POET BIOREFINING
LADDONIA AND MACON

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AEE Tour Group
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US CORN PRODUCTION & ETHANOL PLANTS

- Ethanol Plant
- Corn Production

Corn Production (Bushels)
- Not Estimated
- 1,000,000 - 4,000,000
- 5,000,000 - 9,000,000
- 10,000,000 - 14,000,000
- 15,000,000 - 19,000,000
- 20,000,000 +

Ethanol Plants
- Producing
- Under Construction
LADDONIA PRODUCTION - 2018

65+ MGPY of ethanol annually
  - Over 2 gallons/second

20+ M bushels of Corn
  - $80MM dollars of corn ground in 2018
  - Produce over 150,000 tons of DDGS/year
  - Wetcake
  - Corn oil – started December 2011
    - Animal feed (poultry), biodiesel, asphalt
  - Liquefied CO2 – started March 2013
    - Food and beverage grade
  - Electricity – 15MW
  - Up next – cellulosic ethanol
    - Stover and corn kernel fiber
The process of making ethanol starts here.

1. Corn is processed through a Hammermill to create slurry.
2. Slurry is mixed with enzymes and yeast to create fermentation.
3. Fermentation produces slurry, which is processed through molecular sieves and a regenerative thermal oxidizer.
4. Atmosphere and dryer gas are used to process DDGS (Dried Distillers Grains and Solubles), creating final product.
5. Evaporator and distillation system are used to process syrup, wet grain, and whole stillage.
6. Centrifuge is used to process thin stillage.
7. 5% gasoline is obtained from the process.
8. 200 Proof Denatured Ethanol is produced.
9. 200 Proof Ethanol is further processed to 190 Proof Ethanol.
10. CO₂ is produced as a byproduct.
ETHANOL FACTS AND MYTHS

Ethanol Myth – Ethanol needs and receives government subsidies to survive

- VEETC Blenders credit was allowed to expire on January 1, 2012 (went to oil industry anyway)
- Tariff on imported ethanol (Brazilian sugar cane) also expired on 1/1/2012
- Small Producer Tax Credit expired 1/1/2012
- All ethanol subsidies ended after 2011 and farm subsidies have been reduced
  - Only RFS with RVO gallons remains
  - However oil tax subsidies still remain
  - MO state producer credit also expired
ETHANOL FACTS AND MYTHS

Ethanol Myth - It takes more energy to produce a gallon of ethanol than it generates

- This statement does not include co-products values like DDGS (dried distillers grains)
- Some studies also include some questionable assumptions
- Data or studies referenced are often old and obsolete
- USDA calculated between 2.1x to 4.0x energy benefit using 2015 data, and this ratio has increased further
  - GPS farming, higher yields (more bu/acre), process optimization (more gallons/bu), enzymes/BPX, yeast development, combined heat and power, etc.
LAD Ethanol Yield (gallons/bu)

- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019

Ethanol Yield
Natural Gas Use – BTU/Gallon

Over 20% reduction in gas use since the plant opened in Sept 2006.
Steady improvement with more efficient motors, LED lights, and more gallons produced. Almost 30% reduction in electricity used per gallon produced since the plant opened.
ETHANOL GHG VALUE

- USDA just released a study in April 2019 that shows a 43% GHG reduction using ethanol vs. gasoline when all inputs are considered.
- Includes “land use change” penalties, but with more accurate data based on what has actually happened vs. models.
- USDA estimates ethanol will be 47% lower on GHG emissions compared to gasoline based on current trends in 3 years
CHP OPPORTUNITY

- POET – Laddonia has a 15MW CHP unit
- POET – Macon has a 10MW CHP unit
- CHP could be repeated throughout the USA with more ethanol / electric generation partnerships
- There are over 200 ethanol refineries in the USA
- Natural gas pipelines already exist to service the ethanol plants
- Cost for the natural gas consumed is shared between the utility and the ethanol plant
  - A very cost effective way to reduce GHG and other emissions for both electricity and transportation
CHP OPPORTUNITY

- There is over 15 Billion gallons of ethanol production capacity in the USA primarily in the corn belt
- At a conservative 2MW of electricity for every 10 million gallons of ethanol production, 3,000MW of potential CHP
- Coal power plants are still common in the corn belt
- Ethanol plants run 24/7 unlike wind and solar and are ideal for baseload power
- Distributed generating capacity at 200+ ethanol plants could provide redundancy and energy security from power interruptions to the grid
INDUSTRY CHALLENGES

10% Blend Wall – E15 and flex pumps

- US Market uses 10% ethanol in 98% of gasoline
  Renewable Fuel Standard allows up to 15B gallons of corn ethanol to be used annually. This is often referred to as the “ethanol mandate”.
  Small refinery waivers the last few years have eroded ethanol demand.
  10% maximum ethanol = 90% minimum mandate for oil

- There is NOT a national 10% ethanol mandate, ethanol is just the most economical renewable fuel
  - Biodiesel, biogas, renewable electric, etc. also satisfy the RFS

- E15 (Unleaded88) at nearly 2,000 retailers now
  - EPA has approved E15 for vehicles 2001 and newer

- E15 is an option, NOT a mandate
- Ethanol industry can compete on value and if given market access to consumers
- NASCAR runs on E15
Figure 1. Effect of ethanol blending on vapor pressure of gasoline.
ETHANOL IS NOT NEW

DURING THE 1930s, more than 2,000 service stations in the Midwest sold ethanol made from corn. Ethanol Prohibition changed that by creating a gasoline monopoly.
BREATHE EASIER

HEALTH IMPACT

Gasoline contains toxic chemicals that cause many human health and environmental issues. Adding ethanol to our gasoline reduces the amount of toxins that are in our fuels.

ETHANOL IS A BIOFUEL THAT HAS UP TO 90% LESS GHG EMISSIONS THAN GASOLINE
ETHANOL FACTS

- Ethanol does have ~30% lower BTU content than gasoline
  - But it is also 113 octane (126 octane impact when blended)
- Blended with lower 84 octane gasoline (RBOB)
- Current flex fuel engines are designed to tolerate ethanol, not optimized to use it
- Auto industry is moving to smaller, higher compression, engines that are ideal for higher octane and ethanol
  - Many owners manuals recommend higher than 87 octane now
- Higher ethanol blends like E30 would improve air quality (particularly in cities), engine performance, and reduce CO2 emissions
ETHANOL FACTS

- Engines have evolved, but our fuel has not changed for decades – 87 octane is still the USA standard
- Ethanol has reduced/eliminated farm subsidies
  - Direct payments to farmers have been eliminated
- Monsanto/Bayer and other seed companies expect 300 bushels of corn/acre in a few years
  - Where will all the corn be used in the future?
  - Will we pay farmers to leave land idle (CRP)?
  - What happens to land values, farm income, and local tax revenues without ethanol helping boost the rural economy?
U.S. CORN YIELDS

Bushels/Acre

1860 1880 1900 1920 1940 1960 1980 2000

Open-Pollinated

Single Cross Hybrids

Biotechnology

Double Cross
HISTORY OF CORN PRODUCTION

Then
1970
86\((1)\) bu/acre
2.2 tons of residue
18,000 planting population
1.2 tons left after harvest
Plowing
Picking corn in the ear
Cobs and husks removed
40” rows

Now
2011
172\((1)\) bu/acre
4.3 tons of residue
32,000-38,000 planting population
4.3 tons left after harvest
reduced tillage
combining
residue management problem
30” rows

Tomorrow
2030
300\((2)\) bu/acre
7.5 tons of residue
50,000 planting populations
7.5 tons left after harvest
what do we do with the trash?
combining
bigger residue management problem
12”-20” rows

There is 358% more residue left in the field today than in 1970.
ETHANOL FACTS

- Corn prices and ethanol prices near multiyear lows
- Ethanol displaces carcinogens like benzene/toluene
- Ethanol does not displace gasoline, it really displaces the high octane portion of gasoline to lower per gallon fuel costs (BTX @ $4+/gal vs. ethanol @ $1.35/gal)
- Ethanol is the lowest cost and cleanest way to create premium high octane fuel
- Oxygenate for better combustion (less particulate)
  - Carbon dioxide is not the only air pollutant to worry about
  - The recent Volkswagen diesel issue is a reminder of this
- Biodegradable – “no beaches ever closed due to ethanol spills”
MACON BREAK TIME STATION

FOR USE IN FLEX FUEL VEHICLES ONLY

E85  E30  E15
2.249 2.499 2.599

$ Price per gallon (including tax)

UNLEADED  PREMIUM
2.699 3.199

$ Price per gallon (including tax)

E-85  E-30  E15
70% ETHANOL  30% ETHANOL  CONTAINS UP TO 15% ETHANOL
PUSH HERE  PUSH HERE  PUSH HERE

MINIMUM OCTANE RATING
PUSH HERE  PUSH HERE
87  91

MINIMUM OCTANE RATING
PUSH HERE  PUSH HERE
BENEFITS OF ETHANOL

- Human Health
- Value to the Consumer
- National Security
- The Economy
- Agriculture
- Engine Health
- The Environment