Optimizing Technology for Value: The Cooperative's Role

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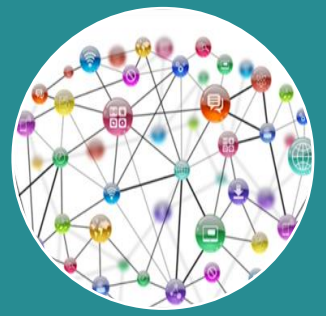
America's Electric Cooperatives

Agenda

- **Background**
- **Technology/Optimization – Lessons of Telecom**
- **Devices vs. Value**
- **Role of Data**
- **Cooperative Leadership**

Business & Technology Strategies

Examples
-Work rules | safety with DER
-Market fundamentals
-Reliability & resiliency
-Cybersecurity



Operate

Optimize

ITC
WYOMING
INTEGRATED
TEST CENTER

Transform

Examples
-Analytical tools
-Understanding Consumer end-use load profiles
-Uses for Carbon
-IT network management

Examples
Solar PV cost screening & system designs
Energy storage | Community storage

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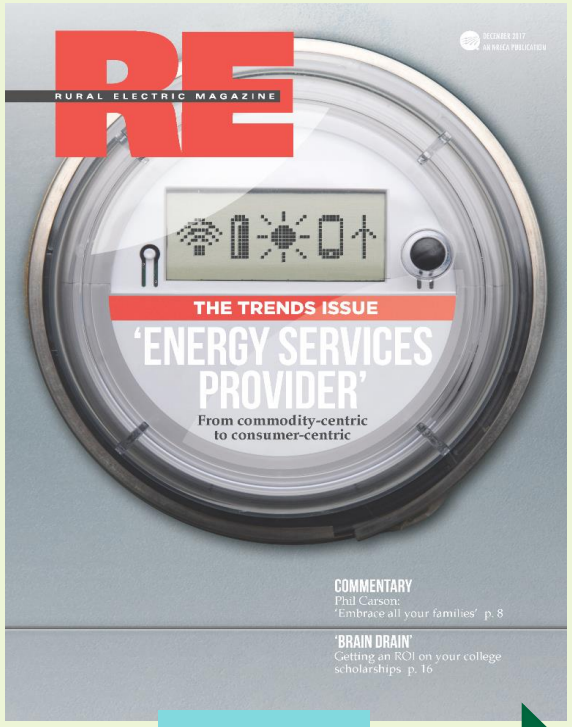
Macro Trends

2014

2015

2016



2017

Member relationship **Control energy use** **Solar & Storage** **Interoperability** **Analytics**
New Planning capability **Distribution optimization** **Evolution of wholesale retail model**

How many of your co-ops are exploring energy services?

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Changing Market Fundamentals

Changes in Technology

- Increased Natural Gas Supply
- Changing Generation Mix
- New Business Models
- Lower Costs for DG, Storage, RE
- Price and Rate Impacts
- Regulatory Change
- Modernization of Grid and Comms
- Transmission Investment
- Customer Expectations

FORECASTING, PLANNING, AND ANALYSIS WILL CONTINUE TO EVOLVE

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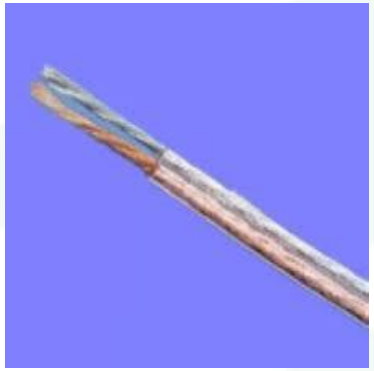
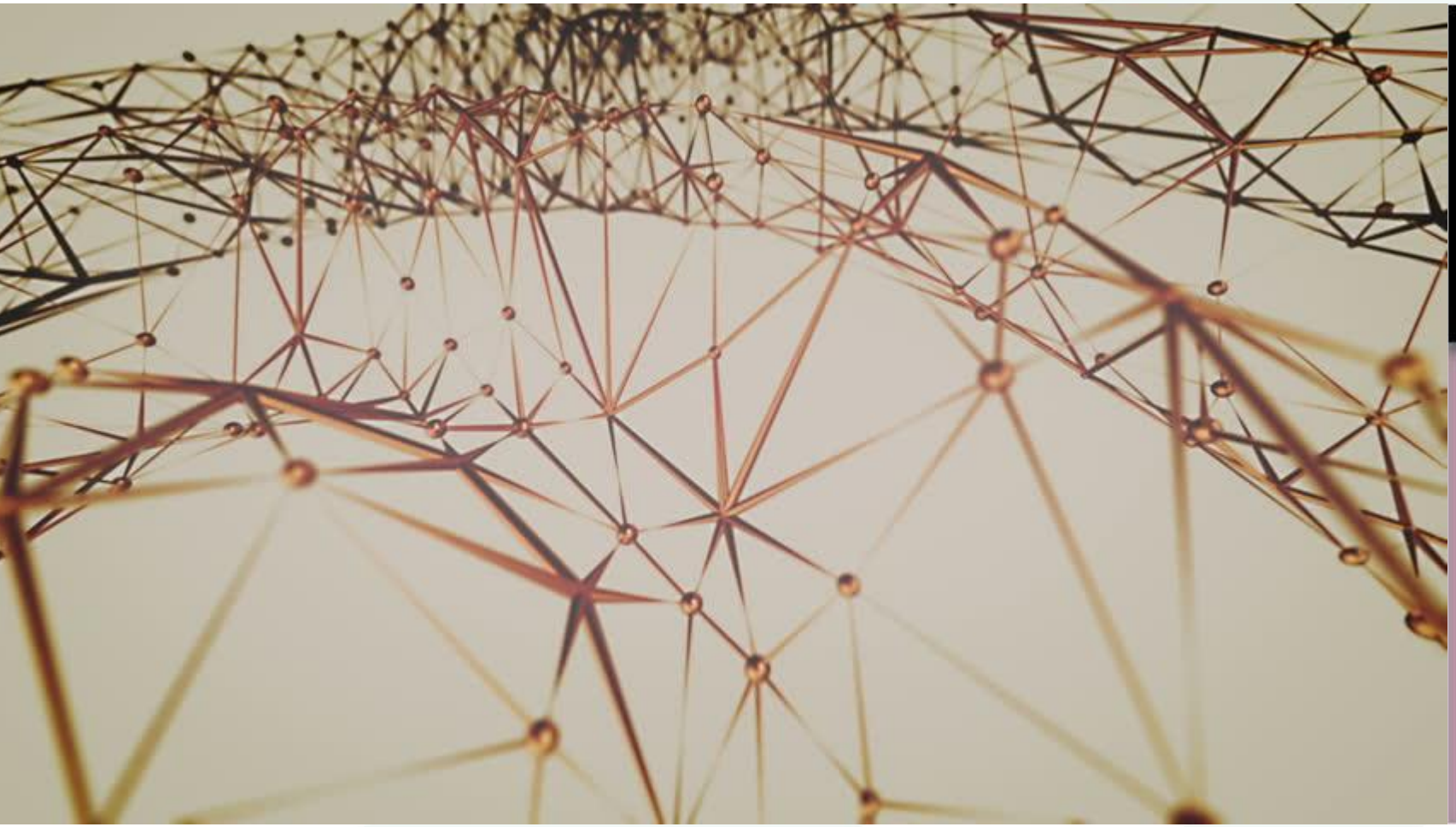
Telecom – moving from devices to software

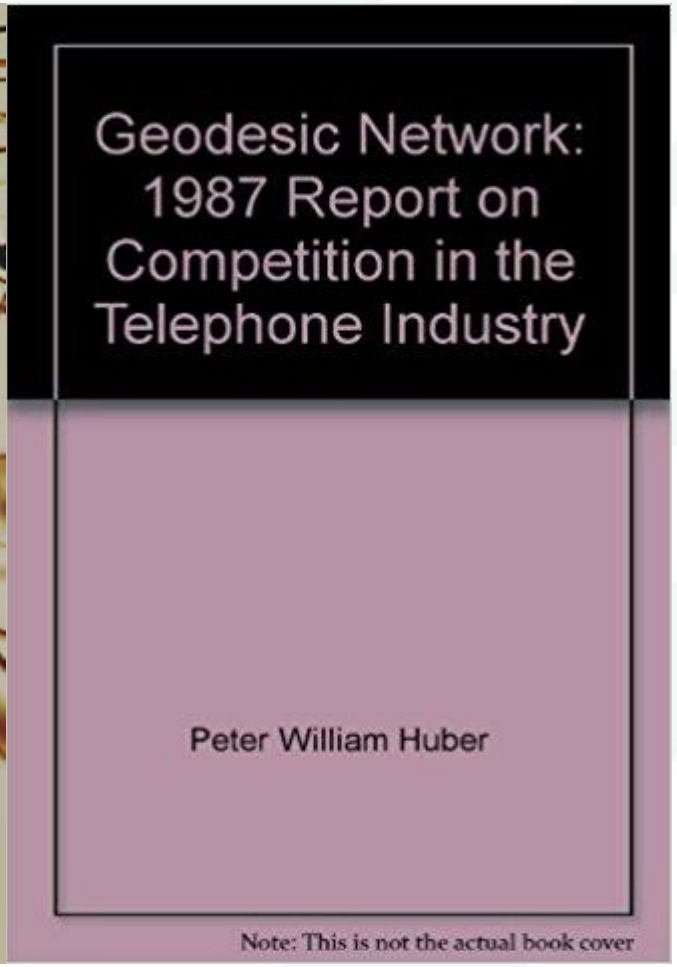
An overview of advances in telecommunications technology that can be anticipated in commercial systems during the 1980s. Topics covered: (1) Computers and components: microprocessors; memory devices; input/output devices. (2) Computer influences on telecommunication systems and services: substitution of information processing for transmission; digital communications; mixing of voice, data, message, and image communications; integration of information processing and communications. (3) Communications terminals. (4) Transmission and switching systems: communications satellites; optical fiber transmission; microwave, cable, wire, and wave-guide transmission; digital transmission; switching technologies. (4) Local distribution: telephone wire pairs, coaxial cable TV, mobile communications; optical fibers.

Technology Evolution



Geodesic Network – predecessor to the Smart Grid





Devices vs. Value

The Challenge and Opportunity of Distributed Energy Resources

DER is not just solar and microgrids.

It is about a fundamental evolution of the grid from inherent stability to active management.

1883→ 1990

Control Through Angular Momentum

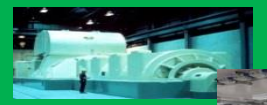
Reliability through overbuilding

Transition

Lack of overall model
Changing Technology
Complicated Transition

2030?→ ooo

Analytically Driven Control



Knowledge of state
Precise control
High performance analytics

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Two sets of challenges

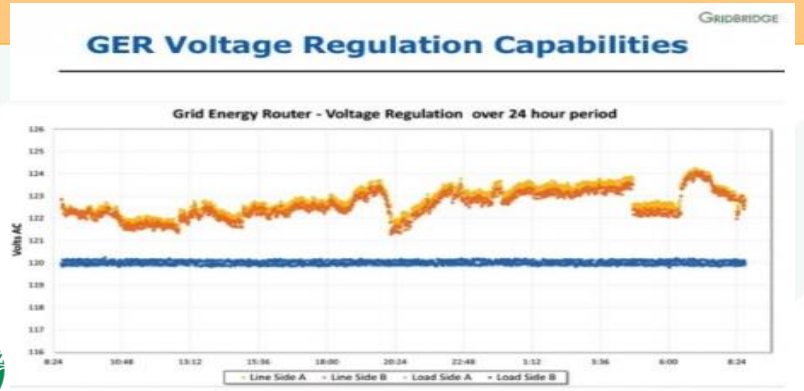
Technology

- Distributed generation
- Edge Volt/VAR control
- Storage
- Smart feeder switching
- Advanced sensors
- New security concerns
- Solid state power electronics

Much more change over time

Business

- Energy markets at multiple levels
- Complex pricing
- Customer self-generation
- Actively engaged consumers
- Sophisticated entities like WalMart and Google



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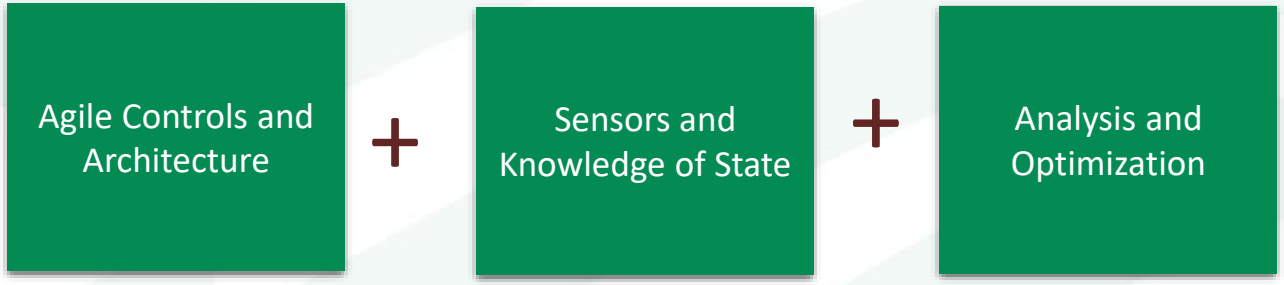
Mastering DER – OPTMIZATION

Its about agility, precision, and intelligence



Distributed Generation, Storage, Volt/Var controls
Advanced sensors, Advanced switching, Expanded SCADA
And much more to come

Telling Our Story through Data & Analysis

America's Electric Cooperatives

From booming suburbs to remote rural farming communities, America's electric cooperatives are energy providers and engines of economic development for more than 19 million American homes, businesses, farms and schools in 47 states.

833 distribution and 62 generation & transmission cooperatives Power

56%

of the nation's landmass.

Own and maintain **42%** (2.6 million miles) of U.S. electric distribution lines.

Power more than **19 million** businesses, homes, schools and farms.

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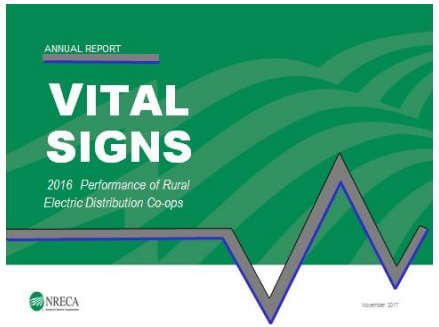
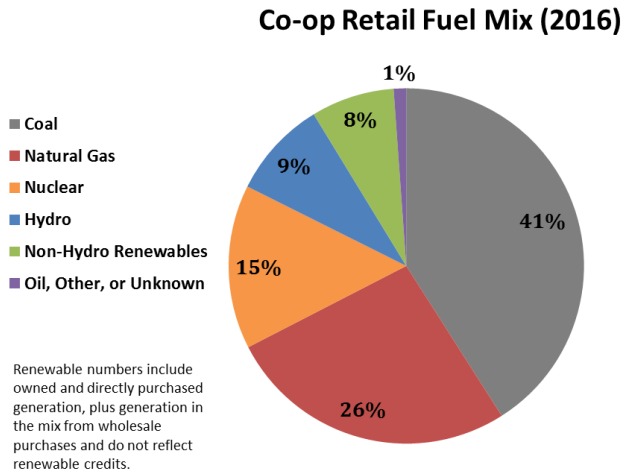
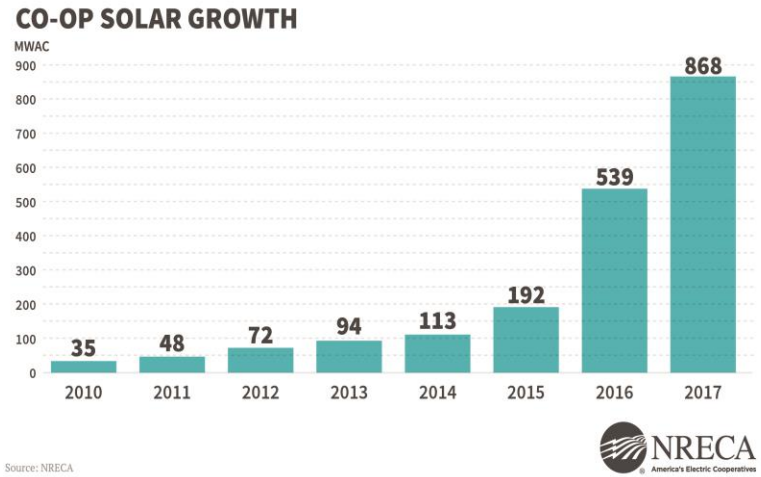


Co-op Fuel Mix



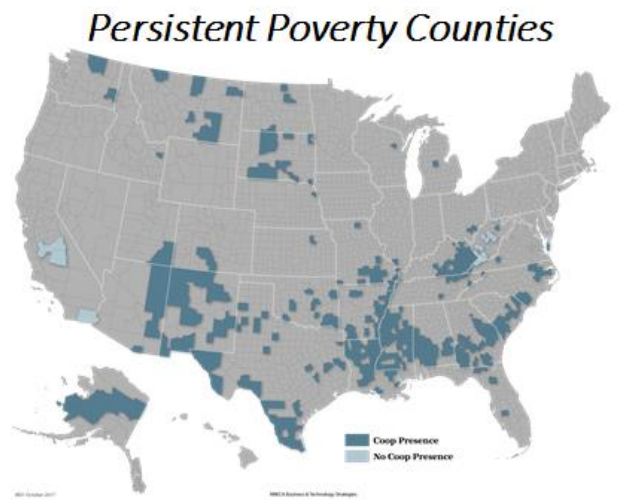
Renewable numbers include owned and directly purchased generation, plus generation in the mix from wholesale purchases and do not reflect renewable credits.

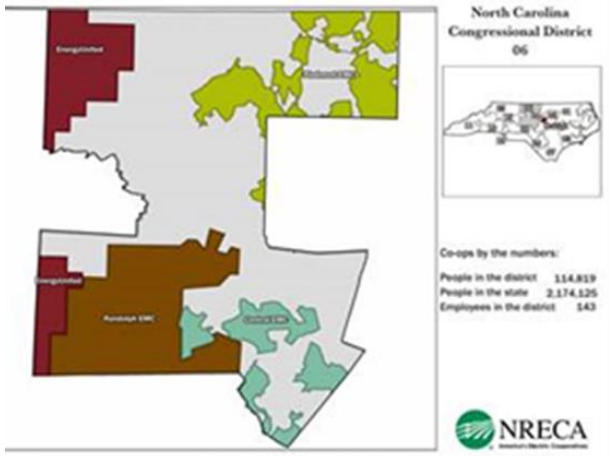
Tracking Co-op Renewables



Source: NRECA

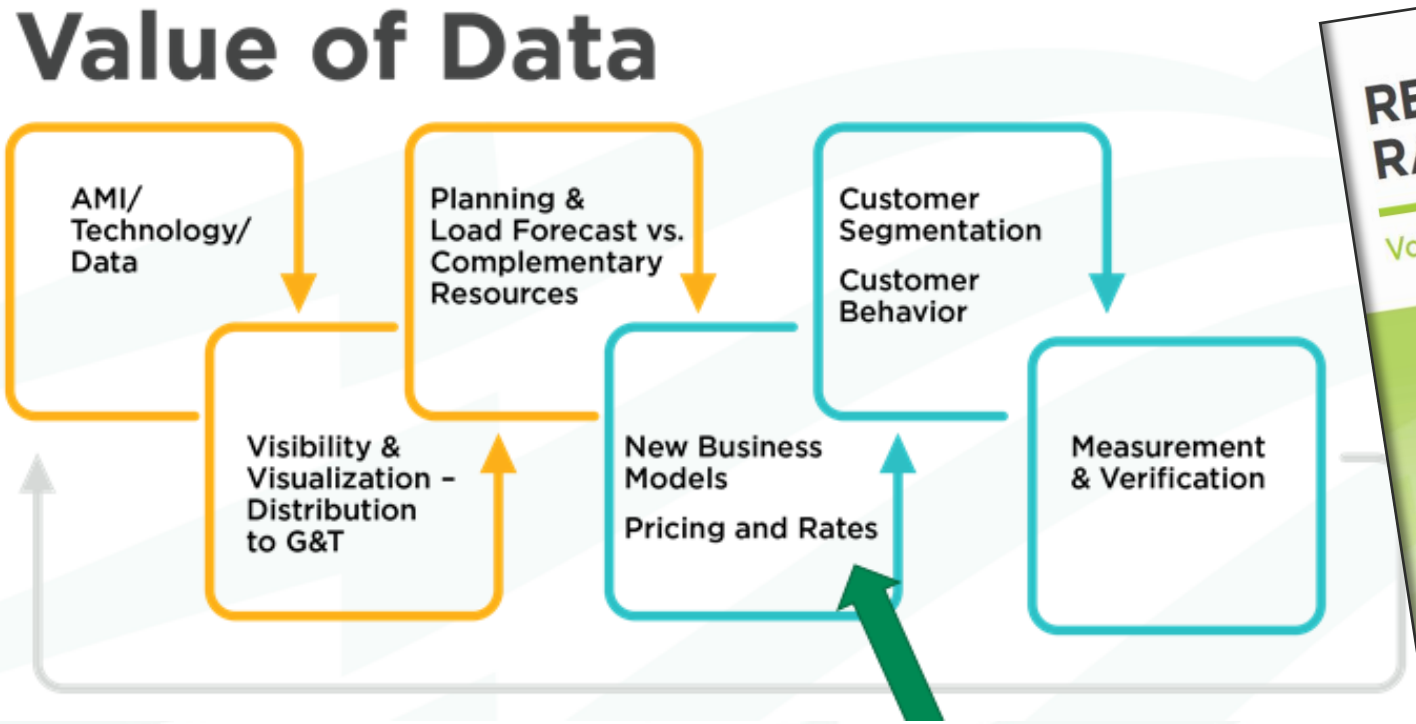
Co-op Demographics

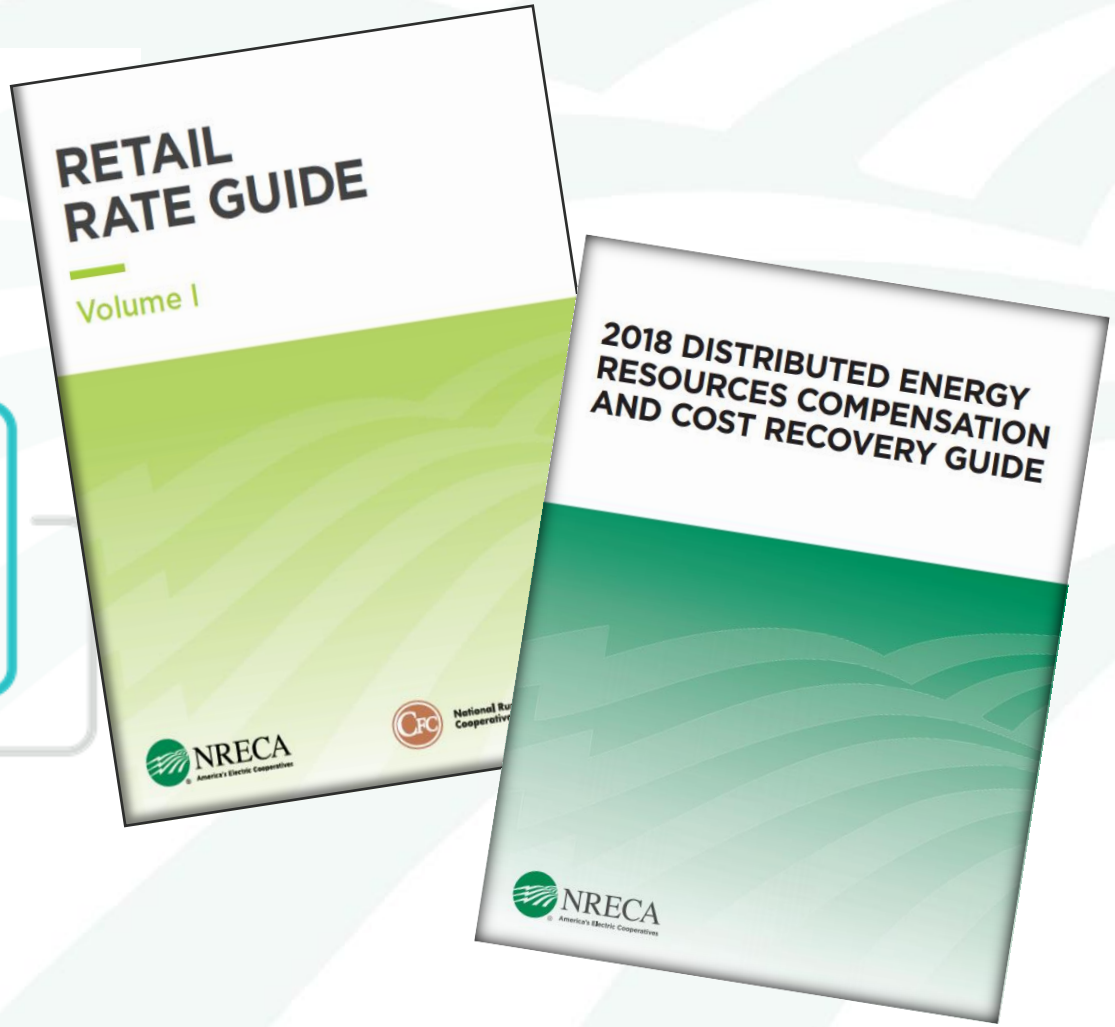




Congressional District Analysis

Role of Data





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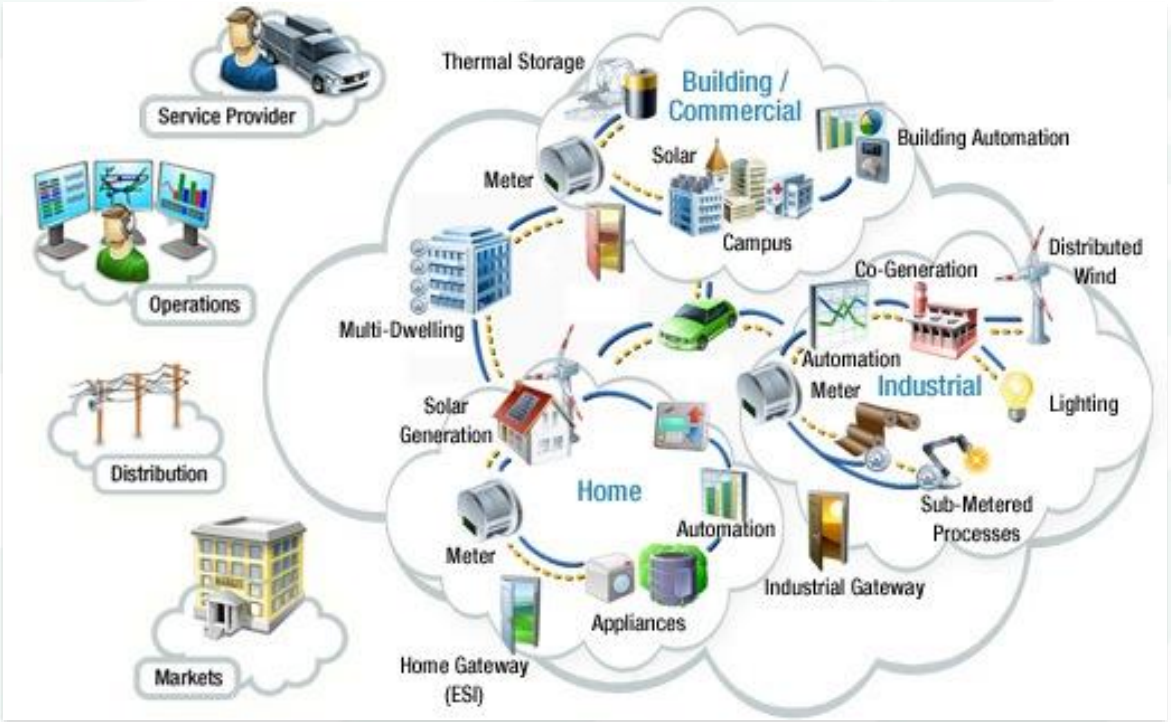
Objectives Can Be Met with a Variety of Technologies

- **Capacity reduction/deferral**
  - Demand Response
  - Behind the Meter Generation
- **Energy Reduction or Electrification**
  - Energy Efficiency
  - Behind the Meter Generation
  - Storage/EVs
- **Ancillary services**
  - Storage
- **Reliability/Resiliency**
  - Microgrid
  - Customer Owned Back-up
- **Political/Regulatory**
  - Rooftop Solar
  - Small wind or hydro
- **Relational**
  - Community Solar/Storage
  - Demand Response



75 Years of Service
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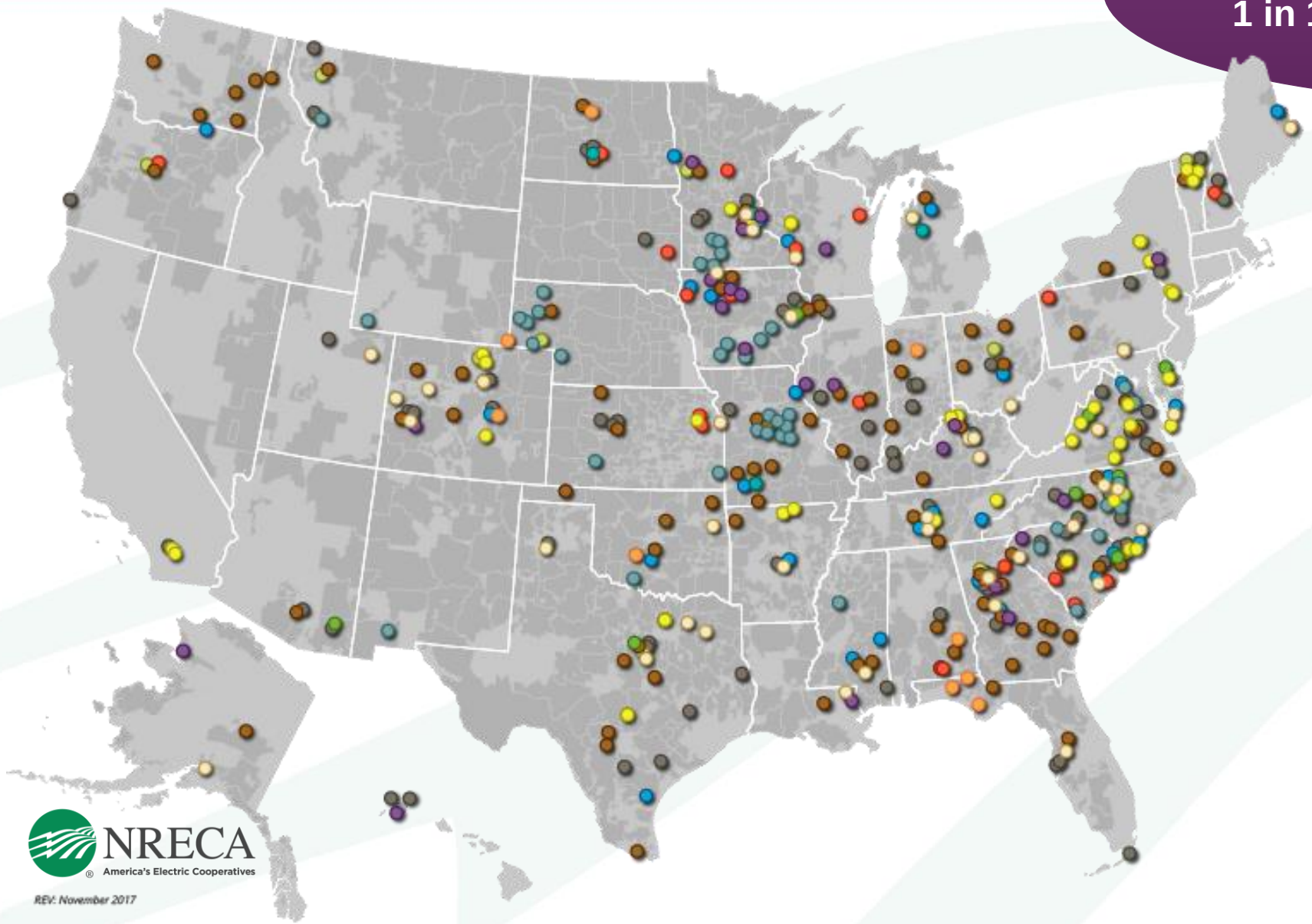
Cooperative Leadership

3 in 10 of co-ops participating
1 in 10 in multiple efforts



- Member Advisory Group
- Strategic Technology Advisory Council
- Transmission & Distribution Engineering Committee
- MultiSpeak Subscriber
- Water Heater Advisory Support
- Analytics
- Cybersecurity
- Distributed Energy Resources
- Generation
- Smart Grid
- Transmission & Distribution
- DOD

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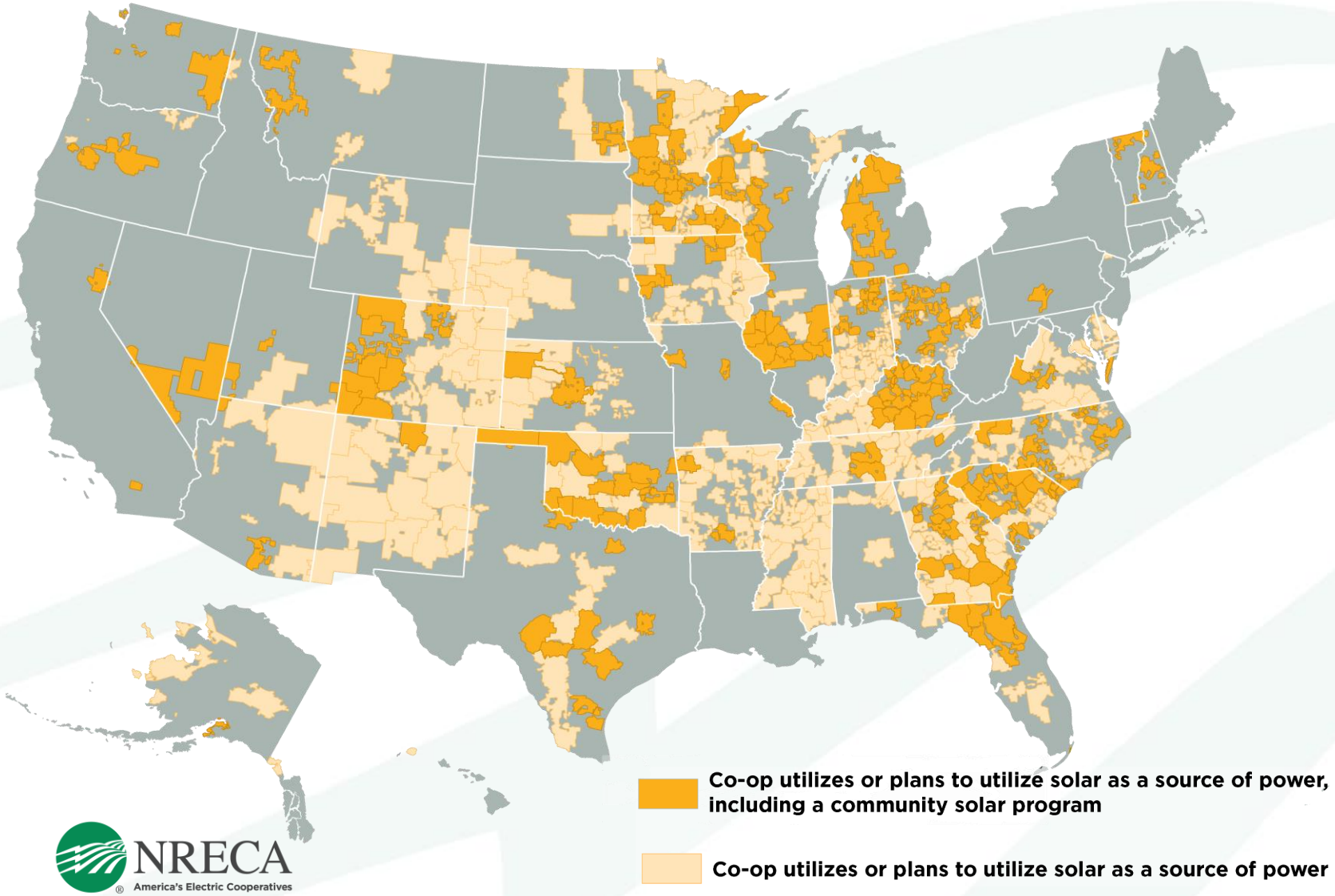
REV: November 2017

Solar - Reducing Costs & Learning Curves



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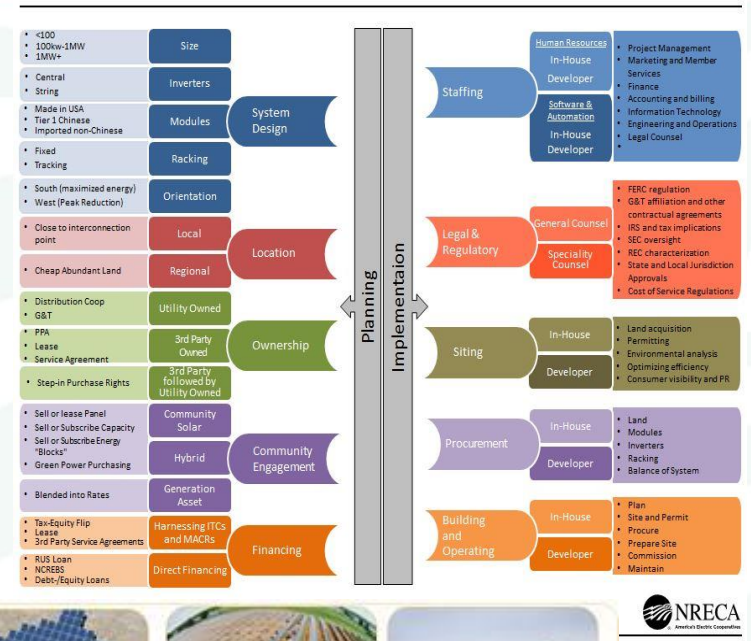
Participating Co-ops

Anza Electric Co-op, CA
Appalachian EMC, TN
Brunswick EMC, NC
CoServ Electric, TX
Eau Claire Energy Co-op, WI
Great River Energy, MN
Green Power EMC, GA
KS Electric Power Co-op, KS
Middle Tennessee EMC, TN
Poudre Valley REA, CO
Sussex Rural Electric Co-op, NJ

For resources, go to nreca.coop/solar

Solar Products

- Getting Started Solar Brochure
- Solar Project Decision Guide
- Solar Project Reference Manuals
- Solar Power Plant Reference Designs
- Online comprehensive training modules
- Financial screening tools
- Community Solar Playbook
- Communicator's toolkit
- Project Manager's quick start



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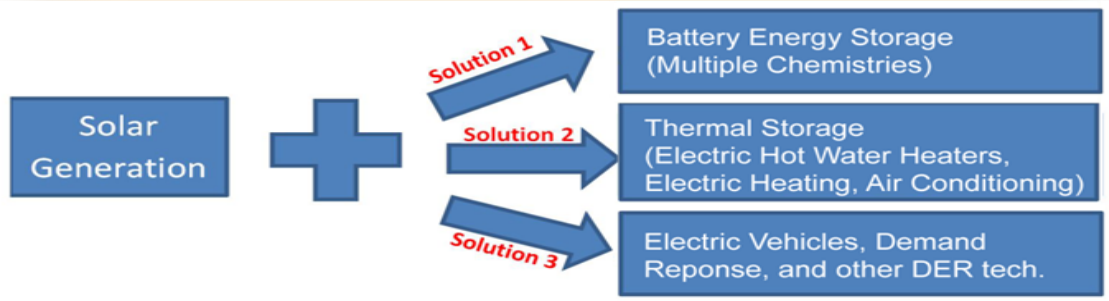
www.NRECA.coop/solar

Solutions for Optimizing DER Technologies

Project Summary

NRECA proposes to create a set of tools and best-practices to help co-ops implement solar plus DER as easily as solar-only systems. NRECA will work with a small team of co-ops to:

- Create a set of analytical planning applications and modeling tools that will calculate the financial and engineering impacts of integrated solar + DER systems.
- Develop and field test extensions to open interoperability standards with wide vendor support to allow simple and effective monitoring and control of consumer systems through integration with existing utility systems.
- Develop reference designs, best practices, and optimal business models derived from field deployments and enable the utility to operate these systems to increase safety, grid reliability, cybersecurity, resilience and affordability.



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Key Personnel/Organizations

Project Team: Jan Ahlen, Venkat Banunarayanan, Paul Carroll, Deb Roepke, Brian Sloboda, Robert Harris

Partner Organizations: NREL, PNNL, Real-Time Inc, A.O. Smith, National Rural Utilities Cooperative Finance Corporation, CoBank

Budget and Timeline

Federal funds: $3,000,000 Cost-share: $750,000 Total: $3,750,000

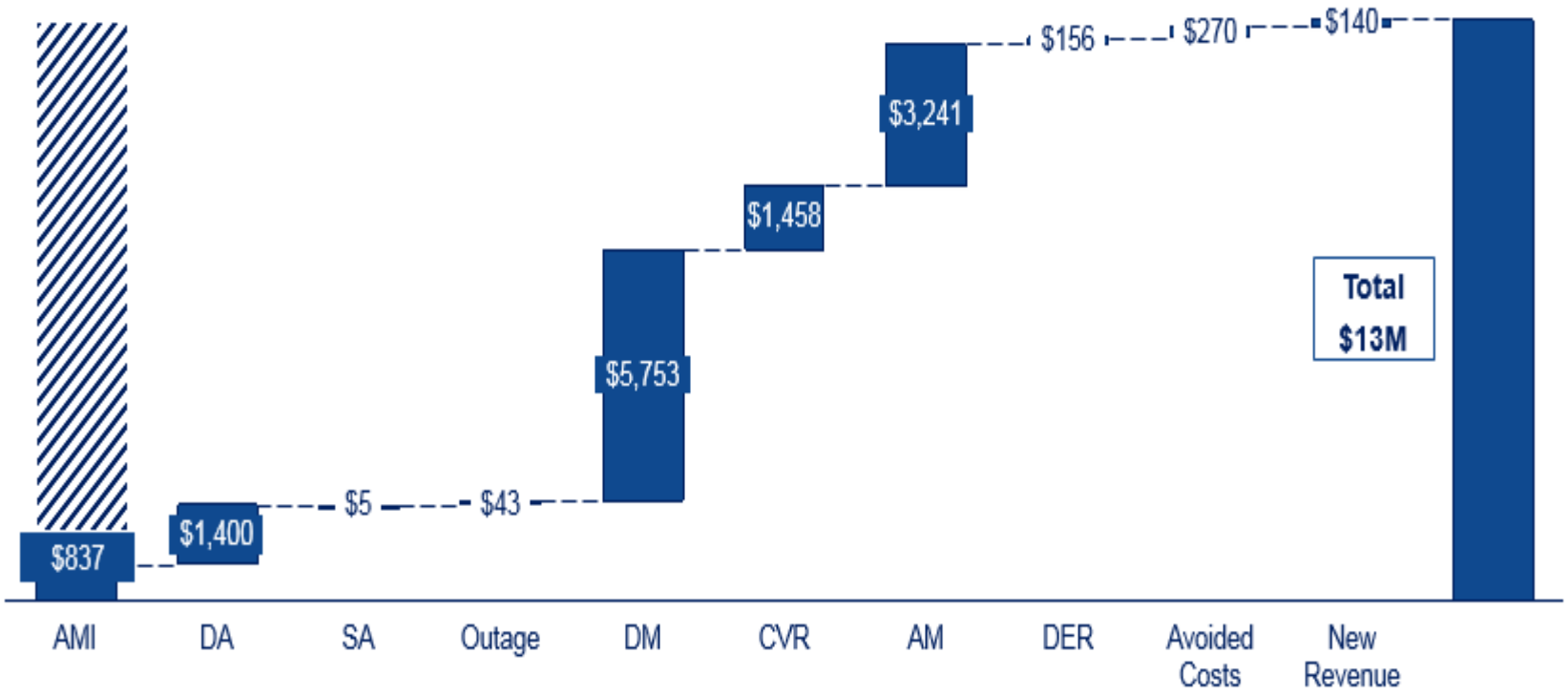
Key Milestones & Deliverables

Year 1:	Enlist at least 8 co-ops. Determine consumer/utility needs, identify value propositions/use cases, create first iteration of analysis tools and reference materials
Year 2:	Phase I field deployments, data collection and analysis, refinement of analytical tools
Year 3:	Phase II field deployments, continued data collection and analysis, evaluation of overall performance of solution sets, and dissemination of tools and results

Project Impact

There are no proven, scalable and sustainable business models making many utilities reluctant to pursue the adoption of solar+X. The project will create the potential for broader solar adoption by developing analytical tools, creating referenceable designs and programs, employing and extending cyber secure interoperability standards & protocols, and engaging co-ops through peer-to-peer learning and dissemination of project results

Optimization value – medium size cooperative



AMI – advanced metering infrastructure
DA – distribution automation
SA – substation automation
Outage - reduction and improved reliability
DM – demand side management
CVR – conservation voltage reduction
AM – asset management (video,drones)
DER/EV - integration
Avoided Cost -Carrier Cost Replacement – Savings from avoiding analogue comm price increases
New Revenue refers to leasing dark fiber

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Energy Storage Pilot Program

- Need for referenceable and credible tools and resources to implement energy storage projects
- Five Pilot Program Reference Packages Planned
    1. **Resilience Microgrids for Resilience and Retail – ongoing at NCEMC**
    2. Behind the Meter
    3. Edge of the Grid (utility-owned)
    4. **Substation T&D support – ongoing at Arizona G&T**
    5. Dispatchable Generators
- Ongoing partnership and scoping discussions
    - DOE, Sandia – National Lab, Vendors – S&C, Sonnen, others….
- **Deliverables**:
    - Microgrid reports available by mid-2018;
    - Other projects in progress by Dec 2018 with interim reports;
    - Final results by 2019 include reference specifications , testing protocols, procurement, commissioning and operating processes etc. for each energy storage application.

NC Electric Cooperatives
Your Touchstone Energy® Cooperatives

Arizona G&T Cooperatives
Touchstone Energy® Cooperatives

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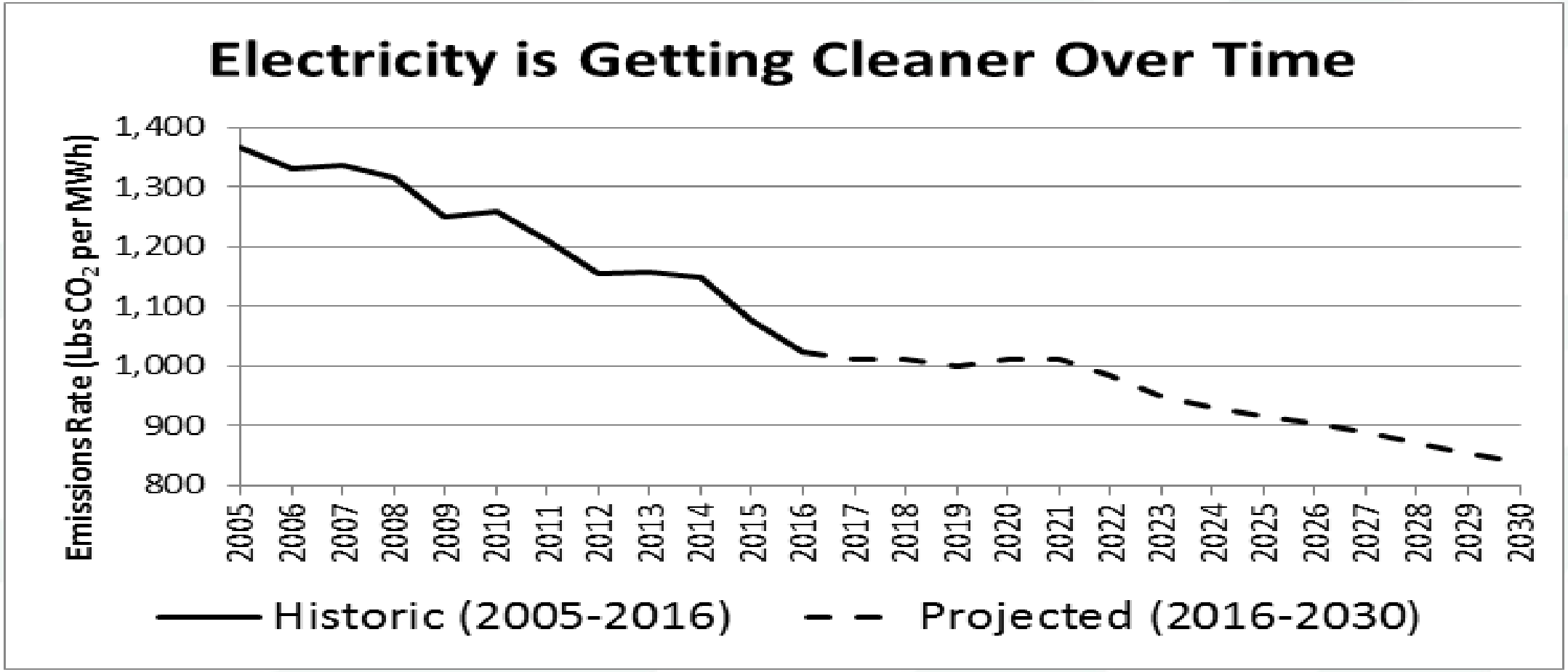
Electricity's Long-Term Strategic Advantage?



Bottom line: Folks who once advocated for less use of electricity are changing their minds

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Resolution:
"Promoting the Benefits of End-Use Electrification"

"We urge NRECA to engage the membership, industry stakeholders, policymakers and regulators on the economic and environmental benefits of electrification….."

Image: Electric rock crushing using electricity in Illinois (Coles-Moultrie) increases co-op load, improves operation, and reduces air pollution

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Example – Dakota Electric School Bus

America's schools spend roughly $2 billion on fuel each year for transportation.

Transitioning to electric-powered school buses could cut these costs in half, down to $1 billion.

Bottom line: We can keep money in local communities and increase co-op revenue

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Sourcing Challenges

- Financial
- Legal
- Time
- Workforce
- Access
- Guidance

Cyber Challenge

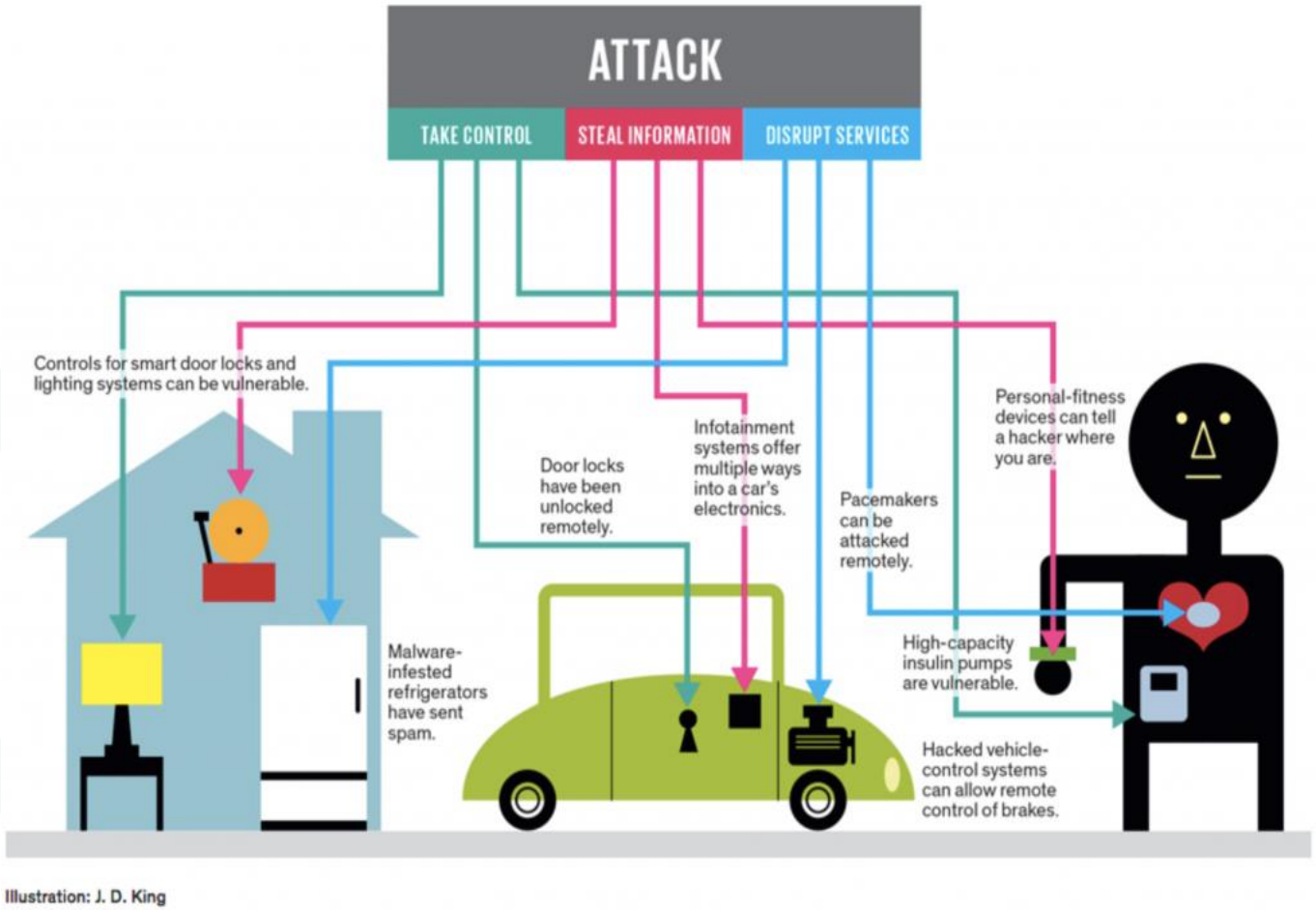
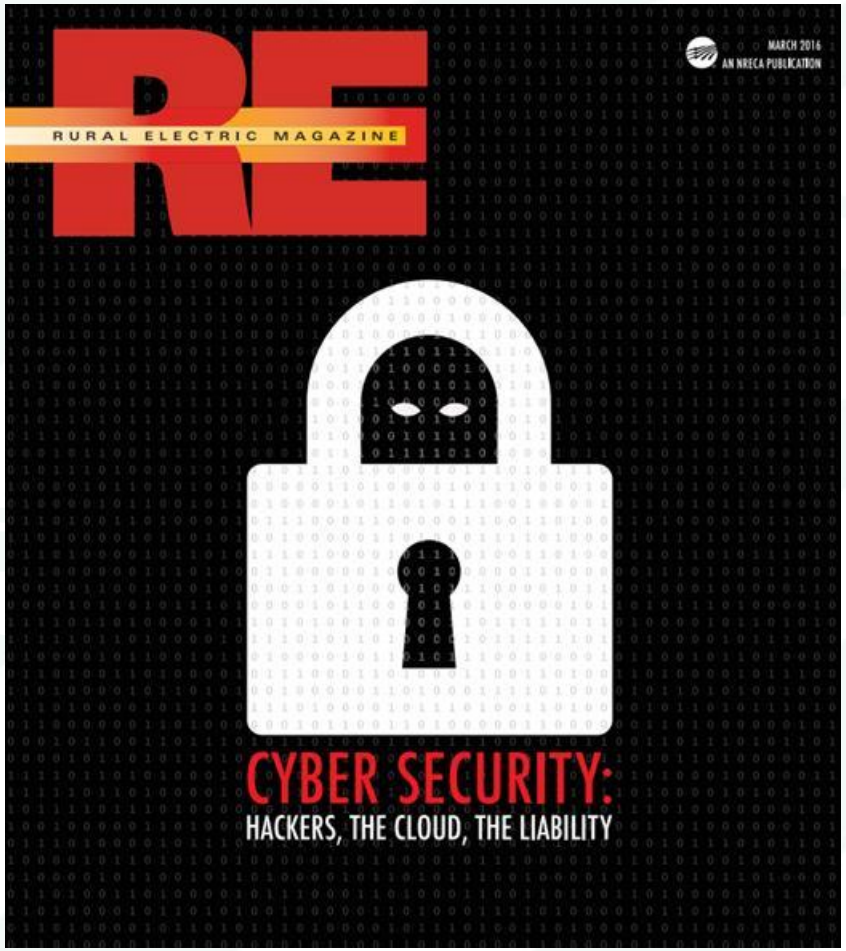


Illustration: J. D. King



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Project: Helping Poultry Operators Extend Equipment Life Reducing Energy Costs

MCEC
Mid-Carolina Electric Cooperative, Inc.
Your Touchstone Energy® Cooperative

Central Electric Power Cooperative, Inc.

Blue Ridge Electric Co-op

Black River Electric Cooperative, Inc.

GridBridge

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A Touchstone Energy® Cooperative

Deploying 5-6 farms, 3 co-ops: *Underway*

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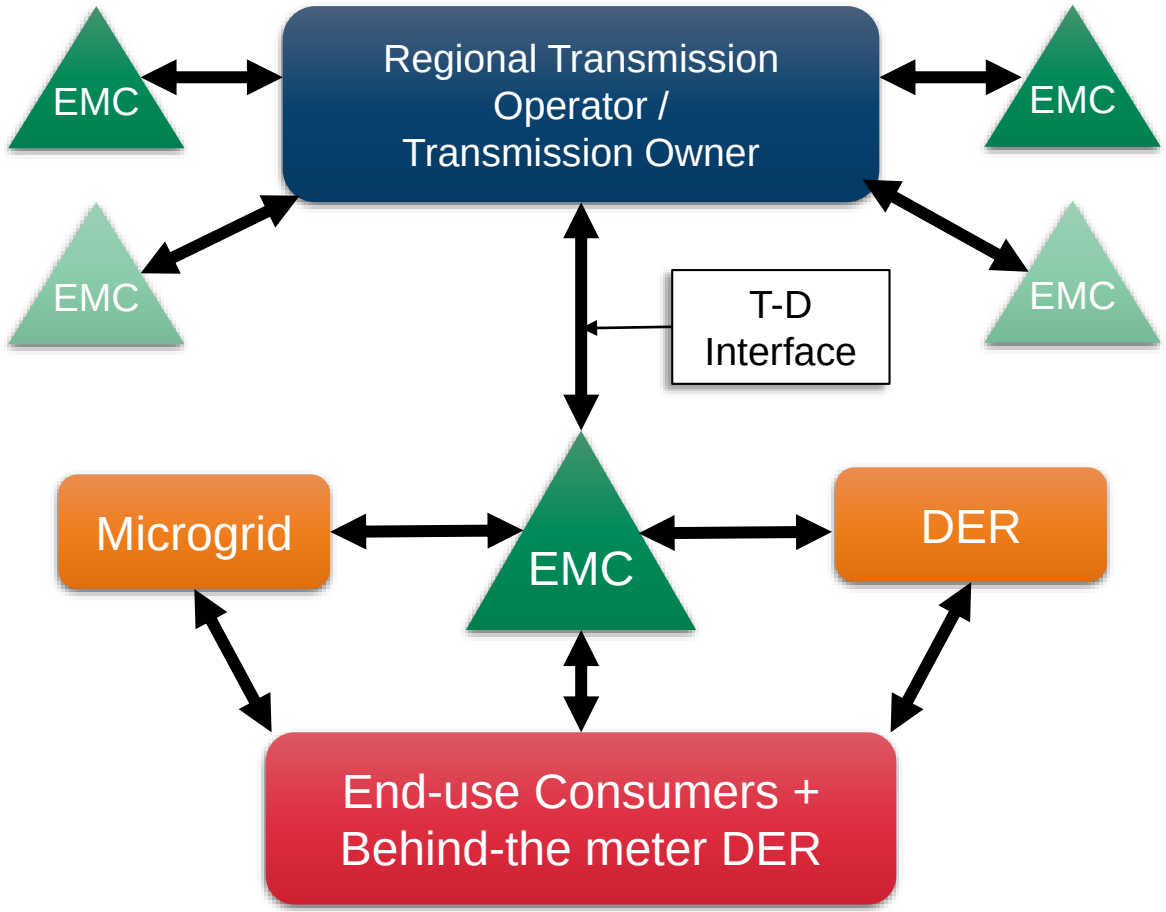
Integrated Coordination



- **Regional Transmission Operator**
  - Market activity of assets
  - Generation, DER or Demand Response
- **Transmission Owner**
  - Provide forecasts
  - Coordinate interconnections in transmission and distribution
  - Impacted by DER utilization
- **EMC (as Distribution Operator)**
  - Manage consumer needs
  - Integrate DER utilization upstream
  - Manage assets for distribution stability and resiliency