Anchoring a Commercialization Ecosystem for Environmental Technologies and Know-How

Semi-annual report on activities through September 30, 2024 supported by the Nevada Knowledge Account Fund

October 2024

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Executive Summary

The Desert Research Institute (DRI) is continuing its program to stimulate the transition of ideas from our research labs to the marketplace. Elements of the DRI program include the commercialization fellowship program that provides limited salary support for DRI faculty to work on commercialization of research products emerging from their labs, targeted commercial research and development in topics of strategic alignment with DRI's interests and expertise, and incentives for Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) grant submissions. Several Commercialization Fellowship projects have progressed to a new phase, while some are on hold pending new information. Submissions of SBIR/STTR grants proposal figure prominently in many of these projects, but no new Phase I proposals have been submitted to date. Separate from the Commercialization Fellowship, four areas have been selected for targeted strategic development with more likely to be added over time. They build on DRI strengths and include financial and other risks related to climate change, critical minerals, products and services that support sustainability and resilience, and products and services that support water resource planning nationally and worldwide. Progress on several of these topics has been accelerated by the launch of an NSF Type II engine (SWSIE), itself enabled with support from the Knowledge Account. With DRI as one of the four primary academic partners, SWSIE represents an important development for Nevada and DRI's commercialization efforts in terms of sustainability in water resources, electricity, and carbon capture.

Commercialization Fellowship Program

DRI established a program to foster faculty engagement in the commercialization of research products resulting from DRI's labs and programs. The Commercialization Fellowship program has continued into the current biennium. It is designed to achieve several specific goals, including: (1) engage faculty who either have an interest in commercializing their research products, or have a research output that they think might have commercial potential; (2) provide limited salary support to compensate faculty for the time they spend exploring the commercialization of their research; (3) provide education to our faculty and opportunities for them to receive direct consultation with experts within our network of strategic partners.

A number of faculty who joined the fellowship in the previous biennium are now in mature and well-developed stages of the commercialization pursuit. Several case-studies of these projects were summarized in the September 2023 Semi-Annual report for this project. Here we provide brief updates for those and describe several new lines of effort.

Update Case study 1: Biochar for water purification (DRI lead: Dr. Erick Bandala):

DRI has completed a license agreement with DASCO Inc regarding commercialization of a process to produce engineered biochar with enhanced efficacy to remove nutrients from water developed by DRI's Environmental Engineering Laboratory (EEL). DRI Scientist, Dr Erick Bandala has joined DASCO as their lead scientist for developing this product line.

Update Case study 2: Technology for defluoridation of water in rural communities (DRI lead: Dr. Erick Bandala):

This project is on hold as the lead scientist (Dr. Erick Bandala) has accepted a position in the private sector and is working with DASCO Inc to develop a separate product line under license from DRI.

Update Case study 3:Climate Engine (DRI lead: Dr, Justin Huntington):

Climate Engine, Inc., a Nevada C-Corp was seeded with DRI-developed IP focused on the use of climate and remote sensing data for asset climate risk assessment, monitoring, and forecasting. The license agreement between DRI and Climate Engine was amicably terminated because the Company was seeking to use a different path towards achieving their technical and commercial objectives. The Climate Engine platform and related Open ET platform continue to enjoy increased adoption by federal and state agencies as key tools in understanding water budgets, a critical resource for Nevada's economic development.

Update Case study 4: Integration of weather forecasting for defense and industrial safety applications (DRI leads: Dr. Dave Decker and Dr. Eric Wilcox):

New technology has been advanced that utilizes weather forecast model output to improve the accuracy of targeting systems that use optical or radar systems to track high-velocity objects in the atmosphere. The system uses forecasts of high-resolution variations in temperature, humidity, and pressure in the atmosphere to compute corrections due to distortions in the propagation of light and radio waves due to refraction in the atmosphere. A provisional patent application was filed in January 2024 and a full patent application is to be submitted in October.

Update Case study 5: Biopassivation of ordinance (DRI leads: Dr. Dave Decker and Dr. Joe Grzymski):

The faculty-led spin-off that was assigned three related patents from DRI continues to build on contacts established with several defense-industry investment groups. Dr. Joe Grzymski has relocated to the University of Nevada, Reno. Dr. Dave Decker remains at DRI.

Update Case study 6: Aerodynamic Lens for Focusing Nanoparticles to Supermicron Particles (DRI lead: Dr. Xiaoliang Wang):

A provisional patent application has been filed. A prototype of the novel design was tested and met or exceeded performance expectations on one portion on the particle size spectrum. More complex testing is required to ascertain technical success for particles as small as 100 nanometers and plans are in development for such testing. While primarily intended as an enhancement to existing precise aerosol measurements, the technology has potential applications in the biomedical, chip manufacturing, and thin film industries. In addition to exploring partnerships for an SBIR submission, Dr. Wang is currently working with Mr. Craig Macy on a full US patent application to be submitted in October.

New Case study 7: Biosynthetic anti-cancer compound (DRI Lead: Dr. Alison Murray)

Dr. Alison Murray is in the early stages of examination and discussions of commercialization potential for a cancer-fighting chemical that is derived from an aquatic organism. The concept builds on her collaborative research with numerous external colleagues and may be complicated by prior publications in the peer-reviewed literature. Preliminary work has demonstrated that the host organism can be grown with the proper gene expression to produce the desired cancer-fighting agent. Craig Macy is investigating the existing literature and partnerships to understand the commercialization potential of this technology.

New Case study 8: STEM Learning Kits (Emily McDonald-Williams)

For over two decades, DRI has been operating some version of the Green Box science program (currently operating under the "Science Alive" brand), whereby green, large suitcases are filled with educational and instructive activities, sent to K-12 teachers in Nevada schools, and are used to provide informal education in support of science learning. These have been funded by donors or the state in some cases. The program includes training for teachers and completely free (including mailing to and from schools) access to the resource for Nevada schools. This informal education space has witnessed considerable growth nationally and there is the potential for the Science Alive program to look beyond Nevada for a market. This can be done either for profit, non-profit, or to raise revenue to expand the free program within Nevada. Ms. McDonald-Williams is examining out-of-state market potential, especially, in rural school districts.

New Case Study 9: Biocidal Humidifier (Dr. Henry Sun)

In this early phase effort, Dr. Sun is examining the biocidal properties of a common, highly reactive mineral to determine comparative efficacy and commercialization potential of integrating this into home humidifiers.

New Case Study 10: Snowpack runoff decision support system (Dr. Anne Heggli)

A tool is under development that provides continuous real-time predictions of flood risk from rain-on-snow events; an increasing risk in the current climate regime for which there are no

existing forecast tools and great variability from one storm to the next. The tool is being developed to integrate with river forecast tools and offers timely information to deploy flood mitigation resources more efficiently. This tool is new element of a broad suite of real-time weather and climate monitoring and prediction products that DRI is advancing that are building on the success of the Climate Engine effort (see case study 3 above).

New Case Study 11: Development of a Groundwater Pumping-Induced Land Deformation and Infrastructure Risk Application (Dr. Sayantan "Monty" Majumdar)

The most recent project added to the Commercialization Fellowship cohort focuses on using satellite remote sensing products from the InSAR platform (Interferometric Synthetic Aperture Radar) to assess land subsidence induced by pumping of groundwater. Such subsidence results in deformations and can place critical infrastructure such as bridges, tunnel, and below ground networks under mechanical stress/strain. The overall goal of the project is to apply DRI expertise toward identifying infrastructure that is under threat of damage over time, beginning with bridges. Groundwater pumping is a critical source of irrigation in large parts of the US including California, Texas, the northeastern US, and the Great Plains. Development of this tool is being piloted for Nevada, but the potential for application on a commercial basis nationwide is being examined.

Incentives for SBIR/STTR Projects

The pursuit of SBIR/STTR funding fosters collaboration among DRI faculty and the private sector on research oriented toward commercialization. To incentivize such proposals, we continue to offer matching funds to faculty up to the amount of the federal Phase I SBIR/STTR grant awarded to DRI. To date, there have been no successful Phase I SBIR/STTR proposals that have qualified for these matching funds. DRI was a sub-awardee of an STTR Phase II award (Primary awardee: American Ecotech) that does not qualify for the incentive but may yield new technologies that can be developed within the Commercialization Fellowship Program. In addition, several of our Commercialization Fellowship participants continue to include pursuit of SBIR/STTR Phase I funding in their approach to commercialization and are actively seeking private sector partners to collaborate on submissions.

Targeted Commercial Research and Development

The faculty-driven projects undertaken through the Commercialization Fellowship program represent a bottom-up approach to striving towards a vibrant commercialization ecosystem. DRI is also initiating efforts to identify and pursue targeted research and development activities in areas of strategic alignment with DRI's expertise. Specific areas that are advantageous for development have already been identified and DRI's research leadership continues to pursue partnerships that can be developed to leverage state resources towards commercial success. This is an ongoing process and it is expected that new topics will be added as new information becomes available and others may be deprioritized as part of the vetting process. Areas that are actively being pursued include:

- Partnering with institutions (banks, insurance companies, investment firms, planning agencies) to identify ways that DRI's expertise in climate change modeling can inform risk based decisions. DRI has joined the Affinity Group of the Climate READi initiative of the Electric Power Research Institute (EPRI), a research organization for the electric

utility industry. Climate READi brings industry engineers and executives together with academic and industry researchers to discuss strategies to understand and mitigate impacts of climate variability and change on utility operations and planning. This effort aligns with ongoing DRI research to simulate candidate strategies for mitigating extreme urban heat in numerical climate models (PIs: John Mejia and Juan Henao through funding from NOAA) and validate those strategies with drone-based observations (PI: Eric Wilcox in partnership with the City of Henderson).

- Critical minerals pipeline development. These pipelines often include complex and competing resource utilization needs including water, energy, land ownership (private public, tribal), and transportation. DRI can serve as both a resource to support informed decision-making and potentially a purveyor of professional services either directly or through license to an external entity. Through a federal earmark, DRI has been awarded a $1.6M Department of Energy project to map the nature and extent of lithium resources in Nevada. This partnership with the Nature Conservancy, US Geological Survey (USGS), and University of Nevada Reno (UNR) supports Nevada's role in the electric vehicle economy. This is an example of an actively targeted topic of opportunity.
- Sustainability and resilience products and services. Climate adaptation planning is increasingly a mainstay of strategic plans for organizations of all sizes. What services and skills that are currently non-standardized, research-grade products are amenable to transition to a spin-off company(ies)? Both case studies 10 (*Snowpack runoff decision support system*) and 11 (*Development of a Groundwater Pumping-Induced Land Deformation and Infrastructure Risk Application*) described in the section on Commercialization Fellowship are relevant to this topic. Additional opportunities for technology development related to excessive heat, wildfire mitigation, and water resources are actively being examined.
- Water Resource Management. Increasingly, fresh water resources worldwide are under strain. As we enter a new era of shortages, what tools and services can be transitioned out of DRI to support water allocation decisions, remote usage monitoring, and dynamic allocation readjustment in response to changing inputs?

These topics are somewhat outside the scope of the typical applied research that DRI faculty excel at and accordingly require different or in some cases, new approaches to development. They are being furthered through several approaches, including education through attending meetings and conferences with topic focus, supporting participation in large collaborative proposals that span some of these focal areas, and targeting specific partnerships with the aim of working collaboratively to develop these concepts into successes for the state. A demonstrative example of resources directed at participating in large multi-disciplinary proposals and investing in promising technologies is the Southwest Sustainability Innovation Engine or SWSIE.

<u>SWSIE (Southwest Sustainability Innovation Engine)</u>

The NSF SWSIE Type I engine was awarded to Arizona State University, DRI, University of Nevada Las Vegas, and University of Utah this winter. This project, potentially funded at $160M over ten years pending satisfactory progress, focuses on sustainability issues for the southwest. "Shovel-Ready" projects have been funded in the near-term for early successful results (needed for NSF to continue funding), while lower TRL technologies will be considered at a later time. The majority of the potential $160M in funding will be for facilitating,

cost-matching, and implementing innovative projects within the three main foci of water, energy, and carbon capture.

While Nevada stands to be a significant beneficiary of the incentivized expenditures from SWSIE over the foreseeable future, there have also been more immediate impacts. In partnership with Hydrosat (California based space technology firm), DRI received funding for an early "shovel-ready" project. Hydrosat successfully launched satellites on August 16, 2024 that will provide three times the spatial resolution and almost 20 times the temporal resolution of existing Landsat products. SWSIE is providing the venue and most of the funding (with partial support from the Knowledge Account) that will enable DRI researchers to use the higher-resolution information for accurately estimating the amount of water that is evaporating from critical reservoirs along the Colorado River (e.g., Lake Mead in Nevada, Lake Powell in Utah). As water resources become increasingly limiting in the arid Southwest, it is essential to have an accurate inventory of water losses/uses along the Colorado River system for purposes of planning, sustainability, and a credible assessment of the future availability of water for businesses wishing to relocate to Nevada.

SWSIE has also enabled development of connections and partnerships with the K-12 STEM education as well as workforce development ecosystems in Arizona and Utah. These may be leveraged in support of one of the case studies (8) described in the Commercialization Fellowship section above.