Portfolio of

Business and Technology

projects, products, and services

December 2018

NRECA’s Business and Technology Strategies Department provides resources and insights for America’s Electric Cooperatives to support them as they operate, optimize and transform their systems and relationships with consumer members. The work is coordinated through work groups, with collaboration with other NRECA Departments, participating member systems, network partners, Associate Members and other strategic partners. The following is a summary of the Business and Technology Strategies portfolio of projects and activities. Related technical reports, guides, and on-demand webinars are available to members on www.cooperative.com. Links are available for certain materials throughout the portfolio. Please note that only NRECA members will have full access to Cooperative.com.

Note: In May 2018, National Consulting Group (NCG) was reassigned to be part of BTS; future volumes will include appropriate work of the NCG team.

# Distributed Energy Resources Work Group

For more information on this Work Group, please contact: Brian Sloboda at [brian.sloboda@nreca.coop](mailto:brian.sloboda@nreca.coop)

The DER Work Group delivers tools and products that provide guidance to cooperatives as they seek to manage today’s modern utility system. Ensuring grid stability in an era of connected devices is critical. Today’s utility can tap into a variety of tools to increase reliability while minimizing costs. Technologies and techniques such as distributed generation, voltage optimization, demand response, energy storage and energy efficiency are valuable resources. Today these resources need to be viewed as part of a single portfolio. The DER workgroup seeks partnerships with both the public and private sector to introduce new technologies to cooperatives and the members they serve. The DER workgroup will provide the necessary guidance so cooperatives can use the right mix of these and other tools to ensure their mission to provide safe, reliable and cost effective power.

**Projects, Products, and Services**

**Operate**

* *Electrification 2018 Conference*

NRECA was an official supporter of the inaugural Electrification 2018 International Conference & Exposition to be held Aug. 20-23, 2018, in Long Beach, California. This conference offered in-depth examination of the biggest issues and opportunities associated with electrification.

View [additional information](https://www.cooperative.com/programs-services/bts/pages/advisories/nreca-is-official-supporter-of-electrification-2018-conference.aspx).

* *Community Storage Initiative*

NRECA hosted a meeting of the Community Storage Initiative in Arlington, VA, on July 18-19 to discuss beneficial electrification. This meeting – the first day will be for NRECA members only and the second day will bring in a couple of dozen of stakeholder experts working on the issue of beneficial electrification for a forum discussion. The guests confirmed for the second day include Edison Electric Institute, American Public Power Association, Natural Resources Defense Council, National Renewable Energy Lab, Electric Power Research Institute. View [additional information](https://www.cooperative.com/conferences-education/meetings/Beneficial-Electrification/Pages/default.aspx).

* *Community PV Webinar Series*

This series of online webinars is offered to help cooperatives address and evaluate community solar options. Topics include how to communicate with your members about solar, cooperative experiences with community solar, and tools available for cooperatives considering solar. View webinar series.

Status: Final

* *Cooperative Utility PV Field Manual*

NRECA’s Cooperative Utility PV Field Manual is a three volume series designed to support electric cooperatives as they explore and pursue utility-scale solar PV deployments. The SUNDA products and lessons learned for evaluation, implementation and operation of utility scale solar PV are discussed in detail:

* Volume I: Business Models and Financing Options
* Volume II: Planning, Design, Installation/Interconnection, and Commissioning
* Volume III: Operations, Maintenance, and Monitoring

Status: Final

* *Smart Thermostats for Demand Response Programs*Advancements in thermostat technology have introduced connected and smart thermostats into the broader consumer electronics market and led more utilities to consider using these technologies for DR programs. Electric cooperatives are using smart thermostats to provide cost-management options to individual members to increase their satisfaction and engagement, while also giving the cooperative tools to manage the operation of the distribution grid, defer distribution investment, avoid purchasing energy during high-cost periods, and reduce wholesale demand charges.   
  Status: Final
* *Utility Connected Home Demonstration*

The utility connected home empowers the homes occupants to save money, energy and maintain comfort while work in cooperation with their utility. BTS has partnered with Pacific Northwest National Lab to demonstrate this concept at a small group of co-ops. Lessons learned from the pilot will help to shape future programs and consumer technology offerings.

Status: In Pipeline

* *End Use / Energy Efficiency Data Analysis and Mapping*

NRECA conducts data and reporting analysis, including EIA data, along with updates of demographic information.  An updated energy efficiency map is in development and will be made available on Cooperative.com to demonstrate the extensive activity by co-ops in this technology area.

Status: In Pipeline

* *Cooperative PV Cost and Finance Screening Tool*

This tool was created by NRECA under the SUNDA DOE grant project to help co-ops quickly estimate the cost of a solar project in their territory and the expected output and levelized cost of energy based on common financing options.  This spreadsheet-based tool is frequently updated with the latest pricing on panels, inverters and ancillary costs and can be modified and refined to create highly accurate forecasts of the project finances.  The spreadsheet is available for download in the [SUNDA Tools and Resources](https://www.cooperative.com/programs-services/bts/sunda-solar/Pages/default.aspx) section.

Status: Final

* *Energy Storage Lexicon*

Provides a set of standard terms, specifications, and definitions around energy storage.

Status: Final

* *Solar Case Studies*

Eight case studies illustrate some of the innovative ways cooperatives are satisfying member-consumers’ demand for solar-derived electricity. View [Tools and Resources](https://www.cooperative.com/programs-services/bts/sunda-solar/Pages/default.aspx).

Status: Final

* *Energy Storage Case Studies*

Case studies illustrate some of the innovative ways cooperatives can use energy storage for peak shaving in demand-side management, the deferral of transmission and distribution assets, etc.

Status: Final

**Optimize**

* *Design Thinking Program Design*

BTS has partnered with E Source , Poudre Valley Electric Cooperative and United Power Cooperative to test the concept of applying design thinking to co-op programs and services. The Design Thinking program will introduce to the electric utility sector the same sort of consumer- focused program design used by industries such as consumer electronics, automotive and banking. By doing this, electric utilities should be able to introduce programs and services that not only benefit the grid but also benefit the person.

Status: In Pipeline

* *Community Solar Playbook*

Developed from experienced cooperatives and solar developers, the playbook provides practical step-by-step guidance for planning and executing a community solar program. Split up into five modules, each focuses on the actions required from a particular division of a cooperative utility in order to establish a community solar program and includes “Planning and Execution Checklists”, “Key Templates”, “Information on critical concerns”, and a lists and contact information for additional resources. View the [Tools and Resources](https://www.cooperative.com/programs-services/bts/sunda-solar/Pages/default.aspx).

Status: Final

* *Internet of Things (IoT) Applications for Grid Operations*

Now is the time to engage in short-term and long-term planning for the incorporation for a wider array of IoT devices into the co-op’s DSM portfolio. A piecemeal reactionary approach will be costly to the utility, confusing to the consumer and provide opportunities for non-co-op entities to provide services to co-op members. This project will separate hype from the reality of how IoT devices can improve grid operations and focus on those benefits that are of a technical grid nature. This will include functions such as power quality management, peak management, frequency regulation and response to market conditions.

Status: Final

* *Cooperatives and Renewable Resources Map*

NRECA provides a summary and interactive map of renewable resources owned and purchased by G&Ts and distribution cooperatives.

Status: Final

* *Solar Utility Network Deployment Acceleration (SUNDA)*

This project is to enhance the ability of co-ops to design, deploy, and operate utility-scale, utility-owned solar PV systems at their facilities. Funded in part by the Department of Energy (DOE), the project team developed a package that includes business models that work for co-ops, standardized engineering designs, negotiated pricing on equipment, a cost and financial screening tool, a communications toolkit, and training. Co-op project partners installed more than 20 MW of utility-scale, utility-owned solar PV. Typical projects range in size from 250 kW to 5 MW. Program partners include: National Rural Utilities Cooperative Finance Corporation (CFC), National Renewable Cooperative Organization (NRCO), Federated Rural Electric Insurance Exchange, CoBank, PowerSecure Solar, and 14 co-ops. The project was conducted from September 2013 through early 2018.

Status: Final

* *Water Heater-Thermal Storage Support and Research*

NRECA provides continued research and reporting on standards and technology changes affecting water heaters as thermal storage.  A Community Storage Initiative and Interest Group of approximately 100 members has formed and provides a forum for updates and dialogue.  Efforts include multi-stakeholder engagement, including co-ops, industry experts, vendors, and others.

Status: In Pipeline

**Transform**

* *Beneficial Electrification Concept Development*

For decades, policymakers have viewed appliances that are fueled “on-site,” for example, natural gas-powered or propane-fired water heaters, as environmentally preferable to electric appliances that rely on electricity generated at an off-site “source,” such as at a coal or natural gas power plant.

[Environmentally Beneficial Electrification: Electricity as the End-Use Option](https://www.cooperative.com/programs-services/bts/Documents/EnvironmentallyBeneficialElectrificationElectricityJournal.pdf)

Status: Final

* *Beneficial Electrification for C&I Case Studies*

Electrifying industrial and commercial processes is a proven method to help local businesses stay competitive. Beneficial electrification strengthens the cooperative presence in the community and offers benefits to the electric system. Working with C&I customers is a good place to start. To provide examples of various approaches to working with C&I customers on beneficial electrification initiatives, NRECA offers a series of case studies. Case studies include:

* Forklifts
* Rock Crushing Equipment
* Cooking Equipment
* Irrigation Systems
* Space Heating in Schools
* Dairy Water Heating
* Natural Gas Pipeline Compressor Stations  
  Link to [Beneficial Electrification C&I Case Studies](https://www.cooperative.com/programs-services/bts/pages/techsurveillance/beneficial-electrification-ci-case-studies.aspx)   
  Status: In Pipeline
* *Energy Storage Pilot*

Co-ops’ experiences with battery technology report that batteries are an immensely complex technology in utility applications. Therefore, there is a significant benefit for co-ops to test out and gain experience with this technology today in order to be prepared to invest in this rapidly evolving technology and shape its progress. This project will create a series of Reference Battery Pilot Program templates that will provide reference designs for battery systems that include all sensory, communications, and controls. They also will cover various testing protocols and guidance on interpreting data. NRECA will provide opportunities to take part in low risk, high value testing as well as opportunities to share results and experiences with co-ops across the nation.

Status: In Pipeline

* *SEEDs II*

The impact of small, distributed, variable generators can create a number of power quality issues when they are heavily concentrated. This project will identify key metrics that can predict the adoption of DER technologies within a service area. NRECA has teamed up with Virginia Tech for DOE-funded project.

Status: In Pipeline

* *Electric Vehicles Planning Guide:  Data Driven Method for Co-op EV*

This guide is a three-part article series exploring the electric vehicle market trends, impacts to the distribution system, and advice on developing an Electric Vehicle (EV) program, particularly as such supports beneficial electrification strategies.

Status: Final

* *Smart Appliance Communication Pilot*

NRECA is testing the ease of deployment, consumer acceptance, and effectiveness of products with CTA 2045, a new appliance standard interface and communications protocol. The goal of the standard is to support off-the-shelf residential devices that are compatible with many demand response systems and programs.

Status: Final

* *Energy Storage Toolkit*

This project provides complementary tools to the Energy Storage Handbook to help cooperatives identify and screen energy storage technology applications. The project provides cooperative-specific guidance for producing effective Request For Proposals (RFPs) by way of spec sheets and an online training course. The Financial Screening for Energy Storage provides a structure for calculating the financial benefits of energy storage for 17 different applications.

Status: Final

* *DOE/EPRI 2013 Electricity Storage Handbook (ESHB) in Collaboration with NRECA*

The Electricity Storage Handbook is a how-to guide for utility and rural cooperative staff to plan and implement energy storage projects. The Handbook was jointly sponsored by the DOE, EPRI and NRECA. The ESHB is currently being updated by DOE Sandia National Labs (SNL), EPRI, and NRECA with NRECA contributing a new section on thermal energy storage (using the dynamic dispatch of distributed hot water heaters not only demand-side management but also for spinning reserve, frequency regulation and other value-add services).

Status: In Pipeline

* *Solar PV – Getting Started: A Governance Quick Guide*

This brochure outlines steps for evaluating and implementing a utility solar program and highlights critical information and tools. It provides a framework for board members to develop a [PV policy](https://www.cooperative.com/programs-services/bts/sunda-solar/Pages/default.aspx).

Status: Final

* *Strategic Options for Integrating Emerging Technologies and Distributed Energy Interest (SOIG)*

Centre for Energy Advancement through Technological Innovation (CEATI) is a collaborative organization with over 120 participating electric and gas utilities, governmental agencies and provincial and state research bodies. NRECA in 2017 entered into a new three year agreement with CEATI that provides cooperatives with expanded access to the research from nine CEATI utility research consortia. In addition to facilitating information exchange through topic-driven interest groups and industry conferences, CEATI International brings partners together to collaborate on technical projects with a strong practical focus, and develops customized software and training solutions to fit the participants’ needs. NRECA is a member of the SOIG group, through which collaborative research provides information on renewables, diesel alternatives, energy storage, Greenhouse Gas Mitigation, distributed generation, and combined heat power.

Status: In Pipeline (ongoing partnership)

* *TechSurveillance and Advisories*

NRECA’s TechSurveillance provides research and reporting on technology and market issues pertinent to cooperatives, in line with the Work Group research efforts. NRECA also produces frequent Technology and Member Advisories, focused on newsworthy events and issues which have business and technology impacts on cooperatives business operations. See last page of this Portfolio summary for recent articles and advisories.

**Regional Centers Initiative Projects**

* *Voltage Optimization Demonstration*In partnership with Central Electric Power Cooperative (SC), Mid-Carolina Electric Cooperative, Blue Ridge Electric Cooperative, Black River Electric Cooperative and ERMCO we are demonstrating the capabilities of ERMCO’s TIGER (Transformer Integrated GridBridge Energy Router) unit at several poultry houses. The demonstration will run until the 3rd quarter of 2018. Preliminary results have shown an improvement in power quality and the ability to precisely control voltage. This has allowed the cooperatives to utilize the voltage optimization function in the peak reduction program.

Status: Final

* *NCEMC - Customer (C&I - Butler Farms) Microgrid*

The overall goals of this project were to understand the impacts and opportunities of integrating utility dispatch batteries and consumer owned solar on the distribution grid. Secondary goal included supporting the member-consumer’s sustainability goals and providing standby power. These projects benefit the G&T, the distribution co-op and the end use consumers by improving reliability and saving money through improved grid optimization.

Status: Final

* *NCEMC - Ocracoke Island Utility Operated Microgrid (Outer Banks, NC)*

The overall goals of this project were to understand the impacts and opportunities of integrating utility dispatch batteries and consumer owned solar on the distribution grid. Secondary goals include improving reliability and service to the island’s residents during and after storm events. This project was the launch pad for the Energy Storage Pilot Program and established the first two of five planned energy storage pilot project reference design packages for future cooperatives to implement and share experiences.

Status: Final

* *Planning for Distributed Energy Resources on the Bulk Power System*

The goal of this collaboration is to assist in understanding the impact of Distributed Energy Resources (DER) on bulk power systems through accurate modeling and studying tradeoffs between improving transmission infrastructure and central generation supply vs distributed generation. The project is being performed at Great River Energy, in collaboration with their distribution co-ops. Phase 1 using the EPRI DRIVE feeder hosting capacity model, is complete. In a succeeding phase, the Open Modeling Framework tool is intended to be used for dynamic distribution grid analyses, and more distributed resources such as conservation energy efficiency programs, proposed community storage and community solar initiatives, will be incorporated into integrated resource planning.

Status: Ongoing

* *Beneficial Electrification Dual Fuel Heating Systems*

Mountain Parks Electric Cooperative in Colorado has identified an opportunity to lower member’s overall energy bills by deploying mini split heat pumps to be used in shoulder months. When outdoor air temperatures dip below the capabilities of the mini-splits, the home’s propane furnace would be used. A field demonstration is planned for the winter of 2018-2019 where the co-ops and BTS will new control systems that would allow the two units to work together.

Status: Ongoing

* *Design Thinking*

Design thinking is a three year project exploring how co-ops can enhance their position as the trusted energy provider. The concept focuses on consumer attitudes and emotions and how utility programs can improve the quality of like. In the first year NRECA worked with Poudre Valley Electric Association (CO) focusing on residential programs. In 2018 NRECA United Power (CO) exploring the needs of small commercial members and how to better serve them.

Status: Ongoing

* *Microgrid Deployment at Anza Electric Co-op, California*

The overall goals of this project are to understand the applications of energy storage and microgrid for grid resilience and transmission investment deferral. This project is also part of the Energy Storage Pilot program and is being done by AEPCO (the G&T for Anza) in collaboration with Anza and with technical assistance from Sandia national labs. This is a first of a kind project with specific field deployment assistance from a DOE-National Laboratory, and will serve as a test bed for future such partnerships. This project also serves to illustrate the collaborative and mutually beneficial G&T – Distribution cooperative partnership. Deliverables from this project for the larger cooperative community will include reference design and value assessment packages, lessons learned on design, installation and operation of energy storage and the microgrid.

Status: Ongoing

* *Microgrid Enhancement at Cordova Electric Co-op, Alaska*

The overall goals of this project are to enhance the resilience of the existing microgrid and Cordova through energy storage and hardening of other existing grid infrastructure. This project is also part of the Energy Storage Pilot program and is being performed with funding and technical assistance from the Department of Energy and Sandia, Idaho, Pacific Northwest and Lawrence Berkeley National Labs. Deliverables from this project for the larger cooperative community will include reference design and value assessment packages for energy storage, cybersecurity assessment templates, lessons learned on design, installation and operation of energy storage and the microgrid.

Status: Ongoing

# Transmission and Distribution Work Group

For more information on this Work Group, please contact: Robert Harris at [robert.harris@nreca.coop](mailto:robert.harris@nreca.coop)

Extending the useful life of existing infrastructure, maintaining system reliability, improving power quality, and leveraging advanced technologies pose increasing challenges for all cooperatives as the distribution system optimizers. Through the years, co-ops have shown a talent for cost-effective improvements and practical solutions to these current problems. These are the areas of focus for the T&D Work Group, which brings together co-op engineers who provide direct support to RUS’ engineering and standards efforts for the benefit of all co-ops. This Work Group supports and influences other key standards bodies, such as the National Electrical Safety Code (NESC) and IEEE. It also produces research in collaboration with industry partners, such as the Electric Power Research Institute (EPRI), CEATI, PSERC and national laboratories.

**Projects, Products and Services**

**Operate**

* *Avian Issues*

NRECA continues to encourage its members to develop and implement Avian Protection Plans (APPs) through various outreach opportunities. Though voluntary, these plans are necessary to meet the obligations of several federal regulations/laws associated with the protection of many avian species. NRECA and several cooperatives are members of the Avian Power Line Interaction Committee (APLIC) which provides a collaborative industry voice to address avian issues.  
Status: In Pipeline

* *Mitigation of the Negative Impacts of Solar and Wind DG Connections in Distribution Systems*

This report presents a detailed overview of the major issues caused by high penetration levels of Distributed Energy Resources (DER) based on an extensive literature search. Mitigation techniques which can be added to the distribution system as well as with smart inverter functions are explored.

Status: Final

* *Best Practices for Copper Theft Deterrence*

This report summarizes industry best practices to deter copper theft. It includes economic, reliability-related, and other consequences of copper theft on utility systems. The report also identifies several countermeasures available and implemented by utilities for theft deterrence.   
Status: Final

* *Design Guide for Anti-Cascading Structures*

The objective of this investigation is to develop a guide for the design of anti-cascading structures to be placed at recommended intervals in the straight sections of transmission lines to minimize damages due to cascading failure of structures during extreme events.  
Status: Final

* *Distribution Line Asset Management*

NRECA in 2017 entered into a new three year agreement with CEATI that provides cooperatives with expanded access to the research from nine CEATI utility research consortia. NRECA has membership in the DLAM group (formerly DALCM). This group provides collaborative research and technical information for asset management, optimization, cost reduction and life extension for existing distribution lines and equipment, while improving safety and looking at emerging challenges and opportunities.   
Status: In Pipeline

* *DSTAR Membership*DSTAR is a group of nine electric utilities that are committed to researching methods to increase reliability and lower cost of service. As a longtime member of DSTAR, NRECA is positioned in a leadership role within the organization.   
  Status: In Pipeline
  + *DSTAR eHandbook*Distribution engineers and technicians frequently use several hard-copy handbooks to find vital engineering information or refer to tables to obtain simple calculated values. Some of the data handbooks still being used today have not been updated in years and may contain obsolete data. Finding the appropriate information this way can be time consuming. A searchable, interactive electronic handbook that compiles several different handbooks and data sources could reduce the amount of time engineers have to spend looking through reference materials so they can focus on solving problems, which is the goal of this project.  
    Status: Ideation
* *Prevention, Assessment and Remediation of Corrosion in Weathering Steel Transmission Line Structures*

This report offers the means to practically understand the combined impact of the environmental corrosivity parameters examined, together with other factors influencing corrosion behavior (e.g., design and detailing). In particular, it demonstrates how the results of field inspections and measurements, and laboratory characterization tests, can be used to understand present and future susceptibility to corrosion damage.

Status: Final

* *Station Equipment Failure Rates*

This project was initiated to identify the failure rates used by utilities for station equipment.  It examines the failure rate values of 15 surveyed CEATI member utilities on up to 20 various types of electrical apparatus. Several of these equipment types are further broken down into age groups in which relative failure rates are identified.

Status: Final

* *Guide for Fire Protection of Transmission Lines*

The scope of this guide is the review of incidents of brush fires near transmission lines, review the conditions and causes of such fires to provide guidance and a methodology to utilities in forecasting fires near or under transmission lines and steps that can be taken to minimize the risk.  
Status: Final

* + *Corrosion Assessment for Steel Tubular Poles*

This study was initiated from the interest of cooperatives and evaluates the effectiveness of two commercially available non-destructive evaluation (NDE) technologies in detecting and providing an accurate assessment of below-ground corrosion in tubular galvanized steel poles. The methodology relied on blind field tests on selected poles, followed by excavation for visual inspection and thickness loss measurements.

Status: Final

* *T&D Vegetation Management Program*NRECA in 2017 entered into a new three year agreement with CEATI that provides cooperatives with expanded access to the research from nine CEATI utility research consortia. The Vegetation Management Program brings together industry professionals to discuss and develop solutions on common industry vegetation issues, create networking opportunities for vegetation managers, make improvements in the management of vegetation, and assist in the development of improved planning techniques, regulatory filings and sustainable planning. It serves as a forum to identify knowledge gaps and to provide future research and study to address these gaps.

Status: In Pipeline

* *Impulse Testing of Electronic Controllers*

DSTAR in conjunction with NRECA evaluated the performance of capacitor controller installations to lightning strikes for different pole installations.  
Status: Final

* *RUS Specifications and Drawings for Underground Electric Distribution*NRECA worked with the Underground Subcommittee of the Transmission & Distribution Engineering Committee to update the 2000 version RUS Underground Specification Manual. A draft of the manual and numbering system was presented at TechAdvantage 2016. Further review took place at the IEEE Rural Electric Power Conference in May and the draft was posted to Cooperative.com for review and comment by co-op engineers. Final review to ensure compatibility with RUS publishing guidelines took place last winter and the Subcommittee submitted the completed draft to RUS for their processing and final acceptance spring 2017.  
  Status: Final, for TDEC, RUS Review Scheduled
* *Substation Design Manual*

NRECA is working with the Transmission & Distribution Engineering Substation Subcommittee to update existing RUS Bulletin 1724E-300 - Substation Design Manual. A majority of the technical work is being completed by NRECA members. A consultant was secured to complete sections associated with topics that are not the expertise of the subcommittee members and a technical writer is formatting the document to adhere to RUS requirements.   
Status: In Pipeline

* *Online Monitoring Equipment for Substation Apparatus*

An investigation into the state of the art in substation equipment monitoring devices and approaches to data collection and analysis to advance substation operations efficiency and maintenance practices.  
Status: Final

* *Specification Guide for Medium & High Voltage Disconnect and Ground Switches*

This project documents a quality process for developing specifications for medium and high voltage disconnect and ground switches.  The key objectives of the project were to develop and document technical specifications for high voltage disconnect and ground switches in the form of a guide documenting the processes and key sections of specification documentation.

Status: Final

* *Station Battery System Maintenance and Condition Monitoring*

The objective of this report is to ensure compliance with North American Electric Reliability Corporation’s (NERC) Protection and Control (PRC) requirements for DC supply. NERC (Board of Trustees Approved Definition) identifies the Protection System Station DC supply associated with protective functions (including station batteries, battery chargers, and non-battery-based DC supply) as one of the five specific elements of the Protection System.  
Status: Final

* *State of the Art Review of Mobile Substations*

This project will investigate and provide details of the characteristics and possible suitable applications for the many alternative designs and arrangements for mobile substation equipment presently on the market.  This information should be gathered from known users and manufacturers of this equipment and will serve as a technical reference for utility planners and maintenance personnel when arranging for future work, identifying available alternatives and also requirements for use and upkeep of these units.

Status: In Pipeline

* *Transmission Overhead Design and Extreme Event Mitigation*NRECA in 2017 entered into a new three year agreement with CEATI that provides cooperatives with expanded access to the research from nine CEATI utility research consortia. NRECA participates in the Transmission Overhead Design and Extreme Event Mitigation Interest Group. This group provides collaborative research and technical information on modern and efficient line design, construction and maintenance, methods to reduce the impacts of extreme weather conditions, and other reliability/resiliency issues associated with transmission construction, ownership and operation.   
  Status: In Pipeline

**Optimize**

* *DOE Energy Efficiency Specification for Distribution Transformers- RFI*

In September 2017 DOE issued a Request for Information (RFI) regarding different Per-Unit Levels (PUL) for distribution transformer testing and efficiency evaluation. We have talked with APPA and EEI about possible motives for the request and responses. This could be a reaction to information we provided EPA last year on their proposed Energy Star program for distribution transformers in which we proposed the use of Total Ownership Cost (TOC) methods (see below). Regardless, NRECA plans to submit comments as requested and stay engaged.

Status: Ideation

* *EPA Energy Star Specifications for Distribution Transformers*

EPA began working on an updated Energy Star specification for distribution transformers early in 2015. NRECA has been participating in conference calls and meetings with Energy Star staff and other interested parties to influence the process and lay the groundwork for an Energy Star specification which may be helpful with future revisions of the DOE Distribution Transformer specification. Efforts have focused on flexibility with load factors and use of TOC processes. The effort appeared to be shelved indefinitely, but we received a draft of an updated Buyer’s Guide recently which appears to incorporate many of our suggestions. NRECA published a [Technology Advisory](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-Transformer-Efficiency-Standards-May-2018.pdf) summarizing this effort and result.

Status: Final

* *Station Equipment Asset Management*

NRECA in 2017 entered into a new three year agreement with CEATI that provides cooperatives with expanded access to the research from nine CEATI utility research consortia. The “Substation of the Future” concept initiated at NRECA and proposed to CEATI is now a major focus of this interest group. This objective of the group is to optimize the station equipment management to improve performance, reliability and availability of equipment, and to reduce O&M costs through collaborative research on station equipment, methods procedures and practices.  Specific interests include substation modernization, current trends in design and future prospective.  
Status: In Pipeline

* *Performance and Diagnostic Center – A Center of Excellence*NRECA is developing requirements and preparing a roadmap for successful implementation of a demonstration Performance and Diagnostics center at the host G&T, Georgia Transmission. The Center will focus on data collection and equipment monitoring to enable critical information assessment and decision making at cooperatives that will improve reliability and support rapid system restoration. The project is a collaborative undertaking among interested participants, including members of the CEATI Substation Interest Group.   
  Status: In Pipeline
* *Review of Non-Ceramic Insulator Standards, Manufacturer Practices and Design Information*

This report contains a user survey, literature review and parametric study to investigate the differences, discrepancies and difficulties associated with using manufacturers' design data to select and analyze non-ceramic insulators.

Status: Final

* *Substation Resiliency Assessment, Design Improvement Considerations and Restoration Planning for Non-Utility Triggered Events*Of similar emphasis to the *Substation of the Future,* this investigation by NRECA considers design practices that will enhance substation operations and continuity of services through modifications and proactive efforts to thwart the impacts of environmental or third-party events.   
  Status: Final

**Transform**

* *IEEE 1547: Standard for Interconnection of DER*This effort to completely overhaul the original standard from 2003 began in late 2013. NRECA has been an active participant in most of the meetings to represent co-op interests and keep them informed of developments. In 2017, ahead of the ballot, NRECA published four TechSurveillance articles reviewing proposed changes and possible impacts to cooperative systems which E&O personnel needed to be aware of. Several co-ops joined the ballot and our collective comments influenced the final standard, which was published in April of this year.

Status: In Pipeline

* *State of the Art Review of Mobile Substations*

This project will investigate and provide details of the characteristics and possible suitable applications for the many alternative designs and arrangements for mobile substation equipment presently on the market.  This information should be gathered from known users and manufacturers of this equipment and will serve as a technical reference for utility planners and maintenance personnel when arranging for future work, identifying available alternatives and also requirements for use and upkeep of these units.

Status: In Pipeline

* *Design Guide for Station EMI Protection*

The objective of the investigation is to deliver an EMI immunity design guide for substations incorporating up-to-date standards, guidelines and technology. In order to ensure reliable and cost-effective substation facilities, a comprehensive design strategy must be established to ensure that all the key issues for the substation electromagnetic compatibility design process are properly identified and formally documented. This will provide supplemental information for the substation design guide.

Status: In Pipeline

* *Unmanned Aerial Systems Demonstration*BTS staff worked with Oak Ridge National Laboratory to create an operations guide for the electric utility industry. We have also published several case studies on cooperative.com and are actively working with the vendor community of software and control advancements.  
  Status: Final
* *Guidelines for Compact Line Design*

In association with an industry consortium, NRECA is investigating the opportunities and options available for advanced transmission line design techniques and approaches to improve right-of-way utilization. The compact designs will increase transmission capacity while providing aesthetic improvements and enhanced public acceptance of transmission. The objective of this project is to develop practical guidelines for innovative design in HV line compaction for both new and existing lines.  
Status: In Pipeline

* *Electric Distribution System Operations Training*

Working with a vendor to provide cooperatives access to computer based training (CBT) modules focused on electric Distribution System Operations including the challenges associated with the integration of a renewable energy portfolio. This self-paced CBT material includes visual and text descriptions of basic electric grid characteristics, devices, technology and components such as a substations, aerial/underground conductors, transformers, overcurrent devices, etc. Status: Training is available to members

* *Grid Scale Energy Storage Implementation and Applications at Substations*

This research involves storage options available for use within utility substations, evaluating the practical applications and benefits of substation-based energy storage. Consideration is being made of the implications and impact of this technology, and of the best practices to incorporate and accommodate storage solutions.   
Status: In Pipeline

* *TechSurveillance and Advisories*

NRECA’s TechSurveillance provides research and reporting on technology and market issues pertinent to cooperatives, in line with the Work Group research efforts. NRECA also produces frequent Technology and Member Advisories, focused on newsworthy events and issues which have business and technology impacts on cooperatives business operations. See last page of this Portfolio summary for recent articles and advisories.

# Generation, Environment, and Carbon Work Group

For more information on this Work Group, please contact: Dan Walsh at [daniel.walsh@nreca.coop](mailto:daniel.walsh@nreca.coop)

The GECO2 Work Group provides resources and tools that prepare co-ops for the future and help keep existing generation assets viable in the face of current and future market and regulation impacts. The work group is focused on ensuring cost-effective, reliable, and environmentally compliant power supply for electric cooperatives. This is done through the collection of data, information, monitoring of technologies, and research that reduce costs and maintain or improve reliability, while minimizing environmental impact of existing assets. The data collected and ensuing research is meant to support members of the electric co-op community on issues related to fossil and nuclear generation and fuels; utility scale wind energy and large utility scale storage systems including pumped hydro, batteries, liquid air storage systems and flywheels;, environmental compliance; and carbon mitigation, capture, sequestration, and utilization.

**Projects, Products and Services**

**Operate**

* *Damage to Combined Cycle Gas Turbines ( CCGTs) due to Cyclic Operation*

This technical review evaluated equipment and material damage caused by power plant cycling (cyclic operations, e.g., two shift operation) of CCGTs to meet market and operational requirements resulting in increased thermal cycle fatigue failures caused by increased penetration of renewables or reduced system loads. The project has identified measures to mitigate the impacts of cyclic operation.  
Status: Final

* *Damage to Coal Fired Power Plants due to Cyclic Operation and Guidelines For Best Practices*

This technical review evaluated cycling and two shift operation of coal-fired power plants, based upon experience from Europe as well as the U.S., caused by increased penetration of renewables or reduced system loads that result in increased operation and maintenance costs of millions of dollars a year while increasing forced outage rates by 15 percent to 25 percent or more. The [report](https://www.cooperative.com/interest-areas/generation/aregc/documents/dalebradshaw060611pm.pdf) also indicated measures to mitigate the impacts of cyclic operation.   
Status: Final

* *Impact of Cycling/Two Shift Damage on the O&M Cost and Reliability of Natural Gas – Fired Combined Cycle (NGCC) Power Plants*

This technical review evaluated the impact on economics and reliability of cycling and two shift operation of NGCCs, based upon experience from Europe as well as the U.S., caused by increased penetration of renewables or reduced system loads that result in increased operation and maintenance costs of millions of dollars a year while increasing forced outage rates by 5 percent or more as a function of the number of hot, warm, and cold startups.   
Status: Final

* *Reliability and Performance Issues with Combustion Turbines*

NRECA is identifying issues with the operation of natural gas and or oil-fired simple cycle and combined cycle combustion turbines and providing information on ways to address reliability and performance problems. The scope of this project is to perform a detailed evaluation of the technical factors and issues that impact the performance of combustion turbines, including impacts of a range of operating conditions, including cyclic operation and rapid starts. It covers specific performance issues, their causes, and appropriate resolution of them.  
Status: Final

* *Best Practice Guidelines for the Operation and Maintenance of Steam Condensers and their Auxiliaries*This manual describes design, materials, and construction of steam condensers followed by discussion of the factors affecting plant thermal efficiency, air extraction equipment that removes air and in condensable gases from the steam space in the condenser, and considerations governing overall condenser design. In addition, the cooling water circuit is also described with details of pumps and energy consumption, cooling tower performance, and the influence of ambient conditions. The impact of cyclic operation on condenser performance and maintenance is discussed along with mitigation factors.   
  Status: Final
* *Impacts of Cyclic Operation on Maintenance Programs*Many of the conventional and combined cycle (CCGT) power plants, which have been in operation for a number of years, are presently being subjected to frequent start-stop cycles for longer periods of time. This report provides appropriate guidance for the improvement of plant existing maintenance programs in order to ensure significant savings, higher operational flexibility, faster response and improved profitability when plants undergone changes in operating mode from base load to cycling. Analysis revealed that cycling units require more maintenance due to additional damages/issues (which are mostly related to fatigue damage) and, therefore, more focused inspections are required. A summary of general guidelines is developed in this report for maintenance of the cycling units. The report also provides maintenance activities including inspection guidelines and recommendations for component based damage inspection for both base load and cycling units.  
  Status: Final

**Optimize**

* *ClearSign’s Electro dynamic Combustion Control ECC Solid Fuel Consortium (SFC)*

Through this consortium, tests are still being conducted of the ClearSign Electro dynamic combustion control with biomass and coal solid fuel for reduction of nitrogen oxides NOx, particulate matter, and carbon monoxide while improving flame stability and combustibility. The ECC has been tested with natural gas combustion showing over a 99% reduction in NOx while maintaining low CO emissions.  
Status: In Pipeline

* *Generator Maintenance and Condition Assessment Guide*A final draft report has been completed that provides a detailed guide of best practices for maintaining electric generators and assessing the condition of electric generators. Prevention of generator failures can eliminate long outages lasting for 6 months to over one year, significantly reducing replacement energy costs and the cost to replace the generator.  
  Status: Final
* *On-Line Monitoring and Evaluation of Critical Components*

A final draft report has been completed and identifies and documents best known State of the Art on-line monitoring tools. These tools and best practices include those that are utilized to monitor all major equipment in a generation facility to reduce operation and maintenance costs by 30 percent to 50 percent as well as improve plant reliability.  
Status: Final

* *University of North Dakota Energy & Environmental Research Center Multi-Element Sorbent Trap (MEST-H) Method for HCl – (UND EERC collaborative R&D)*

The UND EERC MEST-H has been demonstrated to be up to three times cheaper than the EPA method 26 for measuring halogens like HCl. This project is partially funded by NRECA along with EPRI, the Lignite Energy Council (LEC), and others; and will complete the validation of the MEST–H method for final approval by the EPA. Test has been completed, but we are waiting on the final report of the results.   
Status: Final

* *Guidelines for the Re-Commissioning of Coal-Fired Power Plant*

This document is a very detailed guide, essential for the recommissioning of a coal-fired power plant that has been laid up for months at a time. During the spring and fall off peak seasons, when wind generation and solar PV generation is the highest or when major plant failures have rendered the coal-fired power plant inoperable for long periods of time awaiting spares or major repairs. This will become more of an issue as efficient coal-fired power plants become older and availability of critical parts becomes a major issue.  
Status: Final

**Transform**

* *Monitoring CO2 Capture and Utilization Technologies*

NRECA participates in research with partners in the Carbon Capture and Sequestration (CCS) and Carbon Capture Utilization and Sequestration (CCUS) space. Our close network of affiliations and partners includes the Department of Energy, the National Carbon Capture Center (NCCC), Electric Power Research Institute (EPRI), vendors like Sustainable Energy Systems Cryogenic Carbon Capture, along with several Universities and testing centers across the International Test Center Network.   
Status: In Pipeline

* *Integrated Test Center – Carbon (ITC-C)*

NRECA is supporting the construction of the ITC-C advanced technology test center, which is built at Basin G&T’s coal-fired power plant at Dry Fork Station in Gillette, WY. The Center aims to demonstrate integrated CO2 capture and utilization technologies, with combined funding from the state of Wyoming, Tri-State Generation and Transmission Association, Inc., and NRECA, including hosting an international carbon utilization research initiative through the XPRIZE foundation. The ITC is a public-private partnership designed to foster the next generation of energy technology. The ITC will provide space for researchers to test Carbon Capture, Utilization and Sequestration (CCUS) technologies using actual coal-based flue gas from the Dry Fork Station near Gillette. The Test Center will host several technology providers including a global carbon utilization research initiative through the XPRIZE foundation. The Wyoming ITC-C was dedicated in May 2018 with a Ribbon Cutting Ceremony and is now open to XPRIZE Testers. Additionally Kawasaki, J-Coal and Wyoming entered a memorandum of understanding in which Kawasaki pledges 9 million to the test center and will mobilize to the site in 2020. In addition MTR had agreed to test its membrane technology in Wyoming in 2019. Ongoing funding discussions are being held with Oil and Gas Companies such as Exxon Mobil, Shell Oil, Statoil, and BP regarding support for the test center.  
Status: On-going

* *Fractional Micronization of Coal (FMOC) with EnerChem LLC*

NRECA is planning on a pilot scale test of the FMOC at a small combustor test facility at Southern Research Institute (SRI) to demonstrate at pilot combustor scale (~ 1 MW thermal) that a small percentage micronization of coal and the resultant fly ash (5 percent to 20 percent) will result in a micronized fly ash that acts as a sorbent in the coal-fired furnace and convection pass that will absorb a high percentage of S02, S03, HCL, and HF as well as a possibly a significant percentage of NOx, mercury, CO2 etc., significantly reducing costs for sorbents and allowing for lower cost and higher chlorine content coal. Final results of the tests will be forthcoming.   
Status: Final

**Joining the NCCC**

The NCCC operates as a cost-shared collaborative R&D venture.  The U.S. DOE provides significant funding to support the testing and scale-up of technologies with commercial potential, but requires significant private industry cost-sharing in R&D costs.  DOE also provides access to a large Fossil Energy R&D program.  Many laboratory-stage technologies under development by DOE and by private developers can be brought to NCCC for scale-up and integrated testing.  The private sector, led by Southern Company, provides: cost-share to match DOE’s investment, NCCC management oversight and process technology expertise to gain access to performance information on emerging technologies.  Insights gained can help power companies, coal companies and other energy-related companies to assess the future of carbon capture technologies fossil fuel combustion processes.

Joining the NCCC as a co-funding partner has many benefits.  Partners have a unique opportunity to participate firsthand in R&D test plan development and in understanding technology performance through observing NCCC’s operation.  These insights will assist partners in consideration of technology scale-up and assessment of commercial potential of advanced fossil fueled power generation and CO2 capture technology.  Partners will receive timely information detailing progress made in developing the technology, thereby enabling them to evaluate the suitability of the technology for commercial deployment in their generating systems or in project wherein they may have commercial interests.

**Benefits**

* Partners will receive summaries of technology evaluation and performance results.
* Access to a wide-range of international CCUS R&D collaborations and knowledge sharing groups.
* Invitation to bi-annual technology review meetings for updates on latest operations data.
* Detailed performance information and R&D results for technology development for pre-combustion or post-combustion CO2 capture.  This information may be marked confidential.
* Detailed performance information on balance-of-plant systems (e.g. other syngas treatment systems, solids feed systems, etc.)
* Access to NCCC staff, on a mutually acceptable basis, for clarification of any issues of particular interest.
* Annual technical reports and economic analysis through case-studies and reports.
* Assistance from NCCC staff in internal planning activities for analysis of economic and engineering aspects of CO2 capture technology.
* The opportunity (at own expense) to provide a suitable candidate to work as part of the NCCC Project Team.
* In Pipeline(on-going partnership)
* *Thermal Generation Interest Group (TGIG)*

NRECA in 2017 entered into a new three year agreement with CEATI that provides cooperatives with expanded access to the research from nine CEATI utility research consortia. NRECA has membership in this Center for Energy Advancements through Technology Innovation (CEATI) Interest Group, through which collaborative research provides information on operation and maintenance issues, impact of cyclic operation on, and efficiency improvement technology associated with coal-fired and natural gas fired power plants.   
Status: In Pipeline(on-going partnership)

* *Strategic Options for Integrating Emerging Technologies and Distributed Energy Interest (SOIG)*

Centre for Energy Advancement through Technological Innovation (CEATI) is a collaborative organization with over 120 participating electric and gas utilities, governmental agencies and provincial and state research bodies. In addition to facilitating information exchange through topic-driven interest groups and industry conferences, CEATI International brings partners together to collaborate on technical projects with a strong practical focus, and develops customized software and training solutions to fit the participants’ needs. NRECA in 2017 entered into a new three year agreement with CEATI that provides cooperatives with expanded access to the research from nine CEATI utility research consortia. NRECA is a member of the SOIG group, through which collaborative research provides information on renewables, diesel alternatives, energy storage, Greenhouse Gas Mitigation, distributed generation, and combined heat power.   
Status: In Pipeline (on-going partnership)

* *Microgrid Scoping Studies*This report presents a detailed analysis for evaluating the use of microgrids to improve reliability and develop islanding for critical infrastructure and services; in particular, from a utility-owned and operated feeder-level microgrid perspective. The report draws on an in-depth literature review of existing microgrid installations and practices supporting microgrid design and deployment. Microgrid design considerations are discussed, resulting in a clear understanding of the relationships between various components of microgrid systems including dynamic distribution grid infrastructure, AC and DC considerations, storage and distributed generation, and responsive load resources. An economic analysis is presented detailing the costs and benefits of microgrids, as well as an accompanying Excel-based microgrid cash flow modeling tool that stakeholders can utilize to test the financial viability of various microgrid designs under specific conditions.Status: Final
* *Leveraging Fast Ramping Capabilities Beyond Frequency Regulation*

This report establishes an understanding of the technical, regulatory, market and performance landscapes for fast-ramping electric power generation technologies. This study provides an up-to-date snapshot of how fast ramping technologies are utilized, where they can be used more, and what markets or technological changes are needed to achieve higher utilization. The goals of this study are to conduct an assessment of potential fast ramping technologies, analyze how different markets are taking advantage of their capabilities, determine the market-readiness of energy storage systems for fast ramping applications, identify any gaps between technology capabilities, how they are currently being used in markets, and quantify the value than can be derived from leveraging more of the fast ramping capabilities of these technologies.

Status: Final

* *White Paper - Small, Local Generation Options to Mitigate Potential Future GHG Regulations/CPP*

While solar and wind resources receive significant attention, there are several other potential generation technologies that can be sited locally and provide credit as low-emitting or renewable resources under the Clean Power Plan (CPP). This report details the economic viability of six local generation options that cooperatives can utilize for power generation to augment their electricity production in a manner that keeps money at home and can help meet any carbon/GHG regulations in the future, such as the EPA Clean Power Plan.   
Status: Final

* *TechSurveillance and Advisories*

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# Analytics, Resiliency and Reliability Work Group

For more information on this Work Group, please contact: David Pinney at [david.pinney@nreca.coop](mailto:david.pinney@nreca.coop)

Economic operations and reliability data analytics present both opportunities and challenges for electric utility co-ops. Opportunities in predictive analytics to better understand, manage, and forecast energy use and economic consequences of changes in markets, regulation, or operations, gave rise to this work group, which focuses on current and future data and research required to provide prompt technical and economic support to the NRECA membership. Specifically focused toward the electric co-op community, Analytics, Resiliency and Reliability (ARR) products and services include: development and maintenance of a portfolio of energy analytics products and services; collection and analysis of data; and provision of additional products and services in the areas of the data collection, IT architecture, sensors, and energy markets.

**Projects, Products and Services**

**Operate**

* *Annual NRECA Distribution Reliability Benchmarking Study*

An annual benchmarking study is conducted by NRECA to evaluate changes in distribution reliability within the rural electric distribution cooperatives.  This effort also feeds the Touchstone Energy Balanced Performance Scorecard indices of SAIDI, CAIDI and SAIFI.  With the recent adoption of analytical tools used to calculate reliability indices, both NRECA and members have access to a very powerful analytics engine applied to distribution. Such reliability systems can be connected, through MultiSpeak®, to many outage management systems (OMS).  This allows query of the OMS on a daily basis and brings cooperatives the needed feedback loop, so that the advantages of quality management can be achieved through statistical process control.

Status: In Pipeline

* *Modeling and Economic Analysis*  
  NRECA provides economic modeling to analyze and evaluate the impact of evolving market fundamentals and public policy changes on electric cooperatives, in order to support informed decision making. Recent projects include analyses of low natural gas prices, as well as EPA’s Clean Power Plan. Additionally, NRECA has modeled the affordability of electricity across the United States to identify the value of affordable electricity and the negative economic impacts that could come from rate increases, particularly in rural economies.  
  Status: In Pipeline
* *U.S. Co-ops by the Numbers*

NRECA has developed an online overview of where electric cooperatives fit in the U.S. electric utility industry. These resources are updated annually or periodically. This includes [Vital Signs](https://www.cooperative.com/programs-services/bts/Pages/Data/Vital-Signs.aspx), an overview of cooperative financial performance, and [fact sheets](https://www.cooperative.com/maps-facts-figures/Pages/default.aspx) on cooperative.com.

Status: Final

* *Demographic Analysis*

Staff perform demographic analysis for each member including the calculation of co-op served population estimates and various demographic statistics such as age, income, poverty rates and housing characteristics. This data is aggregated to the state and national levels, and by federal legislative districts to help guide regulatory, policy and government relations initiatives. These estimates are updated periodically, generally around the federal election cycle.   
Status: Final

* *Geographic Analysis*Performance of Geographic Information Systems (GIS) analysis for many projects across the association. Past work has included legislative maps to guide grassroots legislative outreach efforts, analysis of the rural broadband landscape, visualization of NRECA employees’ engagement with cooperatives. Work includes an update of the [America’s Electric Cooperative Network map](https://www.cooperative.com/maps-facts-figures/Pages/default.aspx).   
  Status: Final

**Optimize**

* *Dynamic Engineering Analysis – Open Modeling Framework (OMF)*

The impact of smart grid technologies, such as networked sensors, distributed generation, and energy storage, varies depending on the distribution feeder. Utilities are faced with several problems in trying to determine the costs, benefits, and system impact of new grid technologies. NRECA developed this analytics platform, which was funded by the U.S. Department of Energy, to enable co-ops to simulate engineering and financial impacts of grid technologies.   
View [software](https://www.omf.coop/).  
Status: Final

* *GridLAB-D and OMF Solar Enhancement and Dissemination (GOSED)*

This project aims to develop the online analytical tool – the Open Modeling Framework – to model the engineering and financial impact of new solar deployments on distribution feeders. This effort is funded by the Department of Energy. Results incorporated [here](https://www.omf.coop/).   
Status: Final

* *DSOSS, Distribution System Operator Simulation Suite*

Distribution System Operator (DSO) functionality is seeing huge interest as a method for integrating distributed energy resources (DERs). The DSOSS research project, led by Georgia Tech, aims to develop a suite of simulation software that will allow distribution operators to plan distributed energy resource deployments. The simulations will include models for distributed generation, energy storage, real time pricing and new consumer loads like electric vehicles. This effort is funded by ARPA-E, the advanced research division of the U.S. Department of Energy. [Press Release](https://www.electric.coop/nreca-test-integration-renewable-energy-grid/)

Status: In Pipeline

* *Energy Storage Dispatch Model*

NRECA is creating a model that allows the simulation of different energy storage dispatch strategies. The model will also show expected impacts on peak demand reduction, energy consumption, and number of discharge/recharge cycles. Furthermore, the model will monetize the results to estimate the expected benefit of the energy storage technology.  
Available at [www.omf.coop](http://www.omf.coop)  
Status: Final

* *Load Controls for Energy Storage Applications "VirtualBatteries"*

Through a partnership with Pacific Northwest National Laboratory (PNNL), NRECA is creating software that will allow cooperative utilities to estimate what energy storage applications—such as peak demand reduction or asset upgrade deferral—could be served through more precise management of thermostatically controlled loads. The software will also be able to estimate the financial value of these services to the utility, and later stages of the project will create reference control algorithms on top of the Volttron platform.  
Status: In Progress

* *Distribution Resources Pricing Study*

NRECA is working with Boston University through funding from the Sloan Foundation. The goal of the project is to perform a systematic estimation of resource value on the distribution system, and to analyze the economic drivers in the calculation of distribution resource pricing so that utilities can better understand the value of these attributes on their grids.

Status: In Progress

* *Report on Open Source GIS*

Co-ops are looking to advance how they can use data for operational and productivity gains, and different paths suit different cooperatives. NRECA members have expressed ongoing interest in seeing different approaches cooperatives use to deploy technology and to problem-solve. Additionally, with the rising gap in qualified workers, sharing stories of creative solutions to strategically source technical talent is of increasing value. NRECA produced a report of Coles-Moultrie Electric Cooperative in Mattoon, IL, (CMEC) and how it developed its own Geographic Information System (GIS) from open source software in less than a year. The co-op also leveraged Lake Land College, hiring and training Geospatial Technology students to support development of the system. Status: Complete

**Transform**

* *Achieving a Resilient and Agile Grid*

The grid is changing in response to new requirements and also in response to the increasing potential of advanced sensors, controls, and analytics. The rapid and accelerating deployment of distributed and especially intermittent renewable technology is challenging the operation of the grid at the edge. Many envision a grid built of smaller, independent or quasi-independent generating entities which will operate under dynamic, reconfigurable control in response to changing conditions. There would be utility advantages to increased awareness and access to and control of distributed energy resources. This technical report looks at what a potential future grid could achieve and the technologies that will be needed to re-engineer the grid.   
[View Report](http://www.nreca.coop/wp-content/uploads/2014/05/Achieving_a_Resilient_and_Agile_Grid.pdf)  
Status: Final

* *GridBallast, Load Control for Frequency and Ramping Support*

The GridBallast project is a research effort led by NRECA to develop low-cost demand-side management technology to address resiliency and stability concerns accompanying the exponential growth in distributed energy resources. Specifically, devices based on GridBallast technology will monitor voltage, frequency and control load to address excursions from operating targets. The devices can operate autonomously, allowing for rapid local response. Autonomous operation removes the need for central control and a potentially costly communications infrastructure, but GridBallast devices can optionally include direct load control. The project team includes Carnegie Mellon University with NRECA to develop simulation software based on NRECA’s Open Modeling Framework to support utilities in designing, deploying, and operating GridBallast networks. The GridBallast hardware will be designed and manufactured by Eaton Corporation. This effort is funded by the ARPA-E organization, which is part of the Department of Energy.

View more information about the [project](https://www.gridballast.com/).  
Status: In Progress

* *Research Collaboration on Open Data Models (“SDET” and “DRPOWER”)*

The vast majority of North American electric utilities have accurate circuit models but researchers in the field typically work on only a few models available in the public domain. NRECA has joined two projects funded by ARPA-E called DRPOWER and SDET, which aim to create better visualization, anonymization and data sharing capabilities to enable researchers to work on models and problems much closer to those that electric utilities deal with day-to-day. View the [model repository](https://egriddata.org/).  
Status: In Pipeline

* *Grid Resiliency Research “LPNORM”*

Using research and output from other NRECA work, efforts are underway to consider how to improve the ability of the grid to react to and recover from disruptions – man-made and natural. NRECA is a key partner on a project called LPNORM, a Los Alamos and Pacific Northwest National Laboratories and NRECA Optimal Resiliency Model. The Department of Energy-funded effort is partnering with cooperative advisors to develop new engineering analysis methods for increasing resiliency of distribution systems.   
Status: In Progress

* *Grid Resiliency Intelligence Platform “GRIP”*NRECA is a core partner in the Department of Energy funded project "GRIP", which is building a software platform that combines artificial intelligence with massive amounts of data and industry experience from a dozen U.S. partners to identify places where the electric grid is vulnerable to disruption, reinforce those spots in advance and recover faster when failures do occur. View [press release](https://www6.slac.stanford.edu/news/2017-09-14-slac-led-project-will-use-artificial-intelligence-prevent-or-minimize-electric-grid).   
  Status: In Progress
* *Cybersecurity Via Inverter-Grid Automatic Reconfiguration “CIGAR”*

The Project seeks to develop methodology and tools allowing distribution grids to automatically reconfigure themselves to counteract cyberattacks against cyber-physical systems that have compromised multiple independent systems in the electric grid. This research will begin with an effort to analyze the stability of different types of feedback control systems (e.g., distributed energy resources, voltage regulation and protection systems) in the electric grid to determine what parameters an attacker would change if a given system (or multiple systems) were to be compromised. Then, the research team will design reinforcement learning-based algorithms to reconfigure settings of non-compromised systems to actively fight a variety of cyberattacks. The reinforcement learning defensive algorithms will then be incorporated into the National Rural Electric Cooperative Association (NRECA) Open Modeling Framework (OMF), thereby allowing defensive strategies to be tailored on a utility specific basis. The major outcomes of this project will be the creation of tools that monitor system telemetry to provide alerts of possible imminent attack and/or an attack in nascent stages as well as system reconfiguration rules to mitigate a wide variety of cyberattacks, as well as enhancements to modeling tools for inverters, loads and protective devices.  
Status: In Progress

* *Wireline Broadband and Connect America Fund Geographic Analysis*   
  To support analytics and co-ops’ decision-making, NRECA is updating maps showing strategic broadband opportunities for co-ops across the nation. New state-by-state analysis has identified co-op areas which continue to be un- or under- served by wireline broadband. This data is also used to support NRECA white papers on the economics of rural broadband growth.  
  Status: In Progress
* *TechSurveillance and Advisories*

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# Cybersecurity Work Group

For more information on this Work Group, please contact: Cynthia Hsu at [cynthia.hsu@nreca.coop](mailto:cynthia.hsu@nreca.coop)

The interdependence of digital communication technologies and grid operations has substantially increased the vulnerability of our co-ops to malicious cyber intrusions, data theft, lost productivity and, potentially, service disruption. All co-ops, regardless of size, need to take ongoing steps to ensure the security of their data and systems. The increasing sophistication of cyber threats, the sheer number of things connecting to the grid (nodes on the system), the increasing use of mobile devices, and the reliance on third party suppliers for services and parts are just a few of the current challenges co-ops face that can affect their cybersecurity.

The Cybersecurity Work Group has identified three major goals: protecting sensitive data; ensuring reliability; and maximizing productivity. The Cybersecurity Work Group supports co-ops to reach these goals by investing in research and products that help co-ops: identify cybersecurity issues, protect data and systems, detect problems, respond to cyber incidents, and recover quickly.

**Projects, Products and Services**

**Operate**

* *RC3 – The Rural Cooperative Cybersecurity Capabilities Program*

In July 2016, NRECA received a $7.5 million award from the Department of Energy to develop a three-year program to increase the cyber security capabilities of small- and mid-sized co-ops. This funding is being used to support a wide range of efforts, many of which are listed here. All of the materials developed through the RC3 Program will be available to members through the RC3 website. Year three funding has been awarded; major goals are addressed below. For more information see the [RC3 Program](https://www.cooperative.com/programs-services/bts/rc3/Pages/default-old.aspx) website.

Status: In Progress

* *Self-Assessment Research Program through RC3*

Many cooperatives have few or no information technology staff and face unique challenges in developing and implementing a cyber security program. The RC3 Self-Assessment Research Project is developing tools and materials to help cooperatives conduct an assessment of their existing cybersecurity capabilities. These tools will allow co-ops to baseline their current capabilities and document progress over time, and to benchmark their capabilities against similar cooperatives. In the first year of the Research Program, the RC3 Team worked with 36 cooperatives across 13 states. Tools developed and tested through the Research Program will be released to the cooperative community in 2018, enabling cooperatives to engage in self-assessment.

Status: In Progress

* *Managed Cybersecurity Service Providers Catalogue through RC3*

To aid NRECA members that may be looking to outsource cybersecurity work, NRECA worked with the American Public Power Association on a joint project to develop a catalogue of managed security service providers that offer commercial off-the-shelf solutions. NRECA Service and Associate Members who provide cybersecurity products and services are included. View the [catalogue](https://www.cooperative.com/programs-services/bts/rc3/Documents/Secure/PreScouterReport.pdf).

Status: Final

**Optimize**

* *National Cybersecurity Awareness Month Collaboration*NRECA, in collaboration with the National Cyber Security Alliance (NCSA) and the Department of Homeland Security (DHS), hosted “Insights on Cybersecurity for Electric Utilities” as part of National Cyber Security Awareness Month (NCSAM) in October 2017. More than 50 utility staff attended and more than 1,500 people logged in to watch the event live on Facebook. NRECA will be working with NCSA and DHS to develop another series of cybersecurity resources for members and events to promote National Cyber Security Awareness Month in October 2018.

Status: 2017 Final and 2018 In-Progress

* *Free Cybersecurity Peer-to-Peer Training through RC3*The RC3 Program sponsored six Cybersecurity Summits in 2017, providing cybersecurity training to cooperative staff from more than 150 cooperatives. More than 15% of our member utilities attended an RC3 Cybersecurity Summit. The RC3 Cybersecurity Summits are free and funded by the U.S. Department of Energy. Five additional Summits are in the planning stages for 2018. Agendas and presentations from the 2017 Summits [here](https://www.cooperative.com/programs-services/bts/rc3/Pages/default-old.aspx).   
  Status: 2017 Final and 2018 In-Progress
* *Reduced Registration to Attend “Security Education Week” through RC3*

Investing in a cooperative’s existing staff provides long-term benefits. The RC3 Program, in collaboration with the American Public Power Association, negotiated a $1,000 discount in registration fees for our members to attend Security Education Week, a weeklong cybersecurity training program held in Phoenix, AZ, in April 2018 and organized by the Energy Sector Security Consortium, Inc. (EnergySec).

Status: Final

* *Free Participation in CyberStrike Workshop through RC3*In a collaboration with the American Public Power Association, NRECA offered members an opportunity to participate in the U.S. Department of Energy’s (DOE) CyberStrike workshop. CyberStrike was developed by the DOE, the Electricity Information Sharing and Analysis Center (E-ISAC), and Idaho National Laboratory (INL) to enhance the ability of energy sector owners and operators in the U.S to prepare for a cyber incident impacting industrial control systems. The training offered attendees a hands-on, simulated demonstration of a cyberattack, drawing from elements of the 2015 and 2016 cyber incidents in Ukraine. Attendance was free and funded by the DOE.  
  Status: Final
* *Free Access to On-Line Cybersecurity Training Offered by SANS™ through RC3*

SANS™ is a world-renowned cybersecurity training, certification and research company (https://www.sans.org/). The RC3 Program created the SANS Voucher Program to allow cooperatives to attend up to three online training classes provided by SANS, and to build a strong network with other cooperatives while completing the training. These courses typically cost $2,500 to over $6,000 each. Applications to participate in the RC3 SANS Voucher Program were accepted in March 2018, and 41 cooperatives were selected to access this leading cybersecurity organization’s training courses for free, funded by the U.S. Department of Energy. NRECA is now opening an opportunity for a second group to take part in the RC3 SANS Voucher Program. View information about the [Program](https://www.cooperative.com/programs-services/bts/rc3/Documents/RC3_SANS_Voucher_Program_March_2018.pdf).

Status: In Progress

* *Developing New Cybersecurity Training Courses through RC3*

A successful cybersecurity program rests on the combined efforts of the entire staff. However, many staff may not realize the important role they play in securing their cooperative. The RC3 Program is developing cybersecurity training programs and guidance documents specifically for communicators and member services staff, legal staff, and any staff involved in purchasing decisions. Additional training programs may be created over the course of the RC3 Program.

Status: In Progress

* *Developing an Information Sharing Resources through RC3*

When it comes to cybersecurity, there are many challenges co-ops face deciding what information to share, who to share it with, and how to share it. The RC3 Program is developing case studies and guidance materials to help cooperatives answer these questions, and we are creating a secure information sharing platform to facilitate the timely sharing of relevant cybersecurity information among cooperatives.

Status: In Progress

**Transform**

* *Identifying and Integrating New Cybersecurity Technologies through RC3*

New cybersecurity technologies are being developed every year and the RC3 Program will be searching for cutting edge ideas that can help Co-op Nation. Possible projects include creating a virtual ‘work laboratory’ for information technology staff to practice their cybersecurity skills, creating a vulnerability scanning tool for cooperatives to use to do their own internal assessments, and advancing machine-to-machine capabilities to more rapidly share cybersecurity threats.

Status: Ideation

* *Essence Cybersecurity Prototype*

Essence provides a capability to capture utility network traffic and detect anomalies using a variety of methods, including advanced artificial intelligence and machine learning. *Essence* has demonstrated an ability to detect anomalies indicative of potential security breaches in minutes, compared with the 140 days on average that it currently takes before a breach is detected. The *Essence* prototype was completed on time and under budget in 2016. It met all technical objectives. In recognition of the performance of *Essence*, DOE extended the project to December 2016 to allow NRECA to make additional improvements.  
Status: Final

* *GridState*

The Department of Defense (DoD) initiated an effort “to develop innovative technologies for detecting and responding to cyber-attacks on U.S. critical infrastructure.” View [brief summary](http://www.darpa.mil/program/rapid-attack-detection-isolation-and-characterization-systems). NRECA received substantial funding from DoD to extend *Essence* in support of this effort.   
Status: In Progress

* *Cybersecurity-Collect-Communicate-Collaborate (C4) Research Project through RC3*

The RC3 Program is working with BlackByte Cyber Security, LLC, to develop a platform specifically designed for sharing information about cyber threats across NRECA member electric cooperatives. Secure, intelligent sensors will collect and analyze localized data at the source, and automatically share an abstraction of such data via an encrypted machine-to-machine nation-wide communications mesh instituted within the C4 sensor framework.  
Status: In Progress

* *React*

In February 2017, NRECA announced “React”, a collaborative effort between NRECA, N-Dimension Solutions, Inc., Milsoft Utility Solutions, and NRTC to advance *Essence*, NRECA’s prototype cybersecurity technology. The React Team will integrate *Essence* into the Team’s existing commercial offerings to dramatically reduce the time it takes to detect a cybersecurity breach. REACT has the potential to benefit more than 3,000 utilities across the country.

View [press release](https://www.electric.coop/nreca-announces-team-for-react-cybersecurity-project/).

Status: In Progress

* *TechSurveillance and Advisories*NRECA’s TechSurveillance provides research and reporting on technology and market issues pertinent to cooperatives, in line with the Work Group research efforts. NRECA also produces frequent Technology and Member Advisories, focused on newsworthy events and issues which have business and technology impacts on cooperatives business operations. See last page of this Portfolio summary for recent articles and advisories.

# Resource Adequacy & Markets Work Group

For more information on this Work Group, please contact: Michael Leitman at [michael.leitman@nreca.coop](mailto:michael.leitman@nreca.coop)

The Resource Adequacy and Markets Work Group is concerned with electric co-ops’ challenges to new or changing regulatory proposals, as well as evolving market fundamentals, standards development, and economics issues. The Work Group was established to help co-ops with sound financial management decisions and to protect the electric co-op industry interests. A main focus is to analyze current and evolving resource adequacy and market issues and initiatives, rates and price formation, and to monitor regulatory and legislative issues through collaboration with NRECA and external groups in support of overall policy objectives. Additionally, the Resource Adequacy and Markets Work Group educates members on RTO/ISO market and reliability developments, emerging distribution market structure, and initiatives affecting resource adequacy and pricing.

**Projects, Products and Services**

**Operate**

* *Fuel Mix of Electric Cooperatives*

NRECA has estimated the retail fuel mix of electric cooperatives for 2016, and will update to 2017 in Q4 of 2018. G&Ts provided information on their resource mixes, which was supplemented by publicly available data from integrated resource plans, annual reports, and other industry resources. The generation from cooperative-owned plants is also available through 2017 based on EIA reporting.   
Status: In Pipeline

* *NERC Support*

NRECA staff supports the ongoing efforts of the stakeholder-driven North American Electric Reliability Corporation (NERC) standards development program, which ensures the reliability of the bulk power system by developing quality [reliability standards](http://www.nerc.com/pa/Stand/Pages/ReliabilityStandards.aspx) in a timely manner that are effective, clear, concise, and technically sound. Significant NRECA efforts are being focused on standards associated with emergency operations including geomagnetic disturbances, physical and cybersecurity, communications protocols, and personnel training.   
Status: In Pipeline

* *FERC Support*

NRECA staff supports the on-going advocacy and general Government Relations efforts as pertaining to the Federal Energy Regulatory Commission (FERC), and maintains and builds expertise on issues arising at FERC. Significant efforts are focused on market oversight and reforms, electric reliability, gas-electric coordination, integration of renewables into the wholesale markets, transmission planning and cost allocation, and generator interconnection issues.   
Status: Ongoing

**Optimize**

* *The Eastern Interconnection Planning Collaborative (EIPC)*

Several related studies on electric and fuel supply adequacy and infrastructure requirements under several possible policy futures are developed through this collaborative effort. View [results](http://www.eipconline.com/home.html) to date.  
Status: Final

* *The Eastern Interconnection States’ Planning Council (EISPC)*

Through this Council, several reports and initiatives on resource, fuel, and infrastructure adequacy to date and ongoing are developed. Information on EISPC products and initiatives can be found [here](http://www.naruc.org/naruc-research-lab/eispc-archive/).   
Status: Final

* *Department of Defense Engagement and Energy-as-a-Service*

NRECA is working with cooperatives that serve military installations across the country. The goal is create a community of these co-ops that can share information and lessons learned about how to work with the military. Additionally, NRECA is taking the lead to understand the challenges that these co-ops face in working with these unique commercial customers and finding innovative ways to meet their needs. In fall of 2018, the Air Force released their first Energy-as-a-Service pilot project at Altus Air Force Base in Oklahoma. This first pilot will be done in conjunction with the Western Farmers Electric Cooperatives and their members. NRECA plans to support the cooperatives in this endeavor with program evaluation and research needs through the early part of the pilot project.

Status: In Progress

**Transform**

* *Market Fundamentals*

BTS staff is engaging in ongoing work to assess the market fundamentals that are driving change in the electric industry. These include recent trends and projections in areas including fuel prices, the evolving generation mix, expanding DER, and developing technologies. This ongoing work has been presented in various reports and presentations and is forward looking to assist cooperatives in planning for a shifting and uncertain future.  
Status: In Pipeline

* *Electric Industry Generation, Capacity, and Markets Outlook Report*

This report by Work Group staff focuses on how shifting market fundamentals are affecting the U.S. electric sector in general and electric cooperatives in particular. It presents analyses and projections of electricity capacity and generation, transmission, and markets to provide a summary of the current state of the industry and where it may be headed. This report will be updated annually to include new information and projections. View [report](https://www.cooperative.com/programs-services/bts/resource-adequacy-markets/Documents/ElectricIndustryGenerationCapacityandMarketsOutlook.pdf).  
Status: Final

* *NRECA Guide on Designing Retail Rates*  
  NRECA collaborated with CFC to revise a co-op member guide on the development of retail rates and product and service pricing. In the past, NRECA and CFC have collaborated to produce, and then update, a rate guide to help our members think through how they want to set up their rate structures based on their individual circumstances.   The rate guide has been updated to reflect the ongoing transformation of the electric industry and to look beyond rates to pricing as part of revenue recovery. View the [Retail Rate Guide](https://www.cooperative.com/rates) and its companion rate communications guide, introducing a Rate Change to Consumer-Members.  
  Status: Final
* *DER Compensation and Cost Recovery Guide*  
  The guide identifies objectives that cooperatives are looking to achieve and whether DER technologies and services may help provide them. It also discusses the wide variety of ways in which utilities, including many cooperatives, compensate participating DER consumer-members for providing value through DER programs and the equally varied means by which utilities can recover the costs of DER programs, including the role that aligning wholesale and retail pricing structures may play. Finally, the guide offers an overview of elements that cooperatives may wish to consider in developing a stakeholder engagement process for DER.  
  Status: Final
* *Broadband Due Diligence Guide*

Broadband Stretches the traditional investment envelope and the need for due diligence by electric cooperatives is important. Major technology upgrades such as an expansion of broadband coverage come with significant, and sometimes unprecedented, challenges and costs. The business cases and cost recovery mechanisms are different for so-called “last-mile” deployments in which a cooperative extends broadband communications to homes and businesses in the community compared to operationally driven broadband expansion for internal communication purposes. The purpose of this executive white paper is to provide CEOs and other decision makers at electric cooperatives who are considering significant broadband deployments with a high-level, due diligence framework.

[View Report](https://www.cooperative.com/programs-services/bts/Pages/Due-Diligence-of-High-Speed-Broadband-Investment.aspx)

Status: Final

* *The Value of a Broadband Backbone for America’s Electric Cooperatives: A Benefit Assessment Study*

This paper outlines and quantifies the benefits of a broadband backbone for electric cooperative operations. A broadband backbone is defined as a high-speed, high bandwidth, low latency data connection enabled by wired or wireless technology that connects systemically important infrastructure. Importantly, it provides backhaul – the delivery of data collected by the wide area networks (WAN) – which is critical to managing electric operations. Broadband backbones are necessary to accommodate new data intensive use cases that are becoming available to optimize utility operations and to adapt to changing consumer behavior that demands a more flexible grid*.*

Status*:* Final

* *3rd Party Product Offerings in Cooperative Communities*

The proliferation of Distributed Energy Resources (DERs) has created a competitive market for various products and energy services.  Third-party vendors are approaching co-op communities with product offerings such as solar (rooftop and community), energy storage, and solar plus storage solutions.  As trusted energy advisors and community business leaders, co-ops now find themselves in a position to help evaluate and guide purchasing decisions on behalf of their members.  In addition, co-ops have a vested interest in how distributed energy solutions impact their systems.  This article is focused on the emerging market for solar plus storage solutions offered to residential customers in co-op communities.

Status: In Pipeline*TechSurveillance and Advisories*

* *TechSurveillance and Advisories*NRECA’s TechSurveillance provides research and reporting on technology and market issues pertinent to cooperatives, in line with the Work Group research efforts. NRECA also produces frequent Technology and Member Advisories, focused on newsworthy events and issues which have business and technology impacts on cooperatives business operations. See last page of this Portfolio summary for recent articles and advisories.

***Articles and Advisories Summary***

January 6, 2014

***2018 to Date***

NRECA’s Business and Technology Strategies *TechSurveillance* articles and *Member and Technology Advisories* provide up-to-date reviews on an array of energy issues affecting cooperative members. Below is a summary listing of those issued in 2018 to date. You can find the full articles and advisories of these highlights below through the links provided:

**Analytics**

* Advisory: [Project Advisor Opportunity “VirtualBatteries”](https://www.cooperative.com/programs-services/bts/analytics-resiliency-reliability/Documents/ProjectAdvisoryVirtualBatteries_Jan2018.pdf)
* Advisory: [Contributor Opportunity for ARPA-E Open Grid Data Project](https://www.cooperative.com/programs-services/bts/analytics-resiliency-reliability/Documents/TechAdvisoryProject%20AdvisorGRIDDATAFebruary2018.pdf)
* Advisory:[Leveraging Technology for Avian Protection](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech%20Advisory-AvianProtection-Feb2018-FINAL.pdf)
* Advisory:[Electric Cooperatives Lead Industry AMI Deployment](https://www.cooperative.com/programs-services/bts/Documents/Advisories/TechAdvisory-Co-opsAMIDeploymentFeb2018FINAL.pdf)

**Cyber Security**

* Advisory: [Opportunity to Participate in NRECA’s RC3 SANS Voucher Program for FREE Cybersecurity Online Courses](https://www.cooperative.com/programs-services/bts/rc3/Documents/RC3_SANS_Voucher_Program_March_2018.pdf)
* Advisory: [RC3 Self-Assessments: What CEOs and GMs Have to Say About Cybersecurity](http://nrecanow.nreca.org/sites/bts/Shared%20Documents/RC3%20Self-Assessments:%20What%20CEOs%20and%20GMs%20Have%20to%20Say%20About%20Cybersecurity)

**Distributed Energy Resources**

* Article: [Do Smart Thermostats Make for Smart Demand Response Programs?](https://www.cooperative.com/programs-services/bts/Documents/TechSurveillance/TS-Smart-Thermostats-April-2018.pdf)
* Article: [Beneficial Electrification - Space Conditioning in Schools](https://www.cooperative.com/programs-services/bts/Documents/TechSurveillance/TS-Beneficial-Electrification-GSHP-and-Schools-April-2018.pdf)
* Article: [Beneficial Electrification - Agribusiness: Dairy Water Heating](https://www.cooperative.com/programs-services/bts/Documents/TechSurveillance/TS-Beneficial-Electrification-Dairy-Water-Heating-April-2018.pdf)
* Article: [Beneficial Electrification – Natural Gas Pipeline Compressor Stations](https://www.cooperative.com/programs-services/bts/Documents/TechSurveillance/TS-Beneficial-Electrification-Natural-Gas-Pipeline-Compressors-May-2018.pdf)
* Advisory: [Electric Vehicle Market Potential](https://www.cooperative.com/programs-services/bts/Documents/Advisories/MemberAdvisoryEVMarketUpdateFeb2018.pdf)
* Advisory: [NRECA is Official Supporter of Electrification 2018 Conference](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-EPRI-Conference-FINAL-March-2018.pdf)
* Advisory: [Changes to Tax Code & Imposition of Solar Panel Tariffs Will Impact Co-op Solar Development Prospects](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-CREBS-ITC-Tariffs-April-2018.pdf)

**Generation, Environment, & Carbon Dioxide**

* Article: [Wind Turbine Operation & Maintenance Issues](https://www.cooperative.com/programs-services/bts/Documents/TechSurveillance/TS-Wind-Generation-Maintenance-March-2018.pdf)
* Article: [Several Technical and Economic Options Can Help G&T Electric Cooperatives Integrate Renewable Energy into the Grid](https://www.cooperative.com/programs-services/bts/Documents/TechSurveillance/TS-Renewables-Variability-Part-3-March-2018.pdf)
* Advisory: [Today’s Natural Gas Supply: Pipeline Infrastructure and its Challenges](https://www.cooperative.com/programs-services/bts/Documents/Advisories/TechAdvisory-NaturalGasPipelines-Feb2018FINAL.pdf)
* Advisory: [Wyoming Integrated Test Center–Carbon (ITC-C) and XPRIZE Update: Finalists to Be Announced April 9; Major Construction Complete on Test Center](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-for-Wyoming-ITC-C-and-XPRIZE-UPDATE-March-2018.pdf)
* Advisory: [Wyoming Integrated Test Center–Carbon (ITC-C) and NRG COSIA CARBON XPRIZE Update: XPRIZE Finalists’ Innovative Approaches to Converting CO2 Waste to Sellable Products](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Wyoming-ITC-C-and-XPRIZE-Finalists_Advisory.pdf)

**Resource Adequacy & Markets**

* Advisory: [Rate Options To Support EV Programs](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-EV-Rates-FINAL-2-27-18.pdf)
* Advisory: [From Finding the Gaps to Bridging the Gaps: An Electric Cooperative’s Need to Source Strategically](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech%20Advisory%20-%20Strategic%20Sourcing%20-%20Feb%202018%20-%20Final.pdf)
* Advisory: [Strategic Sourcing Case Study: North Dakota IEAC](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-Sourcing-Case-Study-Noth-Dakota-Alliance-May-2018.pdf)
* Advisory: [How One Cooperative Leveraged Data to Advance its Pole Attachment Policies](https://www.cooperative.com/programs-services/bts/Documents/Tech-Advisory-NOVEC-Pole-Attachment-Case-Study-FINAL-2-22-18.pdf)
* Advisory: [NRECA Releases Distributed Energy Resources Compensation and Cost Recovery Guide](https://www.cooperative.com/programs-services/bts/Documents/Secure/Advisories/TechAdvisoryDERCompensationGuideMarch2018.pdf)
* Advisory: [Broadband Case Study: Anza Electric Cooperative](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-Broadband-Case-Study-Anza-April-2018.pdf)
* Advisory: [Broadband Case Study: Roanoke Electric Cooperative](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-Broadband-Case-Study-Roanoke-April-2018.pdf)
* Advisory: [Broadband Case Study: Orcas Power and Light & Rock Island Communications](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-Broadband-Case-Study-OPALCO-May-2018.pdf)
* Advisory: [The Evolving Electric Cooperative Fuel Mix](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Technology_Advisory_The_Evolving_Electric_Cooperative_Fuel_Mix.pdf)
* Advisory: [Electric Cooperatives and Opportunities For Working with the Military](https://www.cooperative.com/programs-services/bts/Documents/Secure/Advisories/Member-Advisory-Working-with-the-Military-April-2018.pdf)
* Advisory: What to Know About Cryptocurrency Mining

**Transmission and Distribution**

* Advisory: [MultiSpeak Case Study: Wake EMC](https://www.cooperative.com/programs-services/bts/Pages/MultiSpeak-Use-Case-Study-Wake-EMC.aspx)
* Advisory: [Seeking MultiSpeak Case Studies](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Advisory-Seeking-MultiSpeak-Case-Studies-March-2018.pdf)
* Advisory: [Energy Efficient Transformer Standards](https://www.cooperative.com/programs-services/bts/Documents/Advisories/Tech-Advisory-Transformer-Efficiency-Standards-May-2018.pdf)