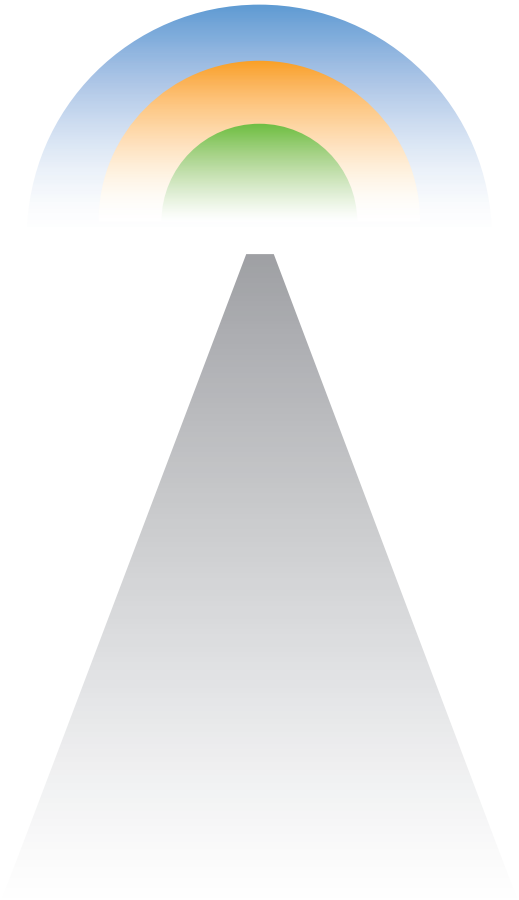


Creating a Pathway to Sustainability

WANGER INSTITUTE FOR SUSTAINABLE ENERGY RESEARCH
[WISER]

ILLINOIS INSTITUTE OF TECHNOLOGY

Creating a Pathway to Sustainability

IIT Wanger Institute for Sustainable Energy Research

Table of Contents

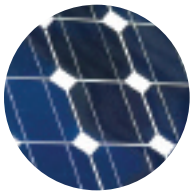
Energy and Sustainability Educational and Research Activities at IIT

IIT's foray into the energy arena can be traced to the 1940s, when IIT first developed a formal affiliation with the Institute of Gas Technology (IGT), establishing the gas engineering graduate program and launching energy-related research between the two entities. This arrangement continued until 1985, when IGT phased out its gas engineering program and, at the same time, the Gas Research Institute, under the direction of Henry Linden, provided funding to the IIT Department of Chemical Engineering to attract new faculty to energy-related areas. Hamid Arastoopour was the faculty member hired by IIT to establish the Energy Technology education and research program. As part of this program, a specialization (minor) in energy technology at the undergraduate level and an energy research program focus were launched. An industrial membership program was also established to attract funding to support student scholarships at the undergraduate and Ph.D. levels. In addition, funds were raised to establish the Max McGraw Endowed Professorship in Energy and Power Engineering and Management, occupied by Linden.

Hamid Arastoopour
Max McGraw Professor of Energy, Environment, and Economics

During the 1990s, the scope of the Energy Technology Program was broadened and renamed the Energy, Environment, and Economics (E^3) program. During this time, educational specializations in E^3 at both the graduate and undergraduate levels, and a Master of Environmental Management degree (a collaborative program between IIT Stuart School of Business and the Department of Chemical and Environmental Engineering) were launched. In addition, funds were raised for two endowed chair professorships, namely, the Linden Chair and the Max McGraw Chair in Energy, Environment, and Economics, occupied by Arastoopour. Several clusters of excellence in research—including the Energy + Power Center, the Electric Power and Power Electronics Center, the Center for Electrochemical Science and Engineering, and the environmental engineering research focus—were also established.

In response to national need, in 2004 IIT took a leadership role in establishing the Energy and Sustainability Institute (ESI), building on the university's reputation for more than six decades as a leader in energy research and education. ESI activities were significantly expanded beyond engineering and science to include strong participation with IIT College of Architecture and Stuart School of Business as well as involvement of faculty from law, design, and psychology.

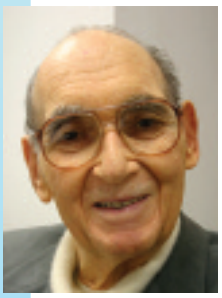


In 2007, IIT benefactor and trustee Ralph Wanger provided funding to further enhance the scope of energy and sustainability research activities at IIT, formerly under the auspices of ESI, under the renamed Wanger Institute for Sustainable Energy Research. This funding will provide needed infrastructure support as well as seed-research grants for faculty and initial graduate scholarships to attract the brightest and most creative Ph.D. students to WISER. This funding will also allow IIT to assume a leadership position as we face significant future challenges to the security of our national energy supply and the sustainability of our natural resources.

WISER is positioned to make key contributions to the advancement of national and global energy and sustainability education, research, development, economic, and policy issues.

Henry Linden:

IIT's Sustainable Energy Architect



Henry R. Linden
Max McGraw Professor of Energy and Power Engineering and Management
Director, IIT Energy and Power Center

Known in many circles as the "energy czar," Henry Linden has spent his more than 60-year chemical engineering career researching, developing, and implementing sustainable global energy technology. A recognized expert in national and international energy economics and policy, Linden holds 27 patents in energy supply, utilization, and petrochemical technologies, and is author or co-author of more than 240 published journal articles, papers, book chapters, and congressional testimony. He has been widely acclaimed for his contributions to the energy field, and is a member of the National Academy of Engineering and a fellow of both the American Chemical Society and the American Association for the Advancement of Science.

"The Energy/Environment/Economics model gives students a totally different view. Energy is a good thing: this is such a simple concept. Like all beneficial input into human activities, it has to be done with concern that it doesn't create harm."

Linden began his longstanding affiliation with IIT as a Ph.D. candidate in chemical engineering, completing his doctorate in 1952 while working full time at the Institute of Gas Technology (IGT). There he would ascend the ranks for the next 30 years, holding numerous positions in research administration, culminating in his appointment as president and trustee. During all of his years at IGT, Linden simultaneously held a number of faculty appointments at IIT in chemical and gas engineering.

A visionary in the field, Linden set his sights on developing a much-needed research arm for the natural gas industry, and in 1977 secured federal approval and funding to establish the Gas Research Institute (GRI). As GRI president, Linden would oversee the planning and financing of a research program based on energy technology precepts, supplying sustainable energy sources and services to natural gas ratepayers at the lowest economic and environmental cost. During this time, he also served on numerous government advisory bodies from the Kennedy through the Clinton administrations, and held a presidential appointment during the Ford administration.

Professors Arastoopour and Linden in IIT's chemical engineering lab (circa 1987)

A lifetime devotee to engineering education, Linden provided funding from GRI to hire Hamid Arastoopour in 1985 to launch the Energy Technology Program in the IIT Department of Chemical Engineering. The goal of the program was to provide formal training for a new breed of engineers who not only understood engineering fundamentals, but also learned to account for the economic, social, and environmental factors that influence intelligent energy technology decisions. Linden joined Arastoopour as a full-time IIT faculty member upon his retirement from GRI in 1987, and was named Max McGraw Professor of Energy and Power Engineering and Management in 1990.

As an IIT faculty expert in energy economics and policy, Linden has brought the university to a leadership role in energy policy analysis and forecasting, focusing on issues such as decarbonization of energy systems; national strategies for bridging the carbon gap, including coal gasification processes as the transition step toward the long-term development of sustainable, climate-friendly energy technologies; and strategies and policies for long-term sustainability using high-tech renewables in a hydrogen-based economy.

The new millennium has seen escalated global concern for depleting energy resources, mounting threats to supply security, and increasing environmental vulnerability. Led by its very own sustainable energy architect, IIT is uniquely prepared to meet these challenges.

[WISER]

Mission

The mission of WISER is to continue to improve the quality of life in our nation while preserving our natural resources and the environment for future generations. Fulfillment of this mission will reduce our nation's dependence on foreign energy and, at the same time, provide our nation with sufficient affordable domestic sources of clean energy.

Goals

The goals of WISER are to:

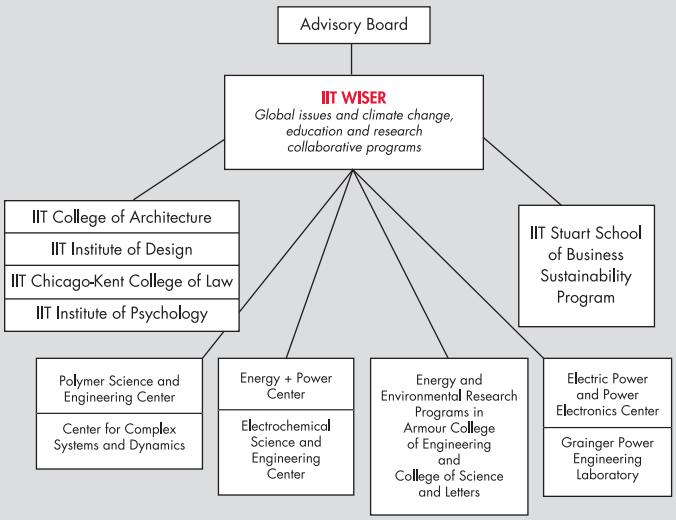
- Continue to develop state-of-the-art interdisciplinary education and research programs, and commercialize technologies in partnership with industry, national and research laboratories, and other universities
- Establish IIT as a national leader in energy and sustainability, complementing Chicago's emergence as a sustainable city

Strengths

As a university-wide initiative, WISER capitalizes on IIT's:

- International recognition in specific areas of energy production and efficiency, power, and environmentally related research and education
- Leadership role in energy policy and forecasting
- Original formulation of the Energy/Environment/Economics paradigm
- Current and emerging strengths across several disciplines: engineering, science, architecture, design, business, law, and psychology [see diagram]

Organizational Structure of the IIT Wanger Institute for Sustainable Energy Research [WISER]



Philosophy

The WISER approach to sustainability utilizes a least-cost strategy to:

- Provide reliable, secure, and affordable energy
- Improve energy efficiency and conservation
- Continue the ongoing decarbonization of the global energy system
- Minimize wastes and pollutants

WISER researchers believe that the endpoint of this evolution will be the electrification of most stationary energy uses with such high-tech renewables as photovoltaics, solar-thermal and wind energy, and the use of non-fossil hydrogen as the dominant transportation fuel.

In other words, sustainable energy systems must meet two criteria:

- The primary energy sources must be renewable or essentially inexhaustible.
- The system must cause no CO_2 emission or potentially harmful, dissipative material flows into the biosphere.

Activities

More than 35 faculty members are currently involved in energy and sustainability research and education initiatives from different colleges and institutes at IIT. In addition, different academic units offer courses and Interprofessional Projects (IPROs) in specific topics that attract numerous graduate and undergraduate students. WISER activities are grouped according to the following research areas of core competency:

- *Energy production:* clean coal, methane production from unconventional sources, biofuels, and renewable energy (hydrogen, fuel cells, and batteries)
- *Energy efficiency, conservation, and sustainability:* hybrid systems, optimum energy conversion, climate change, sustainable buildings, nuclear energy safety, water resources, air pollution, and rubber recycling
- *Power:* small hydro, power reliability, security, and grid design

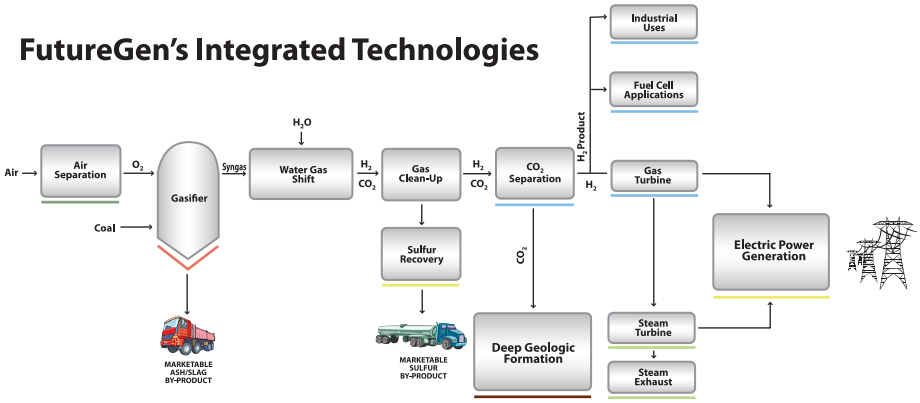
The broad array of current research and education programs in the WISER core competency areas are described in detail in the following section.

Energy Production

Guaranteeing secure, environmentally safe and economically feasible energy supply sources is of critical national and international interest. WISER's comprehensive strategy targets research, development, and education on energy supplies over the near and long terms. WISER near-term supply strategies include clean coal technology, methane from hydrates and tight sands formations, nuclear energy, and biofuels. The longer-term resource strategy includes renewable energy from solar, wind, and geothermal sources, and requires the use of hydrogen as an energy carrier and storage.

Clean Coal Technology

Coal-fired power plants currently account for more than 50 percent of the electricity used in the United States. It is anticipated that coal will continue to play a leading role in the total energy picture considering the unpredictability of petroleum supplies, recent volatility of petroleum and natural gas prices, and unavailability of alternative large-scale sources of energy. At the same time, global warming, which has been associated with the increasing concentration of greenhouse gases, mainly carbon dioxide (CO_2), has emerged as one of the key environmental issues in the twenty-first century. IIT has been involved in a number of fundamental research projects and several collaborative initiatives with the Gas Technology Institute during the last two decades in different areas of clean coal technology, including computational fluid dynamics (CFD) modeling and fluidized bed coal-gasification processes, hydrogen and methane production from coal, CO_2 separation, hot gas cleaning, and SO_x and NO_x removal.



Research Programs

The goal of this research program is to develop innovative, advanced design tools for gasification processes based on the CFD approach, produced hot gas cleaning, and novel sorbents for CO_2 removal and hydrogen separation.

Gasification of solid waste—including waste polymers, tires, biomass, and coal, along with CO_2 sequestration (including the FuturGen Project)—continues to play a critical role in the nation's sustainable energy program. During the energy crisis in the 1970s, gasifiers and fluidized bed combustors could not be designed in accordance with the first principles of transport phenomena due to a lack of understanding of gas-particle flow. IIT Department of Chemical and Biological Engineering (ChBE) professors Hamid Arastoopour and Dimitri Gidaspow positioned IIT as a leading university in this area, with research initiatives supported by the National Science Foundation, the United States Department of Energy (DOE), and industry. They received five national awards from the American Institute of Chemical Engineering for this pioneering research. Arastoopour and his research team developed a mathematical model for multi-size particle flow systems, which is being used in DOE's MFIX computer code for optimum design of coal gasification or other solid fuels conversion based on fluidized bed processes. In addition, they currently are using both CFD models with population balance equations to develop more realistic advanced design needed for more efficient and cost-effective gasification systems. This advanced design tool will be available for the design of FuturGen and mobile small-scale gasification processes.

Coal gas desulfurization and CO_2 removal at elevated temperatures and pressures has been recognized as crucial to efficient and economic coal utilization processes. Although H_2S and CO_2 can be removed from coal gas by commercially available technologies, such processes require expensive solvents and operate at low temperatures, imparting a severe energy penalty on the system. Professor Javad Abbasian and his team are conducting advanced research on coal gasification and high temperature gas cleaning, and have succeeded in developing highly reactive and attrition-resistant sorbents to capture sulfur compounds and CO_2 from coal gas.

Mechanical and Aerospace Engineering Professor Herek Clack is conducting research on the mitigation of toxic products of combustion, specifically mercury waste remediation from coal—part of a research effort that yielded him a National Science Foundation Career Award as one of our country's most promising researchers.

Production of Methane from Hydrates and Unconventional Sources

As energy prices increase, the cost of producing unconventional sources of natural gas is becoming less prohibitive. Unconventional natural gas supplies will play an increasing role in supplementing the nation's future natural gas supply. In collaboration with the Gas Technology Institute, IIT researchers are conducting research in the areas of natural gas production from unconventional sources—including methane hydrates and tight sand formations.

Natural gas hydrates are solid molecular compounds composed of water and a large amount of methane trapped in reservoirs. A less carbon-intensive fuel than other hydrocarbons, including oil or coal, natural gas hydrates occur in two zones: in permafrost and under the sea floor. According to DOE assessments, 1 percent of the methane trapped in hydrates is sufficient to provide 100 years of today's U.S. natural gas demand.

According to DOE assessments, 1 percent of the methane trapped in hydrates is sufficient to provide 100 years of today's U.S. natural gas demand.

ChBE Professor Hamid Arastoopour and his research group are developing a mathematical model and simulation tools to predict the rate of attainable natural gas production from marine hydrate reserves and to evaluate the significance of methane hydrates in the future energy supply mix. Arastoopour's group also developed models for production of natural gas trapped in "tight," nearly impermeable formations, a resource that could yield, according to estimates reported in *Oil and Gas Journal 2007,* close to 254 trillion cubic feet of technically recoverable tight gas.

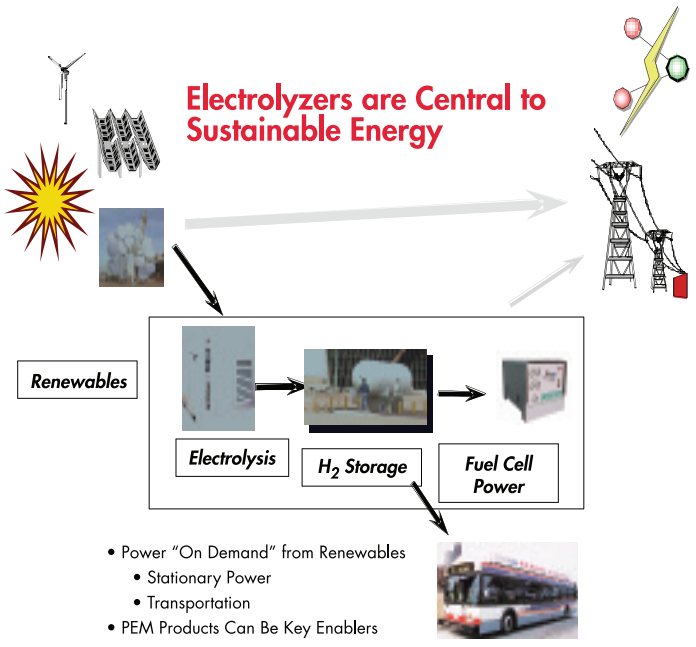
Biofuels

IIT researchers have been conducting collaborative research across the engineering and science disciplines on the production of biofuels, or agrofuels—fuels derived from biomass. Chemical engineering professors Fouad Teymour and Satish Parkulekar are exploring the design of efficient large-scale production of biomass for biofuel applications as well as fuels derived from agricultural products. Biology Professor Ben Stark is researching microorganisms that enhance fermentation and digestion of agricultural products.

Renewable Energy

Solar

WISER renewable energy projects are coordinated under the umbrella of the Energy + Power Center by Said Al-Hallaj, research associate professor of chemical and biological engineering and coordinator of the WISER Renewable Energy Program. Through major support from the State of Illinois, the City of Chicago, BP, ComEd, Proton Energy Systems, TurbodynamX, and the Illinois Clean Energy Foundation, several renewable energy-based demonstration projects are in progress at WISER. The focus of the solar-hydrogen hybrid demonstration project is the integration of photovoltaic, electrolyzer, a 250W polymer electrolyte membrane fuel cell, and a battery bank (as standby) to power a 400W (maximum) LED sign. Currently, conventional gas cylinders are being used to store the hydrogen produced at a pressure of 200 psi by the electrolyzer, to be used later as fuel. The main challenge for this project remains the same—better and safer technology for hydrogen storage.



J. Robert Selman

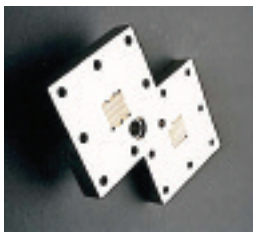
Fuel Cells and Batteries

IIT has a long history of leadership in the area of electrochemical science and engineering, and has been recognized for decades as one of the premier institutions in fuel cell and battery technology. A key event in this development was the establishment at IIT of the Army Research Office "Hub" for R&D in manufacturing advanced batteries and fuel cells (1994–2000). The Center for Electrochemical Science and Engineering (CESE) was established within the IIT Department of Chemical and Biological Engineering (ChBE) in 2000 to coordinate and continue the ongoing research and education programs in this area, directed by IIT Distinguished Professor of Chemical Engineering J. Robert Selman. Currently under the direction of ChBE Professor Jai Prakash, the mission of the CESE is to investigate new means of making these technologies more efficient and affordable.

Research in the area of rechargeable batteries is focused toward developing high-performance Li-ion and Li-polymer batteries for the hybrid electric and plug-in hybrid [described on page 9]. The overall research includes the development of high-performance electrodes, modeling of Li-ion cell reactions, and understanding of thermal runaway reactions. This work is funded by federal agencies, national laboratories, and increasingly, by private industries.

CESE researchers have an international reputation in research related to fuel cells, an electrochemical device in which fuel is oxidized electrochemically to produce electric power. Due to their high efficiency and negligible emissions of pollutants, fuel cells are becoming a viable energy source for transportation and consumer applications. The focus on the entire fuel cell system—a systems approach—is ultimately what sets IIT's research in this area apart from that at other institutions.

Fuel cell research concerns all current systems, including polymer hydrogen-oxygen, reformate, direct methanol, and solid oxide fuel cells. Research studies are directed toward the development of inexpensive and high-performance cathode and anode catalysts, carbon-monoxide tolerant anodes, methanol insensitive cathodes, and electrochemical modeling to optimize fuel cell performance. Prakash is focusing on the integration of batteries, fuel cells, and capacitors in renewable power/energy systems.



Most recently, Selman, Al-Hallaj, and their team of student researchers have focused on practical fabrication and design of electrolytes for solid oxide fuel cells. In March 2007, Selman, in collaboration with Al-Hallaj, was awarded a patent for an electrostatic spray deposition technique that makes electrodes thinner at the micro-level in high throughput applications. Combining this research with his interests in hybrid vehicles, Al-Hallaj is also working on a hybrid scooter that combines a battery with a fuel cell to operate with hydrogen fuel.

Hydrogen Storage

Hydrogen storage plays a critical role in the feasibility of future renewable energy technologies. Started in 2002, the hydrogen storage program at IIT focuses on the use of the various adsorption and absorption techniques, particularly sorption using carbon nanoparticles and activated carbon micro-sized particles, and storage of hydrogen in the form of hydrates.

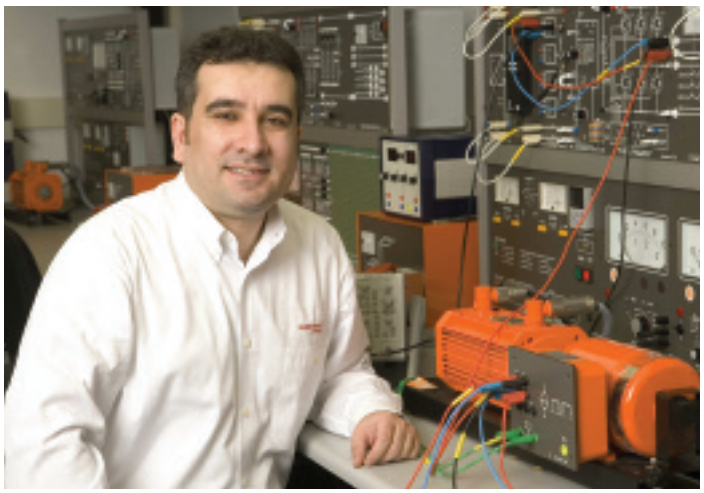
Energy Efficiency, Conversion, Conservation, and Sustainability

This area of research enables us to convert and use our available energy efficiently, and to simultaneously protect our environment and significantly reduce the depletion of our resources.

Hybrid Systems

There are more than 15 million fractional horsepower electric motors manufactured every day worldwide. In fact, more than 50 percent of the world's electricity is consumed by electric motors.

Professor Ali Emadi, director of IIT's Electric Power and Power Electronics Center, and his research team have developed a patented digital technological breakthrough in motor drive design and control that is extremely simple and far less expensive to implement than existing technology. This invention can transform standard household appliances into "smart," variable-speed appliances that can be controlled by a computer chip, making way for the development of a plethora of sophisticated new products at a much lower cost. The cost of moving "dumb" appliances to computerized technology is estimated to be about 10 times cheaper than existing technology—allowing the appliance industry to compete on innovative products.



Ali Emadi

In addition, Emadi has developed a state-of-the-art power electronics and motor drives teaching lab at IIT (Grainger Foundation Laboratories). He has established a solid research program focused on pioneering sustainable energy-efficient solutions from advanced electric machines to plug-in hybrid vehicles. A leader in electric-hybrid vehicular research, Emadi states, "The biggest challenge of our time is in the area of energy and power. Transportation is at the heart of this challenge, and electrification of vehicles is the best sustainable solution to move forward.

Professors Said Al-Hallaj and Ali Emadi are converting a hybrid Ford Escape SUV into a plug-in hybrid for the Chicago Department of Fleet Management.

We should increase the electrification level of propulsion systems as much as possible and move toward all-electric as quicklyas possible."

Hybrid-electric cars have been on the market for years and are steadily becoming a sought-after, high-tech commodity in showrooms. Although consumers can help the ecosystem by shopping for hybrid cars, the vehicles in most driveways are not the only environmental offenders that can be improved by hybrid technology.

Public transit, military vehicles, and private transportation providers account for a sizeable portion of the world's fossil fuel use and pollution. By conducting research including retrofitting military vehicles with electric hybrid systems and hybridizing transit and school buses, IIT is transforming some less glamorous "working" vehicles that are in desperate need of change.

Emadi believes plug-in hybrid technology is the best practical solution to move forward. His proposed long-term sustainable solution includes: (1) integrating the transportation industry with the electric power industry, (2) using electricity as the carrier, and (3) generating electricity from renewable energy sources such as solar, wind, hydro, etc.

His groundbreaking research in hybrid/plug-in hybrid electric systems is two-fold, including an adaptive controller, i.e., "brain" of the vehicle, which is optimized in real-time, a process that improves the fuel economy drastically, without sacrificing performance. The second facet of the research is the creation of unique integrated electro-mechanical drive trains.

Under the direction of Emadi, IIT's Formula Hybrid Racing Team placed among the top finishers in the 2007 Formula Hybrid student automotive design competition (sponsored by the Society of Automotive Engineers and the Institute of Electrical and Electronics Engineers).

Sustainable Buildings
(Integrated Photovoltaics and Wind)

As global concern and competition intensifies over diminishing fossil fuels reserves, the need to conserve energy, develop renewable resources, and design more efficient ways to build increases. IIT is combining its recognized expertise in the architecture of high-rise and wide-span sustainable buildings with wind turbines and its patented HoloSun™ solar window technology to design sustainable buildings that represent highly innovative configuration and structural and energy concepts.

Peter Land

Professor of Architecture Peter Land is conducting an extensive research program in collaboration with IIT Armour College of Engineering to develop innovative, sustainable high-rise buildings that utilize energy and structural concepts that actually produce energy, utilizing renewable resources such as wind, sun, and geothermal. The main idea underlying the work is to shape a single tall building or a complex so that it performs new functions that accommodate, changing economic and cultural reality. Land and his research group are designing a built environment that is ultra-efficient in its use and conservation of energy, and that incorporates new technologies, materials, and structures that enable a building to generate the energy it requires for its own operation and, in some cases, for export. The team has recently developed a unique high-rise and wide-span structure equipped with wind turbines—the concept for which is being further developed by Mechanical, Materials, and Aerospace Engineering Professor Dietmar Rempfer using a computational fluid dynamics approach.

Building-integrated photovoltaics (BIPV) integrate PV material with the building component skin to create a unique product—a building component with PV functionality. The total integration is realized when the building component and PV element cannot be dissociated. An increasingly popular BIPV application is that of solar windows comprised of glass embedded with PV cells. These windows generate electricity for use in the building, reducing the owner's utility costs and dramatically increasing the energy efficiency of the structures. Said Al Hallaj, chemical and biological engineering research professor, and his team have developed the proprietary flat-panel solar concentrator technology called HoloSun™ for electricity-generating solar windows, skylights, and window walls.

Quadruple tower with middle, yaw-able wind turbines for electrical generation and alternative evacuation routes

Innovative Recycling Solutions

Used tires represent one of the major solid waste streams in every state of our nation. Recycling these tires in a manner that is economically feasible and environmentally acceptable remains a continuous challenge.

Under the direction of Professor Hamid Arastoopour, IIT researchers have developed a novel rubber recycling technology that consists of two processes.

Solid State Shear Extrusion Pulverization
This process produces rubber powders at ambient temperatures and, at the same time, partially devulcanizes the rubber particles without the use of chemicals. This process is expected not only to be more economical than the cryogenic process, but also to provide manufactured recycled rubber products with properties similar to the original rubber.

Interpenetrating Polymer Network (IPN)
IIT's patented rubber modification process, developed by Arastoopour and Chemical and Biological Engineering Professor Fouad Teymour, adds hydrophilic character to rubber particles, making them usable as coating or mixed with soil to significantly reduce water consumption for irrigation.

Indoor Air Quality

Civil, Architectural, and Environmental Engineering (CAEE) Professor Dimitrios Moschandreas identified a strong association between student health symptoms and in-class indoor air quality. Additionally, using only occupant symptoms, the IIT-developed Indoor Environmental Index provides an externally validated metric of in-office environmental quality. CAEE Professor Ahmed Megri is also conducting studies in comfort and indoor air quality.

Power

This area of research enables us to deliver reliable electricity to consumers. The areas of research include grid design, grid to vehicle, power reliability and security, and small hydropower systems.

Lighting the Way to Perfect Power

At least once each year, Chicago residents are inevitably stuck at work or home during a power outage, waiting for their world to light up again. In many cities, due to extreme summer and winter temperatures, blackouts can be more than an inconvenience; they can be deadly.

Imagine a power system so intelligent and sustainable that entire cities can mitigate outages during the harshest weather, terrorist attacks, or natural disasters. This system is coming to life with the help of Illinois Institute of Technology and researchers from across the country. WISER has teamed up with the Galvin Electricity Initiative to convert IIT Main Campus into a living laboratory and one of the first "Perfect Power" prototypes in the United States.

Mohammad Shahidehpour

The Galvin family, famous for founding Motorola, Inc., formed the not-for-profit Galvin Electricity Initiative to fund research to create an interactive power system, most simply described as a smart electrical distribution network. With the help of more than 60 independent experts who specialize in power system design, technology, and the environment, Department of Electrical and Computer Engineering Chair Mohammad Shahidehpour and Professor Alex Flueck have been asked to completely re-imagine the U.S. electric power system and design a new system that will keep the lights on for millions of Americans under any circumstances.

Alex Flueck

On the surface, this seems like an uncomplicated task; however, the problems with the U.S. power system do not end at frequent outages. Over the course of the last hundred years, electricity has increased mankind's ecological footprint on the planet 100-fold. "While electricity has produced tremendous good over the past century, it has also inevitably created side effects, which must be resolved if we are to achieve a sustainable world," says Kurt Yeager, leader of the Galvin Electricity Initiative.

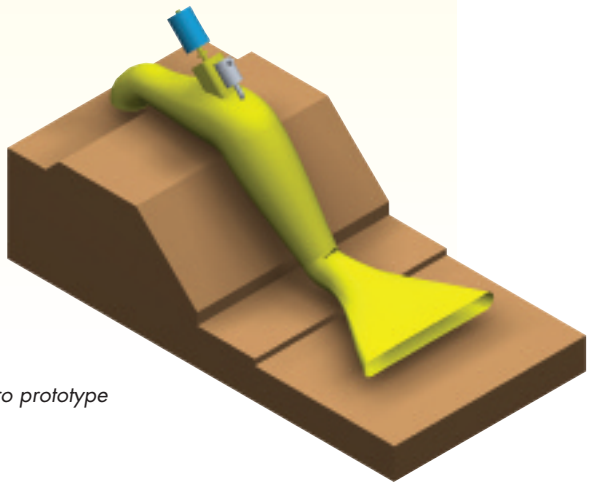
The Perfect Power system will provide an electricity-based platform to address an array of global energy issues, including the challenges of population, poverty, and pollution. The goal is to catalyze the necessary structural and cultural changes and to create an electricity system that never fails, under all conditions, to meet every consumer's expectations of an intelligent, independent, and flexible electricity system that provides optimal energy use and management in the least complex way.

With these goals driving the effort, the initiative and IIT are on the cusp of implementing the project. The team plans to create a sustainable long-term solution for powering the IIT community using the best possible integration of the Perfect Power system into IIT Main Campus's current infrastructure. The initiative's approach is to implement local microgrids, which will act as intelligent, consumer-driven capillaries fed from the existing electricity distribution arteries. Using this approach, the system can adapt to trends in electricity usage and change the supply accordingly, producing less waste. This intelligent power system fundamentally increases efficiency, reducing the need for fossil fuels and the resulting CO_2 emissions. The system can also incorporate much larger quantities of renewable solar-based energy without degrading reliability.

Recognizing the Potential of **Small Hydro**

Mohammad Shahidehpour, Bodine Professor and chair of the electrical and computer engineering department [right], and Mauricio Burgos-Lopez, ECE senior, recently received the T. Burke Hayes Prize Paper Award from the IEEE Power Engineering Society for their technical paper on the Fox River small hydro project. This award is given annually to one student in the nation and his/her adviser for an innovative project on renewable energy and sustainability.

The project stemmed from an Interprofessional Projects course in which students in several disciplines worked with IIT alumni Alex Tseng and Carl Spetzler and Shahidehpour to design prototypes of small hydroelectric plants—including mechanical designs, economic analyses, and environmental assessments—and to identify potential implementation sites in Illinois. As undergraduate team leader for the small hydro project, Burgos-Lopez organized and presented the project technical report, which demonstrated the advantages of implementing small hydro plants at two existing dams on the Fox River in northern Illinois. Shahidehpour's plans for phase II of the project include the construction of a small hydro prototype in the ECE department lobby [see schematic].



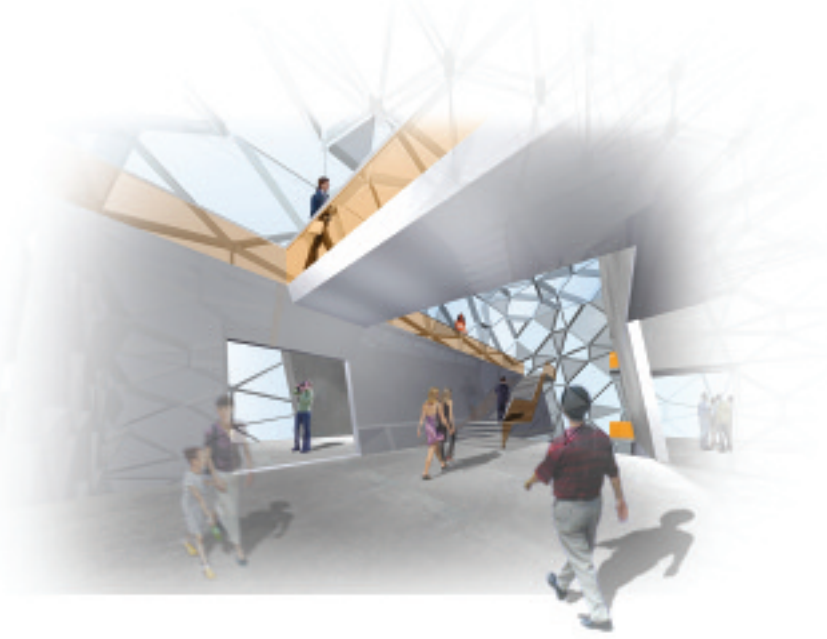
Initial design for small hydro prototype

WISER Outreach and Education Programs

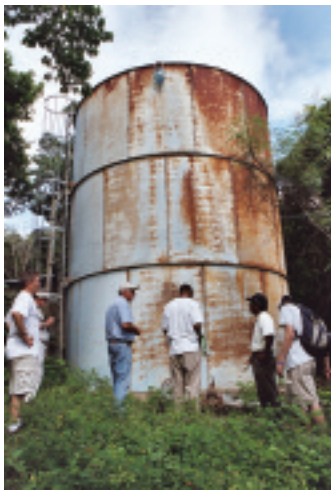
House of the Future Project Demonstrates IIT Vision

In spring 2005, the Energy and Sustainability Institute (ESI) began the first phase of the House of the Future project—a living laboratory that will integrate clean energy, new materials, appliances, and products with the latest technologies to achieve sustainable design and functionality. The House of the Future will not only serve as a major research and development facility, but also will demonstrate IIT's vision of the energy future by attracting the most creative and brightest young minds to this area of critical national importance.

This demonstration facility will also provide a showplace for K–12 students to increase their interest in science and engineering, especially in the area of energy and sustainability.



Hamid Arastoopour, Max McGraw Professor, and Chemical and Biological Engineering Professor Said Al-Hallaj received startup funding for the initial design of the House of the Future from the Tellabs Foundation. Based on Interprofessional Projects-developed student designs, in fall 2007 Behnisch Architects proposed a design that allows a minimal amount of building equipment that supplements the building's natural operation. The House of the Future utilizes strategies and equipment that complement the intent of the structure and local climate [see schematics]. IIT faculty are working with the IIT facilities department to incorporate the project as part of the McCormick Student Village renovation and expansion.



Engineering a Clean Water Supply in Haiti

Under the direction of Civil and Environmental Engineering Professor Krishna Pagilla, IIT undergraduate and graduate students are developing a clean water distribution system for the people of Pignon, Haiti—a small town of roughly 10,000 residents in the poorest country in the western hemisphere. Currently served by an outdated water supply and distribution system, only about 200 households in the area are supplied with contaminated water for approximately two hours every five days. The far-reaching scope of the project has provided the focus of two IIT Interprofessional Projects to date and has incorporated the work of 10 multidisciplinary engineering undergraduate students.

Led by Pagilla, environmental engineering graduate student Alexandre Miot, and IIT Vice President David Baker, the team has now taken five trips to Haiti, sponsored by IIT, Haiti Outreach, the local Rotary Club, and the United States Environmental Protection Agency. The first trip had an objective to explore the creation of education-oriented projects that would benefit the Haitian community. Overwhelmed by the poor living conditions that they encountered on their arrival, the IIT team dedicated its efforts to creating sustainable change in Haiti and established the first Haiti Outreach Student Chapter at IIT. As the umbrella organization for all campus groups with an interest in Haitian development, Haiti Outreach–IIT currently manages three large-scale projects to provide clean water access, sanitation, education, and infrastructure to the impoverished area. Campus groups currently collaborating with Haiti Outreach–IIT include the Water Environment Federation, Architecture That Matters, and the American Society of Civil Engineers; in the future, it will incorporate Engineers Without Borders.

[From left] Alexandre Miot, Krishna Pagilla, and Haiti team members

Community Outreach

The IIT Office of Community Affairs and Outreach Programs (OCAOP) is partnering with WISER to conduct community outreach and educational services for underserved and distressed communities. Specifically, IIT's OCAOP will assist WISER faculty in providing and facilitating seminars, community outreach, and educational opportunities that advance public understanding and generate community discourse on energy and environmental issues, problems, concerns, and solutions and options within underserved communities. Additionally, OCAOP will work with WISER to develop relationships, partnerships, and strategic alliances with both public- and private-sector entities, as well as with other universities and governmental agencies, for the resolution of pertinent energy and environmental concerns for underserved communities.

Javad Abbasian
Energy/Environment/
Economics (E^3)
Faculty Director

Education Programs

IIT's Energy/Environment/Economics (E^3) program was developed to provide the interdisciplinary research and training required to produce a new breed of engineer—one who specializes in energy technologies and who understands the associated environmental issues and economic forces that drive technology choice.

E^3 is designed primarily for students who are planning careers in energy-related fields. This interdisciplinary training prepares students to possess a broad knowledge base of different energy sources, environmental issues related to energy production, conversion and utilization, and of the impact of industrial ecology principles on the design and operation of energy systems. Furthermore, students gain sufficient knowledge of economic and regulatory issues to enable them to make more viable technology choices. The E^3 specialization is offered as a program of study within the M.S., Master of Engineering (Professional Master), and Ph.D. programs.

Undergraduate Programs Offered with E^3 Specialized Minor

E^3 is also available as an undergraduate specialization and requires students to take 15 credit hours in courses from interdisciplinary curricula, including Energy, Environment, and Economics (ChE 543), and courses in Energy Production, Conversion, Utilization and Distribution, Energy and Environmental Systems Analysis, and Special Problems.

Gas Engineering Program

IIT Armour College of Engineering, in collaboration with the Gas Technology Institute (GTI), the nation's premier industry-led natural gas education and R&D organization, launched several research collaborative programs and an online professional master's program in fall 2003. Capitalizing on its strength in gas and energy engineering, IIT and GTI have combined forces to develop unique, state-of-the-art joint research activities in areas related to gas production and gasification, as well as an Internet-based program customized to meet the changing needs of today's professional engineers.

This flexible master's program, which is a unique blend of IIT's expertise in graduate education and GTI's proven practical knowledge and experience in natural gas technologies and applications, provides a solid foundation on which today's students and professionals can advance their careers. The program includes options for those interested in furthering their education without completing a full degree, including a three-course Certificate Program in Current Energy Issues. All of the courses offered as part of this program can be taken individually for graduate credit.

ILLINOIS INSTITUTE OF TECHNOLOGY

Contact

Hamid Arastoopour
Max McGraw Professor of Energy, Environment, and Economics
220 Engineering 1 Building
10 W. 32nd St.
Chicago, IL 60616
312.567.3038

arastoopour@iit.edu