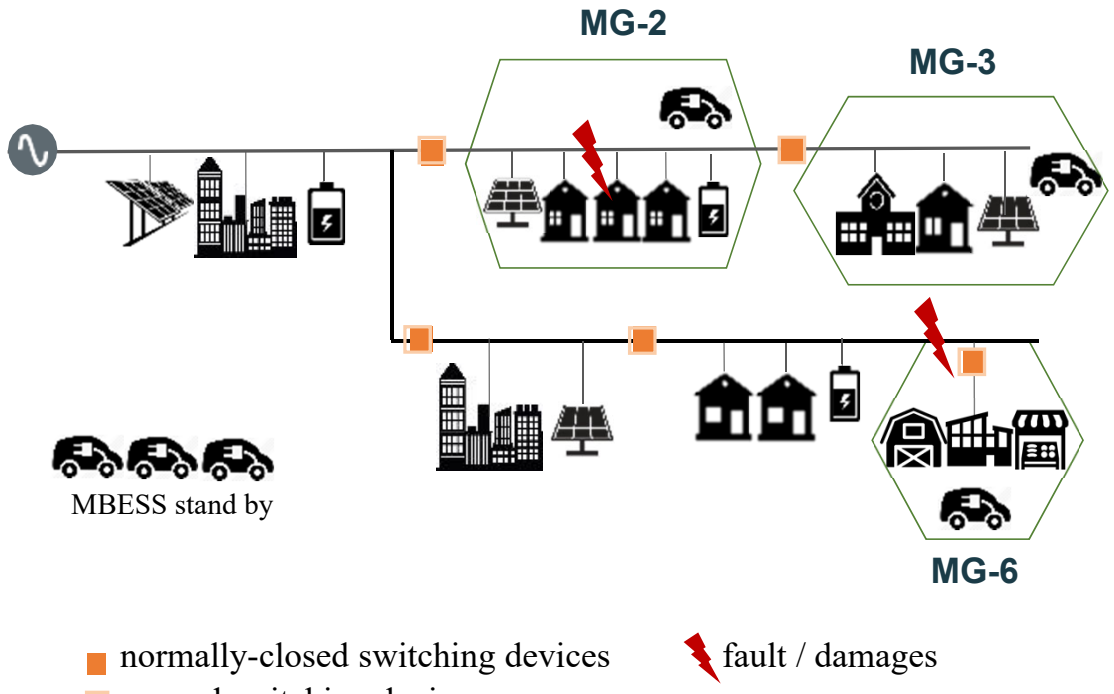
The candidate circuits have a few characteristics defined in the scope:

- 300+ residential and 300+ commercial customers, with 4+MW peak demand and 300+ kW distributed solar PVs
- A large solar PV farm and >10MWh energy storage systems
- Some critical loads as large C&I installations
- Multiple existing bus depots and park-n-ride lots to host mobile Battery Energy Storage System.



Cell Microgrid Operation

Use Cells to form islanded community microgrids and quickly restore local services.



- Open switching devices to form cell-based microgrids
- Route mobile BESSs to optimal depots
- Each microgrid black starts by using inverter-based grid-forming resources
- Cell control agent: optimize the operations of DERs within each microgrid to maximize resilience

Project Schedule

2021-2022- Resilience, Stability and Voltage Sensitivity Analysis, and Cell Formulation and Operation

- Use network models and machine learning, to create algorithms to determine how cells are calculated and operated

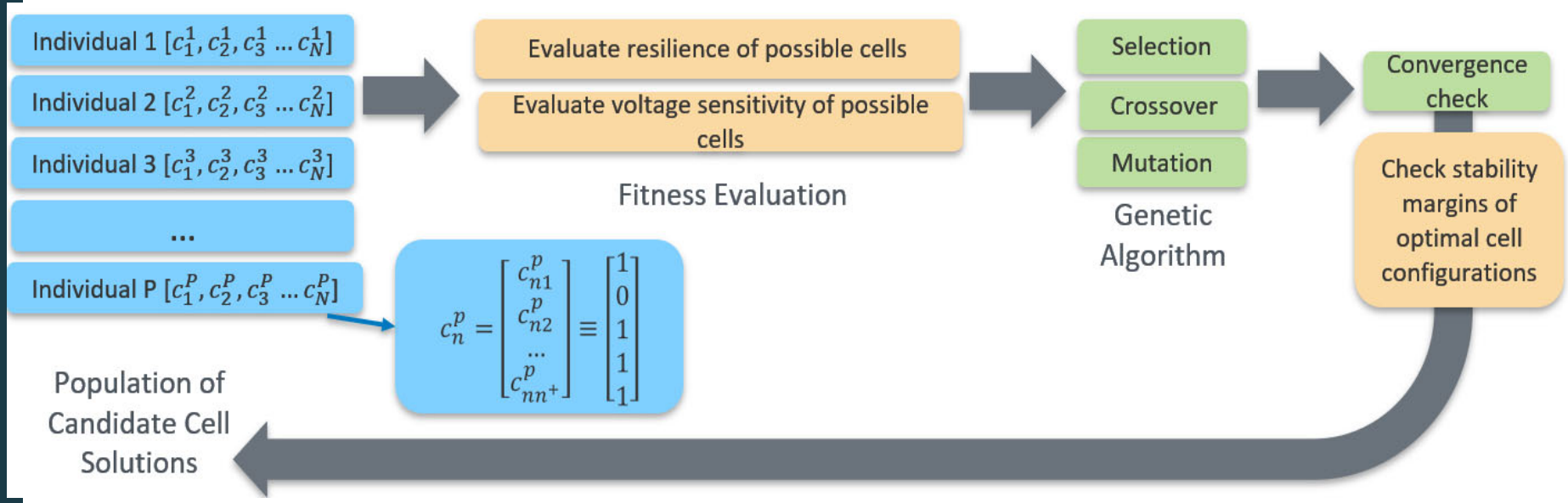
2022-2023- Simulate at NREL Lab Facility

- Test scenarios, demonstrate and validate, test on different time frames and various critical loads scenarios

2023-2024- Field Deployment

- Implement at Holy Cross, prove that solar and battery-based cells can restore service for at least 1 critical load facility

Network Partitioning-Cell Formulation

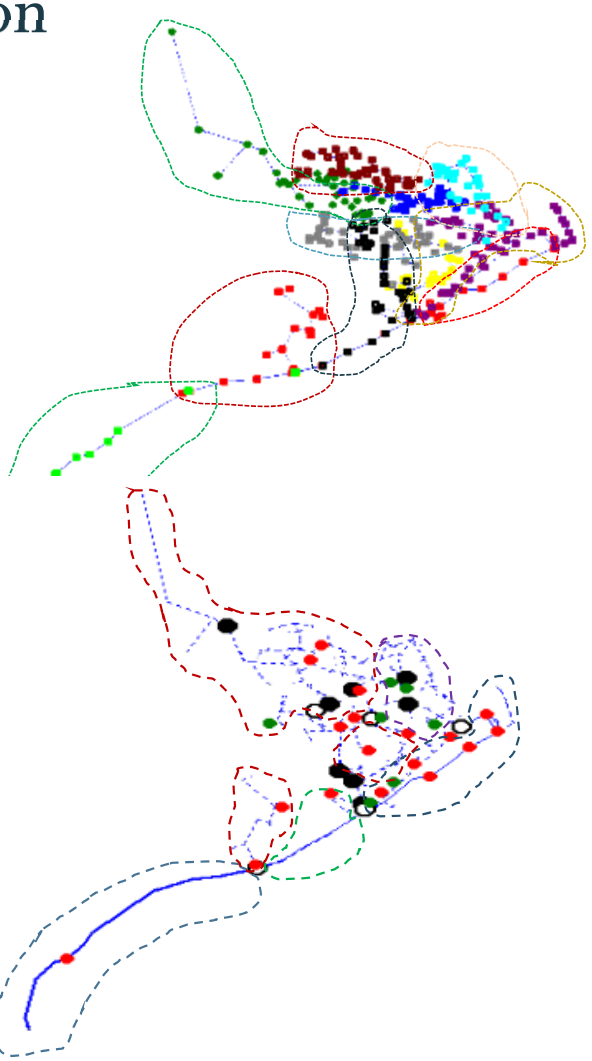


Network Partitioning-Cell Formulation

HCE 623-node system

Voltage sensitivity-based partitioning

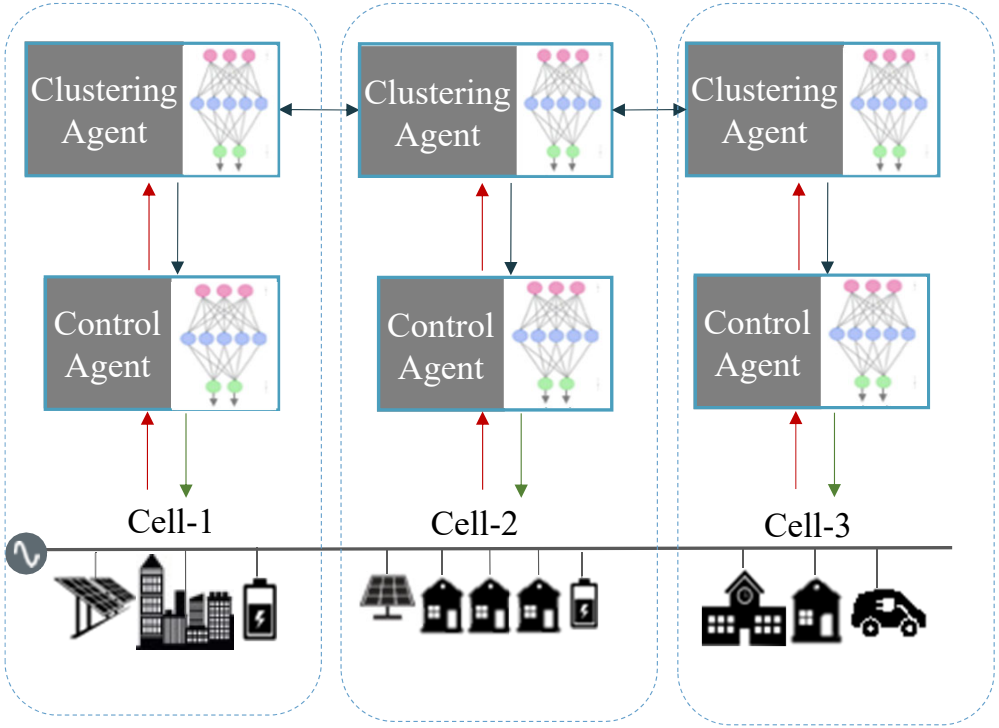
Resilience-based partitioning



MISSISSIPPI STATE UNIVERSITY

NREL Transforming ENERGY

Technical Approach: Operate Cells



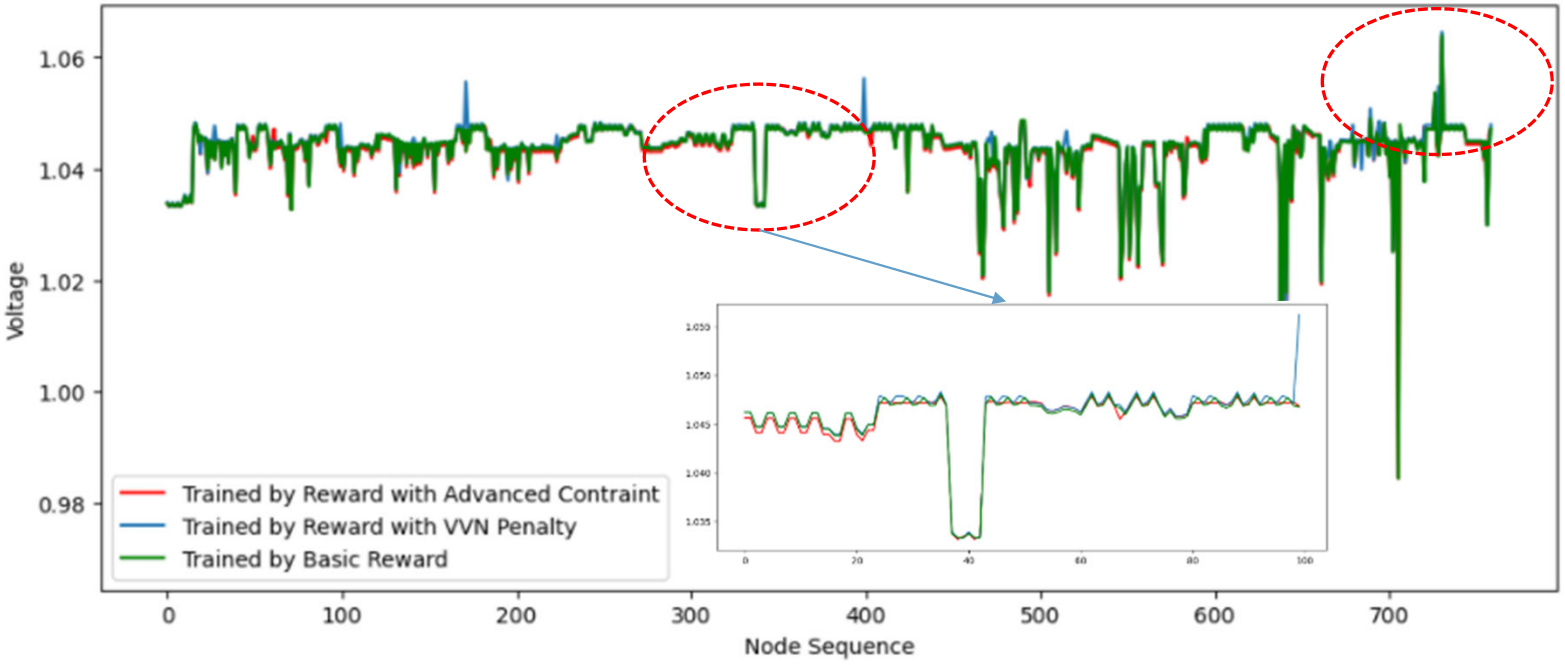
Use machine learning to reduce the reliance on accurate system model and massive communication

Use **Multi-Agent Deep Reinforcement Learning (MADRL)** to design a 2-Level Control Strategy:

- **Cell Control Agent:** Control DERs inside the cell
  - only require local cell data
  - Accounts for frequency and voltage responses to conditions as load changes
- **Cell Clustering Agents**: Coordinate with other cells when needed
  - communicate with other clustering agents and require system-wide information when getting trained

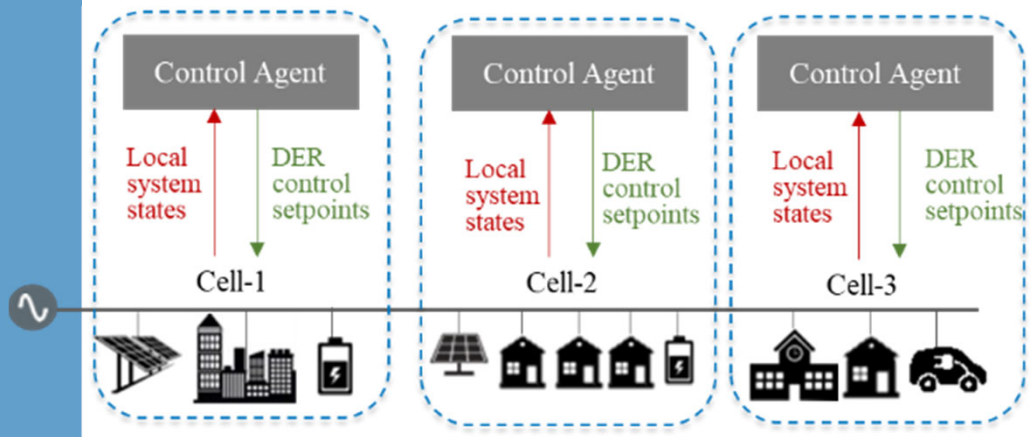
Deep Reinforcement Learning Approach to Control DERs

Training using OpenDSS with 3 different rewards. All node voltages at 100th timestep are compared, which around the PV peak generation. The number of voltage violations is only 2 for the proposed method.



Minsait's Contribution: Cell Management System using IoT Platform

Cell control agent: optimize the operations of PVs, BESSs, and other DERs within each microgrid to maximize local microgrid resilience.



No control command among cells to reduce the vulnerability to cyberattacks and communication loss

- Collect, process and store data locally in every node

Onesait Things Edge

onesait platform

- Real-time control for inverters, P&C devices, controllers via DNP3, ICCP, MODBUS, etc.

Babel (Protocol Manager) and

MultiSpeak

- Field message bus for cell-to-cell communication and for node-to-microgrid

iSPEED (Smart Platform for Efficient Electrical Distribution)

RTI Connext® DDS

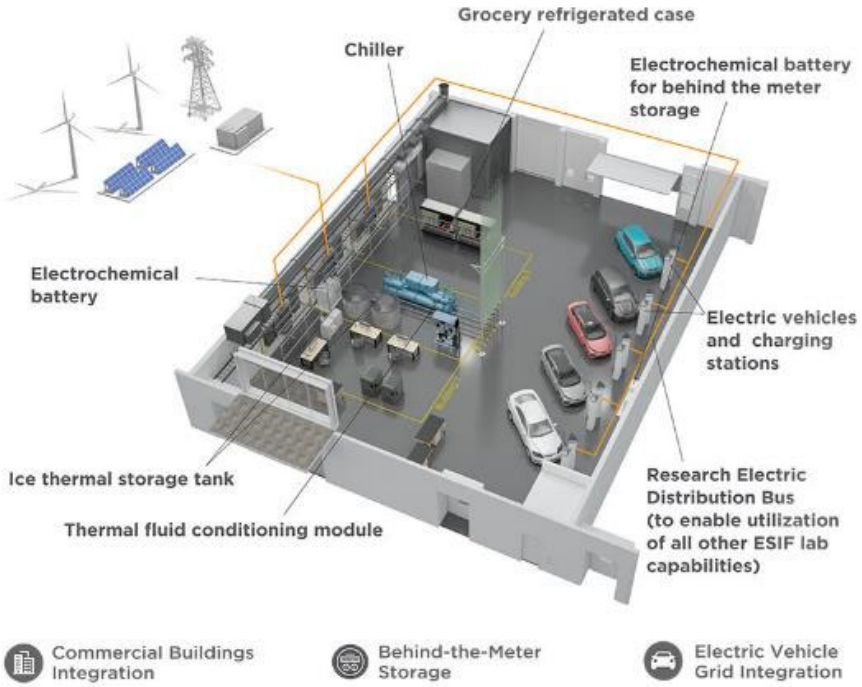
rti

Lab Simulation

NREL's Energy Systems Integration Facilities (ESIF) will be used to conduct **hardware-in-the loop experiments** for validating the REORG approach.

Hardware devices to integrate:

- Grid-forming and grid-following PV inverters
- Grid-forming and grid-following battery inverters
- Building loads
- EV supply equipment



Project Outcome

- Create a distributed and secure **microgrid management platform** that can be adopted by utilities to operate communities from small to large numbers of connected DERs
- **Resolve prolonged outages** by integrating solar and energy storage to operate in island condition
- Fulfill need for **wildfire mitigation** by leveraging innovative, resilient and stable microgrids

What is there for you?

Any utility can implement REORG and increment the resiliency of their network.

REORG identifies the weakest sections of the network where energy storage is most needed.

When in normal operation, REORG helps reducing peak loads and managing utility-owned storage and generation.

Restoration of services is performed autonomously, and cells are reconnected to the grid when available.

Are you interested? Let us know.

QUESTIONS?