Business & Technology Report

Summer 2019

Portfolio of Projects, Products, and Services

NRECA

America's Electric Cooperatives

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.

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1: Distributed Energy Resources Work Group

For more information on this Work Group, please contact: Brian Sloboda at 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

- *The Beneficial Electrification League*

  NRECA co-founded the Beneficial Electrification League with Natural Resources Defense Council to help promote the benefits of electrification. This group has gained the support of dozens of organizations of diverse background to develop resources that work to develop the market for electric products, including agricultural pumps, motors, space heating, water heating, school buses, electric vehicles, and more.
  View additional information.

- *State-Level Electrification Meetings*

  NRECA has hosted and helped plan a number of meetings that bring together stakeholders to discuss beneficial electrification. These meetings include an Electrify Minnesota, Electrify North Carolina, Colorado and Wisconsin. Electrify Indiana and Iowa events have been planned for fall 2019. These events typically draw over 100 attendees and over a dozen expert speakers. View additional information.

- *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

- *Energy Storage Value Streams and Use Cases*

  As the cost of utility scale and BTM storage continues to decline the value propositions that could be realized by deploying energy storage are becoming more compelling to cooperatives. Many co-ops are interested in evaluating how storage fits into their DER strategy and what value streams it can provide. The purpose of the report is to explore the potential value of storage, costs and risks, rates and pricing structures and use cases. The report will examine several business models and the potential value streams and pricing structures that benefit market participants at the wholesale (G&T), distribution and member consumer levels.
  Status: In Pipeline

- *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

- *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 section.
  Status: Final

- *Energy Storage Lexicon*

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

Optimize

- *Design Thinking Program Design*

  BTS has partnered with E Source , Poudre Valley Electric Cooperative and Roanoke 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. View the Tools and Resources.
  Status: In Pipeline

- *Million LED Challenge*

  NRECA in partnership with the University of California, Davis and the California Lighting Technology Center will develop a list of approved LED products to replace linear fluorescent lamps in commercial and industrial applications. An online store will give co-ops ad their members access to the approved lamps at discounted bulk pricing.
  Status: In Pipeline

- *Enabling Energy Access for All through Innovative Programs*

  In October 2017, the U.S. Treasury Community Development Financial Institutions Fund (CDFI) released an updated list of the nation's Persistent Poverty Counties (PPCs). PPCs are counties that have experienced very high poverty rates over a long-term. Cooperatives provide electricity in more than 360 PPCs identified by CDFI (~90%), serving an estimated 4.2 million people in these counties as poverty rates range from 20-60%. The initiative will:
    - Inform and educate our NRECA member cooperatives
    - Support community growth, member engagement/satisfaction
    - Advocate for our NRECA member cooperatives
    - Identify and establish partnerships to advance solutions for our members
    - Communicate best practices and lessons learned

  Status: In Pipeline

- *Energy Services Tools and Marketing Assessment*

  Market segmentation can be used to select programs and to communicate existing programs to members. Using the existing customer information system (CIS) platforms co-ops could increase program participation and member satisfaction. This project will demonstrate these capabilities and information co-ops in recommended practices.
  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.
  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

- *Energy Management Best Practices for Cannabis Greenhouses*

  Cannabis greenhouse are intense users of electricity and have traditionally show little ability to shave usage during peak. This project will look at solutions related to lighting, ventilation and general energy usage and how commercial grow houses could adopt new practices to lower their energy intensity.
  Status: In Pipeline

- *Energy Efficient Refrigerator Glass Doors for the Commercial Sector*

  The objective of this study is to develop supporting research and a substantiation document that can be used by participating co-ops to launch a program offering to improve the efficiency of open refrigerated display cases. The aim is to quantify savings resulting from refrigerated display cases with glass doors compared to open refrigerated display cases.
  Status: In Pipeline

- *Energy Efficient Lighting Reference Guide*

  A guide to existing and emerging lightning technologies and the impact to co-op energy efficiency programs.
  Status: In Pipeline

- *Energy Efficient Compressed Air Reference Guide*

  A guide to help co-op staff assist commercial customers in improving and optimizing compressed air systems.
  Status: In Pipeline

- *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
  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

  Status: Final

- *Electric Vehicle C&I Adoption*

  Develop tools and case studies for co-ops to use with C&I customers to increase interest in electric fleets.
  Status: In Pipeline

- *Utility Connected Home*

  In partnership with East River Electric and Dakota State University the project will create a home energy management interface the seamlessly connect a home with the electric utility. A prototype will be built and placed on the campus as a living lab for vendors and utilities to learn and test new products and ideas.
  Status: In Pipeline

- *Beneficial Electrification - Promoting the Benefits of End-Use Electrification*

  To build and maintain an advanced knowledge base through focused research in order to demonstrate and deliver service excellence and industry leadership in beneficial electrification and to coordinate with membership, internal departments at NRECA, and outside stakeholders to tell the cooperative story, engage members, demonstrate cross-network collaboration, and enhance cooperative communities around issues of beneficial electrification.
  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

- *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

- *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

2: Transmission & Distribution

For more information on this Work Group, please contact: Robert Harris at 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 and is presently developing a guide. 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

- *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 electric utilities that are committed to researching methods to increase reliability and lower cost of service.
  Status: In Pipeline

- *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

- *Vibration Effects on Overhead Line Splices*
  Overhead lines are constantly in motion. This investigation provides a basic understanding of the various vibration problems and structural issues that the line may experience and the impact on the performance of wire splices in use and to know how vibration affects the longevity of the line.
  Status: In Pipeline

- *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

- *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. The updated standard was published by RUS in October 2018. Status: Published

- *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

- *Operating Limit for Conductor Temperature and its Impact on Splices*
  An investigation and evaluation to provide guidelines on what operational thermal limits should be imposed on various conductor types under normal loading and emergency loading conditions (traditional ACSR and several HTLS conductors). This study specifically identifies the thermal limits and impact on the performance of splices and other line hardware as well as the technical life of conductor with specific reference to ACCR and ACCC. These advanced conductors are increasingly under consideration for reconductoring or new installations to obtain greater transmission capability.
  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. Provides reference material for advanced substation development to optimize performance.
  Status: Final

- *Station Battery System Condition Remote 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. . This study examines the potential for automated monitoring system in order to receive an exemption from manual battery inspections, and assists in formulating an effective protection system maintenance plan required by NERC.
  Status: In Progress

- *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

- *Impact on Worker Safety of DER Connected to The Distribution Grid*
  Concerns about the safety risks to line workers arising from the proliferation of DER have nagged workers and safety personnel since they first started to be installed. This study outlines basic safe work practices and how, when properly applied and carried out, they can help mitigate risks to workers without unduly increasing the burden of setting up safe work zones.
  Status: Final draft

- *Pole Attachment Guide*
  Broadband telecommunications is something co-ops across America are seeking to provide their members. Telecom providers, understandably, want to build to the most densely populated areas first since they can get the best return on investment. In their haste to connect these areas they have to pass through co-op service territories and do not consistently pay attention to fundamental design, construction and operating requirements- most notably the NESC. This often leads to inadequate clearances, overloaded pole lines and other hazards for both workers and the public. The TDEC Overhead Lines Subcommittee is working to help RUS develop a Guide which will be posted to their website and available to all co-ops and telecom providers, providing common ground on fundamental safety and operational requirements telecom providers must meet when attaching to co-op facilities.
  Status: In the pipeline

Optimize

- *Guide for Asset Replacement Strategies with an Asset Management Plan Leveraging a Risk Based Approach*
  The second phase of replacement strategies that includes development of an analytic model supported by a member distribution cooperative that will help identify which assets should be replaced and with what priority. Case studies will be based on actual data received from the participating coop and other utilities to illustrate the use of the developed models.
  Status: In Progress

- *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 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 has contributed to the development of requirements and the preparation of a roadmap for successful implementation of a demonstration Performance and Diagnostics Center, now being implemented at the host G&T, Georgia Transmission. The Center provides system performance data collection and equipment monitoring to enable critical information assessment and decision making at cooperatives to 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

- *Substation Resiliency Assessment, Design Improvement Considerations and Restoration Planning for Non-Utility Triggered Events*

  In support of enhanced system resilience, and in consideration of future substation development, 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 a wide range environmental and third-party events.
  Status: Final

Transform

- *Guide to IEEE 1547-2018*

  The final standard was published in April 2018. It increased substantially from the original version released in 2003 both in scope and detail (16 pages to over 120 as one measure) and the additional complexity make applying the standard a serious challenge for many small utilities. This Guide was published in an effort to help co-ops begin to understand key changes in the Standard to help them get started.
  Status: Published

- *IEEE 1547.1- Proposed Update & Changes to Interconnection testing*

  Revisions to the base standard above required that the accompanying Testing Standard be revised to match. The proposed revisions have increased substantially to reflect the changes to the base standard (from less than 60 pages to over 250) and is being balloted now. The sheer complexity and volume will make this revised standard a challenge for co-ops to follow and will likely result in extensive use of consultants and contract testing services for new DER in order to comply.
  Status: Expect publication by end of 2019

- *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: Final Draft Under Review

- *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

- *Innovative Aesthetic Transmission Structures for Better Public Acceptance*

  This investigation is focused on applications of the innovative structures that are more compact, visually acceptable and have lower environmental impact, including costs and benefits versus the conventional structures currently in use throughout the industry.
  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

- *Guidelines for Optical Ground Wire Technology*

  The objective of this research is to report on current design and installation practices of OPGW and associated hardware on existing and/or new overhead high voltage transmission lines. The study provides an overview of industry standards, current "knowledge gaps" on both cables and hardware design, and recommends mitigation strategies to close these gaps. It provides knowledge of OPGW construction, design constraints, performance-driven specifications, compliant hardware, and specific installation parameters, with lessons learned and "best practice" guidelines that will support optimization of OPGW networks.

  Status: Final

- *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.

3: Generation, Environment, and Carbon Work Group

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

The $GECO_2$ 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

- *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

- *Best Practice Guidelines for Pressure Part Management*
  This Report has been produced as Guidelines for best practices that may be adopted for the safe and economical operation of pressure components in fossil fired power plants. A variety of pressure vessels have been covered ranging from headers and steam drums to boiler and HRSG tubes, valves, pumps etc. The report explains the challenges experienced by these components related to the operating heat flux and attendant metal temperature and pressures that vary within fired and non-fired components. This is then followed by the description of the degradation mechanisms and the rate at which damage may affect these pressure parts. Damage mechanisms have been discussed in detail with the industrial examples of various components and materials of construction and how they are affected. Remedial steps needed to ameliorate such damage have been discussed in detail with various examples and how practically such problems can be resolved.
  Status: Final Draft is available

- *Best Practice Guidelines for Operation and Maintenance of Steam Turbines*
  This report discusses the task of the steam turbine converting steam energy into motion and electricity is explained including why, compared to a reciprocating steam engine, it is perfectly suited to driving a generator. This report provides an understanding of the basics of steam turbines for those less familiar with their application and later chapters delve into their constructional, operational, maintenance and thermodynamic complexities. Damage mechanisms are identified and mitigation strategies are developed to reduce the chance of steam turbines failures and costs for O&M.
  Status: Final Draft is Available

Optimize

- *How Low Can the Cost for Solar PV go?*
  A CEATI SOIG study has evaluated all of the current technology developments that will continue to drive the cost of Solar PV down like single and dual axis tracking, improved solar cells, lower cost installation methods, etc. and then projected the capital cost and levelized cost of electricity (for different financing solutions) for residential, commercial, and utility scale solar PV from 2017 thru 2030 for San Diego, Atlanta, Calgary, and Toronto (and they have developed an Excel spreadsheet with default economic data by components for Solar PV-modules, inverters, interconnection, etc. and financial assumptions that can be modified and input.).
  Status: Final

- *Generator Maintenance and Condition Assessment Guide*

  A final 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

- *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 CO_2 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: Ongoing

- *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 CO_2 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. Recently MTR has 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

- *CEATI SOIG Technology Database*

  CEATI SOIG is continuing to develop a technology database for Solar PV, Energy Storage, Wind, Advanced Nuclear, Carbon Capture, Carbon Utilization, Off gas monitoring of Li ion battery overheating, Electric Vehicles, etc. The data base has collected information on the companies (over 50 battery, thermal energy storage, pumped hydro storage, etc.), company contacts and web sites, description of the technology, etc. This is a continued work in progress that is on the CEATI SOIG portal.
  Status: In progress

Joined 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 CO_2 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. We view this relationship as a pipeline for the Wyoming ITC. Technology providers who are successful at a small pilot scale in NCCC are invited to interact with Cooperative G&T members for future larger scale testing opportunities prior to full scale deployment.

Benefits

- Partners receive summaries of technology evaluation and performance results. These results can be shared with all Cooperatives across NRECA.
- NRECA has 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. Additional cooperatives may attend with NRECA.
- 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, 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 CO_2 capture technology.
- The opportunity (at own expense) to provide a suitable candidate to work as part of the NCCC Project Team.
- 3-year Agreement finalized May 2019.

➢ *Thermal Generation Interest Group (TGIG)*

NRECA in 2018 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

- *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.

4: Analytics, Resiliency and Reliability Work Group

For more information on this Work Group, please contact: David Pinney at 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: Ongoing

- *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: Ongoing

- *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, an overview of cooperative financial performance, and fact sheets 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: Ongoing

- *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.
  Status: Ongoing

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.
  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.
  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
  Status: Final

- *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
  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: Final

- *Mitigating Phase Unbalance Using Photovoltaics (MPUPV)*

  High penetrations of distributed solar PV continually change the net loading on each phase, resulting in time-varying phase unbalances that can damage three-phase devices and violate grid codes. Argonne National Laboratory, in partnership with NRECA, is leading a project to develop control strategies for solar PV inverters that mitigate power quality issues related to phase unbalance. Specifically, this project will use the Steinmetz circuit concept to motivate real-time control actions for the reactive power outputs of solar inverters in order to achieve the goal of balanced operation at specified system locations. The project will study a variety of approaches for achieving this goal, including a decentralized approach that is solely based on local measurements, a grouped approach that considers small sets of loads and PV generators, and a

centralized approach that leverages measurements from a variety of locations, including smart meters, in order to compute optimal setpoints for each inverter. The resulting controllers will be computationally evaluated on actual distribution system models obtained from a variety of NRECA members. The resulting techniques and models will be available to all NRECA members.
Status: In Progress

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
  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.
  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.
  Status: In Progress

- *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.
  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*

  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.

5: Cybersecurity Work Group

For more information on this Work Group, please contact: Cynthia Hsu at 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 are 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 website.
  Status: In Progress

- *RC3 Cybersecurity Self-Assessment Do-It-Yourself Toolkit*

  Many cooperatives have few or no information technology staff and face unique challenges in developing and implementing a cybersecurity program. The RC3 Self-Assessment Research Project has developed the RC3 Cybersecurity Self-Assessment Do-It-Yourself Toolkit to help cooperatives conduct an assessment of their existing cybersecurity capabilities. These resources allow co-ops to baseline their current capabilities and document progress over time. The RC3 Cyersecurity Self-Assessment Toolkit was released in late 2018 and more than 250 cooperatives had downloaded the Toolkit as of June 2019.
  Status: Final

- *RC3 Cybersecurity Tabletop Exercise (TTX) Toolkit*

  Tabletop exercises (TTX) for cybersecurity provide a structured opportunity for cooperatives to test the organization's ability to assess and respond to a potentially damaging cyber incident. The *RC3 TTX Toolkit* includes a user guide, checklists, situation manuals, and a sample set of a dozen cybersecurity scenarios for a variety of skill levels within the cooperative community. With the *RC3 TTX Toolkit*, cooperatives will be able to test and validate their organization's incident response plans and capabilities, as well as identify existing gaps and areas for improvement.
  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.
  Status: Final

- *Improving the Use of Cybersecurity Assessment Providers through RC3*
  In 2017, the RC3 Team created a cybersecurity class focused on how to hire a security assessment provider. The course was originally offered at NRECA's Cooperative University – a professional development program for cooperative utility employees. Since then the RC3 Team has offered the course on how to hire a security assessment provider four more times, providing training to more than 70 cooperative staff.
  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), participated in National Cyber Security Awareness Month (NCSAM) in 2017 and 2018. 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 2019.
  Status: 2017 & 2018 Final, 2019 In-Progress

- *RC3 Cybersecurity Summits: Addressing Cybersecurity Risks*

  The RC3 Program sponsored eleven RC3 Cybersecurity Summit: Addressing Cybersecurity Risks, providing cybersecurity training to cooperative staff from more than 230 cooperatives. More than 25% of our member utilities attended an RC3 Cybersecurity Summit. The RC3 Cybersecurity Summits were free and funded by the U.S. Department of Energy. Resources and presentations from the RC3 Cybersecurity Summit series are available on the RC3 website.
  Status: 2017, 2018 & 2019 Final

- *Improving Cybersecurity Information Sharing in the Co-op Community through RC3*

  Information sharing is a critical component of cybersecurity awareness for NRECA's members and the security of the nation's grid. The RC3 Program has partnered with the Electricity Information Sharing and Analysis Center (E-ISAC) to ensure that cybersecurity information sharing discussions are part of every *RC3 Cybersecurity Summit*. The sessions help cooperatives understand what information to share, with whom, and when.
  Status: Final

- *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 three Security Education Week trainings. These were weeklong cybersecurity training programs 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 two opportunities 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. A third opportunity to participate in planned for October 2019
  Status: 2017 & 2018 Final, 2019 in Progress

- *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. The RC3 Program has offered opportunities to participate in the RC3 SANS Voucher Program twice and more than 70 cooperatives were selected to take SANS training courses for free, funded by the U.S. Department of Energy. NRECA offered a third opportunity to take part in the RC3 SANS Voucher Program in spring 2019 View information about the Program.
  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 a brief summary. 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.
  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.

6: Resource Adequacy & Markets Work Group

For more information on this Work Group, please contact: Michael Leitman at 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 2017. 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: Final

- *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 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

- *The Economic Impact of America's Electric Cooperatives*

  This study, jointly commissioned by NRECA and NRUCFC, and conducted by FTI Consulting, finds that co-ops supported nearly 612,000 American jobs and contributed $440 billion in U.S. GDP from 2013 to 2017, or $88 billion annually. It quantifies what many rural American families and businesses know well—electric cooperatives are powerful engines of economic development in their local communities. From 2013-17, electric co-ops contributed $881 billion in U.S. sales output, $200 billion in labor income and $112 billion in federal, state and local tax revenues. Over the same period, electric co-ops spent $359 billion on goods and services across the economy, including $274 billion on operational expenditures, $60 billion on capital investments, $20 billion on maintenance, and $5 billion on credits retired and paid in cash to consumer-members under the membership structure of cooperatives. BTS is building on this study to build in-house economic impact modeling capability.
  Status: Final

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 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.
  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.
  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 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
  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

- *Unlocking the Value of Broadband for Electric Cooperative Consumer-Members*

  Many areas served by electric cooperatives are characterized by low population density causing broadband deployment costs per cooperative household to be so high that private carrier returns often cannot justify the costs. Approximately 6.3 million electric co-op households, totaling 13.4 million people, lack access to adequate, high-speed broadband service (25/3 Mbps). Over a 20-year period, the estimated loss in consumer-member value due to lack of broadband deployment to electric cooperative areas is more than $68 billion. The deployment of retail broadband to unserved electric co-op areas can also enable additional community and network benefits beyond the $68 billion of value for individual consumer-members.

- *Electric Cooperatives Bring High-Speed Communications to Underserved Areas: Insights from NRECA's 2018 Twelve Broadband Case Studies*

  Electric cooperatives of all sizes and in many regions across the United States are building broadband communication networks, a focus seemingly beyond their traditional mandate. These networks enhance electric grid operations and member services, and just as significantly bring much-needed, high-speed Internet access to their communities. Numerous lessons can be learned by carefully examining experiences of electric cooperatives that have entered the broadband business. This report looks at twelve electric cooperatives profiled by NRECA during 2018 to learn from their bellwether successes (and challenges) in broadband.

- *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*

  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.

7: Management Services Work Group

For more information on this Work Group, please contact: Ginny Beauchemin at ginny.beauchemin@nreca.coop

Management Services Work Group provides targeted services to help member Cooperatives navigate through the industry's emerging challenges. Through our services, we work closely with NRECA member systems to provide them the methods, tools, analysis and improvement plans that ultimately translate to higher value to their membership.

Projects, Products and Services

Market Research

- *Member Satisfaction Studies*

  This research is designed to gauge members' satisfaction and commitment to the co-op and help them understand what it is about their service that causes members to be more or less satisfied. Using residential member survey data from the co-ops we serve, we can compare a co-op's survey results to others nationwide. This helps co-ops benchmark their performance against others. For Touchstone Energy co-ops, we will include the necessary questions to have your American Customer Satisfaction Index (ACSI) calculated.

- *Member Engagement & Loyalty Studies*

  Member Engagement & Loyalty Studies help Co-ops to assess, analysis and increase member engagement and loyalty, a key function of the communications department. The Member Loyalty Index (MLI) is a statistically significant and reliable measure of member engagement and loyalty. The MLI also measures a member's emotional attachment to their co-op. Increasing emotional attachment is the key to increasing member trust in the co-op, consumer-member identity, and willingness to take grassroots action on behalf of the co-op. The Member Loyalty Index consists of four measures which survey participants are asked on a likert-type scale. These four measures are then collated to create your MLI score.

- *Communication Studies*

  The communications and readership studies utilize surveys to help co-ops determine how best to communicate with members. These surveys may assess preferred methods of communication (print vs. online), topics of interest and overall awareness of the information included in your magazine or newsletter. By establishing reader preferences, likes, and dislikes, these studies provide actionable results that co-ops can use to improve and strengthen member communications.

- *Product and Service Concept Testing*

  With the increased focus on providing products and services beyond just electricity, the need to obtain consumer feedback on products and services that the co-op may offer has become increasingly important. Surveys are designed to understand member interest in products, test price points, as well as collecting information about competitors in the market.

- *Renewables and Energy Efficiency Studies*

  Finding the right message to communicate the co-op's products and services is one of the big challenges that marketers and communicators face. Communicating a co-op's emerging energy programs is no exception. One of the keys to creating a message that will resonate with your members is to understand their views on renewable energy. A common tool used in traditional marketing is customer segmentation. Consumer packaged goods companies invest heavily in understanding who their customers are and how they think about their products. They use this information to build messages that "speak" to the way those customers think and behave. Effectively communicating an energy project is no different. Market research can help co-ops better understand their members by using a segmentation model:

- *Collaborative Market Research Studies*

  Electric co-ops strive to fulfill the 6th Cooperative Principle, Cooperation Among Cooperatives. NRECA Market Research Services can help co-ops achieve this principle by working to design a research program that brings multiple co-ops together in a collaborative environment. We have worked with a number of systems in the past 10 years to bring co- ops together to conduct joint research and user group meetings and to share results and best practices.

- *Appliance/Electric Use Surveys*

  Market Research offers survey options for G&Ts that are interested in conducting usage surveys across the consumer members of their distribution co-ops. These surveys are often conducted every 5 to 7 years and collect information regarding the number of appliances and major electronic devices in homes along with information on HVAC systems and energy efficiency efforts taken by consumers. We offer G&Ts options for conducting mail, online, or a combination of mail/online surveys to meet these needs.

- *Association Member Surveys*

  Member satisfaction and engagement are critical areas for any organization and more G&Ts and Statewides are turning to formal assessments to measure satisfaction levels and evaluate the services and programs they offer. Market Research Services offers research capabilities allowing these organizations to conduct studies with key stakeholders at their member systems. These studies are designed to provide valuable insights into member's perceptions and attitudes and include evaluations of overall satisfaction and perceptions of the value provided for the member's investment along with an assessment of the additional service provided by the organization (i.e. IT support, HR services, etc.).

- *Employee Engagement and Satisfaction Surveys*

  Engagement studies are designed to measure an employees' emotion attachment to the organization and focus on the components most important to an employees' performance within the organization. The survey works to measure what make the employee passionate about their job. Attributes commonly measured in an engagement study include: resource/workload perceptions; job fit; meaning and purpose; management relationship; empowerment; accountability; and teamwork. Employee satisfaction surveys are designed to provide general feedback related to an employees' satisfaction with a number of attributes, including but not limited to: their job; total compensation; their job duties, interactions with supervisors; and general policies. The results of the study provide general indicators of overall satisfaction and issues related to retention.

- *Organization Culture Assessment Surveys*

  Recognizing and understanding how the current culture enables or hinders performance results is the first step to improve it. We provide a service to measure and assess the current state of the co-op's culture using a diagnostic survey tool that measures the strengths of agreement under six key factors. The results from this 30-question confidential online survey are analyzed assessing strengths and gaps by organization level and work environment. The overall results capture the current levels of perceived influences that shape the current culture and establish a baseline for continuous improvement

Executive Search Services

The Executive Search team continues to be a key player in CEO/GM placements and Senior Staff searches for cooperatives. The integration of a 365-day guarantee and a first-year appraisal creates a strong value-add. Ensuring that we are meeting the divergent needs of our membership, our traditional approach to Executive and Senior Staff searches as a comprehensive solution continues to be available as we create additional solution tiers and advisory services. Key to this intiative will be the integration of the NRECA leadership competency model in the Position Qualification, Candidate Screening and Interviewing processes.

Closer integration with Management Services solutions such as talent and leadership coaching, organizational assessments, cooperative staffing analysis, succession planning and culture assessments will be critical to address greater cooperative needs and to present a holistic approach to meeting members where they are.

Lastly, utilizing a consistent, yet flexible, competency model sets up expansion into industries and organizations that are similar to our membership, such as public power and DER organizations.

- *3 Tiers of Search Services*

  Recognizing that not all cooperatives are inclined to choose our historical comprehensive Executive Search service, we provide 3 tiers of Executive search to help guide and facilitate searches for a greater range of cooperative needs. For those cooperatives that need additional information in how to get started, they will be able to use our multiple toolkits, checklists and tip sheets available through cooperative.com. Examples include the following:

  - Checklists and Tip Sheets: Interview Tips, Management Contract Tips, 21st Resume tips, Hiring an Executive Search firm; Going it alone v using a Search Firm
  - Toolkits: Steps to a Successful Search, How to conduct Board Assessments, How to conduct CEO/GM assessments, Roadmap to Onboarding, Strategic Planning, Succession Planning, Using the NRECA Competency Model

  The next level up includes the cornerstone of any search process, that of Position Understanding for the cooperative's next leader. Using our Leadership Profile Questionnaire (LPQ) that aligns with NRECA's Leadership Competency Model, we work with the cooperative's board or hiring team to ensure that there is consensus understanding of the qualifications needed for success in their next leader. Cooperatives that are positioned with in-house or Board expertise in Candidate Generation, Screening and Interviewing can then use the LPQ to direct their efforts. They also have the option to engage NRECA in any of the

post-LPQ services to augment their search on a menu basis.

Cooperatives that want the security and expertise of a third-party consultant can still use our Comprehensive Executive Search solution that encompasses the search process from Position Understanding to Candidate Interviews and Negotiations. This comprehensive approach provides the ability to create a level playing field particularly if there are internal candidates, further ensuring that a strong fit for the position.

- *Executive Search Advisory Services*

  Executive Search Services provides additional Leadership and Talent Assessments to further ensure that you are hiring the right person for the right job. The results of these assessments can also be used as the basis of new Leader and Senior Staff coaching in addition to team development. Executive Search Advisory Services also offers Leader Appraisals, New Leader Onboarding, Goal Setting, Competency Model alignment and Resume/Cover Letter/Social Media Review.

Human Capital Services

The Human Capital group is a new program, expanding beyond the scope of compensation to building programs and services that add value for our membership in the Human Capital arena. Planning for human capital is a strategic imperative, especially in today's rapidly changing environment. Human Capital is typically a cooperative's second largest cost, after the cost of power supply. At NRECA we help you manage your Human Capital effectively and efficiently, by providing you with the tools, guidance and consulting you need to increase your organization's effectiveness.

- *Leadership & Strategy*

  Leaders drive strategy, culture and Human Capital direction. We work with leaders to develop their leadership skills, employing a 360-feedback assessment tool. Our approach combines the 360-survey feedback with ongoing coaching to help leaders achieve cooperative goals, and their own personal leadership goals. Executive coaching benefits leaders by helping you increase your self-awareness, learn new ways to respond, leverage your existing strengths, build productive relationships, and motivate your teams.

  The NRECA Difference - we focus on results. Our experts focus on helping you create Actionable Strategic Plans – partnering with you to develop action plans that drive the strategic objectives deep into the organization: aligning department, team and individual goals, and coaching managers to ensure goal completion and metrics achieved.

- *Creating Intentional Cultures*

  Culture defines your organization. It is also critical to business success. Culture is a competitive advantage when attracting and retaining top talent – high performing employees want to work at an organization that recognizes performance, supports accountability and where everyone is motivated to do their best. Culture is not a one size fits all strategy – leaders define their desired culture and align their people management practices with that culture. We assess your current culture using our customized NRECA Market Research culture survey; identifying gaps between the current state and desired state. We then facilitate action planning, developing goals and timelines, helping you create a culture that aligns with your business strategy.

- *Strategic Workforce & Succession Planning*

  We offer a systematic approach to analyze and your future workforce needs, current workforce and identify strategies to address gaps. Our approach proactively assesses leadership transitional risk, critical job roles and talent capabilities to help Cooperatives actively plan for future workforce needs consistent with the organization strategic direction. After assessing your overall workforce needs we emphasize effective succession planning to minimize the impacts from the pending risk of losing critical knowledge, specialized talents, and essential leadership capabilities. Strategic Workforce & Succession planning ensures that you get the right people, at the right time, with the right skills.

- *Talent Management*

  Talent Management is key to a successful organization. We will work with you to develop talent management strategies and implementation plans that help you attract and retain staff. Development is a critical retention driver; employees want to know that you are invested in their success and that you support their career goals. We can help you build development strategies, build career ladders. Performance management is also critical to ensuring employee success. We build customized performance competency models, outlining the behaviors expected within each competency and driving positive employee behaviors.

- *High-Performing Teams*

  The goal of team coaching is to shift the culture of the team and increase their focus on collaboration and results. The team coaching approach is more than a team building event. It is a methodology that examines the team's positivity and productivity; supporting the team in addressing issues that are critical to the team's performance. We use a globally recognized assessment tool to provide insights into teams. After receiving the assessment results we work with the team to increase their ability to work together to achieve results. We provide on-going coaching for the team for the first six months through conference calls or on-site visits to reinforce the actions steps and accountability for the team and support the team's on-going development.

- *Targeted Functional Assessment*

  These assessments assist Cooperatives to recognize the critical issues and outline high level improvement actions to achieve measurable improvements on key functional areas within the Cooperative. These tailored assessment services are facilitated by NRECA Consultants who have extensive field experience and best practice knowledge on the related performing areas for distribution and G&T Cooperatives. The results of the assessments serve to engage the Cooperative's key personnel to understand the current performance, recognize the underlying issues impacting performance, assess the gaps in comparison to best practices, and to identify the necessary actions for improvement.

- *Employee Engagement*

  Are your employees engaged? Are they putting forth their best efforts every day and contributing to the success of your cooperative? Employee engagement is the alignment of an employer's personal goals and interests with the vision, mission and strategic goals of their organization. The cost of disengagement is high. Gallup reports that only 33% of employees are engaged at work. Disengaged employees create a negative workplace environment, impacting their colleagues' productivity and results. We deploy our NRECA Market Research Employee Engagement Survey, taking it one step further, engaging with your cooperative to identify the critical factors that drive engagement and building action plans to improve engagement, tying engagement factors to strategic objectives so that both engagement and results improve.

- *Total Compensation*

  Total Rewards are the #1 driver of attraction and retention. Attracting and retaining the best and brightest talent can be challenging, especially when unemployment is at an all-time low. Remaining market competitive is critical. If your competitors are paying more, you need to know! A robust, best practice and defensible compensation analysis requires time, knowledge and data from multiple sources. NRECA offers a variety of compensation products and resources to help you stay competitive. Total rewards strategies; comprehensive market analysis and reports; a customized point factor compensation model that evaluates both market data and internal equity; salary structures and merit matrices; executive level compensation analysis and reports; individual market analysis for those hard to benchmark positions; and customized board director surveys and reports.

Strategic, Operations and Technology Services

- *Strategic Planning and Execution*

  We offer a facilitated-guided, structured, and consensus-based approach to guide the board and management team to develop meaningful strategic plans that address the most critical issues and challenges facing the Cooperative. We apply a structured process that encourages the decision-makers active role in setting the overall strategic direction for the organization, selection of appropriate strategies and related initiatives, development of performance scorecard and framework for effective strategy execution.

- *Technology Planning*

  Our technology planning service emphasize a collaborative approach covering the following four phases: (1) establishing a technology direction (what technology direction best positions us to meet our strategic vision?); (2) conducting a technology needs assessment (what are the critical technology needs and capabilities essential to achieve this direction?); (3) organizing technology priorities and roadmap (what are our technology priorities and how do we proceed?); (4) establishing a technology governance structure (how do we manage to ensure successful outcomes?). Each phase provides for specific deliverables, which collectively contribute to the formation of a comprehensive strategic technology plan. The plan provides the framework for the Cooperative to identify the appropriate technology initiatives that best meet the needs of the organization and its members.

- *Grid Technology Planning and Deployment*

  We provide subject matter experts and related services to assist the Cooperatives in the planning, evaluating and supporting the deployment plan of AMI, MDM and other grid and operating related technologies. We provide specific support services that guide Cooperatives to address complex technology issues including aligning the technology investment to the strategic priorities; business case modeling of technology investments; selecting right technology solution partner; addressing the essential system integration with other core applications; aligning technology with business process; and supporting the successful execution of the technology deployment.

- *Organization Assessment*

  This service involves a comprehensive and objective analysis to assess all aspects of the organization's structure, functions and operations including the alignment of resources, staffing levels, and effectiveness of business practices. The outcomes of this service include the assessment conclusions, identification of performance gaps and an improvement plan to strengthen organization effectiveness to achieve higher performance results in such critical areas as safety, reliability, service, cost efficiencies, leadership, technology, core business processes, and workforce development.

- *Business Process Improvements*

  We offer a structured program that engages employees to apply improvement techniques to analyze and improve business processes. We emphasize a collaborative approach to assess the current process and identify the underlying factors hindering performance. We apply best practices to redesign processes for improvements, develop a process measurement system, and formulate a comprehensive plan to manage and monitor on-going performance.

- *Mergers and Consolidation Analysist*

  The decision to merge Cooperatives or acquire a municipal electric utility requires careful and objective analysis. NRECA Management Services offers a comprehensive business case analysis service to guide and facilitate the Cooperative's decision makers through collaborative analysis assessing the synergies, obstacles, strategic value and overall financial implications. The outcomes of the business case analysis include the service, operational, and financial strategic case and well as the decision factors and proposed next steps.

Safety Services:

- *Rural Electric Safety Achievement Program*

  Rural Electric Safety Achievement Program (RESAP) is a national safety program that offers member co-ops the opportunity, on a voluntary basis to participate with other cooperatives in a continuous safety improvement process that includes a peer-to-peer onsite review of their safety efforts. This program is supported nation-wide by member co-ops and statewide associations. The program helps cooperatives receive honest feedback on strengths and improvement areas regarding their current practices, and helps co-ops build improvement plans that involve their employees and improve their day-to-day safety performance. Program resources include:

  - A co-op specific dashboard to complete and track program steps
  - Onsite observation forms and reports
  - Benchmarking safety measures
  - Internal evaluation forms and reports
  - Safety roles and responsibility forms and reports
  - Leadership commitment video
  - Other support resources

- *Commitment To Zero Contacts Program*

  Commitment to Zero Contacts, is a nationwide safety initiative to help eliminate serious injuries and fatalities due to electrical contact. The initiative encourages co-ops to review their current safety practices and provides co-ops resources to implement, as needed to meet this challenge. These resources jointly developed by NRECA and Federated Rural Electric Insurance Exchange include:

  - S.A.F.E. job-planning app – available in Apple or Goggle play stores (developed by Federated Rural Electric Insurance Exchange)
  - Videos – to explain introductory findings and rationale, and help created two-way discussion around important work practices, and examples of great implementation practices.
  - Implementation guides – that provide step-by-step considerations and suggestions to help mitigate risk
  - Commitment templates – that support individual and group commitments to the initiative
  - Graphics and other support items – logos, promotional items and implementation tools

- *Safety Improvement*

  We offer a safety improvement service that engages the organization leaders to address fundamental attributes of safety leadership culture. Our process involves a safety culture assessment and analyzing the related organizational attributes of safety to help the Cooperative's leaders to address the following:

  - What behaviors, practices and policies are driving the current culture of safety?
  - What are the primary goals and the key elements required within your safety system?
  - How do we as leaders formalize a process for continuous safety improvement?
  - What safety management structure is needed to maximize employee involvement and ensure safety expectations are followed up on.

  We facilitate a planning workshop with organization leaders assessing the current culture of safety, reviewing leading safety practices and formulating safety improvement strategies. We emphasize strategies that promote employee and leadership engagement; pro-active practices to reduce risks, and enhancing drivers of safety culture to sustain top safety performance levels.

8: Articles and Advisories – 2019 to Date

NRECA's Business and Technology Strategies *Surveillance* articles and *Advisories* provide up-to-date reviews on an array of energy issues affecting cooperative members. Below is a summary listing of those issued in 2019 to date. You can find the full articles and advisories of these highlights below through the links provided:

Analytics

- Advisory: Project Advisor Opportunity CIGAR (inverter cybersecurity)
- Advisory: NRECA's Co-op Technology Survey (Invitation to Participate in the Updating of the 2013 Survey)
- Advisory: Project Advisor Opportunity - PV Power Quality Phase Balance

Cyber Security

- Advisory / Factsheet: RC3 Cybersecurity Self-Assessment Do-It-Yourself Toolkit
- Advisory: Tabletop Exercises in Cybersecurity Help Cooperatives Prepare for 'The Real Thing' (New NRECA RC3 Cybersecurity Toolkit To Be Available Soon)
- Advisory: Cooperatives Are Gaining Cybersecurity Skills with the RC3 SANS Voucher Program
- Advisory / Factsheet: RC3 Cybersecurity Tabletop Exercise (TTX) Toolkit
- Advisory / FAQ: RC3 Cybersecurity Tabletop Exercise (TTX) Toolkit
- Advisory / FAQ: SANS Voucher Program (Cohort #3)

Distributed Energy Resources

- Article: Electric Vehicle Charging Control Strategies
- Article: Evolving Energy Efficiency Programs to Incorporate Beneficial Electrification and Demand Response (Public Utilities Fortnightly Article: Toward A New Energy Efficiency World Order)
- Advisory: Opportunity to Lend Input on DOE RFI On Efficient and Flexible Building Loads (link unavailable as this is a past opportunity)
- Advisory: Updated Battery Energy Storage Technology Overview Report Shows: Cooperatives Add Battery Storage Projects As Prices Fall
- Advisory: Spotlight on Community Assistance Programs: Meeting Core Community Needs Through Innovation - *Advancing Energy Access for All*
- Advisory: Advancing Energy Access for All – Case Study: Cherryland Electric Cooperative

Generation, Environment, & Carbon Dioxide

- Article: Advanced and Emerging Technologies for Wind Generation
- Advisory: Wind Turbine Leading Edge Erosion
- Advisory: NRECA Joins the National Carbon Capture Center (NCCC)

Resource Adequacy & Markets

- Advisory: Strategic Sourcing Case Study: Sandhills Utility Services (Cooperative Opportunities To Work With The Military)
- Advisory: Innovations in Pricing - Energy Service Subscription Pricing
- Advisory: Analysis of 2017 Cooperative Retail Fuel Mix
- Advisory: Electric Co-op Fact Sheet
- Advisory: DOE Funding Opportunity for Energy Infrastructure Deployment on Tribal Lands
- Advisory: Broadband Case Study: Allamakee-Clayton Electric Cooperative
- Advisory: Broadband Case Study: Blue Ridge Mountain Electric Membership Corporation

Transmission and Distribution

- Article: Revision of IEEE Standard 1547.1® (The DER Interconnection Testing and Verification Standard)

  Advisory: Station Battery Update - National Fire Protection Association Standard 855 for Energy Storage