Energy, Environmental & Chemical Engineering
In 2006, Washington University became the first university in the world to create a Department of Energy, Environmental & Chemical Engineering (EECE) by bringing together faculty involved in the interdisciplinary Environment Engineering Science graduate program and the Department of Chemical Engineering.
Energy, Environmental & Chemical Engineering at Washington University

The Department of Energy, Environmental & Chemical Engineering continues to advance and make tremendous strides. Since its launch in 2006, our student populations have grown considerably: the number of undergraduate students has doubled, and the number of graduate students has increased to more than 115.

Our tenured/tenure-track faculty now stand at 19, with a plan to grow to 24 by 2020. Each new faculty member has already attained national recognition for his or her work, and many of them have received prestigious national awards. Since 2006, seven of our junior faculty received NSF CAREER Awards. Our faculty’s diversity better reflects the diversity among our students.

Our new programs, both in research and education, are being sustained. The innovative international programs continue to grow through the McDonnell Academy Global Energy & Environment Partnership. We have involved our undergraduates and have plans to continue the interactions with our 34 partner universities. The department is recognized worldwide through our various global programs, including the McDonnell Academy Global Energy & Environmental Partnership, the Consortium for Clean Coal Utilization, and the National Nanotechnology Infrastructure Network, which we hope to scale up. New initiatives include the Shared Environmental Analysis Laboratory, Center for Aerosol Science and Engineering and the Center for Energy initiative. We are in the final planning stages of launching an undergraduate degree in Environmental Engineering.

We are enhancing our interactions with industry and organizing workshops and other collaborative programs. We have launched new classes such as Sustainability Exchange, where our students work in teams on real-world problems. We have revamped the Unit Operations Laboratory and look forward to teaching the classes with new, modular equipment.

We are now housed in two new, state-of-the-art and sustainable buildings. To bring all of these things to reality, the school and university have invested more than $75 million over the last six years. This is paying off and is resulting in significant growth, which will continue as energy, the environment and sustainable technologies are among the pillars of the university’s ongoing Leading Together capital campaign. But the most important part of our growth is the people — from the young leaders we are training to become critical thinkers and problem solvers to the more than 2,870 alumni and friends who have been leading in their fields for years.

Pratim Biswas, PhD
Assistant Vice Chancellor & Department Chair
Lucy & Stanley Lopata Professor
Research

The rapid pace of globalization provides unprecedented opportunity for developed and developing countries to restructure and grow their economies. However, society must meet the heightened demand for energy and goods through responsible, sustainable sources and with technologies that will have limited environmental impact, such as materials and devices for solar photovoltaics and new pathways for biofuel and biochemical production. We must create and improve the infrastructure required to ensure the highest quality of environmental and human health, which will require both fundamental and applied research in order to address environmental challenges comprehensively. Through the cross-disciplinary research of physical, chemical and biological processes in engineered systems, we can achieve cleaner air and water worldwide.

Research
ccluster areas

» Aerosols:
  » Aerosol science and technology
  » Nanoparticle technology
  » Combustion
  » Instrumentation
  » Particle emission control
  » Air quality & climate change

» Engineered aquatic processes:
  » Aquatic chemistry
  » Water treatment
  » Environmental restoration

» Metabolic engineering & systems biology:
  » Cellular pathways for chemical transformation
  » Biological routes to chemical/energy production

» Multiscale engineering:
  » Nanoscale & mesoscale phenomena
  » Catalysis & reaction engineering
  » Electrochemical engineering

138
Referred journal publications in 2017
$7.4M
Annual research expenditures (FY18)

Education and research in

» Energy
» Environmental engineering science
» Advanced materials
» Global outreach
Research centers and collaboration

Center for Aerosol Science and Engineering (CASE)

The Center for Aerosol Science & Engineering (CASE) is focused on the advancement of knowledge and technology through aerosol techniques in energy, environment, materials, and health. The center is composed of a collaborative group of faculty, students, and affiliates within EECE and across the university, as well as with partners at universities and corporations worldwide. CASE activities include extensive collaborative research with shared instrumentation facilities, education through coordinated coursework and workshops, special seminars and discussion groups, and social networking events. case.wustl.edu

Consortium for Clean Coal Utilization (CCCU)

Established in December 2008, the CCCU is a center for research in advanced coal and carbon capture technologies. The consortium’s goal is to foster the utilization of coal as a safe and affordable source of energy and as a chemical feedstock with minimal impact on the environment. The consortium was established by financial commitments from the lead sponsors: Arch Coal, Peabody Energy, and Ameren. Funding goes to support a variety of research projects, advanced research facilities in the engineering school, and outreach activities relating to the clean utilization of coal. The research projects are led by faculty at Washington University and performed in collaboration with faculty from international partner universities. cccu.wustl.edu

International Center for Energy, Environment and Sustainability (InCEES)

InCEES was created in June 2007 to encourage and coordinate university-wide and external collaborative research on energy, environment, and sustainability that cannot be done by single investigators or by single disciplines alone. incees.wustl.edu

McDonnell Academy Global Energy & Environment Partnership (MAGEEP)

MAGEEP is a consortium of 34 McDonnell Academy universities and global corporate partners that supports the development of innovative ideas in energy, environmental, and sustainability research, education, and operations. mageep.wustl.edu

The Nano Research Facility (NRF)

The NRF is positioned among the physical science and engineering departments and cultivates an open and shared research and education environment that brings researchers across disciplines together, particularly in the emerging area of nanomaterials with applications in the energy, environment, and biomedical fields. Scanning and transmission microscopes as well as a micro- and nano-fabrication lab (clean room class 100/1,000), surface characterization lab, particle technology lab, and bio-imaging lab represent the core of capabilities. The NRF services and equipment, supported by NSF’s National Nanotechnology Infrastructure Network, are available for both university and industry users. nano.wustl.edu

U.S.-India Joint Clean Energy Research & Development Center

The SEES initiative focuses on enabling sustainable energy harvesting and storage technologies globally by transcending scale-up, cost, and reliability barriers. This will be done by engaging in a wide portfolio of renewable and sustainable energy generation and storage technologies, with an emphasis on solar energy. The integration of energy generation, storage, transmission, and distribution at a systems level and interface with partners in industry, government, and academia will be promoted. Specifically, research and education in harvesting of solar energy for conversion to electricity and fuels/chemicals. Integrated to this is the storage component, with an emphasis on electrochemical techniques. solarstorage.wustl.edu
Recent major research awards

» $3 million from federal grants and a gift from SunEdison/MEMC, as part of the $125 million U.S.-India Clean Energy Center.

» Pratim Biswas, US DOE, $1,498,323, Catalytic Removal of Oxygen and Pollutants in Exhaust Gases from Pressurized Oxy-Combustors

» Richard Axelbaum, US DOE, $1,167,332, Enabling Staged Pressurized Oxy-Combustion: Improving Flexibility and Performance at Reduced Cost. Dr. Axelbaum also is a PI of the US-China Clean Energy Center which provides $3,500,000 to Washington University for research on oxy-coal technologies.

» $2,000,000 to Vijay Ramani from US DOE ARPA-E program to support research in Energy Storage Systems. Ramani also received additional funding from ONR and USDOE for his Electrochemical Engineering Projects

» The National Science Foundation awarded several research grants to faculty in EECE in 2017: Giammar, Jun, Thimsen, Biswas, Axelbaum, Moon and Tang.

Selected national awards

» Pratim Biswas was elected Fellow of the American Association for Environmental Engineering Science Professors (AEESP) in 2017.

» Kimberly Parker and Yi Jiang won the Best PhD Award in Environmental Engineering awarded by AEESP in 2017.

» Will Heinson received a prestigious Post Doctoral Fellowship Award from the National Science Foundation.

» PhD student Apoorva Pandey was awarded the Environmental Management/Policy Research and Study from the Air & Waste Management Association.

» Ahmed Abokifa won the Innoryze Excellence in Computational Hydrology Award.
Faculty

Aerosol Science & Engineering

The field of aerosol science and technology covers the basic principles that underlie the formation, growth, measurement and modeling of systems of small particles in gases. These systems play an important role in nature and industry and in the study of nanoparticles — building blocks for nanotechnology. The impacts of aerosols on human health and climate change are of critical importance.

Pratim Biswas
Assistant Vice Chancellor & Department Chair
Lucy & Stanley Lopata Professor
PhD, California Institute of Technology, 1985
MS, University of California, Los Angeles, 1981
B Tech, Indian Institute of Technology, 1980

Pratim Biswas’ research interests include aerosol science and engineering; nanoparticle technology; air quality engineering; environmentally benign energy production; combustion; materials processing for environmental technologies, environmentally benign processing, environmental nanotechnology, and the thermal sciences.

Professor Biswas is also the director of the McDonnell Academy Global Energy & Environment Partnership (MAGEEP) and a member of the McDonnell Academy Steering Committee.

Richard Axelbaum
The Stifel & Quinette Jens Professor of Environmental Engineering Science
PhD, University of California, Davis, 1988
MS, University of California, Davis, 1983
BS, Washington University, 1977

Richard Axelbaum studies combustion phenomena, ranging from oxy-coal combustion to flame synthesis of nanotubes. His studies of fossil fuel combustion focus on understanding the formation of pollutants, such as soot, and then using this understanding to develop novel approaches to eliminating them. Recently, his efforts have been focused on addressing global concerns over carbon dioxide emissions by developing approaches to carbon capture and storage (CCS).

Axelbaum’s synthesis research has yielded methods of producing stable metal nanoparticles and single-walled carbon nanotubes in flames. His present research in materials synthesis is directed towards producing next-generation battery materials for electric vehicles. Xtend Energy has recently acquired a license for the technology developed under this research.

Rajan Chakrabarty
Assistant Professor
PhD, University of Nevada-Reno, 2008
MS, University of Nevada-Reno, 2006
BS, University of Madras, 2003

Rajan Chakrabarty’s research focuses on two distinct themes: (i) Investigating the role of atmospheric aerosols in earth’s energy balance using novel instrumentation and diagnostic techniques, and numerical models; and (ii) Understanding aerosol formation in combustion systems toward synthesis of high porosity and surface-area materials for energy applications.

In 2014, Professor Chakrabarty joined the faculty at Washington University in St. Louis. He operates the Aerosol Physics and Technology laboratory (APT Lab). From 2011 to summer 2014, he served as an assistant research professor at the University of Nevada-Reno/Desert Research Institute. He currently serves as the American Association for Aerosol Research (AAAR) Chair of the Aerosol Physics working group.
The Interface Research Group led by Elijah Thimsen focuses on advanced gas-phase synthesis methods that operate very far away from local equilibrium, for example low temperature plasma. Such methods are capable of creating beyond equilibrium materials, which represent one of the greatest opportunities for synthesis science. Examples of applications currently being pursued in the Interface Research Group are: advanced lightweight aerospace composite materials, optoelectronic semiconductor nanostructures, analog low power artificial intelligence, and high energy density fuel synthesis from renewable resources.

Jay Turner’s research primarily focuses on air quality characterization and management with emphasis on field measurements and data analysis to support a variety of applications in the atmospheric science, regulation and policy, and health studies arenas. His current and recent research has been funded by the National Institutes of Health, United States Environmental Protection Agency, Airport Cooperative Research Program of the Transportation Research Board, and ConocoPhillips.

He currently serves on the United States Environmental Protection Agency (EPA) chartered Science Advisory Board (SAB) and chairs the Science and Technological Achievement Awards (STAA) Committee of the EPA’s SAB.

The broad theme of Jian Wang’s research is to understand key processes that drive the properties, distribution, and evolution of aerosols, and to elucidate and quantify the effects of atmospheric aerosols on radiation, clouds, climate, and air quality. The approach consists of developing cutting-edge instruments and deploying of these instruments in field observations focusing on regions where aerosols have major impacts on climate system and air quality.

Wang also is director of the Center for Aerosol Science & Engineering. Wang served as a member of the steering committee of Department of Energy’s Atmospheric System Research Program (ASR) and co-chair of the ASR Aerosol Lifecycle Working Group from 2009 to 2016. At Brookhaven National Laboratory, Wang was a Goldhaber Distinguished Fellow from 2002 to 2005. He led several field campaigns, focusing recently on aerosols and clouds in the Amazon Basin and the Eastern North Atlantic. Wang received the Kenneth T. Whitby award from American Association for Aerosol Research in 2013.

Brent Williams’ research interests focus on the exploration of the composition, chemistry and physical properties of Earth’s atmosphere to determine the role of biogenic and anthropogenic gases and particles in Earth’s climate system and their impact on human health. Recent work also incorporates the chemistry of indoor environments. Current projects include the study of particle formation from biomass combustion, secondary particle formation from photochemical aging, indoor/outdoor pollutant exchange, and novel instrumentation development.
Faculty

Aquatic Processes

Water quality in natural and engineering aquatic systems is governed by chemical, physical and biological processes. Engineered aquatic processes have applications in water and wastewater treatment, contaminated site remediation, waste-to-energy technologies and environmental restoration.

Young-Shin Jun
Professor & Director of Graduate Studies
PhD, Harvard University, 2005
SM, Harvard University, 2003
MS, Ewha Womans University, 1999
BS, Ewha Womans University, 1997

Young-Shin Jun’s research is highly interdisciplinary: Her group’s expertise includes environmental chemistry and engineering, geochemistry, nanochemistry, materials chemistry and engineering, surface chemistry, and chemical engineering. Their work investigates energy-related subsurface engineering systems, including geologic CO2 sequestration, conventional and unconventional oil and gas recovery, hydrothermal energy, and nuclear waste disposal. Based on a scientific understanding of nanoscale interfacial chemistry and solid nucleation, they seek new treatment techniques and new catalysts for purifying drinking water and remediating contaminated water and soil, benefiting water reuse, managed aquifer recharge, and membrane processes (reverse osmosis membranes and ultrafiltration). In addition, her group studies biomineralization and bio-inspired chemistry to develop novel materials for a more sustainable environment.

Fangqiong Ling
Assistant Professor
PhD, University of Illinois at Urbana-Champaign, 2016
MS, University of Illinois at Urbana-Champaign, 2011
BS, Tsinghua University, 2008

Fangqiong Ling leads a computational and experimental lab to study bacterial colonization and transmission at the boundary of built and natural environments. She explores microbiomes as environmental sensors and public health sentinels. Her research employs genomics, machine learning and theory. The lab’s ultimate goal is to discover the principles underlying the diversity, functioning and resilience of microbial ecosystems and develop tools to enable ecologically aware designs. Current research topics and interests include:

- Assembly, structure and dynamics of bacterial communities in tap water and water supply networks
- Biodiversity and ecosystem functioning in biofuel production processes
- Development of population matrices based on personal microbiome data
- Development of tools to tackle hospital-acquired infections

Dan Giammar’s research focuses on chemical reactions that affect the fate and transport of heavy metals, radionuclides, and other inorganic constituents in natural and engineered aquatic systems. He is particularly interested in reactions occurring at solid-water interfaces. His recent work investigated the removal of arsenic and chromium from drinking water, control of the corrosion of lead pipes, geologic carbon sequestration, and biogeochemical processes for remediation of uranium-contaminated sites.

Giammar is an environmental engineer with active educational and research programs. He teaches courses on environmental engineering and water quality. His current and recent research has been sponsored by the National Science Foundation, Department of Energy, and Water Research Foundation.

Daniel Giammar
Walter E. Browne Professor of Environmental Engineering
PhD, California Institute of Technology, 2001
MS, California Institute of Technology, 1998
BS, Carnegie Mellon University, 1996

Dan Giammar's research focuses on chemical reactions that affect the fate and transport of heavy metals, radionuclides, and other inorganic constituents in natural and engineered aquatic systems. He is particularly interested in reactions occurring at solid-water interfaces. His recent work investigated the removal of arsenic and chromium from drinking water, control of the corrosion of lead pipes, geologic carbon sequestration, and biogeochemical processes for remediation of uranium-contaminated sites.

Giammar is an environmental engineer with active educational and research programs. He teaches courses on environmental engineering and water quality. His current and recent research has been sponsored by the National Science Foundation, Department of Energy, and Water Research Foundation.
Cleaning chromium from drinking water

An engineer at WashU has found a new way to convert the dangerous chromium-6 into common chromium-3 in drinking water, making it safer for human consumption.

“The health effects are quite well-known. It’s very potent as an inhaled contaminant, but in drinking water chromium-6 definitely has a negative impact on human health,” said Daniel Giammar, the Walter E. Browne Professor of Environmental Engineering.

Scientists have previously converted chromium-6 to chromium-3 in a chemical process using iron. During the course of the new research, recently published in the journal *Environmental Science & Technology*, Giammar and his team took a novel approach, using electricity to do the job.

“Electrocoagulation is the particular approach we used to introduce iron into the water,” Giammar said. “Typically, you would use an iron salt and physically add a dose to the water. Electrocoagulation uses two pieces of iron metal in the water, you apply a voltage between them, and that is how you dose iron into the water and convert the chromium-6.”

Electrocoagulation systems are widely available, and Giammar finds using electricity as opposed to chemical alteration is an easier, more precise and scalable process.

Experiment designed by WashU engineer launched on SpaceX

An experiment designed by an engineering team at Washington University in St. Louis soon will be performed in space.

The experiment, called Flame Design, was on board a SpaceX Dragon rocket that launched into orbit June 3 and arrived at the International Space Station (ISS) two days later. Scientists there will conduct the experiment in 2019 and 2020. Flame Design is part of NASA’s Advanced Combustion via Microgravity Experiments (ACME) project. ACME is a suite of experiments that will be performed in the Combustion Integrated Rack onboard the ISS.

Richard Axelbaum, the Jens Professor of Environmental Engineering Science, is the principal investigator of the project. Flame Design seeks to improve our fundamental understanding of the formation of soot — a major pollutant — and how it can be controlled. The findings will be useful for developing guiding principles behind designing flames that are both strong and soot free. The approach employed is relevant to oxy-combustion technologies, which are being developed for mitigating greenhouse gas emissions from power plants through carbon capture and storage (CCS).

Additionally, Flame Design will allow ISS scientists to observe flames in zero gravity, a phenomenon that’s virtually impossible to study on Earth.
Faculty

Metabolic Engineering & Systems Biology

Metabolic engineering is used to better understand and use cellular pathways for chemical transformation, energy transduction and molecular assembly. This can explain the holistic functioning between, for example, gene and protein networks and metabolic pathways, system biology and mathematical and computer simulation for useful research methodologies.

Marcus Foston
Assistant Professor
PhD, Georgia Institute of Technology, 2008
BS, Georgia Institute of Technology, 2003

Marcus Foston’s research program seeks to develop innovative and novel routes to exploit and utilize lignocellulosic biomass, taking advantage of materials involved in industries such as agriculture, papermaking, and forestry products. His primary research themes are:

» Sustainable conversion of biomass into chemicals using liquid-phase, heterogeneous catalysis.
» Interfacing the catalytic depolymerization of biomass with microbial utilization.
» Understanding how plant cell respond to mechanical stimulus

He is also faculty fellow in the NSF STC: Center for Engineering Mechanobiology. The center will train a new generation of scientists and engineers in the emerging discipline of mechanobiology, specifically, how to use mechanical force to engineer plant cell walls and how plant cell wall respond to mechanical force.

Tae Seok Moon
Associate Professor
PhD, Massachusetts Institute of Technology, 2009
MS, Seoul National University, 2000
BS, Seoul National University, 1998

Tae Seok Moon’s research goals are to construct programmable cells that are able to process multiple input signals and to produce desirable outputs to solve energy, environment, agriculture, and health problems. He has a broad background in systems and synthetic biology, with expertise in gene regulation as well as design and construction of synthetic metabolic pathways, biosensors, and complex genetic circuits. His current projects include (1) engineering probiotic bacteria for medical applications, (2) systems engineering of bacteria to enable production of fuels and chemicals from lignocellulose, (3) understanding biological robustness by building genetic sensors and complex circuits from the bottom-up, and (4) engineering predictable RNA regulators.

He is a recipient of an NSF CAREER award (2014) and an ONR Young Investigator award (2017).

Yinjie Tang
Professor
PhD, University of Washington, 2004
MS, Tianjin University, 1999
BS, Tianjin University, 1997

Yinjie Tang’s research involves two fields including the bioremediation of toxic compounds such as heavy metals and aromatic compounds and the analysis of cellular metabolic network using mass spectrometry based tools. His research provides important knowledge of cellular metabolic network for rational genetic engineering microbes of biofuel production.

In 2010, he earned a National Science Foundation CAREER Award: “Development of 13C-assisted Metabolic Flux Analysis Tools for Metabolic Engineering of Cyanobacteria.”
Fuzhong Zhang's research interests focus on developing synthetic biology approaches to produce advanced biofuels, chemicals, and materials from sustainable resources. Current research projects include: (1) developing dynamic regulatory systems for biosynthetic pathways; (2) engineering microbes to produce structure-defined biofuels and chemicals; (3) developing microbial factories for advanced materials; (4) engineering cyanobacteria for synthetic biology applications.

Zhang is a recipient of the 2013 DARPA Young Faculty Award, the 2013 ORAU Junior Faculty Award, the 2014 NSF CAREER Award, the 2015 AFOSR YIP Award, and the 2015 HFSP Young Investigators Award.
Faculty

Multiscale Engineering

The knowledge gained through our department’s multiscale engineering research extends to engineered systems for the production of chemicals, materials and other commodities. Efficient large-scale production of chemicals and fuels is the domain of heterogeneous catalytic processing and multiphase reaction engineering.

Bai’s research focuses on the development of next-generation batteries. The Battery Analytical Investigation (BAI) Group he leads adopts a combined theoretical and experimental approach to:

(i) probe the in situ electrochemical dynamics of miniature electrodes down to nanoscales;

(ii) capture the heterogeneous and stochastic nature of advanced electrodes to understand and optimize the macroscopic behavior; and

(iii) identify the theoretical pathways and boundaries for the rational design of materials, electrodes and batteries through physics-based mathematical modeling and simulation.

Knowledge and tools developed in the BAI Group also apply to and benefit the design of other electrochemical energy systems like supercapacitors and fuel cells.

Milorad Dudukovic

The Laura & William Jens Professor of Environmental Engineering

PhD, Illinois Institute of Technology, 1972
MS, Illinois Institute of Technology, 1970
BS, University of Belgrade, 1967

The main drive of Milorad (Mike) Dudukovic’s research remains advancing the frontiers of reaction engineering and effective use of reaction engineering methodology, including tracer methods, in multiphase systems in scale-up of bench-scale information to new environmentally clean processes for production of fuels, materials and chemicals. Unique features of his research involve use of radioisotopes to monitor and map various multiphase flows and enable validation of advanced models and theories in this complex field. He is working to establish a broad novel multiscale process engineering program in cooperation with industry.

John Gleaves

Associate Professor

PhD, University of Illinois, 1975
MS, University of Illinois, 1972
BS, University of Louisville, 1968

John Gleaves’ research group is interested in the application of kinetic investigations to catalysts. They investigate both real and model catalyst systems using a battery of analytical techniques.

His areas of expertise include heterogeneous selective oxidation and the development of novel transient response techniques to study gas-solid catalytic reactions. Gleaves is a co-inventor of the TAP reactor system and developed the commercial TAP reactor system, the TAP high-pressure reactor system, and is the inventor of the TAP-2 reactor system. There are currently 18 TAP reactor systems, designed and/or built by Gleaves operating in academic and industrial laboratories throughout the world.
Palghat Ramachandran’s research interests are in chemical reaction engineering, three phase catalytic reactors, mathematical modeling, semiconductor material processing, boundary element and integral equations, and reactor design for pollution prevention.

Vijay Ramani’s research interests lie at the confluence of electrochemical engineering, materials science and renewable and sustainable energy technologies. The National Science Foundation, Office of Naval Research, ARPA-E, and Department of Energy have funded his research, with mechanisms including an NSF CAREER Award (2009) and an ONR Young Investigator Award (2010).

Positively charged: Engineers win $2 million grant to design better batteries

Vijay Ramani, an expert in electrochemical engineering and renewable energy integration at WashU, has received a $2 million grant from the U.S. Department of Energy’s Advanced Research Projects Agency – Energy (ARPA-E) to create a new membrane that can be used in batteries for grid-scale electric energy storage.

Ramani’s team will use inexpensive commercial polymers to create the membrane for redox flow batteries, which are rechargeable batteries that store electricity in chemical solutions during charging and release electricity on demand while discharging. The layered membrane, which the team will make functional with a nanopowder, prevents the chemicals in the two sides of the battery from mixing, which would lead to a chemical short circuit, while enabling ions to flow effectively between the solutions. A key novelty is that this membrane would also allow for different chemical combinations to be used at each electrode of the battery, which increases versatility while lowering costs. Ramani’s lab will primarily investigate cerium, iron and chromium couples in their research.

One advantage of the redox flow battery is that energy and power are effectively decoupled, making them readily scalable. While the flow batteries are yet to be fully deployed at a commercial scale, they have multiple applications, said Ramani, the Roma B. and Raymond H. Wittcoff Professor and the director of the university’s Center for Solar Energy and Energy Storage, within which the project will be performed.
Undergraduate students
Bachelor of Science in Chemical Engineering

Chemical engineers are involved in the transfer of scientific discoveries to modern technologies and novel products that benefit society and minimize the impact on the environment. They deal with multiscale aspects of generating clean energy, producing novel and superior materials and using the biological revolution to manufacture new products. They are involved in developing and manufacturing consumer products, as well as in design, operation and control of processes in a variety of industries (e.g., petroleum, petrochemical, chemical, consumer products, food, feed and pharmaceuticals). Their broad training in basic sciences, coupled with a strong foundation in chemical engineering principles, makes them invaluable team members and leaders in any engineering enterprise. It also prepares them well for graduate studies in biochemical, biomedical, chemical, environmental, energy and materials engineering.

In addition, the ABET-accredited BS degree in chemical engineering is a great starting point for pursuing a degree in business, law or medicine. Undergraduate students can also minor in energy engineering, environmental engineering and nanoscale science & engineering.

Research & Independent Study

Undergraduates are encouraged to pursue laboratory or industrial research during the school year or summer break. Many Washington University faculty have research openings for students.

International Experience

Each year, students are selected for this program that will be guided by faculty from the Department of Energy, Environmental & Chemical Engineering. The highlight of the class is a summer visit to a city where partner schools of the McDonnell Academy are located. Students then register for the class in the following fall semester and engage in project discussions, presentations and report writing. This program will not only provide an international experience to the student but will also promote teamwork and leadership skill development.

- Beijing, China, 2008
- Seoul, Korea, 2009
- Mumbai, India, 2010
- Hong Kong, China, 2011
- Campinas, Brazil, 2012
- Brisbane, Australia, 2013
- Singapore, 2014
- Istanbul, Turkey, 2015
- Budapest, Hungary, 2016
- Bangkok, Thailand, 2017
- Taipei, Taiwan, 2018
- New Delhi, India, 2019

engineering.wustl.edu/studyabroad
Graduate students

A key objective of the doctoral program is to promote cutting-edge multidisciplinary research and education in the thematic areas of energy, environmental & chemical engineering. The doctoral student collaborates with his or her adviser in designing a program of study and research. Students are admitted to the program by a competitive process, and they typically start in the fall semester. The doctoral program requires 36 units of course work and 36 units of research.

The Master of Engineering in energy, environmental & chemical engineering is a coursework-based master’s program requiring 30 credits. A full-time student could complete the degree program in 12 months. Part-time students will require a longer duration. The curriculum is geared to enhance skill sets for practice in industry. Courses required for this program will provide a broader background in project management, business, leadership and entrepreneurship. Students can choose a set of electives to obtain certificates in specialized tracks.

The Department of Energy, Environmental & Chemical Engineering (EECE) along with the Olin School of Business launched a new dual degree program — MEng and MBA. The program was initiated due to the rapidly growing interest in the intersection between the Engineering and Business schools’ approaches to the issues of sustainability, energy, the environment and corporate social responsibility. An interdisciplinary approach will be adopted to approach these issues with effective, innovative and critical thinking leading to solutions that are effective and impactful. The dual-degree program capitalizes on two programs that are well positioned to help address this critical intersection.

“The fact that WashU is the first university in the world to create a highly specialized and interdisciplinary Department of Energy, Environmental & Chemical Engineering speaks volumes about the university’s strategic plan for the future of our world.”

— Adewale Adeosun

HOMETOWN Eruwa, Nigeria

RESEARCH Combustion numerical and experimental study of pressurized oxy-combustion processes for clean coal utilization

85 PhD students

34 Master’s students
Graduate degrees offered

» Master of Engineering (MEng) in energy, environmental & chemical engineering
» Master of Science (MS) in energy, environmental & chemical engineering
» Doctor of Philosophy (PhD) in energy, environmental & chemical engineering
» Combined MEng/MBA (given jointly with the Olin Business School)
Alumni

Melissa L. Holtmeyer, PhD
AAAS Science and Technology Policy Fellow, U.S. Department of Defense
Melissa Holtmeyer has helped to shape the direction of national science and technology policy through her opportunities as an American Association for the Advancement of Science (AAAS) Science and Technology policy fellow in both the U.S. Senate and the U.S. Department of Defense, where she is currently performing the duties of the deputy director for energy security in the Office of the Secretary of Defense.

Using her engineering background, she advised senators and congressional staffers on energy, environment and climate change legislation. At the DoD, she is helping to develop plans to reduce military fuel use, ensure secure fuel supplies for global operations and provide technical expertise on next-generation DoD technologies to military leaders.

While her research background in fundamental combustion has been surprisingly drawn upon many times, her communication and writing skills, approach to solving problems and ability to understand highly technical topics have all been valued assets and very respected by high-level leaders.

Bruce Rittmann, PhD
Professor, School of Sustainable Engineering and Built Environment, Arizona State University and member of the National Academy of Engineering
An international leader in the study of microbiological systems, Bruce Rittmann leads research teams that combine engineering with microbiology, biochemistry and geochemistry to address fundamental and applied issues in the treatment of wastewater, bioremediation of contaminated environments and production of renewable energy. A member of the National Academy of Engineering, Rittmann is known for pioneering the development of the Membrane Biofilm Reactor, which uses naturally occurring microorganisms to remove contaminants from water.

Rittmann is an inventor on nine patents, is a fellow of the American Association for the Advancement of Science, a recipient of the Clarke Prize for Outstanding Achievement in Water Science and Technology, and a winner of the Huber Research Prize from the American Society of Civil Engineers. He has published more than 550 peer-reviewed papers and is one of the world’s most highly cited researchers. He is a recipient of the 2018 Stockholm Water Prize.

Select companies where our alumni work:
- Abengoa
- Anheuser-Busch InBev
- Applied Materials
- The Boeing Co.
- Boston Scientific
- Burns & McDonnell
- Cabot Corp.
- Capital One
- Chevron Corp.
- ConAgra Foods
- Corning Corp.
- Dow Chemical Co.
- DuPont
- Emerson
- Environmental Quality Management Inc.
- ExxonMobil Corp.
- Genentech Inc.
- General Mills Inc.
- The L’Oreal Group
- Jacobs
- MIT Lincoln Laboratory
- Monsanto Corp.
- Nestlé Purina
- PetCare Co.
- National Corn-to-Ethanol Research Center
- Peace Corps
- POET Energy
- Pfizer Inc.
- Phillips 66
- Procter & Gamble
- Sigma-Aldrich Corp.
- Solae LLC

$70,222
Reported starting salaries for recent WashU chemical engineering Bachelor of Science graduates

$68,455
National average
Living in St. Louis

Centrally located, the WashU campus offers myriad opportunities for enrichment and exploration. St. Louis has also developed into a national hub for important research and business development, especially in the fields of biotechnology and plant science.

Consistently ranked among the nation’s most affordable and best places to live and raise families, the St. Louis region offers many opportunities to watch or participate in a wide range of sports, recreational activities and cultural events.

Adjacent to campus is Forest Park, one of the largest urban parks in the nation at approximately 1,400 acres. In addition to space for tennis, golf, baseball, skating, jogging, rollerblading, bicycling, boating and more, Forest Park includes several of St. Louis’ cultural institutions, including the zoo, science center, art museum, history museum (all with free admission) and the nation’s largest and oldest outdoor theater — The Muny.

Make St. Louis your home

NEIGHBORHOODS

» Central West End
» Clayton
» Forest Park
» University City (The Loop)
Realizing the need for new research laboratories and specialized facilities that would support the school’s intellectual vision and plans, Chancellor Mark Wrighton committed the site at the northeast corner of WashU’s Danforth Campus for the School of Engineering & Applied Science. In 2007, the school developed a master plan for a new engineering complex that would complement and connect to the existing Uncas A. Whitaker Hall for Biomedical Engineering. The proposed, approximately 700,000-square-foot complex would provide modern research and instructional facilities equipped with state-of-the-art technology needed to enable collaboration across disciplines.

The Stephen F. & Camilla T. Brauer Hall is the home of Energy, Environmental & Chemical Engineering with additional laboratory space in Preston M. Green Hall. Each of these state-of-the-art teaching and research facilities contains modular office, laboratory and teaching complexes of various sizes. The flexible design of each building also easily accommodates different types of research and the requisite infrastructure, such as specialized imaging equipment, scanning and transmission electron microscopes, and high-speed, high-capacity computing clusters.

**Facilities**

**Stephen F. & Camilla T. Brauer Hall**

Brauer Hall opened in June 2010 with approximately 151,000 square feet of space for the Department of Energy, Environmental & Chemical Engineering and the Department of Biomedical Engineering.

**Preston M. Green Hall**

Green Hall opened in August 2011 with approximately 84,000 square feet of space for the Department of Electrical & Systems Engineering and the Department of Energy, Environmental & Chemical Engineering.
School of Engineering & Applied Science

As an engineering school, we aspire to discover the unknown, educate students and serve society. Our strategy focuses intellectual efforts through a new convergence paradigm and builds on strengths, particularly as applied to medicine and health, energy and environment, and security. Through innovative partnerships with academic and industry partners — across disciplines and across the world — we will contribute to solving the greatest global challenges of the 21st century.