



For far too long, society has looked at Energy, Ecosystem and Wildlife as three separate aspects of our existence – each operating in their own circle. The results have been less than ideal. At Roeslein Alternative Energy (RAE), we believe Energy, Ecosystem and Wildlife must work together. We are building projects across the country to produce Renewable Natural Gas (RNG) from livestock waste and sustainably harvested prairie plant biomass. Rooted in the vision of our founder, Rudi Roeslein, RAE is committed to producing highly valuable clean energy while restoring our landscape and providing benefits to wildlife.



ENERGY production no longer has to be damaging to ecosystems and wildlife. RAE turns a waste product into revenue. The RNG we produce is highly valuable in the clean energy market. Especially when used as transportation fuel and credited through California’s Low Carbon Fuel Standard. The RNG we produce is a much cleaner option than traditional fossil fuels. Our system of energy production keeps dangerous greenhouse gases from entering the atmosphere, helping to alleviate climate change through a market-based approach. It is possible to produce clean energy while benefiting our landscape and all of its inhabitants.



ECOSYSTEMS do not have to suffer. RAE is restoring native prairie plants and grasses to marginal agricultural acres across the Heartland to improve soil health and water quality, while offering farmers a new source of income. Prairie absorbs water reduces flooding. This saves taxpayers substantial amounts of money. Prairie also sequesters carbon, creating opportunities to enter the lucrative carbon credit market. When sustainably harvested for energy production, these plants and grasses allow farmers to yield additional revenue from otherwise marginal land, while reducing fertilizer and insecticide runoff into our waterways.

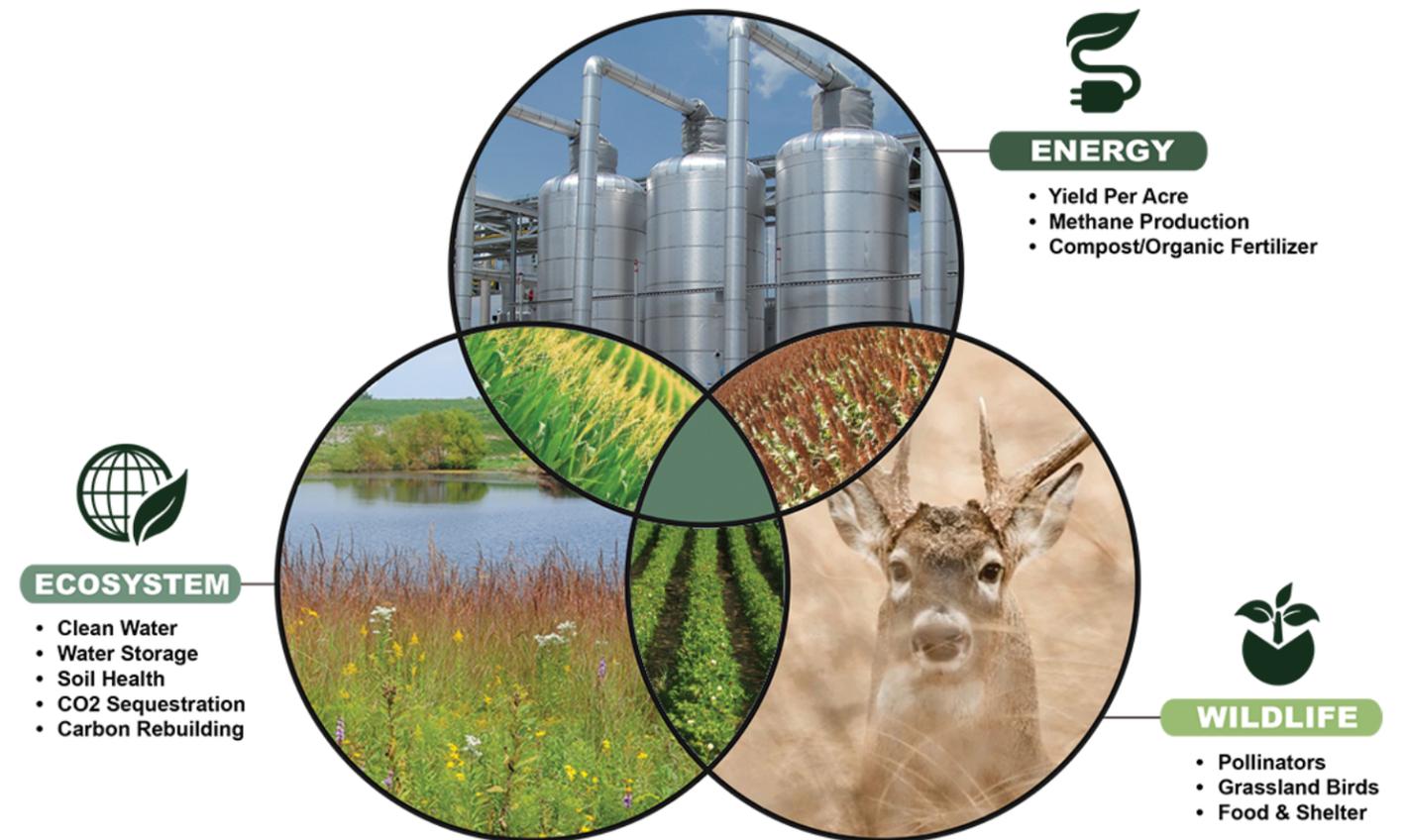


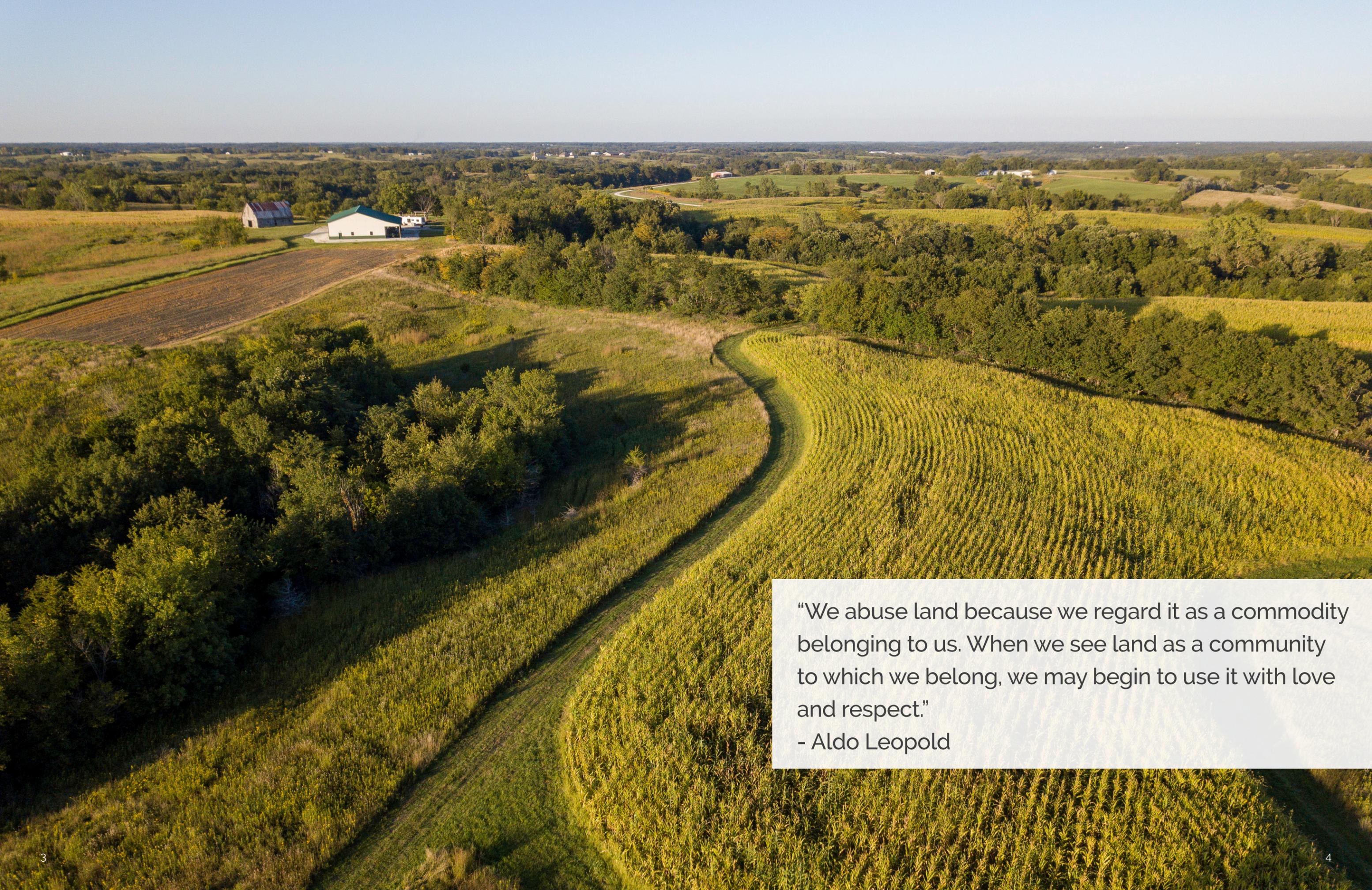
WILDLIFE needs the plants and grasses native to their ecosystem. Through prairie restoration, we are able to provide a valuable resource for birds, insects, fish and mammals. Thus, allowing populations to remain healthy while eliminating the need for stricter regulations associated with endangered or threatened species. Our emphasis on perennial grasses mimics the natural conditions for these grasslands. This helps to provide ongoing food and water resources for wildlife. Restored prairies provide the nectar insects need to pollinate food crops in nearby fields. Sustainable harvests encourage new growth which maintains biodiversity.

OUR MISSION

At Roeslein Alternative Energy, our mission is to help individual landowners and society as a whole collaboratively discover and implement alternative biomass and energy solutions. This mission will be accomplished in both ecologically and economically sustainable ways to protect and restore our environment and ecosystems.

An Alternative Solution That Restores Balance





“We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.”

- Aldo Leopold

RUDI ROESLEIN – FOUNDER & CEO

My extensive 45 years of experience in designing and building some of the most complex industrial systems around the world has taught me there are no simple solutions to complex issues but rather an integrated approach of listening to all of the stakeholders and coming up with a holistic solution that takes all of the dimensions into consideration.

If we are to solve the growing concerns of producing more food responsibly for a growing population, while also providing energy in a sustainable way to meet the growing demands of a growing global community, then conservationists, food producers, scientists, educators, farmers, policy makers, and many other interested members of our community must unite behind a sincere interest in working together to take on the challenges.

Roeslein Alternative Energy is a complex integration of technology and natural systems working together for a balanced and holistic solution that provides all three dimensions of our VENN – Energy Production, Ecological Services and Wildlife Benefits.

Anaerobic Digestion and renewable natural gas can provide an alternative to diesel and gasoline that is significantly friendlier to the environment. All the while solving problems of what to do with nutrients from animal waste that cannot be economically moved very far from the source and are typically land applied on surrounding farms.

I always ask myself Aldo Leopold’s challenge, “Does it tend to preserve the integrity, stability and beauty of the biome?” If not I must keep searching for a better solution. My vision to restore 30 million acres of native grassland and forbs around our streams, rivers, and critical uplands is an approach to solving our energy needs while considering the needs of the system as a whole. If a biomass does not provide or improve ecological services and wildlife habitat, we will just continue down this path of trying to develop a monoculture that profits one dimension while not symbiotically serving the other two. We have many cultivars with a tremendous amount of energy potential, but do they also provide ecological services and wildlife habitat? One dimension is not wholly effective without the other two.

The thing that inspired me the most about conservationist Aldo Leopold was he never condemned society or agriculture or farmers for doing what they did. Even in the dust bowl era. He chose instead to illustrate the facts in a very humanistic and artistic way that really touched my soul to try to do something. I have built upon Leopold’s approach by combining the altruistic perseverance of wilderness and finding a way to define its value in terms of economic benefits. No one who has ever immersed themselves in a true wilderness experience can put a monetary value on how it recharges your soul and stimulates your mind.

My St. Louis University 1967 National Championship soccer team had a motto, “Alone you can go fast but together you can go far.” I believe we can go far in solving the energy and environmental challenges we face and lead the way to holistic solutions for a truly sustainable way to produce food responsibly, while preserving our natural resources for this and many generations to come.



Rudi Roeslein
Roeslein Alternative Energy





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ROESLEIN ALTERNATIVE ENERGY

Roeslein Alternative Energy (RAE) is an owner, operator and developer of renewable energy production facilities that convert agricultural wastes, along with biomass feedstocks to renewable natural gas and sustainable co-products. RAE engages in these business operations with a focus on incorporating native prairie restoration. RAE is a limited liability corporation with its principal offices located in St. Louis, Missouri. RAE was launched in 2012 by Rudi Roeslein, co-founder and CEO of St. Louis based Roeslein & Associates (a global leader in engineering, modular fabrication, and construction of industrial plant facilities).



OUR VISION

Energy Production
Naturally create sustainable energy using organic inputs that are often considered waste.

Ecological Services
Work to restore the land to a more native condition to produce biofuels and deliver many other natural benefits, including clean water, clean air, healthy soil and a sustainable environment.

Wildlife Benefits
Restore wildlife habitats from biomass crops that are similar to native ecosystems.

ABOUT US



Roeslein Alternative Energy (RAE) was founded in 2012 as an operator and developer of renewable energy production facilities that convert agricultural wastes, along with renewable biomass feedstocks, into renewable natural gas and sustainable co-products.

RAE engages in these business operations with a focus on sustainability and environmental improvement. Rudi Roeslein's vision is to restore 30 million acres of grasslands on marginal lands throughout the Midwest in 30 years. Beyond that, we hope to use this as a model to restore hundreds of millions of acres of grasslands around the globe.

A rapidly growing population is causing an incredible amount of stress on our landscapes. At Roeslein Alternative Energy, we have a market-based solution to the competing demands of the need for both sustainable agriculture and renewable energy.

When land not naturally suited for agriculture is used to raise corn or soybeans; erosion, soil degradation, and water problems emerge. Ironically, the quest for additional energy often finds prime agricultural acres raising crops for fuel, rather than food. But, there is an alternative that restores balance. It creates a new sustainable energy industry, manages livestock and land resources, while delivering healthier soil, cleaner water and healthier wildlife habitat.

The solution is anaerobic digestion, which naturally breaks down organic matter in an oxygen-free environment. A byproduct is methane-rich biogas which can be converted to renewable natural gas. The remaining solids can be used as natural fertilizer and the water for irrigation.

Roeslein Alternative Energy works to preserve our lands for the future, and to show individual landowners and society as a whole we can collaboratively discover and implement alternative agriculture and energy solutions.



HORIZON ONE

Partnering with livestock producers, RAE places impermeable covers over hog manure lagoons to capture methane gas created by anaerobic digestion. The methane gas is upgraded to renewable natural gas and injected into the natural gas pipeline grid where it is available to millions of potential customers.

RAE's efforts contribute to reducing greenhouse gas emissions into our atmosphere from animal waste. By trapping the gases under covers and moving them through an onsite gas purification system and into the natural gas grid, we are combating climate change and improving local air quality.

Roeslein Alternative Energy's integrated system of renewable natural gas production uses animal waste and cellulosic biomass to produce clean energy in a sustainable manner. Our system benefits the environment and is helping turn around the economic downturn of America's agriculture economy.



HORIZON TWO

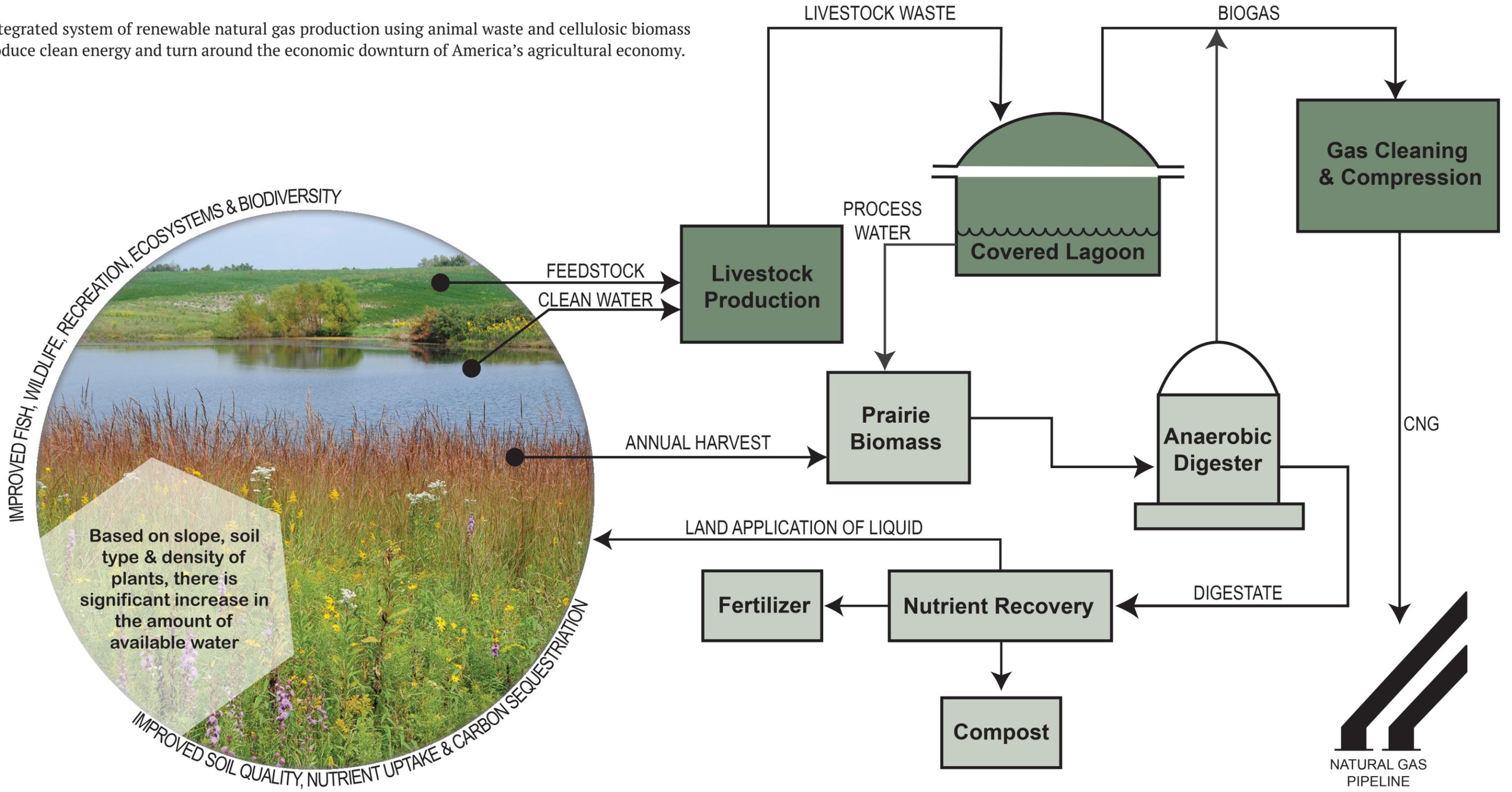
In addition to converting hog manure into renewable natural gas, RAE is converting marginal and highly erodible land back to native species polyculture prairies, which can be harvested and used as a biomass feedstock to produce even more renewable natural gas.

This underlying goal is to restore and convert 30 million acres of land to native prairie grasses in just 30 years. This vision benefits farmers economically and positively impacts surrounding ecosystems by creating habitat for various types of wildlife, providing erosion control and preventing flooding.

The deep and complex root system of native prairie plants sequester carbon in the soil and absorb large quantities of water from rain falls, combatting downstream floods.

HOW IT WORKS

An integrated system of renewable natural gas production using animal waste and cellulosic biomass to produce clean energy and turn around the economic downturn of America's agricultural economy.



MONARCH BIOENERGY

Smithfield
Good food. Responsibly.®



Smithfield Foods, Inc. and Roeslein Alternative Energy have formed a joint venture called Monarch Bioenergy to produce renewable natural gas (RNG) across Smithfield's hog farms in Missouri. This partnership converts manure collected from Smithfield farms into RNG, while simultaneously delivering ecological services and developing wildlife habitat. Once complete, all Smithfield company-owned finishing farms in Missouri will have the infrastructure to produce RNG, resulting in approximately 1.3 million dekatherms of RNG annually, which is the equivalent to eliminating 170,000 gasoline vehicles.



Smithfield Foods and RAE Partner to Produce Renewable Energy while Restoring Missouri's Natural Environment

Joint Venture Transforms Manure, Prairie Plants, and Cover Crops into Renewable Natural Gas

St. Louis, MO (April 24, 2019) – Smithfield Foods, Inc. and Roeslein Alternative Energy (RAE) have formed a joint venture called Monarch Bioenergy to produce renewable natural gas (RNG) across Smithfield's hog farms in Missouri. This partnership converts manure collected from Smithfield farms into RNG, while simultaneously delivering ecological services and developing wildlife habitat. Once complete, all Smithfield company-owned finishing farms in Missouri will have the infrastructure to produce RNG, resulting in approximately 1.3 million dekatherms of RNG annually, which is the equivalent to eliminating 170,000 gasoline vehicles.

"This joint venture represents our continued commitment to doing business in a way that is good for our planet and its people," said Kenneth M. Sullivan, president and chief executive officer for Smithfield Foods. "This innovative collaboration creates value for our company and our partners, and benefits the environment as we work to feed the world's growing population."

Monarch Bioenergy builds upon the successful first phase of Smithfield and RAE's groundbreaking "manure-to-energy" project across nine Smithfield farms in northern Missouri, which is the largest project of its kind. This joint venture will install and utilize infrastructure on Smithfield farms in Missouri to capture methane emissions from hog farms and convert them into pipeline-quality natural gas, which will be distributed to RNG markets across the country.

The biogas created by Monarch Bioenergy is transported through a gas gathering network and purified in a centrally located gas cleaning system designed and installed by RAE. This project produces biogas that has received the lowest carbon intensity score ever recorded. Biogas with low carbon intensity, such as that created by Monarch Bioenergy, reduces greenhouse gas emissions and achieves air quality benefits.

Monarch Bioenergy will also sustainably harvest native prairie plants and cover crops that have been restored on highly-erodible lands. The biomass will be digested to produce additional RNG in Missouri. This project leverages harvested prairie plants to create biomass for

RNG production while also providing wildlife habitat for monarch butterflies. These are critical components of Smithfield and RAE's holistic vision for creating renewable energy in a way that wisely utilizes land resources, prevents fertilizer runoff into watersheds, improves soil organic matter, and cools the atmosphere through natural transpiration while creating critical new wildlife and pollinator habitat.

"From their leadership in creating renewable energy and in conservation, Smithfield is changing what it means to be a food company," said Rudi Roeslein, president of RAE. "Smithfield's willingness to embrace the power of prairie proves the industry can play a meaningful role in seizing the economic benefits of conservation."

Commitment to Sustainability

This joint venture helps both Smithfield and RAE meet their companywide sustainability goals. Monarch Bioenergy is supporting RAE's goal to restore 30 million acres of land to native prairie plants strategically located around waterways, streams, rivers and highly erodible lands. Sustainable prairie plants have a valuable ecological, economic, social and environmental impact on our environment.

"We are extremely grateful that Smithfield is committed to this vision. It begins with converting methane from hog manure to renewable natural gas. But that's the tip of the iceberg. We hope to show the agriculture community, with the help of our joint venture partner Smithfield, how to take all these steps and make an enormous impact for energy, the environment, and wildlife," Roeslein said.

This project is implementing technologies to allow smaller-scale operations to implement "manure-to-energy" projects, supplemented with cover crop and native prairie biomass, to reap economic and environmental benefits. The standardized gas purification systems will be scalable, able to accommodate small to medium-sized finishing farms, and allow for incremental increases as farms grow or harvest more biomass to supplement manure.

Monarch Bioenergy is also part of Smithfield Renewables, Smithfield's platform to unify and accelerate its carbon reduction and renewable energy efforts. Launched in 2016, Smithfield Renewables helps the company meet its industry-leading goal to reduce greenhouse gas emissions 25 percent by 2025. In addition to renewable energy projects, Smithfield is implementing a variety of projects across its supply chain to support its carbon reduction efforts. To learn more about Smithfield's carbon reduction efforts, please visit smithfieldfoods.com/environment.



Smithfield Foods, Inc. and RAE
Continue Development of
Manure-to-Energy Projects in Missouri
**Projects to produce enough renewable natural gas to
power more than 2,700 homes and businesses**

Smithfield, Va., February 20, 2020 – Smithfield Foods, Inc. and Roeslein Alternative Energy (RAE) announced an additional \$45 million investment in their Monarch Bioenergy joint venture, which captures methane from hog manure to produce renewable natural gas (RNG) in Missouri. The additional investment will enable the continued implementation of “manure-to-energy” projects on Smithfield’s farms, resulting in RNG generation across 85% of the company’s hog finishing spaces in the state.

This activity builds upon the “manure-to-energy” projects currently in operation across five Smithfield farms in northern Missouri and puts the company one step closer to equipping nearly all its finishing spaces in the state with the technology to produce RNG. The continued progress underscores Smithfield’s industry-leading commitment to sustainability, and is key to achieving the company’s goal to reduce greenhouse gas (GHG) emissions 25% by 2025.

“Smithfield and RAE have been innovating ‘manure-to-energy’ technology together in Missouri since 2014,” said Kraig Westerbeek, senior director of Smithfield Renewables and hog production environmental affairs for Smithfield Foods. “Our companies have a longstanding commitment to renewable energy, and we’re thrilled to be one step closer to having nearly all our Missouri finishing farms engaged in producing RNG.”

The “manure-to-energy” projects allow Monarch Bioenergy to leverage the infrastructure of Smithfield’s farms to capture methane emissions from hog farms and convert them into pipeline-quality natural gas, which will be distributed to RNG markets across the country.

“The scale of Smithfield’s operations and our expertise in renewable energy production have created the ideal partnership to have a tangible impact on carbon emissions,” said Rudi Roeslein, president of RAE. “The latest phase of Monarch Bioenergy demonstrates our shared commitment to creating a sustainable future for families with new sources of renewable energy.” Monarch Bioenergy is part of Smithfield Renewables, Smithfield’s platform to unify and accelerate its carbon reduction and renewable energy efforts. Today’s investment complements numerous initiatives Smithfield is implementing across the country, including additional renewable natural gas projects in North Carolina, Utah and Virginia.

To learn more about Smithfield’s carbon reduction efforts, please visit smithfieldfoods.com/environment.

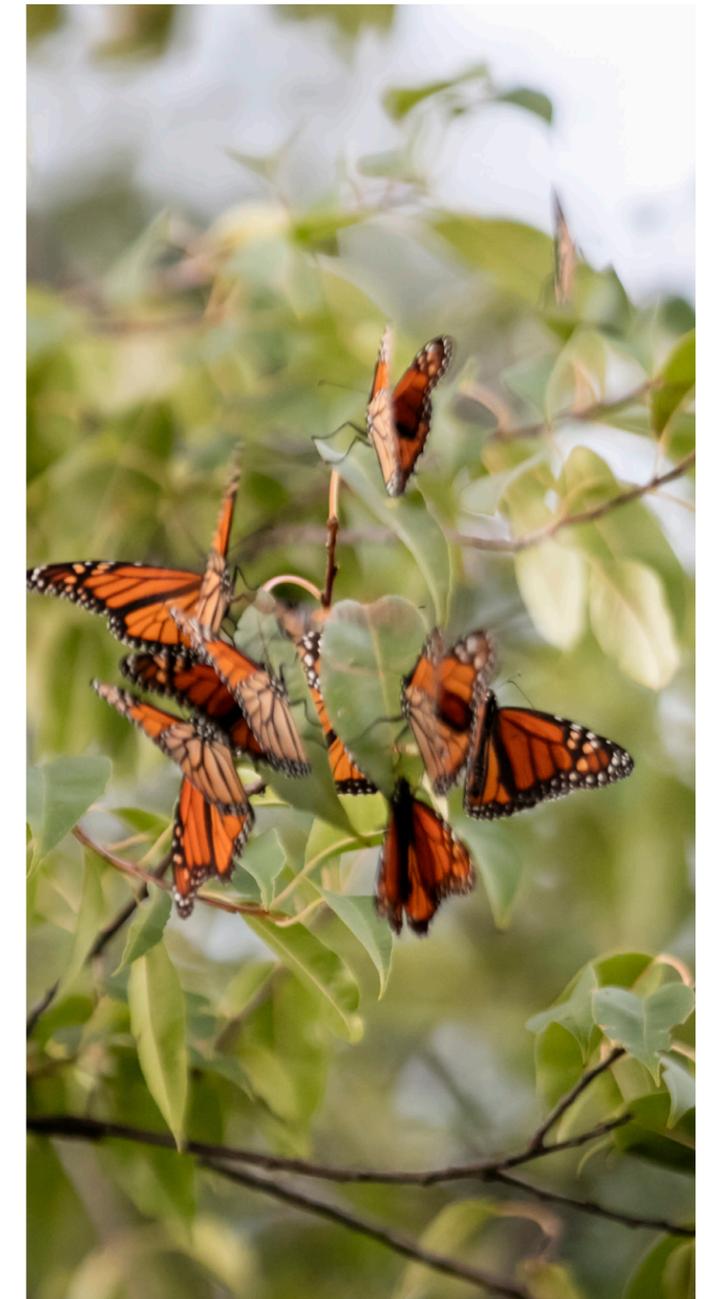
About Smithfield Renewables

Smithfield Renewables is a strategic platform within Smithfield Foods, a \$15 billion global food company and the world’s largest hog producer and pork processor. Smithfield launched this platform in 2017 to lead, unify, and accelerate the company’s renewable energy efforts to help meet its industry-leading goal to reduce greenhouse gas (GHG) emissions 25% by 2025—the first commitment of its kind by a protein company. To achieve this goal, Smithfield has implemented a wide range of projects across its farms and facilities, including converting hog manure into renewable nature gas and commercial-grade fertilizer, streamlining its transportation network, launching an ambitious solid waste reduction plan, sourcing sustainably grown feed grain, and implementing operational efficiency projects. For more information, visit www.smithfieldfoods.com/renewables.

About Smithfield Foods, Inc.

Headquartered in Smithfield, Va. since 1936, Smithfield Foods, Inc. is an American food company with agricultural roots and a global reach. Our 40,000 U.S. employees are dedicated to producing “Good food. Responsibly.®” and have made us one of the world’s leading vertically integrated protein companies. We

have pioneered sustainability standards for more than two decades, including many industry firsts, such as our ambitious commitment to cut our carbon impact by 25 percent by 2025. We believe in the power of protein to end food insecurity and have donated hundreds of millions of food servings to our neighbors in need. Smithfield boasts a portfolio of high-quality iconic brands, such as Smithfield®, Eckrich® and Nathan’s Famous®, among many others. For more information, visit www.smithfieldfoods.com, and connect with us on Facebook, Twitter, LinkedIn and Instagram.



Ecological Services

America's grasslands are of great value to our nation economically, intrinsically and ecologically. At Roeslein Alternative Energy (RAE), we are working towards our vision of restoring 30 million acres of native grass to marginal agricultural lands in just 30 years. Our vehicle to reaching this vision is renewable natural gas.

Across the Heartland, marginal lands continue to be planted in row crops with the hope of turning a profit. Rarely is this the case. As farmers lose money to input costs, the soil becomes further degraded and wildlife loses more critical habitat.

At RAE we know there must be balance. One where prime acres are reserved for corn and soybeans, while marginal lands are retuned to native prairie plants. We also know farmers are struggling to make a profit. Our market-based solution offers agriculture an opportunity to enter the renewable energy industry, while providing ecological services and wildlife benefits and a means to a healthier landscape and more robust bottom line.

By working with farmers and landowners, our vision for restoring native grasses incorporates wildlife, water quality, and carbon sequestration to create a system where the restoration of native prairie allows farmers to yield additional revenue from otherwise marginal land.

Through the harvesting of diverse prairie plants for energy applications, farmers and landowners see the economic benefits of biomass production as well as the savings earned through efficient use of the land's water, nutrients, and energy resources.

Without native plants and their deep roots, heavy rain quickly turns into runoff. The resulting floods dump fertilizers and pesticides into our waterways, degrading water quality and accelerating the Gulf of Mexico dead zone.

Roeslein Alternative Energy, with our partners in agriculture, conservation, science, education, politics and other interested members of society, is working to develop the future of responsible land management through market-based solutions that significantly improve water quality, soil erosion, nutrient losses, carbon sequestration, and soil health.

Those living in urban areas may not think about the importance of prairies, but beyond the asphalt, concrete, and glass of the city, was a country rich in prairie grasses. Roughly one-third of Missouri was once covered by tallgrass prairie, with root systems several feet long capable of absorbing and storing water deep in the soil. Roeslein Alternative Energy is working to strategically re-introduce native grasses to provide an enormous impact on the environment, wildlife and renewable energy.



THREE GOALS. ONE SOLUTION.

Roeslein Alternative Energy can turn a waste stream into cash flow while improving the environment by working with food producers and landowners to create renewable energy, sustainable wildlife habitat, and ecosystem benefits by focusing on three distinct focus areas.

- Anaerobic digestion with biogas upgrading and nutrient recovery produce renewable natural gas, fertilizer, and clean water.
- Biomass producing grasslands reduce nutrient runoff, prevent erosion, improve soil quality, sequester carbon, absorb rain, and filter water.
- Landscapes designed and managed to provide habitat, food, and shelter for wildlife and pollinators.

Our goal is to convert 30 million acres of highly erodible land to native prairie, reducing millions of tons of carbon emissions, producing billions of gallons of renewable fuel, trillions of gallons of clean water, and preserving native landscapes for future generations.



Wildlife Benefits



The diversity of a habitat is directly related to the diversity of the wildlife populations which it houses. Roeslein Alternative Energy's vision for prairie restoration calls for providing a diverse mix of prairie biomass plantings that would be similar to those grasses native to the ecosystem. All of which increase native habitat for countless wildlife species.

By planting similar grasses to those naturally found in the ecosystem, we are able to provide a valuable resource for the area's birds, insects, and animals to thrive. The emphasis on perennial grasses to mimic the natural conditions for these grasslands helps to provide ongoing food and water resources for the animal and bird populations. Restored prairies provide nectar that supports insects to benefit pollinated food crops in nearby fields.

Seasonal harvesting of the restored grasses allows for their use as a valuable biomass feedstock while encouraging new growth to maintain biodiversity.

Wildlife and Habitat Crisis

- Nature is declining globally at rates unprecedented in human history
- 1 million animal and plant species face extinction in the coming decades
- Nearly 40% of all species require urgent conservation action
- Native species in most major land-based habitats have fallen by at least 20% in 100 years



Endangered Species Act (ESA)

- 1,600+ endangered and threatened animals on the list
- 1.5 billion annual costs associated with administrating the ESA
- Burdensome and costly regulations for industry and landowners
- Broad economic costs of hundreds of billions annually
- Prairie Chicken listing estimated at 5.6 billion annual economic impact



RAE Wildlife Benefits

- Restored native habitat for prairie and grassland species
- Improved water quality for aquatic species
- Increased nutrients in soil supporting life underground
- Supports \$40 billion worth of pollinated products annually



Design & Build

Roeslein & Associates (R&A) provides engineering, procurement, and construction (EPC) services for anaerobic digestion technology and prairie restoration practices. Through rigorous front-end planning, feasibility studies, and concept definition, Roeslein is able to strategically engineer the best solution for your project.

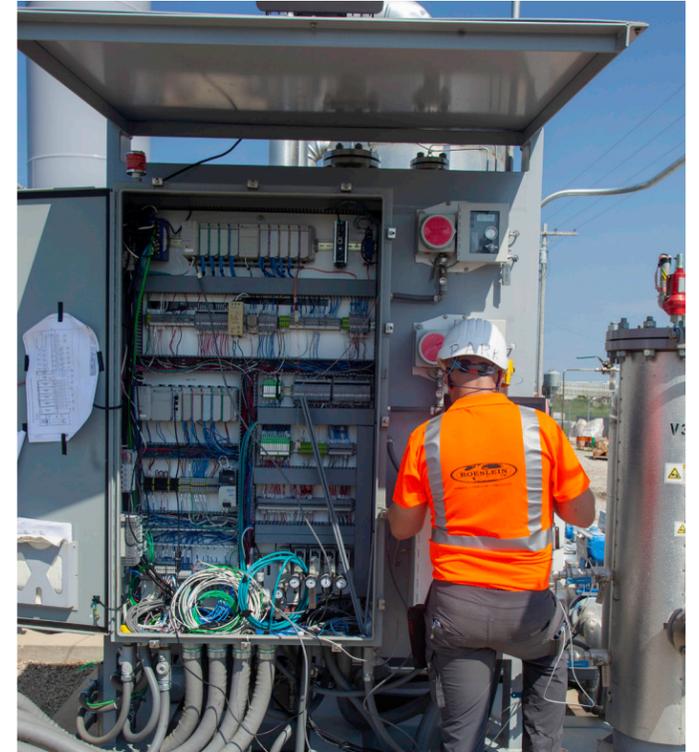
You will discuss your personalized needs and wishes with Roeslein's team of experts, not only for now but also for the future. With Roeslein orchestrating all business, finance, and technical aspects of all phases of project development, Roeslein is able to guarantee the best and quickest return on your investment while providing the optimum solution.



ENGINEERING

The professional engineering team at Roeslein & Associates uses a results-driven strategy to generate engineering and design documents with final project construction, operations, and maintenance in mind. Roeslein produces precise fabrication drawings to facilitate a consistent, turnkey experience. Roeslein's engineers follow the project from construction bidding through the actual construction and start-up, minimizing conflict that traditionally exists between engineering and construction contractors.

Roeslein's engineering approach spans the entire project scope, taking into consideration existing site general arrangements, operating production schedules, specialized site safety plans, and materials lead time that would adversely affect a project's schedule.



Roeslein’s procurement division has years of experience building relationships within the industry to ensure optimal quality and value in all goods purchased for a project. We offer a turnkey product. With a wide range of experience in sourcing everything from OEM equipment and structural steel, to piping and electrical components, procurement teams work closely with project managers and fabrication teams to manage procurement schedules. We always keep lead times and project deadlines in mind.

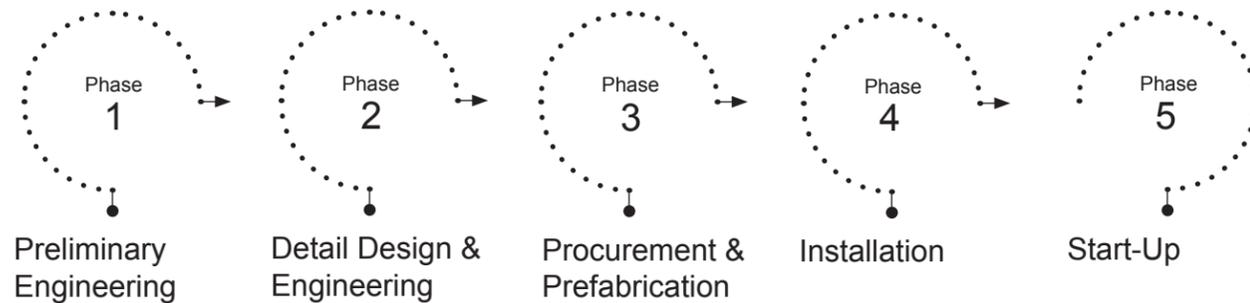
CONSTRUCTION

Roeslein employs skilled manufacturing and construction professionals. Our modular fabrication facility gives us the flexibility to assemble the right combination of resources for every project. Our specialized modular, prefabricated, and preassembled approach reduces project risks associated with lack of available manpower at site, adverse weather conditions, and overlapping site trade work. This gives Roeslein the edge to deliver the highest-quality product on schedule and within budget.

PROJECT MANAGEMENT

Roeslein’s project management team guides projects from initial conceptual design all the way through to project start-up and commissioning. Continuous and thorough involvement in all aspects of project execution allows Roeslein’s project management team to cohesively manage customer-driven metrics of cost, schedule, and overall project quality.

CONSULTING



The key to success in offsite, prefabricated project execution lies in thorough front-end planning. Roeslein guides clients through the early stages of a project by performing capital budgeting, feasibility studies, marketing planning and process flow diagrams to ensure a smooth project implementation. We know return on investment and cost certainty is a top priority, so at Roeslein, we continuously work to mitigate project risks and unknowns, while managing a project through to successful completion.

FABRICATION

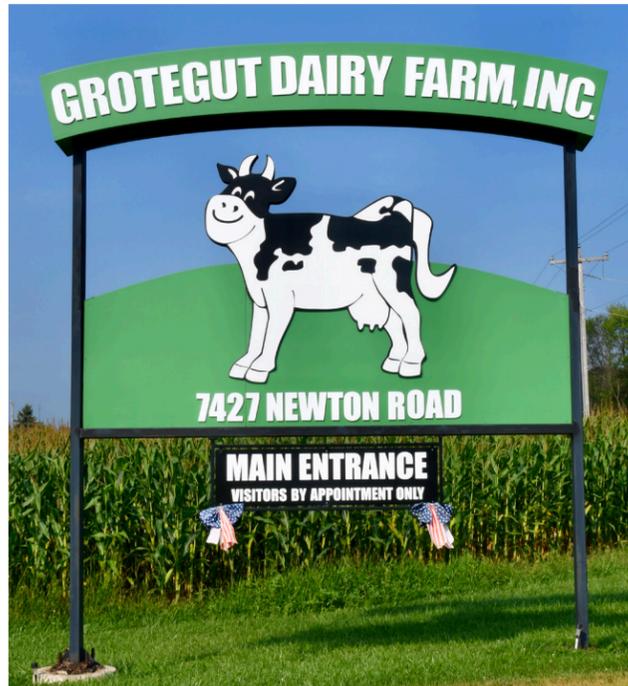
When it comes to fabrication processes, Roeslein Alternative Energy is proud to partner with R&A. Roeslein has over 600,000 sq. ft. of manufacturing space across three manufacturing facilities located in Red Bud, Illinois; Hollister, California; and Shanghai, China. Roeslein’s unique Modular Design-Build construction process is a high-performance, integrated solution. It’s proven to deliver improved design and construction phase productivity, enhanced project quality, and the quickest operations deployment. Ultimately, delivering a greater return on invested capital. Below are the services provided:

- Steel Fabrication
- Carbon Steel Pipe Fabrication
- Stainless Steel & Alloy Pipe Fabrication
- Painting & Coating Shop
- Electrical & Instrumentation Department
- Preassembly Areas
- Conveyance Assembly
- Inspection, Testing & Shipping/Receiving Department
- Raw Methane Gas Conditioning Systems
- Methane Membrane Gas Purification Systems



Dairy Digester Projects

Roeslein Alternative Energy and Roeslein & Associates built the first dairy RNG biofuels projects in Wisconsin for the integrated energy company, DTE. The state had long been a leader in dairy AD gas to combined heat/power projects, but new to upgrading the gas for vehicle fuel CNG use. DTE selected RAE and R&A to support project development, pathway consultation, virtual pipeline support, EPC, commissioning and startup for the five dairy farms' 17,000 head "hub-n-spoke" arrangement.





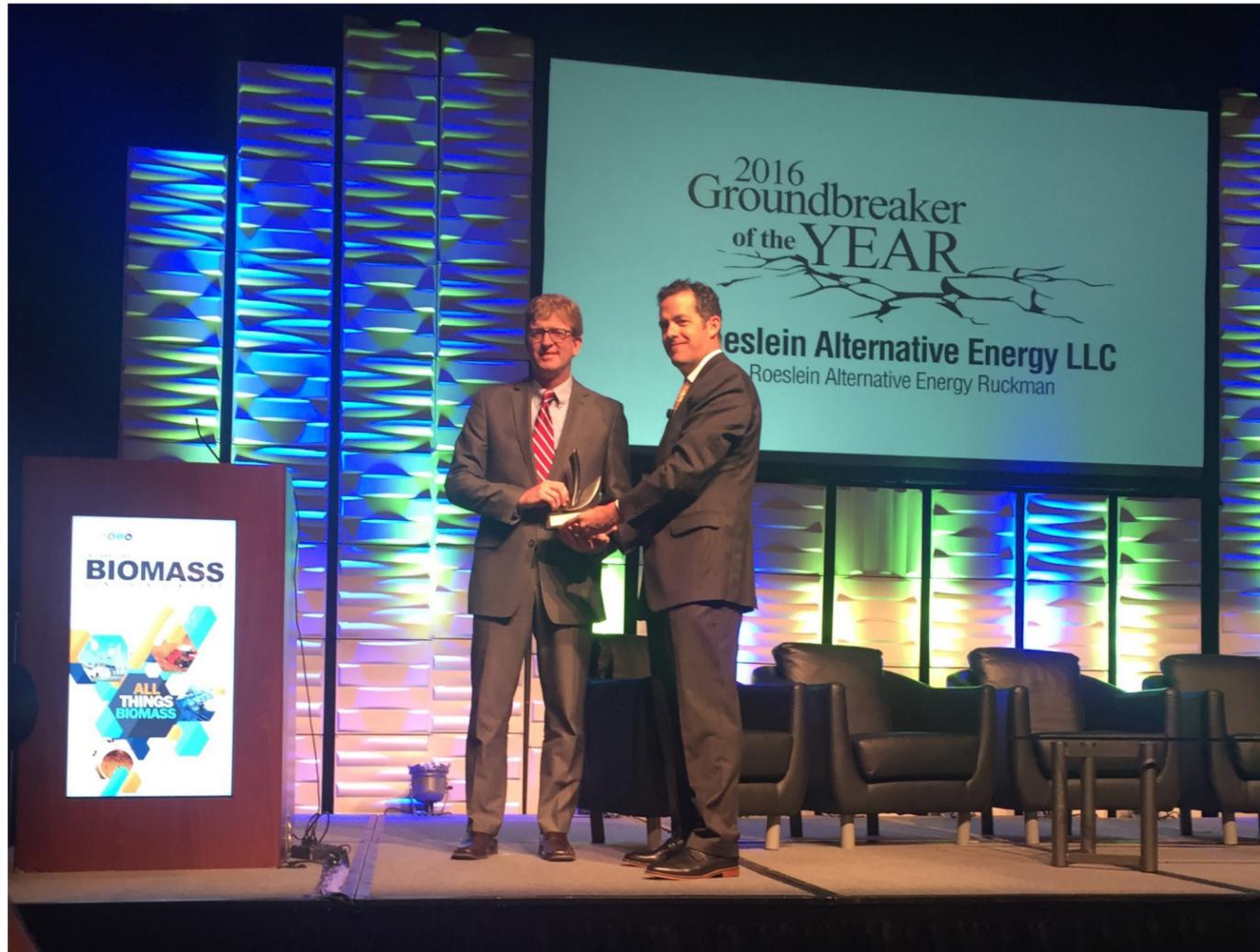
Roeslein's extensive experience in swine RNG projects helped guide DTE in some of the known project complexities (design, equipment, instrumentation, monitoring, gas conditioning/upgrading, virtual pipeline truck loading/unloading design and build know-how). The project successfully started up in the summer of 2019. The project was awarded 2019 Biogas Project of the Year by the American Biogas Council for use of an innovative business model to managed dairy RNG through a virtual pipeline.

The projects are expected to produce 380,000 MMBtus of RNG annually, which is enough energy to remove the equivalent of 26,669 vehicles from the road.



2016 Groundbreaker of the Year

Roeslein Alternative Energy was named the 2016 Groundbreaker of the Year by BBI International, at the annual International Biomass Conference. The Groundbreaker of the Year Award is given to one company that has significantly advanced the bioenergy industry by breaking ground and making meaningful headway on a commercial scale biomass-to-energy project.



Rudi Roeslein Received the 2018 Saint Louis University Alumni Merit Award

Saint Louis University honors distinguished graduates in recognition of their outstanding achievements, dedication to a chosen profession, and commitment to the mission of the University. The National Alumni Board, Development Division, and SLU leadership from twelve SLU schools and colleges select the winners.

2017 Air Conservationist Award

Rudi Roeslein was named the Conservation Federation of Missouri's 2017 Air Conservationist of the Year.

"This award is a symbol of success. It's a symbol of the hard work and dedication my teams have put forth. It's also a symbol of what is yet to come. Many times where it seemed hopeless, the people, organizations, and non-profits who have assisted me on various projects are what gave me the hope that an organization like Roeslein Alternative Energy can really make a difference and keep us at the forefront of showing others what we can do to help keep our wildlife and environment growing," said Rudi Roeslein when receiving his award.



2019 Project of the Year Award by the American Biogas Council

Roeslein Alternative Energy's Valley View project was bestowed the distinction of the American Biogas Council 2019 Biogas Project of the Year Award for the continued commitment from Roeslein and Smithfield to generate clean, green, renewable RNG from hog waste.

Rudi Roeslein Named 2012 Missouri Prairie Landowner of the Year

The Missouri Prairie Foundation presents the Prairie Landowner of the Year Award to an individual who has made an outstanding contribution to the cause of prairie through ownership and stewardship.



Energy Vision Leadership Award

Rudi Roeslein, Founder and CEO of Roeslein Alternative Energy, was honored for his vision of using anaerobic digesters on large farms to produce renewable natural gas (RNG) from animal waste and native prairie plant biomass. Roeslein's RNG has received the lowest Carbon Intensity score ever recorded by the California Air Resources Board.



THANK YOU ST. LOUIS BUSINESS JOURNAL



Chris Roach, President
Roeslein Alternative Energy

At Roeslein Alternative Energy (RAE), we are committed to our mission of helping individual landowners and society as a whole collaboratively discover and implement alternative biomass and energy solutions, in both ecologically and economically sustainable ways to protect and restore our environment and ecosystems. We may not have invented the process of renewable natural gas production, but we are taking it to the next level.

SUSTAINABLE SOLUTIONS RENEWABLE ENERGY



ST. LOUIS BUSINESS JOURNAL CUTTING EDGE AWARDS 2019

RAE FIRSTS:

- RAE is the first company to register with the EPA for a Swine Manure Digester Registration for renewable natural gas.
- RAE has been awarded the first EPA "Cluster" Registration for RNG production from multiple sites.
- RAE is the first RNG producer to have an EPA Virtual Pipeline Registration for moving RNG in Compressed Natural Gas transportation trailers.
- RAE is the first company to achieve the California Air Resources Board Swine Pathway Registration for RNG production.
- RAE has achieved the lowest Carbon Intensity Score ever certified for the production, transportation and usage of renewable natural gas.
- RAE has received the highest price ever for a cellulosic Renewable Identification Number.

LEARN MORE AT
ROESLEINAE.COM

SF SPECIAL: HOW SMITHFIELD SAVED THE WORST HOG FARM IN AMERICA

By Betsy Freese, Executive Editor
Successful Farming magazine at Agriculture.com

The history of the former Premium Standard Farms (PSF) hog operation in northern Missouri is as tortured as any in the modern swine industry.

When Smithfield Foods bought the formerly bankrupt 221,000-sow complex in 2006, PSF was the second-largest pork producer in the U.S. (behind Smithfield). It was bogged down in nuisance lawsuits, the barns were in disrepair, and pig performance was poor.

Keeping the operation running was a struggle for several years after the purchase. One industry analyst told *Successful Farming* magazine in 2011, “I advised them to get a bunch of bulldozers and push it in a hole and walk away. That would be cheaper than feeding it.”

Smithfield stuck with the business, now called Smithfield Hog Production - Missouri, bringing in a new general manager, Michael Rainwater, more than six years ago and infusing substantial capital to turn the operation around.

A tour of the headquarters and a winding drive up and down rolling hills between Princeton and Milan showcases the improvements made to the pork complex, which includes 56 sow farms over 600 square miles. (There are also 7,500 sows in Wayne County, Illinois, as part of gilt multiplication.)

Sow units are in clusters with three to 16 barns in a cluster. The finishing sites are in clusters of eight barns, with sites ranging from five to 17 clusters. Each barn holds 1,100 pigs.

These tight building clusters reflected historic design practices that had to be overcome.



“All this was built before PRRS was a big problem,” says Rainwater. “These large concentrations of animals can involve ongoing animal health challenges.”

Rainwater, who joined Smithfield in 2008 to run its Oklahoma sow farms, was assigned in 2011 to run the struggling northern Missouri operations. At the time, Premium Standard Farms was facing nuisance lawsuits, a federal and a state consent decree, and a corporate farming law issue. Most importantly, the operation was struggling to be competitive in the Smithfield system.

Today, Smithfield-Missouri is producing more pigs from fewer sows, has resolved the disease and labor issues, and has settled most legal issues. “We’ve been on a growth path in the last five years. That’s all been about understanding our role within Smithfield and making the most with what we’ve got,” says Rainwater.

3 WAYS SMITHFIELD TACKLED THE PROBLEMS

1. LABOR

When Rainwater arrived in 2011, there were 1,200 employees, a number he immediately saw was inflated based on pig production on the farms.

“My first summer here we significantly trimmed the workforce during the first 90 days in order to increase the percentage of frontline workers and to get them better trained and engaged,” he says.

To facilitate the transition to an improved system, Rainwater’s team depopulated several farms in the production system and then began to rebuild with a new employee training program.

“Twenty years ago, when I was hiring workers for dairy farms, I would get 50 résumés, and 20 of those came from farm kids,” says Rainwater. “Now I get 100 résumés and if five have a farm background I’m lucky. We have to teach people the basics.”

The on-farm training, called onboarding, takes four weeks. About 30% of the people don’t make it through the training and evaluation process. Those who do start at \$11.25 an hour plus benefits. After 90 days, they are eligible for a pay bump to \$14.50. If they become certified to work in farrowing barns, for example, they qualify for another raise. Bonuses for production workers are common, says Rainwater.

Turnover is always an issue, he says, because jobs like power-washing barns are tough to keep filled. The Smithfield-Missouri labor pool contains about 10% of employees from outside of the U.S. “Many of those are highly skilled managers and supervisors who help train the remaining workforce,” says Rainwater.

The Missouri operation is unique in the Smithfield business in that the ratio of company-owned to contract operations (pigs are raised by local independent farmers) is much higher, with approximately 80% company-owned and 20% contract operations. Finding people with experience in pig raising is a challenge.

“The old regime that was here confused good leadership with being demanding,” says Rainwater. “There isn’t a tree where herdsmen grow. You must develop them.”

He encouraged all his employees to watch the movie *Moneyball*. “They needed to understand that we are not the Yankees and we never will be,” he explains. “This is a commodity business. We may not be the homerun leader, but we can be good at base hits. Our nearby plant in Milan needs the pigs.”

2. HERD HEALTH

A huge challenge for Smithfield-Missouri is the 30-year-old cluster barn design and the implications on pig health. The former herd health strategy, says Rainwater, focused on trying to create pristine conditions; the modern strategy focuses on the broader issue of herd health.

With the challenges of herd health that face the hog industry today, large concentrations of pigs add complexity.

“We have modified our acclimation strategy for the sow farms, reduced the number of gilt sources, and continue to find ways to reduce the number of pig sources that we place into a grow-finish complex, along with a continuous improvement effort in our biosecurity practices,” says Rainwater.

3. MANURE MANAGEMENT

As part of federal and state consent decrees, the company had to use “next generation” technology for manure management including covers on lagoons, scrapers in barns, and a process called AND, which stands for advanced nitrification/denitrification.

“All of that is not something in the normal part of producing pigs, so those additional costs were just killing us,” says Rainwater. More than 100 finishing barns were sitting idle because there were other priorities for capital other than to install barn scrapers and related technology.

Along came Rudi Roeslein in 2011 with an idea. His company, Roeslein Alternative Energy, St. Louis, Missouri, wanted the methane gas from the lagoons. Rainwater was listening.

“I told him he could have whatever gas he captured for the next 10 years if he put new covers on the lagoons and scrapers in the barns,” Rainwater says.

Done. Finishing barns were soon back online.

“All of a sudden we go from selling 1.4 to 1.5 million pigs a year to almost 2 million,” says Rainwater. “Now my feed mills are used at 100% and my trucking fleet is used at 100%. All that math falls to the bottom line. That is pivotal.”

“We’ve come a long, long way, and part of what has helped us get to where we are today is the relationship we have with Roeslein,” says Rainwater.



Rudi Roeslein and Michael Rainwater

INNOVATION AND RISK

The first Smithfield-Missouri finishing farm Roeslein worked with had nine lagoons and roughly 70,000 finishing hogs. (The smallest farm in the system has 40,000 hogs and the largest has 170,000 hogs.)

Roeslein (pronounced Race-line) used several different gas purification systems to remove hydrogen sulfide, carbon dioxide, and some nitric oxide from methane trapped and collected at each covered 3-acre lagoon. One large-scale system, pressure swing absorption, is designed to handle the potential gas from 70,000 finishing hogs. A new, simpler membrane system is capable of purifying gas economically from as few as 30,000 finishing hogs.

“We have to be 98.6% pure methane. If the gas is not pure, we send it back to the closest lagoon and run it through the purification process again,” says Roeslein.

A natural gas pipeline happens to cross Smithfield’s Ruckman farm, where Roeslein installed a facility to inject the gas into the pipeline. Purified and compressed methane produced at other Smithfield-Missouri farms is transported in special trailers to Ruckman where it can also be injected into the national pipeline. The operation has the capability of purifying and injecting about 1,350 standard cubic feet per minute. Methane release is recognized by the EPA as a much more potent greenhouse gas than carbon dioxide.

“We are selling this pipeline quality renewable natural gas to the California transportation market,” says Roeslein. “They have a D3 RIN (renewable identification number) market that is fairly lucrative right now and everybody is chasing. We’ve had to go through the EPA and other agencies to meet regulatory requirements.”



Covered lagoon at Ruckman farm.

THREE MUSTS

The three things Rainwater required for the biogas project were:

1. It had to be environmentally sound and sustainable as well as fully compliant with all applicable requirements.
2. There would be no involvement by Smithfield in the technology. The company’s core competency and business is producing pork, not energy.
3. Smithfield needed help with costs and asset utilization of its land and facilities.

Roeslein, who has designed and built more than 200 modular beverage-can manufacturing systems collectively worth about \$2 billion, has a bigger goal than just anaerobic digestion technology. He wants to reduce greenhouse gas emissions, help shrink Smithfield’s carbon footprint, and much more.

“I want to give farmers the opportunity to be in the energy market, a market that helps assure that we have clean water, soil for our future generations, and habitat for wildlife,” explains Roeslein. “I didn’t invest \$50 million in this project because I needed to make more money. If you drink out of an aluminum can, I probably built the factory that made it. My real goal at this point in my

life is to build habitat for wildlife and keep our water and air clean. Those are my altruistic goals, but I’m pragmatic enough to understand that if it doesn’t make money, other people aren’t going to do it.”

Besides the gas component, Roeslein wants to create revenue from the nutrient component – the nitrogen, phosphorous, and organic matter that’s left. “We are having discussions with people who have really great technology on how to separate nitrogen and phosphorous from the liquid,” he says. “We want to replace these denitrification systems that blow a bunch of air around.”

NOT EASY

There have been stumbles. First, fluctuations in pig production resulted, at times, in much less manure and methane production than expected. Next, a tornado swept through the main finishing site last June demolishing 16 finishing barns and ripping the covers off lagoons.

“We had fewer pigs than we anticipated and a capital asset sized for the expectation of more methane,” says Roeslein. “If we have a steady flow of pigs, we are looking at mid-teens returns on investment for the methane collection.”

Rainwater commiserates. “We continue to learn. We are going to get there. I am very impressed that Rudi can inject methane into a natural gas line. He has figured out how to take that gas out from under the covers and make it pipeline quality,” he says.

The EPA has identified 8,200 potential anaerobic systems on swine operations in the U.S., says Roeslein. “Smithfield is the largest producer of pork in the world. My hope is I could demonstrate some successes with them and then other farmers will see this and want to try it. My goal is to have it sized to the point where it has application to many farms. The Germans have more than 9,000 aerobic digestion systems and 25% of their energy is now produced through various renewable ways. It is possible,” Roeslein says.

MANY RISKS

This isn’t the first time the hog industry has tried to turn manure into a salable product. Looming next to Roeslein’s shiny new methane collector is a rusting “monument of what never to do again,” says Rainwater. The grain-elevator-sized project was the Crystal Peak fertilizer plant Premium Standard Farms built in 2004 to take solids out of the lagoons, pelletize it, and sell it as organic fertilizer.

“It never worked; never even close,” says Rainwater. The plant was shut down years before he came on board. “It causes me grief because people look at this new project and say, ‘Yeah, it sounds like another Crystal Peak.’ This is night and day from Crystal Peak.”

Roeslein understands the risk. “Nobody goes into these things thinking it’s going to fail, but there are a lot of unknowns. Knowing what I know about industry, I can see how something like that would fail. The engineer was trying to pioneer a new technology and unfortunately it didn’t work,” he says.

In the past, most attempts to collect gas and convert to energy have been failures both in function and financial returns. The vast majority of pig and poultry manure, when agitated correctly and applied in an agronomic fashion, is safe, efficient, and good for the soil, say experts. It is hard to get any high-cost system to compete with that unless carbon credits become very valuable.

Roeslein's new proprietary system costs about \$4 million, plus \$350,000 for the lagoon covers. The pipeline and transportation costs are on top of that. "The entire thing for me is an R&D effort," he explains.

PRAIRIE RESTORATION

Roeslein and Smithfield-Missouri share another goal: to improve the land in the area. Smithfield-Missouri partnered with the Missouri Prairie Foundation and set aside 500 acres of land to be turned back to true prairie. Another 1,000 acres is going in the program in 2018. Smithfield owns or leases about 45,000 acres in the state.

"We are establishing prairie habitat around the perimeters of our freshwater lakes to act as filter breaks so sediment doesn't accumulate in the lakes," says Rainwater. "We are proud of our prairie restoration project."

Roeslein has a 1,758-acre farm in Missouri where he is restoring prairie habitat for wildlife and outdoor activities. An avid outdoorsman who loves hunting and fishing, he has a vision that there needs to be 30 million acres in the U.S. put back into savanna and prairie. Roeslein, who was named the Conservation Federation of Missouri Air Conservationist of the Year in 2016, wants to turn erodible land into prairie for ecological services that reduce erosion, prevent nutrient runoff, sequester carbon dioxide, absorb excess rainfall to reduce flooding, and create habitat for wildlife and pollinators.

But the pragmatic Roeslein knows landowners need to make money to think about converting erodible cropland back to prairie. So, he plans to test a system where sustainably harvested prairie grass silage is used in anaerobic digestion to produce additional marketable purified methane. He believes that could make the environmental benefits of restoring prairie financially appealing.

This vision to restore prairie is decades in the making, says Roeslein. "I kind of feel like Moses. I don't think I will ever see the promised land of restoring 30 million acres in 30 years, but I'm hoping this is the beginning of planting some seeds with Smithfield's help. We are working with conservation groups, the Missouri Prairie Foundation, the Nature Conservancy, the National Wild Turkey Federation, the Department of Conservation, the Environmental Defense Fund, and a lot of other agencies. I've paid a lot of research money to Iowa State University and the University of Missouri to test water quality. I want to contribute to mankind. I don't want my legacy to be that I made a lot of money."



Smithfield-Missouri prairie restoration.

MAKING PROGRESS

The improvements in the Princeton hog production operation are paying off, says Joe Szaloky, vice president of business development and planning for Smithfield. "I believe Missouri has the potential to be the most cost-efficient business in our hog-production group. The grain cost is reasonable there. With the great progress they are making, I think they will soon be right up there at the top of our group rankings. It's a good potential business, and the numbers are showing that," he says.

The University of Missouri estimated the economic impact of Smithfield-Missouri to the state at \$1.1 billion five years ago when he arrived, says Rainwater. "With all the things we've changed, I know it's now \$1.5 billion plus. If we don't make this work, the world up here in these six counties is different."

Rainwater is not ready to breathe easy. "This business is much better than it was, but we can still do better. We are in the commodity business, so we have to be in the top 10% to stay alive," he says.

Opinion: Hog manure project a lesson in clean energy



BY: U.S. CONGRESSMAN BILLY LONG

Last week, the Energy and Commerce Committee hosted an Energy and Environment Innovation Showcase in Washington, D.C. Its purpose was to highlight companies and organizations from across the United States that are using innovative technologies to address climate change and strengthen our energy security.

It showcased how supporting research and technologically driven policy can achieve significant results in addressing climate change. As a member of the Energy and Commerce Subcommittee on Environment and Climate Change, I recognize the importance of providing reliable, yet affordable, energy sources that are not detrimental to the environment — a view shared by both Democrats and Republicans. We will continue to work together to develop pragmatic solutions and realistic goals, which is a balance that was highlighted in the showcase.

As a member of the subcommittee, I was asked to invite a business or organization that uses innovative approaches to energy consumption and conservation. I invited Missouri-based Roeslein Alternative Energy. Roeslein partnered with Smithfield Foods to produce renewable natural gas from hog manure.

Concentrated animal feeding operations, defined by the U.S. Department of Agriculture as an intensive animal feeding operation wherein over 1,000 animals are confined for over 45 days a year, can be controversial because of the large amounts of waste produced and the odor associated with raising these animals. Roeslein's renewable natural gas production system successfully converts animal waste into clean energy, addressing the problems associated with CAFOs while moving toward more environmentally friendly and renewable energy sources.

What's even more impressive about their clean energy initiative are the glowing ratings they've received for their process. Roeslein recently received the lowest carbon intensity score ever recorded by the California Low Carbon Fuel Standard, which is not an easy task. CI scores are measured by the direct levels of greenhouse gas emissions associated with producing, transporting and using an energy source.

While reports suggest Missouri has room to improve its clean energy efforts, clean energy supports over 55,000 jobs across the state, boasting a growth rate faster than its overall job growth. As a result, clean energy jobs now represent 2% of all jobs in Missouri. These figures show how our state is moving toward a cleaner energy portfolio without radical and restrictive legislation like the Green New Deal. With more companies across the state taking concrete steps to use renewable energy alternatives, passing legislation that forces businesses to do something they're already pursuing voluntarily is not only unnecessary but also could derail progress.

Policies like the Green New Deal would dramatically increase our national debt, while offering no realistic pathways toward increasing the availability of clean energy. The notion that our nation could immediately eliminate fossil fuels, nuclear power and the vast majority of modern transportation options is unrealistic at best.

Rather than legislate based on knee-jerk reactions, we need to recognize the value of taking a realistic businesslike approach to tackling climate change, and this event highlighted the success companies across the country are having in addressing climate change, including right here in the Show-Me State.

U.S. Rep. Billy Long, R-Missouri, can be reached at (202) 909-3744. His Twitter handle is [@USRepLong](https://twitter.com/USRepLong).





BY DEAN HOUGHTON

DREAMS FOR THE PRAIRIE

Pigs and prairie plants pair up as Monarch Bioenergy rolls out a plan to help save the planet

Pigs and pink blazing star. Lagoons and larkspur. An entrepreneur with a dream, a food company with a mission to help heal the planet, and monarch butterflies. Don't forget the butterflies.

Oddly enough, these disparate jigsaw pieces have been seamlessly fitted together to result in a new entity called Monarch Biofuels. It's a joint venture between Smithfield Foods and Roeslein Alternative En-

ergy (RAE) in order to produce renewable natural gas (RNG) on Smithfield's hog farms in north Missouri. That's just the tip of the iceberg, however. The vision for this partnership includes restoring prairie, with an eye on using sustainably harvested prairie biomass as an additional feedstock for producing RNG.

The impacts could be significant; when all Smithfield company owned pig finishing barns are fitted

with infrastructure to produce RNG (targeted for completion during 2021), annual RNG production is expected to hit 1.3 million dekatherms.

That level of RNG production has a beneficial impact on air qual-

ity equivalent to taking 130,000 gasoline-powered vehicles off the road. And much of the RNG produced here is, indeed, likely to displace fossil transportation fuel. California's Low Carbon Fuel Standard provides incentives that has created a lucrative market for RNG as a vehicle fuel.

Dream to reality. The entrepreneur with the dream is Rudi Roeslein, now 71 years of age. He was introduced to readers of *The Furrow* in a Spring 2017 story called *Gas Natural*. His pipe dream—or, more accurately, *pipeline* dream—was to cover the Smithfield lagoons with an impermeable membrane, capture the methane produced by anaerobic action, clean up the gas, and inject it into the U.S. pipeline system.

All those dreams in the first phase of the project are now reality. "This project is definitely a

marathon," says Roeslein, who founded Roeslein and Associates, a St. Louis based engineering and modular fabrication company. "But we are off and running."

The project reduces or removes greenhouse gases, as defined in



the California Carbon Offset credits program, so the RNG produced from these Smithfield pig farms centered around Milan, Mo., is highly valued in the pipeline.

In early 2019, the Monarch Bioenergy joint venture received the lowest Carbon Intensity Score ever awarded by California's Air Resources Board. Lower numbers indicate less carbon intensity, and thus a higher value. The RNG from Monarch Bioenergy received a score of negative 374. "That makes our RNG the most valuable of any currently available in the California market," Roeslein says.

Stewardship. Monarch Bioenergy is now pursuing its second horizon, one that looks for ways to include native plants from restored prairie on highly erodible land. Such a vision fits well with the goals of Smithfield Foods, the world's largest hog producer; in

addition to being a \$15 billion global food company, Smithfield also wants to be known as a responsible steward of the planet. The company recently introduced a strategic platform called Smithfield Renewables to lead and ac-



celerate the company's renewable energy efforts. Smithfield's goal is to reduce its greenhouse gas emissions 25% by 2025.

The Smithfield Foundation has teamed with RAE and the Environmental Defense Fund to restore 1,000 acres of prairie on land surrounding its Missouri farms. These areas serve as key prairie habitat for the monarch butterfly—which flies here on its annual migration—but they provide ecological services and additional wildlife habitat as well.

"We recognize that the prairie is both an environmental and an economic force," says Kraig Westerbeek, senior director of Smithfield Renewables. "While helping to protect the environment, prairie also is a potential new revenue opportunity," he says. "Prairie biomass could provide an alternative feedstock to provide clean, renewable energy." ❁

Above, left to right. Covered lagoons allow methane gas to be captured, scrubbed, and injected as renewable natural gas into the nation's pipeline system. Rudi Roeslein says sustainably harvested prairie plants may be a new feedstock option.



RAE and Smithfield Foods have created a joint venture called Monarch Bioenergy to produce renewable natural gas from swine manure.

PRAIRIE POWER: Roeslein Alternative Energy Moves Toward Horizon 2

by Brandon Butler

Roeslein Alternative Energy (RAE) is through its initial phase as a startup company and is now tackling the challenge of a startup's second phase—growth. With renewable natural gas (RNG) production underway from the anaerobic digestion of animal waste, RAE continues to look to the future and implementing the plan for Horizon 2, which focuses on RNG production from the digestion of prairie plant biomass.

Conservation interests are diverse among the six million of us who call Missouri home. This fact became clear to me during the five years I served as Executive Director of the Conservation Federation of Missouri. Primarily a sportsman when I arrived in 2014, the education I received from countless leaders of natural resource organizations, like the Missouri Prairie Foundation, provided an incredible opportunity to learn about conservation initiatives taking place across the state, thus changing my mentality from that of a mostly consumptive user to one of a landscape steward. Yet, nothing moved me more during my tenure than the story of Roeslein Alternative Energy (RAE).

RAE is a renewable energy company with three areas of focus: energy production, ecological services, and wildlife benefits. The company offers a market-based solution to improve our environment by producing a renewable natural

gas (RNG) used mainly to power transportation vehicles, but also has many other applications. Through a process called anaerobic digestion, RAE converts animal waste and reconstructed prairie plants into a clean energy biogas. This process produces a valuable product while stopping a highly potent greenhouse gas from entering our atmosphere and contributing to climate change.

The RAE model also brings numerous ecological services to our landscape that benefits mankind and wildlife. RAE has a vision of restoring 30 million acres of native prairie plants to marginal lands over the next 30 years. This will be accomplished by converting highly erodible lands to native prairie plantings instead of row crops, instituting cover crop programs on agricultural land, installing riparian buffers at river and stream banks, and planting contour native plant buffer strips to absorb rainfall and fertilizer runoff. All of these

landscape improvements will significantly curb soil erosion and nutrient load in our water sources.

As my knowledge of issues surrounding pollinators, clean water, healthy soil, sustainable agriculture, and climate change grew, I became increasingly enthralled with RAE CEO and Missouri Prairie Foundation member Rudi Roeslein's vision for renewable natural gas production from the digestion of livestock waste and prairie plant biomass. The resulting ecological services and wildlife benefits should appeal to anyone who cares about our environment and the conservation of wildlife and native lands. Ultimately, I approached Rudi about joining the team at RAE. What I have learned since doing so has only multiplied my excitement for the company and our mission—*To help individual landowners and society as a whole collaboratively discover and implement alternative biomass and energy solutions, in both ecologically and economically sustainable ways to protect and restore our environment and ecosystems.*

Start-Up Phase Done: On to Growth

Founded in 2012, RAE, like most start-ups, has faced numerous challenges. Some were typical of a new company, like proving the concept to viable partners. Others were less controllable, like the Porcine Reproductive and Respiratory Syndrome virus in 2016 that drastically affected gas production and a tornado in 2017 that wiped out early operations and tested the resolve of the company's future. But the team at RAE persevered and overcame those challenges, and today is experiencing growth that indicates an incredibly bright future for the company.

In early 2019, RAE took a huge step towards solidifying our future through the formation of a joint venture with Smithfield Foods. This partnership is called Monarch Bioenergy. Smithfield Foods is the world's largest hog producer doing \$15 billion in business annually. They lead the world in pork processing and offer popular brands, like Smithfield, Eckrich, Farmland, and my favorite, Nathan's Famous hotdogs.

"The last six months has been a real uptick in optimism based on the results of our performance," said Chris Roach, President of RAE. "The consummation of our joint venture with Smithfield and the capital they have invested is not only a validation of what we are doing, but also a financial infusion that allows us to build out the remaining farms and to attract additional capital. We are on the cusp of having a very successful operating year in terms of producing biogas."

In northern Missouri, Smithfield has nine finishing farms with 88 lagoons. There is an annual potential of producing about 1.2 million dekatherms of energy from the manure of 2 million hogs. This amount of energy is the equivalent of offsetting approximately 10 million gallons of diesel fuel or 130,000 gasoline vehicles. Currently, 20 lagoons are producing renewable natural gas. In 2019, we are adding 17 lagoons to take us to 37 and we'll add 17 more in 2020. We plan to finish installing impermeable covers over the rest of the lagoons in 2021.

"RAE is in the second phase of a startup where you're past the critical point of survival, of proving a business model, and have shown we are going to make it. Now we have to manage growth



At top, Roeslein Alternative Energy (RAE) has overcome numerous challenges during the start-up phase, including a devastating tornado in 2017. Above, RAE is nearing the completion of a 1,000-acre prairie planting on Smithfield Farms in northern Missouri.

Roeslein Alternative Energy (RAE) is a pioneer of "firsts" in the production of renewable natural gas (RNG). Our current list of firsts includes:

- RAE is the first company to register with the EPA for a Swine Manure Digester Registration for RNG
- RAE has been awarded the first EPA "Cluster" Registration for RNG production from multiple sites.
- RAE is the first RNG producer to have an EPA Virtual Pipeline Registration for moving RNG in Compressed Natural Gas transportation trailers.
- RAE is the first company to achieve the California Air Resources Board Swine Pathway Registration for RNG production.
- RAE has achieved the lowest Carbon Intensity Score ever certified for the production, transportation and usage of renewable natural gas.
- RAE has received the highest price ever for a cellulosic Renewable Identification Number.



ROESLEIN ALTERNATIVE ENERGY



MDC NORPADOE PHOTOGRAPHY

Benefiting wildlife is a core aspect of the mission of RAE. The restoration of 30 million acres of prairie landscape—Roeslein's ultimate vision—would also alleviate a significant amount of flooding on marginal agriculture lands.

and how we run our business to become a long-term successful energy producer while adhering to our principles of ecological services and wildlife benefits. We are beginning to answer the questions: how do we contract with landowners, how do we create this economic return we talk about in our vision," said Roach.

Monarch BioEnergy & Manure

Concentrated animal feeding operations (CAFOs), are controversial to say the least. It seems no one wants a CAFO in their backyard, yet most people love bacon and baby back ribs. With our world population expected to hit nearly 10 billion by 2050, there is certainly a dilemma over how to conduct sustainable agriculture in a way that produces enough food for so many people, while not causing further damage to our environment. Fights continue to take place in our Missouri legislature over the existence of CAFOs and their effects.

"This joint venture represents our continued commitment to

doing business in a way that is good for our planet and its people," said Kenneth M. Sullivan, President and CEO for Smithfield Foods. "This innovative collaboration creates value for our company and our partners, and benefits the environment as we work to feed the world's growing population."

For reference, a CAFO is an operation with more than 1,000 animal units. An animal unit is equivalent to 1,000 pounds live weight. The number of animals held in one location is often staggering, with some hog operations holding over 10,000 animals.

"CAFOs, when operated correctly, provide the efficient conversion of feed, and the best biosecurity for the industry," said Roeslein. "China is currently suffering a dramatic destruction to their hog production from African Swine Fever, caused primarily from due to a lack of biosecurity in the feed chain and production process."

These animals are kept more than 45 days in the enclosed feed operations. An immense amount of manure is generated from these operations. Dealing with this manure is a challenge. Monarch Bioenergy has produced a system of addressing these challenges by eliminating odor and reducing excrement, while creating a new valuable commodity.

Michael Rainwater, General Manager of Smithfield Hog Production, said, "We believe there is a right way and a wrong way to do things. Sustainability is not something we talk about. It's something we do. We have to sustain the environment, because we don't want to be in business for the next five years, we want to be in business for the next hundred years and beyond."

The concentration of Smithfield's Missouri facilities is about 600 square miles, and Rainwater says they have about a \$1.5 billion dollar impact on the local economy. They produce about 2 million hogs annually in Missouri, and mill about 14,000 tons of feed per week, grinding about 16-million bushels of corn annually. Their operations use between \$125,000 and \$175,000 worth of energy a month.

A significant success for the entire operation was recently announced. The gas Monarch Bioenergy is producing received the lowest Carbon Intensity (CI) Score ever recorded for RNG at -374. As defined by the California Air Resources Board, a CI score is expressed as the amount of life cycle greenhouse gas emissions per unit of fuel energy in grams of carbon dioxide equivalent per megajoule (gCO₂e/MJ). CIs include the direct effects of producing and using this fuel, as well as indirect effects that may be associated with how the fuel affects other products and markets.

Basically, the lower the CI score, the more valuable the gas. RAE has thus produced the most valuable RNG available today in the California market, where it is actively being used to power transportation vehicles.

Natural Gas from Prairie Plants

While the production of RNG from the digestion of manure is already happening, RAE is continuing to move forward with our plans to implement Horizon 2, which is centered on the production of RNG from the digestion of native prairie plants. While the manure digestion takes place in lagoons, the prairie

plant digestion will take place in above ground digesters. These have not yet been installed, but progress is being made as we establish prairie plantings on a number of Smithfield's farms.

"Manure digested in lagoons is what is driving our very favorable CI score. We don't want to modify that approach," said Roach. "The prairie plant digestion will take place in separate digestion systems. They will be co-located with the lagoons so that they'll share water, gas storage, and cleaning, and interconnect with the pipelines. So both manure and prairie will be digested on the same farms, but physically the digestion will be in two separate reactors. They're coming."

RAE's research and development group, led by Dr. Hassan Loutfi, is working with several technologies providers and universities on the best process. RAE is working with the California Air Resources Board on a preliminary CI score.

RAE has been working hard to move forward with the prairie reconstruction aspects of our mission. Led by John Murphy, RAE Wildlife and Ecological Services Manager, these efforts are being supported by the Environmental Defense Fund and Smithfield Farms. RAE Conservation Coordinator, Connor Woods is working with Murphy to bring the company's ecological services vision to reality.

"We are nearly complete with our 1,000-acre prairie reconstruction project across five different Smithfield farms," said Woods. "We are working with Smithfield and the Environmental Defense Fund to identify the last 300 acres. On these acres, we are using a seed mix with four grass and 15 forb species. But we are also working with scientists from Iowa State to determine the best native seed mix. On some acres, we are planting both high diversity and low diversity mixes. Across both, we have stuck with a mix of six grasses, but have fluctuated the number of forbs—between 15 and 31. When Iowa State does their monitoring they will see whether or not a high diversity is more beneficial for pollinators, grassland birds, and other species of wildlife."

Cover crops also remain a focus for future gas production. On the RAE north farm, a variety of cover crops are being planted. Species vary depending on whether the land is going into corn or beans, but winter ryes, triticale, wheat, Austrian winter peas, turnips and radishes have all been planted after a cropping season ends. All of these provide ecological services, including soil health and reducing water runoff. Cover crops also provide numerous benefits for wildlife, like food and cover.

In all, the future is looking very bright for Roeslein Alternative Energy. The company has made enormous strides in the last couple of years and is now diving into a new set of challenges surrounding growth and expansion. This unique partnership between Smithfield Foods and RAE, involving energy, agriculture, and conservation, is rapidly developing into a model



ROESLEIN ALTERNATIVE ENERGY

Construction is now complete on numerous farms in northern Missouri, and renewable natural gas production is underway.

for North American agriculture and energy production in a safe, sustainable way.

"From their leadership in creating renewable energy and in conservation, Smithfield is changing what it means to be a food company," said Rudi Roeslein. "Smithfield's willingness to embrace the power of prairie proves the industry can play a meaningful role in seizing the economic benefits of conservation. We are extremely grateful that Smithfield is committed to this vision. It begins with converting methane from hog manure to renewable natural gas. But that's the tip of the iceberg. We hope to show the agriculture community, with the help of our joint venture partner Smithfield, how to take all these steps and make an enormous impact for energy, the environment, and wildlife."

As RAE continues to grow, we fully expect to be digesting prairie biomass into RNG in the near future. By creating a market-based solution to the question of how we convince farmers to adopt more landscape friendly practices, we are going to see improvements in soil health and water quality, and ultimately human health and quality of life. All Missouri citizens will be better for it.

Brandon Butler is the Director of Communications for Roeslein Alternative Energy. He joined the company in February of 2019.

Learn more about grassland habitat and the work of Roeslein Alternative Energy (RAE) in northern Missouri at the MPF Annual Dinner in Jefferson City on August 10, with after-dinner speaker biologist John Murphy, who is the Wildlife and Ecological Services Manager for RAE. Details on back cover.

Renewable Effort Driven by Hog Waste

By Laura Handke
High Plains Journal

In partnership, Roeslein Alternative Energy and Smithfield Hog Production are working to capture renewable natural gas from the waste of the approximate 2 million hogs that circulate through Smithfield's northern Missouri operations each year.

The venture, now called Monarch Bio Energy, was first initialized by RAE's founder Rudi Roeslein in 2011 when he approached Smithfield Hog Production's predecessor company Murphy Brown about the project; the conversations resulted in a business agreement in 2012 to launch Horizon 1 of Roeslein's RNG project. Believing in the ultimate success of the model, Roeslein committed to invest in the needed infrastructure on the farms and financially support the project through initial phases.

In early 2019, the Monarch Bio Energy partnership was created making RAE and Smithfield 50/50 partners. Today, RNG harvest operations are currently happening on 20 of Smithfield's 88 lagoons in the region with plans underway to add another 17 in 2019. Monarch Bio Energy's goal is to have all lagoons covered by the end of 2021.

Roeslein, an avid conservationist, says that the efforts of the partnership have the ability to change manure management and believes that the technology is a piece of the puzzle of saving the planet from greenhouse gasses.

"When you think about dealing with the waste of 2 million hogs, that requires a water treatment facility similar to that of a city the size of Kansas City or St. Louis," Roeslein says.

The process of extracting methane from the manure seems simple; however, the technology and intricate logistics of the system are anything but.

Barns are scraped and the waste is piped into a lagoon that measures between 3 to 4 acres in area. Lagoons are covered with a heavy impermeable cover and as the methane is released from the manure the cover inflates.

"Methane is lighter than air, so it rises and inflates the covers. The gas that we extract is 65% methane, 30% carbon dioxide and the remainder is hydrogen sulfide. The gasses are separated and the product that we sell for Renewable Fuels Standards credits on the carbon market, exclusively for use in California, is 99% methane," Roeslein says.



Justin Thomas discusses the process of transporting RNG through a virtual pipeline.

Monarch Bio Energy's RNG received the lowest Carbon Intensity score ever recorded, minus 374; a number calculated from the net usages of producing, transporting and using the RNG. A lower CI score, therefore, translates to lower greenhouse gas emission rates and creates higher value in the RNG. To date, Monarch Bio Energy's RNG is the most valuable RNG on the market.

"When you see a feed truck pull up to the farm, that's an energy delivery. It might be corn or soybean meal, whatever it is, the animal consumes that energy. And what isn't converted to gain is expelled. They aren't 100% efficient and some portion of that energy is going to end up in the lagoons," says Senior Director of Smithfield Renewables and Hog Production Division Environmental Affairs Kraig Westerbeek. "This methane collection process allows us to get the most out of our energy."

After collection and cleaning, the RNG is transported through what the project calls a "virtual" pipeline, specially designed semi-trailers that allow the RNG to be compressed to 3600 pounds per square inch. Once transferred to the trailer, the gas is trucked to an injection point into a natural gas pipeline.

The methane from the lagoons is transferred twice per day, creating four semi-trailer loads of RNG every 24-hour period. When the northern Missouri project is complete, roughly 2 billion cubic feet of RNG per year from the region's 88 lagoons will be injected into the pipeline—the equivalent of filling 56,000 semi-trucks with diesel.

And while RNG makes the venture economically sustainable, methane isn't Roeslein's only goal.

"I wanted to use my integration and engineering know-how to do this (capture RNG), but in the back of my mind, and what I kept telling Smithfield, was that I wanted wildlife to have a place. And I wanted conservation to be a part of this effort, too," he says.

Horizon 2 of Roeslein's project focuses on the restoration of native prairie in North Missouri and will see prairie plants sustainably harvested and digested into RNG. The project will create both another source of RNG and a new revenue stream for farmers.



Pig Project Fuels Alternative Energy

Anaerobic digester shows how hog farming can be more sustainable while supplying natural gas.

By JoAnn Alumbaugh
Progressive Farmer
Contributing Editor

From a distance, the heavy, black plastic tarp looks like a huge bouncing pillow that kids love to jump on. But, upon closer inspection, you realize it covers a 3-plus-acre lagoon filled with waste from 8,000 pigs, along with the methane gas it creates. Surprisingly, you can stand right next to the lagoon and notice no decipherable odor.

The covered lagoon is part of a pilot project partnership between Smithfield Foods and Roeslein Alternative Energy (RAE). The joint venture -- Monarch Bioenergy -- converts manure collected from Smithfield farms, in northern Missouri, into renewable natural gas (RNG), while also providing ecological benefits for wildlife and natural habitats.

The anaerobic digester project fulfills a commitment to sustainability held by both parties. Smithfield's goal is to reduce its companywide greenhouse gas emissions 25% by 2025. Rudi Roeslein, RAE founder and president, plans to dovetail this project with an effort to increase plantings of prairie grasses. His long-term goal is to restore 30 million acres of land in the U.S. to native prairie plants over the next 30 years and use those plants to create biogas.

HOLISTIC APPROACH

Roeslein is a self-made man. An engineer by trade, the company he and Fritz Dickmann founded in 1990, Roeslein and Associates, is a global leader in engineering, procurement, modular fabrication and construction of can-making and industrial plant facilities. He learned about anaerobic



Rudi Roeslein (Progressive Farmer image by JoAnn Alumbaugh)

digestion technology in Europe and saw its potential application for the U.S.

Since 2012, Roeslein has invested \$57 million of his own money to prove this technology could work on a large scale.

Converting methane to natural gas works by sucking the gas out of the lagoon into the gas purification system. Gas molecules are separated resulting in almost 99% pure methane. "Because we can't connect to a pipeline very easily from this farm, we set up a virtual pipeline," Roeslein says. The gas is compressed to 3600 pounds per square inch (psi) and moved by two trailers to a farm about 60 miles away. It's injected into the natural gas pipeline and sold through the Renewable Fuel Standard and to the carbon market in California.

"We approached Smithfield and asked for their pig manure, because that would give us an

opportunity to prove the technology," he says. "As the project moved along, Smithfield saw the value and became a 50/50 partner in the venture.

"We are the first D3 renewable identification number [RIN] for swine manure renewable natural gas," Roeslein says. "We also have the lowest carbon intensity score in the country." EPA uses five RIN D-codes (D3, D4, D5, D6 and D7) to define biofuels under the Renewable Fuel Standard. D3 and D7 are for cellulosic biofuels with a greenhouse gas reduction requirement of 60%. The value of the gas is about \$18- to \$20-per-million BTUs.

Although it's not commercially ready for use on most farms yet, the pilot project showcases the capability of the technology and how it can potentially be incorporated in the future through partnerships and cost-share programs.

ENERGY CONVERSION

Smithfield owns nine finishing farms in northern Missouri that were previously part of the Premium Standard Farms system. Each farm consists of numerous "pods." The Locust Ridge farm has 14 pods with eight barns per pod. Each barn holds about 1,000 pigs, which arrive weighing about 50 pounds and leave when they're marketed around 250 to 280 pounds.

There is the annual potential to produce about 1.1 million dekatherms of energy from the 90 lagoons and 2 million pigs Smithfield has in this region of the state.

"This amount of energy is equivalent to offsetting approximately 5.7 million gallons of diesel fuel annually," says Brandon Butler, director of communications for RAE.

Kraig Westerbeek, senior director of Smithfield Renewables and hog production environmental affairs for Smithfield Foods, likes to explain the process as energy conversion.

"When you see a feed truck come onto the farm, it's delivering energy in the form of corn, soybean

meal and other feedstuffs," Westerbeek says. When the animals consume feed, the energy can be tracked as feed conversion. But, pigs aren't 100% efficient. Some energy goes through the animal and ends up as manure that's scraped from the barn and piped to the lagoon digester.

"That energy is processed through anaerobic digestion: The solids break down, and methane gas is emitted -- that's the energy we're capturing," Westerbeek says. "Between what the animals have consumed, the energy they utilize to make body mass and the energy we're using to make natural gas, it's a very efficient process and a great recycling story."

The project is a big step toward Smithfield's goal of reducing carbon emissions, Westerbeek says.

"Forty percent of our carbon footprint comes from methane emissions -- from the crops used for feed all the way to the consumption of our product," he says. "To hit that 25% reduction, 90% of the finishing animals in the states of North Carolina, Virginia and Utah will be on biogas-based systems by the year 2028; and in northern Missouri, our goal is 100%."

WIN-WIN

Roeslein and Westerbeek believe their projects represent the future of agriculture. The wet weather experienced in much of the Midwest this year puts an exclamation point on the need to minimize erosion and runoff.

"When you look at the landscape, it can't absorb all the water," Roeslein says. "Native grasses have very deep roots that can sequester water and carbon that, through the process of transpiration and respiration, can help cool the atmosphere. We have 300 million acres of agriculture around the world that is not cooling our atmosphere for a good portion of the year because it's barren soil and acts as a passive solar collector."

Roeslein's working on another pilot project to convert 1,000 acres to native grasses for

pollinators, wildlife and biogas production. Iowa State University has indicated the biomass potential is between 4 and 10 tons per acre.

“The next step is to find out what that biomass receives as a carbon intensity score, so we can give it a value. After that, we’ll know what we can offer landowners to grow that commodity,” he says.

HELPING THE ENVIRONMENT

The volume of gases under the lagoon-covered tarp is made up of about 65% methane, 30% carbon dioxide and the remainder hydrogen sulfide and other impurities. Methane is nearly 30% more destructive than carbon dioxide, Roeslein says, so keeping it under cover prevents it from being released into the atmosphere.

“It’s a market-based solution that will allow farmers to grow something besides corn and beans while providing ecological and wildlife benefits in addition to renewable natural gas,” Roeslein says. “We have a good market, and we have a good partner.

“Smithfield is committed to the environment, and that keeps me energized,” he adds. “I could have taken my \$57 million and bought a ranch next to Ted Turner somewhere and lived happily ever after. But, I’ve seen what’s happened around the world [with environmental degradation]. I couldn’t have slept thinking I was sitting on the sidelines doing nothing when there was this great opportunity to show the world there was a different way to do things.”



by Jim McCarty | jmccarty@ruralmissouri.coop

Rudi Roeslein will be the first to tell you he’s no farmer, even though he owns two Missouri farms. The Austrian immigrant made his money building machinery to make beverage cans and selling it all over the world. Now 71 years old and wealthy enough to chase his dreams, Rudi has three lofty goals. He wants to find alternative sources of energy, protect the environment and create more habitat for wildlife.



That’s the reason he launched Roeslein Alternative Energy in 2012, partnering with Smithfield Farms on a project that today is literally turning manure into money. On a blustery day in June, Rudi speaks to a group of ag journalists next to a confinement barn housing 1,000 hogs and a 4-acre manure lagoon located north of Milan.

You would expect an operation of this type to smell. Concentrated Animal Feeding Operations, or CAFOs, are known for two things: producing large amounts of meat in a short time, and creating controversy from the associated odor. It’s quickly obvious something is different about this one: There’s no smell.

Stretched tightly over the lagoon is a black plastic cover. It bulges skyward with an accumulation of nearly 2 million cubic feet of methane gas. Unseen pipes suck the gas away, where a compressor filters out impurities, then funnels it into tanks on a trailer.

From there it will be trucked to another farm and injected into a pipeline. Once the source of complaints from neighbors, the gas is now a valuable commodity, Rudi says. It’s highly prized in California where strict carbon standards favor natural-gas powered vehicles. In fact, the gas collected here is so clean it received the lowest carbon intensity score ever by the California Low Carbon Fuel Standard.

“What motivated me to do this is I spent a lot of time over 35 years working in China,” Rudi says. “I watched the development in China and it is pretty disturbing to see the eastern border. The amount of pollution and the landscape that has no wildlife, no clean water, and you think, ‘Can that happen here?’”

Rudi invested \$50 million to prove the technology would work. Already in place on three of Smithfield’s farms, the technology will soon roll out to all nine facilities. “We ended up approaching Smithfield and asking for their manure as an opportunity to prove this will work,” Rudi says. “As we moved along, Smithfield started to see the value. So we are now 50-50 partners in this venture.”

As if removing a harmful greenhouse gas and eliminating its odor wasn’t enough, Rudi is moving on to the second phase of the project. The farm he owns north of Unionville has been turned into a 1,700-acre laboratory with the goal of growing prairie grass to feed into digesters and create even more renewable gas. If the plan works, farmers could find a new cash crop that can be successfully grown on marginal land.

A side benefit will be more habitat for wildlife, as evidenced by the quail, turkey and deer that are thriving on the native grass and cover crops at the farm.

Typical of most north Missouri row-crop operations, about 80 percent of the land here is suitable for cultivation. The rest is either too steep or the soil is too poor for corn and soybeans. Instead of wasting fertilizer and other inputs on this marginal ground, Rudi “fired” the acreage and returned it to prairie.

“We ran around in combines and looked at the yields and took out some of those poor-producing acres and sowed them down into prairies,” says John Murphy, wildlife and ecological services manager at the farm. “Rudi would be the first to tell you that we have the luxury of not depending on every single acre for production. If we are not making a profit we are going to fire those acres and do something different with it.”

The “something different” is an impressive sight in summer when colorful blue spiderwort, purple milkweed and pink blazing star mingle with waist-high big bluestem grass. Besides feeding pollinators, the native plants send deep roots into the ground, keeping nutrients in place and slowing runoff.

Experiments here are not always successful. John tells of the decision to plant sorghum to use as biomass for the digester. Drought caused the plants to wilt, making them impossible to harvest. The failure is one less mistake a future farmer will make.

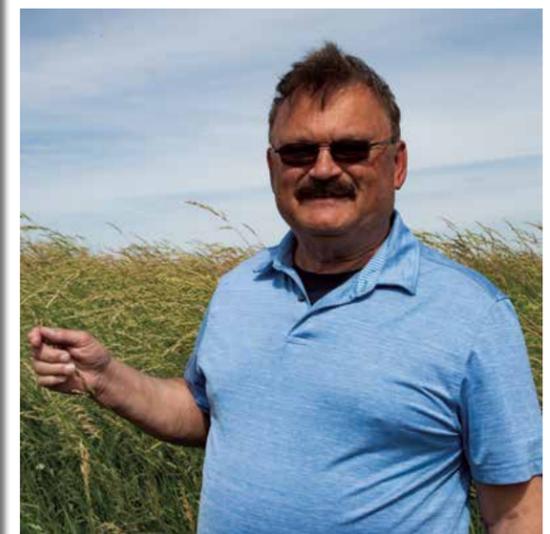
In time, Rudi plans to offer long-term contracts to farmers to feed his digesters. In the meantime, work continues to find the best combination of plants to achieve his goals.

“I could have taken my \$50 million and moved next to Ted Turner and rode horses and lived happily ever after,” Rudi says. “The problem is, I’ve seen what’s happening around the world and I couldn’t have slept thinking I’m sitting on the sidelines doing nothing.”

For more information call 314-729-0055 or visit www.roesleinAE.com.



photo courtesy Roeslein Alternative Energy
Top: John Murphy checks a stand of native prairie on a research farm located north of Unionville. **Above:** Methane collected from manure is turned into renewable energy at this farm and others near Milan.



Rudi Roeslein left his native Austria at age 8. Now 71, he is devoted to feeding a growing world population while finding opportunities where others see challenges.

Butterflies and Biogas a Focus of Smithfield Foods

Hog farms in Missouri are planing habitat for methane and monarchs

By Betsy Freese, Executive Editor
Successful Farming magazine at Agriculture.com

Standing in an established pollinator patch means bees are regularly buzzing your head, but that doesn't bother these three men. They are happy to see the bees and butterflies in this prairie planting.

The field is a part of a Smithfield Foods hog finishing site, called Valley View Farm, near Greencastle, Missouri. This site has spaces for 114,000 hogs, and half of the lagoons are harvesting methane gas. Three years ago, Smithfield teamed up with Roeslein Alternative Energy (RAE) to install biogas infrastructure across all company-owned finishing farms in Missouri. In addition to using manure, the project will harvest prairie grass from this field and others for methane generation.

Smithfield has made a commitment to reduce the company's greenhouse gas emissions 25% by 2025. In 10 years, says Smithfield, nearly 100% percent of company-owned hog finishing spaces in Missouri will have the capabilities to produce renewable natural gas (RNG).

In 2018, Smithfield joined the Environmental Defense Fund's Monarch Butterfly Habitat Exchange, which restores monarch butterfly habitats on private lands including Smithfield hog farms in Missouri. Smithfield planted almost 1,000 acres of pollinator habitat in Missouri this year, with more to come.

Successful Farming joined these three experts in the prairie grass patch to get the scoop on the projects:

- Rudi Roeslein (pronounced race-line), Founder & CEO of Roeslein Alternative Energy
- David Wolfe, Director of Conservation Strategies at Environmental Defense Fund
- Michael Rainwater, General Manager, Smithfield Hog Production Missouri



Rudi Roeslein, David Wolfe & Michael Rainwater

You are going to produce methane gas from prairie grass?

MR: Yes. We hope to be able to harvest the prairie grass like silage during the times when our lagoons are inactive because of cold weather. We would cut it like forage, store it like you were going to feed cows, then feed it to the digester. It's basically the same process that silage goes through as cows digest it and make methane.

RR: These plants build deep root systems. By the third year, they have tremendous biomass to harvest for methane.

Where will additional prairie acres be added?

MR: Some of that will be driven by the final placement for the digester. You locate the prairie next to that. We have a lot of options. Smithfield owns 44,000 acres in six counties of Missouri. About 12,000 acres are in traditional row crops, 20,000 in hay and grazing, and the rest is with hog production. Most of the land is grazed because we don't have a viable solution to work with the slope without creating erosion. We own 5,000 acres around this farm because if you are going to water all these pigs you have to somewhat control the watershed. We have some land that needs further development, and rather than look at drain tiles, we are going to look at contour till with prairie grass. That will be my next step, and when the digester comes on, we will figure out the rest. We could plant prairie strips to hold water and then harvest the forage off those strips for the digester. You could grow conventional crops with the prairie strips. I don't want to build terraces and lay tile. That is too expensive. All you do with drain tile is create velocity with water.

Rudi, why are you working with Smithfield?

RR: This is the largest hog farmer in the U.S. I felt like I could demonstrate to them that this will save them money, provide them with income from the alternative energy industry, solve the issues of rain events increasing their cost to treat water, reduce odor, and help their image by showing that big ag can be an environmental steward. We are also working with Smithfield in Utah, where they are expanding and adding 350,000 new finishing spaces. We started that project last year. There is a previous project from another developer that failed because they were trying to produce electricity at a low selling price; unless you use the waste heat coming off the generators, it's wasted energy. They were leaving the manure in the pits for a long time and moving manure long distances and this exposed it to the atmosphere, which reduces the methane potential by over 50%.

What is involved with the biogas system here?

RR: All 14 lagoons at Valley View are covered, but only six are in the methane purification system. The rest are flaring. We are trying to do it incrementally, so we don't have one big installation that fails. My goal is to develop a digester that is economic enough and small enough that I can put one at each lagoon. I want to start on a small scale, demonstrate that it works, and then slowly expand it. I don't want another failure like the abandoned fertilizer plant model from a decade ago that still stands at the Valley View Farm site. We do everything in modular systems, so that system can be moved to other locations in case one farm has to be shut down.

We have one pipeline at another location interconnected. That site has nine lagoons and 70,000 hogs. That was a \$1.5 million investment in pipeline. We are hoping to get the funds to add another 13 miles from the purification point to Milan for Valley View. I want the Smithfield hog processing facility there to work off natural gas.

How does the digester work?

RR: The model at this location uses membrane technology, instead of pressure swing absorption – which is a lot more complicated. This is like turning on a compressor. We still have things to work on. Last winter we had some temperature-dependent issues, so we may enclose the digester this winter.

Let's talk about the monarch butterfly project. How did you get involved?

RR: I had a conversation three years ago with David Wolfe and gave him my vision for combining market-based energy with ecological services and wildlife habitat. They are interested in saving the monarch. My interest is not in saving one thing, but putting the right mix of grasses together so it can serve as biomass for energy, have ecological benefits, and help save the monarchs. I want to provide commercial solutions that provide a return for both the farmer and society.

What is in this patch?

RR: This has a mixture of 25 forbs and legumes, which provides an entire season of pollination. It costs about \$400 an acre to seed this, but it is a one-time cost. My vision is to restore 30 million acres of prairie and put 100 million acres of cover crops on the ground. I've spent 10 years restoring and reconstructing my farm. I have 1,700 acres and have spent significant money on savannah and prairie restoration.

David, why is the monarch project important?

DW: The migratory pathway for monarchs comes through the Great Plains and Midwest. The Midwest is most important for breeding. Monarch numbers have declined by 90% in the past 20 years. It's important to add this habitat back to the landscape, not just for monarchs, but for water quality and soil health. This habitat can solve all those problems. The caterpillars feed on common milkweed exclusively, so we need that for them to lay eggs on. We also need nectar sources for energy to help them along the migratory pathway.

How do we make this a reality?

DW: Public and private funding are important. We need to get the cost down on seed mixes. Biogas creates an alternative income from this habitat. We need a lot of different approaches and tools, incentives and motivations, to get this habitat across the landscape. You don't need large expanses of land for monarchs, just little patches along the migratory path. Our goal with the

current project here is to get 1,000 acres in. We have over 600 now. There is more potential beyond that with Smithfield.

Is regulation of farmland use a possibility?

DW: The monarch was petitioned in 2014 for listing on the Endangered Species Act. The Fish and Wildlife Service is looking at the science and assessing efforts like this one and others across the country. They are scheduled to make a decision in June 2019 as to whether the monarch should be listed or not. If it is listed, it means potential regulations. We would like to see an option for farmers that if you are participating in a conservation program that is putting in habitat such as this, you can avoid any additional regulation by participating in a conservation plan. Farmers in a watershed could work together to set aside a total of 1,000 acres, for example, so that everyone is participating. We want to make it flexible and appealing for farmers. We don't want to make it a burden on them.

New Venture

In November 2018, Dominion Energy and Smithfield Foods formed a joint venture called Align Renewable Natural Gas to capture methane emissions from hog farms and convert them into renewable energy for residential home heating and power for local businesses. Using anaerobic digestion, the projects will capture and process methane from large clusters of Smithfield's company-owned and contract hog farms. The natural gas will then be transported to a central conditioning facility where it will be converted into renewable natural gas.

The companies are jointly investing at least \$250 million in this initiative over the next decade, with application on 90% of Smithfield's finishing spaces in North Carolina and Utah. Construction at two larger farm clusters in Duplin and Sampson Counties, North Carolina, as well as farms in Waverly, Virginia, and Milford, Utah, will begin in late 2018 with the first projects scheduled to be in-service in late 2019.



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