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By Michael Matz

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NRECA
America's Electric Cooperatives

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SUBJECT MATTER EXPERT ON THIS TOPIC

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ARTICLE SNAPSHOT

WHAT HAS CHANGED?

Ammonia production today is largely powered by fossil fuels. There is growing interest in producing zero-carbon or "green" ammonia using renewable energy sources such as wind and solar. Green ammonia has several potential uses that could significantly contribute to the efforts of electric cooperatives to decarbonize their grids and integrate variable renewable energy. These include transportable energy storage, transport fuel, and hydrogen carriers.

WHAT IS THE IMPACT ON ELECTRIC COOPERATIVES?

With nearly $30 million in funding and participation by 20 diverse stakeholders, a new research initiative in Minnesota is investigating numerous aspects of green ammonia, including production, use, commercialization, and decarbonization potential. For cooperatives, green ammonia offers potential new business models and synergies with the agricultural industry.

WHAT DO ELECTRIC CO-OPS NEED TO KNOW OR DO ABOUT IT?

Green ammonia is a potential opportunity for cooperatives to pursue beneficial electrification, enabling greenhouse gas emissions reductions across multiple industries; more reliable, cost-effective electric grid operations; and lower costs for members.

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What is Green Ammonia?

Most ammonia worldwide is produced with processes that use natural gas or coal, accounting for about 2% of total final energy consumption and 1.3% of CO_2 emissions from global energy systems—equivalent to the energy system emissions of South Africa. About 70% of global ammonia production is used to make fertilizers for agriculture. Based on these figures, ammonia represents a significant decarbonization opportunity for both energy systems and agriculture.[1] In addition, the United States imports more than $700 million worth of ammonia annually, presenting an economic opportunity for domestic production.[2]

In recent years, there has been growing interest in producing zero-carbon or "green" ammonia. This would involve electrifying ammonia production with the use of electricity from renewable energy resources, such as wind and solar or other zero-carbon sources like nuclear power. It is envisioned that there would be three primary production steps, each powered by zero-carbon energy:

- A process known as electrolysis splits water into hydrogen and oxygen
- An air separation process produces nitrogen from air
- The Haber-Bosch process combines nitrogen and hydrogen to form ammonia

A number of technical barriers need to be overcome in order to make green ammonia production cost-effective, including the following:

- Ammonia production typically does not work well with variable energy sources, such as wind and solar. Process refinements are needed to address this challenge.
- Because production traditionally requires high temperatures and high pressures, it is energy-intensive and has high capital and operating costs. To reduce costs, researchers are investigating ways to enable production at lower temperatures and pressures.
- More cost-effective approaches are needed to extract ammonia from the Haber-Bosch reaction mixture.
- Much of today's ammonia production occurs in very large, centralized facilities that produce about 3,000 tons per day. Such facilities are located close to cheap fossil fuel sources, take several years to build, and require several billion dollars in investment. To make green ammonia production viable in rural, agricultural areas, smaller scale production needs to be cost-competitive.

Green Ammonia Applications for the Electric Power Sector

Green ammonia has several potential uses that could significantly contribute to the efforts of electric cooperatives to decarbonize their grids and integrate variable renewable energy:

- **Transportable energy storage:** Green ammonia can provide zero-carbon, medium- and long-duration energy storage for distribution and transmission grid applications, such as shaving peak demand and absorbing excess wind and solar generation. Research at the University of Minnesota has shown that ammonia-based, grid-scale storage is lower cost than batteries.[3] Another key advantage is that it is transportable. Because large quantities of ammonia are produced and traded globally today, extensive infrastructure for safe, reliable ammonia storage and transportation is already well-established—much more so than hydrogen.[4] As a result, ammonia offers significant potential to cost-effectively transport zero-carbon energy by road, rail, ship, or pipeline.[5] Many ports already have

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1 Data on final energy consumption, CO_2 emissions, and ammonia fertilizer production from: International Energy Agency, *Ammonia Technology Roadmap: Towards More Sustainable Nitrogen Fertiliser Production*, October 2021, p. 1.

2 See: **https://oec.world/en/profile/hs92/ammonia?redirect=true** and **https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2019/tradeflow/Imports/partner/WLD/product/281410**

3 Matthew J. Palys, Prodromos Daoutidis, Department of Chemical Engineering and Materials Science, University of Minnesota. "Using hydrogen and ammonia for renewable energy storage: A geographically comprehensive techno-economic study," *Computers and Chemical Engineering*, Volume 136, 2020.

4 International Energy Agency, *Ammonia Technology Roadmap: Towards More Sustainable Nitrogen Fertiliser Production*, October 2021, p. 71.

5 The Royal Society, *Ammonia: Zero-Carbon Fertiliser, Fuel and Energy Store*, February 2020, p. 4.

ammonia transport terminals. When stored ammonia arrives at its destination, it can be converted to electricity either by combusting it or using it in fuel cells.

- **Transport fuel:** Green ammonia can be used as a zero-carbon fuel in gas turbines, portable internal combustion generators (also known as gensets), and fuel cells. It has a wide range of potential applications, including heavy-duty vehicles, ships, trains, and aviation.
- **Hydrogen carriers:** Relative to hydrogen, ammonia is easier and cheaper to transport and store because of its higher energy density and liquefaction temperature, as well as its well-developed transportation infrastructure. Regions with abundant renewable energy resources could potentially produce green ammonia and ship it as a zero-carbon hydrogen carrier to regions with limited renewable energy, where it would be split or "cracked" into hydrogen for use in fuel cells and other hydrogen applications.[6]
- **Thermal energy storage:** Ammonia can store thermal energy through phase changes (such as liquid to gas), potentially enabling decarbonization of heating and cooling systems. For example, UK-based company Star Refrigeration has developed a heat pump based on ammonia.[7]

For cooperatives, these uses could potentially lead to new business models and synergies with other industries. Agriculture presents particularly compelling opportunities. Spring and fall are the peak seasons for agricultural use of ammonia and ammonia-based fertilizers, while summer and winter are when green ammonia might be used to reduce peak electricity demand. This complementary timing could enable cooperatives to partner with farms and other agricultural stakeholders on green ammonia production, storage, and transport in rural areas. In addition, green ammonia can be used as a fuel to operate farm equipment and grain dryers.

In the trucking industry, green ammonia can enable electrification and decarbonization. It can be delivered to a network of hydrogen fueling stations and converted back to hydrogen for use in fuel cells in heavy-duty trucks. Similarly, decarbonization in the maritime industry is possible through the use of green ammonia for engine fuel in ships. A recent maritime industry survey by Lloyd's Register and Lloyd's List found that industry stakeholders expect ammonia to account for 20% of shipping fuel by 2050.[8] Major manufacturers like Man Energy Solutions and Wärtsilä are developing ammonia-powered engines for the maritime industry. Man expects its engines to be commercially available by 2024.

As with green ammonia production, a number of barriers with ammonia use need to be addressed. For example, fuel cells need to be more durable. While ammonia combustion in engines and turbines does not produce CO_2 emissions, it does emit nitrogen oxides (NOx) that can have adverse local environmental impacts, such as acid rain and haze. Researchers are developing approaches to reduce NOx emissions. Additionally, codes and standards will be needed for utility applications of ammonia.

A Multifaceted Green Ammonia Research Initiative in Minnesota

Fall 2021 marked the launch of an extensive set of green ammonia research projects in Minnesota. The research spans numerous aspects of ammonia production and use, with total funding of nearly $30 million (see Appendix A **"A Deep Dive into the Green Ammonia Ecosystem"**). This includes $10 million from the Minnesota legislature and more than $18 million from the Renewable Energy to Fuels Through Utilization of Energy-Dense Liquids plus Integration and Testing (REFUEL+IT) program funded by the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E). The research and development timeline is about four years.

[6] Information on ammonia's ease of transport and use as a hydrogen carrier can be found in publication: International Energy Agency, *Ammonia Technology Roadmap: Towards More Sustainable Nitrogen Fertiliser Production*, October 2021, p. 71.

[7] The Royal Society, *Ammonia: Zero-Carbon Fertiliser, Fuel and Energy Store*, February 2020, p. 32.

[8] Lloyd's Register provides engineering and technology services for the maritime industry. Lloyd's List is a maritime industry publication.

There is substantial interest in the initiative, with participation from 20 partners, including demonstrators, technology providers, potential licensors, and end users (see Appendix B **"An Impressive Roster of Participants"**). The projects integrate and build upon prior green ammonia research by many of these stakeholders, mostly funded by ARPA-E's REFUEL program. One notable example is the University of Minnesota's West Central Research & Outreach Center (WCROC), which conducts applied agricultural research for farmers and rural communities. In 2013, WCROC commissioned a first-of-its-kind pilot facility that uses wind power to produce green ammonia. Since then, it has used the facility to investigate the potential for green ammonia production in rural agricultural areas. Many of the research activities launched this fall will take place at WCROC.

By establishing and upgrading a test facility at WCROC, the initiative aims to demonstrate efficient, cost-effective green ammonia production in small-scale, modular distributed facilities that can accommodate the various size requirements of different farms and agricultural cooperatives in rural areas. This includes enabling production that can tolerate variable electricity sources. With the test facility, researchers also seek to demonstrate the technical feasibility and cost-effectiveness of several green ammonia uses, including storage, power generation, fuel, hydrogen, and heat.

The team will craft comprehensive commercialization packages of ammonia production and use technologies that are economically attractive for the agricultural and electric power industries. Researchers are investigating synergies between these two industries in the Midwest. According to WCROC's Renewable Energy Program Director Michael Reese, numerous large, refrigerated ammonia storage facilities across the Midwest are used to support application of fertilizer on farms in the spring and fall. These are shoulder seasons for utilities when they typically have light power demand and would not need ammonia for long-term energy storage. In the summer and winter, when fertilizer is not needed and power demand is high, the facilities are available for utilities to store ammonia for power generation and other uses. This potential for the two industries to share infrastructure could potentially reduce the cost of numerous green ammonia applications.

An operational small-scale, modular, flexible pilot plant producing one metric ton of ammonia per day[9] is expected to be completed in two years. An additional year is planned for testing in real-world conditions and developing business models. The next commercialization step would be to develop and demonstrate a larger plant suitable for an agricultural cooperative. This would take approximately three years.

A Perspective from Runestone Electric Association

Runestone Electric Association (REA) is a member-owned electric cooperative that serves 15,000 members in seven counties in west central Minnesota. In 2020, its electricity sales were 42.8% residential, 30.4% agricultural, and 11.7% commercial. The cooperative provides electricity to WCROC. REA and WCROC have had a long working relationship, previously collaborating on a number of research projects on distributed energy resources.

According to REA's CEO Al Haman, there is already significant ammonia storage, handling, and transportation infrastructure in REA's service territory, and the cooperative's members are comfortable and familiar with the infrastructure. A significant proportion of the storage facilities sit idle for a good percentage of the year. The potential to produce and use green ammonia for grid operations presents opportunities for REA to engage with its members and local agricultural cooperatives on ways to make better use of that infrastructure.

"We have 4.9 members per mile of line, so we have to be creative on keeping down the costs to serve our members," said REA Energy Services Manager Ryan Rooney.

REA is participating in the research initiative because it is interested in connecting ammonia-fueled portable generators to the distribution system for short-duration, high loads. This could potentially serve as a non-wires alternative to defer or eliminate traditional

grid infrastructure investments, such as new substations and reconductoring power lines. The research team is studying two specific applications for REA's grid:

1. **Corn-drying loads during harvest:** In a highly agricultural part of REA's service territory, numerous farms run large fans to dry their corn for about six weeks during the harvest season. In 2016, REA built a new substation to serve this high load because its existing grid infrastructure could not accommodate it. Researchers are investigating whether a portable ammonia-powered generator could have addressed this challenge and avoided the need for the substation. The cooperative has provided the research team with technical data on this part of its grid to inform the analysis. REA is considering this application if a similar challenge were to emerge in the future.
2. **Vacation homes around lakes:** REA's service territory has many lakes surrounded by vacation homes used most often on summer weekends. Typically, visitors arrive on Friday afternoons, turn on their air conditioners, and use their ovens to make dinner. According to REA's Haman, the resulting load spikes are manageable now. However, REA is concerned that its grid infrastructure will not be able to accommodate the load in the future if a larger proportion of the visitors drive EVs and charge their vehicles when they arrive for the weekend. The research team is evaluating whether connecting an ammonia-powered genset to the distribution grid in a lake neighborhood could address such a scenario to defer or eliminate grid investments. Haman said that the genset could potentially be moved in the winter to a different part of REA's territory with a high heating demand.

In addition to the use of green ammonia for non-wires alternatives, REA is also interested in using ammonia-based energy storage for demand management. According to Haman, potential demand management applications include power generation to shave peaks and a program to encourage commercial customers to use ammonia instead of diesel for generators.

A Perspective from Great River Energy

Great River Energy, a wholesale electric cooperative which provides electricity to 28 distribution cooperatives in Minnesota, is participating in the research initiative because of its relevance to the cooperative's long-term generation planning. It has a high penetration of wind power today, with 669 megawatts of capacity in its 2,800 megawatt power supply portfolio. It is planning for a future with a much higher penetration. Great River Energy anticipates adding 900 megawatts of wind capacity by 2025 and has set a goal of having 50% renewables by 2030.

"The decision to power our system with new sources of wind energy is in line with our mission to provide member-owners with affordable, reliable, sustainable energy," said Great River Energy Vice President and Chief Power Supply Officer Jon Brekke.

During the spring and fall when wind production is typically high and power demand low, the price Great River Energy receives for wind on the wholesale market operated by MISO (Midcontinent Independent System Operator) can be very low. The cooperative also periodically contends with grid congestion due to the significant wind production. According to Jeff Haase, who manages member services and end use strategy at Great River Energy, green ammonia production facilities sited near wind turbines present a promising option to use that low-cost wind energy and reduce the congestion. This solution has potential to increase revenue and reduce electricity costs for Great River Energy and its members.

Also notable is Great River Energy's long-standing relationship with the University of Minnesota and WCROC, including a recent project to explore electrification opportunities for the WCROC campus. As part of the current research initiative, Great River Energy is partnering with WCROC on potential green ammonia applications for the electric grid.

[9] When operating at 100% power capacity, the plant will make 1 metric ton per day of ammonia. When in load-following mode, the plant will not run at 100% capacity so its daily production will be lower.

Haase said that if green ammonia production facilities become cost-effective at commercial scale, a number of issues would need to be addressed in order to build local ammonia markets. A key would be to encourage the use of green ammonia by electric cooperatives. Power providers and other local stakeholders would need to identify locations for production facilities that have access to water, wind power, and transportation infrastructure, such as rail and road. Sites would need to be optimally located to support local distribution grid operations as well as local economic development.

There also is the question of how to encourage investment in green ammonia production facilities. "Would there be an appetite among incumbent ammonia producers that currently rely on natural gas to build large green ammonia facilities?" said Haase. "Or will an entirely new industry emerge in the Midwest to build these facilities? What policies could help?"

The Importance of Monitoring Green Ammonia Developments

There are a number of reasons why cooperatives should pay attention to the Minnesota research initiative, monitor other ammonia research developments, and consider ammonia's implications for their grid operations.

Research focus on commercialization. The Minnesota initiative is evaluating and demonstrating a comprehensive set of business models that span green ammonia production and use. The research team also is developing a license package for potential use by fertilizer companies, utilities, and logistics companies.

Significant public investment. There is high level of policymaker interest and public investment in green ammonia—at both the state and federal levels—as a tool to reduce greenhouse gas emissions.

Significant investment and research in the private sector. There is an active ecosystem of research in the private sector spanning numerous aspects of green ammonia production and use. For instance, multinational manufacturer Siemens has built a green ammonia demonstration system in the UK, and industrial giant Mitsubishi is investing in green ammonia production and developing an ammonia-fired gas turbine. U.S. company HEC-TINA developed and demonstrated an ammonia-powered internal combustion engine about five years ago. The membership of the Ammonia Energy Association—a non-profit organization that aims to decarbonize ammonia for existing and new uses—includes companies such as multinational utility Engie, Mitsubishi Heavy Industries, Shell, engineering firm Black & Veatch, and shipping giant Maersk. The broad spectrum of stakeholders involved in advancing green ammonia reflect its rapidly growing promise.

Increasing need for energy storage to enable high levels of renewable energy. In a growing number of regions, wind and solar are among the lowest cost energy sources and offer a clear path for cooperatives to achieve their decarbonization goals. As the penetration of these variable resources reaches high levels, cooperatives will need both short- and long-duration energy storage to balance energy supply and demand. Relative to batteries, green ammonia offers a lower cost approach to store wind and solar power when there is excess generation, reducing the costs of running the grid. Because ammonia is transportable, it can help avoid the need to build expensive transmission lines to deliver renewable energy from remote locations. Additionally, ammonia potentially offers a cost-effective approach to store and transport hydrogen to various parts of a cooperative's service territory.

New business opportunities and synergies with other industries. There are potential opportunities for cooperatives to work with existing fertilizer companies and agricultural cooperatives on business ventures to produce and use green ammonia. These partnerships can help decarbonize both the utility and agricultural industries by taking advantage of complementary timing: Ammonia can be used by farms for fertilizer in the spring and fall, and used by utilities in the summer and winter when electricity demand is

higher. Since green ammonia can be a drop-in replacement for conventional ammonia, there is minimal disruption for farming operations. In contrast, other routes to decarbonizing agriculture, such as changing crop production systems, are very disruptive. Growing interest in green ammonia in the trucking and maritime industries could lead to additional business opportunities for cooperatives.

A big opportunity for beneficial electrification. Green ammonia production leverages zero-carbon wind and solar power in a process that would otherwise use natural gas. At the same time, it enables applications (such as power generation, fuel, energy storage, and hydrogen fuel cells) that have the following benefits:

- Reduction of greenhouse gas emissions
- More reliable grid operations (through approaches such as peak demand reduction)
- Lower grid costs due to infrastructure investment deferral and the ability to use excess wind and solar energy
- Lower costs for customers

What Cooperatives in Other Regions Can Do to Explore Green Ammonia Opportunities

Consider your energy mix. Cooperatives that have access to inexpensive wind or solar power in their service territories or in adjacent territories could potentially use green ammonia for transportable, long-term energy storage to balance variable renewable energy and decarbonize the grid. For example, a Minnesota cooperative could use abundant wind resources in South Dakota and North Dakota to produce green ammonia and then transport it to Minnesota for various applications. A long-term, low-priced wind or solar energy contract can enable cooperatives to lock in low costs for green ammonia production.

Consider the size of your region's agricultural industry and how much ammonia it uses for fertilizer. In the United States, regions with the best wind resources are typically agricultural. The corn belt is nearly identical to the wind belt. This synergy makes it logistically easier for agricultural and utility stakeholders in a given region to collaborate on ammonia production and use. Corn production has a particularly high ammonia demand, and green ammonia can reduce its fossil fuel use by more than 90%.[10]

Consider the existing ammonia storage and transportation infrastructure in your region and how it is used. Cooperatives can leverage ammonia storage facilities if they are inactive or not fully utilized during periods of high power demand.

Understand ammonia safety concerns. While ammonia is corrosive and toxic to humans if inhaled, the ammonia industry has established safety protocols to avoid human health impacts during storage, handling, and transportation.[11] Cooperatives can take advantage of existing knowledge on ammonia safety.

Get connected with stakeholders active in green ammonia research and development. These may include companies like General Electric, universities located in a cooperative's service territory, and industry trade groups such as the Ammonia Energy Association.

Monitor the availability of federal and state research grants for green ammonia. Grants can serve as a catalyst for cooperatives to engage their members to generate ideas related to green ammonia. ■

[10] The 90% reduction in fossil fuel use is based on research by the University of Minnesota's WCROC to collect crop production energy consumption data. It assumes that green ammonia can be used to replace conventional nitrogen fertilizer and as fuel for grain drying, tractors, and trucks. See page 9 of the University of Minnesota presentation at the Minnesota Public Utilities Commission.

[11] Ash, N. and Scarbrough, T., *Sailing on solar: Could green ammonia decarbonise international shipping?*, Environmental Defense Fund, 2019, p. 39.

APPENDIX A: A DEEP DIVE INTO THE GREEN AMMONIA ECOSYSTEM

A defining feature of the Minnesota research initiative launched this fall is its comprehensive nature. More than a dozen distinct, yet related, research activities delve into a broad spectrum of green ammonia production and use issues that require attention to enable widespread commercialization.

Research activities related to green ammonia production include:

- Demonstrate a modular facility that can produce one metric ton of green ammonia per day at low temperatures and pressures
- Test process controls that can adjust production levels with varying wind power output and electricity market prices to enable load-following operation and production turndowns of up to 90%
- Test a new method developed by University of Minnesota to separate ammonia as it is produced

Research activities related to green ammonia applications include:

- Develop and demonstrate a 250-kilowatt mobile electric generator (genset) powered by green ammonia
- Evaluate the potential for use of ammonia storage and ammonia-powered gensets as non-wired distributed power generation alternatives and to stabilize the grid
- Develop retrofit options for ammonia combustion in gas turbines and conduct related modeling and economic studies
- Demonstrate a portable ammonia-fueled fuel cell to produce electricity for backup, off-grid applications, and substation support
- Demonstrate a process to crack ammonia to produce hydrogen for use in fuel cells
- Model control strategies for microgrids that incorporate green ammonia and hydrogen production, storage, and use for power generation
- Evaluate the potential to use ammonia instead of diesel in tractors
- Develop and operate an ammonia-powered forklift

Other research activities:

- Develop planning tools to couple the use of green ammonia in electric grid and agricultural operations
- Develop an ultra-safe, stationary ammonia storage system for use in high-population areas
- Quantify the costs and carbon intensity for green ammonia production and use at various production scales and geographies
- Evaluate the commercialization potential for green ammonia production and use based on analyses of competitors in energy storage, fuel, and fertilizer markets
- Evaluate policy options to support green ammonia production

APPENDIX B: AN IMPRESSIVE ROSTER OF PARTICIPANTS

A remarkable aspect of the Minnesota green ammonia initiative is the large number of stakeholders involved. Led by the University of Minnesota and non-profit research institute RTI International, twenty companies, universities, and other organizations are participating. The broad participation reflects the wide range of research activities aimed at commercializing a comprehensive lifecycle of green ammonia production and use. The team includes:

- University of Minnesota's WCROC is providing its wind-powered green ammonia production facility and is hosting and leading numerous aspects of the research at the facility.
- Swiss ammonia production technology provider Casale, RTI International, and Texas Tech University are developing various aspects of the modular production facility to optimize operations and lower costs.
- University of Minnesota's Department of Chemical Engineering and Materials Science is developing a novel technology to separate ammonia from the reaction mixture. It is also modeling supply chains and other technical and economic aspects of green ammonia, and it is conducting life cycle assessments of ammonia production and use technologies.
- Nel Hydrogen, one of the world's largest manufacturers of electrolyzers, is developing the electrolysis process for the production facility.
- General Electric (GE) is examining how to retrofit a gas turbine to enable combustion of ammonia for power generation.
- Multinational energy company Shell is analyzing the economics and commercialization potential of ammonia use for fuels, energy storage, and power generation.
- Nutrien (one of the world's largest fertilizer producers with 500,000 grower accounts) is providing operational and safety know-how and is evaluating the production facility's implications for fertilizer production. It is also a potential licensor of the facility.
- Utah-based clean energy startup Chemtronergy is demonstrating a direct ammonia-powered fuel cell.
- University of Minnesota's Mechanical Engineering Department is investigating ammonia-fueled tractors.
- The University at Buffalo/State University of New York, University of South Carolina, Gas Technology Institute (GTI), and Media and Process Technology are developing a novel ammonia cracking reactor for hydrogen production. Pacifica (a Washington state–based company that assembles various types of vehicles) is designing and assembling an ammonia-powered forklift that uses the cracking reactor.
- Electric cooperative Runestone Electric Association, wholesale energy provider Great River Energy, Otter Tail Power Company, and Xcel Energy are evaluating energy storage and power generation applications of green ammonia.
- Software company OATI is developing an approach to send price signals to the production facility so that it can adjust to variable wind output and energy prices.
- The Agricultural Utilization Research Institute (AURI) is evaluating potential business opportunities for farmers and utilities in rural regions.

ABOUT THE AUTHOR

Michael Matz is a writer and editor with decades of experience distilling insights and crafting stories from interviews with experts in a broad range of subjects, including energy, environment, policy, science, and technology. In recent years, he has gained wide-ranging expertise in utilities and energy through stints as managing editor of EPRI Journal (the flagship publication of the Electric Power Research Institute) and associate editor at Photon (a magazine covering the global solar industry). Before that, he was a science writer at the Exploratorium (a science museum in San Francisco), a consultant for the Natural Resources Defense Council, and communications manager at Conservation International.

QUESTIONS OR COMMENTS

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- To find more resources on business and technology issues for cooperatives, visit our **website**.

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The Distributed Energy Resources (DER) Work Group, part of NRECA's Business and Technology Strategies department, is focused on identifying the opportunities and challenges presented by the continued evolution of distributed generation, energy storage, energy efficiency and demand response resources. For more information, please visit **www.cooperative.com**, and for the current work by the Business and Technology Strategies department of NRECA, please see our **Portfolio**.