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CENTER FOR
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POSTER 1

IMPACT OF NITROGEN RATE ON NITROUS OXIDE EMISSIONS AND LIFE CYCLE GREENHOUSE GAS EMISSIONS IN SWITCHGRASS-BASED CELLULOSIC ETHANOL

Andrew McGowan *IGERT in Biorefining, Kansas State University,* and Charles Rice

Department of Agronomy, College of Agriculture, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

The 2007 Energy Independence Security Act mandates the production of 16 billion gallons per year of cellulosic biofuel by 2022. These biofuels will be required to have life cycle assessment (LCA) greenhouse gas (GHG) emissions 60% below gasoline. Switchgrass is one potential feedstock for the production of cellulosic ethanol in Kansas. Emissions of the GHG nitrous oxide (N_2O) from soils treated with nitrogen (N) fertilizer could negatively impact the GHG balance of biofuels. The objectives of this study were to 1) characterize the yield and N_2O emissions from switchgrass receiving different rates of N fertilizer and 2) determine the impact of these emissions on the LCA GHG emissions of switchgrass-based ethanol. In 2012 and 2013, 0 – 200 kg of N were applied to switchgrass plots in Manhattan, KS. Annual N_2O emissions were measured from soils in the plots using static chambers. Measured yields and N_2O emissions were used as inputs in the GREET LCA model to estimate the life cycle GHG emissions of switchgrass-based ethanol. There was a quadratic relationship between N rate and yield. In 2012, N_2O emissions increased exponentially with increasing N rate. In 2013 N_2O increased linearly with increasing N. Increasing N rates caused substantial increases in the LCA GHG emissions of switchgrass-based cellulosic ethanol. Much of the increase was due to increased N_2O emissions, which accounted for 67% and 44% of total LCA GHG emissions in switchgrass receiving 150 kg N ha^{-1} in 2012 and 2013, respectively. LCA GHG emissions of ethanol were lower than emissions from gasoline at all N rates. Increased N rates increased yield but also substantially increased N_2O emissions and the GHG balance of ethanol, indicating that trade-offs may exist in managing nitrogen to maximize agronomic productivity and to reduce nitrogen losses as N_2O.

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POSTER 2

POTENTIAL IMPACTS OF STALK ROT DISEASES ON THE SORGHUM BIOETHANOL INDUSTRY

Y.M.A.Y. Bandara[1], D.K. Weerasooriya[2], T.T. Tesso[2], P.V.V. Prasad[2] and C.R. Little[1]

[1]Department of Plant Pathology, Kansas State University, Manhattan, Kansas, USA

[2]Department of Agronomy, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Stalk rots are among the most detrimental diseases of sorghum worldwide. Grain yield reduction and plant lodging due to these diseases are major sources of concern in using sorghum as a feedstock for bioethanol production. The objective of this study was to test the effects of Fusarium stalk rot and charcoal rot on sorghum grain yield and total soluble solids (TSS) of stem juice, when plants were inoculated at two growth stages. Four sorghum genotypes were tested in the greenhouse and field against three *Fusarium* spp. (*F. thapsinum, F. proliferatum, F. andiyazi*) and *Macrophomina phaseolina* at GS1 (30 d after emergence) and GS3 (14 d after flowering). Panicles harvested at physiological maturity were measured for total seed weight (TSW). Juice collected from crushed stems was measured for TSS using a handheld brix meter. Pathogens significantly decreased TSW over the control and at GS1 and GS3. There was a greater reduction of TSW at GS1 (50%) than GS3 (30%). These figures are directly proportional to the ethanol yield reduction where grain is used as the raw material. On average, pathogens decreased TSS by 0.75 and 1.2% over GS1 and GS3 inoculations compared to the control. Assuming that total juice production is 20 m^3 ha^{-1}, 75% of TSS is fermentable sugar and the conversion factor of sugar to ethanol is 0.581, stalk rot pathogens, in general, can decrease ethanol yield by 65 and 104 L ha^{-1}, respectively, upon GS1 and GS3 inoculation. These findings demonstrate the potentially serious impacts of stalk rot diseases on sorghum bioethanol industry when either grain or stem sugars are utilized as raw materials. Therefore, sorghum breeding programs should focus on producing high yielding as well as stalk rot resistant or tolerant genotypes that could cater to the sorghum bioethanol industry.

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POSTER 3

FULLY UTILIZING NON-STRUCTURAL CARBOHYDRATES IN SWEET SORGHUM VIA DIFFUSION PROCESS

Nana Baah Appiah-Nkansah *IGERT in Biorefining, Kansas State University,* Donghai Wang

Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Sweet sorghum is attractive for bioethanol production because of its high biomass and fermentable sugar yield (Rooney et al., 2007). The crop has relatively short period maturity cycle of 120-150 days. The stalk has similar fermentable sugar content comparable to sugarcane. These desirable agricultural characteristics make sweet sorghum a promising alternative feedstock for fuel ethanol production in the southern United States (Gibbons et al., 1986; Steduto, 1997; Prasad et al., 2007). At present, when using the sugarcane harvest approach for sweet sorghum, the sorghum plant is "topped" and the panicle is cut and dropped on the ground; it is not included in the biomass brought to the processing plant. Significant amount of non-structural carbohydrates which can be converted to sugars thus remains in the field. The goal for this research is to integrate the utilization of both fermentable sugars and no-structural carbohydrate for ethanol production to increase the total conversion efficiency and final ethanol yield using pre-processing methodologies that integrate the extraction of both fermentable sugars and starch via the diffusion process. Whole sweet sorghum biomass will be harvested, and hummer-milled into particle sizes 5-15 mm, and pressed to extract the fermentable sugars. Remaining sugars and starch in the bagasse will be hydrolyzed by way of a developed bench-scale diffusion system. Economic analysis on the feasibility of diffusion process will be performed. It is expected that milling procedure, optimum diffusion conditions, and optimum SSF process, necessary for the highest conversion rate and ethanol yield would be achieved.

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POSTER 4

HYDROGENATION OF HYDROXYMETHYLFURFURAL USING A RUTHENIUM COATED POLYMERIC MEMBRANE REACTOR

John Stanford *IGERT in Biorefining, Kansas State University,* Peter Pfromm, Mary Rezac
rezac@ksu.edu

Department of Chemical Engineering, Kansas State University, Manhattan, Kansas, U.S.A.

Catalytic membrane reactors afford an alternative and potentially more efficient method for performing three-phase heterogeneous chemical reactions. Traditional three-phase reactors often present mass transfer limitations, namely gas solubility in the liquid phase. Membrane reactors can alleviate the inherent mass transfer limitations by directly and abundantly supplying gas to the catalytic sites on the membrane surface, which acts as a gas/liquid contactor. The focus of this study is the application of a polymeric catalytic membrane reactor to the hydrogenation of hydroxymethylfurfural (HMF), a biomass-based chemical derived from fructose. Hydrogenated HMF intermediates have a variety of manufacturing uses, and a notable product, 2,5-dimethylfuran (DMF), has many attractive characteristics as a liquid fuel.

Polyimide polymers are used for membrane synthesis because of their good chemical and high temperature resistance. The polymer solutions are cast as asymmetric integrally-skinned flat sheet membranes and are then coated with a ruthenium catalyst on the non-porous surface. The completed membrane is positioned in a flow over configuration maintaining liquid contact on the metal coated surface while allowing hydrogen gas to permeate from the porous support side to the catalytic sites on the non-porous surface. This study explores reaction kinetics and the influence of reaction temperature and gas phase pressure on system performance. Scanning electron microscopy is employed to examine the membrane and catalyst morphology before and after the reaction. An important parameter of this study is the reaction solvent choice, which is crucial for maintaining a functional membrane reactor as the necessary elevated temperatures for the chemical reaction also increase the solubility of the solvent in the membrane, leading to swelling and possible membrane failure. Solvent solubility in the polyimides of this study at different solvent vapor activities and temperatures is measured using a quartz crystal microbalance. Solvents of interest include water and short-chain alcohols. This research on the development and characterization of a functional polymeric catalytic membrane reactor for HMF hydrogenation provides an example of the methodology needed for applying membrane reactors in heterogeneous catalysis.

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POSTER 5

LACTIC ACID PRODUCTION FROM BIOMASS DERIVED SUGARS USING CO-CULTURE FERMENTATION

Yixing Zhang, Praveen Vadlani

Bioprocessing and Renewable Energy Laboratory, Department of Grain Science and Industry, College of Agriculture, , Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Lactic acid is a versatile and important chemical widely used in food, cosmetic, and pharmaceutical industry. Poly lactic acid (PLA) polymer made of both poly-L and D-lactate and has a higher melting temperature with extended applications. Most of the homofermentative lactic acid producers, such as *Lactobacillus plantarum,* cannot convert pentose sugars to lactic acid. In contrast, some heterofermentative lactic acid bacteria, such as *Lactobacillus brevis,* have been used to produce lactic acid from xylose. Co-culture fermentation using both these cultures could increase the production of lactic acid as well as the utilization of all biomass sugars. In our study, lactic acid production using *L.plantarum* and *L.brevis* as co-cultures was investigated in detail. Batch fermentation were perfomed using mixture of glucose and xylose and wood hydrolyzate as substrate. *L.brevis* and *L.plantarum* were simultaneously co-cultured at 37 ˚C; *L.brevis* was sequentially cultured after 12 hours at 30 ˚C. In our experiments, a lactic acid yield of 0.92 g/g and productivity of 0.51 g/L/h was obtained from mixture of glucose and xylose, and ethanol was completely removed *via* sequential co-culture fermentation of *L. brevis* and *L.plantarum*. Further, complete substrate utilizaton was achieved by co-culture fermentation with enhanced product formation. Efficient utilization of both cellulose and hemicellulose components of the biomass will improve the overall lacti acid productivity and enable an economic process to produce biodegradable plastics.

POSTER 6

LIGNIN VALORIZATION USING CATALYTIC MEMBRANE REACTORS

Michael D. Wales *IGERT in Biorefining, Kansas State University,* L. Joos; P. H. Pfromm; M. E. Rezac

Department of Chemical Engineering, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

The Renewable Fuel Standard 2 (RFS2) mandates the production of 16 billion gallons of cellulosic ethanol by the year 2022; however, cellulosic ethanol production is not currently economically feasible and no commercial sources exist. To help cellulosic ethanol biorefineries compete with corn ethanol and petroleum based fuels, value added products must be integrated into their production stream. Lignin valorization offers biorefineries a unique opportunity to act analogues to their petroleum counterparts, i.e. produce fuel **and** chemicals. This can be done by converting lignin (20-30 wt% of biomass) into valuable chemicals. Depolymerized lignin can be hydrodeoxygenated into the platform chemicals benzene, toluene, and phenol. These hydrodeoxygenation (HDO) reactions possess inherent mass transfer limitations due to low hydrogen solubility in liquid and slow diffusion to the catalyst surface resulting in hydrogen depletion at the catalyst surface. To minimize this problem extreme operating conditions with pressures of 100 atmospheres are frequently employed. Previous work in our group has shown that both hydrogenation and HDO reactions can be achieved in membrane reactors at pressures in the 1-5 atmosphere (atm) range. The use of membrane contact reactors will be explored for HDO of lignin model compounds at pressure between 1-5 atm.

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POSTER 7

EVALUATION OF ORGANIC SOLVENTS FOR THE BIOMASS PRETREATMENT TO PRODUCE 2, 3-BUTANEDIOL

Yadhu N. Guragain, Praveen V. Vadlani

Bioprocessing and Renewable Energy Laboratory, Department of Grain Science and Industry, College of Agriculture, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Integrated biorefineries should utilize all components of the lignocellulosic biomass, including cellulose, hemicellulose and lignin, for economic and commercial viability. Currently, they are using energy-intensive thermo-chemical biomass pretreatment processes. Such processes produce inhibitors for the fermentation of released sugars, and degrade lignin quality for high value application. Extraction of lignin using green solvents can be an alternative approach to fractionate biopolymers with minimal degradation and thereby retain their quality for high value fuels and chemicals production. We evaluated various alkaline organic solvents for the pretreatment of corn stover and poplar, and compared them with optimized aqueous alkali as a control. We tested glycerol, dimethyl sulfoxide (DMSO), (2, 3)-butanediol, ethanol, propanol, butanol, and acetonitrile as the organic solvents. In control pretreatment, we mixed corn stover and poplar in 1% and 5% (W/V) aqueous sodium hydroxide (NaOH) solution, respectively, in 1:10 (W:V) ratio and autoclaved at 121°C for 30 min. Organic solvent pretreatment was optimized for processing temperature at atmospheric pressure and catalyst (NaOH) concentration. Results showed that glycerol is the best among the evaluated solvents for pretreatment of poplar using 0.4% NaOH at 170°C, which led to 36% more sugar yield than control. While using corn stover, effectiveness of alkaline organic solvents was less than control; however, equal mixture (by volume) of ethanol, butanol and water showed promising results. Overall sugar yield in the solvent mixture process was only 8% less than control even though the pretreatment condition was very mild as compared to control (refluxed at around 80°C using 0.4% NaOH). This indicated that the process can be further improved with optimum proportion of solvent mixture at higher temperature using pressure reactor. A schematic diagram for overall mass balance and further bioprocessing steps for complete utilization of biomass is proposed.

POSTER 8

THE ECONOMIC DEVELOPMENT-ENERGY NEEDS SYSTEM: A SIMULATION OF ALTERNATIVE FUTURES FOR GHANA

Frank Kyekyeku Nti[1,2] and Vincent Amanor-Boadu[1,3]

[1]Department of Agricultural Economics, [2]IGERT in Biorefining, [3]Associate Professor

BACKGROUND: Ghana is endowed with a wide range of potential energy resources – solar, wind, mini-hydro, biofuel, and currently fossil fuel – yet to be exploited. This article identify and quantify the consequence of alternative energy sources on the future growth of Ghana's economy in light of current and potential future energy challenges and prospects, coupled with population growth and other socioeconomic factors.

METHOD: The paper uses a system dynamic modeling approach to assess the effect of the alternative energy generation sources on Ghana's development effort within the context of environmental sustainability. The system dynamic modeling approach allows the incorporation of alternative policy and production options into the model and evaluate their feedback effects on the endogenous outcomes of interest. It also allows an evaluation of alternative scenarios of policies, investments, consumption and supply conditions to determine the system that engenders the most sustainable outcome.

EXPECTED OUTCOME: The results offer policy options for embarking on addressing Ghana's energy challenges over time. They would also help investors considering this sector develop a better understanding of the potential challenges and opportunities that prevail in developing sustainable energy solutions.

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POSTER 9

NUTRIENT AMENDMENT AND MANAGEMENT EFFECTS DURING BIOFUEL PRODUCTION ON SOIL MICOBIAL DYNAMICS AT KONZA TALLGRASS PRAIRIE ECOSYSTEM

Vanessa R. Walker *IGERT in Biorefining, Kansas State University, a*nd Charles W. Rice

Department of Agronomy, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Growing biofuel crops can have a significant impact on agriculture and land use change, which have been linked to changes in atmospheric CO_2 concentrations. Global climate change has been associated with increasing amounts of atmospheric greenhouse gases, including CO_2. The reduction of soil disturbance can result in increasing the amount of soil organic carbon (SOC). Understanding the impacts of crop production practices on soil microbial dynamics is vital to soil quality and mitigation of atmospheric CO_2. A long-term field experiment site at Konza Prairie Biological Station was used to understand the influence of belowground dynamics when comparing perennial and annual plant management practices. To assess SOC dynamics, we included grain sorghum (*Sorghum bicolor*) planted in no-tillage (NT) or continuous tillage (CT), and replanted native prairie grass, (*Andropogon gerardii*) (RP). The field experiment investigated SOC as affected by agricultural nutrient amendments (N, P or no nutrient addition). Treatment effects on SOC was measured at 0-5, 5-15, and 15-30 cm depths. Soil quality will be assessed through the examination of soil aggregate stability, microbial biomass C and N, and an assessment on microbial community through phospholipid fatty acids analysis. We plan to see higher biological activity associated with the least soil disturbed RP and NT, than in the more disturbed CT, and therefore, higher sequestration of SOC in RP.

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POSTER 10

HYDROTREATING OF FAST PYROLYSIS OIL WITH CATALYTIC INTEGRAL-ASYMMETRIC MEMBRANES AT MILD CONDITIONS

Michael G. Heidlage[1,3] *IGERT in Biorefining, Kansas State University,* Frank Nti[2,3], Peter H. Pfromm[1], Mary E. Rezac[1], and Vincent Amanor-Boadu[2]

[1]Department of Chemical Engineering, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

[2]Department of Agricultural Economics, Kansas State University, Manhattan, Kansas 66506, U.S.A

Fast pyrolysis of biomass is a thermochemical approach to obtain liquid fuels and chemicals. Fast pyrolysis is feedstock agnostic as opposed to fermentation-based processing which requires adaptations and sophisticated pre-treatments for different feedstocks. Bio-oil is not sufficiently stable after fast pyrolysis to allow storage and/or transport. Post-pyrolysis chemical reactions due to high oxygen content of the molecules that comprise bio-oil are generally thought to be a main issue. Partial deoxygenation is therefore desirable. Oxygen-rich bio-oil requires stabilization that can be achieved through heterogeneous liquid-phase catalytic hydrodeoxygenation (HDO). State of the art HDO typically requires severe conditions (20-55 atmospheres and 250-400°C). H_2 is fed from the substructure (permeate side) of the membrane through the selective membrane skin directly to the catalyst avoiding the hydrogen solubility issue of conventional liquid phase hydrotreating. HDO was tracked by monitoring the greatly increasing water concentration in the bio-oil. Here we report successful HDO of bio-oil at mild conditions near 3 atm H_2 and 90°C using a catalyst-decorated polymeric integral-asymmetric membrane. The treated oil phase-separated into water and organic rich phases while the original untreated bio-oil did not. HDO at mild conditions as demonstrated here could enable decentralized processing of biomass first by fast pyrolysis followed by stabilization of the oil on site prior to storage and transport. Decentralized processing is important to overcome the well-known transport issue for non-densified biomass. Rural economies would likely benefit from exporting an intermediate such as stabilized bio-oil rather than unprocessed materials.

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POSTER 11

CHARACTERIZATION OF PBI-MATRIMID BLEND GAS SEPARATION MEMBRANES FOR LIGNIN UPGRADING APPLICATIONS

Leslie Schulte *IGERT in Biorefining, Kansas State University,* Michael Wales, Dr. Mary Rezac* *

Department of Chemical Engineering, Kansas State University, Manhattan, KS 66506, USA

* rezac@k-state.edu

Lignin makes up about 30% of all plant material. It is currently used for fuel by industry but, because it is a renewable source of aromatic hydrocarbons, it could be more profitable to use this material as a feedstock for industrially important chemicals. It has been proposed that a membrane reactor could be used to transform lignin compounds into chemically useful products. A polymeric membrane has been fabricated that can maintain its properties in the presence of oxygenated aromatics. The membrane has large gas fluxes and significant thermal and chemical stability. It is made of two polymers, polybenzimidazole (PBI) and Matrimid 5218. PBI has remarkable chemical and thermal resistance but low gas permeabilities. Matrimid 5218 has good chemical and thermal stability and higher permeabilities. By blending these two polymers we have achieved a membrane with hydrogen permeances over 100 GPU and better chemical and thermal resistance than pure Matrimid membranes. Flat sheet membranes with equal parts PBI and Matrimid have been fabricated and characterized by gas permeation both before and after annealing at 300°C. PBI-Matrimid membranes with no heat treatment retained 94% of their mass at 500°C under air while annealing the membranes at 300°C for 18 hours results in a retention of 97%. The membranes were tested for chemical resistance in toluene, xylene, methyl benzoate, ethyl benzoate, and guaiacol.

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POSTER 12

HYPER-EXTRACTIVE IRRIGATION AND THE OGALLALA AQUIFER: AN ECONOMIC POLICY ANALYSIS USING OPENMI AND ARCGIS

Michael B. Lindbloom *IGERT in Biorefining, Kansas State University.*

Department of Agriculture Economics, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

The Ogallala Aquifer is a water table aquifer located beneath eight states in the Great Plains region of the United States. Starting around the 1950's, agricultural producers in the Great Plains took advantage of lowered pumping costs and improved center pivot technology, and began to utilize the ground water stored in the aquifer to irrigate crops. Since then, the magnitude of pumping from the aquifer has only increased. And like any nonrenewable resource, removal without replenishing results in depletion. The purpose of this research is to determine the effects of different water rights policies on ground water extraction in Western Kansas. To accomplish this task, I will link an OpenMI system to an ArcGIS system to model the economic optimization problems facing irrigators in Western Kansas. Using OpenMI and ArcGIS will allow for a model that is dynamic and realistic.

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POSTER 13

IN-SITU ATOMIC FORCE MICROSCOPY STUDY OF METAL SURFACES IN CATALYTIC HYDROGENATION MEMBRANE REACTORS

Matthew J. Young[a] *IGERT in Biorefining, Kansas State University,* Peter H. Pfromm[a], Mary E. Rezac[a], Bruce M. Law[b]

[a]Department of Chemical Engineering, [b]Department of Physics

Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Heterogeneous catalysis is a commonly used process with applications in fields ranging from pharmaceuticals and petrochemicals to biomass conversion and food production. One such process, hydrogenation, presents difficulties for liquid-phase reactions due to the poor solubility of hydrogen. Low hydrogen concentration at catalytic sites can result in unwanted side reactions and coking. Hydrogen pressures of tens or even hundreds of atmospheres are used to overcome the solubility limitation. Catalytic membrane reactors (CMRs) have been shown to improve the selectivity of hydrogenation processes by supplying adequate hydrogen directly to catalyst sites avoiding liquid-phase mass transfer limitations and utilizing hydrogen supplied near ambient pressure. Most hydrogenation CMR research focuses on the nature of the membrane material, but it is also important to consider the nature of the catalyst and its interactions with hydrogen. In the past, it has been suggested that hydrogen permeates through the membrane and migrates to catalytic sites, but this has been difficult to prove. Although a range of technology exists to study catalytic surfaces, most of it relies upon high-vacuum conditions that make in-situ research difficult, or impossible in the case of liquid-phase applications. Atomic force microscopy (AFM) is one technology that does allow for the study of solid-liquid interfaces. Tapping-mode AFM allows further expansion of the range of information that can be obtained from a sample using measurement techniques based on the responses of probes to various stimuli. The work presented shows the application of tapping-mode AFM in real-time studies of catalytic surfaces under liquid at ambient conditions. This is hoped to enable an improved understanding of the dynamics of hydrogen coverage and mass transfer on catalytic surfaces at atmospheric pressure and under liquid. Such information on the mechanism and kinetics of liquid-phase hydrogen/catalyst interactions will aid in the optimization of CMRs.

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POSTER 14

AGRICULTURAL LAND-USE AND SPATIAL PROXIMITY OF ETHANOL PRODUCTION: A COUNTY-LEVEL ANALYSIS WITHIN KANSAS

Brian Lauer[1,5] *IGERT in Biorefining, Kansas State University,* J. Bergtold[1,5], M. Caldas[2,5], J. Peterson[1,5], D. Earnhart[3,6] , C. Brown[2,6], E. Hanley[4,6]

[1] Agricultural Economics, [2] Geography, [3] Economics,[4] Political Science, [5] Kansas State University, [6] University of Kansas

Applied economists have dedicated much literature to the design and specification of acreage allocation models for land use decisions. These models can play an important role in understanding how acreages might shift in the event of new policy or in a changing agricultural landscape, especially with the increasing demand for biofuel production. The purpose of this paper is to examine the impact of ethanol production on agricultural land-use in Kansas. The paper builds on previous acreage allocation studies by correcting for spatial autocorrelation and spatial proximity to ethanol refineries using capacity as a function of distance to a refinery as an explanatory factor in the model. Bioenergy is an important agricultural topic to the state of Kansas, and understanding how the presence of ethanol plants effects producers' acreage decisions is critical as the bioenergy industry moves forward and new policies are developed. This study will use a 1996-2009 Kansas county level dataset for analysis. Variables that will be examined include revenues, production costs, livestock populations, government programs, site and soil characteristics, weather, and ethanol plant characteristics such as proximity to a county and size of the plant. Models will be estimated for Corn, Wheat, Sorghum, Soybeans, Alfalfa, and CRP land in a dry land system and Corn, Wheat, and Soybeans in and irrigated system. The methods in this paper will follow similarly the methods proposed by Wu and Brorsen (1995) which extended the HEAR model proposed by Kmenta (1996) to a set of seemingly unrelated equations. These methods will be expanded to take account of spatial dependence using the Spatial Error Model of LaSage and Pace (2009).

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.

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POSTER 15

HYBRID ELECTRODES BASED ON METAL OXIDES AND VERTICALLY ALIGNED CARBON NANOFIBERS SHELL-CORE HETEROSTRUCTURE FOR LITHIUM ION BATTERIES

Steven Klankowski, Yichen Zheng and Jun Li, Department of Chemistry, Kansas State University, Manhattan, Kansas, 66506, U.S.A., Rongtao Lu, Chunrui Ma and Judy Wu, Department of Physics and Astronomy, University of Kansas, Lawrence, KS 66045, Ronald Rojeski, Catalyst Power Technologies, 200 Carlyn Avenue, Suite C., Campbell, CA 95008

Lithium ion batteries are considered to be the most important energy storage technology of today, with prominent advantages of high energy and power density as well as long cycling life, for large-scale application in portable electronic devices, stationary energy storage systems, and the ever-enlarging market of electric vehicles. Nevertheless, these applications have become more demanding and constrictive, pushing the need for greater power from an even smaller form factor. Three-dimensional architectures can provide this by taking advantage of all three dimensions to increase the amount of active surface area on the electrode within a given footprint and at reduced weight.

We present the use of a core-shell nanowire architecture that utilizes vertically aligned carbon nanofibers (VACNF), functioning as a rigid backbone, to support an active lithium intercalatable metal/transition metal oxide (MO) for use as electrode. The VACNF template offers a unique freestanding brush-like structure where each carbon nanofiber is strongly anchored to the substrate and fully separated from others, leaving sufficient space for uniformly coating MO materials using chemical vapor deposition (CVD) and pulsed laser deposition (PLD). The carbon nanofibers provide a very large active surface area and highly conductive electron pathway between the shell material and the current collector. Lithiated Cobalt Oxide ($LiCoO_2$) and Titanium Oxide ($LiTiO_2$) are studied as a cathode and anode, respectively, to utilize the proper electropotential of each material. The performance in power and energy densities in correlation with the electron and lithium-ion transport is under investigation. The cycle stability of the active MO shell is expected to improve with the core-shell structure.

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POSTER 16

A WELFARE ANALYSIS OF PREFERENTIAL FUEL TAXES FOR ETHANOL IN BRAZIL

Mario A. Ortez, Ana Claudia Sant'Anna, Nathan P. Hendricks

Department of Agricultural Economics, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Brazil is one of the world's largest producers of ethanol. Nevertheless, the Brazilian ethanol industry still depends on governmental programs. Our study analyzes the welfare change due to the removal of the fuel tax for ethanol in Brazil in 2003 to 2004. We use an Equilibrium Displacement Model that analyzes the gasoline and ethanol markets jointly. We estimate the demand for ethanol in Brazil using state-level data from 2002-2010. The demand elasticity for ethanol is elastic in all regressions estimated. These estimated parameters along with others collected from previous studies are then used to calculate changes in welfare measures due to the removal of a fuel tax for ethanol but holding constant the tax for gasoline. Consumer surplus and producer surplus in the ethanol market are estimated, as well as, the change in consumer surplus in the gasoline market. As expected, due to the tax removal, the prices of gasoline and ethanol increase. The price of gasoline increased due to the tax, while the price of ethanol increased due to the increase in quantity demanded. Furthermore, the quantity consumed of gasoline decreases while that of ethanol increases. We estimate that the welfare of ethanol producers increased U$ 116.26 million from 2003 to 2004, at the expense of a decrease in consumer surplus in both markets. Notwithstanding, the policy achieved its aim which was to support the ethanol industry making it more competitive to the gasoline market.

POSTER 17

OPTIMIZING MAXIMUM DISTRIBUTED WIND GENERATION AND ENERGY STORAGE IN THE THREE-PHASE UNBALANCED RADIAL DISTRIBUTION SYSTEM WITH NON-DOMINATED SORTING GENETIC ALGORITHM II

Dulan J Weerasinghe, Ruth Douglas Miller

Electrical and Computer Engineering Department, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

According to the US Energy Information Administration (EIA), renewable generation will provide 14.1% of total power generated in US in 2015. In recent years many studies have investigated the high utilization of renewable distributed generation (RDG), especially wind turbines. Although distributed wind generation provides grid independence, the stochastic nature of its generation limits the high penetration of RDG in three-phase unbalanced distribution systems. In our studies, we are focusing on maximizing distributed wind generation and using distributed energy storage systems (ESS) to minimize the stochastic nature of the RDG.

Although high utilization of ESS will increase the reliability of power and escalate the grid independency, cost associated with these projects will not make them economically viable. Our goal is to optimize the maximum amount of distributed wind generation with the help of ESS units in a three-phase unbalanced radial distribution system considering economic viability, minimum system loss, and improved voltage profile of the system. We are using the Non-dominated Sorting Genetic Algorithm II (NSGA II) method for the optimization process. NSGA II provides a set of optimized solutions called a Pareto front. Pareto fronts consist of non-dominated solutions for the problem. Without any predefined conditions and associated factors none of the solutions in the Pareto front is more important than any other solution in the same Pareto front.

Finalizing our goal we are planning to develop a Distributed Renewable Energy Optimization and Analysis Package (DREOAP), a Matlab program with a Graphical User Interface (GUI), which can be used to optimize the time and effort of the research community, serve as an educational tool, and analyze the economic viability of renewable projects.

POSTER 18

A NONLINEAR CONTROL SCHEME FOR EXTREMUM POWER SEEKING IN WIND TURBINE ENERGY CONVERSION SYSTEM

Fariba Fateh[1], Warren White [2], and Don Gruenbacher [1]

[1]Department of Electrical and Computer Engineering, [2]Department of Mechanical and Nuclear Engineering, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Wind is a cost-effective, clean renewable energy that can benefit the state future energy needs.

A report by the U.S. Department of Energy presents a framework for achieving 20% of the U.S. electrical energy generation from wind by the year 2030 [1]. In 2012, 13 GW of wind power was added, and leading states for the capacity added were Texas, California and Kansas [2]. This desired growth in wind energy provides motivation to conduct many engineering investigations to improve efficiency and productivity of wind turbines. A technical challenge is to develop a robust control scheme for maximum power seeking in wind turbines in the presence of wind speed fluctuations. A novel nonlinear control scheme for maximum power seeking in wind turbine energy systems is presented in this paper. In the proposed control scheme, the wind turbine power coefficient is estimated using a Lyapunov-based adaptive control technique. The power coefficient estimation procedure differs from previous estimation strategies. The estimated power coefficient is used to determine a desired turbine rotor speed based on an estimate of the power coefficient gradient with respect to rotor speed. The desired rotor speed moves the turbine operation in the direction of increasing power coefficient and a PI controller causes the turbine rotor speed to track the desired rotor speed. The presented extremum seeking procedure differs markedly from the well-known perturb and observe scheme and does not require the addition of a dither signal. The NREL FAST numerical results are presented to demonstrate the validity and robustness of the developed control scheme.

1. U.S. DOE Office of Energy Efficiency and Renewable Energy Report July 2008.
2. Renewables 2013 Global Status Report, www.ren21.net/GSR.
3. F. Fateh, W. N. White, and D. Gruenbacher, “A Nonlinear Control Scheme for Extremum Power Seeking in Wind Turbine Energy Conversion Systems,” will be presented at the American Control Conference, June 4-6, 2014, Portland, Oregon.

POSTER 19

AB INITIO STUDY OF THE MECHANISM FOR WATER OXIDATION TO MOLECULAR OXYGEN BY COBALT OXIDE ELECTROCATALYST

Amendra Fernando Hewa Dewage, Christine M. Aikens

Department of Chemistry, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

The development of a commercial electrocatalyst for water splitting is a major step in utilizing molecular hydrogen as a cleaner and sustainable next generation power source. Hydrogen itself is a very efficient energy source compared to present carbon based petroleum fuels and it is environmentally friendly as the combustion products are free of carbon dioxide and monoxide. Of the two half-reactions, which are the anodic reaction of water oxidation and cathodic reaction of hydrogen evolution in water electrolysis, water oxidation is the bottleneck reaction and catalysis of this reaction is necessary to enhance the efficiency of the overall reaction.

Currently Pt like precious metals are used as electrocatalyst for cathode but their large-scale deployment is limited due to high cost. Very recently, a precious metal free cobalt oxide water oxidation catalyst by Nocera and co-workers has generated a wide popularity because of its high efficiency at neutral pH and stability under operating conditions. It is important to investigate this system as it has a huge potential to be a next generation electrocatalyst. From these studies not only can we modify and thus optimize the catalyst but this understanding may also lead to suggestion of other alternatives.

Presently, there are a couple of suggestions on the structure and the mechanism of the cobalt catalysis but up to date there is no widely accepted theory. Our aim is to develop a fundamental understanding of the reaction mechanism involved in oxygen evolution on this cobalt oxide catalyst. For this we are investigating the reaction mechanism in three approaches. We modeled our catalyst based on experimental evidence and investigated all the possible mechanisms from a minimum structural requirement of a dimer to extended cubane like model. Current status of the project will be discussed in the poster session.

POSTER 20

REVIEWING TEXTILE AND APPAREL PRODUCTION ENERGY CONSUMPTION AND CONSERVATION LITERATURE: IDENTIFYING ESSENTIAL FACTORS AND DEVELOPING A MEASUREMENT MODEL

Md. Imranul Islam, Melody L. A. LeHew,

Department of Human Ecology, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Problem statement: An intensified demand for sustainability in the past few decades coupled with ever-increasing demand for apparel products has encouraged increasing initiatives to reduce the textile and apparel (T&A) industry environmental footprint. This environmental footprint deals with reducing energy consumption and greenhouse gas (GHG) emission. There is a lack of research regarding environmentally sustainable apparel production in comparison to textile production.

Purpose: Extant literature focused on energy consumption and conservation in T&A production was reviewed, identifying the essential energy consumption factors and developing a model to capture energy consumption levels for an apparel production firm.

Rationale: Knowing the consumed energy from the model will enable a firm to assess magnitude of GHG emissions using a GHG calculator.

Methodology: An extensive review of published research detailing energy consumption and conservation efforts was conducted to identify key contributors to energy consumption and GHG emission within the T&A industry.

Findings: Twelve factors causing energy consumption in the apparel industry have identified and a model is developed through employing regression analysis.

Conclusion and Implication for research and/or practice: Today and even more so in the future, the pressure to reduce energy consumption will come from the twin drivers of improving cost competitiveness and ensuring market acceptance of the textile sector as well as the apparel sector. It will help apparel manufacturers to determine their energy consumption and energy efficiency effortlessly which will give them an impetus in environmental action through reducing energy consumption & GHG emission from their industry.

POSTER 21

COORDINATED ELECTRIC VEHICLE CHARGING SOLUTIONS USING RENEWABLE ENERGY SOURCES

Kumarsinh Jhala, *Student Member, IEEE*, Balasubramaniam Natarajan, *Senior Member, IEEE*

Anil Pahwa, *Fellow, IEEE* and Larry Erickson, Wi-Com Group, Department of Electrical and Computer Engineering, Kansas State University Manhattan, Kansas 66502, U.S.A.
kumarsinh@k-state.edu, bala@k-state.edu

The growing concerns about global warming, air pollution and oil shortage have motivated the research and development of electric vehicles (EVs), which are energy efficient. The US government has stated its goal of putting 1 million EVs on the road by 2015. Due to the anticipated increase in number of EVs, EV charging is emerging as a significant challenge for customers and utilities. In this work, we propose coordinated EV charging strategies for residential chargers and commercial charging stations at parking lots. In residential charging, the main focus is on the investigation of distribution transformer overloading. In commercial charging stations, the focus is on minimizing energy drawn from grid while utilizing energy from renewable energy resources in order to maximize benefits to the parking lot owners. We propose an optimal control strategy for EV charging that maximizes the use of renewable energy sources. The coordination strategies are discussed for both of these scenarios.

1) *Residential charging (Distribution transformer overloading):* According to, the current distribution system is incapable of supporting large number of EVs. In case of uncoordinated charging, as few as two charging EVs can force transformer to operate above its rating. We have developed charging strategies that avoid transformer's overloading while ensuring fairness to customers. Staggered Charging and Proportional Charging are examples of charging methods that prevents transformer's overloading and loss of life.

2) *Commercial Parking lot charging (Coordinating Distributed Generation (DG) and EVs):* We consider a parking lot with M charging stations that uses solar and wind energy to charge plug-in EVs in addition to grid power. The goal of our work is to coordinate the charging rate in order to minimize the power drawn from grid while providing the desired level of charging within the available time frame. We propose an optimal control strategy for EV charging while maximizing the use of renewable energy sources in order to provide for maximum benefit to the charging station operator.

This work is supported in part by a grant awarded by The K-State Electric Power Affiliates Program.

POSTER 22

EFFECTS OF MICRO-STRUCTURED SURFACE GEOMETRIES ON CONDENSATION HEAT TRANSFER

Andrés Martínez, Caleb Chiroy, Amy Rachel Betz

Mechanical and Nuclear Engineering Department, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

The purpose of this research is to experimentally study how micro-structured geometries affect the heat transfer coefficient on a surface under filmwise condensation conditions. Filmwise condensation is a major concern when designing steam condensers for thermoelectric power plants. These plants currently account for 40% of freshwater withdrawal and 3% of freshwater usage in the United States. Filmwise condensation averages five times lower heat transfer coefficients than those present in dropwise condensation. Currently, filmwise condensation is the dominant condensation regime in thermoelectric power plants due to their prolonged usage. The film thickness is directly proportional to the condenser's overall thermal resistance. This investigation focuses on optimizing surface geometries with sinusoidal patterns to reduce film thickness and maximize filmwise heat transfer. The experimental setup allows us to control the cooling load, pressure, and steam quality in order to measure the steam-side surface temperature under steady state conditions. The test apparatus allows control of the cooling load and steam properties while being able to interchange the surface structures. The heat transfer coefficient is determined by measuring surface temperature. By comparing the heat transfer coefficients, we can find the optimal surface geometries by varying fin height, fin pitch, and surface curvature. A four axis micro milling machine with precision of one micron was used to machine the desired surface patterns. Aluminum was chosen based on its machinability, cost, and thermal properties. Type T thermocouples, hygrometers, and pressure transducers were used for data acquisition. A vacuum pump creates low pressure conditions and temperature steam that mimics condenser conditions. The steam-surface temperature is measured once the system achieves steady state conditions.

POSTER 23

PROPERTY CHARACTERIZATIO OF MATRIMID/P84 BLEND FILMS

Shuzhen Qiu and Mary Rezac

Department of Chemical Engineering, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

BACKGROUND AND PURPOSE: Matrimid and P84 are common commercial polyimide polymers employed for membrane preparation. Matrimid shows great permeability and P84 shows great solvent resistance, both of which are importance properties for membrane reactor for biomass hydrogenation. Literatures have shown that the blend membranes of Matrimid and P84 demonstrated the combination of high permeability and great solvent stability. In this study, blend films of Matrimid and P84 have been prepared and characterized.

Approach and Experiments: In this study, blend films of varied ratios of Matrimid and P84 have been made. D-spacing, density, glass transition temperature and permeability of the blend films using XRD, density gradient column, GTA, DSC, and constant volume flux text system.

RESULTS of Key Experiments: Generally, the permeability of gases increases as the ratio of Matrimid/P84 increases, yet the selevtivity of H2/N2 has an opposite trend. D-sapacing, density, glass transition temperature will be measured, and possible differences of those properties due to varied ratios of Matrimid/P84 will be discussed.

POSTER 24

SYNTHESIS OF GOLD NANOPARTICLES TOWARD PLASMONIC ENHANCED DYE SENSITIZED SOLAR CELLS

Joshua Toevs, Yiqun Yang, Jun Li

Department of Chemistry, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Dye-sensitized solar cells (DSSCs) are a class of emerging solar cells that convert sun light into electricity. Incorporation of plasmonic nanoparticles into DSSCs has been recognized as a viable approach to enhance the energy conversion efficiency and lower the cost. Gold nanoparticles (GNPs) have the desired plasmonic properties for increasing light harvesting of DSSCs. Toward this goal, it is desired to synthesize large quantities of GNPs with controlled dimension and plasmonic properties matching the dye absorption wavelength. This research is focused on using the solvated metal atom dispersion method (SMAD) followed by digestive ripening in proper ligands. The combined approach was able to convert the widely dispersed GNPs into rather uniformly dispersed GNPs at ~7.3 nm. The surface plasmon resonance peak was observed at 510 nm wavelength, matching that needed to excite the N719 dye.

POSTER 25

MINERALOGICAL CHARACTERIZATION OF THE ARBUCKLE AQUIFER: IMPLICATIONS FOR CO_2 STORAGE

Michael Vega and Saugata Datta

Department of Geology, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

In response to increasing concern over anthropogenic greenhouse gas emissions, the saline Arbuckle aquifer of south-central and western Kansas has recently become a subject for assessing regional CO_2 storage potential. Two well locations were chosen (Cutter KGS#1, south-western Kansas; Wellington KGS 1-32 & 1-28, south-central Kansas) to assess the depthwise mineralogical and petrophysical variations that exist throughout the vertical extent of the Arbuckle and its surrounding units. Over 2000' of core was obtained from Cutter KGS#1 to aid in the characterization of this complex aquifer system. The scope of this project is to analyze the depth-wise mineralogical and petrophysical properties of the Arbuckle rock structure and its overlying formations in order to interpret potential post-injection reaction pathways. Ultimately, the goal is to confirm that sustainable geologic storage via carbonate mineralization is probable in these natural systems. 235 core plugs and 17 thin sections were petrographically analyzed and three zones of particular importance were identified in these two wells: 1) The overlying Pennsylvanian and Mississippian oil reservoirs; 2) The Jefferson City dolomite, a potential baffle; and 3) The Arbuckle Group, which represents the proposed injection zone. Arbuckle thin section and core analyses revealed fine grained dolomite dominance with heterogeneously distributed vugs and fracture-pathways. Vugs and fractures were often infilled with argillaceous, sulfide, or carbonate components that can release precipitating cations into the aqueous phase when dissolved by the CO_2-brine solution. The dissolution of carbonates will also enhance dissolved CO_3^{2-} concentrations, which can then combine with major and accessory mineral derived cations to ultimately precipitate carbonate minerals. It is vital that reactions between the CO_2-brine solution and surrounding rock are understood in order to ensure that secure, long term geologic storage of CO_2 occurs and the extent of carbonation in this system due to injection can be measured.

POSTER 26

UTILIZATION OF HEMICELLULOSE-RICH BIOMASS FEEDSTOCKS FOR PRODUCTION OF SINGLE CELL OILS

Kyle Probst *IGERT in Biorefining, Kansas State University,* and Praveen Vadlani

Bioprocessing and Renewable Energy Laboratory, Department of Grain Science and Industry, College of Agriculture, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

Utilization of pentose sugars (e.g. xylose) derived from hemicelluose-rich biomass feedstocks for the production of cellulosic ethanol has been a challenging endeavor. One of the major set-backs includes the inability of the yeast *Saccharomyces cerevisiae* to utilize pentose sugars. Oleagnious yeast species such as *Lipomyces starkeyi* are capable of converting said pentose sugars including xylose into single cell oils (SCOs). SCOs are valuable intermediates that can serve as renewable inputs for many oleochemicals including fuels, polymers, food ingredients, cosmetic additives, and lubricants. Previous work in our laboratory showed that *L. starkeyi* yielded 0.14g SCO/g sugar when using xylose as the major carbon source compared to 0.08 g SCO/g sugar for glucose. The ability of *L. starkeyi* to produce high yields of SCOs from xylose may indicate that biomass sources rich in hemicellulose (i.e. xylose) such as wheat bran (25-38%, dry wt.) and corn bran (44-55%, dry wt.) may serve as viable feedstocks for SCO production. The purpose of this research is to develop and test a bioprocess to produce SCOs using corn bran and/or wheat bran feedstocks. Different pretreatment strategies will be tested for hydrolysis efficiency of hemicellulose fractions. Hydrolysates will be used as the substrate for batch-flask fermentation using previously optimized fermentation conditions. Hydrolysis efficiency, substrate uptake rate, biomass growth, SCO production, and fatty acid profiles will be quantified and discussed at the presentation. The results from this study may have significant economic implications for the development of an industrial SCO bioprocess.

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POSTER 27

ROLE OF BICYCLE IN ACHIEVING SUSTAINABLE URBAN DEVELOPMENT

[1]Maryam Hamehkasi, [2]Charles Barden

[1]Ph.D. student in Biological and agricultural engineering, Kansas State University

[2]Charles Barden: Professor, Department of Horticulture, Forestry and Recreation Resources State Extension Forester, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

The uncontrolled growth of urbanization and transportation systems is leading to social and environmental concerns .Uses of bicycles as a part of urban transportation helps to create attractive and healthy cities. Today, cycling as transport networks in many large cities around the world has raised. The creation of bike lanes in cities and metropolises of the world as one of the emergency planning and urban management is needed to solve some of the problems of the city. This paper aims to investigate the role of the bicycle in urban sustainable development of applied research - development and cross - sectional study to collect data library - documentation and the Internet. : The relationship between bikes and components of sustainable development, college campuses are privileged places to communicate sustainability and to help reshape society's transportation patterns. Also this paper attempts to answer how college campuses have encouraged a modal shift from cars to other modes, in particular to bicycling and walking.

POSTER 28

GENERATION OF REDUCED VISCOSITY PLANT OILS USING AN UNUSUAL ACYLTRANSFERASE: A STEP TOWARDS SUSTAINABLE PRODUCTION OF AN ADVANCED BIOFUEL

Sunil Bansal & Timothy P. Durrett

Department of Biochemistry and Molecular Biophysics, Kansas State University, Manhattan, KS 66506, U.S.A.

Currently seed oils have to be converted to biodiesel for use in conventional diesel engines; our goal is to develop plants that synthesize seed oils with improved properties that can be used directly as a transportation fuel. The use of straight vegetable oils as alternative fuel suffers from problems such as high viscosity, low volatility and poor cold temperature properties. In nature, the seeds of a few plant families produce unusual TAGs called acTAGs that possess an acetyl group at the *sn*-3 position instead of long chain fatty acids. These acTAGs were found to possess 29% lower viscosity than long chain triacylglycerols (lcTAGs). The enzyme EaDAcT (*Euonymus alatus* diacylglycerol acetyltransferase) responsible for the generation of these acTAGs is an acyltransferase that utilizes acetyl-CoA as a substrate. *Camelina sativa*, an emerging industrial oil seed crop, was used as a platform to synthesize large amounts of acTAGs. As the kinematic viscosity of oils increases with increasing molecular mass of TAGs, the incorporation of short and medium chain fatty acid instead of long chain fatty acids is expected to further decrease the viscosity of acTAGs. We therefore transformed EaDAcT into transgenic *Camelina sativa* lines producing high amounts of low and medium chain fatty acids. EaDAcT expression was combined with the knockdown of DGAT1 and PDAT enzymes, which compete with EaDAcT for their common diacylglycerol (DAG) substrate. Seed oil from homozygous T3 transgenic lines was found to contain novel short and medium chain fatty acid containing acTAGs. Lines giving maximum yield of these acTAGs will be bulked up to produce sufficient oil for physical properties and engine fuel testing.

POSTER 29

SOLAR POWERED CHARGING OF ELECTRIC AND HYBRID VEHICLES

Matthew Reynolds, Dr. Larry Erickson

Department of Chemical Engineering, Kansas State University, Manhattan KS, 66506, U.S.A.

As the market for electric vehicles increases, it is important that the demand for the electricity needed to power these cars is met. One promising solution to this necessity is solar powered charge stations. When implemented, these stations would provide EV drivers the ability to charge outside of just the home increasing the reliance on the vehicle by decreasing range anxiety. This increase in reliance will then cause more EV's to be driven increasing the market for not only EV's themselves, but for solar provided electricity. The upfront cost of a solar powered charge station is then weighed against the major returns in economic, environmental and social benefits. This support of the electrification of transportation will significantly decrease the emissions released to the environment and the dependence on oil, as well as increase the social benefits such as shaded parking.

POSTER 30

FARMERS' WILLINGNESS TO GROW OILSEEDS AS A BIOFUEL FEEDSTOCK FOR JET FUEL: A LATENT CLASS MODEL APPROACH

Graciela Andrango, Graduate Research Assistant, Department of Agricultural Economics, Kansas State University
Jason Bergtold, Associate Professor, Department of Agricultural Economics, Kansas State University
Alex Shanoyan, Assistant Professor, Department of Agricultural Economics, Kansas State University
Dave Archer, Research Agriculturalist, USDA-ARS Northern Great Plains Research Laboratory
Cornelia Flora, Distinguished Professor, Department of Sociology, Iowa State University

Oilseeds are increasing on interest as feedstock crop for production of renewable fuels due to their diverse oil compositional structure that provides optimal oil properties for certified hydrotreated renewable jet (HRJ) fuel conversion efficiency. Few studies have focused on determining the farmers' behavior and attitudes towards farmers' willingness to grow oilseeds for bio-jet fuel. Specifically, little is known about: 1) the farmers' willingness to produce oilseeds in the western region of the US; 2) how marginal changes in particular oilseed contract features can alter producer valuation of such contracts; 3) how oilseed characteristics can determine producer s' willingness to grow oilseeds crops; and 4) how crop producers respond to marginal changes in contract specifications.

Using data from a stated choice survey administered to non-irrigated wheat farmers in the western US, the objective of this study is to evaluate whether or not farmers are willing to grow specialized oilseed crops usable for HRJ production into existing wheat based production systems under certain crop and contract attributes. Specifically, this study seeks to explore the general insights regarding producer preferences over the attributes of oilseed contracts by determining: 1) oilseed variety characteristics that can affect on the decision of adopting oilseeds into the rotation system; 2) contract features; and 3) farmers' willingness to pay.

A latent class logit modeling framework is used to assess which variables and contract attributes are important for decision makers, as well as capturing heterogeneity across the survey population. Results of this study will help contractors measure how marginal changes in contract provisions will alter producer acceptance and enrollment. In addition, inferences from this study will provide policymakers with tools to measure the impact of government policies regarding oilseed crops.

POSTER 31

SORGHUM AS AN ADVANCED BIOFUEL: PRICE EFFECT ON WHEAT, CORN AND SOYBEAN MARKETS

Krishna Pokharel, Rulianda Wibowo, and, Frank Kyekyeku Nti *IGERT in Biorefining*

Department of Agricultural Economics, Kansas State University, Manhattan, Kansas, 66506, U.S.A.

BACKGROUND: The 2007 US Biofuel mandate requires total biofuel production to increase to 36 billion gallons by 2022. The Energy Independence and Security Act further specify that more than 55% of total biofuel production in 2022 must come from sources – grain, sorghum, wheat, etc – other than cornstarch. In 2012, the EPA announced that grain sorghum ethanol is qualified as renewable fuel with more carbon credit than the corn based ethanol. This may result to the land use changing from planting wheat and other grains to planting sorghum. However, the problem of increase sorghum production could cause a decrease in food supply leading to an upward pressure on grain prices. This article will examine impact of biofuel mandate on wheat, corn, soybean and sorghum prices considering the new situation where sorghum gets more credits than the corn based ethanol.

METHOD: The stochastic partial equilibrium model is used to evaluate the short run implication of demand and supply shock of the policy on corn, wheat and soybean prices in Kansas. Different scenarios are simulated and compared to a counterfactual.

EXPECTED OUTCOME: The use of sorghum as an input for biofuel could alter grain prices in Kansas. With higher competitive prices from sorghum, the possibility of decrease production in wheat and other grains is inevitable. Since Kansas a leading wheat producer any decline in its production will have effect on the global wheat market.

This material is based upon work supported by National Science Foundation Grant: From Crops to Commuting: Integrating the Social, Technological, and Agricultural Aspects of Renewable and Sustainable Biorefining (I-STAR); NSF Award No.: DGE-0903701.