Technology Development & Commercialization

at Argonne National Laboratory

Argonne NATIONAL LABORATORY

ARGONNE STAFF, INDUSTRY, AND ACADEMIA WORKING TOGETHER | CREATING INNOVATIVE ENERGY FOR TOMORROW TODAY

The vision of Argonne's Technology Development and Commercialization Division is to work proactively to develop commercialization strategies for new applications and introduce transformational technologies into commercial use through licenses and start-ups.

TECHNOLOGY DEVELOPMENT AND COMMERCIALIZATION BY THE NUMBERS

- 417 new licenses issued since 2000
- Over 700 patents issued on Argonne-developed technology
- 117 R&D 100 Awards
- 31 start-up companies based on Argonne technology

* Argonne, U.S. Department of Energy, The University of Chicago Office of Technology and Intellectual Property

Argonne — with hundreds of scientific and engineering experts in dozens of fields — is highlighting the following innovative technologies for commercialization.

Superhard and Slick Coating
Versatile coating promises to improve reliability and performance in mechanical components

Diesel DeNO$_x$ Catalyst
New Argonne-developed catalyst can reduce NO$_x$ emissions from diesel engines by 80–85%

Upcycling
A green solution to the problem of plastic

Supergel
System cleans radioactively contaminated structures

Nanotube Composite Anode Materials
Improves lithium-ion battery performance

Resin Wafer Electrodeionization Technology
Reduces the cost of clean energy, chemicals, and industrial process water

Electrode Materials for Rechargeable Lithium-ion Batteries
A new synthetic approach

Nanostructured Photovoltaics
Atomic layer deposition thin film technology enables cost-effective solar cells

Enhanced Renewable Methane Production System
Benefits wastewater treatment plants, farms, and landfills

Redox Shuttle Electrolyte Additive
Helps make batteries safer, more economical

Advanced Analysis Software Key to New, Energy-Efficient Technologies
Leveraging scientific and engineering know-how to advance sources of renewable energy

Customizable Fuel Processor Technology
Benefits fuel cell power industry

Argonne's Integrated Approach to Developing Biofuels and Engines
Increases efficiency through combined production and design efforts

Argonne leads the way in new energy sources and sustainability with these cutting-edge technologies.

Superhard and Slick Coating

Argonne's superhard and slick nanocomposite coating improves reliability and performance in mechanical components. It reduces friction by 80%, increasing energy efficiency and eliminating wear and scuffing-related failures, extending the life of heavy machinery and equipment.

BENEFITS

- Prevents crack initiation and growth in critical components
- Eliminates wear under lubricated sliding conditions
- Excellent compatibility with oils, greases, and other fluids
- Reduces environmental emissions
- Cuts energy costs

APPLICATIONS AND INDUSTRIES

- Auto industry – engine and drive-train components, such as power transmission and transaxle components and fuel injectors
- Manufacturing
- Mechanical systems – gears, bearings, piston pins, valves
- Lightweight materials and steel components

Researcher Osman Eryilmaz loads various gears onto apparatus for coating with Argonne's superhard and slick material.

Inventor Chris Marshall shows the new catalyst that could help remove nitrogen oxides from diesel engine exhaust while saving energy.

Diesel DeNO$_x$ Catalyst

This diesel DeNO$_x$ catalyst removes 80–85% of nitrogen oxide (NO$_x$) emissions from diesel fuel combustion by converting NO$_x$ to nitrogen, a harmless compound that makes up about 78% of the atmosphere. The high conversion rate of the Argonne catalyst results from its effective interaction with the hydrocarbons in diesel fuel; the diesel fuel itself reduces NO$_x$ to nitrogen.

BENEFITS

- Utilizes on-board diesel fuel or power plant #2 heating oil for regeneration
- Easy to use — uses heat supplied by diesel engines
- Long lifetime — 400,000 miles
- Inexpensive and relatively nontoxic materials are used to produce the catalyst
- Ultra-low sulfur diesel fuel extends the life of the catalyst technology
- Environmental benefits reduce global industrial footprint

APPLICATIONS AND INDUSTRIES

- New and existing diesel vehicles
- Stationary and portable power
- Fossil fuel power plants
- Chemical plants

Customizable Fuel Processor Technology

Benefits Fuel Cell Power Industry

Argonne has developed and patented a unique fuel processor technology that can be customized to produce hydrogen-rich gas mixtures (reformate) for automotive, residential, and portable fuel cell power applications. The fuel processor technology converts fuels (e.g., natural gas, gasoline) and renewable fuels (e.g., bio-ethanol, landfill gas) into a hydrogen-rich gas suitable for fuel cells. The patented components of the processor and the unique approach allow researchers to produce a custom processor that maximizes the proportions of fuel, air, and water to achieve high process efficiency.

BENEFITS

- Provides industry with the opportunity to obtain and use a customized fuel reformer for a specific application, a specific fuel, and specific constraints
- Enables the licensing of the customizable technology for specific applications

APPLICATIONS AND INDUSTRIES

- Automotive – range extenders for electric vehicles
- Residential – heat and power
- Remote and portable power

Dr. Magali Ferrandon reviews a durable autothermal reforming catalyst that she has coated on a ceramic foam for use in a fuel reforming reactor designed to produce hydrogen from hydrocarbon fuels.

Argonne's Integrated Approach to Developing Biofuels and Engines

Philip Laible, a biophysicist within the Biosciences Division, holds an aliquot of cells that has been removed from the large suspension culture behind him, for analysis of fuel production levels during various stages of growth.

Biochemists, theoretical chemists, and mechanical engineers are collaborating to make new higher-performance, lower-emissions biofuels and internal combustion engines work together more efficiently. Biofuels are a key part of the national plan to reduce dependence on imported energy and decrease greenhouse gas emissions. The group is joining forces for in-depth research on fuel production, combustion analysis, engine evaluation, and life cycle analysis and process economics. Biochemical engineers are teaming with biophysicists to create new bacteria to produce next-generation biofuels and feedstocks. Their work includes developing algal-type strains that efficiently use sunlight, carbon dioxide, nutrients, and water to produce biofuels; directly producing biofuel molecules in engineered bacteria and efficiently separating them to improve the energy efficiency of the fuel production process; tailoring feedstock composition and processing techniques to produce and enhance fuel properties while controlling fuel costs; and scaling up production of promising biofuels for combustion data acquisition/simulation and engine performance testing.

BENEFITS

- Cleaner, more efficient vehicle fuels
- Affordable biofuels for consumers
- New higher-performance, lower-emissions combustion strategies and engine designs
- Groundbreaking, new paradigms for the transportation industry

APPLICATIONS AND INDUSTRIES

- Transportation sector
- Petroleum pipeline refinery and existing petroleum infrastructure

Argonne's Junbing Yang, developer of the silicon composite anodes, works on the synthesis of composite materials.

Nanotube Composite Anode Materials Improve Lithium-ion Battery Performance

Argonne researchers have developed an innovative anode material comprised of a composite structure of a lithium-alloying material coated on the wall of an aligned nanotubular base material to help improve the energy capacity of lithium-ion batteries. These nanotube composite materials provide increased structural stability during lithiation and delithiation. The materials also offer a significant increase in specific capacity and improvements in long-term stability.

BENEFITS

- Increases capacity
- Improves safety
- Increases long-term stability and reliability

APPLICATIONS AND INDUSTRIES

- Transportation applications, such as electric and plug-in hybrid electric vehicles
- Portable electronic devices, such as cell phones and laptop computers
- Medical devices
- Space, aeronautical, and defense-related devices

Electrode Materials for Rechargeable Lithium-ion Batteries:

A New Synthetic Approach

Dr. Christopher Johnson measures the surface area of a new synthesized Li-ion battery cathode material made by a novel lithium for sodium ion-exchange process.

Researchers at Argonne have created a new cathode material from new synthesis methods that can solve problems associated with conventional Li-ion high-capacity (energy) batteries. This unique approach lowers the irreversibility capacity loss on the first cycle, increases the rate capability, and improves structural stability at high voltages in the cathode. These Li-ion cathode materials consist of layered transition metal containing oxides that have a unique bi-layered domain structure produced by the synthesis method. This new material allows for rapid lithium intercalation/de-intercalation within the crystal, resulting in a cathode with very high rate and high-power capability.

BENEFITS

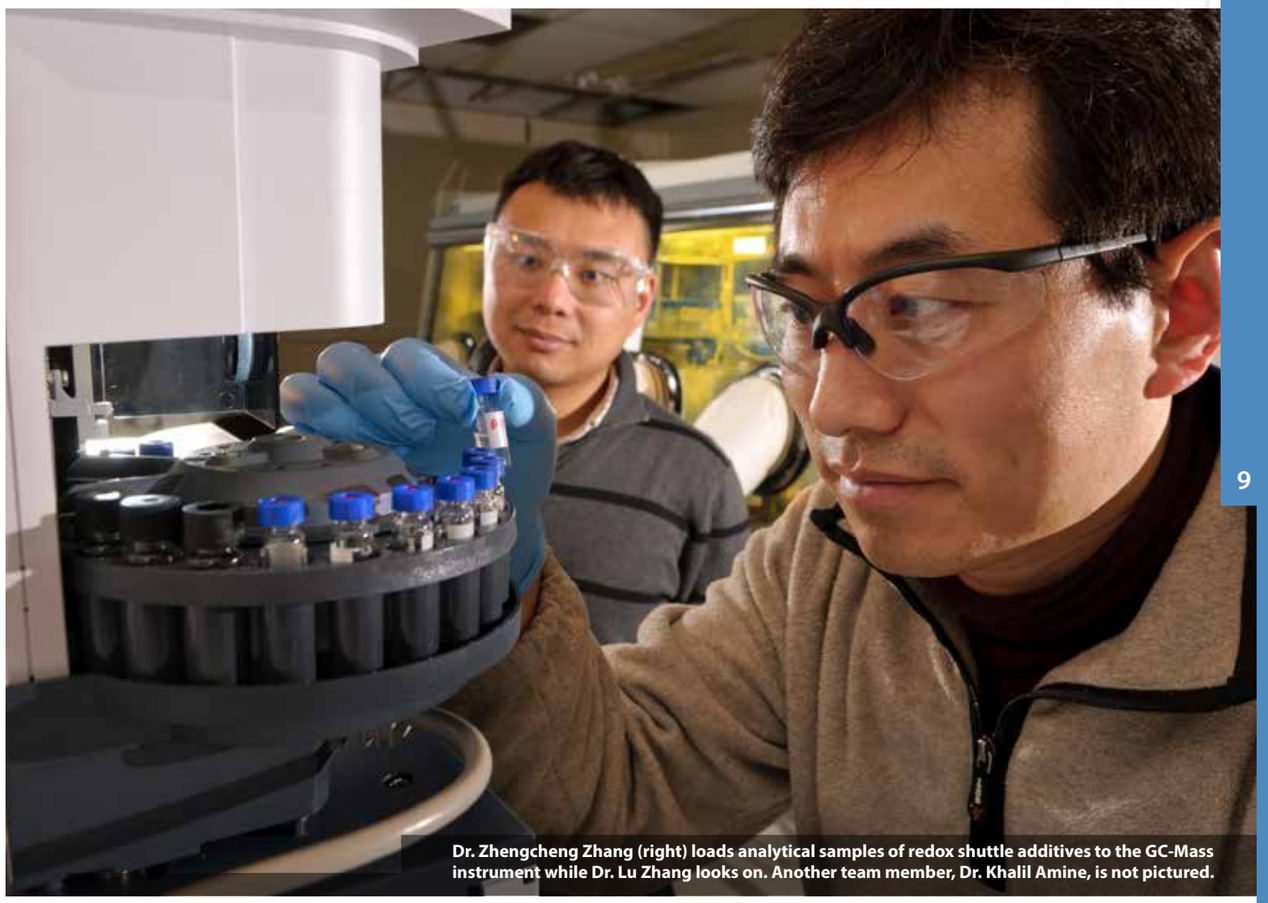
- Higher-performance, more cost-effective batteries for Plug-in Hybrid Vehicles and Electric Vehicles
- High-performance cathode reduces costs by lowering the number of cells needed in the battery pack and reducing associated hardware

APPLICATIONS AND INDUSTRIES

- Aerospace and defense
- Automotive and transportation
- Portable communication and computers
- Stationary energy storage
- Medical

Redox Shuttle Electrolyte Additive

Could Help Make Batteries Safer, More Economical



Dr. Zhengcheng Zhang (right) loads analytical samples of redox shuttle additives to the GC-Mass instrument while Dr. Lu Zhang looks on. Another team member, Dr. Khalil Amine, is not pictured.

Argonne has developed a way to make commercially viable lithium-ion batteries for plug-in hybrid electric vehicles and electric vehicles that are safer, will last longer, and cost less than current Li-ion batteries. Argonne's invention is a charge transfer mechanism for Li-ion battery overcharge protection. When the battery is overcharged, the redox shuttle is oxidized by losing an electron to the positive electrode. The radical cation formed is then diffused back to the negative electrode, causing the cation to obtain an electron and be reduced. The net reaction is to shuttle electrons from the positive electrode to the negative electrode without causing chemical damage to the battery.

BENEFITS

- Prevents overcharge and improves safety
- Balances cell in a battery pack
- Reduces cost
- Increases reliability
- Saves $100–200 per battery pack, thanks to the change in chemistry. Savings result from lower battery manufacturing and maintenance costs, as well as from an extension of battery life.
- Provides 500+ overcharge cycles compared to others that work for only a few cycles

APPLICATIONS AND INDUSTRIES

- Hybrid electric vehicles
- Plug-in hybrid electric vehicles

Upcycling:
A Green Solution to the Problem of Plastic

A green solution to the problem of plastic transforms a range of waste plastics — grocery bags, packaging foam, plates, and cups — into a fine black carbon powder or carbon nanotubes. The powder contains tiny carbon spheres — about 2 to 5 micrometers wide and one-twentieth the width of a human hair. If a cobalt-based catalyst is added during the heating, the powder forms microscopic carbon nanotubes. This carbon-based substance has numerous industrial applications ranging from its use as an anode material in manufacturing lithium-ion batteries to serving as a component in water purification, tires, electronics, paints, and printer inks and toners.

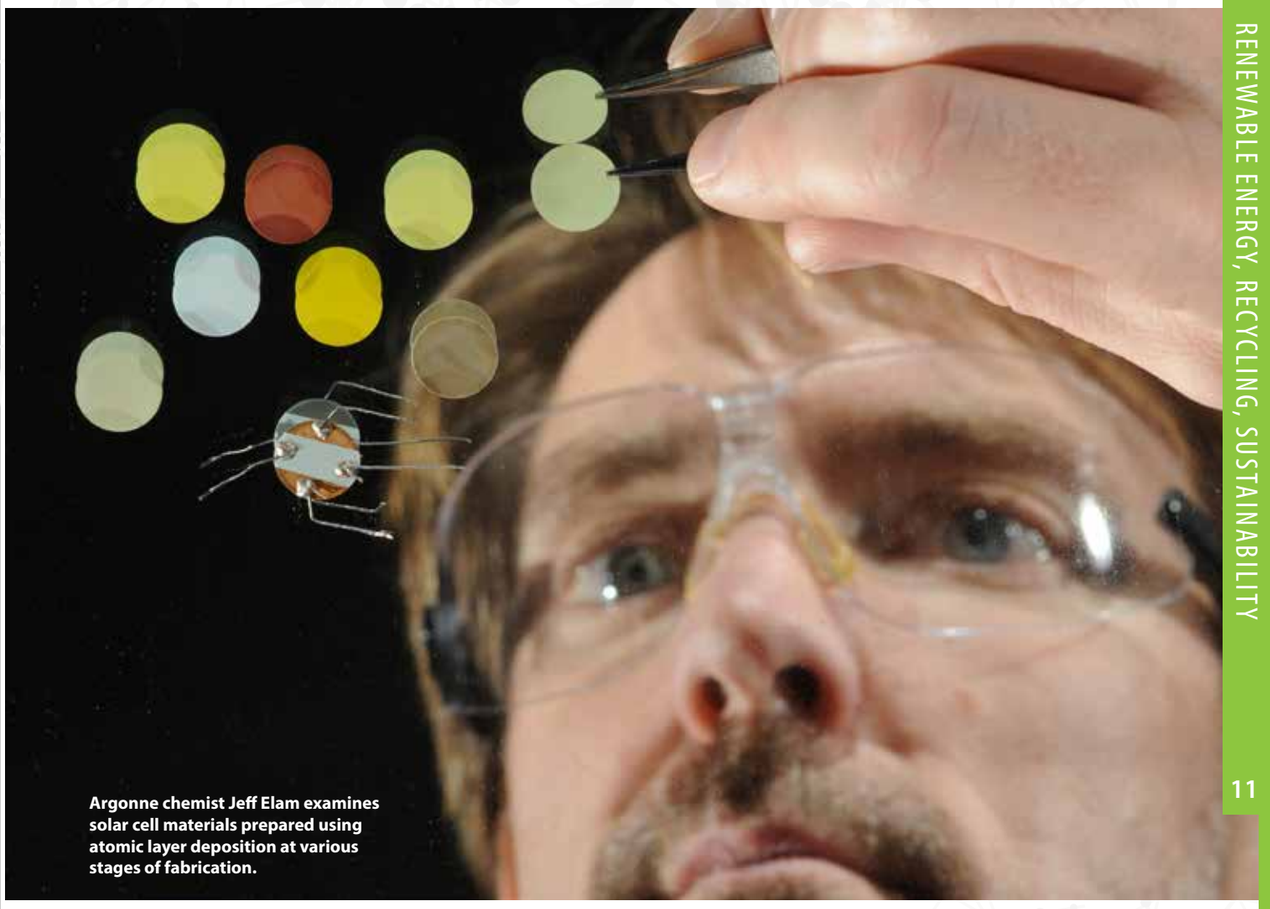
BENEFITS

- Efficient removal of a nonbiodegradable plastic from the environment
- Cost-effective, environmentally green method for transforming plastics into a useful commodity
- Provides a new source for a material with properties that make it useful in other industries, including manufacturing

APPLICATIONS AND INDUSTRIES

- Electronics — lithium-ion batteries for cell phones, laptops, electric cars, and more
- Water purification — for adsorption properties
- Tires — for heat-dissipation properties
- Paint — unique spherical morphology with conducting nature
- Computer inks and toners — highly suitable micrometer size

Dr. Vilas Pol inserts plastic bags into a reactor specially designed for upcycling.



Argonne chemist Jeff Elam examines solar cell materials prepared using atomic layer deposition at various stages of fabrication.

Nanostructured Photovoltaics:
Atomic Layer Deposition Thin Film Technology Enables Cost Effective Solar Cells

Argonne and partner Northwestern University invented a nanostructured photovoltaic device allowing dramatic cost savings of up to 70% compared to crystalline silicon solar cells. Photovoltaic manufacturing is an emerging industry that promises a carbon-free, nearly limitless source of energy for our nation. These nanostructured photovoltaics exploit a novel design to enhance efficiency and utilize atomic layer deposition technology for low-cost, low-temperature manufacturing. Argonne's nanostructured solar cells, an improved version of the dye-sensitized solar cell, are fabricated using cheap, low-energy processes performed at low temperatures and fabricated by depositing a series of thin conformal layers over aerogel scaffolds using atomic layer deposition, a technology commercialized by the microelectronics industry.

BENEFITS

- Provides abundant, renewable, carbon-free energy
- Reduces manufacturing costs and greenhouse gas emissions by >70%
- Utilizes scalable, established nanomanufacturing methods

APPLICATIONS AND INDUSTRIES

- Manufacturing
- Solar panels

Enhanced Renewable Methane Production System

Benefits Wastewater Treatment Plants, Farms, and Landfills

Researchers at Argonne have developed a novel, low-cost treatment to accelerate biological methane production rates — at least fivefold — while sequestering CO_2 enhances the heating value of biogas, delivering a gas that is close to pipeline quality. In addition, the renewable methane process leaves coal's environmental pollutants, such as sulfur and mercury, in the ground, avoiding their emissions.

BENEFITS

- Produces pipeline- or near-pipeline-quality methane
- Enables simultaneous carbon dioxide sequestration

APPLICATIONS AND INDUSTRIES

- Wastewater treatment plants
- Recovery of methane from agricultural processing
- Coal bed methane
- Landfill methane production
- Methane from other carbonaceous feedstock

Seth Snyder, biochemical engineer, examines a microbial culture used to produce renewable methane prior to sample analysis. The Argonne process increases methane production rates by about fivefold and increases purity in the biogas to near pipeline grade.

Resin Wafer Electrodeionization

Reduces the Cost of Clean Energy, Chemicals, and Industrial Process Water

Argonne biochemical engineer Seth Snyder is pictured with the laboratory's resin wafer technology.

Argonne's patented technology processes biomass-based feedstocks into biofuels and chemicals, removing charged products like organic acids from aqueous streams and eliminating the need to add neutralizing agents continuously. Argonne's resin wafer electrodeionization technology is made from commercially available materials; by controlling dimensions, composition, porosity, and conductivity, researchers have adapted the resin wafer technology to a variety of target products.

BENEFITS

- Reduces cost of biofuels production
- Facilitates domestic production of biomass-based biofuels and chemicals
- Improves the economic competitiveness of bio-based products
- Reduces the cost for process water in power plants and industry

APPLICATIONS AND INDUSTRIES

- Manufacturing processes

Scientists at Argonne demonstrate the application of the super-absorbent polymer gel on a concrete building.

Supergel System

Cleans Radioactively Contaminated Structures

Argonne's system consists of engineered nanoparticles and a super-absorbent polymer gel, that rapidly cleans radioactively contaminated porous structures — brick and concrete — as well as metal surfaces with a three-step process: application, reaction, and cleanup. When exposed to a wetting agent, the polymers form a structural scaffold and the gel absorbs great amounts of liquid.

BENEFITS

- Leaves structures intact
- Preserves surfaces — monuments and buildings are protected
- Captures as much of the contamination as possible, as quickly as possible, and fills a technology gap immediately

APPLICATIONS AND INDUSTRIES

- Prepares the United States to respond to the effects of a terrorist attack with radioactive dispersal devices
- Reduces radiation levels to allow resumption of emergency operations
- Decontaminates structures for unrestricted access
- Collects radioactive contamination samples for nuclear forensics
- Converts liquid radioactive waste to stabilized solids suitable for direct disposal

Advanced Analysis Software

Key to New, Energy-Efficient Technologies Leveraging Scientific and Engineering Know-How to Advance Sources of Renewable Energy

Supported by funding from the U.S. Department of Energy, other federal agencies, and industry sponsors, Argonne is providing broad-based scientific and engineering expertise to create analytical software tools that will enable the United States to make substantive enhancements in energy efficiency and serve the growing demand for renewable energy.

Hydropower

To support DOE's goal of increasing generation from existing hydropower facilities, Argonne is leading the development of an integrated modeling and simulation toolkit dealing with water forecasting, reservoir and power supply modeling, stream flow routing, and hydropower unit performance metrics. The toolkit will enable the optimization of hydropower operations and environmental performance and improve the ability of plant operators to manage the risk of hydrological uncertainty. Argonne is leading a multi-laboratory project team that includes Oak Ridge, Pacific Northwest, and Sandia National Laboratories.

Wind Power Forecasting and System Integration

Key challenges in meeting DOE's target of 20% wind power by 2030 are the need for enhanced wind forecasting and better integration of wind plants into power system operation. To meet these challenges, Argonne is developing new unit commitment models that account for wind uncertainty and leading an international team developing improved methodologies for short-term wind forecasting.

Building Efficiency

Buildings use more energy than any other sector of the U.S. economy, consuming over 70% of electricity and over 50% of natural gas. Argonne's team is working to deliver important new technologies that will help reduce energy use and make new and existing buildings more energy efficient.

BENEFITS

Industrial

- Enables informed decisions about optimizing operations, reducing costs, managing operational and environmental risks, and increasing capacity in hydropower plants and elsewhere
- Drives the use of energy-efficient technologies in new and existing commercial buildings

Environmental

- Effects changes in hydropower plant operations that enhance the ecosystem
- Aids in the recovery of endangered species
- Allows higher levels of renewable capacity in the power system
- Reduces the use of fossil fuels and related environmental emissions

APPLICATIONS AND INDUSTRIES

- Electric utilities with hydropower generation
- Marine and freshwater resources
- Wind power plants
- Oil and gas
- Commercial building construction and renovation
- Meteorological and forecasting organizations

TD&C PROVIDES INFORMATION TO

Members of the general public who are looking for information on the innovative technologies developed at Argonne, colleagues in the commercial sector seeking information on the technology and expertise available at the Lab for either partnering or licensing opportunities, and Argonne scientific staff looking for insight on technology transfer, partnering, and funding opportunities.

TDC ACCOMPLISHES ITS MISSION BY

Developing valued intellectual property and licensing it for use by the public, working with Argonne R&D divisions to exploit opportunities in research, develop partnerships, and enhance returns from Argonne intellectual property, performing results-oriented outreach to technology stakeholders to develop benefits, improve industry competitiveness, and enhance awareness of new materials, processes, and software.

ABOUT ARGONNE

Argonne is a leader in addressing the nation's critical scientific and technological problems, attracting scientists and engineers from all over the world to open new possibilities for the future. Argonne researchers work closely with researchers from hundreds of companies and universities — and federal, state, and municipal agencies — to help them solve their specific problems and advance America's scientific leadership.

The nation's first national laboratory, Argonne is the Midwest's largest federally funded R&D center, with about 3,200 employees. With more than 1,200 scientists and engineers in dozens of fields as well as a unique suite of leading-edge scientific user facilities, Argonne experts conduct basic and applied research focused on solving the nation's challenges in sustainable energy, biological and environmental systems, and national security.

Location — Argonne is located in DuPage County, Illinois; about 25 miles southwest of Chicago, just south of Interstate 55.
Management — Argonne is managed by UChicago Argonne, LLC for the U.S. Department of Energy's Office of Science.
Funding — Argonne's annual operating budget of about $695 million supports more than 200 research projects.

TECHNOLOGY DEVELOPMENT & COMMERCIALIZATION

Argonne National Laboratory staff, industry, and academia are working together Creating Innovative Energy for Tomorrow Today. For inquiries on commercializing Argonne technologies, please contact partners@anl.gov.

You can access more information about working with Argonne's Technology Development and Commercialization Division with this QR Code:

http://www.anl.gov/work_with_argonne.html

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U.S. DEPARTMENT OF ENERGY

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