Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR)

Purdue University (lead institution)

CISTAR will provide the technological innovation and diverse workforce needed to responsibly realize the potential of shale hydrocarbons

CISTAR
NSF Engineering Research Center

A National Science Foundation Engineering Research Center since 2017

Partner Institutions:

- University of New Mexico
- Northwestern University
- University of Notre Dame
- University of Texas at Austin

Our Mission

We will enable a future where the U.S. meets its energy needs from secure resources and with potentially lower greenhouse gas (GHG) emissions using small, modular, and distributed shale hydrocarbon plants closer to the wellhead.

Rationale for the center

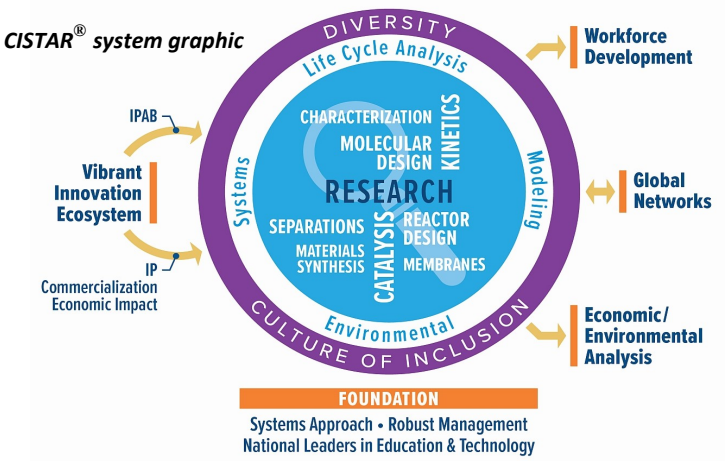
The last 10 years have witnessed an unprecedented revolution in the domestic supply of shale hydrocarbon reserves with the potential to lower the cost of our nation's electricity, power, chemicals, and fuels for the next 100 years. A large fraction of the shale hydrocarbons is composed of natural gas, which could replace coal for use in electrical power generation, resulting in major reduction in U.S. greenhouse gas emissions until economical, scalable, renewable energy resources are developed. In the interim, full utilization of shale-based energy resources requires new technologies to convert the shale hydrocarbons to liquid fuels and chemicals. Processing these shale hydrocarbons closer to the wellhead will reduce transportation costs, provide widely distributed employment opportunities, and improve resilience in the transportation fuels sector. CISTAR researchers and educators will fully utilize shale hydrocarbons from shale and accelerate the transition to a renewable energy future by:

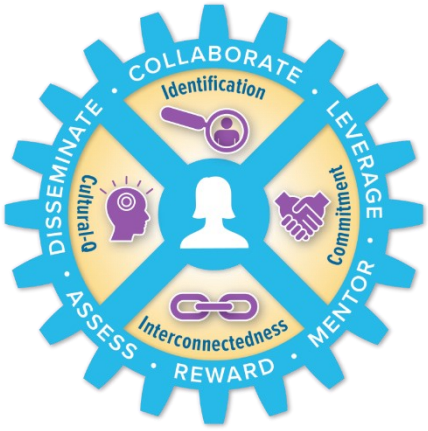
- Producing new, broadly disseminated and impactful science for energy and fuels technology from shale gas hydrocarbons;
- Generating intellectual property to support commercialization of new technologies;
- Demonstrating a combined experimental-computational approach to materials discovery that can be applied beyond hydrocarbon research;
- Providing leading-edge analysis of important environmental issues associated with shale hydrocarbons upgrading;
- Developing a diversified, well-trained workforce of innovative graduates with technical and professional skills; and
- Informing the public about safe and environmentally responsible ways to use U.S. hydrocarbon resources.

The results will be:

- Cost-competitive technology for direct conversion of light hydrocarbons to higher-value fuels and chemicals;
- Modular and mobile small-scale regional production plants;
- Lower capital conversion of shale hydrocarbons to transportation fuels; and
- Potential reduction in greenhouse gases through decreased flaring, lower energy requirements, and higher product yields.

An abundant U.S. energy resource known as shale hydrocarbons could be harvested as a "bridge fuel" until renewable technologies can be perfected. CISTARS's goal is to develop the new technologies needed to convert shale hydrocarbons into transportation fuels and chemicals.





CISTAR inclusion model

Research

CISTAR aims to deliver breakthrough discoveries and process developments in the conversion and separation of shale alkanes to higher molecular weight, higher-value chemicals and fuels. Researchers at the five partner universities will advance catalytic and separation science in collaborative, cross-organizational research programs that draw upon the collective expertise of academics who are leaders in their fields together with guidance from leading scientists from CISTAR's industrial partners. CISTAR will utilize cross-functional research teams that draw on the creativity and diverse technical backgrounds of graduate and post-doctoral students from each of the five partner universities. Promising advances in critical catalytic and membrane materials will be integrated into the testbeds, which will be used to establish proof-of-concept for CISTAR's integrated process system. CISTAR will deliver highly selective and robust catalysts, membrane materials that operate at high temperatures, and efficient reactive separation processes that will transform the way industry produces fuels and chemicals.

Economic and life cycle assessments (LCAs) will provide the consistent guidance necessary to guarantee that CISTAR's innovations will be both economical and practical. Energy efficiency and greenhouse gas reduction will be key areas of emphasis.

Education

CISTAR's Workforce Development goal is to create a technically excellent and inclusive community of hydrocarbon systems researchers, learners, and teachers through competency-based education, best-practice mentoring, and growth in key professional skills.

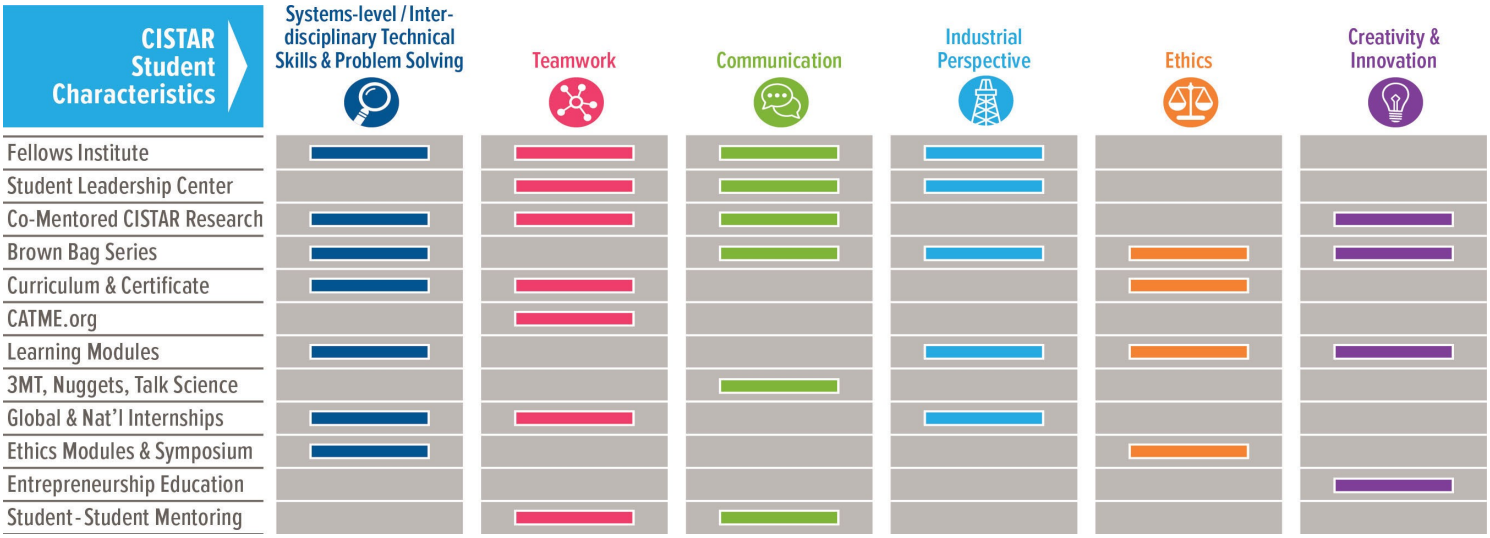
University Education

CISTAR aims to create a research-based, scalable, and sustainable portfolio of best-practice initiatives to attract and develop high-potential, diverse students to CISTAR and prepare them to be innovative leaders in a global energy economy. Undergraduate and graduate students will be CISTAR Fellows mentored to develop an Individual Development Plan (IDP) to identify career interests, strengths, and areas of challenges. Through research, coursework, certificates, workshops, and participation in special activities across all partners, the CISTAR Fellows will become valuable contributors to the hydrocarbon economy.

Pre-College Education

CISTAR is committed to broadening participation in engineering and will actively promote the participation of women and underrepresented minorities in STEM through high-quality pre-college engineering experiences for middle and high school students and teachers.

CISTAR pre-college engineering experiences will be aligned with the Next Generation Science Standards and informed by current research on pre-college engineering education. Activities will include Research Experiences for Teachers, a Young Scholar Summer Research program for students, and zipTrips virtual field trips.



CISTAR student characteristics and strategic activities to develop them

Diversity and Inclusion

CISTAR engages in recruiting efforts and training initiatives that evidence our appreciation for people from diverse backgrounds. Our dedication to creating a culture that helps participants reach their full potential, value cultural differences, and contribute to the energy industry is demonstrated in a welcoming and supportive environment.

Innovation Ecosystem

The vision of the Innovation Ecosystem program is to help CISTAR become recognized globally as the preeminent resource in developing transformative engineered systems to convert shale hydrocarbons chemicals and transportation fuels in smaller, modular, local, and highly networked processing plants. The CISTAR Industrial Membership Program will leverage NSF funding through a membership fee that enables strategic advice and helps accelerate R&D progress and technology transfer to industry. The fee is structured around Large, Medium and Small entities with two tiers of membership, with a first IP Option for the top tier. The results will include cost-competitive technology for direct conversion of shale hydrocarbons to higher-value products. This will be possible via modular and mobile small-scale regional production plants that permit lower-capital conversion of shale hydrocarbons to transportation fuels. Another expectation is the potential reduction in greenhouse gases through decreased flaring, lower energy requirements, and higher product yields.

More specific goals of the Innovation Ecosystem Program include:

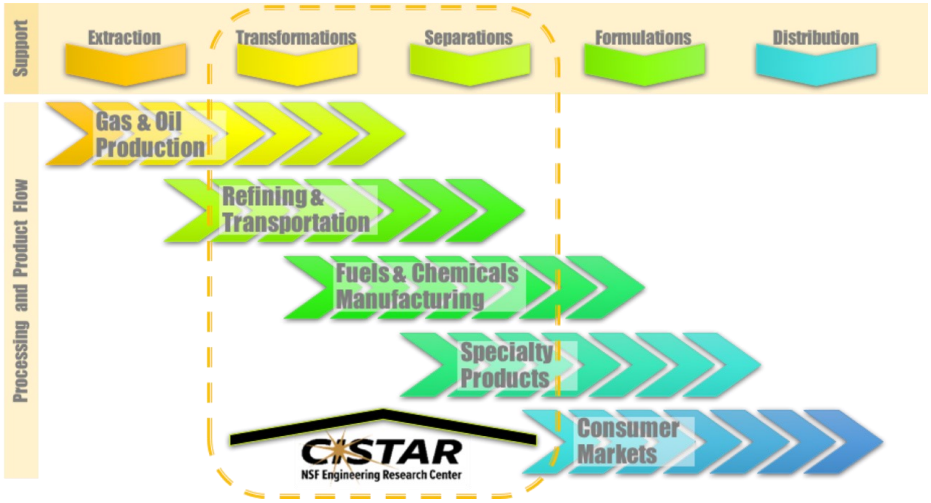
- Leveraging opportunities that closely align with the research in Thrusts and Testbeds, diversity and inclusion, and education and workforce development;
- Recruiting, retaining, and engaging Industry Members in concert with CISTAR Innovation Partners to support innovative R&D opportunities emerging from the Center;
- Developing a more innovative culture in the Center, including fostering a portfolio of patents;
- Enabling an effective flow of information from the center into our industrial member companies to enable them to consider a more active involvement in the center, including sponsoring projects;
- Fostering a technology transfer platform through meetings and information flow for CISTAR inventions into the commercial sector;
- Providing valuable information to the Innovation Partners to help them consider funding startup companies in the area of fuels and chemicals; and
- Supporting and steering the CISTAR management team in ways that enhance the education and research programs.

Flex Labs building where the Purdue CISTAR laboratories are located

CISTAR will continuously explore ways to engage with and nurture good relations with its Industry Members and Innovation Partners. We plan to recruit new member companies, adding their distinctiveness to our growing membership portfolio. To that end, we have identified a wide range of potential member companies and individuals who are actively working in this sector. This includes processors, members of petrochemicals industry from chemical production to product suppliers, fuels companies, and chemicals companies. We will also strive to retain members in the CISTAR network for the lifetime of the Center, with an eventual view of sustainability planning with what will then be long-established industry relationships.

Facilities

CISTAR headquarters is located within Purdue's Discovery Park, a 40-acre and $1 billion complex for interdisciplinary research. Experimental and computational facilities at each partner university are among the best in the world and are available for shared collaboration in areas of catalysis and separations, experimental measurement and modeling of reaction kinetics, atomic level theory, and process synthesis. The CISTAR team also has access to award-winning advanced high-performance computing and data resources.



CISTAR's value chain

Hall for Discovery and Learning Research in Discovery Park, Purdue, where the CISTAR headquarters is located

Center Configuration, Leadership, Team Structure

The CISTAR team is comprised of internationally renowned experts in areas critical to transforming the shale hydrocarbon value chain; CISTAR's inclusive leadership team is organized to effectively meet CISTAR goals. All partners will contribute to technology transfer, as evidenced by a robust innovation infrastructure at all five Universities and over 600 patents held by CISTAR researchers. This cohesive organizational structure balances partner expertise and contributions with center-wide stewardship of the CISTAR vision and enables metric-driven evaluation.

Center Headquarters

Center for Innovative and Strategic Transformation of Alkane Resources
207 S. Martin Jischke Dr., Room 203
West Lafayette, IN 47907
(765) 494-1883

https://cistar.us

Director: Fabio Ribeiro, Purdue University
(765) 494-7799 • fabio@purdue.edu

Deputy Director: Joan Brennecke, University of Texas at Austin
(512) 471-5029 • jfb@che.utexas.edu

Pre-College Education Director: Monica Cardella, Purdue University
(765) 496-1206 • mcardell@purdue.edu

International Programs Director: Abhaya Datye , University of New Mexico
(505) 277-0477 • datye@unm.edu

Administrative Director: Cristina Farmus, Purdue University
(765) 494-0027 • cfarmus@purdue.edu

Workforce Development Director: Michael Harris, Purdue University
(765) 494-0963 • mtharris@purdue.edu

Innovation and Industry Director: Peter Keeling, Purdue University
(765) 494-4859 • pkeeling@purdue.edu

Diversity and Inclusion Director: Adrian Thomas, Purdue University
(765) 494-4835 • atthomas@purdue.edu

Communications Specialist: Brittany Bright, Purdue University
(765) 496-0352 • bright9@purdue.edu

Thrust 1 Leader: Jeffrey Miller, Purdue University
(765) 496-0462 • jeffrey-t-miller@purdue.edu

Thrust 2 Leader: Linda Broadbelt, Northwestern University
(847) 467-1751• broadbelt@northwestern.edu

Thrust 3 Leader: Tobin Marks, Northwestern University
(847) 491-5658 • t-marks@northwestern.edu

Thrust 4 Leader: Rakesh Agrawal, Purdue University
(765) 494-2257 • agrawalr@purdue.edu

Testbed Leader: Thomas Degnan, University of Notre Dame
(574) 631-2617 • tdegnan1@nd.edu