FLC

FAR WEST & MID-CONTINENT REGIONAL MEETING

November 17 - 18, 2020

WELCOME TO THE 2020 FLC FAR WEST & MID-CONTINENT JOINT REGIONAL MEETING

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SCHEDULE AT A GLANCE

TUESDAY, NOVEMBER 17 ALL TIMES MST

TIME	ACTIVITY	INFO
9:30 - 9:50 am	**Platform Orientation**	Corin Hindenach, FLC Regional Support Manager Nerissa Legge, FLC Professional Development Director
9:50 - 10 am	**Break**	
10 - 10:10 am	**Welcome by Your Regional Coordinators**	John Eisemann, USDA National Wildlife Research Center David Nicholson, USDA Agricultural Research Service
10:10 - 10:15 am	**Break**	
10:15 - 10:45 am	**What is the FLC?**	Paul Zielinski, FLC Executive Director
10:45 - 11 am	**Break**	
11 - 11:45 am	**Partnering with Federal Labs - CRADAs**	Moderator: David Nicholson, USDA Agricultural Research Service John Eisemann, USDA National Wildlife Research Center Jason Martinez, Sandia National Laboratories
11:45 am - Noon	**Break**	
Noon - 1 pm	**TFA Collaboration Forum Day 1 - UAS for Defense**	Moderator: David Nicholson, USDA Agricultural Research Service Russel Batman, Naval Facilities Engineering and Expeditionary Warfare Center Alec Sorensen, Tradespace
1 - 1:15 pm	**Break**	
1:15 - 1:45 pm	**Far West Awards Presentation**	Moderator: David Nicholson, USDA Agricultural Research Service
1:45 - 2 pm	**Break**	
2 - 2:30 pm	**Happenings at the FLC National and Local Levels**	John Dement, FLC Chair
2:30 - 2:35 pm	**Break**	
2:35 - 3 pm	**Wrap Up by Your Regional Coordinators**	John Eisemann, USDA National Wildlife Research Center David Nicholson, USDA Agricultural Research Service

WEDNESDAY NOVEMBER 18 ALL TIMES MST

TIME	ACTIVITY	INFO
9:30 - 9:50 am	**Platform Orientation**	Corin Hindenach, FLC Regional Support Manager Nerissa Legge, FLC Professional Development Director
9:50 - 10 am	**Break**	
10 - 10:10 am	**Welcome to Day 2 by Your Regional Coordinators**	John Eisemann, USDA National Wildlife Research Center David Nicholson, USDA Agricultural Research Service
10:10 - 10:15 am	**Break**	
10:15 - 11 am	**Laboratory Spotlights**	Moderator: John Eisemann, USDA National Wildlife Research Center
11 - 11:15 am	**Break**	
11:15 - 11:45 am	**FLC Tools to Partner**	Jenna Dix, Naval Surface Warfare Center, Crane Division John Eisemann, USDA National Wildlife Research Center Katherine Segreti, FLC Marketing Coordinator
11:45 am - Noon	**Break**	
Noon - 1 pm	**Mid-Continent Awards Presentation**	Moderator: David Kistin, Sandia National Laboratories
1 - 1:15 pm	**Break**	
1:15 - 2:15 pm	**TFA Collaboration Forum** **Day 2 - UAS for Agriculture**	Moderator: John Eisemann, USDA National Wildlife Research Center Mark Lutman, USDA Alec Sorenson, Tradespace
2:15 - 2:30 pm	**Break**	
2:30 - 3 pm	**Wrap Up and Networking**	John Eisemann, USDA National Wildlife Research Center David Nicholson, USDA Agricultural Research Service

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Small Business Partner Helps NOAA
meet demand for its popular river gage technology

An innovative river gage developed by a National Oceanic and Atmospheric Administration (NOAA) hydrologist has vastly improved the lab's water resource management capabilities, and the technology's commercialization has helped extend its reach to the remote areas of the country where it is most needed.

Hydrologic monitoring and forecasting efforts in the state of Alaska have long been hampered by the extreme paucity of river observations. Hydrologists have long been seeking a cost-effective means of getting automated river level data for a larger portion of the thousands of rivers and streams in the state.

While working as a hydraulic engineer with the U.S. Army Corps of Engineers in Anchorage, Alaska, Benjamin "Crane" Johnson started developing an inexpensive, easy-to-install river level gage that would be tough enough to withstand the extreme environment of Alaska. After coming to NOAA's National Weather Service at the Alaska-Pacific River Forecast Center (APRFC) in early 2014, Crane continued to improve the iGage design, and what resulted was an innovative and inexpensive sensor with a very small footprint that can be installed anywhere to provide vital situational awareness for flooding and other water resources needs.

At APRFC, 40 iGage units were installed in 40 remote Alaska locations between 2014 and 2016. Each installation immediately raised the number of observations from one per day to 24 per day for a lower cost than the center was paying human observers (about $15 per month vs. $180 per month). Interest began to build from other users, and demand began to exceed the center's ability to build and support gages for all.

The NOAA Technology Partnerships Office helped to identify a small-business partner—Seattle-based Stillwater Technologies LLC—and facilitate a cooperative research and development agreement (CRADA), which was signed in July 2017. Crane and his colleagues at Stillwater leveraged NOAA's Virtual Development Lab (VLAB) to track and share hardware designs and software source code. NOAA also provided field testing to ensure the gage was working correctly and gave feedback on the improvements.

Thanks to this innovation, the number of automated gages in Alaska available to monitor rivers, streams and lakes has increased almost 50% in just a few years. That has led directly to greater situational awareness and improved ability of the APRFC to fulfill its mission of protection of life and property from flooding. Commercial availability of these gages has allowed the APRFC to focus on flood and water resource monitoring and prediction rather than gage production.

Above: *iGage Bridge installation.*

Stillwater Technologies has enhanced the design by designing a Tipping Bucket rain gage interface as well as an SDI-12 instrument interface. This opens numerous possibilities beyond stream level measurements for deployment of iGages providing near real-time reporting throughout the world.

Stillwater has deployed iGage from Southern California to the East Coast and up to the Northern reaches of Alaska. Currently, Stillwater is working with the U.S. Fish & Wildlife Service and the U.S. Geological Survey to develop iGage Temperature Strings for deployment in the Arctic measuring snow and frost depth.

While the impacts of this commercialization may never prove notable on a national scale, the approach was perfectly suited to working with a small business, and has made a notable contribution to NOAA's mission in an area that is ground zero for climate change impacts.

LLNL and partners take COVID-19 ventilator technology from design to EUA in just three months

A collaboration between Lawrence Livermore National Laboratory (LLNL) and medical device company BioMedInnovations, LLC (BMI) resulted in an innovative mechanical ventilator for COVID-19 patients that was approved for emergency use just three months after the design work began.

As the COVID-19 pandemic revealed a nationwide shortage of ventilators, LLNL immediately began designing a durable, portable mechanical ventilator to help fill the gap. LLNL scientists set an additional goal of using readily available parts to avoid impacts to an already-strained supply chain.

On the other side of the country, BMI was also pivoting toward the pandemic from its traditional focus on devices used in organ and tissue perfusion. BMI is a North Carolina-based medical device startup that makes precision air and fluid flow devices.

LLNL and BMI came up with a promising design—tentatively dubbed NERVe (Novel Emergency Response Ventilator)—after only two weeks of late nights and extended hours of remote conferencing. At five weeks, the team had the necessary ventilator test data and documentation to submit the design to the Food and Drug Administration (FDA) for approval. LLNL and BMI also pursued manufacturing assistance to scale production to a high volume, depending on how the disease spread.

The solution to the team's manufacturing needs came from an unexpected source—the race-car engine shops of NASCAR and Indy Car, which were idle due to the postponement of all professional sports necessitated by the pandemic. The ventilators—renamed SuppleVent™—will be manufactured by North Carolina-based Roush Yates Manufacturing Solutions (RYMS), which builds engines for multiple NASCAR teams as well as hardware for aerospace, defense, and medical applications. The racing connection also led to testing and engineering advice from Indy Car engine designer Honda Performance Development.

On June 8, 2020, SuppleVent™ was added to the FDA Emergency Use Authorization (EUA) list, only three months after the project began. One LLNL researcher said that, for this life-saving project, the typical device development process of many years had been reduced to a few weeks.

Above: A group of LLNL researchers representing disciplines from engineering, biotechnology, computer modeling, and micro- and nano-technology convened to develop a prototype portable ventilator that could immediately meet the needs of COVID-19 patients.

LLNL and BMI designed, produced, and tested an easily reproducible design prototype while partnering with manufacturing facilities and gaining authorization for the device's emergency use. This remarkable collaboration was largely remote, with scientists, engineers, and medical experts contributing from home offices, in many cases, due to shelter-in-place orders.

While industry partnerships forged in cooperative research and development agreements (CRADAs) often take years to deliver a commercial product, particularly a medical device, the LLNL/BMI CRADA produced the SuppleVent emergency ventilator—FDA-cleared for use and approved for sale—in just a few months.

BMI estimates the cost of the suitcase-sized SuppleVent™ units will be a small fraction of a traditional ventilator, making SuppleVent™ easy to deploy in a sudden resurgence of COVID-19. The device can also serve patients with Acute Respiratory Distress Syndrome (ARDS) and other breathing difficulties, particularly where ventilators are in short supply such as underdeveloped areas and rural medical services.

The rapid creation of SuppleVent™ in the midst of technical and public health challenges exemplifies the propulsive energy and productivity that LLNL and its industry partners can apply to complex problems. The engineers and scientists involved are proud to contribute to the saving of lives.

ARS leads successful collaborative effort
to manage Central California aquatic weed invasion

Led by the U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) Areawide Pest Management Program, a collection of federal, state and local organizations and university researchers are successfully and safely managing the invasive aquatic weeds that have long plagued one of California's key agricultural regions.

The Sacramento-San Joaquin River Delta (known locally as "the Delta") of northern California is the hub of the water distribution system for domestic water for 27 million people and provides irrigation water for $30 billion in crops annually in California's Central Valley.

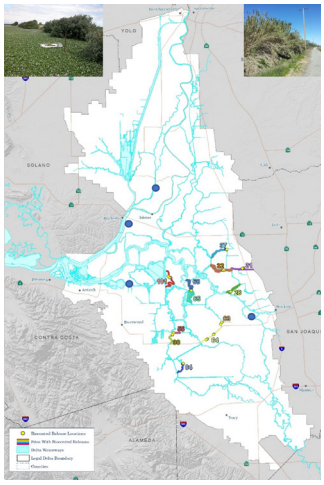
However, the Delta is plagued by invasive aquatic weeds, and chronic drought exacerbates these problems. The most damaging invaders include floating aquatic vegetation (FAV) weeds such as water hyacinth, and submersed aquatic vegetation (SAV) weeds such as egeria or Brazilian waterweed. Riparian (shoreline) weeds like arundo invade levees and shorelines.

Local, state and federal stakeholders and policymakers have called for action, but the complex interweaving of regulations imposed by federal, state, regional and county governments creates numerous issues that prevent a "business as usual" approach to managing invasive aquatic plants.

In response, the ARS, the National Aeronautics and Space Administration (NASA) Ames Research Center, California state agencies and university researchers formed the Delta Region Areawide Aquatic Weed Project (DRAAWP) in 2014. The project's mission was to develop an adaptive management approach that would control invasive FAV and SAV while mitigating potential environmental impact. The project also facilitated collaboration among federal, state, regional and local agencies with interests in managing invasive weeds in the Delta, starting with the state Division of Boating and Waterways (DBW).

The project's successes to date include:

- NASA's satellite-based remote sensing technology was used to identify "nursery" areas where weeds persist year-round, targeting them for proactive management. Biological control was implemented by ARS and DBW across the Delta for water hyacinth and arundo. Several new herbicides were cleared for use in the region, and mechanical removal was implemented strategically.



Left: Releases of new biological control agents of water hyacinth and arundo (weed images at top of map on left and right, respectively) by USDA-ARS, involving collaboration with DBW on water hyacinth, and with other collaborators on arundo. Map shows 12 sloughs where the water hyacinth planthopper was released (total of 20 sites in 2018-2019). Research results are informing planned releases of a cold-adapted biotype of the water hyacinth weevil, pending permits.

- The integrated, adaptive management framework was implemented for control of four FAVs, five SAVs and arundo, far beyond the original focus of one FAV and one SAV. New control approaches were incorporated into major federal and numerous state regulatory permits and other documents covering the next five years of control operations through 2023, beyond the end of the DRAAWP.
- The remote-sensing technology mentioned earlier was also used for monitoring and documentation, along with photo-monitoring, bioacoustics monitoring, and extensive sampling. DBW is now able to demonstrate to stakeholders how much control has been achieved for both floating and submersed species. In addition, ARS is able to document the efficacy of new chemical and biological control tools.
- Aquatic weed control costs to stakeholders such as the U.S. Bureau of Reclamation, the Port of Stockton, and marina operators have been reduced by 33% to 100%. The project has generated more than $44 million in non-federal funding for state and local agencies; the ARS areawide investment in DRAAWP was $4.45 million.

The project's accomplishments were communicated to the public through stakeholder meetings, a website, research-focused symposia, journal articles, and presentations to policymakers. One of the ARS scientists has edited a 14-paper special issue of the Journal of Aquatic Plant Management focused entirely on the DRAAWP, which should be published this winter.

Sandia's Ducted Fuel Injection technology takes soot-NOx emissions tradeoff out of diesel engines

A new fuel injection technology for diesel engines, developed by Sandia National Laboratories, lowers harmful emissions while increasing efficiency. If it can be deployed successfully to improve just a fraction of the more than one billion engines on Earth while facilitating a transition to sustainable fuels, the whole world will benefit.

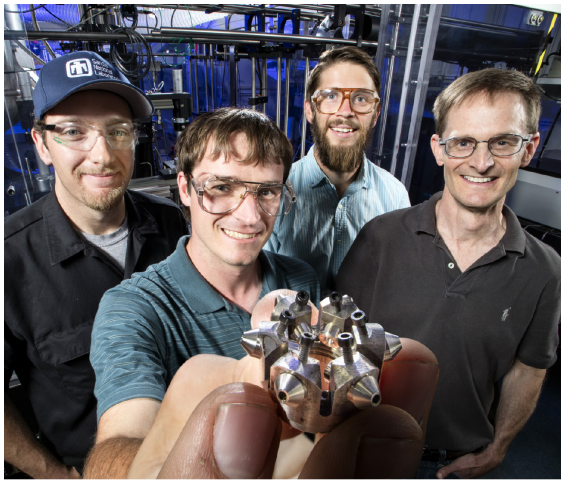
Diesel engines have many desirable attributes, including high efficiency, fuel flexibility, and long range, for relatively low cost, but their emissions have been problematic. This is particularly true for soot and nitrogen oxides (NOx) emissions—when one is reduced, the other goes up. This is called the soot-NOx tradeoff. It's a technical challenge that has been at the heart of diesel-engine development efforts since the first diesel emissions regulations came into force in the mid-1980s.

Minimizing the amount of soot and NOx produced by diesel engines is critical because both emissions are toxic, soot is second in importance only to carbon dioxide as a climate-forcing substance, and the prevailing approaches to clean up these pollutants are costly and cumbersome.

To meet emissions regulations worldwide, modern diesel engines use aftertreatment systems (analogous to catalytic converters on spark-ignition engines, but significantly more expensive). These contain platinum-group metals, require an additional fluid (diesel exhaust fluid), are large, heavy, demand management and maintenance, and/or penalize engine efficiency.

Ducted Fuel Injection (DFI) is a patented technology invented at Sandia National Laboratories' Combustion Research Facility that enhances engine combustion, enabling simultaneously lower soot and NOx emissions while potentially increasing efficiency. The innovation enables soot emissions to be dramatically lowered so that cost-effective exhaust-gas recirculation (EGR; i.e., feeding some of the exhaust gases back into the engine air inlet) can be applied to curtail NOx emissions. In this way, DFI can eliminate 50% to 100% of the soot and NOx produced by a diesel engine.

It's a simple mechanical solution that involves installing some tubes inside of a diesel engine's combustion chamber. Passing each fuel spray through a tube enhances mixing to create combustion that produces less soot than when fuel is sprayed unconfined into a chamber.



Above: *Sandia National Laboratories researchers (from left: Nathan Harry, Christopher Nilsen, Drummond Biles and Charles Mueller) show off a prototype ducted fuel injection module. (Photo by Randy Wong)*

Any diesel engine—whether in a car, truck, ship, train, machine, or generator—can benefit from DFI. It can also be used to retrofit large-bore and expensive engines like those in ships and trains that are not replaced often. This is a cost-effective way to lower emissions on these large engines used in transportation industries where emissions are increasingly regulated.

Because DFI is compatible with existing fuels, it can be retrofitted onto existing engines, enabling immediate environmental benefits. In addition, because of its synergies with renewable, oxygenated fuels produced in the U.S., DFI can help overcome the daunting future challenges of energy security and global climate change. Lowering petroleum consumption benefits the economy and the environment as net carbon dioxide emissions are lowered.

While DFI is currently being evaluated as a technology for heavy- and medium-duty diesel engines, in the future this technology also could be applied to gasoline, natural gas, and jet engines.

The Sandia DFI team is currently seeking commercial partners with whom to further develop the technology.

Navy mechanical engineer designs
energy-efficient engine with thermal cloaking capability

A new engine design for ships could help the Navy save money on fuel and logistics while improving safety and security with a reduced heat signature that makes the ship virtually undetectable to a heat-seeking enemy.

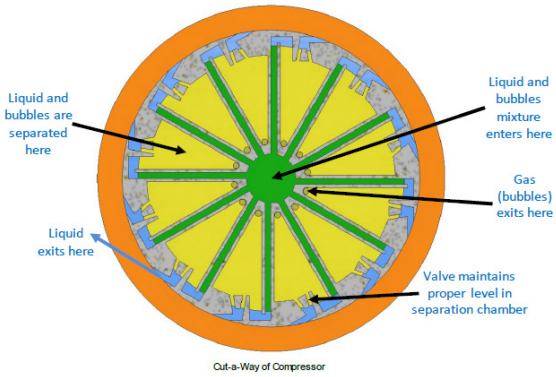
The new design is the first of its kind to combine a trompe compressor and a reaction turbine. A reaction turbine is like those old spinning sprinklers you might remember from childhood, in which the pressure of the water sends the sprinkler arms spinning. But add a trompe compressor that can compound that pressure, and you're in for quite a powerful lawn shower!

Those are the concepts underlying the revised Ericsson cycle engine designed by Geoffrey Kemmerer, a mechanical engineer with the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC).

The benefits of the new engine are not necessarily limited to the Navy. Kemmerer says that his invention could improve marine shipping, railway transportation, electric power generation, and even refrigeration. Thus, any industry for which greenhouse gas production or fuel costs are major concerns can benefit from this invention.

Requiring half the fuel of a diesel engine and one third the fuel of a gasoline or steam engine, the new design will reduce the operating and logistical cost for any equipment with an engine, while doubling the range of Navy ships. With no thermal signature created by the exhaust, enemy combatants will have a hard time tracking fleet movement. The Ericsson Cycle engine can be solar powered, further reducing ships' energy consumption, and when used in unmanned underwater vehicles (UUVs) it will reduce the cost of the power module to one-sixth the cost of fuel cells.

This Ericsson cycle engine is more fuel efficient than any other engine while not being prohibitively expensive to build. This invention consists of isothermal compression, counter flow heat exchanger and isothermal expansion. The compressor is based on a trompe, in which energy generated by falling water pressurizes air bubbles within the liquid. Instead of using the acceleration of gravity to build pressure, the new engine uses centrifugal acceleration to accommodate high pressures in a compact design. The types of liquid and gas used will depend on the application.



Above: As this cross-sectional view of the compressor shows, the liquid is pumped through a filter and heat exchanger, mixed with bubbles and reintroduced into the engine. The gas exits the separation chamber near the center and is ported through the center of the shaft to the heat exchanger.

Energy from the liquid is recovered by jetting it through a nozzle at the outer edge of the compressor disk. The liquid is recovered and pumped through a filter and heat exchanger, mixed with bubbles and reintroduced into the engine. The gas exits the separation chamber near the center and is ported through the center of the shaft to the heat exchanger. The one-piece construction and lack of seals make this a simple engine, and since the exhaust is close to the ambient temperature, the wasted energy is less than other engines.

This revised Ericsson cycle engine uses 100% of the available energy for work. The very small external heat signature comes only from the energy the compressor cooling fluid absorbs during the compression stage. This higher efficiency means ships could increase their range for the same amount of fuel, and expeditionary units could carry less fuel with them. As a bonus, the engine can be configured to run on any heat source, including solar and geothermal.

Commercialization of LLNL's microcapsule production technology starts with focus on air quality

A partnership with a California-based start-up is helping Lawrence Livermore National Laboratory (LLNL) deliver on the promise of its microcapsule production technology for improving indoor air quality.

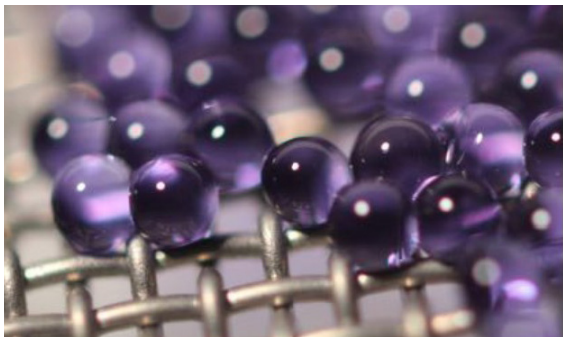
Many applications—from carbon capture for sustainable manufacturing to pharmaceuticals delivery—rely on microcapsules tailored for high surface area and maximum effectiveness of capsule contents. However, commercialization has been hampered by the lack of adequate production methods. Traditional microcapsule production techniques waste significant amounts of encapsulation and active materials, create inconsistently sized capsules, or yield too few microcapsules to meet industry needs.

LLNL's In-air Drop Encapsulation Apparatus (IDEA) creates microcapsules of consistent size and composition 100 times faster than current microfluidic-based, monodisperse capsule production techniques and up to 1,000 times faster when incorporated with a multi-nozzle design. The core-shell and structure of IDEA microcapsules can be tailored to a range of sizes and shapes for industrial and biotechnology applications. By overcoming past production shortcomings, IDEA opens the market to many more microcapsule applications for greater global impact, whether delivering life-saving drugs or enabling carbon dioxide (CO_2) capture and reuse to combat greenhouse gas emissions.

The research and development making IDEA possible started with LLNL's advanced manufacturing expertise and production capabilities. The lab initially applied the IDEA technology to microencapsulated carbon dioxide sorbents (MECS), produced at LLNL's Advanced Manufacturing Laboratory, that can enhance carbon capture from coal-burning power plants, industry processes, and even indoor spaces.

Participation in Energy I-Corps, a Department of Energy (DOE) entrepreneurial program, and university collaborations enabled the IDEA team to explore a range of commercial uses, from CO_2 reclamation in microbreweries to industrial-scale carbon capture at coal-burning power plants.

During this commercial exploration phase, the LLNL team landed a DOE Technology Commercialization Fund (TCF) award by partnering with California-based Artveoli. Artveoli's Air Panel technology captures accumulated CO_2 in a closed space (e.g., office, gym, school) and converts it into O_2 through a photosynthesis process using live algae contained in "biochips." The two-year, $630,000 TCF grant with a 1:1 matching fund from Artveoli supports work to integrate the IDEA technology into Artveoli's conversion biochips and improve the Air Panel's performance and energy efficiency.



Above: Microcapsules with biodegradable shells can deliver therapeutics through a syringe. Microcapsules with gas-permeable polymer shells filled with a sodium carbonate solution, pictured above, act as mini-reactors and a storage unit to draw CO_2 from power plants or manufacturing operations much faster than approaches using unencapsulated materials and leave only non-toxic sodium bicarbonate as a byproduct.

The key to the project is the capability to produce kilogram levels of consistent sample, leading to the team's full-throttle effort in IDEA development. When successfully applied, this partnership will yield an innovation to reduce CO_2 buildup in indoor air environments including hospitals, schools, office buildings, hotels, retail spaces, gyms, and spas—the spaces where U.S. residents spend more than 90% of their time. Long-term exposure to elevated CO_2 levels poses health risks and limits productivity, a growing issue as more people spend time working and living indoors due to the COVID-19 pandemic.

Whether delivering pharmaceuticals to enabling green manufacturing through carbon capture to improving indoor air and even recycling rare earth elements from electronic waste, microcapsules hold the potential to improve lives and the environment. IDEA overcomes longstanding issues to deliver microcapsules at the production levels and consistent size required for industry implementation.

The IDEA team's initiative in exploring commercial applications, industry partnerships, and scale-up opportunities has moved this technology closer to realizing all the benefits microcapsules can offer.

SUSAN SIMPKINS: Her knowledge, insights, and collaborative skills drive T2 growth at SLAC

Since 2017, when she was named director of SLAC National Accelerator Laboratory's relatively new Proposal Advancement Office (PAO), Susan Simpkins has changed the way the lab approaches and processes sponsored research and technology transfer.

The PAO was formed to improve the management and processing of SLAC research proposals, technology transfer agreements and contracts. In this role, Susan has made a tremendous difference for the laboratory.

"Susan Simpkins brings a remarkable combination of skills to every technology transfer project," said Steve Eglash, Director of SLAC's Applied Energy Program. "She has a keen and perceptive business insight that makes her an ideal strategic partner. She has an extensive understanding of Department of Energy [DOE] contracting and proposal processes. And she has a very strong understanding of contract law. These skills enable Susan to bring together the science, business, DOE, and legal perspectives needed for success."

Simpkins has demonstrated many lab values, but the one with the most impact on the transformation of the sponsored research and partnerships at SLAC has been collaboration.

She supports tech transfer initiatives at SLAC by representing the lab at meetings of the Department of Energy (DOE) National Lab Technology Transfer (NLTT) network and the Technology Transfer Working Group. Additionally, Simpkins has strengthened the lab's relationship with Stanford University's technology transfer and contracts team and with the DOE.

As an active member of the NLTT network, Simpkins gathered best-practice information from various federal and non-federal labs and introduced new policies, procedures and systems at SLAC. Susan's leadership has enhanced SLAC's project risk review process, streamlined clearance processes and ensured contractual and fiscal compliance for SLAC's growing portfolio.

Simpkins is also a founding a member of the Bay Area Lab Innovation Networking Center (LINC), which provides a front door to the four DOE national laboratories in the San Francisco Bay Area, linking corporations, startups, and investors to DOE's world-class research and unique facilities.

The transformation of SLAC's technology transfer administrative support has enabled SLAC to work with more diverse research partners, support more proposal and agreement requests and provide compliance without hindering researchers or sponsors.

"It is not always easy to support small businesses working with federal agencies, but with Susan's support we have many successful examples," said Michael Fazio, Associate Laboratory Director, SLAC Technology Innovation Directorate.

> Colleagues say Simpkins brings a remarkable combination of skills to every technology transfer project. These skills enable her to bring together the science, business, Department of Energy, and legal perspectives needed for success.

Simpkins' effort has led to a dramatic increase in T2 funds-in throughput – a 63% increase from FY2016 to FY2019, a period during which SLAC's overall funding grew by 14%. She began her role as PAO manager with responsibility for 5% of the lab's overall funding, and as a result of her success is now supporting more than 7% of that funding, all without increased staffing and while providing compliant support.

Susan makes every effort to ensure efficiency before increasing cost. The DOE Contracting Officer has applauded her efforts to provide thorough documentation, advance notification and updates. SLAC researchers have been educated on processes, sources of funding, invention disclosure and available engagement opportunities, such as small business outreach events, economic development forums and XLab events.

The new processes, systems and policies Susan has developed to support tech transfer at SLAC bring both transparency and accountability to the process, creating the foundation necessary to support the lab's growth.

Sandia National Laboratories

Sandia technology provides foundation for more efficient approach to hydrogen production

BayoTech, a manufacturer of modular hydrogen generation systems, is commercializing technology developed at Sandia National Laboratories to redefine the way hydrogen is produced from natural gas and to facilitate greater acceptance of hydrogen as a clean source of energy.

The Sandia technology involves a bayonet chemical reactor that resulted from an international collaborative effort to develop a sulfur-iodine water splitting process for hydrogen production. BayoTech is using the technology in a steam methane reforming process to make hydrogen from natural gas on a small scale for distributed hydrogen production, with hydrogen being produced at local sites.

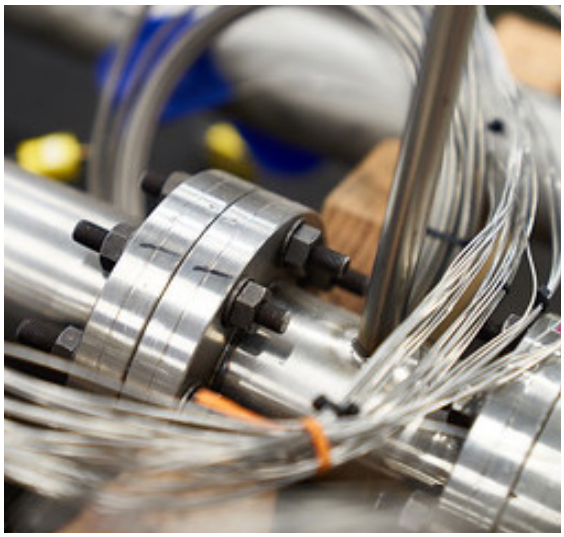
Currently, most hydrogen is generated in large production plants, liquefied, transported, and stored for days to weeks. By using BayoTech's concept of multiple small, distributed systems instead of a single large hydrogen production system, many barriers to the acceptance of hydrogen as an energy source—the cost and dangers of liquefying, transporting, and storing it—are greatly reduced.

The BayoTech production unit features a novel dual-tube design: A small tube open at both ends is positioned inside a larger tube that is open at only one end. The chemicals to be reacted enter, and the resulting products exit through the same end. As the hot product gasses pass through the inner tube, they give off heat to the reactants passing in the opposite direction, therefore recovering heat that would otherwise need to be used in another process or discarded.

The unit allows for a much smaller footprint than if conventional chemical process equipment is used. Due to its simple design, maintenance costs are also significantly reduced.

The bayonet reactor technology was licensed in 2015 by Hydrogen Inventions, the predecessor to BayoTech. There have been three amendments to the license since its execution.

The excellence in this technology transfer story relates to how Sandia dealt with financial terms of the license. Sandia Licensing Executive Bob Westervelt came up with the idea of capacity-based licensing, allowing BayoTech to rent, lease, or sell equipment.



Above: The BayoTech Steam Methane Reformer utilizes a nested tube design.

Due to the units being modular, pricing was based on the capacity of the variously sized models. It doesn't matter if the company is selling, leasing, or renting the equipment—in any scenario, the payments remain the same.

This gave the company flexibility. They could pay Sandia as each unit was manufactured, rather than the more common practice of payment when a unit is sold. This makes accounting simpler for both the lab and the company.

The company now has 30 employees, is headquartered in Albuquerque, NM, and is using a manufacturing partner, creating local jobs. This growth in jobs was partly enabled by investments from local venture capital firms, which have now invested more than $7 million of the $17 million invested so far in the company. Some of these investments require the company to be based in the state as a way to boost the local economy.

BayoTech's success also helps the national economy and environment as the cost and carbon-intensity of hydrogen is lowered, enabling more people to switch to fuel cell vehicles. In addition, the on-site hydrogen production units manufactured in New Mexico will be used around the country and internationally, with revenue from all sales returning to the local economy.

Sandia National Laboratories

Start-up mPower targets space industry for commercialization of Sandia solar cell technology

After a complicated technology transfer process involving a sprawling intellectual property (IP) portfolio and a start-up launched by former laboratory employees, Sandia National Laboratories' Microsystems Enabled Photovoltaics (MEPV) high efficiency solar cell technology is poised for commercialization.

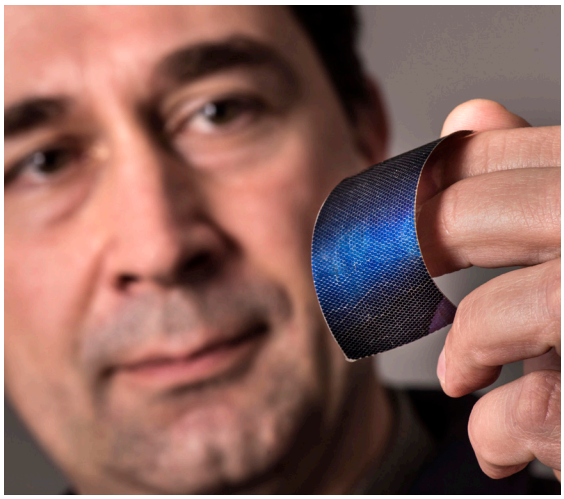
Currently being further developed and marketed by Albuquerque-based start-up mPower Technology, the MEPV technology is now called DragonSCALES™ (SemiConductor Active Layer Embedded Solar). mPower plans to introduce the technology to the space solar power market for low-Earth orbit satellite constellations, an initial demonstration intended to facilitate the technology's introduction into larger, more cost-sensitive markets like rooftop or utility-scale solar energy.

Like more typical solar cells, MEVP solar cells are made from silicon. But while traditional, large format solar cells are quite brittle and fragile, the MEPV cells are small and interconnected, making them foldable and almost unbreakable. MEPV cells are efficient to manufacture since they combine advances in photovoltaic cell design with mature microsystem production and manufacturing techniques.

The small size reduces material costs while enhancing cell performance. It also provides the freedom to integrate solar power capability into everyday objects. The technology's potential applications include buildings, houses, clothing, portable electronics, vehicles, and other contoured structures.

Three Sandia employees from the original MEVP development team left the lab to start mPower Technology in 2015, taking advantage of Sandia's Entrepreneurial Separation to Transfer Technology program (ESTT). In March 2015, Sandia and mPower entered into a nondisclosure agreement, and in April they entered into discussions for a License Option Agreement (LOA) for some of the MEPV portfolio related to the mPower business plans.

An LOA for 20 patents and patent applications in the MEPV portfolio was executed between Sandia and mPower on August 24, 2015. The LOA included business milestones that mPower had to achieve in order to be able to exercise the option and a longer than normal timeline for mPower to reach these milestones. The LOA also included a unique feature: among the 20 patents was a group that



Above: *Scientist Murat Okandan left Sandia National Laboratories to start mPower Technology Inc., whose primary product is Dragon SCALEs, small, lightweight, flexible solar cells that fit into and power devices or sensors of any shape or size. Okandan, who signed a licensing agreement with Sandia, shows a prototype here. (Photo by Randy Montoya)*

Sandia agreed to not license for six months while mPower determined whether it needed them or not.

A full commercial license for 17 patents, 11 of those (seven U.S. and four foreign) partially exclusive for a period of five years and the other six nonexclusive, was executed on January 23, 2017. The license was executed in just four months, a very short time period for a license of this complexity. That license has been amended four times, most recently in December 2019.

mPower has received a $1.1 million Army Small Business Innovation and Research (SBIR) grant for portable remote power requirements and raised $4.35 million in Series A round funding. mPower recently delivered a demonstration unit to Airbus for its Sparkwing product, which was integrated into the upcoming December 2020 launch of the Momentus Vigoride platform.

The excellence in the technology transfer with mPower included aspects unique to this large patent portfolio and its potential markets. Initial protection of the IP in both the U.S. and foreign countries and a long option period were combined with sublicensing rights for mPower, but only when coupled with patents it subsequently developed. The license also was structured with different royalty rates and requirements for four different markets mPower was initially pursuing.

USDA Agricultural Research Service

VIPR system from ARS could save $750M per year and restore U.S. reputation for clean cotton

A low-cost system for detecting and removing plastic contaminants from harvested cotton, developed and commercialized by the U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) and industry partners, could help to restore the financial health and reputation of the nation's cotton industry.

The United States was once known for producing some of the cleanest cotton in the world, but that is no longer true, and the industry has suffered financially as a result. Much of the plastic contamination showing up in marketable, ginned cotton comes from the plastic used to wrap the cylindrical bales of cotton that have become standard. Despite diligent efforts by cotton gin personnel to remove all traces of plastic before processing, the contaminant still finds its way into the cotton gin's processing system at a level ten-fold greater than before the advent of cylindrical baling modules.

This contamination has led to significant financial losses for the cotton industry—more than $750 million annually, compared with market conditions before the new baling technology was implemented. For an average cotton farmer growing 1,500 acres of cotton, the plastic-related losses would be more than $30,000 per year.

To mitigate this loss of quality and profit, ARS and industry partners have developed the Visual Inspection and Plastic Removal (VIPR) technology, which efficiently detects and removes plastic contamination during post-harvest processing of cotton. Because cotton gins operate on extremely low profit margins, the VIPR system was specifically designed to be much less expensive than the detection and removal technologies used in other industries.

The technology is an ultra-low-cost, "bolt on" detection and removal system built using off-the-shelf parts such as cell phone cameras and embedded image processors. This detection system is coupled to a pneumatic ejection system, which blows plastic contamination out of the process stream, preventing it from contaminating marketable cotton fiber. Overall, the VIPR technology prevents more than 90% of all plastic from getting into cotton bales.

Above: The VIPR system blows the green piece of plastic detected (highlighted by the yellow arrow) out of the process stream prior to entering the gin stand.

The ARS Lubbock Lab took the lead in developing the detection hardware and software and forming the strategic partnerships. The Las Cruces Lab designed and built the first prototype and in May 2018 made a proof-of-concept video showing it successfully ejecting plastic from seed cotton.

The new VIPR system was developed, tested and successfully transferred under collaborative research and development agreements (CRADAs) between the ARS and industry partners. Process-engineering firm Bratney Companies became a CRADA partner in October 2018 with the goal of commercializing the technology. Since Bratney was searching for a partner who had experience selling and servicing to the cotton ginning industry, the ARS introduced them to a previous CRADA partner they had worked with, Lummus Corporation, a cotton gin manufacturing and service company that has been in the industry since 1863.

Lummus and Bratney formed a partnership whereby Bratney would manufacture the VIPR units and Lummus would sell, help install, and service them. This partnership helped accomplish one of the main goals of the technology transfer, which was to get a commercially viable system into the hands of the cotton ginning industry as soon as possible.

The first commercial units were sold in December 2019 and installed and tested in a cotton gin in Georgia in January of 2020. VIPR is integrated into some cotton gins, with more expected in the near future.

NREL's new approach to constructing solar cells could greatly expand solar energy utilization

A new method for constructing solar cells, developed at the National Renewable Energy Laboratory (NREL), could expand the reach of solar energy far beyond current applications.

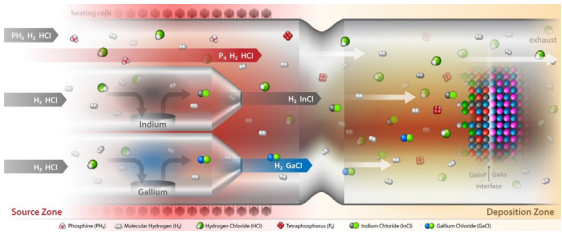
Multijunction III-V solar cells, so called because they are made of elements from the III and V columns of the periodic table, have several features that make them ideal for weight- and space-constrained applications. They are light and flexible; they also absorb less heat and operate more efficiently than solar cells made from silicon. However, all of these benefits come with a major tradeoff—cost.

Current manufacturers of III-V solar cells use a historical growth process that offers precise control but is high cost and has low throughput. That process, metalorganic vapor phase epitaxy (MOVPE), uses complex molecules of organics and group III metals, combined with group V hydride molecules, to deposit metal atoms on a substrate (a surface that provides the base crystalline pattern for the layers of added material).

Hydride vapor phase epitaxy (HVPE) is another growth process for depositing III-V semiconductors. Instead of complex metalorganic molecules, HVPE uses inexpensive, elemental III-V metals (pure gallium, indium, etc.) that are bonded to chlorine and then deposited onto the substrate.

HVPE is the only III-V semiconductor crystal growth process that operates close to chemical equilibrium, meaning it can grow crystals more than 10 times faster than MOVPE at less than 10% of the cost. However, in high-quality solar cells, the interfaces between layers must be abrupt and well-defined. With such a high growth rate, HVPE has, until now, been unable to switch from growing one material to another abruptly enough to create high-performance solar cells.

The NREL team's solution to the HVPE precision problem was simple, but game-changing: If traditional HVPE can't grow high-quality interfaces because precursor gases can't be swapped in the chamber quickly enough, why not leave the gases alone, create parallel chambers, and move the substrate between them? This led to the development of a modified HVPE process called Dynamic HVPE (D-HVPE).



Above: In the HVPE process, only hydrogen chloride and a carrier gas (e.g., hydrogen) are injected into the reactor. At the top of the reactor, in a source zone, hydrogen chloride reacts with liquid pools of pure III-V metals to produce the gaseous precursors (e.g., gallium chloride or indium chloride). Arsenic and phosphide are supplied by phosphine (PH3) or arsine (AsH3) molecules. When these precursors encounter the heated substrate, they break apart and deposit the metal atoms into the growing crystal.

The team constructed a lab-scale reactor to prove this concept. The reactor contains two vertical chambers, in which two different mixes of precursor gases could be maintained, connected by a horizontal transfer passage. In the passage, a flowing curtain of inert gas separates the precursor gases in the two chambers, while allowing the substrate to pass through. This lab-scale reactor successfully demonstrated the growth of abrupt interfaces, achieving similar quality interfaces as MOVPE-grown solar cells and a two-junction cell efficiency of 25%.

Together, all of these improvements have yielded a modified HVPE system that can grow multijunction III-V solar cells in less than four minutes, which would require one to two hours in an MOVPE reactor. Due to the increased deposition rate and simpler material chemistry, D-HVPE grown cells have the potential to be grown much less expensively than otherwise identical MOVPE-grown devices.

NREL has partnered with Kyma Technologies, a producer of semiconductor materials, and Ceres Technologies, a New York-based manufacturing and engineering company, to design and build a next-generation in-line D-HVPE reactor that will improve upon the proof-of-concept D-HVPE chamber described earlier.

NREL and Kyma Technologies combined efforts on the next-generation D-HVPE reactor are supported by the Air Force Research Laboratory's Space Solar Power Incremental Demonstrations and Research (SSPIDR) project.

LANL innovation offers a greener, affordable alternative to conventional laundry detergent

A new product developed by chemists at Los Alamos National Laboratory (LANL) is positioned to change the way the world does laundry, saving money and the environment one load at a time.

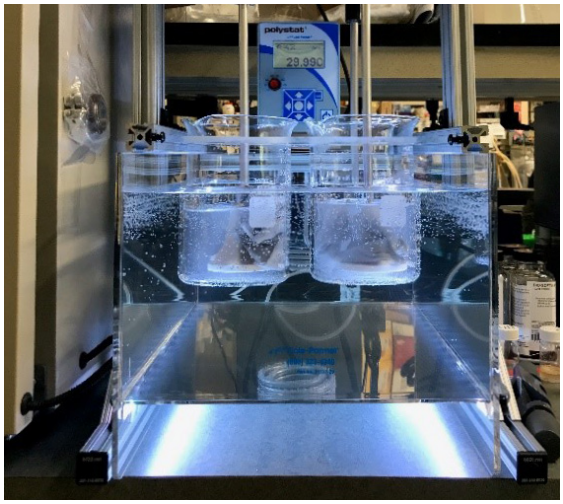
It's a well-kept secret that laundry detergents—even those that market themselves as eco-friendly—are harmful to the environment. One reason involves chemicals called surfactants. Surfactants are the workhorses of laundry detergent and soaps, and their attraction to grease and dirt make them effective for washing those substances away. But these benefits often come with significant drawbacks.

One problem with surfactants is that many are made from petroleum feedstock, which comes with a big carbon footprint. Greener feedstock alternatives for synthesizing surfactants include natural oils, such as palm kernel and coconut oil, but these are costly, and using them to make surfactants competes with the food supply chain.

Another challenge related to surfactants is that they do not work in hard water. Hard water is common; 85% of the U.S. water supply is considered hard because of the presence of small metal ions. These metal ions cover the surfactants, making them useless. Many detergent manufacturers add chemicals called chelators to bind the metal ions and make the water less hard; however, this solution leads to more problems, including increased cost of detergent production and a large output of environmentally harmful chemicals.

There remains a strong need for effective laundry detergents that are eco-friendly and affordable for consumers. That's why chemists at Seattle-based SIRONIX Renewables partnered with LANL to further develop Oleo-furan surfactants (OFS).

OFS are a new class of non-toxic, non-irritating surfactants for laundry detergent that solves each of the pertinent problems facing detergents and our environment today. It is the only class of surfactant that performs effectively in cold and hard water without the need for chelators. OFS can be produced readily from sustainable, bio-derived molecules. They are multi-functional molecules—performing the role of a surfactant and a chelator in one—and are completely bio-degradable. OFS does not rely on petroleum feedstock and is synthesized from non-food, bio-renewable cellulosic feedstock.



Above: A miniaturized laundry testing apparatus is used to test new surfactant molecules in real-life laundry wash conditions. Each glass beaker is filled with a small amount of water, detergent, and pre-stained fabrics. Backlighting allows for researchers to see issues during the wash cycle, such as cloudiness that is a result of incompatibility with hard water.

The Department of Energy, Energy Efficiency and Renewable Energy, Bioenergy Technologies Office (BETO) funded the work at LANL, and SIRONIX contributed cost share. SIRONIX and LANL engaged in a cooperative research and development agreement (CRADA) in April 2018 to develop an improved technology process and demonstrate continuous production at pilot scale.

SIRONIX has partnered with the state of Washington to comply with environmental and regulatory steps toward commercialization. SIRONIX also partners with detergent and personal care product brands to test the ingredients in their existing formulations, then offers these existing brands the OFS based formulas to incorporate into their current formulations. These partnerships provide useful feedback for continued improvements to help change the way the world cleans.

The global market for laundry detergent is currently $12.8 billion and growing, and the global market for cleaning products containing hard water surfactants is estimated to be $9.2 billion. Other products that use surfactants include paints, inks and coatings, oil field chemicals, agriculture and agrochemicals, and personal care and cosmetics. As a result, the improved performance and environmental profile of OFS has the potential to have a major impact.

COVID-19 pandemic inspires modifications to human-powered ventilator developed for space missions

An affordable, easy to use human-powered ventilator developed by the National Aeronautics and Space Administration (NASA) for use on space missions has been modified for use in treating patients with severe COVID-19.

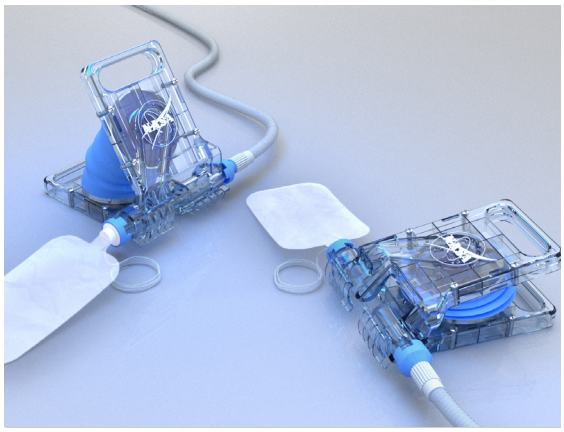
As the COVID-19 pandemic spreads rapidly, medical institutions around the world are experiencing an exponential growth of patients with severe respiratory problems. Some of the primary tools used to treat COVID-19 patients are ventilators.

Electrically powered ventilators are complex machines that assist a patient with inhalation and exhalation. These ventilators use a system of sensors to adapt the timing and pressure of the airflow to fit each patient's individual needs. The complexity of electrically powered ventilators makes these devices expensive and time consuming to manufacture; during the pandemic, these factors have contributed to severe global shortages of both ventilators and individuals with the skills needed to operate them. Resource-poor areas are experiencing additional hardships due to a lack of reliable power and maintenance support for electrically powered ventilators.

Manual "Bag-Valve-Mask" respirators can also be used to treat patients with respiratory problems. These devices rely on tactile feel and visual observation of the patient to determine the required amount and flow rate of air. Operation—squeezing a bag by hand to deliver air—is simple, but cannot be performed for long, continuous periods without fatiguing the small muscles in the operator's hand and wrist.

In 2017, NASA Johnson Space Center designed and prototyped a human-powered ventilator to be used on future long duration space missions, such as Orion's missions to Mars. This human-powered ventilator design was resurrected in March of 2020 and modified for terrestrial application.

The Human Powered Ventilator design uses bellows and a push-pull arm motion to pump air to a patient. Similar to a "Bag-Valve-Mask" design, this device relies on tactile feel for correct operation. The push-pull arm motion required to operate the human powered ventilator utilizes the large upper-body muscles in a person's shoulders, arms, chest, and back. By using these large muscles, the operator is not heavily taxed and is therefore able to operate the device continuously for hours. The device is made from plastic injection-molded or 3D printed components, involves a simple assembly process, and does not require sensors or electricity to operate.



Above: The Human Powered Ventilator design uses bellows and a push-pull arm motion to pump air to a patient. The device is made from plastic injection-molded or 3D printed components, involves a simple assembly process, and does not require sensors or electricity to operate.

Team members from various groups within NASA Johnson Space Center (JSC) worked together to develop the conceptual design of the human-powered ventilator. The JSC team consisted of NASA civil servants and contractors with Dallas-based Jacobs Technology, Inc.

Partnerships were also formed with domestic and international partners in industry and academia. Houston-based re:3D, a developer and manufacturer of 3D printing equipment, assisted with 3D prototyping of the device. The Anheuser-Bush International (ABI) Brazil Division engineering team has invested great effort in refining the device design for use in underserved areas of Brazil. The University of Kentucky is also pursuing design iterations that can be used elsewhere in the developed world. The JSC Technology Transfer office is managing the partnership agreements with all of these supporting entities.

During the COVID-19 pandemic and thereafter, this technology will be a valuable asset for hospitals around the world without access to electrically powered ventilators, whether this is due to supply shortages or a lack of resources.

Sandia National Laboratories

Tech transfer agreements make Sandia's successful partnership with UPRM even stronger

Sandia National Laboratories and the University of Puerto Rico-Mayaguez (UPRM) have reinvigorated their longstanding relationship with three formal technology transfer agreements that provide a launching pad for even greater impacts in the future.

Sandia and UPRM have been collaborating for the past two decades, but the partnership was significantly strengthened in 2016 with the establishment of the Consortium for Integrating Energy Systems in Engineering and Science Education (CIESESE). CIESESE, funded by the NNSA's Minority Serving Institutions Partnership Program, involved five Hispanic serving institutions including UPRM, and initially established a summer student internship program at Sandia and, subsequently, a faculty fellowship program.

UPRM was a very active participant in both of these CIESESE components at Sandia. Between 12 and 15 UPRM undergraduate and graduate science and engineering students per year have taken advantage of this opportunity, and several have been doing graduate research related to Sandia projects. Two UPRM engineering faculty members have spent several summers at Sandia, and a third has been on an 18-month assignment at the lab. Sandia is an official recruiter at UPRM.

These CIESESE-inspired interactions have identified multiple synergies between Sandia and UPRM, and have provided a foundation for three new formal collaborative mechanisms between the two institutions:

- A 10-year cooperative research and development agreement (CRADA)
- A memorandum of understanding (MOU)
- A corporate purchase agreement (CPA)

In December 2019, Sandia and UPRM executed an umbrella CRADA that will enable the two institutions to continue their partnership to develop safe, secure energy and environmental projects for resiliency and reliability. Planned collaborations involve next-generation micro-grids for rural communities, industrial parks, and critical loads; simulation tools to test-run technologies before integration; and enhancing the life cycle of energy components and systems to reduce waste and increase long-term sustainability.

"Collaborative projects undertaken as part of this agreement will leverage the university's academic and research expertise in addressing problems relevant to energy resiliency, critical infrastructure and energy-efficient process development aiming to treat, clean and reuse water and soils, along with Sandia's expertise in materials science; grid modernization and resilience; multiple energy sources and systems engineering," said Tito Bonano, a senior manager at Sandia who helped forge the partnership with the university. Bonano is a UPRM alumnus and a member of the industrial advisory board of its engineering school.

Above: *CRADA Signing Ceremony University of Puerto Rico-Mayaguez on February 25, 2020.*

In June 2020, Sandia and UPRM executed an MOU to formalize their commitment to complementary institutional goals: establishing a cooperative education program for students; increasing awareness of specialized and/or unique research facilities and equipment at both institutions; increasing inter-institutional collaborative engagement of faculty, staff and students; and developing and pursuing joint initiatives that leverage each other's strengths and infrastructure.

Sandia and UPRM have also established a five-year CPA that allows for a more efficient contracting process and supports the broader collaboration objectives memorialized in the CRADA and MOU. Over the last two years, four new projects have been channeled through the CPA mechanism. Technology transfer has been a common theme of these projects, as the work involved the application of advanced technologies and tools developed with federal R&D funds. In some cases, these technologies and tools are being used for curriculum and new R&D capabilities at UPRM, further enhancing the impact of technology transfer.

USDA Agricultural Research Service

ARS-led team demonstrates efficiency of new genome assembly method in cattle and yaks

A multicenter collaboration led by scientists at the U.S. Department of Agriculture (USDA) Agricultural Research Service (ARS) has developed a new technique for assembling genomic data that is significantly more accurate than previous methods and can extrapolate parental genome assemblies from data for a single individual.

The original human genome assembly, first described in 2001, contained hundreds of thousands of gaps and tens of thousands of errors, despite investments of billions of dollars and the efforts of thousands of scientists. About eight years later, the cattle genome was first described with similar attributes of gaps and errors, at a cost of tens of millions of dollars and efforts of more than 100 scientists.

By comparison, the new work—led by the U.S. Meat Animal Research Center of the ARS—involved fewer than 40 total scientists and generated genome assemblies with only a few hundred gaps and a similarly low number of potential errors.

Early genome assemblies were based on inbred individuals, in whom differences between the maternally and paternally inherited sets of chromosomes are minimized, because these differences confused the computer algorithms used to create assemblies from short DNA sequences.

The new method uses long-read sequencing technology and highly heterozygous individuals (in whom the maternal and paternal chromosomes are very different) to generate two separate genome assemblies from that individual—each assembly representing either the maternal or paternal set of chromosomes.

This novel "trio binning" technique was first applied to crosses between diverse cattle breeds, producing reference-quality assemblies of the Angus and Brahman breeds. The technique was then applied to an interspecies hybrid, the offspring of a Highland bull and female yak, with maximal contrast between maternal and paternal chromosomes.

The quality of the resulting individual genome assemblies for both yak and cattle is equal to or better than any existing mammalian assembly, including those of humans or biomedically important species such as mice or rats. Approximately one third of the chromosomes for each of the two parental species were assembled with no gaps, achieving "finished" status.

Above: *The interspecies cattle x yak trio used to create the first genome assemblies that spanned entire chromosomes without gaps in the sequence.*

The technology was transferred to the scientific and agricultural communities via the public repositories GitHub (for algorithms) and GenBank (for genome assemblies). All methods and software were described in detail in the journals Nature Biotechnology and GigaScience.

The effort required a broad range of expertise across multiple federal laboratories and universities. This included animal husbandry expertise from the USYAKS association of yak breeders; veterinary expertise from the University of Nebraska; DNA sequencing expertise and project leadership from the ARS; expertise in development and application of genome assembly algorithms from the National Human Genome Research Institute (NHGRI) and the ARS; and expertise in the development and application of genome scaffolding technology and algorithms from the University of California Santa Cruz and the NHGRI.

The efficiency of trio binning has inspired the creation of the International Bovine Pangenome Consortium, a collaboration to create high quality genome assemblies of all the cattle breeds in existence today. This consortium will work to identify the genetic basis for phenotypic differences between breeds, improve animal health and well-being, and increase sustainability of animal agriculture in the beef and dairy sectors.

Three national labs forge groundbreaking 10-Year T2 partnership with energy giant ExxonMobil

Three U.S. Department of Energy (DOE) laboratories have cooperatively developed and executed a 10-year, $100 million collaboration with ExxonMobil Research and Engineering Company to advance transformative energy technologies that could be brought to commercial scale.

The agreement between the energy giant and the National Renewable Energy Laboratory (NREL), Idaho National Laboratory (INL), and the National Energy Technology Laboratory (NETL) is one of the largest public-private partnerships ever established between DOE national laboratories and the private sector, and exemplifies DOE's commitment to cross-cutting, result-driven research initiatives.

"The National Renewable Energy Laboratory is excited to work with ExxonMobil to develop scalable energy solutions for the future and facilitate research partnerships across the national lab system," said Martin Keller, director of NREL. "Our partnerships with industry, government, academia and other research organizations drive the collaboration and innovation that is integral to revolutionizing the global energy landscape. By working side-by-side with ExxonMobil researchers, this partnership provides an unprecedented opportunity to explore new technologies and transform energy through science."

The partnership leverages existing projects at both ExxonMobil and NREL to identify overlapping opportunities to collaboratively accelerate and magnify the impact of research and development of future low-carbon energy innovations. It has already generated several funded projects among multiple national laboratories. Potential future projects include research and development into biofuels, carbon capture and storage, and life cycle analyses of energy technologies.

"The partnership with the national labs really goes back to the fundamental challenge that we're facing as a society, which is: How do you provide scalable energy to nine billion people while addressing the risks of climate change?" said Vijay Swarup, vice president of research and development at ExxonMobil.

The collaborative framework covers two separate paths for funding research at DOE's national laboratories, led by NREL. Traditional projects, which could include DOE resources, are executed under a cooperative research and development agreement (CRADA), while privately funded projects of strategic interest to ExxonMobil may be funded through the agreement to commercialize technology (ACT).

Above: *ExxonMobil signs 10-year, $100M partnership with NREL, INL and NETL.*

The master agreement delineates these research paths and facilitates collaboration by scientists and engineers across organizations to expedite the exchange of technical ideas. Intellectual property (IP) agreements were negotiated in parallel for the CRADA and ACT, respectively, to address the availability of pre-existing (background IP) and the disbursement of IP developed under each agreement (subject IP).

A collaboration of this size and duration required skilled navigation of DOE regulations governing partnerships, a sophisticated approach to IP management, and a commitment from parties to address contentious issues. It involves steering committee review of potential projects, allows ExxonMobil to engage other national labs through its network of affiliates, and establishes a process for hosting visiting scientists.

NREL led the first round of contract negotiations and partnered with NETL and INL on later rounds. ExxonMobil's ability to access the capabilities of many national laboratories efficiently through one set of agreements was a high priority for the company.

The partnership is expected to foster research collaboration on projects with the potential to move beyond the laboratory, resulting in greater market deployment of laboratory-developed technologies via licensing agreements.

"What excites me," Keller said, "is that there are different mindsets coming together in a breeding ground for tremendous breakthrough ideas."

Sandia National Laboratories

Sandia's regional COVID-19 response efforts address medical and economic effects of pandemic

Sandia National Laboratories took fast action when the COVID-19 pandemic began, supplementing existing technology transfer programs with creative new initiatives. Sandia personnel have been working nonstop to combat both the medical and economic effects of the pandemic, and many of these efforts have been focused locally.

Sandia, one of the largest employers in New Mexico, is positioned to help create new companies and new products that can build upon the lab's intellectual property (IP) and the talent already in the state. These new companies will create jobs that will add to the state's prosperity. They might also become suppliers of goods and services to Sandia.

"This isn't just a public health crisis; it's also an economic crisis," said Susan Seestrom, Sandia's chief research officer. "Companies need new ways of doing business. They need cybersecurity tools so they can operate remotely. They need advanced manufacturing techniques to produce goods that are in high demand. If Sandia's intellectual property can help, we want to lower barriers to people getting it."

The Rapid Technology Deployment Program (RTD) is opening about 75% of Sandia's intellectual property (IP) portfolio for free licensing. More than 1,000 technologies are available for nonexclusive licenses. And the time needed to get the license is fast—a license is returned to applicants, if they are eligible, within two days. Applicants just fill in a form online. The program was up and running just over two weeks after being conceived.

Sandia also became one of the 10 Founding Adopters of the Open COVID Pledge—along with Facebook, Amazon, Intel, Microsoft, and IBM—because its RTD program fit in with the model, which calls on organizations worldwide to make their patents and copyrights freely available in the fight against the pandemic. Other national laboratories have since implemented Sandia's RTD program. At the time of this award submission, 10 licenses had been signed, and some of those were issued the same day the application was submitted.

The New Mexico Small Business Assistance (NMSBA) program has rapidly mobilized to assist local companies with COVID-19 related product development challenges. Individual projects were fast-tracked through the system. NMSBA program managers and principal investigators (PIs) worked evenings and weekends to assess lab capabilities, develop each project's scope of work, and process requests through the approval system. Once the projects were approved, the PIs prioritized the projects and worked long hours to interface with the participating businesses to complete the projects as soon as possible.

Above: Sandia National Laboratories chemist Jessica Kruichak worked with Wayward Sons Craft-Distillery in Santa Fe through the New Mexico Small Business Assistance program. She tested hand sanitizer for the company to make sure it meets standards set by the World Health Organization and the U.S. Food and Drug Administration. (Photo by Lonnie Anderson)

One project helped Wayward Sons Craft-Distillery in Santa Fe quickly develop and produce hand sanitizer. Named Elbow Bump, the product helped the company respond to the widespread shortage of hand sanitizer in New Mexico and nearby states. Another NMSBA project helped Albuquerque medical device manufacturers Marpac, Sierra Peaks, and Sew-EZ test materials being used to make medical-grade N95-like masks.

For leveraged projects—those involving multiple companies—a special call was put out, and the NMSBA process was modified to fast-track COVID-19 related projects. For the first emergency proposal, NTX, NTXBio, Bluveris, and VM Technology were approved for $80,000 of technical assistance from Sandia to aid in the encapsulation of a proprietary RNA-based COVID-19 vaccine candidate. Sandia is testing an approach to scale the manufacturing process to produce up one million doses per day.

BOB WESTERVELT: Bringing experience in science and business to Licensing Executive role

Sandia National Laboratories

Bob Westervelt brings a unique background as both a laboratory scientist and a business executive to his current role as Licensing Executive at Sandia National Laboratories—expertise that is evident in his ability to craft licensing agreements that benefit all parties.

Armed with a PhD in nuclear physics, Westervelt worked as a physicist at Los Alamos National Laboratory before leaving to help commercialize lab-developed control system software at Vista Control Systems—his first introduction to technology transfer. Vista further developed the licensed software and deployed it across a variety of industries.

At Peerless Systems Corp., a digital imaging company, he learned even more about licensing and intellectual property (IP). As CTO, he worked closely with the Business Development team negotiating licenses with the company's customers. As VP of Engineering, he worked closely with the CFO on revenue recognition. Peerless' assets and IP were sold, and Westervelt was heavily involved in the negotiations.

Westervelt came to Sandia National Laboratories to work in licensing in 2012, using his skills to transfer a wide variety of Sandia technologies to the private sector. His creative licensing solutions have included licenses to allow companies to provide training for free emergency response software, a license focused on royalties for an enabling technology for medical isotopes, and a capacity-based licensing plan for a company planning to sell on-site hydrogen production units (see page 11).

Over the last eight years, Westervelt has also developed many of the licensing templates used for Sandia's technology transfer program and trained the T2 professionals on best practices. These include novel ways to handle licensing to startup companies and more effective ways to compensate the lab and its inventors without taking equity.

As the lead software licensing person at Sandia, Westervelt also has been involved in a large number of inter-laboratory collaborations to improve tech transfer practices. These included the Department of Energy (DOE) Practices to Accelerate Commercialization of Technology for Cybersecurity, a current project to commercialize, in conjunction with Cyber Capital Partners, cybersecurity technology developed by four DOE laboratories.

A concept Westervelt developed called High Value Licensing now helps licensing staff analyze and articulate the value of licensing efforts. Value is not only measured as income to Sandia; benefits to the public and U.S. economy are also important.

For the technology transfer of Microsystems Enabled Photovoltaics (MEPV) to mPower Technology (see page 12 for more details), Westervelt decided some flexibility was needed to handle the large IP portfolio. The License Option Agreement (LOA) included business milestones that mPower had to achieve to be able to exercise the option and a longer than normal time to reach these milestones. Uniquely, among the 20 patents in the LOA was a group that Sandia agreed to not license for six months while mPower determined whether it needed them or not. A full commercial license for 17 patents was executed in January 2017, just four months after mPower elected to exercise the LOA—a very short time for a license of this complexity.

> High Value Licensing, which Westervelt developed, now helps Sandia's licensing staff analyze and articulate the value of licensing efforts. Value is not only measured as income to the lab; benefits to the public and the U.S. economy are also important.

For collaborations involving Sandia's academic partners, Westervelt has worked to develop commercialization paths for jointly developed IP. Many agreements have involved joint projects between Sandia and the University of New Mexico (UNM) and its commercialization organization, UNM Rainforest Innovations.

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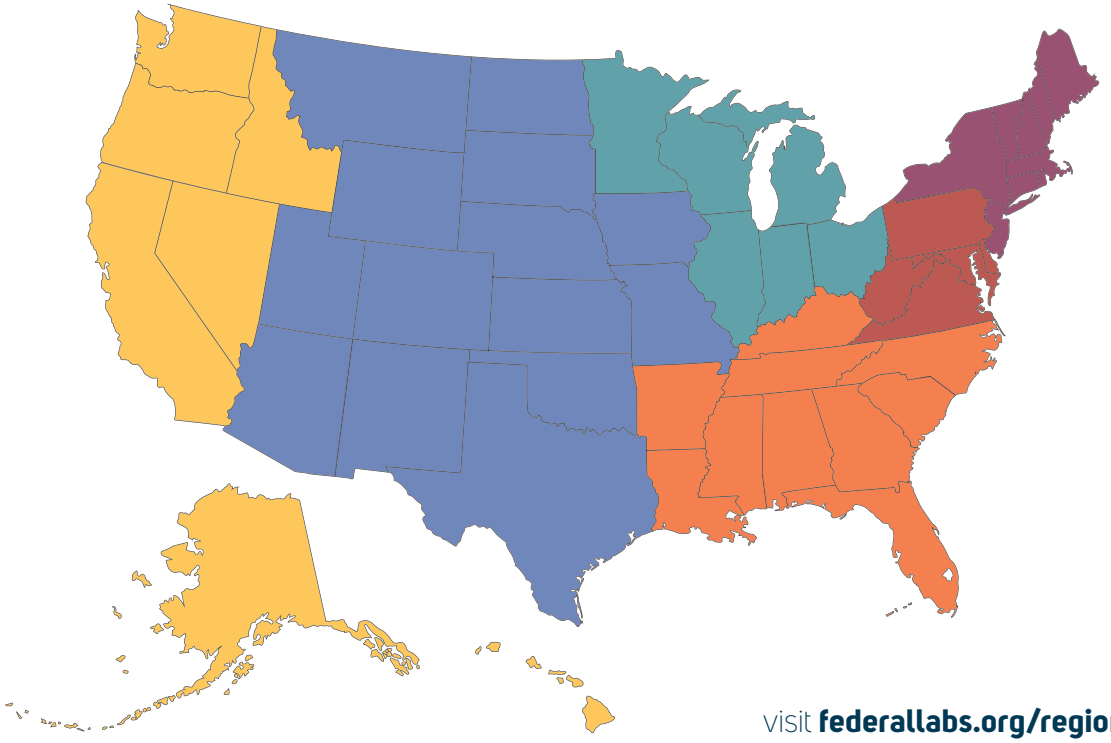

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