

ICPE - INTERDISC CURR PRG ENERGY

ICPE 601 Environmental Issues of Energy Systems

Credit 1.5. 1.5 Lecture Hour. Introduction to energy-related engineering principles and energy conservation efficiency; basic processes and chemicals/materials used in the current and emerging energy systems; impact on the environment; approaches for minimizing contaminants released by usage of energy sources. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 602 Reservoir Characterization and Modeling

Credit 1.5. 1.5 Lecture Hour. Application of geostatistical techniques to build reservoir models through integration of geological core/well log, seismic and production data to generate a consistent reservoir description; background and insights to geostatistical modeling techniques and situation where the application of geostatistics could add value. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 603 Bioenergy

Credit 1.5. 1.5 Lecture Hour. Introduction to the fundamentals of biomass (biochemistry and resources); basics of important processing technologies for the pre-treatment and conversion of biomass to useful products. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 604 Energy Systems Engineering I

Credit 1.5. 1.5 Lecture Hour. State-of-the-art topics for energy systems engineering including modelling of energy systems, mixed integer and continuous optimization techniques for the analysis of energy systems, model based control, and interactions of design, control and scheduling of power and energy systems. **Prerequisite:** Graduate classification; ENGY majors; ICPE 606.

ICPE 605 Energy Systems Engineering II

Credit 1.5. 1.5 Lecture Hour. State-of-the-art topics for energy systems engineering including modeling of hybrid feedstock energy systems, energy supply chain networks, polygeneration systems, model predictive control, fuel cells and combined heat and power systems. **Prerequisite:** Graduate classification; ENGY majors; ICPE 604.

ICPE 606 Introduction to Optimization

Credit 1.5. 1.5 Lecture Hour. Basics of deterministic optimization with focus on modeling and computer solutions; practical examples to develop understanding of modeling and solution techniques that can be used to improve decision-making; linear, non-linear, mixed integer, combinatorial and network optimization problems. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 607 Energy Accounting

Credit 1.5. 1.5 Lecture Hour. Exploration of the financial aspects of the energy industry; emphasis on oil and gas with additional attention placed on all sources of power generation including alternatives; interactive with cases worked in each session; advanced preparation guided by the instructor. **Prerequisite:** Graduate classification.

ICPE 608 Energy Policy

Credit 1.5. 1.5 Lecture Hour. Introduction to the history of U.S. science and technology policy with a specific emphasis on energy; focus on regulatory rules, the key government agencies at the national level, the role states and localities play, how government funds are allocated in research and technology transfer related to energy innovations, the role of universities, the threats and opportunities to energy-related educational success at all levels. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 610 The Global Energy Future

Credit 1.5. 1.5 Lecture Hour. Global energy outlook including energy demand, population growth and humanitarian issues, environmental and climate concerns, and the energy/water nexus and water scarcity; evolution of the global oil and gas industry; controlling nations, laws and agencies (OPEC, IEA, etc.); international and domestic climate change laws and policies; global future of climate change adaptation and mitigation. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 613 Natural and Shale Gas Monetization: Technologies, Fundamentals, Economics and Applications

Credit 1.5. 1.5 Lecture Hour. Focuses on important role played by natural and shale gas in energy market and the potentials to grow; major monetization processes including production, treatment, processing and conversion; key economic and technical aspects as they pertain to the processing technologies and the supply chains of natural and shale gas. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 614 CO2 Sequestration

Credit 1.5. 1.5 Lecture Hour. Introduction to the goals and methods of CO2 sequestration in the subsurface and of monitoring its effectiveness; discussion and explanation of current technological challenges and problems in monitoring CO2 in the subsurface and in implementing sequestration for mitigating climate change; addresses how carbon is transferred between atmosphere, hydrosphere, biosphere and geosphere by natural processes; basic geologic processes influencing sequestration programs. **Prerequisite:** Graduate classification.

ICPE 615 Smart Grid Fundamentals

Credit 1.5. 1.5 Lecture Hour. Fundamentals of electricity grid development; monitoring, control and protection; renewable generation; microgrids and grid integration; electricity markets; long term planning and associated risk, and grid robustness. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 617 Gas Separations for Energy: Fundamentals, Applications and New Directions

Credit 1.5. 1.5 Lecture Hour. Robust foundation of advanced expertise in gas separation technologies including (i) solid-phase absorbent technologies, (ii) liquid amine-based adsorption technologies, (iii) polymeric and inorganic membrane technologies, and (iv) emerging reactive separation for process intensification. **Prerequisite:** Graduate classification, ENGY majors.

ICPE 618 Carbon Capture, Utilization and Storage, CCUS

Credit 1.5. 1.5 Lecture Hour. Introduction to technologies for carbon capture, modeling and technoeconomic analysis and comparison of different carbon capture technologies, and economics of carbon capture, utilization, and storage statewide and nationwide. **Prerequisite:** Graduate classification; ENGY majors; ICPE 606.

ICPE 619 Nanomaterials Engineering and Energy Storage

Credit 1.5. 1.5 Lecture Hour. Nanomaterial synthesis and processing with an emphasis on the creation of materials relevant to energy storage (batteries, capacitors, etc.). **Prerequisites:** Graduate classification; ENGY majors; prior knowledge of an undergraduate engineering level of familiarity of chemistry and physics is desirable.

ICPE 620 Thermoelectric Materials and Devices

Credit 1.5. 1.5 Lecture Hour. Methods useful for the synthesis of both bulk crystals and nanomaterials (nanoparticles and nanowires); focus on the underlying thermodynamics and kinetic principles involved in the synthesis of these materials; pathways useful for the integration of nanomaterials into functional thermoelectric devices, methods used for ascertaining the thermoelectric performance of materials and devices. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 622 Energy Efficiency in Buildings

Credit 1.5. 1.5 Lecture Hour. Introduction to energy efficiency in buildings; understanding the energy use in buildings, the heating and cooling requirements, the role of renewable energy resources, the impact of lighting, the role of optimal control measures in existing and new buildings, the verification of energy savings, and the building energy simulation. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 623 Water-Energy-Food Nexus: Towards Sustainable Resource Allocation

Credit 1.5. 1.5 Lecture Hour. Securing energy, clean water and greening agriculture; principles of the Water-Energy-Food nexus and its application to the corresponding three themes; includes hands on laboratory. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 624 Energy-Water-Nexus

Credit 1.5. 1.5 Lecture Hour. Various aspects of energy-water nexus including the fundamentals, technologies, applications and economics; focus on energy production, conversion and utilization; connection with water production, treatment, delivery and usage. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 626 Safety in Energy Systems

Credit 1.5. 1.5 Lecture Hour. Role of leadership and development of management systems to ensure safety performance in energy systems, a systems approach to safety management for energy systems, lifecycle analysis and the energy supply chain, and applications of engineering principles of process safety and hazards analysis. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 631 Sustainability Considerations In Energy

Credit 1.5. 1.5 Lecture Hour. Introduction to the principles of sustainability within energy systems; examination of economic, environmental and societal aspects using quantitative assessments; promotion of informed decision-making through explanations of available assessment tools, the boundaries of analysis and process integration considerations. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 632 Renewable Abiotic Energy Resources and Conversion

Credit 1.5. 1.5 Lecture Hour. Study of the rapid development and progress of renewable abiotic energy resources and conversion technologies - renewable energy and resources; direct power conversion photovoltaics, thermal conversion via concentrating solar and geothermal power strategies; chemical conversion via photon energy systems; energy from the wind; blue energy from oceans, rivers and lakes; overview of fundamentals of renewable energy storage and distribution. **Prerequisite:** Graduate classification; enrollment in the MS Energy program.

ICPE 634 Energy Policy, Regulation, and Non-Market Strategy

Credit 1.5. 1.5 Lecture Hour. Exploration of how political incentives lead politicians to create and dismantle rules and the role that firms and industry associations play in shaping regulatory environments and social outcomes; emphasis on how non-market strategies such as lobbying, political campaign contributions, coalition building, social media campaigns, (mis)information campaigns, self-regulation and others, can shape the regulatory process and outcomes. **Prerequisite:** Graduate classification.

ICPE 638 Data Science Fundamentals for Energy I

Credit 1.5. 1.5 Lecture Hour. Discussion of basic concepts and methods used in data science with an emphasis on applications in energy; topics include concepts of probability theory, probability distributions, statistical data modeling and inference, linear regression and predictive models, dimension reduction, introduction to machine learning and statistical modeling of dependent data. **Prerequisite:** Graduate classification.

ICPE 641 Data Science Fundamentals for Energy II - Predictive Modeling

Credit 1.5. 1.5 Lecture Hour. Machine learning methods for data science in energy systems, with focus on predictive models and evaluation techniques for understanding performance models; topics include supervised learning, classification, predictive models, performance evaluation, neural networks, and deep learning with different data types. **Prerequisites:** Graduate classification; ENGY majors; ICPE 640 or approval of instructor.

ICPE 642 Advanced Concepts in Machine Learning for Energy

Credit 1.5. 1.5 Lecture Hour. Advanced topics in machine learning for data science in energy systems; topics include supervised and unsupervised learning, clustering, classification, advanced predictive models, advanced performance evaluation, neural networks and reinforcement learning. **Prerequisites:** Graduate classification; ENGY majors; ICPE 640 and 641 or approval of instructor.

ICPE 643 Data Science for Power Systems

Credit 1.5. 1.5 Lecture Hour. Basic concepts and methods of data science with an emphasis on energy-related applications; discussion of probability theory, data-based statistical modeling and inference, linear and non-linear regression and predictive models, dimensionality reduction, introduction to machine learning and statistical modeling of dependent data. **Prerequisites:** Graduate classification; ENGY majors; ICPE 640 and 641 or approval of instructor.

ICPE 644 Data Science for Process Systems

Credit 1.5. 1.5 Lecture Hour. Benefits and limitations of modeling and computational solutions; topics include how to formulate and solve complex numerical problems and understand the limitations and sources of error in simulation and numerical computing packages. **Prerequisites:** Graduate classification; ENGY majors; ICPE 640 and 641 or approval of instructor.

ICPE 645 Data Science for Oil and Gas Production

Credit 1.5. 1.5 Lecture Hour. State-of-the-art digital technologies applied in the context of reservoir exploration and production; instrumentation, workflows for automation in drilling, production, and reservoir; overview of basic working knowledge in artificial intelligence (Machine Learning and Data Analytics) for smart integration of production systems toward the goal of achieving a sustainable form of cleaner energy production. **Prerequisites:** Graduate classification; ENGY majors; ICPE 640 and 641 or approval of instructor; knowledge of basic use of Python.

ICPE 650 U.S. Energy Law

Credit 1.5. 1.5 Lecture Hour. Introduction to energy law and regulation in the United States; focus on the key sources of energy (both nonrenewable and renewable) driving the U.S. economy, and identifies the various challenges facing the industry in their production and distribution; key regulations and laws governing energy production as well as the jurisdictional and regulator divisions between federal and state governments. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 651 International Energy Law

Credit 1.5. 1.5 Lecture Hour. Overview of energy-related international law policies and practices, including detailed case studies and discussions of legal frameworks for trade and investment in the energy sector, as well as rules governing energy development, the climate, and the environment; corporate responsibility and human rights consequences of energy activities. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 652 Renewable Energy Law

Credit 1.5. 1.5 Lecture Hour. Overview of domestic renewable energy law policies and practices; exploration and analysis of laws that allocate interests in energy resources and that regulate energy production and delivery strategies so as to promote economic efficiency and to mitigate adverse impacts on the natural environment; cases studies worked in each session; advanced preparation required, which will be guided by the instructor. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 660 Energy Finance

Credit 1.5. 1.5 Lecture Hour. Analysis of the valuation process for energy industry assets with specific emphasis on project financing, off-balance sheet, and non-recourse financing arrangements; focus on the valuation of alternative energy projects or assets, the development of investment recommendations, and the synthesis and presentation of information for strategic decision-making. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 662 Economics of Energy

Credit 1.5. 1.5 Lecture Hour. Basics of economics concepts as they relate to energy applications; how the government policies affect the energy economy; present the economics of energy and climate change; economics of bioenergy production. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 663 Entrepreneurship in Energy

Credit 1.5. 1.5 Lecture Hour. Focus on developing an understanding of the techniques and issues for growing emerging organizations in the energy field; overview of a range of issues faced by a venture team in building and growing a new organization or pursuing innovative projects inside existing organizations. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 664 Management of Energy Projects

Credit 1.5. 1.5 Lecture Hour. Application of management processes to complex interdisciplinary organizational environments through the study of program and project management; adoptions of traditional management theories to the project environment; master typical project management microcomputer software for project planning; resource allocation; project budgeting; and control of project cost, schedule and performance. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 665 Energy Industry Project Portfolio Management

Credit 1.5. 1.5 Lecture Hour. Overview of project portfolio management (PPM) especially regarding the energy industry; PPM is the highest level of the project organizational hierarchy; appreciation for the elements of portfolio planning and optimizing; focus on portfolio management including selecting projects that align with strategy and monitoring to ensure they continue to add value. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 670 Fundamentals of Supply Chain Management

Credit 1.5. 1.5 Lecture Hour. Overview of supply chains and their key functions; financial impacts and levers; major challenges in managing an efficient supply chain; strategic and tactical supply chain components such as planning and inventory strategies, distribution and fulfillment strategy, outsourcing, sourcing and procurement, the value of information, customer value and supply chain risk management. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 671 Supply Chain Strategic Cost Management

Credit 1.5. 1.5 Lecture Hour. Key cost and working capital elements of the supply chain; impacts on financial statements and market value; levers in the supply chain; key strategic cost and cash applications such as financial and operational analysis, operational and process costs, concepts such as Activity-Based Costing, Should Costs and Total Costs of Acquisition and Ownership, Costs-to-Serve in evaluating customers and service, and a Full-Cycle Costing. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 672 Sustainability and Labor Compliance in Global Value Chains

Credit 1.5. 1.5 Lecture Hour. Supply chain sustainability including issues related to employment and labor compliance in global value chains; compliance with national law and international labor standards highly scrutinized by the public, governments, and international organizations. **Prerequisites:** Graduate classification; ENGY majors.

ICPE 681 Seminar

Credit 1.5. 1.5 Other Hour. Seminars and presentations on important developments and current research in energy; delivered by distinguished energy experts from academia, industry and government. **Prerequisite:** Graduate classification; ENGY majors.

ICPE 689 Special Topics In...

Credits 1 to 4. 1 to 4 Other Hours.

ICPE 691 Research

Credits 1 to 23. 1 to 23 Other Hours. Research for thesis or dissertation. **Prerequisites:** Graduate classification; ENGY majors.