EXTENDING THE CAMPUS – GETTING MICROGRID READY

FEBRUARY 18, 2014 LEIA GUCCIONE

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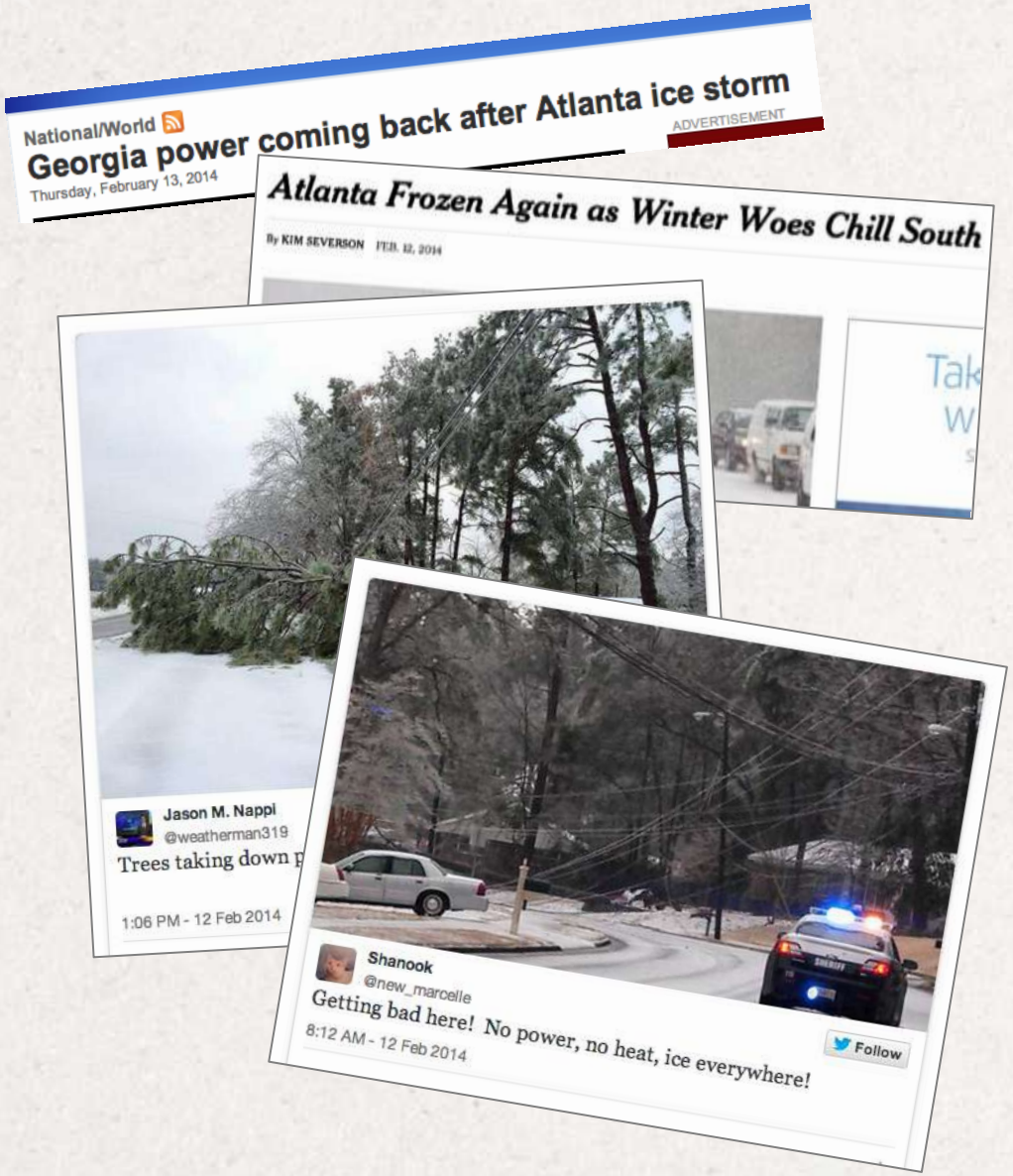
WHY BE MICROGRID READY?

RELIABILITY AND RESILIENCE



"An event of historical proportions"

—National Weather Service

- 236,000 customers without power in Georgia
- Half a million customers without power along the eastern seaboard
- Federal Government closed in Washington D.C.
- Several states declare emergency status

In every season, severe storms continue to wreak havoc on our electrical infrastructure.

SUSTAINABILITY

American College & University Presidents' Climate Commitment

- 679 signatories
- 2,070 GHG Inventories submitted
- 529 Climate Action Plans submitted
- 351 Progress Reports submitted

ECONOMICS

The customer economics for microgrids are already advantageous in several locations:

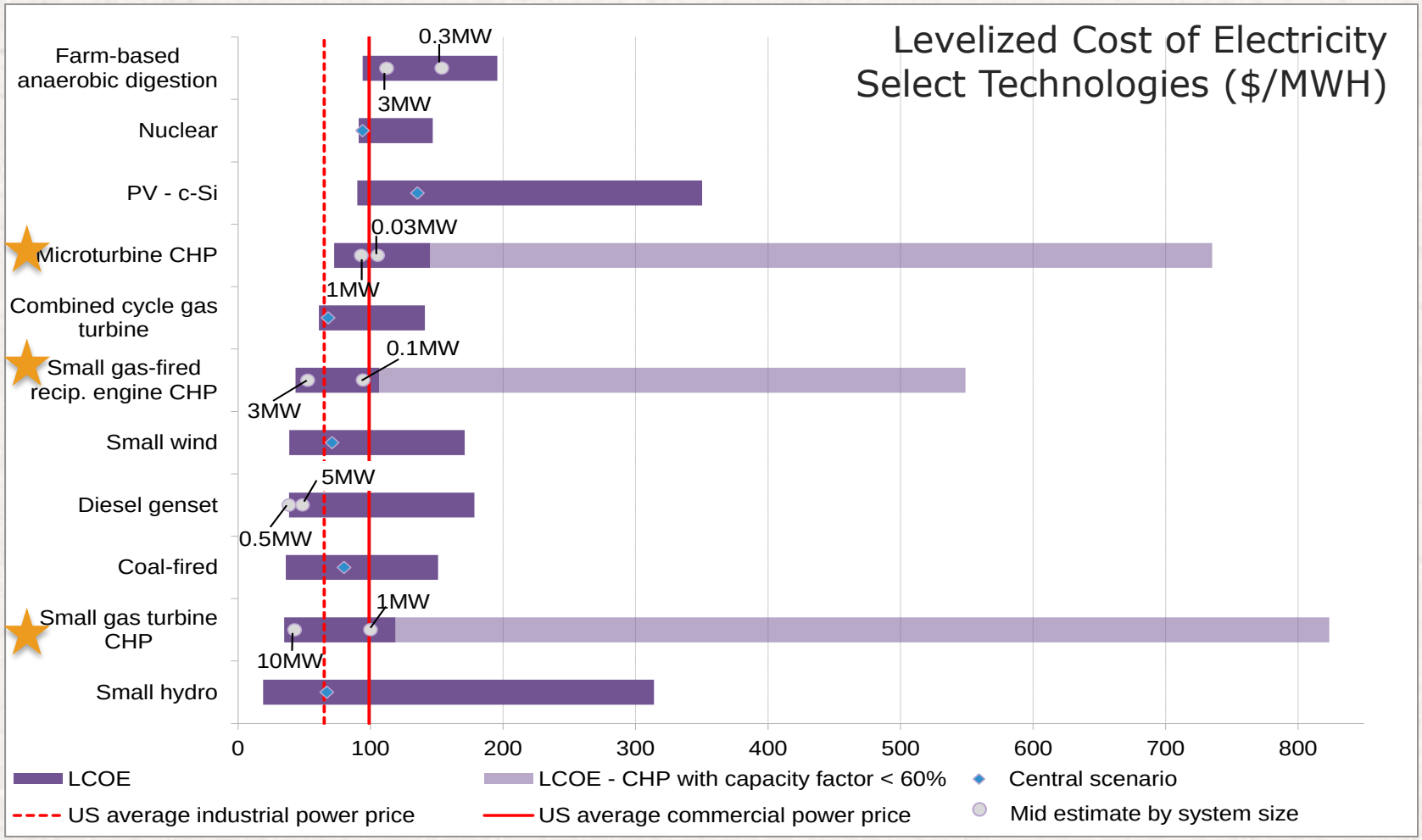
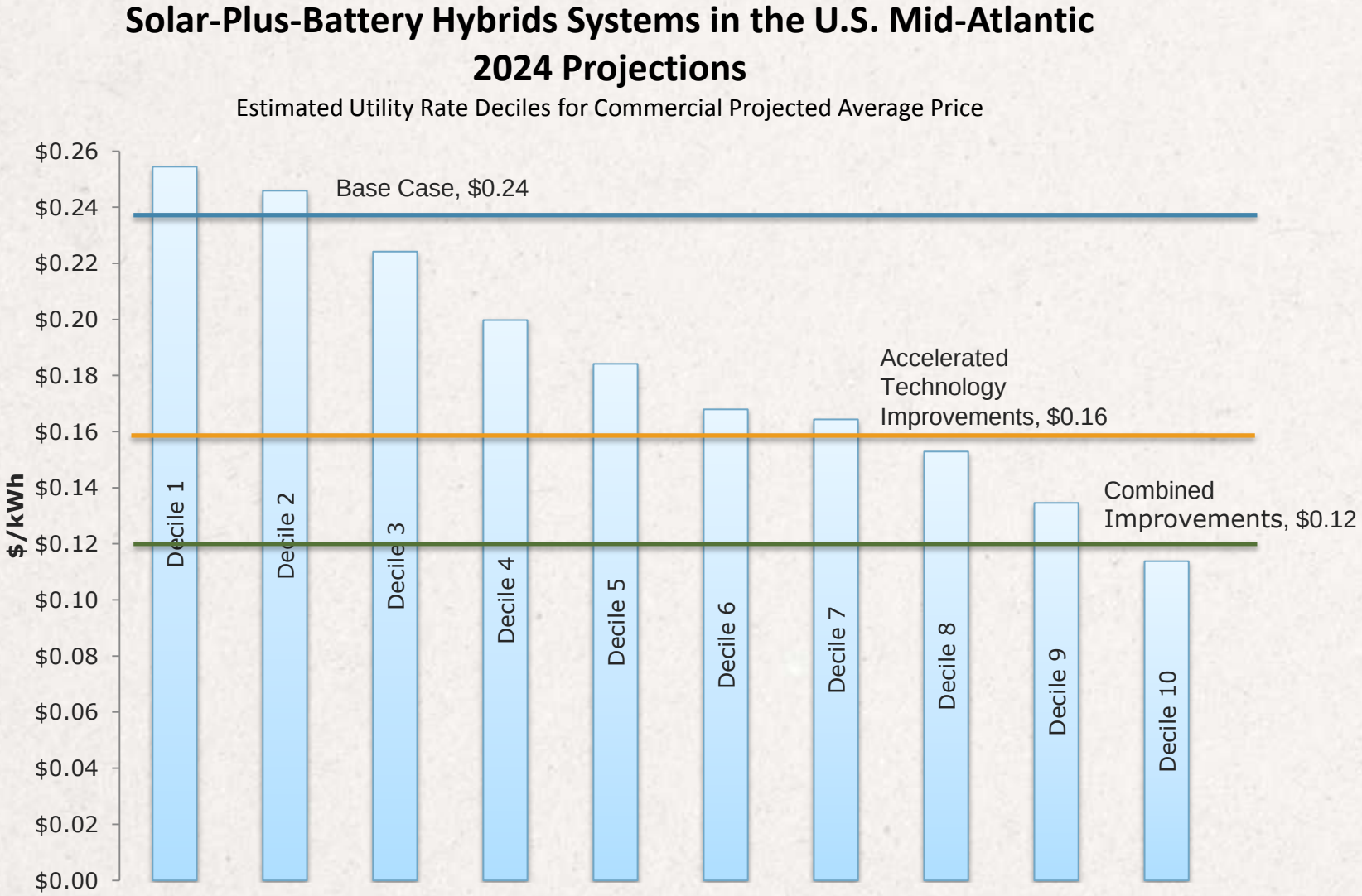


Chart Source: Bloomberg New Energy Finance

AND IT'S NOT JUST CHP ANYMORE



FLEXIBILITY

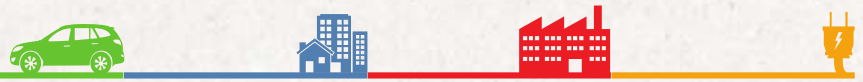
Campuses will continue to grow, with evolving needs

- Enrollment at institutions of higher education continues to climb

New technologies are yielding new capabilities:

- Hybrid Inverters
- Phasor Measurement Units
- ACPV Panels
- Electric Vehicles (V2G)

THE NEXT GENERATION OF MICROGRIDS



FIRST GENERATION MICROGRIDS

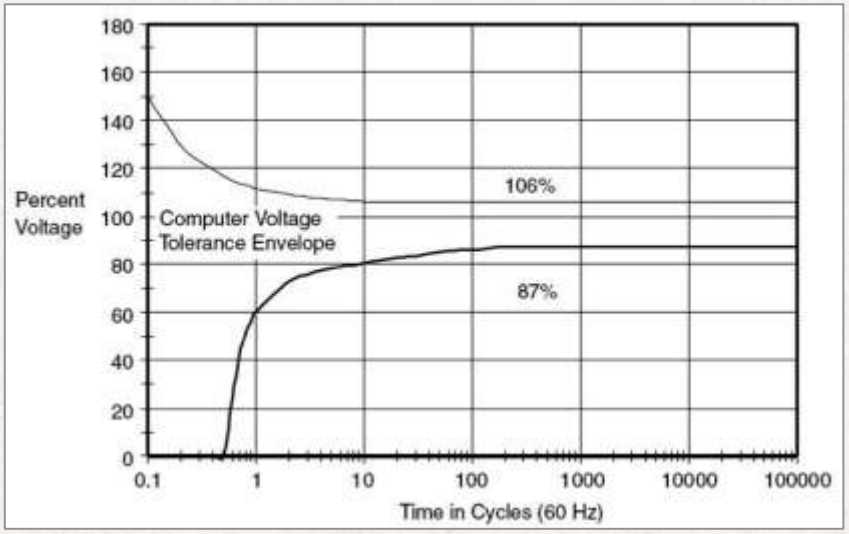
The first wave of microgrids all had similar characteristics:

- Combined Heat and Power (CHP)
- Single Owner Property (Campuses)
- High Reliability Need
- Long Investment Horizon
- One core team of experienced operators

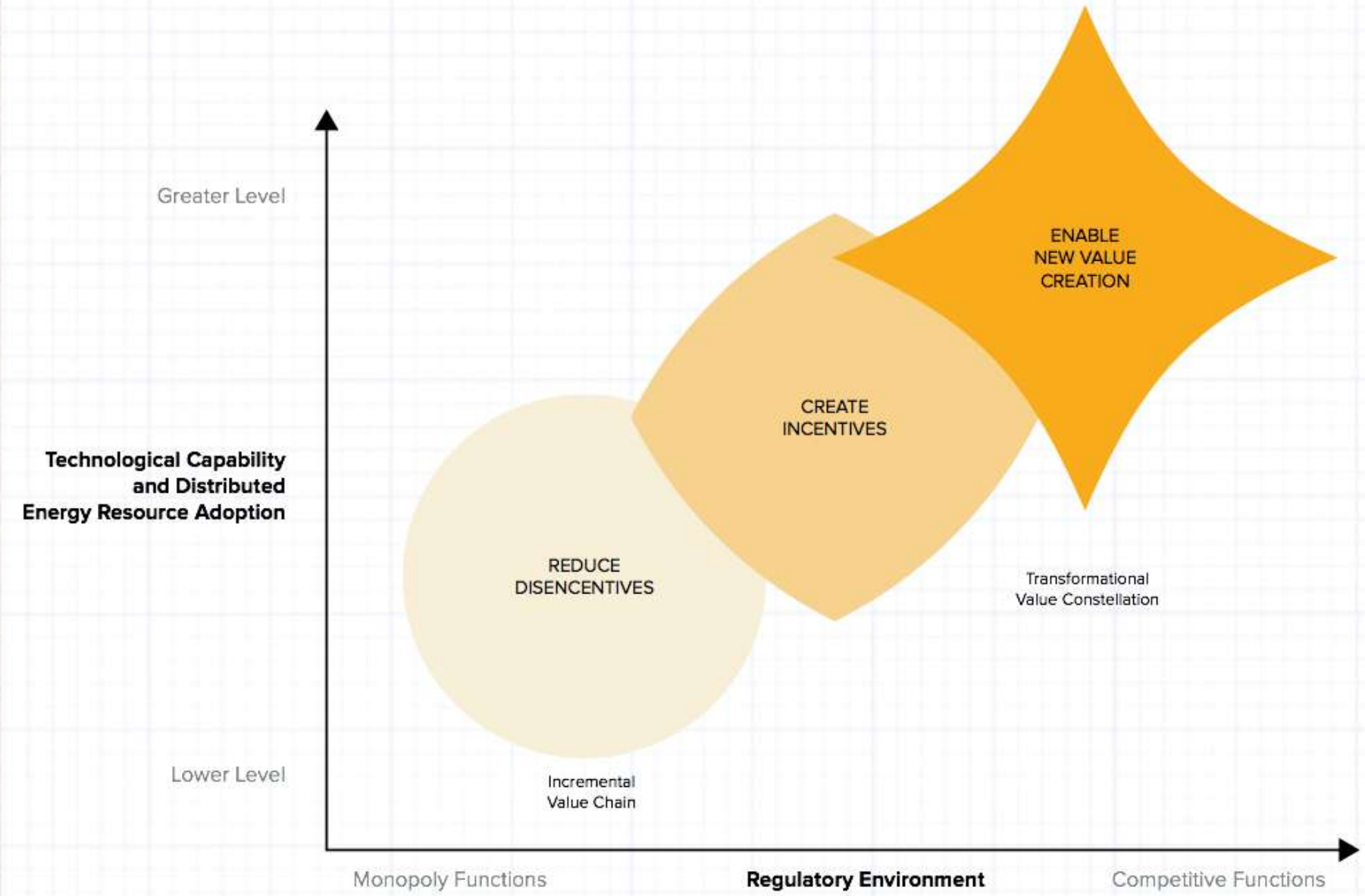
NEXT GENERATION MICROGRIDS

The future comes with options:

- One of many possible circuits
- Integrated renewables
- Higher reliability needs
- Grant Opportunities
- Multiple Stakeholders
- Research Interest
- Priority to Innovate
- New interest from utilities



THE LANDSCAPE IS EVOLVING



NEW TECHNOLOGIES CREATE OPPORTUNITIES AND CHALLENGES

New Opportunities

- Battery Storage
- Smart Inverters
- Hybrid Inverters
- DC Grids
- Networked Controls
- The "Internet of Things"

New Challenges

- Increasing Reliability Needs
- Load Growth
- Output from variable generation
- Evolving interconnection standards
- Evolving regulatory environment

WHAT DOES IT MEAN TO BE MICROGRID READY?

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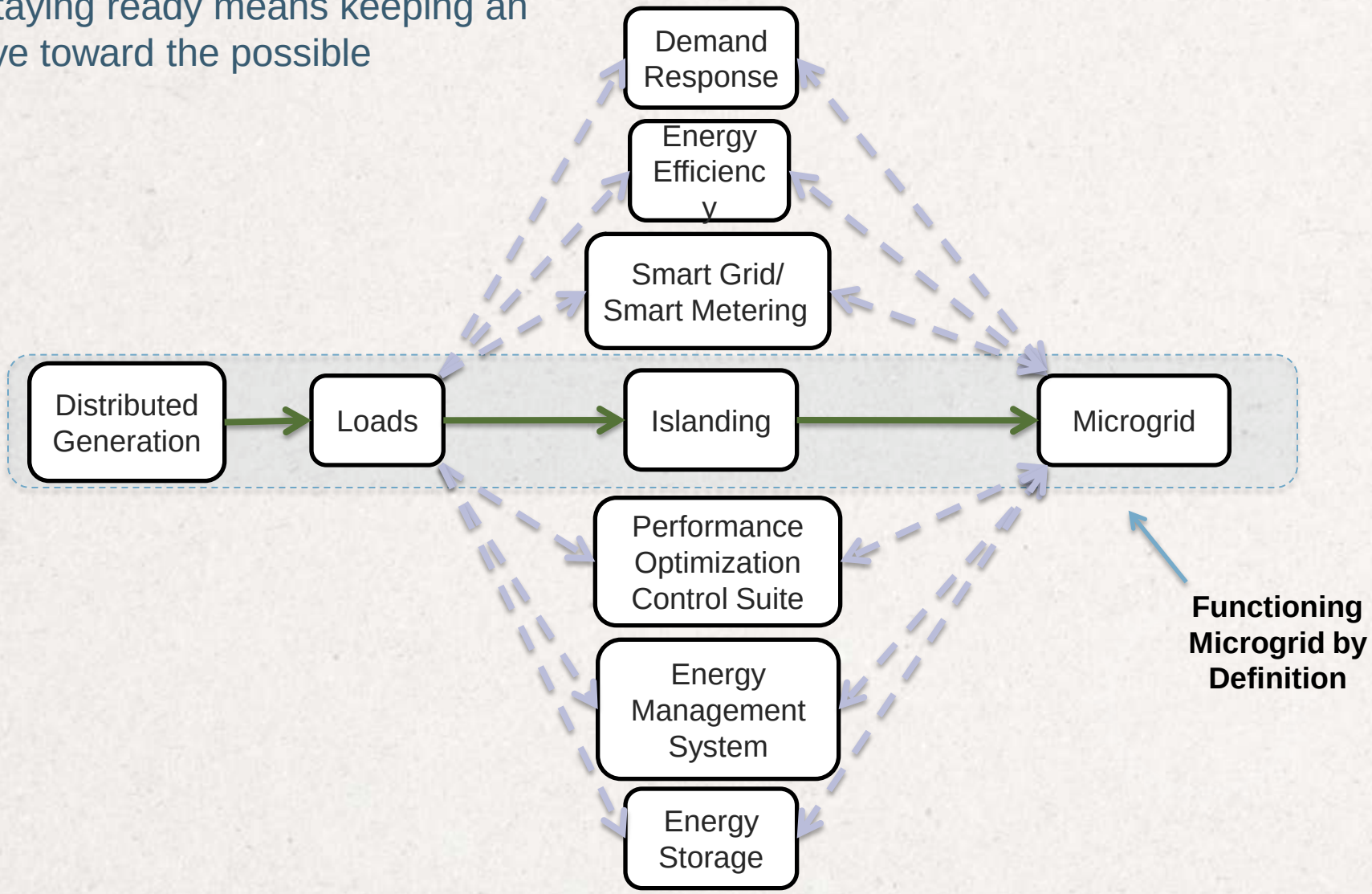
A CONTROLLED EVOLUTION

Staying ready means keeping an eye toward the possible

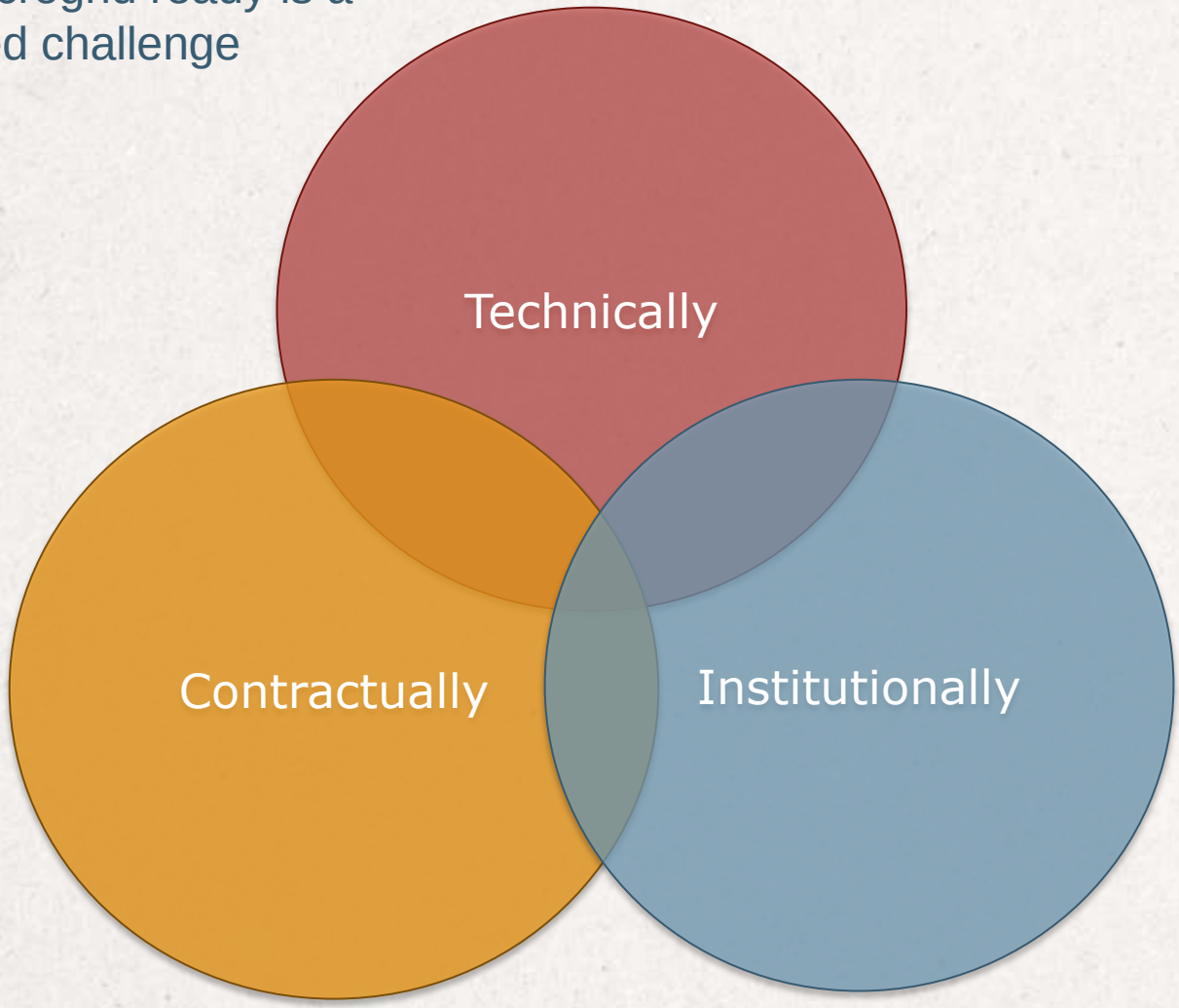


THE VALUES BALANCING ACT

Priorities	Description
Environmental	• Accelerates GHG reductions • Reduces levels of SO_x, NO_x, Ash, and other particulates • Enables a more renewable grid
Economic	• Enhances payback • Mitigates electricity price risk • Requires changes in financing and accounting
Innovative	• Draws attention and accolades to the institution • Opens access to special funding opportunities • Improves the institution's position as a leading research facility
Operational	• Mitigates reliability risks • Requires changes in operations
Community	• Creates greatest advantage to the state and local community • Enhances relationships in campus communities • Engages the student and faculty community

WHAT IS MICROGRID READY?

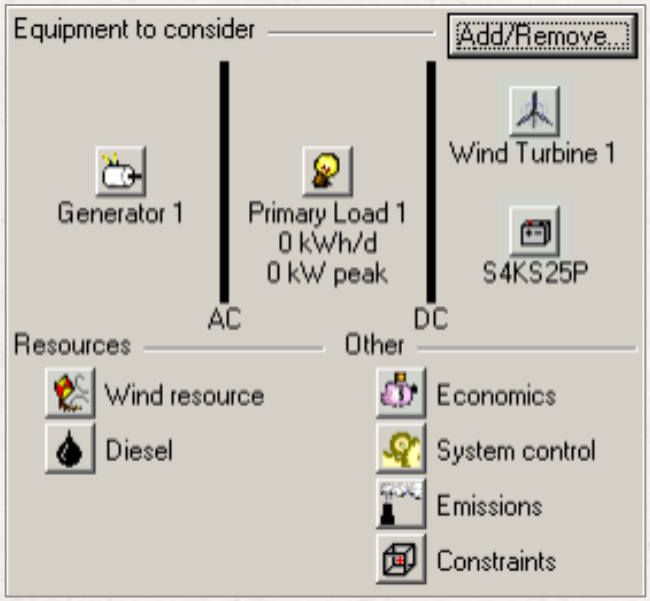
Staying microgrid ready is a multifaceted challenge



HOW TO STAY MICROGRID READY

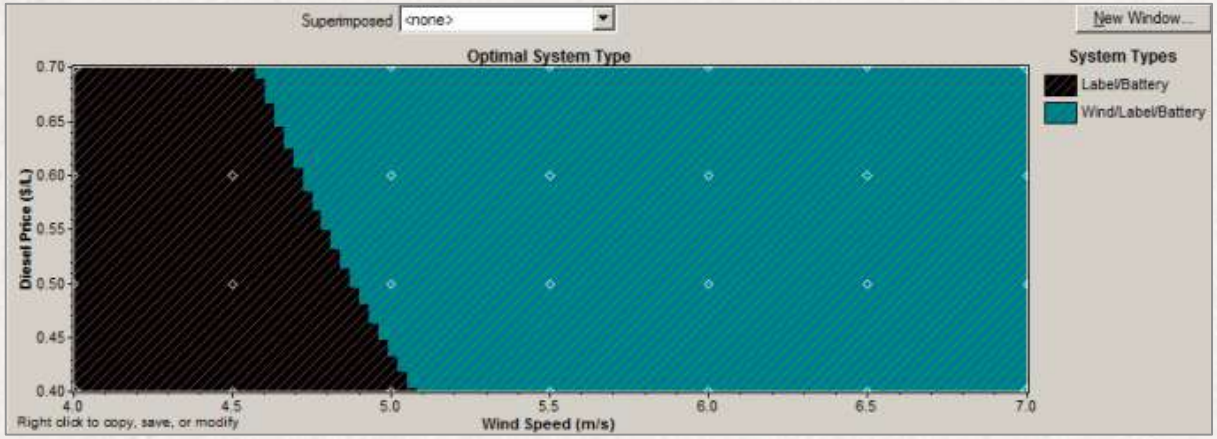
TOOLS FOR PLANNING

A wide-array of software and modeling tools can help:



One example: HOMER Energy Modeling Software

- Developed by NREL for remote communities in the U.S.
- Hourly simulation designed to optimize distributed power systems with renewable energy sources
- Ranks winning combination of generating assets
- Capable of running sensitivity analysis



TOOLS FOR PARTNERING

Set Ground Rules: Collaborating on campus energy issues requires a new approach to planning and problem solving.

- A 5-step process to microgrid planning between multiple stakeholders:

1. Identify goals and priorities
– Examples:
    - Visibility: demonstrating leadership and innovation
    - Reducing campus carbon footprint

2. Organize key criteria for circuit evaluation by goal statement
– Examples:
    - Reducing emissions
    - Improving efficiency

3. Evaluate candidate circuits against the selected criteria
– Example:
    - Central Campus vs West Campus

4. Calculate the scores for each circuit
    - Compare your results to those of other partners

5. Evaluate scoring results
    - Gut check

Why do you want it?

What do you do with it?

Where do you put it?

PRINCIPLES FOR ALL OF US

1. Flexibility is King
   - Contractually
   - Control Systems

2. Interoperability is Essential
   - DERMS, DMS, SCADA, etc.

3. Collaboration is Inevitable

4. Values versus Cost
   - Understand the Difference
   - Strive for Equity in Negotiations

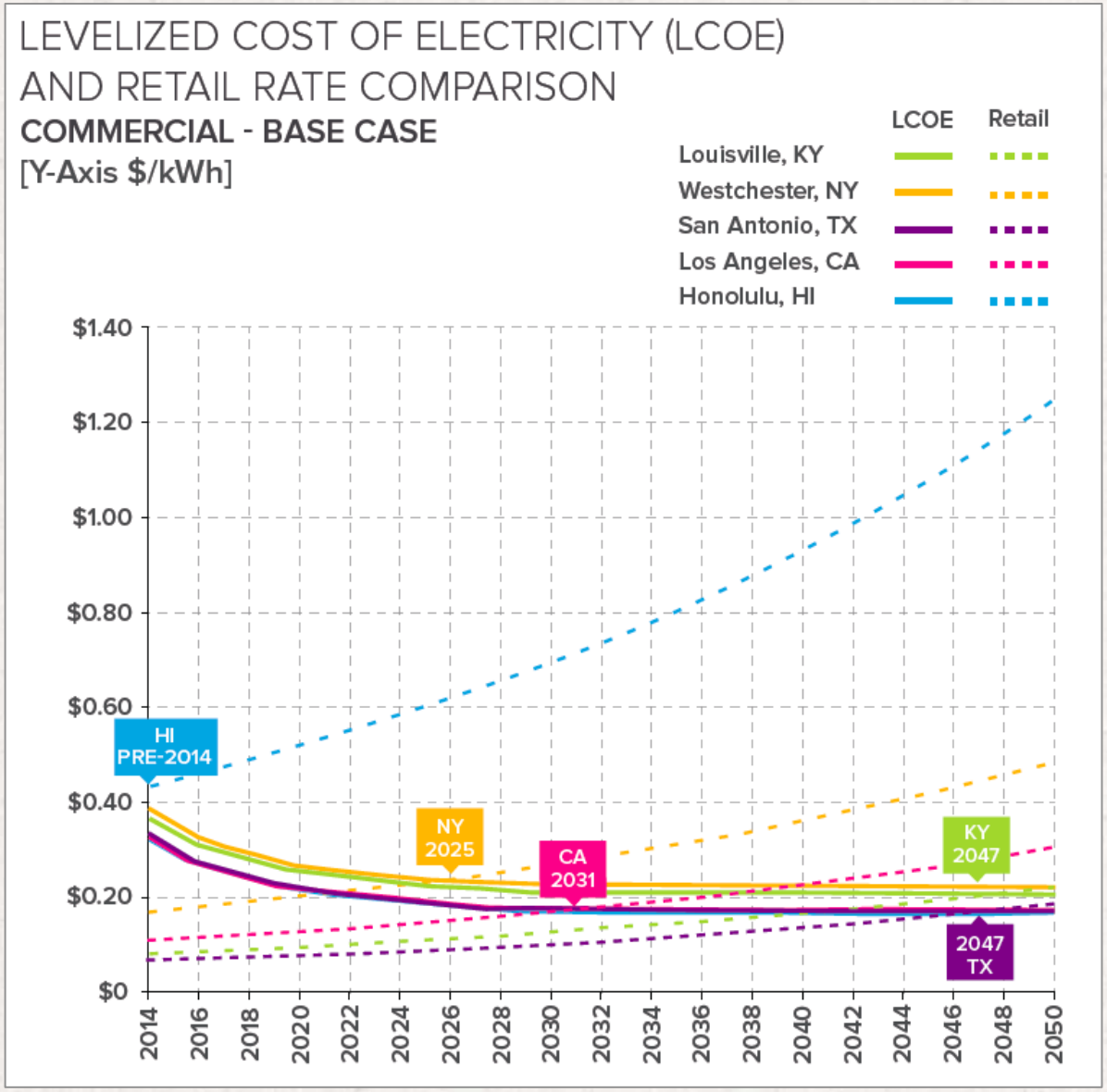
5. Limited regulation for ‘Grid-Neutral’ Systems

6. Open Access to Data

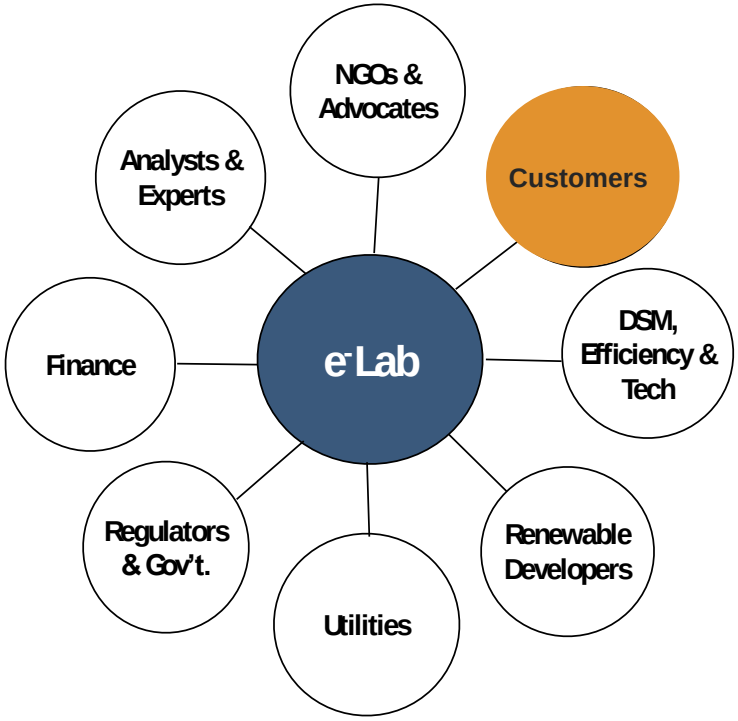
Collaborating to create a clean, prosperous, and secure energy future™

Leia Guccione
303.567.8630
lguccione@rmi.org

THE ECONOMICS OF GRID DEFECTION - PREVIEW



Electricity Innovation Lab
ROCKY MOUNTAIN INSTITUTE



Focusing on the distribution edge

Key questions include:

1. How can we we determine the costs and benefits of distributed resources?

2. How can we harmonize regulatory frameworks, pricing structures, and business models?

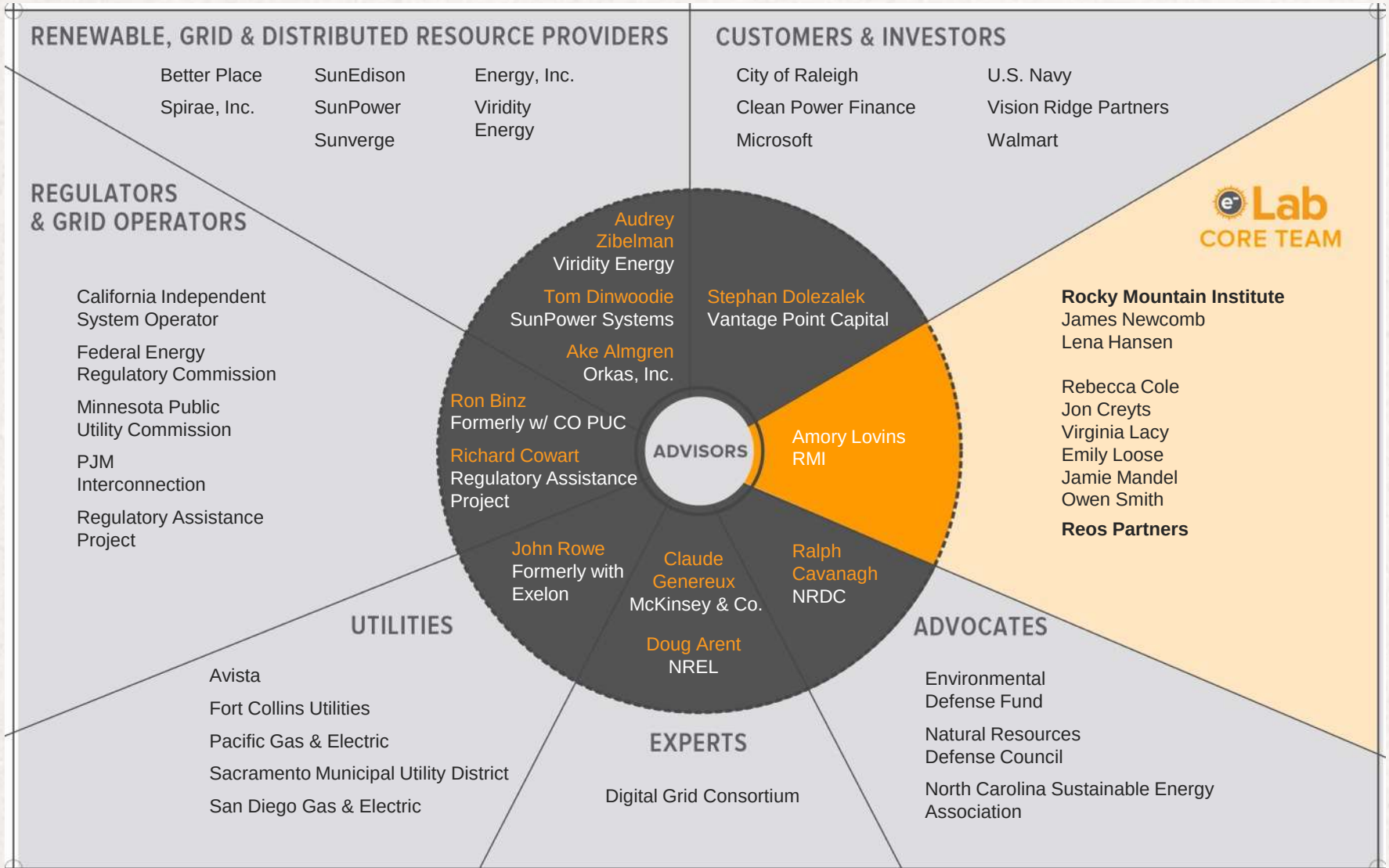
3. How can we accelerate the pace of economic distributed resource adoption?

e-Lab meetings

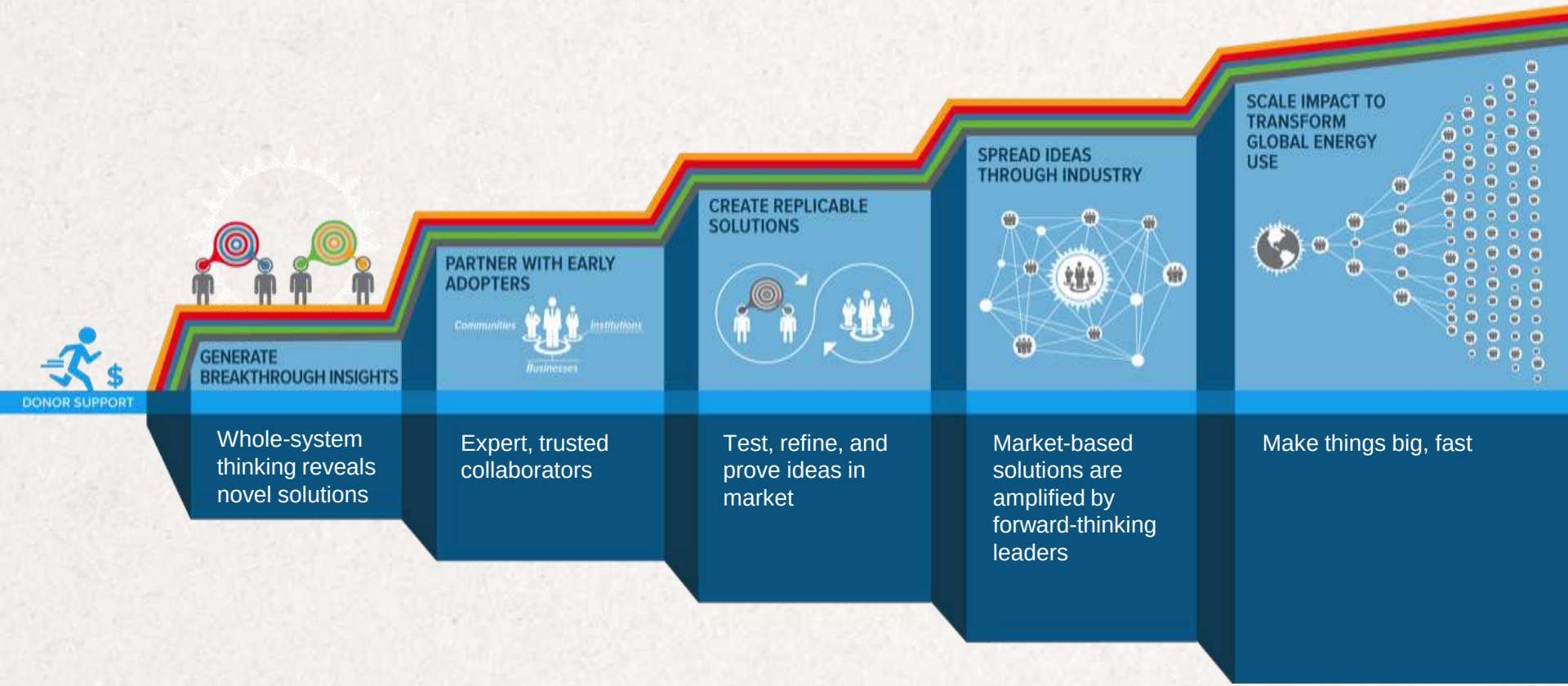
- Multi-stakeholder, multi-year
- Provides a "whole system" view
- Supports practical innovation projects.

ELECTRICITY INNOVATION LAB (e-Lab)

SPEEDING THE ECONOMIC DEPLOYMENT OF DISTRIBUTED ENERGY RESOURCES IN THE U.S. ELECTRICITY SECTOR



HOW WE TACKLE THE WORLD'S TOUGHEST ENERGY CHALLENGES



A MARKET-DRIVEN APPROACH

Change the way the game is played…

We engage market leaders to improve performance, and redirect strategic behaviors using one of two models:

- **Model 1 -** Work with individual organizations to put them on the path to capture value within their business constraints.
- **Model 2 -** Work with stakeholder "ecosystem" to develop shared recognition of the opportunities and develop "win-win" paths to realize.

…and the rules will follow

Market-based changes influence direct policy interventions

- Market performance is the touchstone for policy decisions. We show what's possible, giving regulators and legislators confidence to enact more aggressive policies.
- Findings from industry collaborations often result in policy insights (e.g., potential of feebates, regulatory reform options in electric power).

TWO GUIDING PRINCIPLES

1 Efficiency first, then renewables

2 Whole-system design

2025 GOALS (DRAFT)

ELECTRICITY

Transforming the electricity system

- 20% greater efficiency, 30% renewable energy penetration, 10M households with solar
- New market where distributed renewables compete fairly w/traditional fossil-fuel-based energy supply

COMMUNITY ENERGY

Increasing resilience across the U.S.

- 20M people will live in communities, campuses, and military bases that have strategies to reduce fossil fuel use and stabilize climate impacts

TRANSPORTATION

Drive less, use less

- 25% penetration of 40%-lighter vehicles, and 10% EVs, in the U.S.
- Reducing VMT 25% in 20 municipalities around the world

BUILDINGS

Reducing energy use by 50%

- City and portfolio retrofits
- Real estate finance and value