Nebraska Center for Energy Sciences Research
Benefits Review

NPPD Board of Directors Meeting
Strategic Business Matters
April 11, 2024

George Gogos
Director, NCESR
University of Nebraska

John Swanson
Director of Generation
Strategies & Research

NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

Nebraska Public Power District
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IN OUR GRIT, OUR GLORY™

Organizational Chart

External Advisory Committee (EAC)

University of Nebraska-Lincoln

- **Rodney Bennett -** Chancellor; EAC Chair
- **Sherri Jones -** Interim Vice Chancellor for Research & Economic Development

Nebraska Public Power District

- **Thomas Kent -** President and CEO; EAC Vice-Chair
- **Jerry Chlopek -** Chair, NPPD Board of Directors
- **Aaron Troester -** Energy Supply Committee Chair, NPPD Board of Directors

UNL

Rodney Bennett, Chancellor

Sherri Jones, Interim Vice Chancellor for Research & Economic Development

NCESR

George Gogos - Director
Mark Riley - Associate Director
John Swanson - NPPD Liaison
Roman Estrada - NPPD Liaison

Executive Council

- **Tala Awada -** Agricultural Research Division
- **Karrie Weber -** Biological Sciences
- **Alexander Sinitskii -** Chemistry
- **George Gogos -** Mechanical & Materials Engineering
- **Mark Riley -** Biological Systems Engineering
- **Shireen Adenwalla -** Physics and Astronomy
- **John Swanson -** NPPD
- **Roman Estrada -** NPPD

Power of People Campaign Signage for NCESR

Mission

*To **conduct energy research** that produces new technologies, processes and systems that **provide new or significantly enhanced energy sources** and **improve the quality of life and economic opportunity for Nebraskans***

(Energy Center Charter Document)

To Accomplish the Mission

- Train Students
- Fund Research in Energy Efficiencies and Sustainable forms of Energy
  - Seed projects in promising new areas
  - Facilitate interdisciplinary collaborations
- Have Economic Impact & Leverage Funding
  - NEW Vision to expand Energy Center
  - Attract external funding from federal agencies, foundations and other public or private entities
  - Provide new solutions to problems for Nebraskans and the nation
- Efficient and Effective Operations

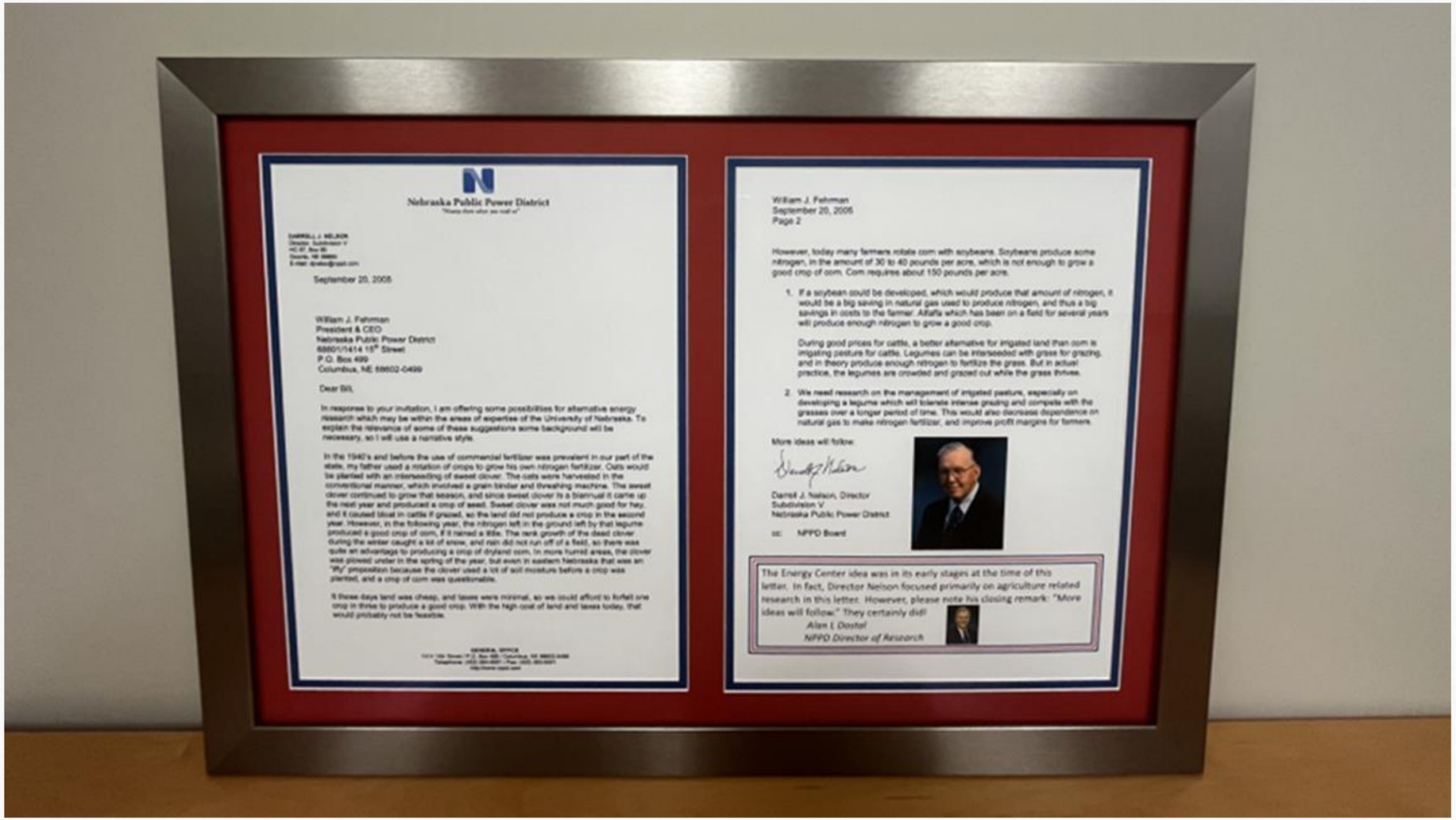
Student Opportunities

Darrell J. Nelson Summer Undergraduate Internship

Darrell J. Nelson

- Annual summer internship opportunity in energy sciences research
  - Internship opportunity started in 2014
  - Eight internships are available this year with a maximum $6,000 stipend
  - Program attracts outstanding students interested in energy science
- NCESR & NPPD will host a Meet & Greet for interns and faculty sponsors in June 2024
- Interns & Faculty Sponsors will tour Cooper Nuclear Station in the Summer of 2024
- Interns will present posters displaying the results of their work at the Summer Research Symposium early August 2024
- Interns'/Faculty Sponsors' reports are due 9/30/2024

Darrell J. Nelson Letter Framed in NCESR Conference Room



Nebraska Public Power District

September 20, 2005

William J. Fehrman
President & CEO
Nebraska Public Power District
6801/1414 15th Street
P.O. Box 499
Columbus, NE 68602-0499

Dear Bill,

In response to your invitation, I am offering some possibilities for alternative energy research which may be within the areas of expertise of the University of Nebraska. To explain the relevance of some of these suggestions some background will be necessary, so I will use a narrative style.

In the 1940's and before the use of commercial fertilizer was prevalent in our part of the state, my father used a rotation of crops to grow his own nitrogen fertilizer. Oats would be planted with an interseeding of sweet clover. The oats were harvested in the conventional manner, which involved a grain binder and threshing machine. The sweet clover continued to grow that season, and since sweet clover is a biannual it came up the next year and produced a crop of seed. Sweet clover was not much good for hay, and it caused bloat in cattle if grazed, so the land did not produce a crop in the second year. However, in the following year, the nitrogen left in the ground left by that legume produced a good crop of corn, if it rained a little. The rank growth of the dead clover during the winter caught a lot of snow, and rain did not run off of a field, so there was quite an advantage to producing a crop of dryland corn. In more humid areas, the clover was plowed under in the spring of the year, but even in eastern Nebraska that was an "iffy" proposition because the clover used a lot of soil moisture before a crop was planted, and a crop of corn was questionable.

In these days land was cheap, and taxes were minimal, so we could afford to forfeit one crop in three to produce a good crop. With the high cost of land and taxes today, that would probably not be feasible.

William J. Fehrman
September 20, 2005
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However, today many farmers rotate corn with soybeans. Soybeans produce some nitrogen, in the amount of 30 to 40 pounds per acre, which is not enough to grow a good crop of corn. Corn requires about 150 pounds per acre.

1. If a soybean could be developed, which would produce that amount of nitrogen, it would be a big saving in natural gas used to produce nitrogen, and thus a big savings in costs to the farmer. Alfalfa which has been on a field for several years will produce enough nitrogen to grow a good crop.

   During good prices for cattle, a better alternative for irrigated land than corn is irrigating pasture for cattle. Legumes can be interseeded with grass for grazing, and in theory produce enough nitrogen to fertilize the grass. But in actual practice, the legumes are crowded and grazed out while the grass thrives.

2. We need research on the management of irrigated pasture, especially on developing a legume which will tolerate intense grazing and compete with the grasses over a longer period of time. This would also decrease dependence on natural gas to make nitrogen fertilizer, and improve profit margins for farmers.

More ideas will follow.

Darrell J. Nelson, Director
Subdivision V
Nebraska Public Power District

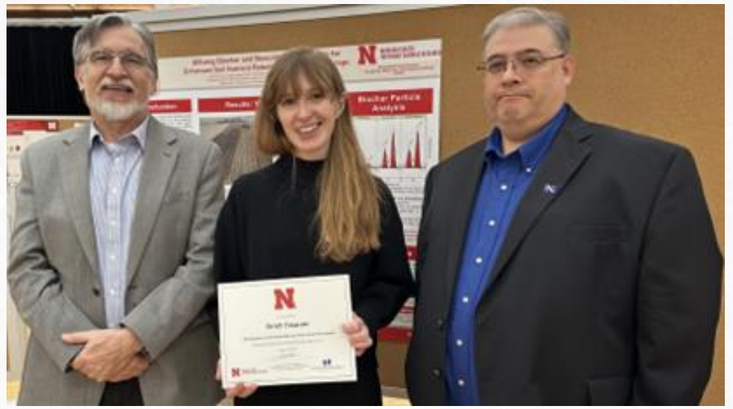
cc: NPPD Board

The Energy Center idea was in its early stages at the time of this letter. In fact, Director Nelson focused primarily on agriculture related research in this letter. However, please note his closing remark: "More ideas will follow." They certainly did!

Alan L Dostal
NPPD Director of Research

Poster Presentations at UNL Student Research Days

- 20 posters associated with Energy Center funded projects were presented on March 26 & 27, 2024
  - 5 Undergraduate Student Posters
  - 15 Graduate Student Posters



Britt Fossum, undergraduate student with Dr. Gogos and Roman Estrada

Undergraduate Students Group with Dr. Gogos and Roman Estrada

Graduate Students Group with Dr. Gogos and Roman Estrada

The Research

Process – Schedule / Timeline

up to 6 NPPD Executives & Board Members participate

- **Cycle 18** (2024 – 2025)
  - 31 Preproposals received 5/15/2023
  - 17 Full Proposals were received upon invitation 7/31/2023
  - 9 projects were selected and started on 1/1/2024
  - Progress Reports due by 7/26/2024
  - Progress Review Meeting on 10/24/2024
    - This review will determine who will be funded for Cycle 18 Year 2

Cycle 18 Grant Recipients (9 total)

Focus Area	PI	Proposal Title
Carbon Sequestration	Wei Niu	Systems Metabolic Engineering of Pseudomonas putida for the Bioproduction of C6 Chemicals from Lignin-derived Aromatics
Energy Infrastructure Resilience	Eric Markvicka	Cure-in-Place Phase Change Thermal Interface Material for Superior Thermal Management in High-Power Energy Systems
Energy Infrastructure Resilience	Jian Wang	Discovery of Multiple Element Alloys for Preventing Hydrogen Embrittlement
Energy Infrastructure Resilience	Joseph Turner	Next Generation Embedded Wireless Sensors for Structural Health Monitoring of Wind Turbines
Energy Literacy	F. John Hay	Microgrid Mastermind: The Quest for Reliable Electricity
Energy Storage	Xiaoshan Xu	Low cost and clean energy storage based on molecular ferroelectrics and antiferroelectrics
Energy Storage	Moe Alahmad	An Intelligent Adaptive Modular Battery Energy Storage System for the Built Environment
Energy Storage	Seunghee Kim	Subsurface hydrogen migration and reactions for geological hydrogen production and engineered storage
Hydrogen Generation	Siamak Nejati	Electrocatalysts for Green Hydrogen: Tailored 2D Materials based on Metal Carbide

Cycle 18 Grant Recipients (9 total)

Low cost and clean energy storage based on molecular ferroelectrics and antiferroelectrics

Xiaoshan Xu, Associate Professor
Physics and Astronomy

Cure-in-Place Phase Change Thermal Interface Material for Superior Thermal Management in High-Power Energy Systems

Eric Markvicka, Assistant Professor
Mechanical & Materials Engineering

Discovery of Multiple Element Alloys for Preventing Hydrogen Embrittlement

Jian Wang, Professor
Mechanical and Materials Engineering

Electrocatalysts for Green Hydrogen: Tailored 2D Materials based on Metal Carbide

Siamak Nejati, Assistant Professor
Chemical and Biomolecular Engineering

Cycle 18 Grant Recipients (9 total) continued…

Next Generation Embedded Wireless Sensors for Structural Health Monitoring of Wind Turbines

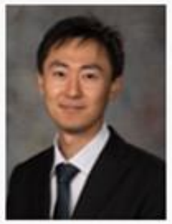
Joseph Turner, Robert W. Brightfelt Professor
Mechanical and Materials Engineering

An Intelligent Adaptive Modular Battery Energy Storage System for the Built Environment

Moe Alahmad, Associate Professor
Durham School of Architectural Engineering and Construction

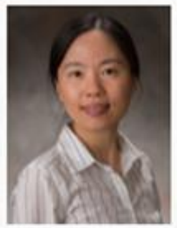
Microgrid Mastermind: The Quest for Reliable Electricity

Francis John Hay, Extension Educator (Energy)
Biological Systems Engineering



Subsurface hydrogen migration and reactions for geological hydrogen production and engineered storage

Seunghee Kim, Associate Professor
Civil and Environmental Engineering



Systems Metabolic Engineering of Pseudomonas putida for the Bioproduction of C6 Chemicals from Lignin-derived Aromatics

Wei Niu, Associate Professor
Chemical and Biomolecular Engineering

Process – Schedule / Timeline continued…

up to 6 NPPD Executives & Board Members participate

- **Cycle 19** (2025 – 2026)
  - ➢ **Request for Preproposals** (RFP) **Released 3/19/2024**

Research Focus Areas

- **Electric utility priorities:**
  - Integration of renewables with fossil fuels
  - Electric system reliability and resiliency
  - Energy storage with potential for use at utility scale
  - Microgrids
  - Agrivoltaics (farming amongst solar farms)
  - Energy generation using hydrogen, nuclear, low carbon fuels
  - Use of ammonium sulfate in agriculture
- **Energy use in transportation and electricity generation:**
  - Electric vehicles
  - Ethanol for aviation or for gas turbines
  - Electric powered off-road vehicles for agriculture, commercial and recreational use
- **Carbon:**
  - CO_2 capture and sequestration
  - Decarbonization processes for heavy industries
  - Carbon measurement instrumentation and tools to ensure compliance with applicable standards
  - Biochar production and utilization
  - Other productive uses of carbon/carbon dioxide
  - Prevention of methane releases to the atmosphere
  - Prevention of hydrogen releases to the atmosphere
- **Nebraska's Bioeconomy:**
  - New approaches to utilize Nebraska's agricultural and natural resources to advance the local bioeconomy (provided examples in RFP).
- **Energy literacy:**
  - Engages the public to increase knowledge of timely energy topics including energy sources, generation, storage, transmission and current limitations of technologies.

Process – Schedule / Timeline continued…

up to 6 NPPD Executives & Board Members participate

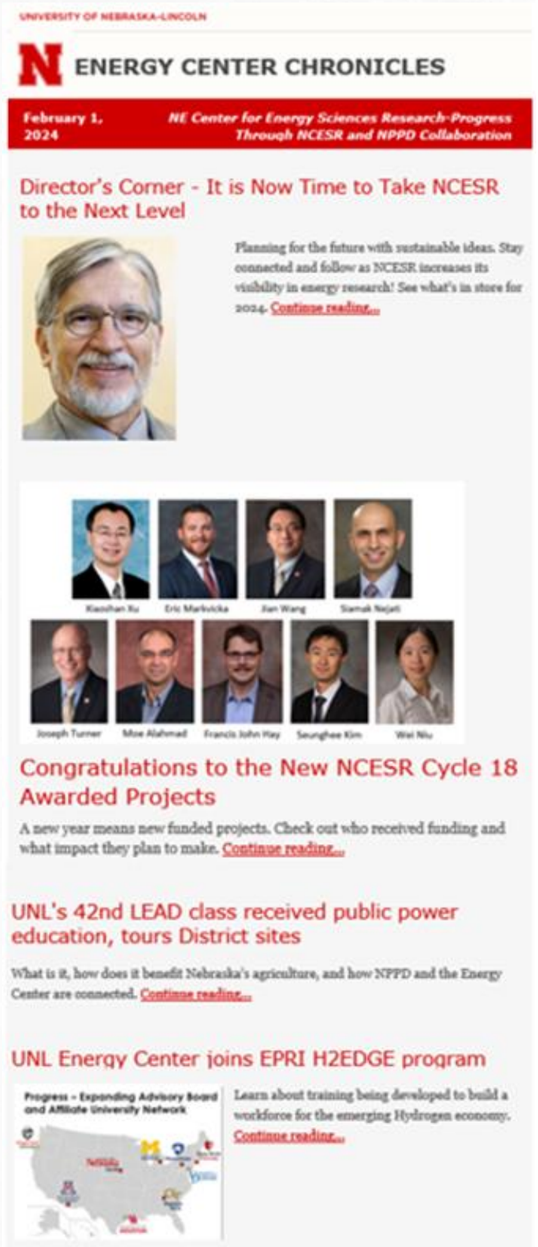
- **Cycle 19** continued…
  - Preproposals will be reviewed by Executive Council (EC) on 6/10/2024
  - A select number will be invited to submit Full Proposals by 7/31/2024
  - Subject matter experts outside of UNL will review the Full Proposals
  - Principal Investigators will present Full Proposals to EC in November 2024
    - This is scheduled once Faculty on the EC know their fall teaching schedule
    - EC will determine which projects to recommend to External Advisory Committee (EAC) for Funding
  - EAC will Select Projects for Funding on 12/18/2024

The Impact

NCESR Newsletter

Started the *Energy Center Chronicles* in 2022

- The newsletter is an outcome of the external review of the Energy Center for increased communications
- The frequency of the e-newsletter is 3 times per year (February – June – October 2024)
  - *additional newsletters or announcements can be released via the UNL ANNOUNCE electronic system if needed*
- It is disseminated to UNL faculty, students involved with NCESR, NPPD leadership, staff & customers
- The newsletter, subscription and feedback opportunity is available on the NCESR website, and the link is provided on the NPPD website
- NPPD also posts on social media


UNIVERSITY OF NEBRASKA-LINCOLN

ENERGY CENTER CHRONICLES

February 1, 2024 — NE Center for Energy Sciences Research Progress Through NCESR and NPPD Collaboration

Director's Corner - It is Now Time to Take NCESR to the Next Level

Planning for the future with sustainable ideas. Stay connected and follow as NCESR increases its visibility in energy research! See what's in store for 2024. Continue reading...

Congratulations to the New NCESR Cycle 18 Awarded Projects

A new year means new funded projects. Check out who received funding and what impact they plan to make. Continue reading...

UNL's 42nd LEAD class received public power education, tours District sites

What is it, how does it benefit Nebraska's agriculture, and how NPPD and the Energy Center are connected. Continue reading...

UNL Energy Center joins EPRI H2EDGE program

Progress - Expanding Advisory Board and Affiliate University Network

Learn about training being developed to build a workforce for the emerging Hydrogen economy. Continue reading...

Thank you!

to the many individuals from NPPD and UNL who provide content and edits.

Discussing the Future of Biochar & Impact

First cluster of researchers to pursue large external funding

NCESR and NPPD Hosted a Biochar Workshop on 4/04/2024

- Alan Dostal provided welcome and introductions
- Dr. Robert Brown provided an overview of Iowa State University's biochar projects and discussed biochar development in the U.S. and the world
- Mr. Chuck Hassebrook discussed the key policy and permitting needs shaping the future of biochar
- Dr. Jiong Hu provided an overview of UNL's biochar projects
- Dr. Sandeep Kumar from USDA presented funding opportunities for biochar research
- Dr. George Gogos moderated the discussion of the group regarding challenges of biochar implementation
- 2 UNL faculty/researchers provided two different lab tours

Entrepreneurship Workshop for Researchers

- The *FREE* **July 22 & 23**, workshop is open to all UNL Researchers
- For those considering launching a company or may have already started the process, this workshop will provide the tools and resources needed to succeed
- Includes a Networking Event to interact with founders, experts, and service providers from the local entrepreneurship ecosystem
- **Roman Estrada**, NPPD Generation Research Sr. Program Manager and NCESR Liaison is on the planning committee and will participate as one of the speakers

Co-hosts and partners are:

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NUtech VENTURES

innosphere ventures

NEBRASKA CENTER FOR ENERGY SCIENCES RESEARCH

Return on Investment

Description	As of April 2024
External Funds Awarded to Recipients of NCESR-funded Seed Grants: **Cycle 1 through Cycle 17***	$ 120.20 million
Other External Funds Awarded to UNL and Administered through NCESR: **Cycle 1 through Cycle 17*** *(Excludes cycle funding, only includes special projects)*	$ 7.28 million
Total External Funds	$ 127.48 million

NCESR-funded Seed Grants: Cycle 1 through Cycle 17* $ 15.99 million

(Includes Instrumentation Funding)

Overall Return on each $1 invested . . . $ 7.97

*Cycle 18 is not figured in these numbers since those projects are only a few months into their work & external funding is minimal.

By the Numbers (as of April 2024)

- **138 Research Projects funded for Cycles 1-18**
  - Includes seed & instrumentation funding
- **576 Publications with 32,803 Citations**
  - Includes Cycles 1-17 and the Water, Energy & Agriculture Initiative (WEAI)

    (Cycle 18 isn't included since it started on 1/1/2024 & the first PI reports won't be received until July 2024)
  - Includes journals, books & conference presentations that have been published
  - Plus, there are another 955 conference presentations and poster presentations not published
- **701 Students working with Cycles 1-17** (counting students each time they worked on a different cycle, etc.)

  (Cycle 18 isn't included since it started on 1/1/2024 & the first PI reports won't be received until July 2024)
  - Includes a student each time if reported on multiple cycles / was a summer intern more than once / worked on a cycle as an undergrad, then another cycle as a grad student or postdoc
  - Includes students from PI reports (undergrads, grad students, postdocs) & summer interns

613 Students for Cycles 1-17 (counting a student only once when worked on multiple cycles, etc.)

By the Numbers (as of April 2024) continued…

- **$ 16.62M investment from NPPD (Cycles 1-17) and $17.38M (Cycles 1-18 year 1)**
  - Includes seed & instrumentation funding, special projects, summer interns
- **13 patents awarded and 6 pending from NCESR Researchers**
  - Information is received from NUtech
- $127.48M Total External funding for Cycles 1-17
  - *Cycle 18 is not figured in these numbers since those projects are only a few months into their work & external funding is minimal.*
- **$100’sM economic benefit to Nebraskans**

Vision to Expand Energy Center

It is time to take NCESR to the next level by elevating its national & international visibility

- **NCESR Director attended University Energy Institute Leadership Collaborate (UEILC)**
  - NPPD/NCESR's collaborative effort was presented
  - Entities similar to NCESR are springing up at various US universities over the last few years
    - John Hopkins University (JHU) received major donation to establish an institute that will conduct research in sustainable forms of energy.
      - *– JHU started hiring new faculty for that purpose.*
    - University of Pennsylvania and Louisiana State University have also received major donations to pursue similar entities.

We owe it to NPPD's leadership whose vision preceded these new entities by nearly two decades, to remain ahead of the competition.

Vision to Expand Energy Center continued…

- **Secure resources to hire approximately 20-25 new faculty who will dedicate their careers to research on energy efficiency and sustainable forms of energy.**
  - These faculty will be hired in various departments in the College of Engineering, in Physics and Astronomy, in Chemistry, in Biochemistry, in Economics and in the School of Natural Resources.
  - UNL, NPPD and Nebraska Government work together
  - Conduct fundraising through the UN Foundation (target $100 million)
    - Had multiple meetings with Dr. Sherri Jones, Interim Vice Chancellor of Research
    - Met with the deans of various UNL colleges. They are onboard to help with fundraising.
      - Deans of the College of Engineering, the College of Arts and Sciences and of the Agricultural Research Division
    - Meetings to be scheduled
      - Directors of NDEE and NDED (NPPD is facilitating these meetings)
      - UNL Leadership
      - NPPD and UNL Leadership
      - NPPD and UNL Leadership with Nebraska Government
  - This NCESR expansion will be impactful to Nebraska's economy. We expect Nebraska government's investment.

It is a vision that will place UNL at the forefront of energy research opportunities as the energy industry transitions to less carbon intensive solutions while maintaining reliability, resiliency and affordability.

The Operations

NCESR and NPPD Team

The Team

NCESR TEAM: *top row*
Dr. George Gogos, *Director (Professor and Associate Chair for Research and Graduate Studies, Wilmer J. and Sally L. Hergenrader Chair of Mechanical & Materials Engineering)*
Dr. Mark Riley, *Associate Director (Associate Dean, College of Engineering)*
Brenda Coufal, *Program Coordinator*
Susan Wesely, *Administrative Associate*

NPPD PARTNERS: *bottom row*
Tom Kent, *President & CEO and NCESR External Advisory Committee Vice Chair*
Jerry Chlopek, *Board of Directors Chair and NCESR External Advisory Committee*
Aaron Troester, *Board of Directors and NCESR External Advisory Committee*
John McClure, *Executive Vice President External Affairs & General Counsel*

John Swanson, *Director of Generation Strategies & Research and NCESR Liaison*
Roman Estrada, *Generation Research Sr. Program Manager and NCESR Liaison*
Alan Dostal, *Part-time Director of Research and NCESR Liaison*
Tannon Asche, *Community Engagement & Public Relations Lead*
Jan Modelski, *Assistant Secretary to the Board*

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Questions?

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