



Center for Energy and Environmental Sustainability

Environmental Sustainability Thrust Area

EAB/ISC Meeting
September 17, 2021

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Center for Energy and Environmental Sustainability (CEES)
Prairie View A&M University



Phase I: Energy & Environmental Sustainability Overview

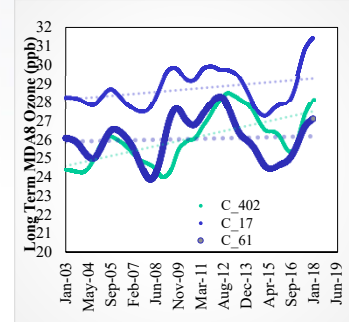
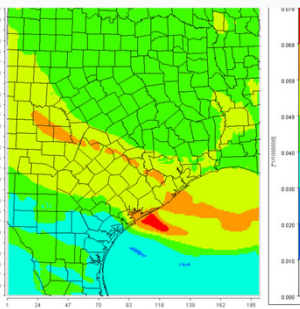
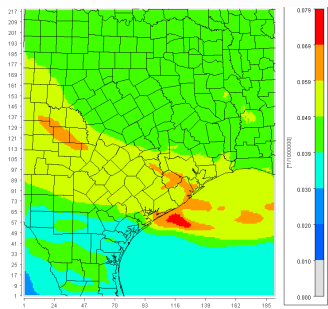



Focus Area One: Sustainable Nuclear Energy

- Project 1: Monte Carlo simulations of nuclear fuel burnup


Focus Area Two: Air Quality Measurement and Modeling

- Project 1: Analysis of air pollutant emissions from a goat farm operation;
- Project 2: Meteorological detrending evaluation of ozone and precursor concentrations monitored in the Greater Houston Area, the Houston Ship Channel Region and Dallas-Fort Worth Area;
- Project 3: Analysis of pollutant emissions from different sources in the 8-counties of the Houston-Galveston-Brazoria area





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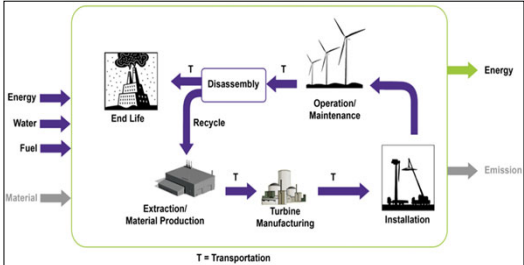


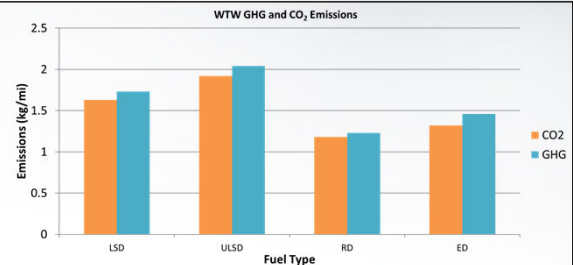
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Focus Area Three: Life Cycle Assessment

- Project 1: Evaluation of the life cycle greenhouse gas emissions from electricity generation: hydropower, nuclear energy, biomass, solar power, wind and coal;
- Project 2: Life-cycle analysis of air emissions of transportation vehicles in the Greater Houston Area: bioethanol, biodiesel, electric car, electric buses, heavy duty trucks, and high speed rail system.

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Fuel Type	CO2	GHG
LSD	~1.6	~1.7
ULSD	~1.9	~2.0
RD	~1.2	~1.3
ED	~1.3	~1.4

Accomplishments


- Peer-reviewed publications: 1 book, 5 book chapters, 31 journal papers, and 23 conference extended abstracts/proceedings; 117 conference presentations; 15 graduate theses



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CEES Phase II Research Thrusts



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RESEARCH THEMES


SUBPROJECT I
BIOENERGY
 ✓ Bioenergy Crops
 ✓ Hydrocarbon Fuels

SUBPROJECT II
OFFSHORE WIND ENERGY
 ✓ Aerodynamic
 ✓ Uncertainty Analysis
 ✓ Data science


SUBPROJECT III
ENVIRONMENTAL SUSTAINABILITY
 ✓ Produced Water Treatment
 ✓ Climate Change & Air Quality

LIFE-CYCLE ANALYSIS


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Thrust Area 3: Environmental Sustainability






Group

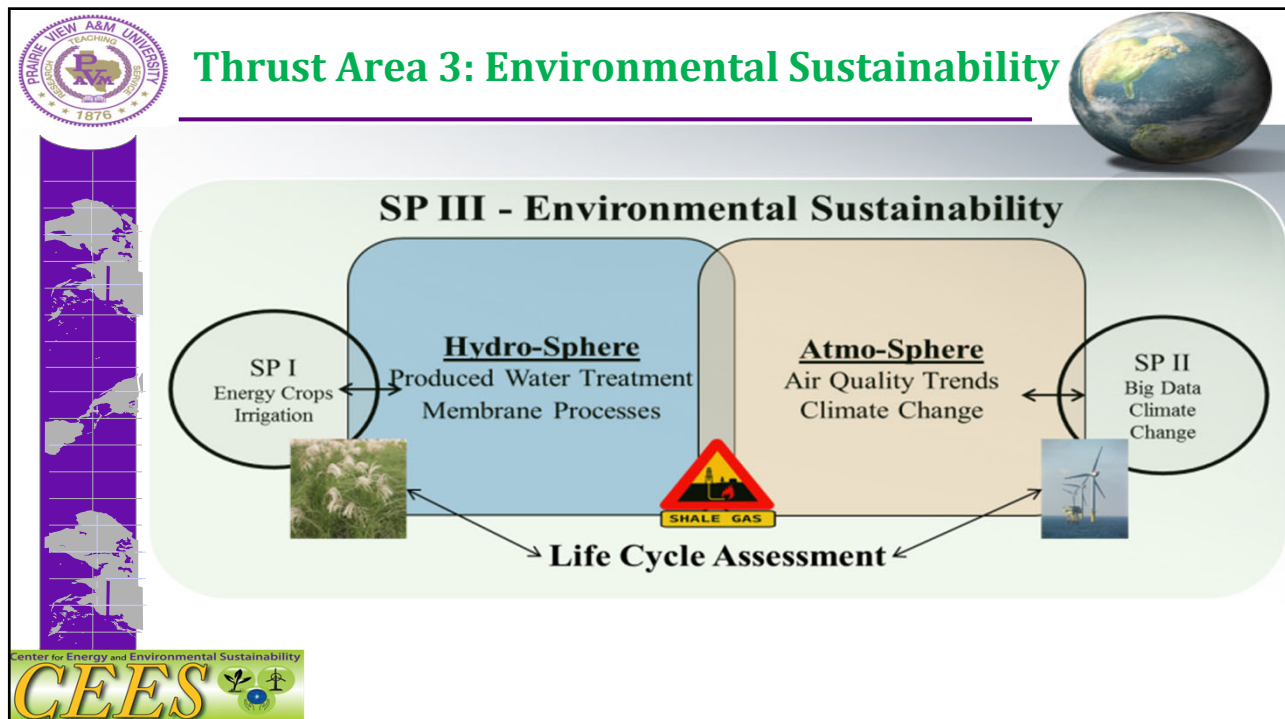
- Dr. Raghava Kommalapati (Civil Eng), Group leader
- Dr. Hongbo Du (CEES)
- Dr. Nabila Shamim (Chem Eng)

Goal

- Enhance the sustainability of fossil fuel energy sources, under a regime of climate change and evolving energy portfolios.
- Three focus areas:
 - (1) Shale gas & oil produced water (PW) treatment
 - (2) Climate change and air quality
 - (3) Life cycle assessment (LCA)



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Focus Area 1: Shale Oil & Gas Produced Water Treatment

Hydrofracking

Shale gas & oil

Produced water

Conventional pretreatment

Photocatalysis

FO-RO
Draw solute: HMNPs or $\text{NH}_3\text{-CO}_2$ salt produced from carbon capture

Product water for irrigation
Subproject I

Major Activities

- Produced water (PW) pretreatment with novel photocatalyst
- PW treatment with forward osmosis using magnetic nanoparticles as draw solute

Schematic of experimental set-up with (a) Xe lamp and (b) LED array

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Focus Area 1: Shale Oil & Gas Produced Water Treatment


Major Activities

- Draw solute production by utilizing carbon capture from power plant flue gas
- Produced water (PW) treatment with an innovative high throughput forward osmosis (FO) membrane
 - Preparation of polyetherimide (PEI)/graphene oxide (GO) nanofibrous support layer of FO membrane
 - Preparation of an ultrathin film active layer by low-temperature interfacial polymerization
 - Zwitterionic-coating on both sides of FO membrane
- Produce clean water for energy crop irrigation


Schematic of the proposed FO membrane


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Focus Area 2: Climate Change & Air Quality





Major Activities

- Spectral decomposition with KZ filter
- Develop multiple linear regression models
- Conduct meteorological detrending of ozone and other air pollutants
- Forecast of future air quality and assessment of environmental risks



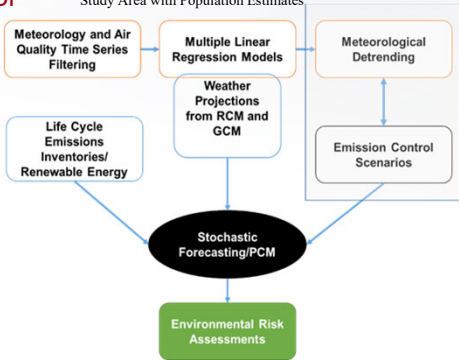
Study Area with Population Estimates

$$Y(t) = KZ_{m,p}[X(t)]$$

$$m \cdot p^{1/2} \leq N$$


$$Y_i = \left(\frac{1}{m}\right) \sum_{j=-k}^k X_{i+j}$$

$$X(t) = e(t) + S(t) + W(t)$$

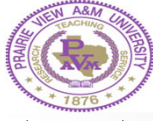


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    graph TD
      A[Meteorology and Air Quality Time Series Filtering] --> B[Multiple Linear Regression Models]
      C[Weather Projections from RCM and GCM] --> B
      D[Meteorological Detrending] --> B
      E[Emission Control Scenarios] --> B
      F[Life Cycle Emissions Inventories/ Renewable Energy] --> G((Stochastic Forecasting/PCM))
      B --> G
      D --> G
      E --> G
      G --> H[Environmental Risk Assessments]
      
```




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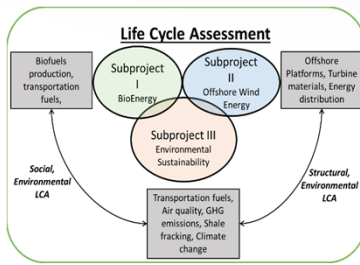
Focus Area 3: Life Cycle Assessment






Major Activities


- LCA tasks linking to Groups 1 and 2
- LCA of biofuel production
- LCA of offshore wind power
- LCA of shale oil & gas produced water treatment
- LCA of sustainable & renewable energies




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    graph TD
      subgraph LCA [Life Cycle Assessment]
        S1[Subproject I BioEnergy]
        S2[Subproject II Offshore Wind Energy]
        S3[Subproject III Environmental Sustainability]
        S4[Biofuels production, transportation fuels]
        S5[Offshore Platforms, Turbine materials, Energy distribution]
        S6[Transportation fuels, Air quality, GHG emissions, Shale fracking, Climate change]
        S1 --- S2
        S1 --- S3
        S2 --- S3
        S4 --- S1
        S5 --- S2
        S6 --- S3
      end
      S4 --- S6
      S5 --- S6
      
```







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Current Leveraged Projects Environmental Sustainability Group




- **Project 1:** Energy and Nutrient Recovery from Goat Manure by Anaerobic Co-Digestion with Cotton Gin Trash and Food Waste, **Kommalapati, Awal, and Du**. US Department of Agriculture, 02/18-01/21, \$300,000;
- **Project 2:** Excellence in Research: A Novel High Throughput Forward Osmosis Membrane for Produced Water Treatment, **Kommalapati, Reeves and Shafer (UH)**, National Science Foundation, 08/19-07/22, \$500,000;
- **Project 3:** Zero-Waste Poultry Processing with Sequential Membrane Separation and Anaerobic Digestion, **Kommalapati, Du, Awal (PVAMU) and C. Coufal (TAMU)**, US Department of Agriculture, 05/20-04/23, \$500,000;
- **Project 4:** Systems-Based Integrated Program for Enhancing The Sustainability of Antibiotic-Restricted Poultry Production, USDA, Univ. of Connecticut, - Prairie View A&M (Sub-award), **Kommalapati**, 09/20-09/24, \$450,000;
- **Project 5:** Potential Use of Renewable Diesel for Transportation in Texas and its Environmental Impacts. USDOT- LSU Tran-SET, **Kommalapati, Du, and Alam**, 08/21-01/23, \$60,000;
- **Project 6:** Ocean Energy Safety Institute (OESI) II. \$40 M funding DoE and DOI thru Texas A&M Engineering Experiment Station, **Kommalapati**, 07/21-06/26, \$148,000 (Admin portion)- Research funds are awarded yearly.


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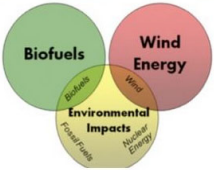


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PVAMU Engineering Center Awarded \$5M for Sustainable Energy Research
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Questions/Further Information?
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