NM SMART Grid Center
ANNUAL REPORT
YEAR 4

New Mexico EPSCoR
Advancing Collaborative Research Excellence in New Mexico

September 2021 - August 2022

Diversity & Inclusion Statement

The diversity of the people of New Mexico has been a source of innovation and creativity throughout our state's history. NM EPSCoR respects and values diversity of all types, including race, ethnicity, national origin, age, gender identity, sexual orientation, education, socioeconomic status, ability, and more.

We see diversity as a source of strength, and we strive to create an inclusive, collaborative, and equitable environment where everyone can realize their full potential. NM EPSCoR particularly acknowledges the acute need to remove barriers to the recruitment, retention, and advancement of talented students, faculty, and staff from historically excluded populations that are currently underrepresented.

NM EPSCoR State Office

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EPSCoR OVERVIEW

New Mexico's Established Program to Stimulate Competitive Research (NM EPSCoR) was established in 2000 and is funded by the National Science Foundation (NSF) to advance the state's capacity to conduct scientific research while cultivating a diverse, well-qualified STEM workforce. The DOD, DOE, USDA, and NASA also have EPSCoR programs.

EPSCoR eligibility has resulted in over **$232 million** in federal investment in New Mexico since 2000

85% NSF

1% DOD

9% USDA

1% DOE

4% NASA

NM EPSCoR IMPACTS

NM EPSCoR investment in New Mexico since 2000

$83 million

NM EPSCoR since 2000...

25
NM higher ed. institutions directly involved

34
university faculty hires

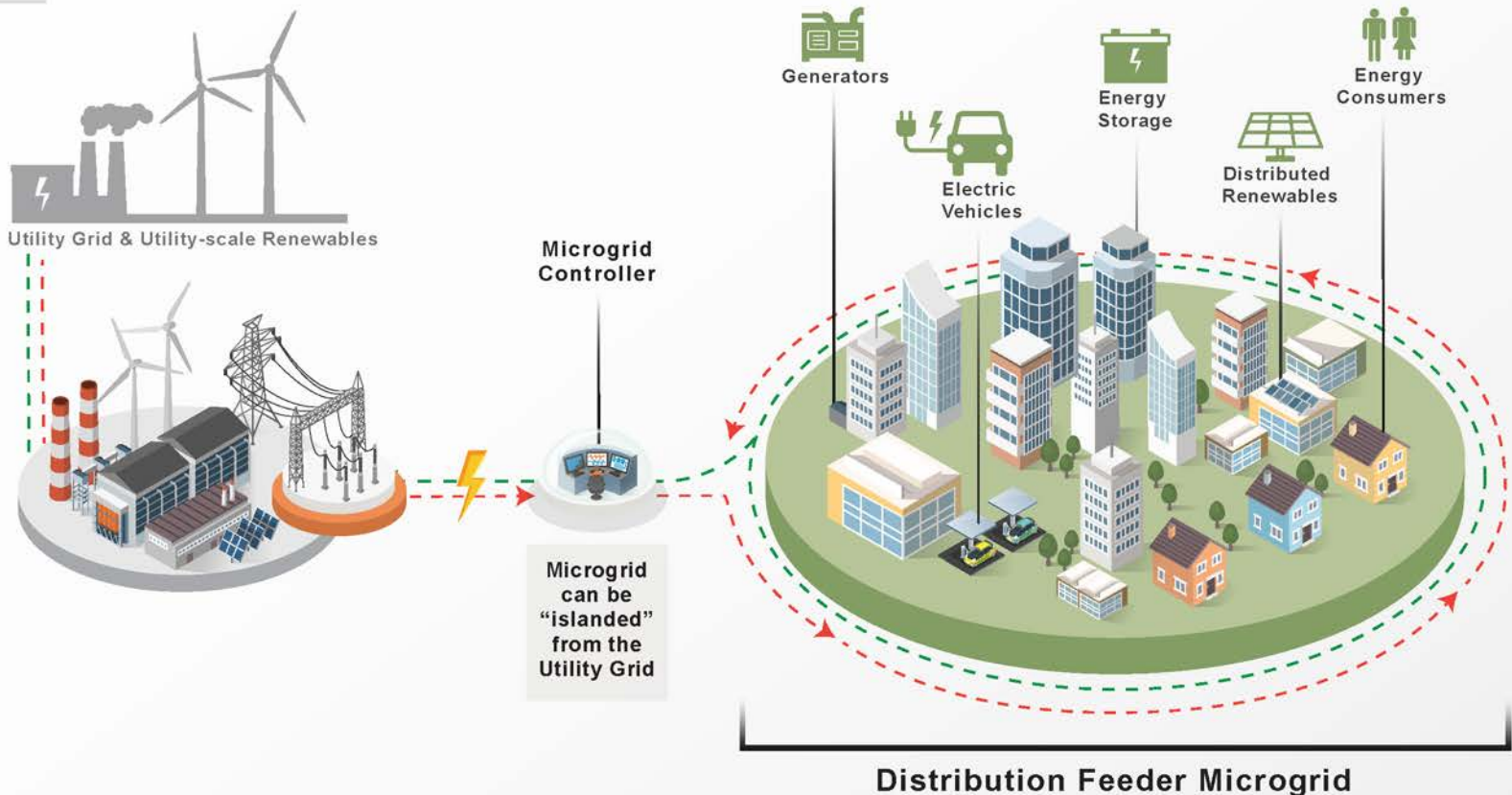**1,903**
project participants

$7.2M
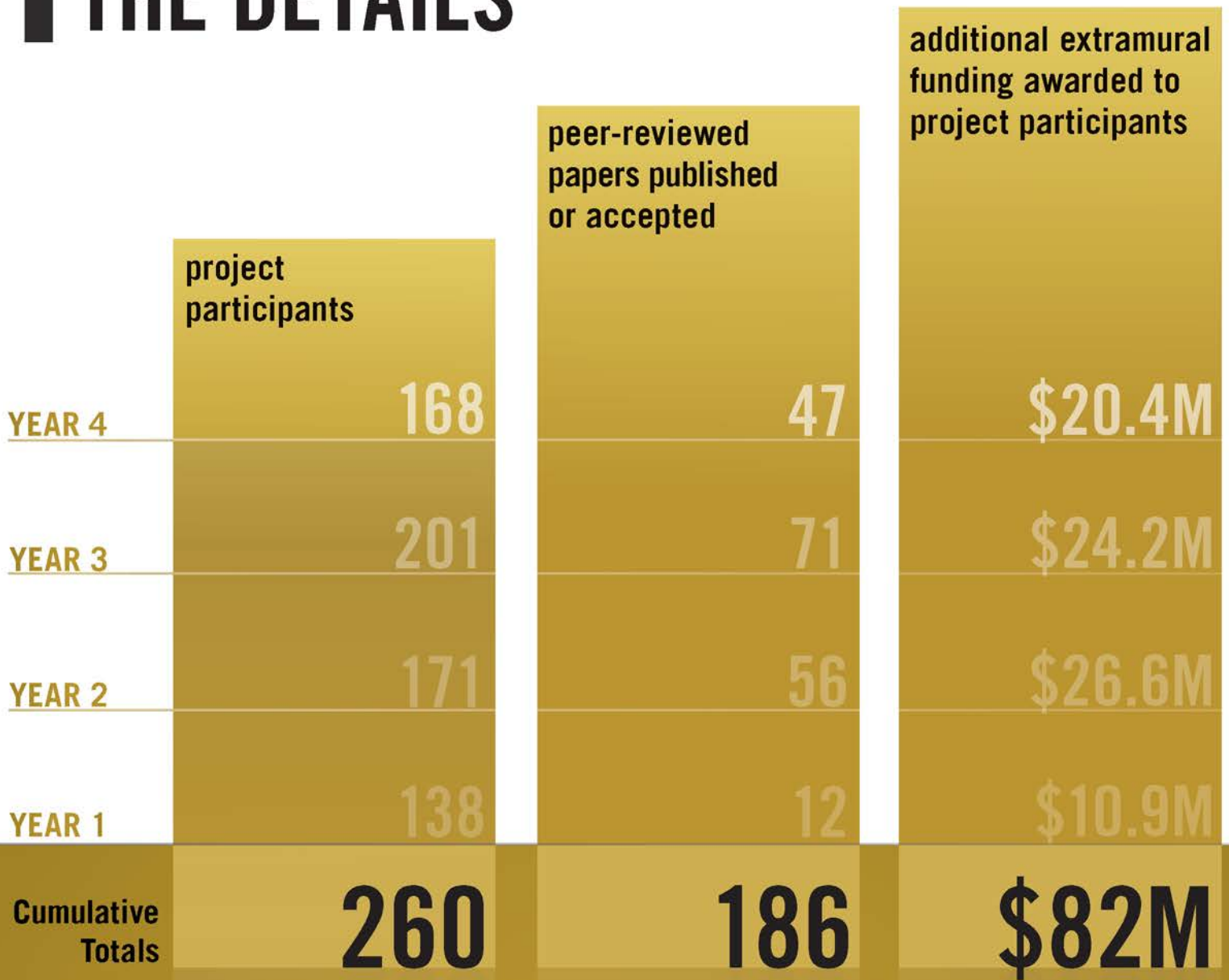scientific & computing equipment purchased

NM SMART GRID CENTER
OVERVIEW

The *NM SMART Grid Center* is a 5-year, $24-million research and human infrastructure project investigating the fundamental challenges to transition existing electricity transmission and distributed energy infrastructure into a SMART (Sustainable, Modular, Adaptive, Resilient, Transactive) grid.

Our mission is accomplished by developing research capacity and education programs to support a modern electric grid, building on the principles of **Distribution Feeder Microgrids (DFMs)** with a focus on architecture, networking, decision-support, and deployment, and by empowering a future workforce through industry partnerships, education, and public outreach.

Distribution Feeder Microgrid

Utility Grid & Utility-scale Renewables

Microgrid Controller

Microgrid can be "islanded" from the Utility Grid

Generators

Electric Vehicles

Energy Storage

Distributed Renewables

Energy Consumers

Distribution Feeder Microgrid

THE DETAILS

	project participants	peer-reviewed papers published or accepted	additional extramural funding awarded to project participants
YEAR 4	168	47	$20.4M
YEAR 3	201	71	$24.2M
YEAR 2	171	56	$26.6M
YEAR 1	138	12	$10.9M
Cumulative Totals	260	186	$82M

DFMs will enable us to retrofit existing utility infrastructure in a way that allows entire sections of communities to operate with or without power supplied by a central utility.

RESEARCH Infrastructure

Architecture Team

The Architecture Team is creating a comprehensive framework for distribution feeders to evolve into managed microgrids. In Year 4, researchers...

- Created algorithms that effectively activate supplemental power generation sources to stabilize DFMs experiencing rapid condition changes.

- Developed protection schemes which use machine learning to detect and isolate DFM system faults even when communication systems are down.

- Integrated economic consumer response models into engineering DFM model simulations and demonstrated that clustering microgrids together significantly increased system profit while decreasing risk.
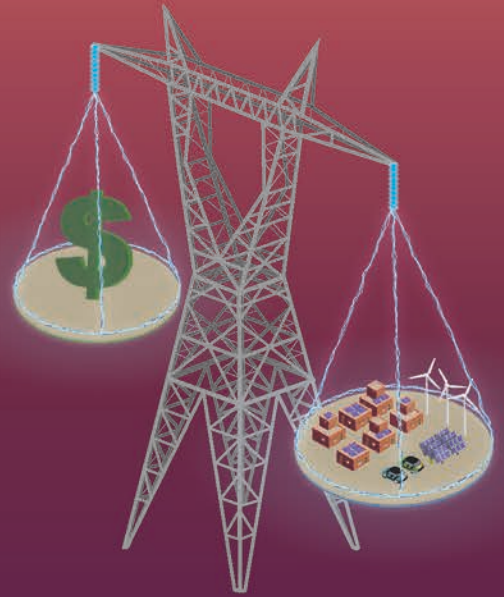
Networking Team

The Networking Team is creating scalable and secure communication systems for DFM frameworks developed by the Architecture Team. In Year 4, researchers...

- Submitted a provisional patent for an enhanced code system which mitigates severe communication failure events.

- Devised a new user authentication method which uses electronic signals on the surface of human skin to verify identity.

- Created a model for smart grid users to make informed privacy decisions about their energy consumption data.

Cyberinfrastructure

In Year 4, the Cyberinfrastructure Team collaborated with the NM EPSCoR State Office to create a project publications and products web page. The web page makes project research more accessible to the public and promotes dissemination to a broader audience.

Decision Support Team

Harnessing the power of machine learning, data mining, and artificial intelligence, the Decision Support Team is designing robust automated and computer-aided decision-making tools for DFM systems. In Year 4, researchers...

- Developed a power modeling technique that dramatically improves power utilization in smart and microgrids.

- Created an advanced data fusion model for solar forecasting capable of training itself.

- Devised methods of inferring building occupancy from existing security equipment.

- Fabricated a prototypical system allowing humans and robots to engage in a dialog to reach a consensus.

Deployment Team

The primary focus of the Deployment Team is to test the models and technologies developed by the other research teams in simulations and diverse testbeds. In Year 4 researchers...

- Received a $102K NSF Major Research Instrumentation award to purchase a network communication and cyber-attack co-simulation tool

- Began utilizing and refining DFM simulation models on systems at NMSU and UNM.

- Made equipment improvements to NMSU and UNM physical testbeds.

- Started work on a portal for remote access to data generated by the Mesa del Sol testbed for project researchers.

YEAR 4 HIGHLIGHTS

› Researchers from New Mexico Highlands University (NMHU) advanced semiconductor and organic solar cell material research with a new Raman spectrometer purchased through a NM SMART Grid Center seed award. This instrument is NMHU's first Raman spectrometer, and the only one accessible to students within 120 miles.

› Project PhD candidate Jesse Kaczmarski found that a significant percentage of ratepayers (40%-45%) in the Four Corners region would be willing to incur an increase on their electric bill ($14-$25) to construct a community microgrid intended to reduce outages. His findings will inform energy policy and grid initiatives in the Southwest.

HUMAN INFRASTRUCTURE

Developing the human resources needed to create, maintain, and build future electricity infrastructure requires a multi-pronged approach that reaches diverse students, faculty, teachers, industry, and entrepreneurs. Here is what NM SMART Grid Center did in Year 4 to build New Mexico's human infrastructure.

1 SUPPORT WORKFORCE DEVELOPMENT

2 INCREASE DIVERSITY IN STEM

3 ENGAGE THE PUBLIC

SUPPORT WORKFORCE DEVELOPMENT ≫

In Year 4, the NM SMART Grid Center hosted a multi-day Early Career Leadership Workshop for post-docs and new assistant professors, conducted a Team Science Leadership Workshop for mid and senior-career faculty, and supported research computing skills through four Carpentries workshops. Project team members facilitated collaboration between two- and four-year colleges, state agencies and industry through a two-day Distributed Energy Summit in July 2021. One Infrastructure Seed Award project was made to support innovative research at UNM. One Collaborative Innovation Working Group was convened to expand access to high school computer science education.

≪ INCREASE DIVERSITY IN STEM

Successfully increasing diversity in STEM requires approaches that target both individuals and the larger systems in which they function. This year, 75% of the students who participated in the project's undergraduate summer research program (STEMAP) identified as female or from an under-represented minority group and 69% of the 64 individuals who attended project-funded Carpentries workshops also belonged to these groups. In Year 4, NM EPSCoR recognized two project faculty with Excellence in Mentoring Awards, Manel Martínez-Ramón (UNM) and Jun Zheng (NMT).

ENGAGE THE PUBLIC ≫

In project Year 4, student researchers from 10 New Mexico institutions participated in a virtual New Mexico Research Symposium hosted by NM EPSCoR. Symposium abstracts were published in the 2021 issue of the New Mexico Journal of Science, a peer-reviewed journal of the New Mexico Academy of Science. Outreach partner, Explora Museum, trained a third cohort of Science Communication Fellows and led a virtual Science Fiesta that engaged more than 1,000 participants and involved 82 STEAM professionals.

New Mexico
EPSCoR

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