

TESTIMONY FOR EERC STATE ENERGY RESEARCH CENTER ACTIVITIES

Testimony of Charles D. Gorecki
CEO
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Senate Bill No. 2014
March 8, 2021

The Energy & Environmental Research Center (EERC) at the University of North Dakota was designated the State Energy Research Center through SB 2249 during the 66th legislative assembly. I want to thank you for providing that designation to the EERC. In doing so, you recognized the importance of fundamental research in energy and environmental topics in North Dakota. The designation of the EERC as the State Energy Research Center filled a gap in exploratory research to serve the state that had been identified by the research and development road map created through EmPower.

State Energy Research Center research helps the state ensure that our energy resources and products remain accessible, affordable, environmentally responsible, and clearly understood. The funding has fostered further collaboration with public and private sector partners to advance successful concepts. Eliminating the sunset clause for State Energy Research Center funding is essential to continuing fundamental research in North Dakota and fostering the growth of that new-found knowledge.

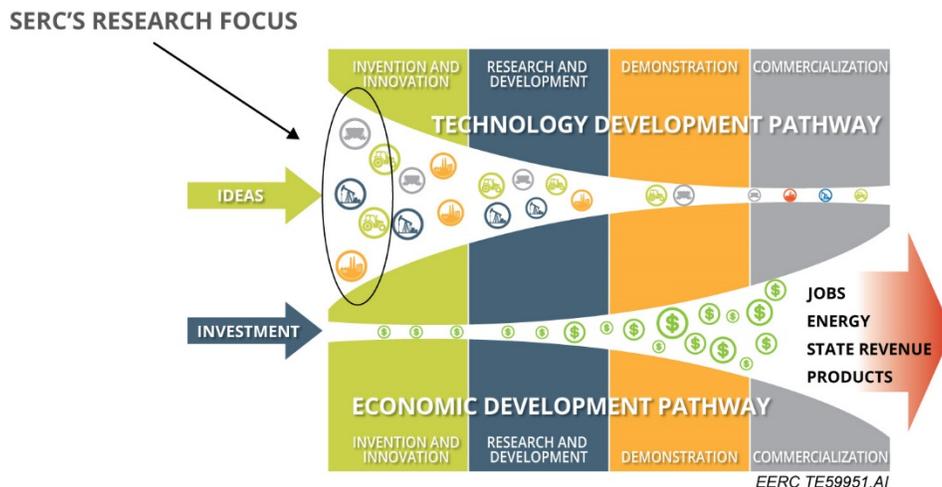
Research results from this funding directly impact and benefit the state. Researchers at the EERC have identified coal as a graphene precursor, and graphene is a high-value product that has application in multiple industries, such as aerospace, sports, automotive, and building and construction. Successful development of technologies to make graphene from North Dakota lignite coal could open new markets in nonenergy sectors such as electronics, optical devices, lightweight farming tools, and military equipment.

My colleague, Tom Erickson, directs our exploratory research at the EERC. He will provide you with specifics on the successes of the State Energy Research Center funding.

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The Energy & Environmental Research Center (EERC) was designated as the State Energy Research Center (SERC) by the 66th North Dakota Legislative Session (SB 2249). Several years ago, an energy R&D road map was developed by EmPower which identified a significant gap in exploratory research to serve the state. To fill that gap, SERC was established to identify and develop new technologies and strategies with the potential to directly benefit the state of North Dakota, the industries operating in North Dakota, and the citizens of North Dakota. This work is conducted through fundamental exploratory research, targeted research directed by the Industrial Commission, and education outreach. As shown below, the primary focus of SERC research is innovation and new inventions that can positively impact North Dakota's future energy industries.

SERC's Research Focus



Exploratory research conducted through SERC is creating the future energy technologies that will serve North Dakota.

SERC has shown significant success within its first biennium, including:

- Twenty-five exploratory research projects funded representing opportunities and solutions across the entire North Dakota energy spectrum.
- Eight new technologies invented to serve the state.

- Over \$6.5 million in follow-on research proposed to external partners based on concepts developed using SERC funding.
- A system dynamics model developed to support North Dakota policy discussions.
- Eleven Energy Hawks from three North Dakota institutions of higher education funded in the summer of 2020.
- Sixteen Energy Hawks from five, possibly seven, North Dakota institutions of higher education planned for the summer of 2021.

The success we have seen in less than 2 years will be magnified by future investment in SERC. We strongly feel that removal of the 4-year sunset clause is in the best interest of the state of North Dakota and the citizens of North Dakota.

The following provides additional information on these successes.

SERC Drives Exploratory Research Directly Benefiting North Dakota

Nearly 60 projects were brought forward through three rounds of internal project solicitation. Out of these proposed projects, only 25 were able to be funded. Some of the highlights from these projects include (please note these are all still in the early stages of development):

- The first-ever graphene dots were created using North Dakota lignite. Graphene is a high-value material (very high strength, great conductivity, and other beneficial properties) made up of the carbon material found in coal. By removing those components in coal that are unnecessary for graphene formation and processing the remaining components, we made small segments of graphene (called graphene dots).
- A novel technique to increase ethanol production was developed. Today's ethanol production relies on "bugs" to do a significant amount of the work during fermentation. Electricity can also be applied to do some of the work in producing ethanol along with the traditional method. By using electricity, more ethanol can be produced per bushel of corn with less CO₂ emitted.
- Multiple methods for enhancing rare-earth element extraction from coal and coal by-products were demonstrated. Three different processes for extracting and separating REEs and other critical materials were demonstrated at the laboratory scale. Each of these processes have separate advantages and challenges warranting further development.
- Advanced analytical and modeling techniques were used to enhance our understanding of the Bakken petroleum system, including how to product more oil. Through advanced analytical and modeling methods we have studied 1) the role of CO₂ swelling in recovering oil via enhanced oil recovery (EOR), 2) methods of characterizing the

extremely small and varied components of shale to support greater fundamental understanding leading to enhanced recovery, 3) new methods to understand fracturing the shale to increase shale oil, and 4) processes to make drilling through pressurized zones more efficient.

- An innovative method of converting brine salts into other chemicals was created. Rather than focus on techniques to remove brine salts from produced water, or other water sources, this effort developed a method to change the chemistry of the brine salts, resulting in a new brine that is easier to deal with and has potential value.

SERC Develops New Inventions and Innovations

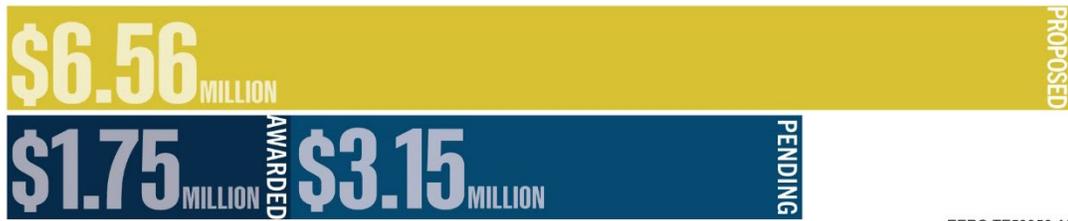
Eight new inventions resulting from SERC efforts have been disclosed to date:

- Methods of Production of Graphene and Its Derivatives from Coal Intermediates
- Methods of Upgrading Coal to Produce Enhanced Graphene Precursors
- Calcination Alternative for Regeneration of CO₂ Capture Materials
- Tunable CO₂ Electro-Valorization (TCEV) to High-Value Liquid Products (*Enhanced Ethanol Production*)
- Automatic Detection of Buried Pipelines and Spills
- High-Durability Silica and Magneli-Phase Composite (SAMPC) Support for Electrocatalyst and Method of Making the Same (*Supporting Ammonia and Other Chemical Production from Electricity*)
- Electrochemical Extraction of Rare-Earth Elements (EEREE) from Coal or Coal By-Products
- Ionic Liquids (IL) and Deep Eutectic Solvents (DES) for Extraction of Rare-Earth Elements (REEs) and Critical Minerals (CMs) from Coal

All eight of these new inventions have been transferred to the EERC Foundation[®] and are being evaluated for potential patent protection. The EERC Foundation serves as the commercialization and intellectual property protection arm of the EERC. To date, three of these inventions have moved forward for patent protection. Additional invention disclosures are expected as the final SERC projects for this biennium are concluded.

SERC Concepts Lead to Additional Funding Opportunities

Concepts being explored through SERC funding are only in the initial stages of development and often require significant other resources to advance and eventually demonstrate and move to commercialization. In the 2 years that SERC has been operating, successful SERC projects have led to significant additional funding. To date, we have submitted over \$6.5 million in proposals to external sources, with \$1.75 million awarded and \$3.15 million pending. These proposed projects are all based on successful SERC projects. The total value of proposals and awards resulting from current SERC projects will continue to increase over the next year.



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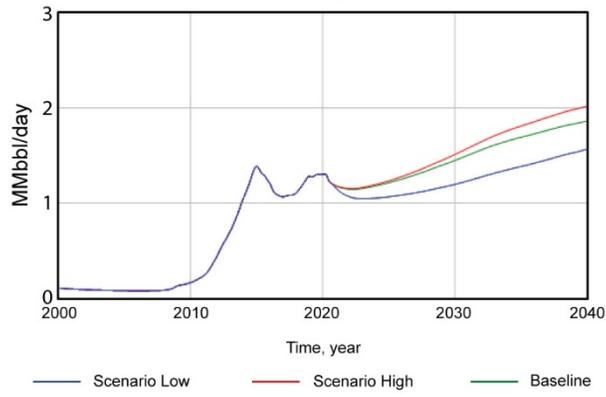
Concepts developed through SERC are being used to pursue additional funding.

North Dakota Sustainability Model

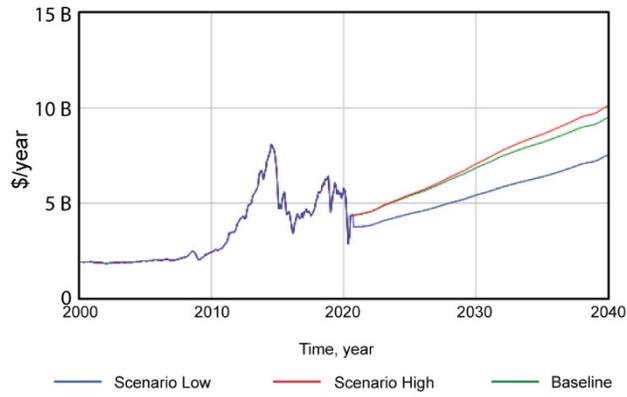
The EERC, along with University of North Dakota (UND) and North Dakota State University (NDSU) faculty, and Ventana Inc., developed a system dynamics model to help understand the potential impacts of national and state policies on the future of energy in North Dakota by looking at their effect on state revenue, jobs, environment, and reliability of electrons.

The system dynamics model was developed based on 1) a broad range of previous studies that forecast the effects of opportunities and challenges facing North Dakota, 2) input from state energy experts, and 3) sound physical and financial principles. Shown below are three different scenarios that include a baseline scenario, a high scenario, and a low scenario based on WTI and technology improvements. A broad number of scenarios can be conducted with the model, including looking at a variety of CO₂ EOR and carbon tax scenarios. The following three figures are the modeling results showing the next 20 years of oil production, tax revenue, and employment for baseline, high, and low scenarios.

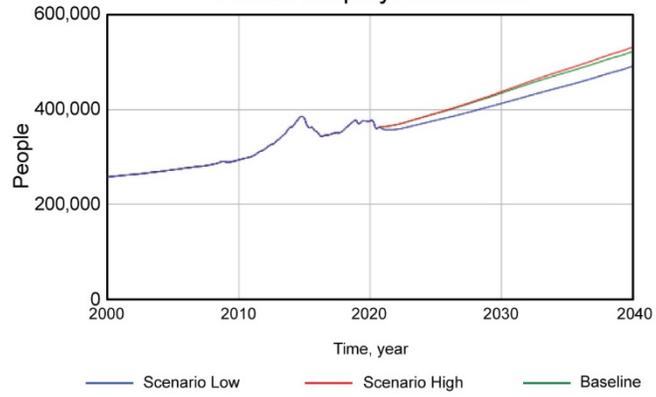
Production Daily Rate Model



Total Tax Revenue Model



Overall Employment Model



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Energy Hawks

During the summer of 2020, 11 students participated virtually as Energy Hawks at the EERC. Nine of the students were from UND, with one from NDSU and one from Bismarck State College (BSC). Over the course of 10 weeks, they were immersed in all aspects of North Dakota energy and conducted research on new areas of potential development for North Dakota. The Energy Hawks Program funded through SERC allows a multidisciplinary team of students to significantly increase their knowledge of North Dakota energy, allowing them to serve as mentors to their peers and, eventually, leaders in North Dakota.



2020 Energy Hawks participating virtually in the summer of 2020.

The 2021 Energy Hawks Program is planning to broaden participation across North Dakota and will include eight students from UND; two from NDSU; and one each from BSC, Minot State University, and Williston State College. We are also in conversations with Turtle Mountain Community College and Nueta Hidatsa Sahnish College for the potential to include a student. The program will likely occur through a hybrid of virtual and in-person activities.



Anticipated Energy Hawks participants will come from six different institutions in 2021.

In summary, SERC has proven its success in:

- Developing new, innovative technologies with the potential to advance North Dakota's future energy opportunities and benefit the state's economy and environment.
- Attracting external funding to further those technologies.
- Increasing collaboration across North Dakota.