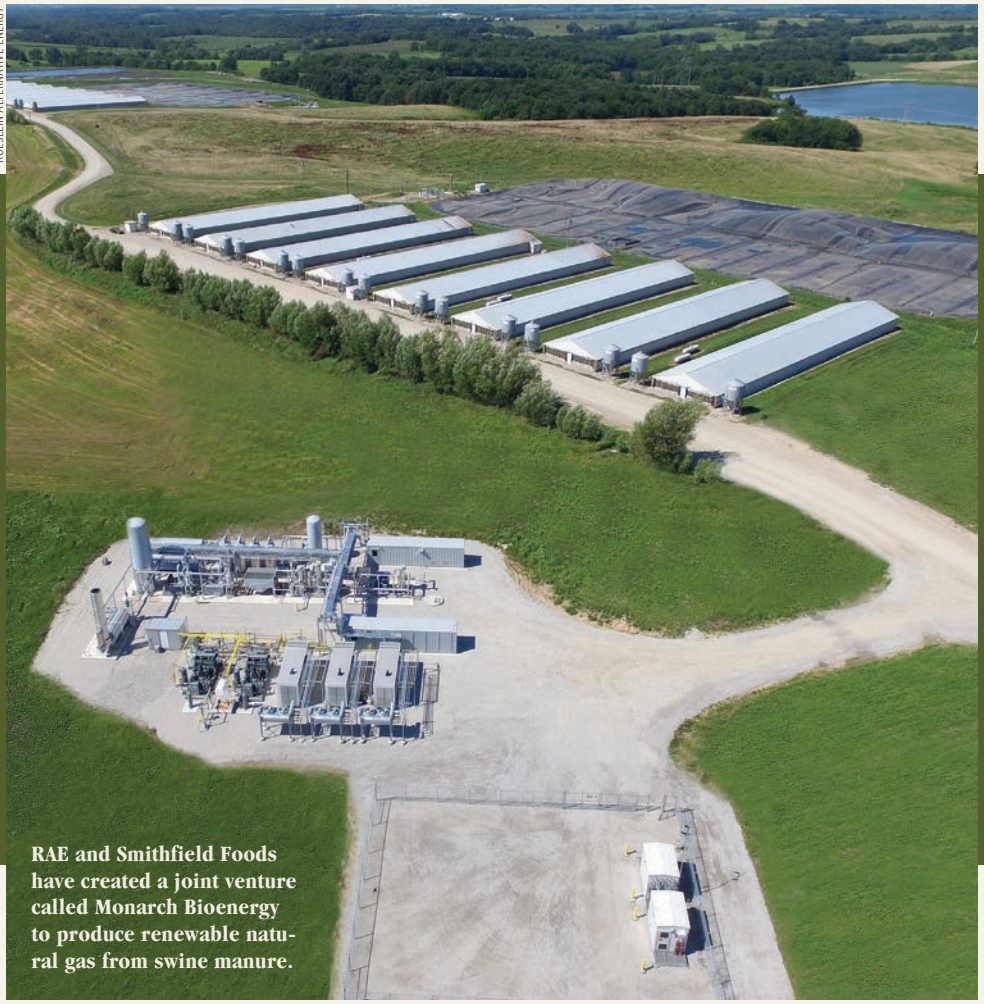
ROESLEIN ALTERNATIVE ENERGY



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

ROESLEIN ALTERNATIVE ENERGY PHOTOS

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 transportion 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.**

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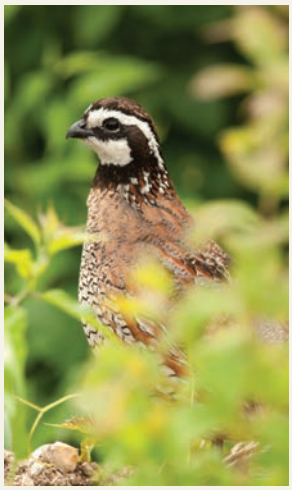

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Benefiting wildlife is a core aspect of the mission of RAE. The restoration of 30 million acres of prairie landscape—Roeslein's ultimate vision—would also alleviate a significant amount of flooding on marginal agriculture lands.

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 (gCO_2e/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 for North American agriculture and energy production in a safe, sustainable way.

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

"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.