

INSTITUTE OF NORTHERN ENGINEERING



COLLEGE OF ENGINEERING AND MINES

University of Alaska Fairbanks

Note from the Director



INE Director
William Schnabel

INE pursues applied science and engineering solutions to Alaska's most pressing needs. Through our research, we seek to light the path to Alaska's future.

During Fiscal Year 2016, INE researchers submitted 173 research proposals and generated over \$13 million in external research revenues. Those research funds were used to support students, staff, and faculty, as well as a host of specialized activities and instrumentation associated with cutting-edge research. In addition, the vast majority of the funds were expended in Alaska, adding a much needed boost to our state's economy. As the state contribution to INE's operating budget was approximately \$2.4 million, INE research represented a solid return on state investment.

Whether you represent an agency or industry seeking Arctic research solutions, a student considering potential opportunities for graduate studies, or a faculty member looking for a research home, please have a look at our FY16 Annual Report. In these pages, we provide a brief glimpse of who we are, where we've been, and where we plan to be tomorrow.

A handwritten signature in black ink that reads "William E. Schnabel". The signature is written in a cursive, slightly slanted style.

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INE INSTITUTE of NORTHERN ENGINEERING

FY16 *Annual Report*



The **Institute of Northern Engineering (INE)** is the research arm of the **College of Engineering and Mines (CEM)** at the University of Alaska Fairbanks and home to many of the world's leading researchers in cold weather and cold climate science and engineering.

INE has several distinct research centers and offers expertise in energy production, modeling and testing of mechanical systems, environmental engineering and hydrology as well as transportation, infrastructure, mining, and petroleum development.

The University of Alaska Fairbanks is an AA/EO employer and educational institution.

Cover photos by Sveta Stuefer/WERC.
Personnel portraits by INE and UAF.

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INE Org Chart

INE



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Alaska Stable Isotope Facility



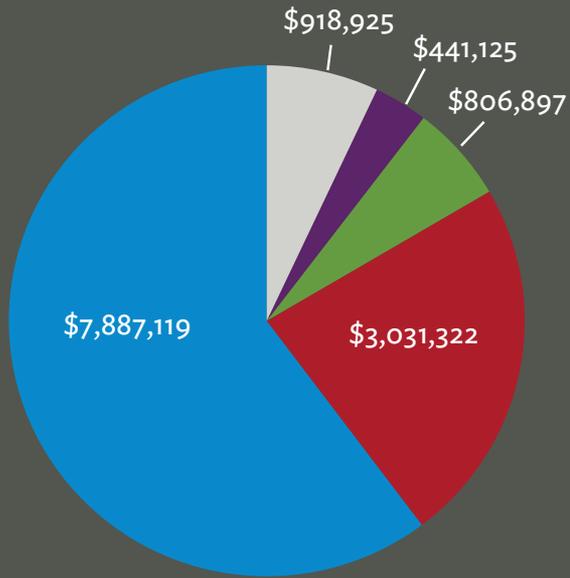
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FY16 Research Revenue Sources

INE by the Numbers - FY16

INE INSTITUTE of NORTHERN ENGINEERING

FY16 Financial Data



TOTAL = \$13,085,389

- Federal
- State and Local Government
- Corporations & Private
- Other Universities
- Other

- 50** Staff
- 20** Research Faculty
- 45** Academic Faculty
- 6** Post Docs
- 89** Graduate and Undergraduate Students
- 35** Temporary Staff and Adjunct Faculty
- 81** Peer-reviewed Publications



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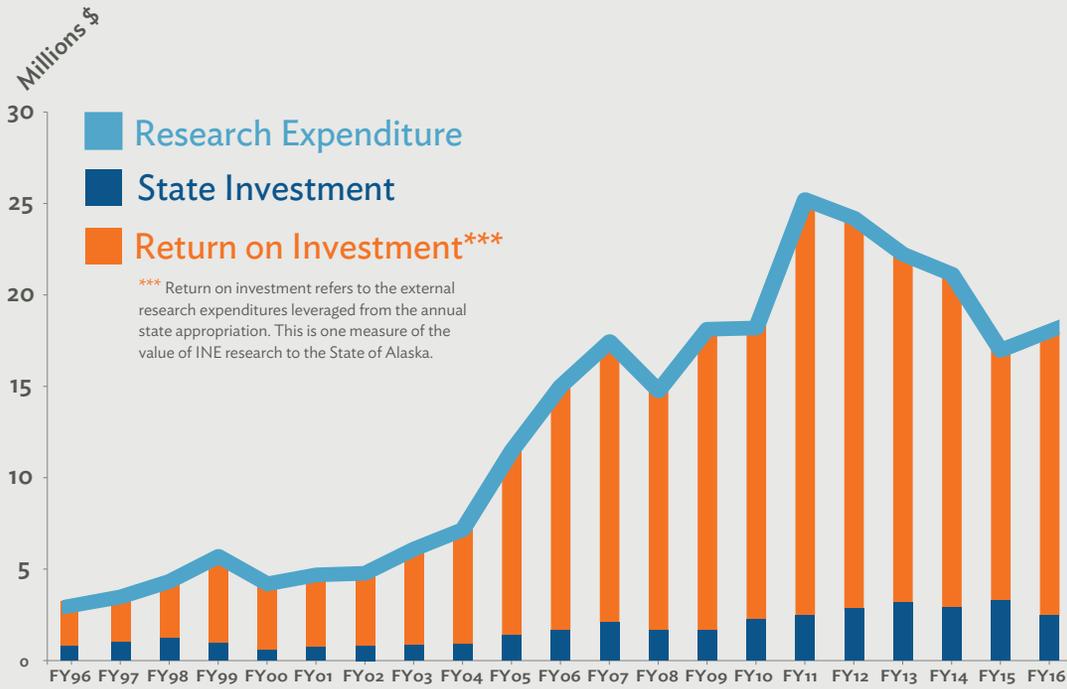
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Cover photo by Ken Tape/WERC. Inside panel photo by Chris Arp/WERC.

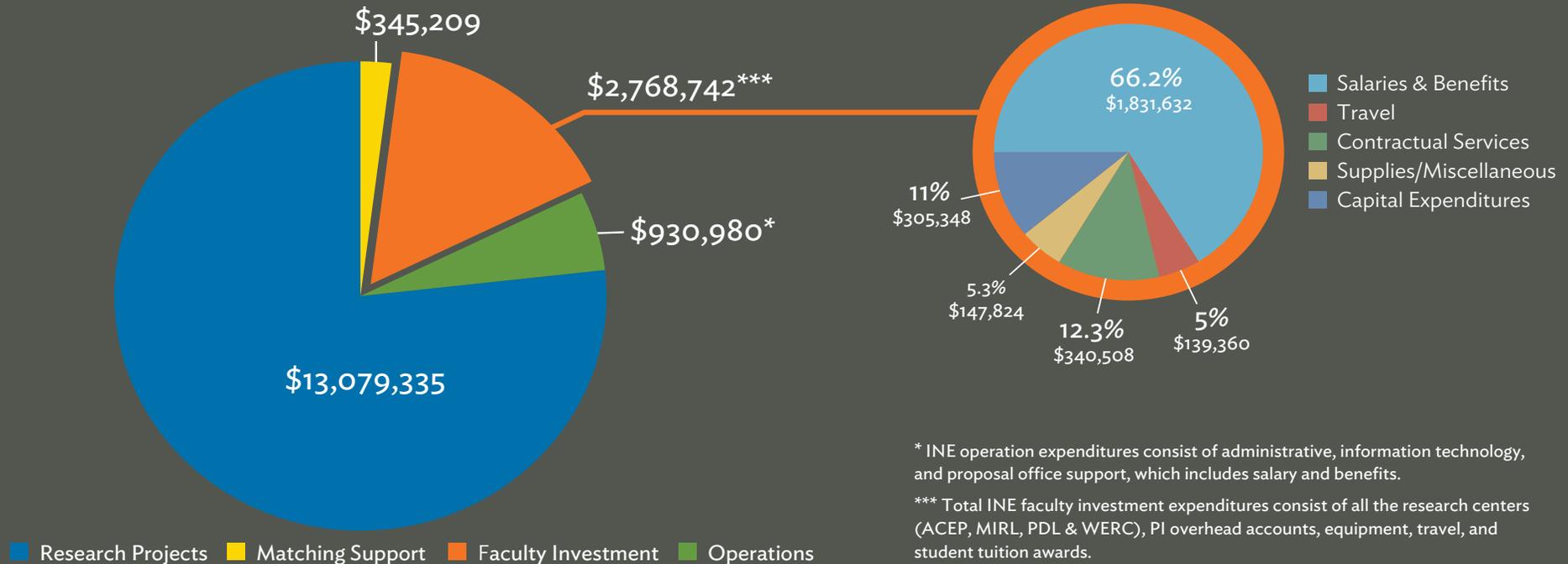
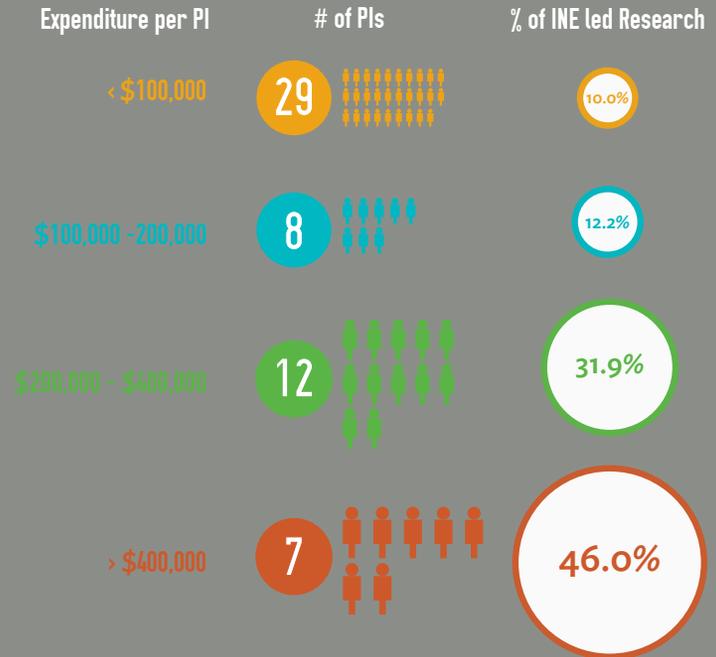


COLLEGE OF ENGINEERING AND MINES

University of Alaska Fairbanks



PI Expenditure



* INE operation expenditures consist of administrative, information technology, and proposal office support, which includes salary and benefits.
 *** Total INE faculty investment expenditures consist of all the research centers (ACEP, MIRL, PDL & WERC), PI overhead accounts, equipment, travel, and student tuition awards.

ACEP

Alaska Center for Energy and Power



The **Alaska Center for Energy and Power (ACEP)** is an applied energy research program that focuses on integrating renewable with nonrenewable power generating sources. ACEP provides support to agencies, utilities, and the private sector to address the technical and policy challenges associated with modern innovations in the energy sector.

Alaska is home to more than 200 small community microgrids distributed across its geographically diverse regions. It is also home to more than 12% of the developed microgrids in the world. The integration of intermittent renewable energy, such as wind turbines and photovoltaic, has led to the development of a niche support industry in Alaska, and also given rise to the Alaska Center for Energy and Power to help address the complexities of integrating renewable energy into a grid system.



INSTITUTE OF NORTHERN ENGINEERING

University of Alaska Fairbanks

Alaska Center for Energy and Power



ACEP is organized into several working groups focused on different topic areas:

The **Power Systems Integration Laboratory** works to optimize diesel-renewable hybrid energy systems for islanded electric microgrids. Its research facility can be fully programmed to emulate a village, up to 500 kW, incorporating on-site diesel generation, programmable wind turbines, plus battery and load banks.

The **Alaska Hydrokinetic Energy Research Center** facilitates development of in-river hydrokinetic power systems. Its Tanana River test site supports a floating platform capable of securing a working load of 22.5 tonnes.

The mission of the **Data Collection & Analysis Program** is to collect, manage, disseminate, and provide analysis of high quality technical energy data in support of data-driven decisions. DC&A serves many kinds of customers, from project stakeholders in need of power system performance characteristics, to researchers in need of data for model design, data validation, and boundary conditions.

ACEP recognizes that a multifaceted approach is necessary for identifying energy solutions that are sustainable for small energy markets, especially where the cost advantages associated with large scales of economy are not an option. The **Energy Analysis Group** provides insight into economic alternatives and works to identify strategies for maximizing the efficient use of government resources and private capital in the context of the social, legal, and regulatory climate.

AUTC

Alaska University Transportation Center



The **Alaska University Transportation Center (AUTC)** performs applied and basic research focuses on transportation in northern climates.

Areas of expertise include:

- Pavement materials, design, construction and maintenance
- Soil and structure interaction for bridges in frozen and partially frozen soils
- Bridge design for arctic and subarctic conditions
- Geotechnical investigation and design
- Design, construction and maintenance of transportation infrastructure in permafrost
- Dust management techniques for roads and airports
- Design, construction and maintenance of drainage structures
- Control of aufeis
- Highway safety in northern climates



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University of Alaska Fairbanks

Alaska University Transportation Center



AUTC has completed over 140 projects over the last 10 years, ranging in cost from less than \$10,000 to over \$500,000, each with a typical duration between six months and 3 years.

Example projects include:

- Monitoring and Analysis of Frozen Debris Lobes
- Improving Passing Lane and Efficiency
- Estimating Future Flood Frequency and Magnitude in Basins affected by Glacier Wastage
- Evaluation of Crack Sealing of Asphalt Concrete Pavements in Alaska
- Frozen Soil Lateral Resistance for Seismic Design of Highway Bridge Foundations
- Impact of Groundwater Flow on Permafrost Degradation & Transportation Infrastructure Stability
- Kwigillingok Runway Stabilization
- Use of Wicking Fabrics to Prevent Frost Boils
- Geophysical Applications for Transportation Planning
- Attenuation of Herbicides in Subarctic Environments

AUTC encourages student participation in its research projects which helps reduce costs, but more importantly, provides an excellent education for the students. Graduates that have worked on AUTC projects are now working for the Alaska DOT&PF, the oil and gas industry, and the private sector.

MIRL

Mineral Industry Research Laboratory



The **Mineral Industry Research Laboratory** performs basic and applied research that supports development, production, processing, refining and transportation related to mineral and energy resources of Alaska and elsewhere.

Alaska's mineral wealth is well known. Less known is that the mining-related expertise present in Alaska's MIRL faculty is in short supply worldwide. Extractive metallurgy expertise has slowly eroded world-wide over the last few years. For instance, there are few mine ventilation experts, especially those with knowledge beyond basic ventilation networks.

For a government agency looking for answers to mining-related questions, or a mining company seeking insight into a problem, MIRL is here to help.



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Mineral Industry Research Laboratory



Some recent and current projects capture the diversity of MIRL activities:

- **Rare Earths:** One project explored the mineral processing options for the Bokan-Dotson Ridge rare earth resources in southeast Alaska. Another examined the rare earth element content of Alaska coal and coal ash.
- **Hazard mapping:** MIRL faculty led hazard mapping studies along the North Slope Transportation Corridor to determine the feasibility of extending the existing railroad to the mineral rich North Slope.
- **Air Inversion in Deep Open Pit Mines:** Air inversion is a common cold climate problem that can impact air quality in deep open-pit mines. MIRL faculty have modeled air inversion in an Alaskan open pit mine to develop possible solutions.
- **Mine Mill Grade Reconciliation:** MIRL is assisting a copper mine in Mongolia in understanding their mine-mill grade reconciliation problem. Mine-mill grade reconciliation is a common problem worldwide.
- **Drones for Mine Rescue:** MIRL is partnering with the Alaska Center for Unmanned Aerial Systems Integration and Sumitomo Metal Mining to test the use of unmanned aerial systems for underground mine

PDL

Petroleum Development Laboratory



The **Petroleum Development Laboratory (PDL)** assists the Alaska petroleum industry, state agencies, and federal agencies in their efforts to develop new technologies through research and development; PDL promotes extraction of Alaska's oil and gas resources under stable and healthy environmental conditions. Cutting edge research provides extensive graduate research opportunities to students from Alaska and all over the world.

PDL focuses on Alaska North Slope conventional and unconventional oil (heavy oil and shale oil) development as well as conventional natural gas and unconventional gas, such as methane-hydrate, resource assessment and development.



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Petroleum Development Laboratory



Some recent and current research areas representing a broad spectrum of R&D technologies :

- Enhanced Viscous/Heavy Oil Recovery
- Chemical Enhanced Oil Recovery (CEOR)
- Low Salinity Waterflooding (LoSal ®)
- Experimental Investigation of Inflow and Lift Performance During the Cold Heavy Oil Production with Sand Process
- Uncertainty Incorporation into Petroleum Production Engineering Models
- CO₂ foam Injection Studies for Heavy Oil Recovery
- Nanoparticle-Based Drilling Fluids
- Methane Hydrate Production Technologies
- Shale Oil and Gas Resources Assessment and Production Technologies
- Permafrost Thaw Induced Subsidence
- Arctic Oil Well and Geothermal Well Cementing
- Gas-To-Liquid Transportation through the Trans-Alaska Pipeline System (TAPS)
- Microbial Enhanced Oil Recovery

WERC

Water and Environmental Research Center



The **Water and Environmental Research Center (WERC)**, established in 1965, is a world leader in addressing research questions involving the Arctic's water and environmental assets.

WERC's researchers have a long history of field operations in Alaska's most remote regions, which stand on the forefront of rapid global change and industrial development in the Arctic. They frequently operate independently without infrastructure or technical support, collecting data in regions where basic environmental information frequently does not exist.



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Water and Environmental Research Center



WERC provides credible and timely information for stakeholders to make informed decisions regarding use of our shared environmental resources. Faculty and staff expertise reflect disciplines relevant to life in cold regions, including arctic, civil, and environmental engineering as well as the environmental and hydrologic sciences.

WERC RESEARCH FACILITIES AND LABORATORIES

complement and expand the scope of our field-based research. Instrumentation is available for quantitative analysis of anions, cations, volatile, semi-volatile, and nonvolatile organics, total organic and inorganic carbon, and gas sample components.

The **Alaska Stable Isotope Facility** specializes in measuring stable isotopes of C, N, O and H of organic and inorganic matter and water samples to track hydrologic sources, climate change, ecological food-webs and biogeochemical cycling in Alaska and abroad.

The **Marine Ecotoxicology and Trophic Assessment Laboratory (METAL)** is a collaborative and multidisciplinary research group that focuses on levels of contaminants, nutrients, stable isotopes, and health biomarkers in the tissues of marine mammals and their prey to assess questions of diet assessment, wildlife conservation, environmental health and movement of contaminants through Arctic and North Pacific food webs.