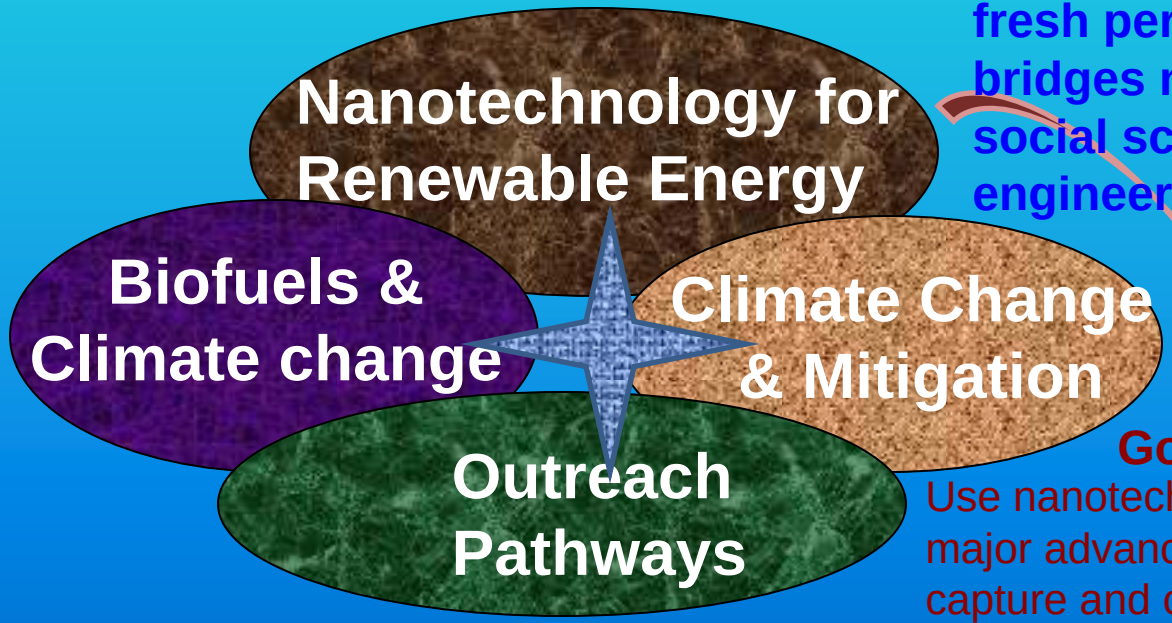
KANSAS EPSCoR Partners in Science & Technology

www.solarenergy.ku.edu

Energy is not an isolated issue!

Interaction and integration with other groups on the team



Kansas EPSCoR Mission: To address global climate change and renewable energy challenges by targeting basic science, impacts and mitigation with a fresh perspective that bridges natural sciences, social sciences and engineering.

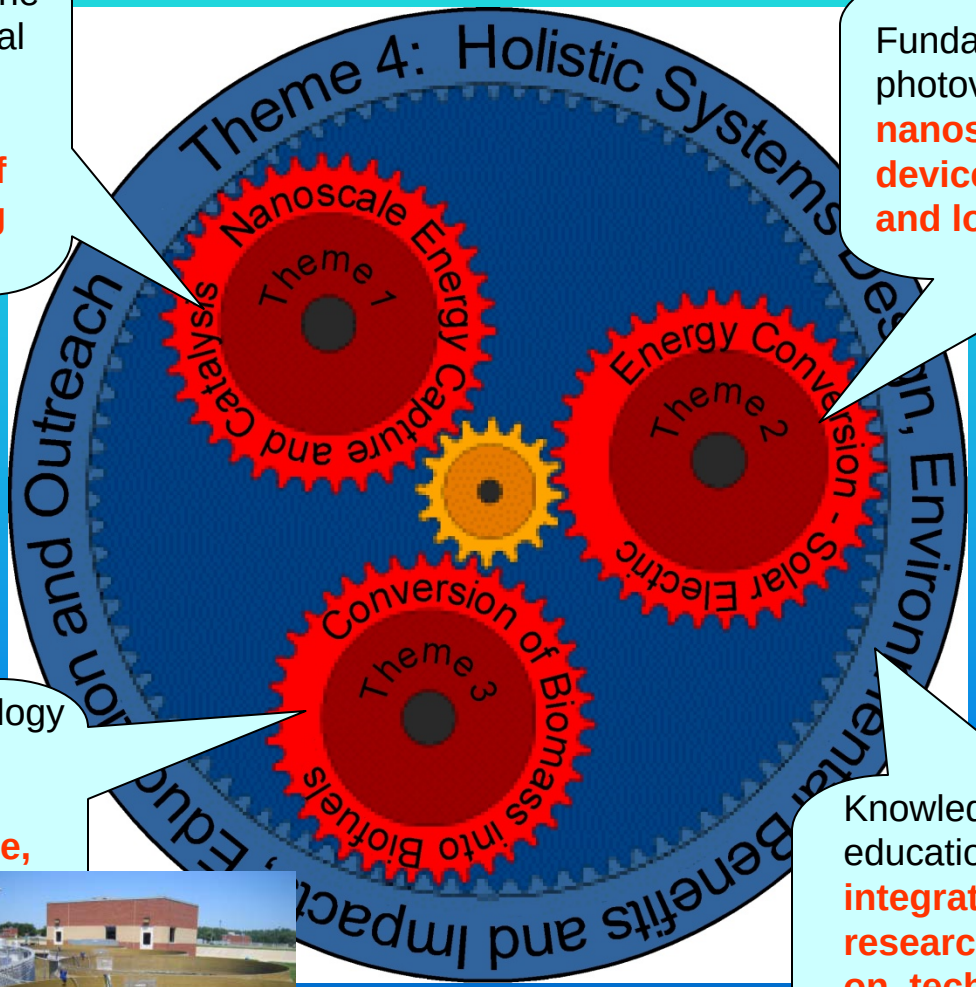
Goal

Use nanotechnology to achieve major advances in solar energy capture and conversion, and to develop useful products using solar-catalysts with minimal harmful impacts on the natural environment

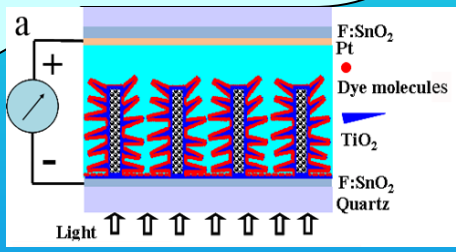
Synergy for Energy: Highly Integrated Research Effort

Nanotechnology for Renewable Energy

New knowledge about the energetics and functional properties of natural & artificial photosynthetic complexes— **Design of novel solar harvesting materials**



Fundamental physics of photovolatic process--- **Novel nanostructured photovoltaic devices with high efficiency and low cost**



Bio-inspired nanotechnology ---**high-efficiency conversion of biomass including crop cellulose, algae and microbial systems**

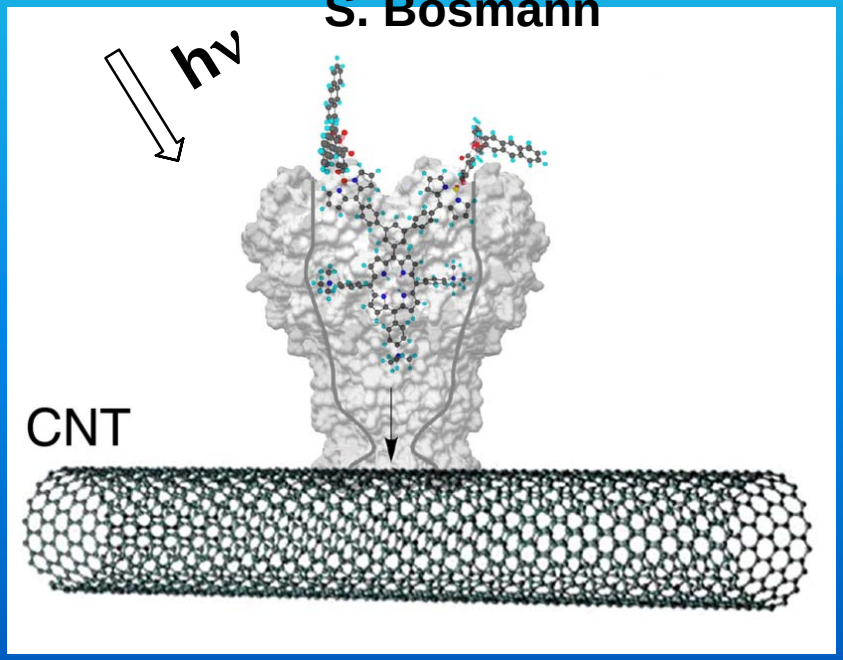
Knowledge integration and education/outreach---**Highly integrated renewable energy research with great impacts on technology transfer & training of next-generation workforce**

Theme - 1

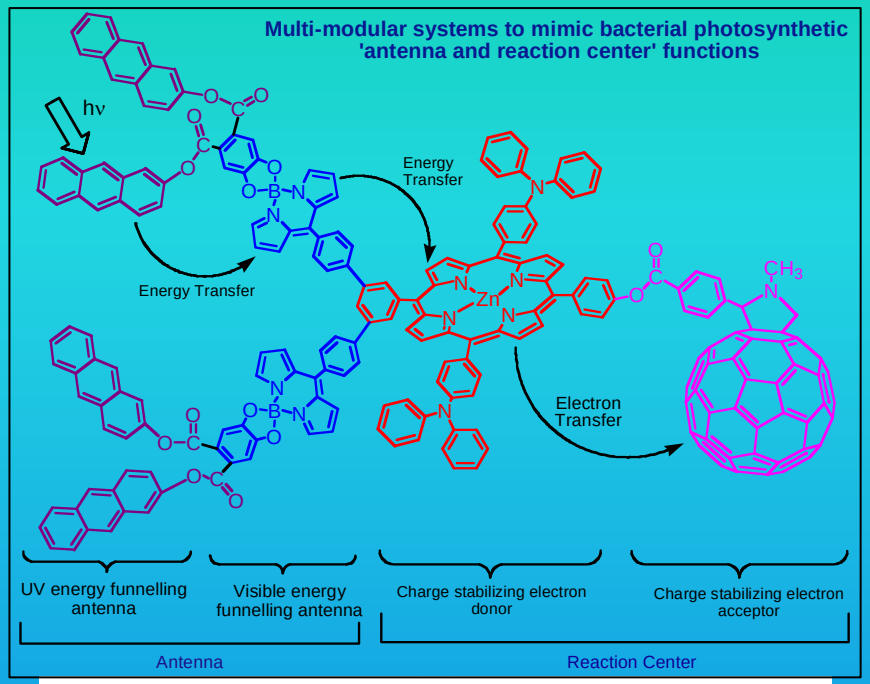
R. Jankowiak
& M. Ritcher

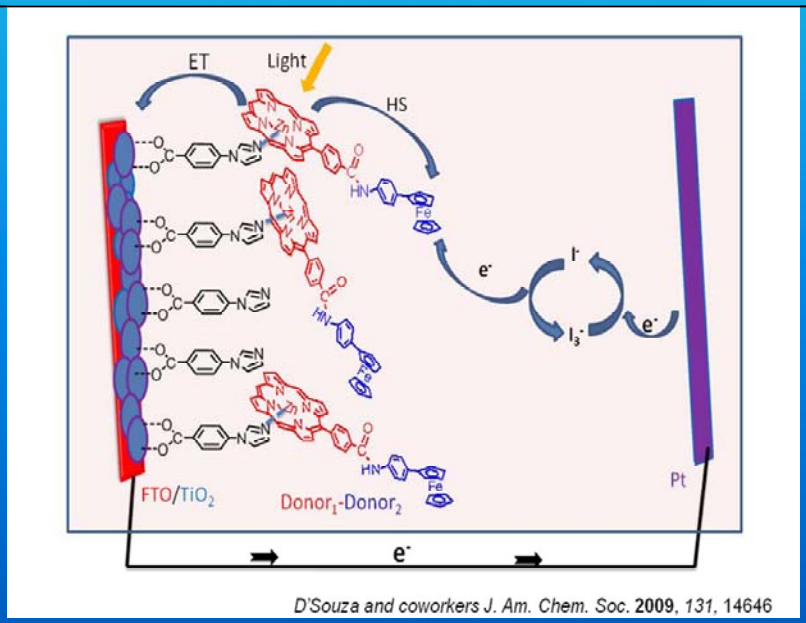
MspA, a very stable channel protein for photo-electron transfer applications

S. Bosmann



Supramolecular Solar Cell via Biomimetic Approach - DSouza

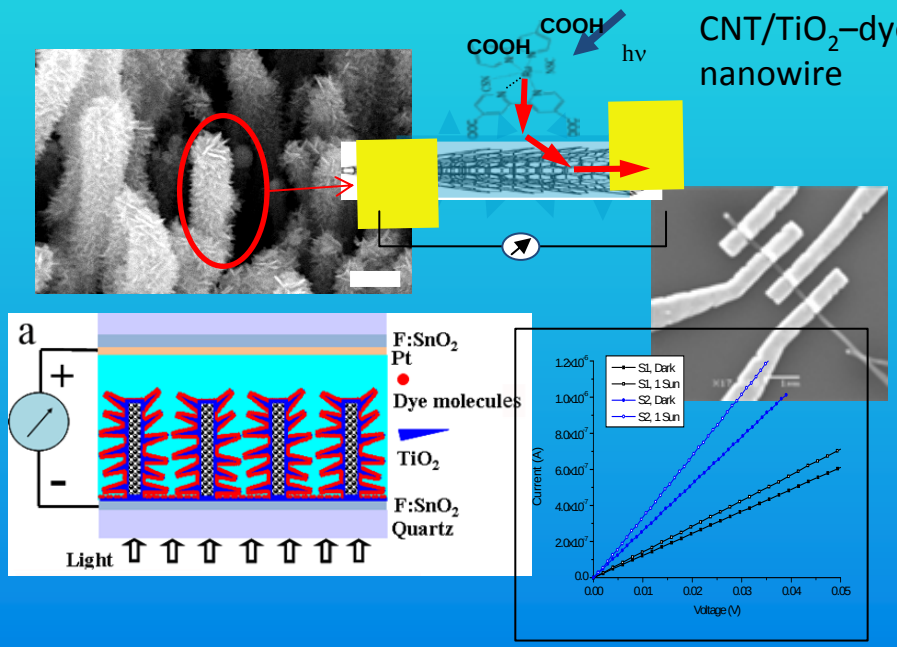




D'Souza and coworkers J. Am. Chem. Soc. **2009**, *131*, 14646

Theme 2 - Investigating novel devices and architectures that are used to convert solar energy into electricity with cost/performance balanced performance.

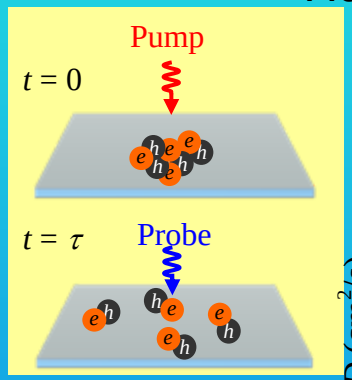
CNF-TiO2 core-shell nanowire dye-sensitized Solar Cells
Jun Li (KSU) and Judy Wu (KU)

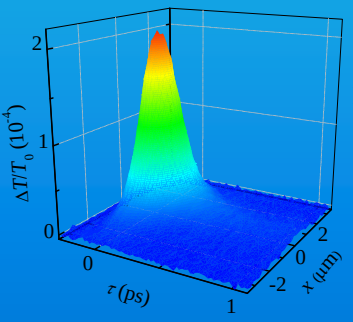


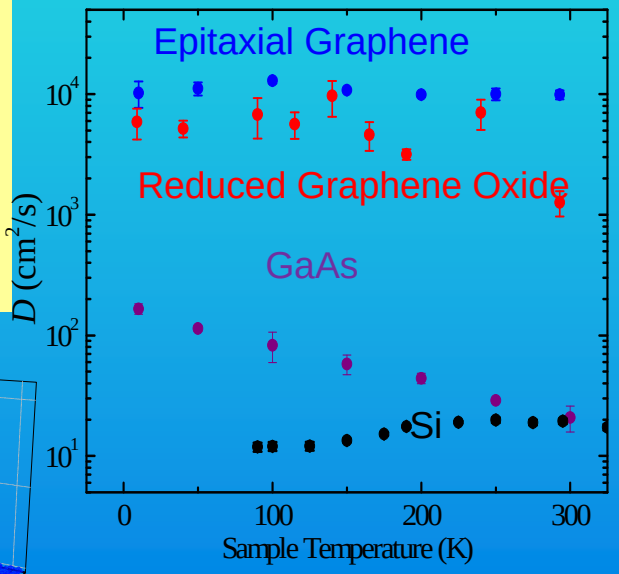
Liu J, Kuo Y-T, Klabunde KJ, Rochford C, Wu J, Li J., *ACS Applied Materials & Interfaces*, **2009,** 1(8), 1645-1649.

Z.Z. Li, C. Rochford, J. Baca, J.W. Liu, J. Li, and J.Z. Wu, *Nanoscale Research Letters*. (2010) DOI 10.1007/s11671-010-9665-3; C. Rochford et al, *Applied Physics Letters* 97, 043102 (2010).

Optical studies of charge carrier transport in graphene
Hui Zhao (KU)







Ruzicka et al, Appl. Phys. Lett. 96, 173106 (2010)

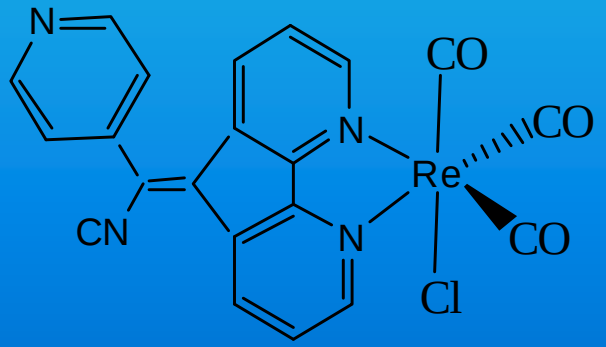
Nanotechnology for Renewable Energy

To develop catalysts for fuel production that include catalysts for water splitting, and for using H_2 and CO_2 to make hydrocarbon fuels.

Kenneth J. Klabunde (K-State), Paul Rillema (WSU)

- Identify new catalysts for water splitting and for conversion of H_2 and CO_2 to hydrocarbons
- Refine catalysts

Catalyst for CO_2 reduction



Nanotechnology for RenewableEnergy

Cumulative Year 1 Activity Highlights and Impacts

- Funded 17 research projects (1 GRA or ½ GRA) via internal SOWs and review, which supported
  - 25 graduate students (6 Female, 1 African American)
  - 3 postdocs (1 female)
- Funded 9 summer REU students, activities joined with KSU NSF REU project
  - (1 Female, 1 African American, 1 Native American)
- Hosted 2 entire team research workshops, 5 bi-monthly joined 3-campus video seminars, plus many small group discussions
- Submitted >20 proposals
  - 8 funded of total: ~ $2.8 M
- Generated 24 manuscripts (many via collaboration)
  - 14 published/accepted, --6 submitted, --4 in final preparation

- Collaborated with

  NCC team to develop survey questions on renewable energy

  Pathways for REU students recruiting and proposal developing

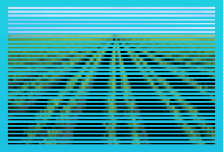
  KSU REU for joint Sustainability REU in summer of 2010

  Industrial network for joined grants (4 funded)

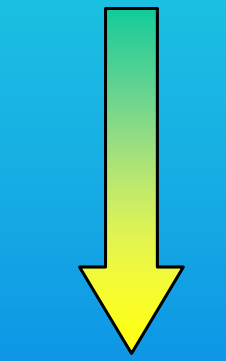
  National labs and other institutions – AFRL, Argonne, AMES, NASA, NREL, Notre-Dame, ONRL, many universities including foreign

Collaboration within the NRE team across three campuses: KU, KSU and WSU
Collaboration with other teams of the State NSF EPSCoR program
Collaboration with industry, national labs, and other institutions

Kansas EPSCoR - Roadmap



Agriculture



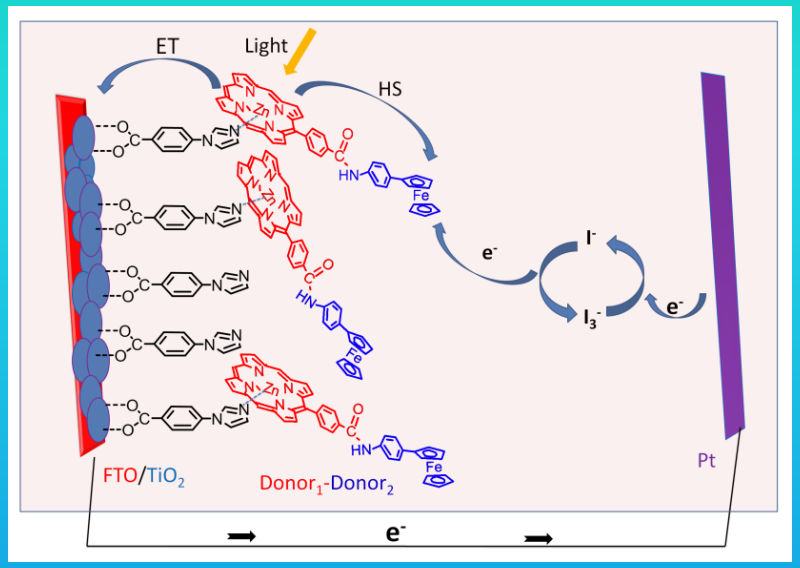
Solar

BASIC SCIENCE	IMPACTS	MITIGATION
	Climate	
Modeling Climate Variables Feddema (KU)/Ma (WSU)	Kansas Farmlands Harrington (KSU)/Gibson (KU)	C-Sequestration Rice (KSU)/Rillema (WSU)
Modeling Human Variables Earnhart (KU)/Peterson (KSU)	Indigenous Farmlands Wildcat (Haskell)/Nagel (KU)	
	Energy	
Biomass → Biofuels Sun (KSU)/Smith (KU)	Life Cycle Analysis Twomey (WSU)/White (KU)	Biomass → Biofuels Williams (KU)/Wang (KSU)
Solar energy → Electricity Richter (KU)/D'Souza (WSU)	Solar Fuels	Solar energy → Electricity Wu (KU)/Li (KSU)

Theme 1: Research Highlights

National Needs:

To improve light energy capture efficiency in natural and artificial materials



Grand Challenges:

- Produce cost-effective, highly efficient energy capture materials
- Increase biomass production by increasing photosynthetic efficiency in natural systems

Objectives:

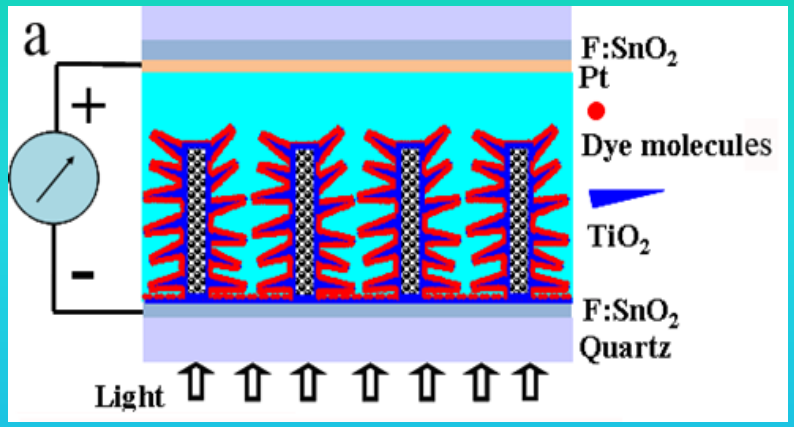
- Create new inorganic and hybrid organic/inorganic platforms for enhanced photosynthetic efficiency
- Engineer biosystems with improved capacity for energy capture and conversion to biomass

Approaches:

- Identify mechanisms of energy capture in efficient natural systems
- Fabricate nanocomposite (wholly artificial) inorganic and hybrid organic/inorganic platforms
- Fabricate bio-inspired/biomimetic energy capture systems integrating biological with non-biological components enhanced solar energy capture

Accomplishments: 2 NSF proposals generated
Published 6 papers at international conferences
Published 6 journal articles, one thesis

Theme 2: Research Highlights



National Needs:

- Highly efficient devices to convert solar energy into electricity
- Technologies to effectively utilize the produced energy

Grand Challenge:

- Cost-performance balanced photovoltaics
- Sustainable nanomaterials and devices for energy production and utilization

Objectives:

- Understanding of fundamental physics and chemistry of nanomaterials and nanodevices toward novel energy conversion concepts
- Development of cost/performance balanced PV technology through nanoengineering of novel nanostructures
- Exploration of new hybrid systems for electricity production/utilization

Approaches:

- Improvement in materials and characterization
- Innovation in device architecture design and fabrication at nano- to macro- scales
- Exploration of breakthrough systems for highly efficient energy conversion

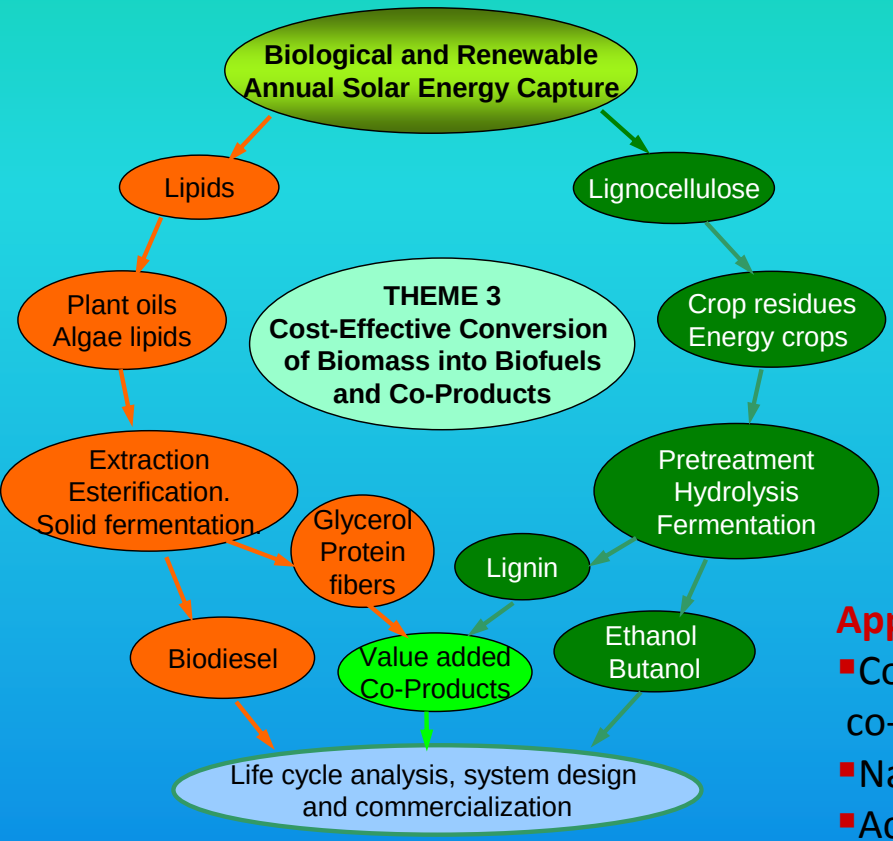
Accomplishments:

Submitted more than 5 research proposals

Delivered more than 7 presentations at international conferences

Published morev than 7 journal papers

Theme 3 Research Highlights



National Needs:

- To improve environment
- To reduce reliance on fossil fuels
- To produce 36 B gallons of biofuel by 2022,

Grand Challenge:

- Cost-effective conversion of biomass into biofuel
- Value-added co-products from biofuel residues

Objectives:

- Improve conversion efficiency of biomass into biofuels
- High efficiency production of biodiesel
- High value co-products from biofuel residue

Approaches:

- Cost-effective algae biorefining for high oil production and co-products
- Nanostructured solid base catalysis for biodiesel production
- Acid-functionalized nanoparticles to hydrolyze cellulose
- Bionano switches to activate enzymes inhibited in biomass
- Value added lignin for chemicals

Accomplishments: 3 NSF awards (~$900k total) received
Published 7 papers at international conferences
Published 3 journal papers, 1 thesis

Theme 4 – Holistic Systems Design, Environmental Benefits and Impacts, Education and Outreach

- Analyzing global environmental benefits and impacts
- Assessing resources, materials, byproducts, waste managements, and infrastructure for ecosystem impacts
- Design of courses: energy efficiencies and environmental implications
- Commercialization possibilities
- Creation of outreach programs
- Public lectures: ”Nano-Day”; ”Green Energy”
- Local and minority colleges
- Historically Black colleges/Hispanic-serving institutions/Haskell Indian Nations/Women in Science and Learning

A Holistic Approach to Energy Capture and Conversion.