2019-2020

EERC

State Energy Research Center

EXECUTIVE SUMMARY

Exploratory, innovative, and transformational research advancing future energy opportunities

The University of North Dakota (UND) Energy & Environmental Research Center (EERC) was designated the State Energy Research Center (SERC) by the 66th Legislative Assembly of North Dakota through SB2249. SERC is built on the reputation of the EERC as a leader in critical energy research, with the purpose of serving the state of North Dakota by developing technologies to ensure a prosperous energy future for North Dakota.

> **"The EERC has demonstrated that we are a critical component advancing energy for the state of North Dakota, the industries and utilities operating in North Dakota, and the citizens of North Dakota. We are asking for your support of Bill 2249, providing us the opportunity to enhance our service to North Dakota through the establishment and funding of the State Energy Research Center. Although the return on investment of this funding may be difficult to quantify, as evidenced by past performance, the benefits of these efforts will be orders of magnitude greater than the investment."**
>
> **Thomas Erickson**, then CEO of the EERC, during testimony for SB2249

The availability of commercially deployable technologies and concepts to serve the state in the future is dependent on continually creating innovative ideas. As shown in Figure ES-1, exploratory research is the first step in the process toward commercialization. Exploratory research feeds research and development, eventually leading to demonstration and commercialization.

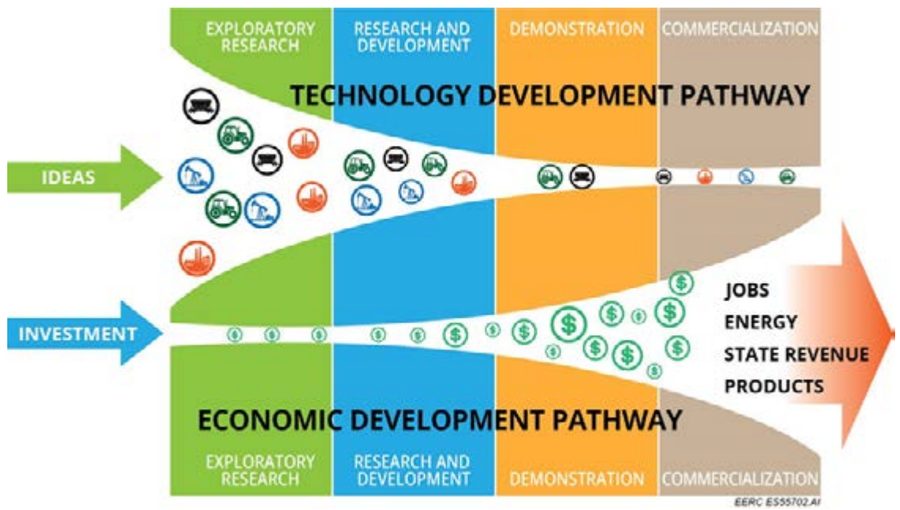

Figure ES-1. SERC funding is focused on accelerating exploratory research to generate new ideas and concepts. Those concepts are then advanced through additional research and development, demonstration, and commercialization with separate funding sources.

ESTABLISHMENT of the State Energy Research Center

As stated within SB2249, SERC was established to allow the EERC to conduct exploratory, transformational, and innovative research that advances future energy opportunities and benefits the state's economy and environment through:

- **EXPLORATORY RESEARCH** of technologies and methodologies that facilitate the prudent development, and clean and efficient use, of the state's energy resources.
- **GREATER ACCESS TO ENERGY EXPERTS** for timely scientific and engineering studies to support the state's interests.
- **EDUCATION AND OUTREACH** related to the state's energy resources.

Funding for SERC, up to $5 million per biennium, is provided from a small portion of the oil and gas production and extraction taxes. The first biennium's funding was completely allocated to SERC activities by February of 2020. SERC funding is currently set to expire after two biennia, on June 30, 2023.

FIRST-YEAR RESULTS

A significant increase in
EXPLORATORY RESEARCH

Research activities across all facets
of **NORTH DAKOTA ENERGY**

A large increase in the number of
NEW INVENTIONS

Initiation of the first phase of a
STATEWIDE ENERGY SUSTAINABILITY STUDY

20 North Dakota students
participating in the
ENERGY HAWKS PROGRAM

Greater collaboration across
the state's **INSTITUTIONS OF HIGHER EDUCATION**

Accelerating EXPLORATORY RESEARCH

Upon initiating SERC efforts, the EERC implemented a five-step innovation process to accelerate exploratory research and serve the state of North Dakota by developing new technology concepts. This process is designed to increase researcher productivity while decreasing unnecessary administrative burden and has successfully generated a broad suite of new concepts in the first year of SERC activities. Only a select number these concepts were ultimately chosen for funding. The five-step process included:

1. Conducting brainstorming sessions to generate innovative research ideas.
2. Reviewing ideas using teams of technical and nontechnical research experts to assess the concepts and support their selection.
3. Working with selected projects to optimize their research plan for service to North Dakota.
4. Conducting exploratory research.
5. Identifying additional funding sources to further the research and development of completed projects and, when appropriate, through demonstration and commercialization, as noted in Figure ES-1.

INNOVATION Is Born

Within the first year of SERC activities, the EERC has seen a significant new focus on exploratory research with a variety of projects touching all facets of North Dakota energy. All $5 million available for the biennium was allocated to projects within the first year. 59 innovative research concepts were brought forward for potential funding from SERC in three rounds of internal solicitation. Rounds 1 and 2 followed the approach noted above. Round 3, which occurred during remote operations resulting from COVID-19 and had significantly less funding available because of the tremendous ideas already funded, was carried out in a slightly abbreviated manner of the same process. Figure ES-2 shows the number of innovative concepts proposed during each round and the number of projects chosen to move forward.

Through significant vetting of the proposed concepts via a peer-led review process (tiger team method), 25 new research projects were selected. The selected projects focused on coal, oil and gas, and renewable energy and included methods of optimized extraction and utilization, critical element extraction, new materials, and environmental protection. A diagram representing the breakdown of areas funded is shown in Figure ES-3. While it was originally envisioned that projects would be selected in stages throughout the biennium, the significant number of ideas brought forth during the innovation process resulted in 100% of the exploratory research funding being allocated within the first year.

Figure ES-2. 59 concepts were brought forward for consideration within the first year of SERC activities. Through significant vetting, 25 were chosen for funding.

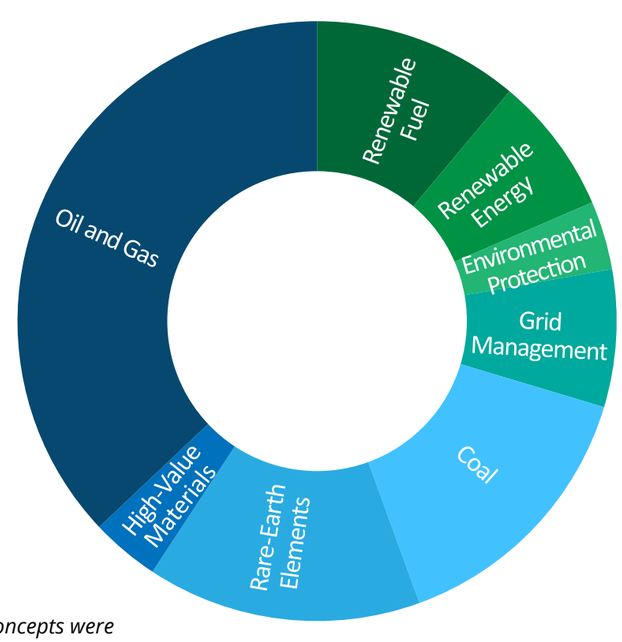

Figure ES-3. Breakdown of areas funded within the exploratory research component of SERC.

Of the 25 research projects initiated, seven projects were completed within the first year of SERC activities. It should be noted that all of these projects are in the exploratory stages of research and significant additional work is necessary to advance the concepts developed. Some of the highlights from those projects include the following:

- Production of the first-ever graphene dot from North Dakota lignite. Graphene is a high-value, high-strength material produced from uniquely arranged carbon molecules. North Dakota lignite has attributes that may make graphene production advantageous.
- A significant analysis was completed on the most efficient and least cost process for conversion of wellhead gas to transportable liquid products.
- Energy storage technologies for use in North Dakota were analyzed, and three technologies were modeled as part of a more detailed analysis.
- Limited research has identified areas within North Dakota shales for potential recovery of rare-earth elements and other critical metals.
- Potential areas of grid vulnerability from naturally occurring electromagnetic pulses were identified.
- Laboratory efforts tested a conceptual in situ method for extracting rare-earth elements from coal.
- The effect of stress shadows on hydraulic fracture development and the optimization of fracture spacing for Bakken wells were investigated.

Primarily as a result of innovative research funded through SERC, the EERC has seen a significant increase in the number of new invention disclosures, as shown in Figure ES-4. Prior to SERC funding, as noted within the testimony supporting SB2249, the EERC had seen a dramatic decrease in new inventions, with 2018 recording zero invention disclosures. The new inventions resulting from SERC projects are currently being examined for legal protection through patenting and other less formal forms of protection.

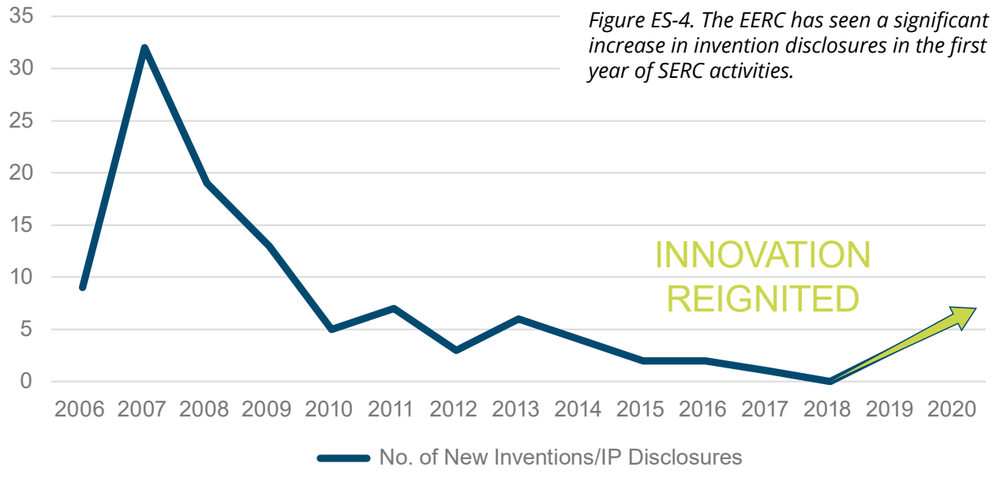

Figure ES-4. The EERC has seen a significant increase in invention disclosures in the first year of SERC activities.

NORTH DAKOTA'S Energy Future

The second focus area of SERC is on providing greater access to energy experts for timely scientific and engineering studies. On April 1, 2020, the North Dakota Industrial Commission (NDIC) approved a SERC-funded project focused on identifying the challenges and opportunities related to achieving energy sustainability for the state of North Dakota within the next 5 to 20 years.

North Dakota's energy industries are constantly adjusting to meet the future environmental, social, and economic needs of its citizens. The state of North Dakota, while continuing an all-of-the-above energy approach, needs to be prepared for transitions in the energy industries that will affect issues such as 1) ensuring affordable, dispatchable energy is available for North Dakota citizens; 2) maintaining existing and expanding future employment opportunities; 3) maintaining North Dakota's healthy environment; and 4) maintaining state, tribal, and local tax revenues.

Within this project, one of the goals is identifying and quantifying relationships between the various components of North Dakota's energy industry and the objective of maintaining and growing jobs and revenues, maintaining a healthy environment, and ensuring affordable and reliable access to energy. Figure ES-5 is a first-generation conceptual model, developed through this effort, which shows the relationships between various components considered in the study.

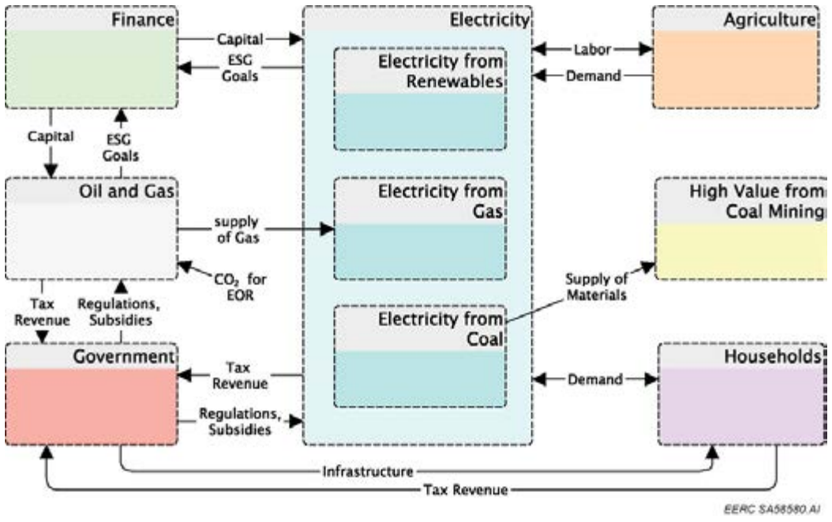

Figure ES-5. Identifying the critical relationships between North Dakota's energy sectors, the state, and citizens of North Dakota.

This project, planned to be completed by the end of 2020, will develop a series of small models that allow us to understand the relationships between the critical components of North Dakota's energy and other industries. These small models, along with other research activities and discussions with industry experts, state leaders, and other stakeholders, will be used to develop options to help ensure sustainability in accordance with the project's direction. This effort is considered Phase I of a much larger vision to develop a more comprehensive approach to ensuring sustainability.

Providing Opportunities and Resources for EDUCATION AND OUTREACH

Within the education and outreach component of SERC, both the 2019 and 2020 Energy Hawks Programs were conducted. The multidisciplinary Energy Hawks Program brings together students from a variety of academic programs to collaborate on identifying value-added opportunities for North Dakota energy. Students spend 10 weeks learning about all forms of North Dakota energy, including a weeklong tour of western North Dakota to visit oil and gas, coal, ethanol, hydro, and wind sites. The 2019 Energy Hawks produced three concept papers with ideas to help add value to North Dakota energy.

The Energy Hawks Program for 2020 is being conducted in a remote, online manner because of COVID-19 safety measures (Figure ES-6). One student from North Dakota State University and one student from Bismarck State College joined nine University of North Dakota students for this year's program. The 2020 program will be completed in early August with three concept papers prepared by the students, similar to previous Energy Hawk years.

STUDENTS' MAJOR AREAS OF STUDY

PETROLEUM ENGINEERING
ENVIRONMENTAL STUDIES
EXPERIMENTAL PSYCHOLOGY
MECHANICAL ENGINEERING
CHEMISTRY • ECONOMICS
BUSINESS ADMINISTRATION
GEOLOGICAL ENGINEERING
ACCOUNTING • MATHEMATICS
AEROSPACE ENGINEERING
COMPUTER SCIENCE
PUBLIC HEALTH • LAW
POLITICAL SCIENCE
INTERNATIONAL STUDIES
BUSINESS ECONOMICS

Figure ES-6. 2020 Energy Hawks participating remotely (top) and 2019 Energy Hawks during their tour of North Dakota.

Accelerating
KNOWLEDGE SHARING

To better foster statewide energy education and outreach, a meeting was held on July 31, 2019, at the EERC to discuss opportunities for collaboration across all institutions of higher education within the state of North Dakota. The invitation to participate went to all institutions across North Dakota and was not limited to those within the State Board of Higher Education. Based on discussions during the July meeting, a web-based system allowing access to energy-related education and outreach information from the participating institutions was created. The online E-Portal system serves as a one-stop shop for education and outreach information already existing within the different institutions. Figure ES-7 shows the concept of providing information and the participating institutions to date. The E-Portal system, www.ndportal.org, went live in June 2020.

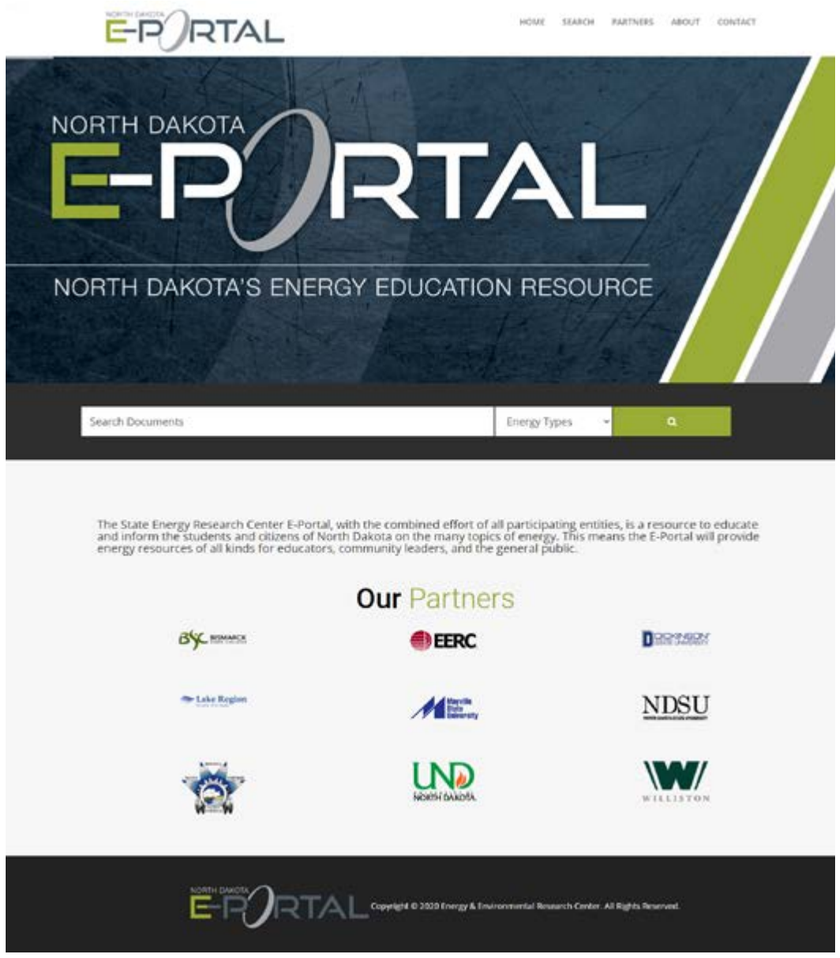

Figure ES-7. E-Portal provides online access to energy information for the students and citizens of North Dakota.

FUTURE EFFORTS

The overall efforts of SERC will continue into the second year of the biennium, with significant work progressing on activities that have already commenced; however, no new projects are anticipated to be funded, as all $5 million available for the biennium were allocated within the first year. Although 25 new research projects was successfully funded, nearly 60 innovative research concepts were brought forth by EERC researchers in the first year alone, with numerous additional ideas in discussion should additional funding become available. As appropriate, results will be presented to NDIC, the Energy Development and Transmission Committee, and the next North Dakota legislative body.

FOR MORE INFORMATION ABOUT SERC ACTIVITIES OR RESULTS, CONTACT:

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