

Food and Sustainable Biofuels: Thinking Clearly about the Issues

(If we only had a brain:
resolving the apparent food vs. fuel conflict by using our heads)

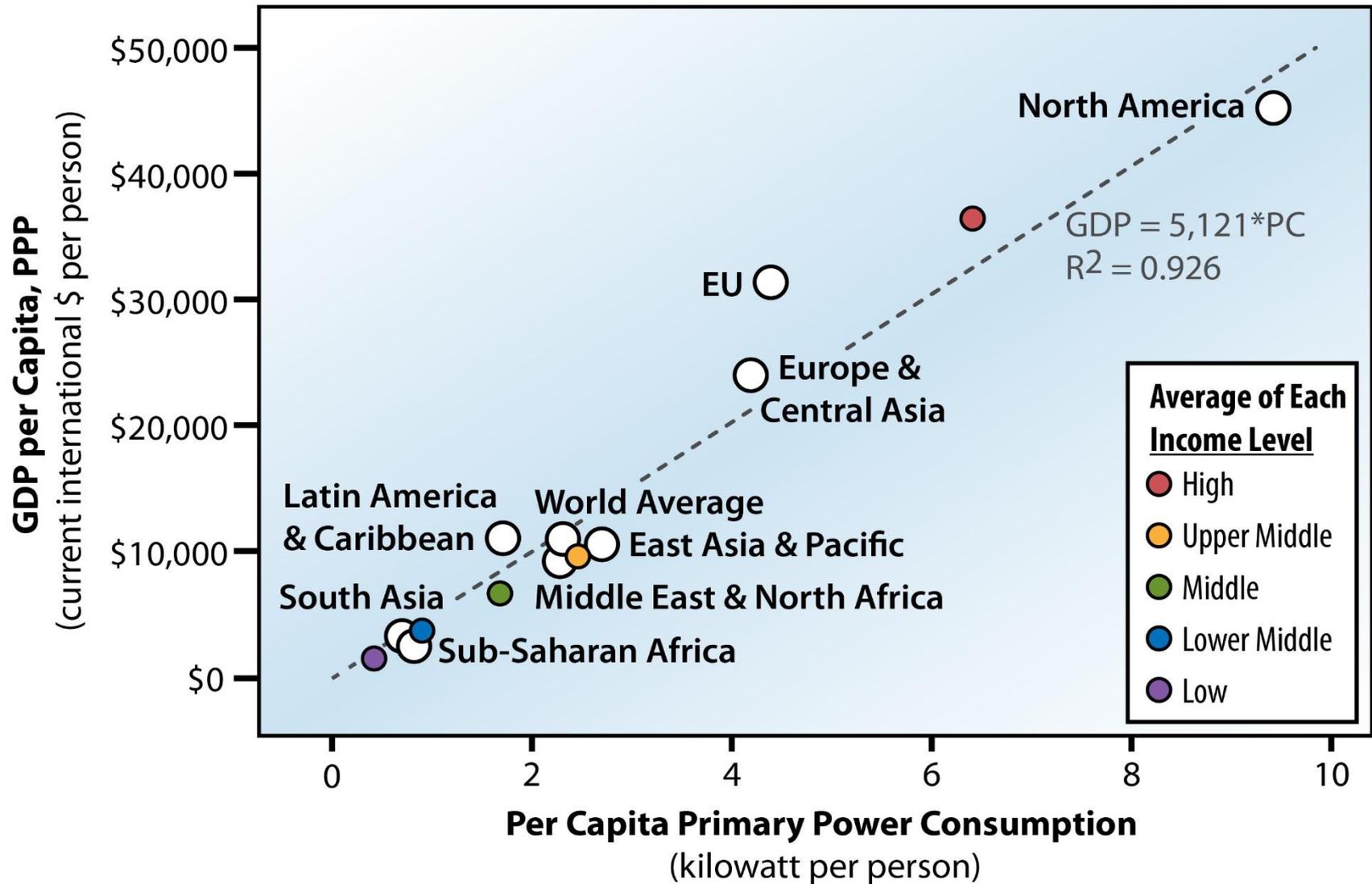
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**Incorporating Bioenergy into Sustainable Landscape Designs-
Workshop 2**
Argonne National Laboratory
June 25, 2014

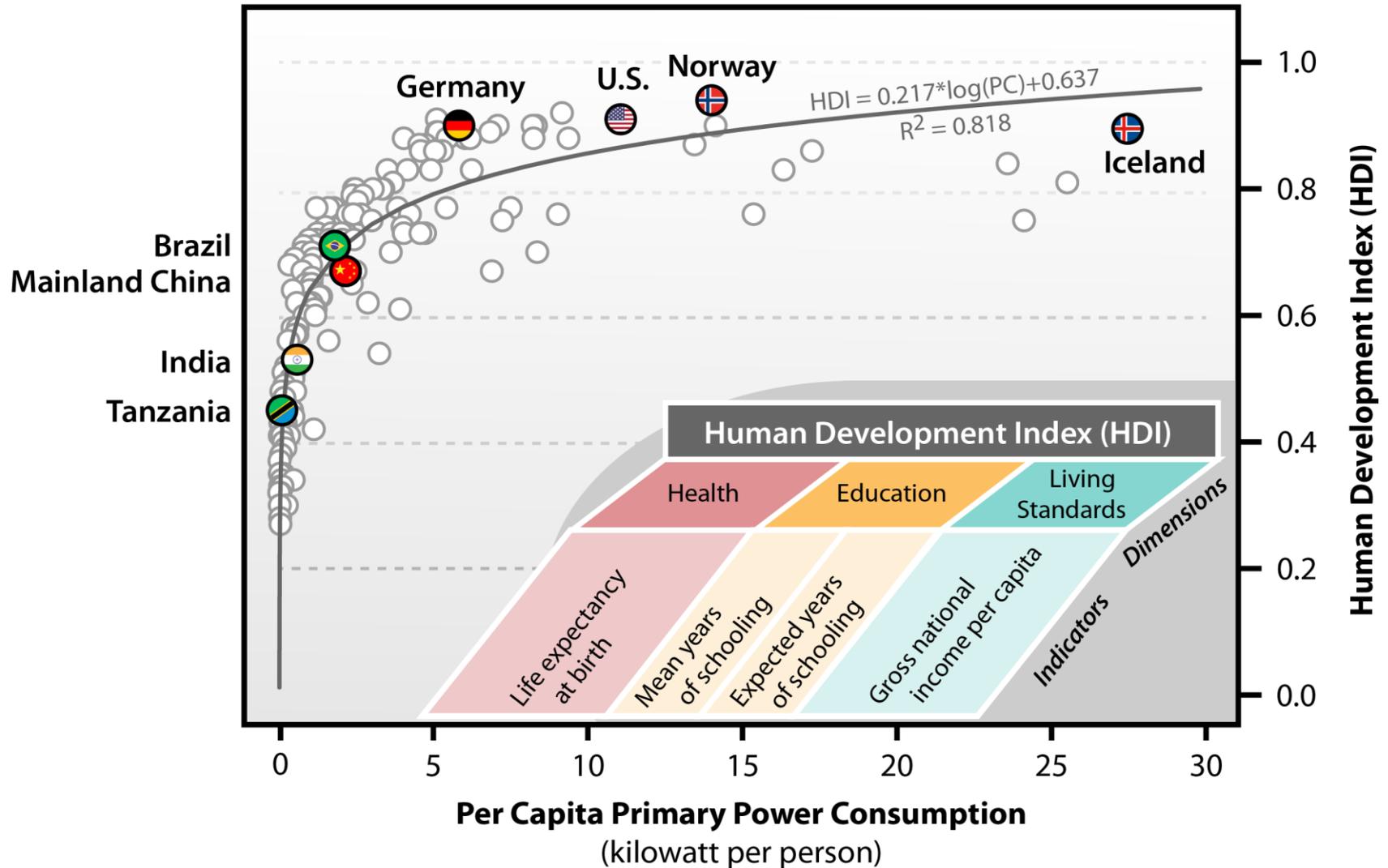
(Renewable) Energy is Critical for Human Well Being

1. Rate of energy use (rate of doing work) strongly affects (determines?) national wealth and opportunities for human development
2. All rich societies use a lot of energy (~33% oil)
3. “Energy efficiency” is essential but insufficient in itself
4. Fossil energy use makes us rich today—what energy sources will make our children rich? ***Answer: fossil energy cannot, it will be gone in the next few decades....***
5. How will the billions of poor people in the world ever access enough fossil energy to develop their potential? ***Answer: they cannot, it will be gone in the next few decades...***
6. We must have renewable energy— **lots of it—in the next few decades**
7. Of all forms of energy, liquid fuels are the most valuable and most problematic in terms of supply, price and price volatility
8. *Peak oil has already arrived- 2005 by my rear view mirror*
9. Only large scale, low cost, low carbon energy sources can reduce GHGs, provide energy security and long term wealth
10. *Biofuels (liquid fuels from plant material) are not optional—we must have them—but they must also become much more sustainable*

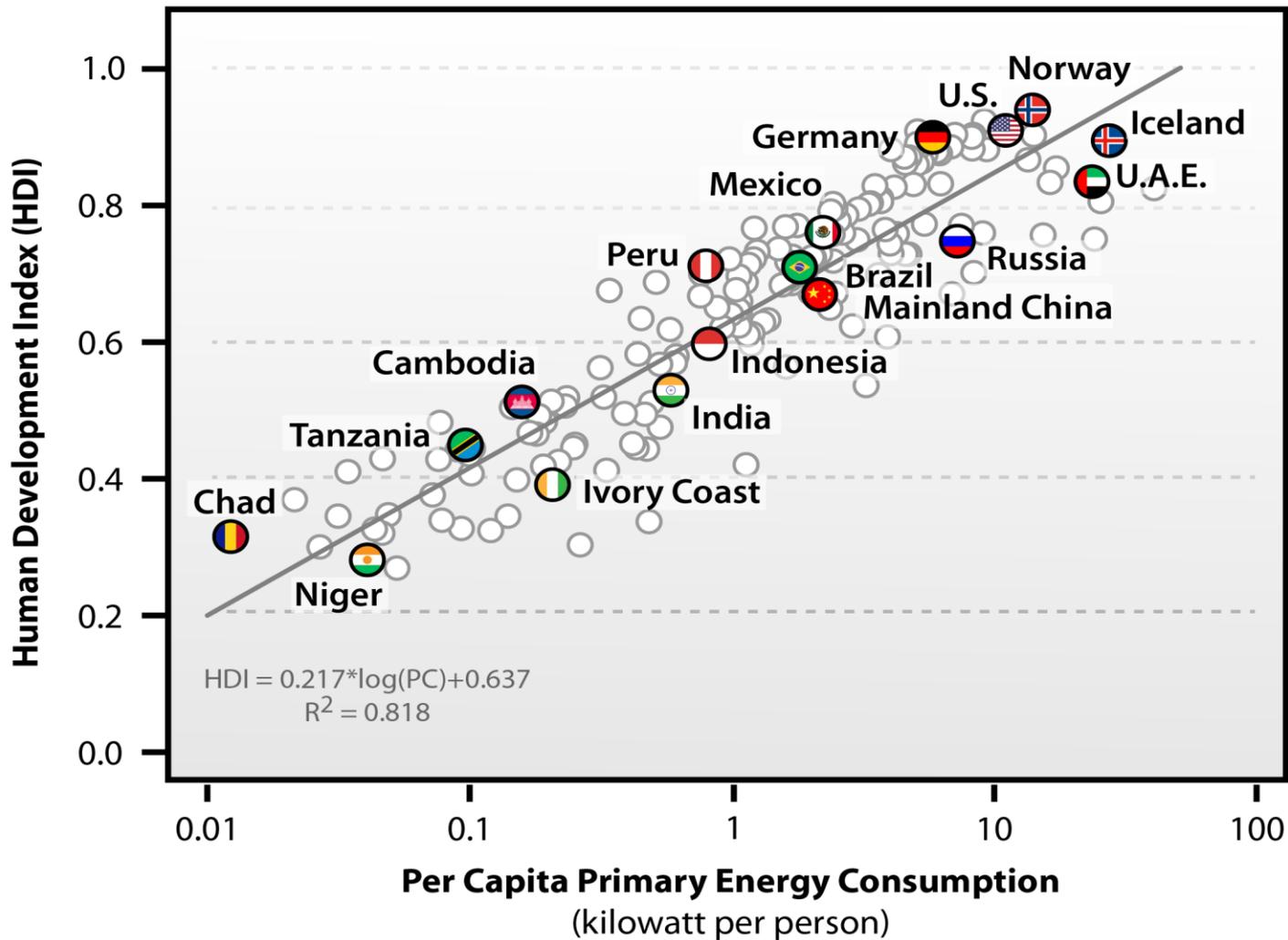
Power Consumption and GDP (World Regions)



Energy Consumption & Human Well Being are Linked: How Much Energy is “Enough”?



Energy Efficiency is Essential but Insufficient



Some Basic Energy Facts:

Why Liquid Fuels are So Important

- **Services** we need from energy (current primary sources of these services: fossil and **renewable**)
 - **Heat** (natural gas, coal— **solar, wind, geothermal, biomass**)
 - **Light/electricity** (coal, natural gas, hydro/nuclear— **solar, wind, geothermal, biomass**)
 - **Mobility** (liquid fuels from oil—96%, some **ethanol & biodiesel**, & CNG)-
most commerce
- **All energy services (all BTU, ergs, GJ) are not created equal—we value mobility (=oil) above all other energy carriers**
- Electricity/batteries can never provide more than about half of mobility needs—and they cannot support commerce at all
- Commerce moves by trucks, ocean shipping, rail & jet aircraft
- Economic chaos results when liquid fuel demand exceeds supply
- *Liquid fuels: not “energy” is the key economic security issue—and right now liquid fuels means refined oil products*
- *The only potentially sustainable, very large scale source of renewable liquid fuels is sustainable plant matter— or “biofuels”*

Love that Volt!



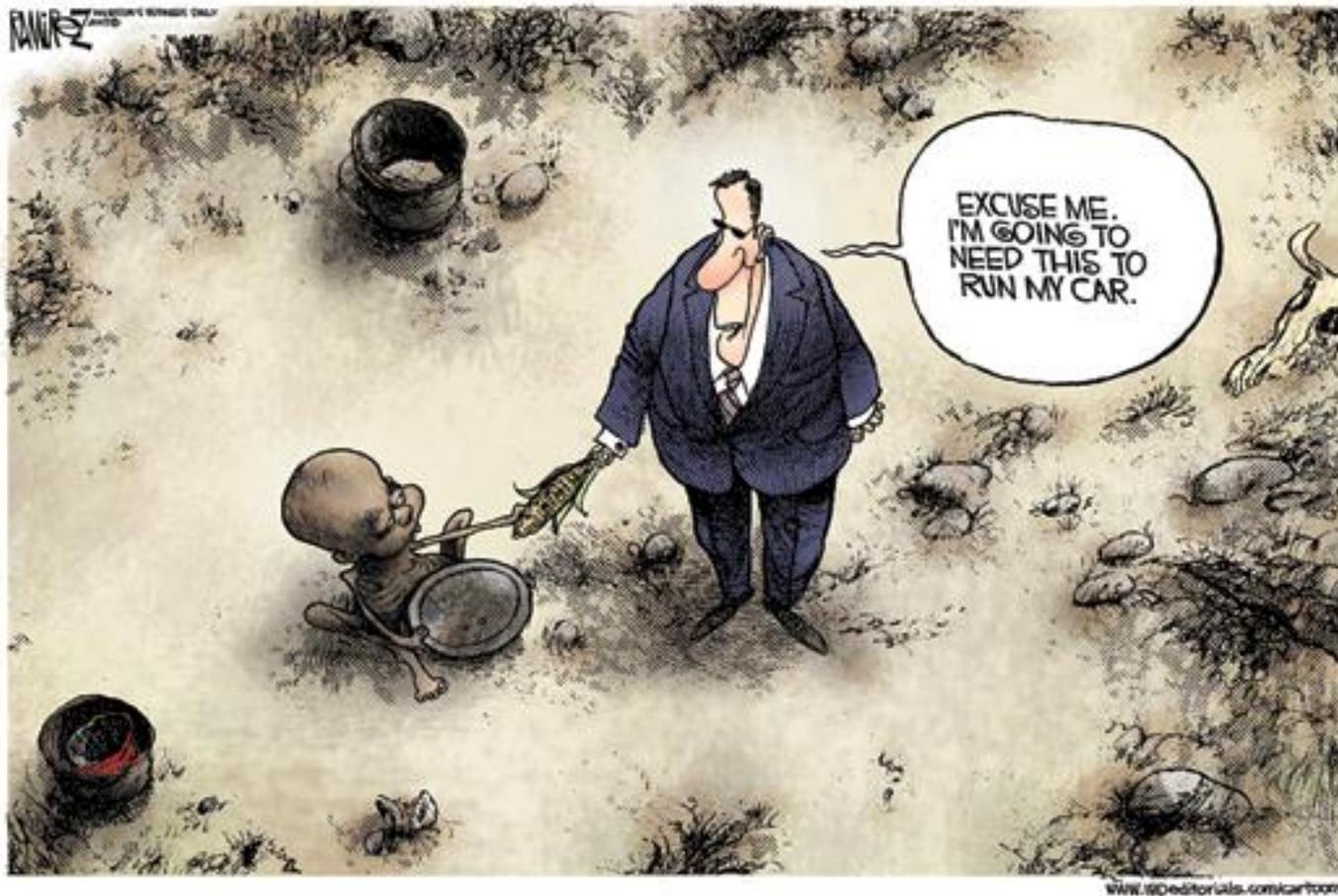
Essay On The Principle of Population



Thomas Robert Malthus
1766 - 1834

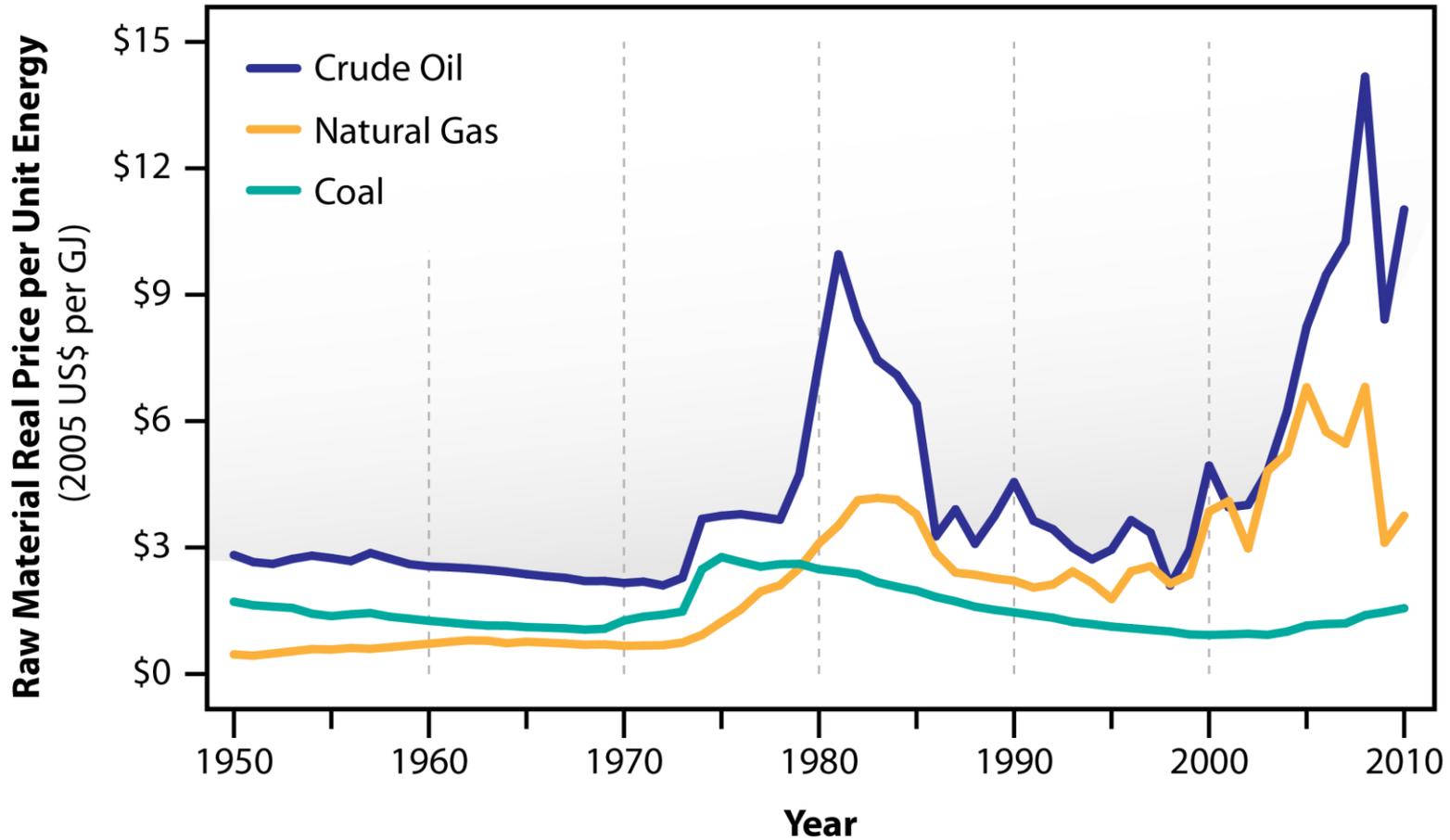
“The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race...”

Biofuels: A crime against humanity?



- “[I]t's a crime against humanity to convert agricultural productive soil into soil... which will be burned into biofuel.”
 - Jean Ziegler, UN Special Rapporteur, 2007

Comparative Value of U.S. Energy Sources over Time



Worldwide Crude Oil Production – Subdivided into World Regions and Top 10 Producers in 2010

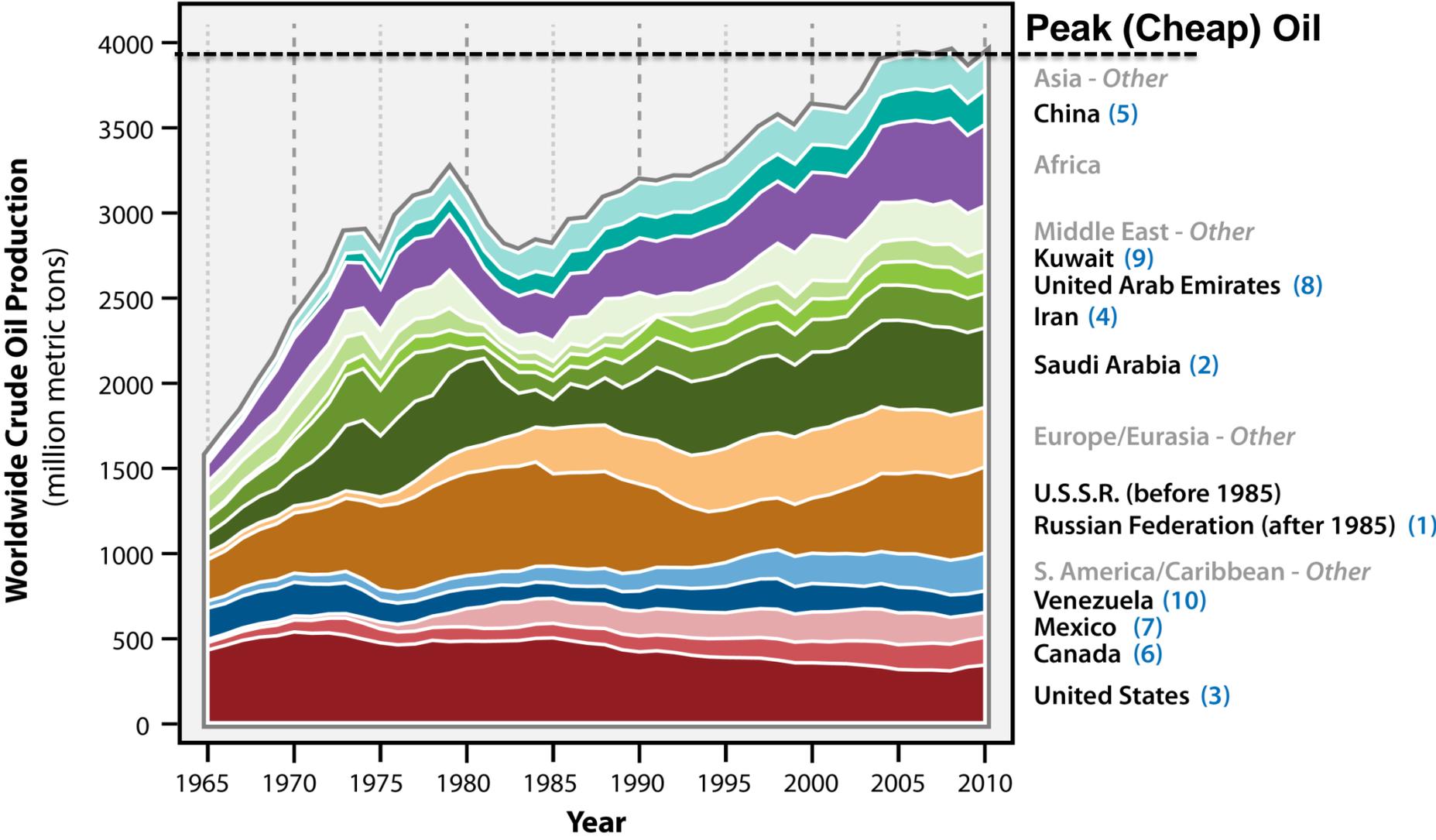
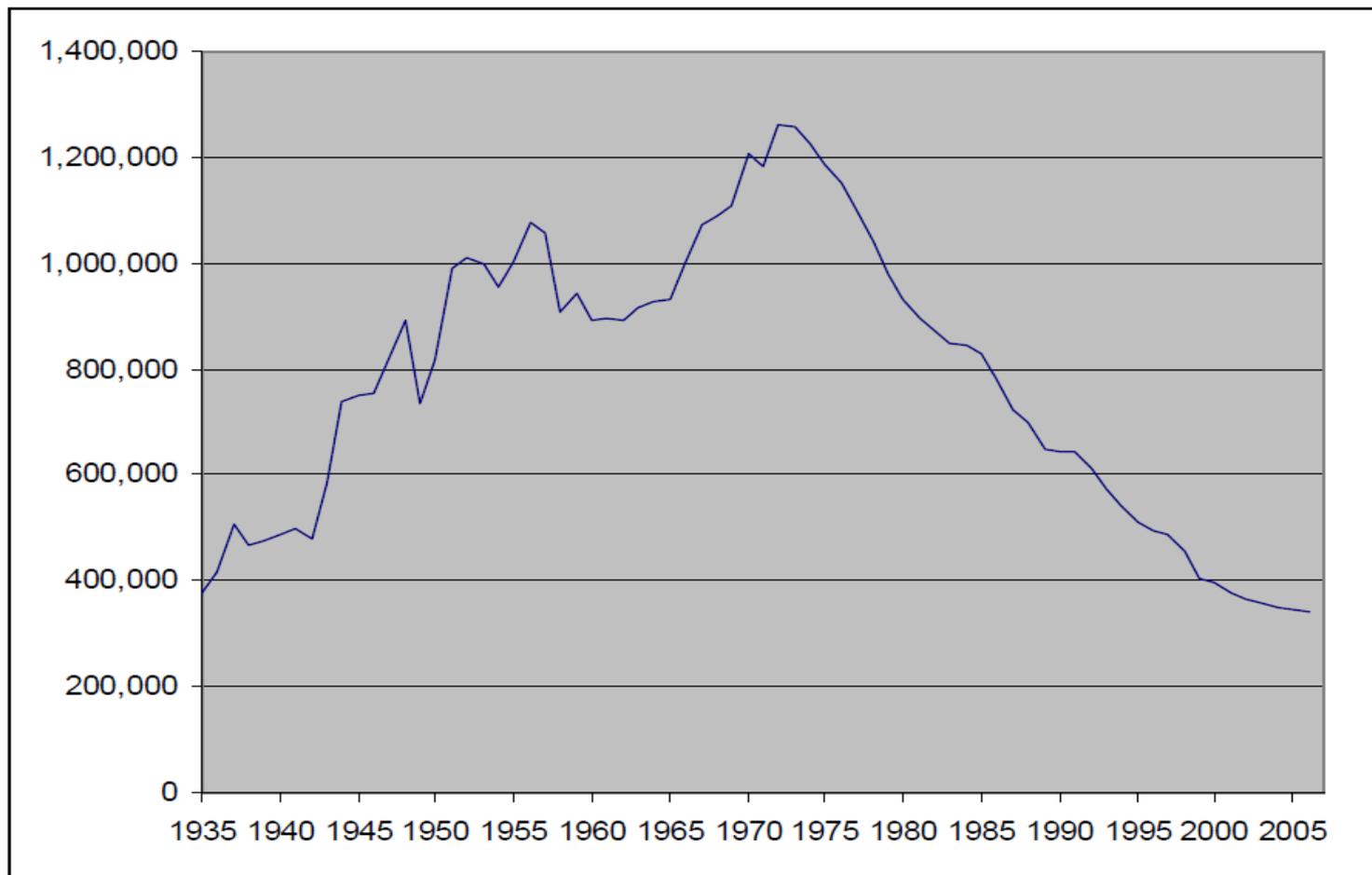
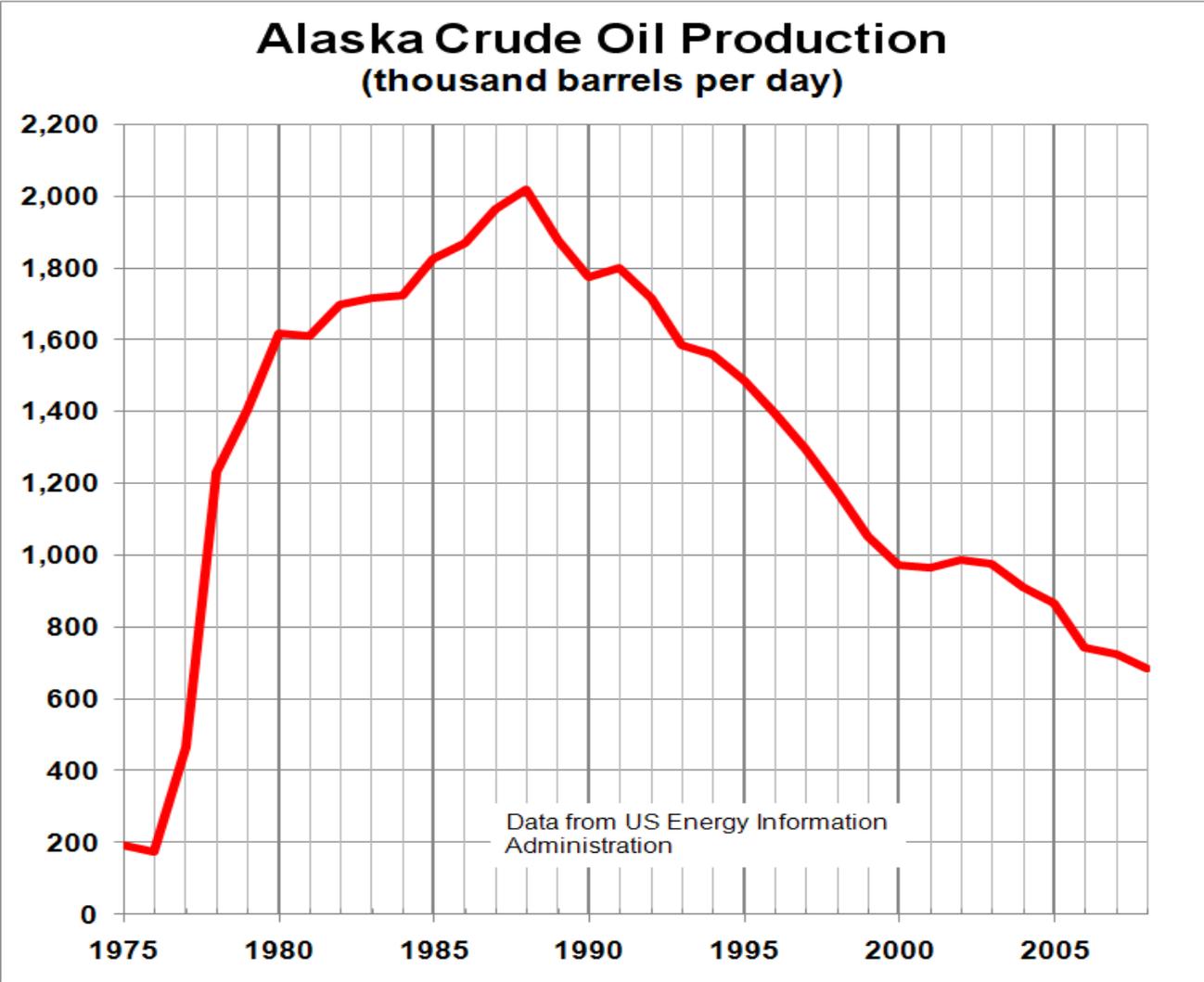


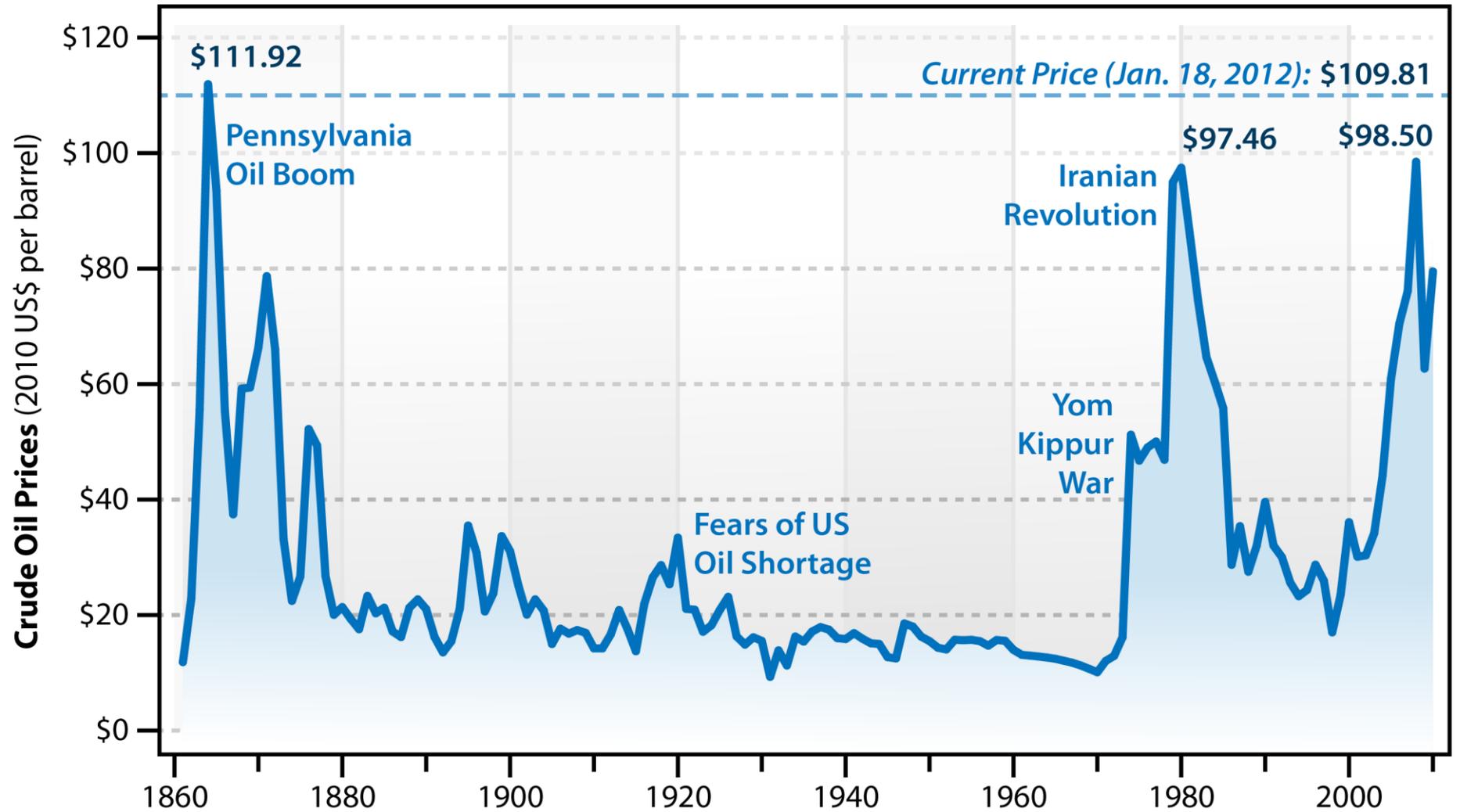
Figure 1 – Annual Oil Production in Texas (in Thousands of Barrels)



Adapted from: Railroad Commission of Texas¹³



Crude Oil Prices from 1861 to 2010



Do we want this fuel future?



Grasses: Sustainable Sources of Protein & Calories for Animal Feed-- & Biofuel Feedstock



Winter rye cover crop
May 5, 2005 Holt, MI

Declining Oil (Energy) Use & Declining Income?

- US oil consumption peaked in 2007 at 20.7 million barrels/day
- Oil consumption was ~18.9 million barrels/day in 2011– down 8.7%
- Since 2007 median US household annual income has declined 8.2% (from \$55,000 to \$50,500)
- *Are people using less oil because they are poorer, or are they poorer because of the wealth = energy use relationship?*

Loaf of Bread

Farmer: Kansas



Truck



50 miles

Elevator: Wichita, Kansas



Train



1,179 miles

**Flour Mill
Buffalo, NY**



Truck: 50 miles



Truck



100 miles



**Van
Truck**



70 miles



**Commercial Bakery
College Point, NY**

**Distribution Center
Long Island, NY**

**Grocery Store
New York, NY**

Steak

Cow/Calf Operator: Florida



Feedlot: Amarillo, TX



Truck
1,432 miles

Truck: 72 miles



Meat Packer
Friona, TX



Truck
1,046 miles



Distributor
Los Angeles, CA

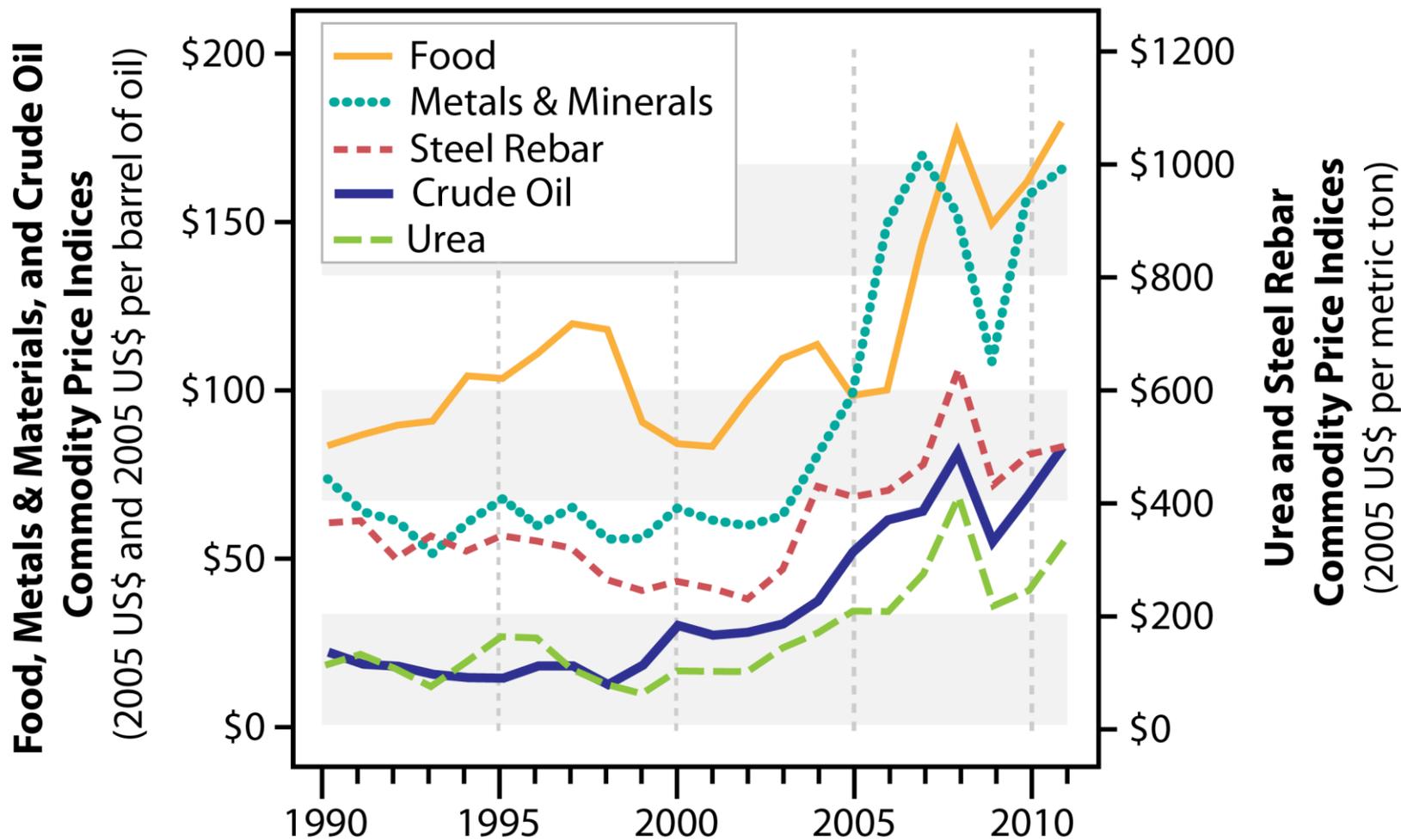


Truck
50 miles



Grocery Store
Los Angeles, CA

Does the Oil Price Drive the Price of all Other Commodities?



*If we only had
a brain:*
resolving the
apparent food
vs. fuel
conflict by
using our
heads



Agriculture and Biofuels:

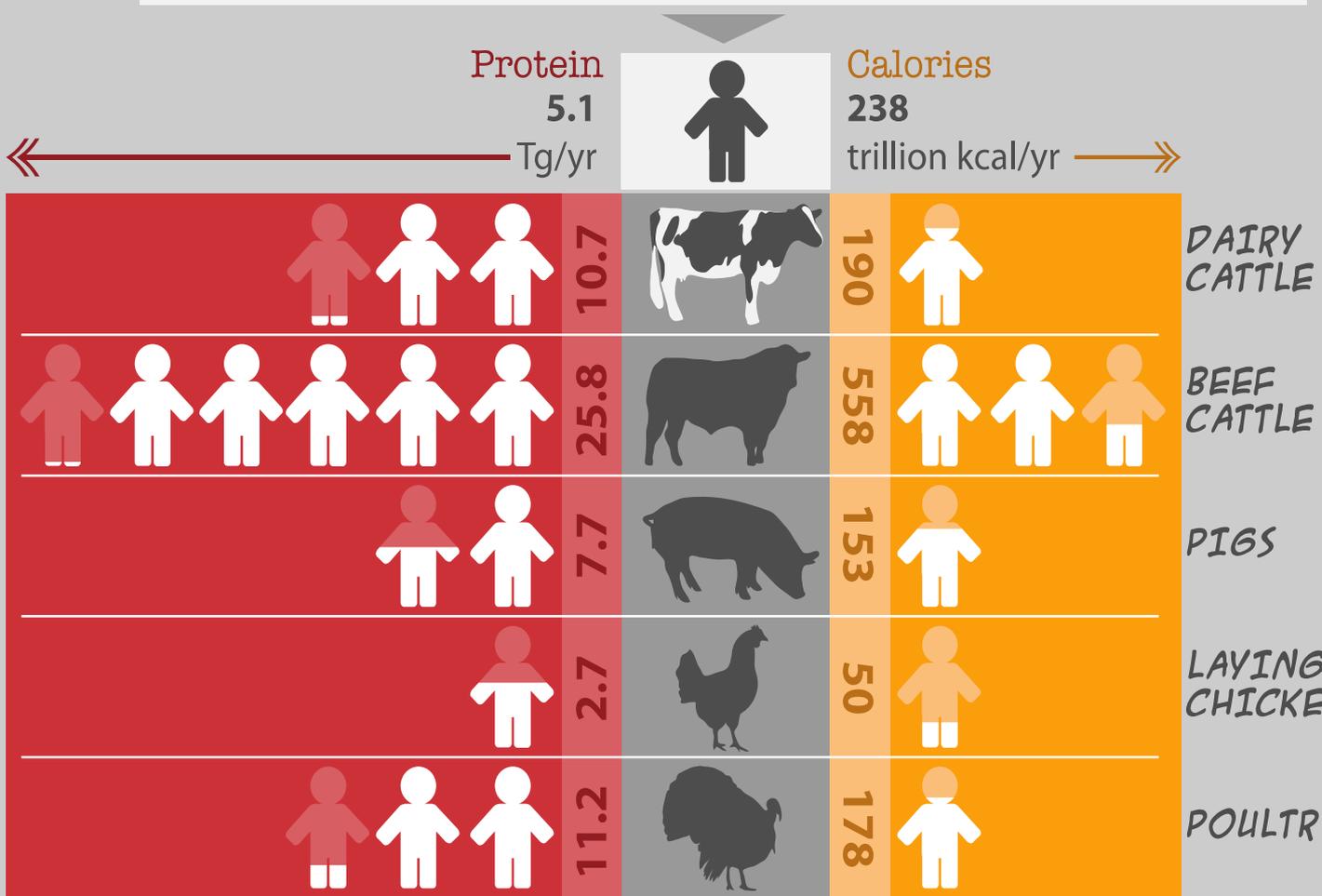
we are not asking the right questions

- We are asking: Can we impose a very large new demand for biofuels on the existing agricultural system without creating problems?
- We should be asking: Can we redesign US agriculture to produce biofuels, food/feed & environmental services?
- Would you enter the Indy 500 race driving a golf cart?
- Would you use a toothbrush to sweep the floor?
- Agriculture has changed before; *it can change again*
- Examine actual land uses: **most land is used for animal feed**
- One solution: coproduce animal feeds with biofuels
- Another solution: make much better use of pasture land

Nutritional Requirements: **Livestock** vs. **Human**

NUTRITIONAL REQUIREMENT OF ALL U.S. LIVESTOCK IN TERMS OF THE...

NUTRITIONAL REQUIREMENT OF THE ENTIRE U.S. POPULATION

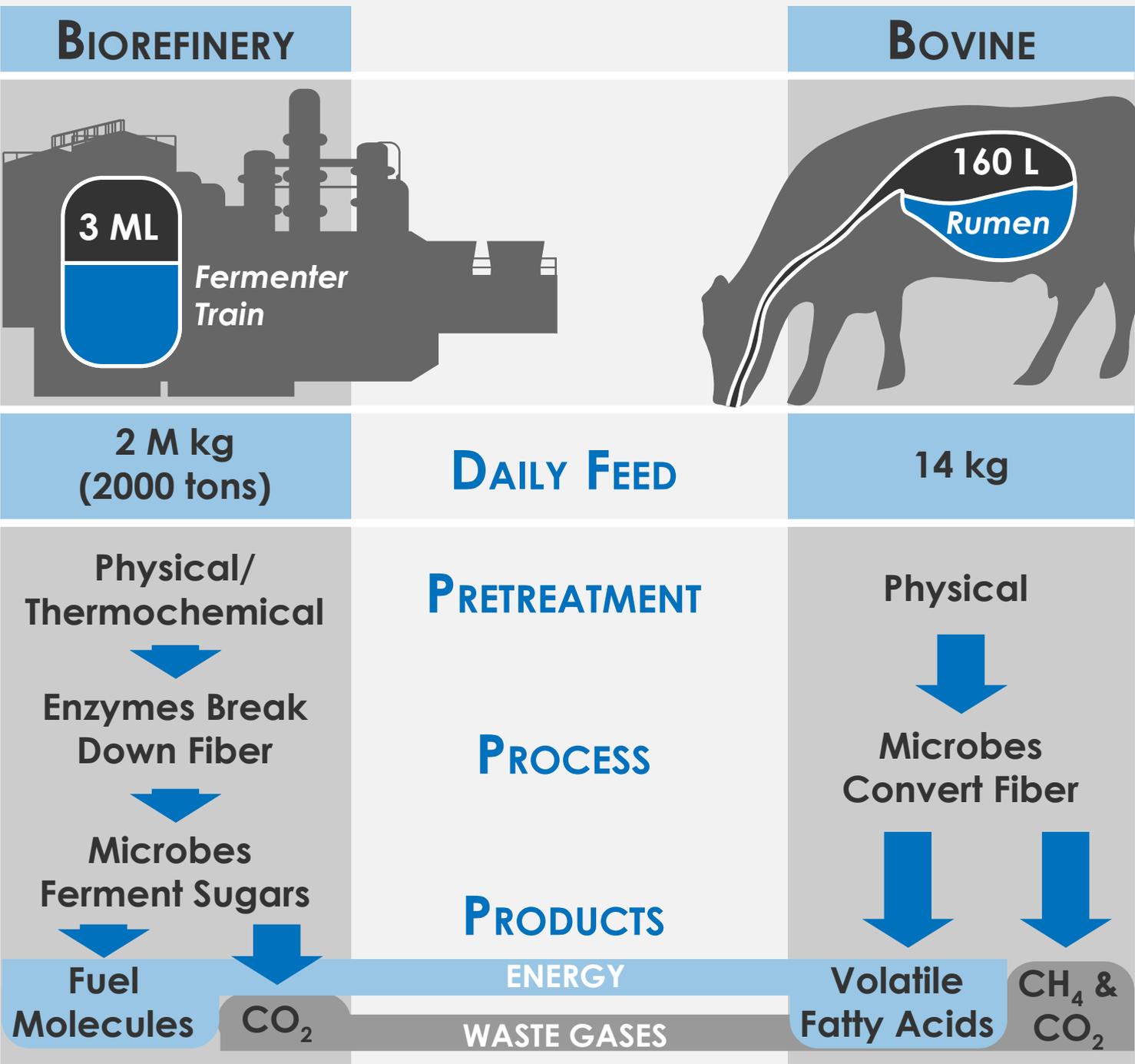


U.S. livestock consumes

11.4 X and **4.8 X**

the amount of **PROTEIN** and **CALORIES** that would **fulfill** the nutritional requirements of the U.S. population

All data from 2010/2011. Livestock population data from USDA-NASS, human nutrition from USDA/USDHHS, U.S. population data from U.S. Census Bureau and animal nutrition from Dale et al., "Protein feeds coproduction in biomass conversion to fuels and chemicals".



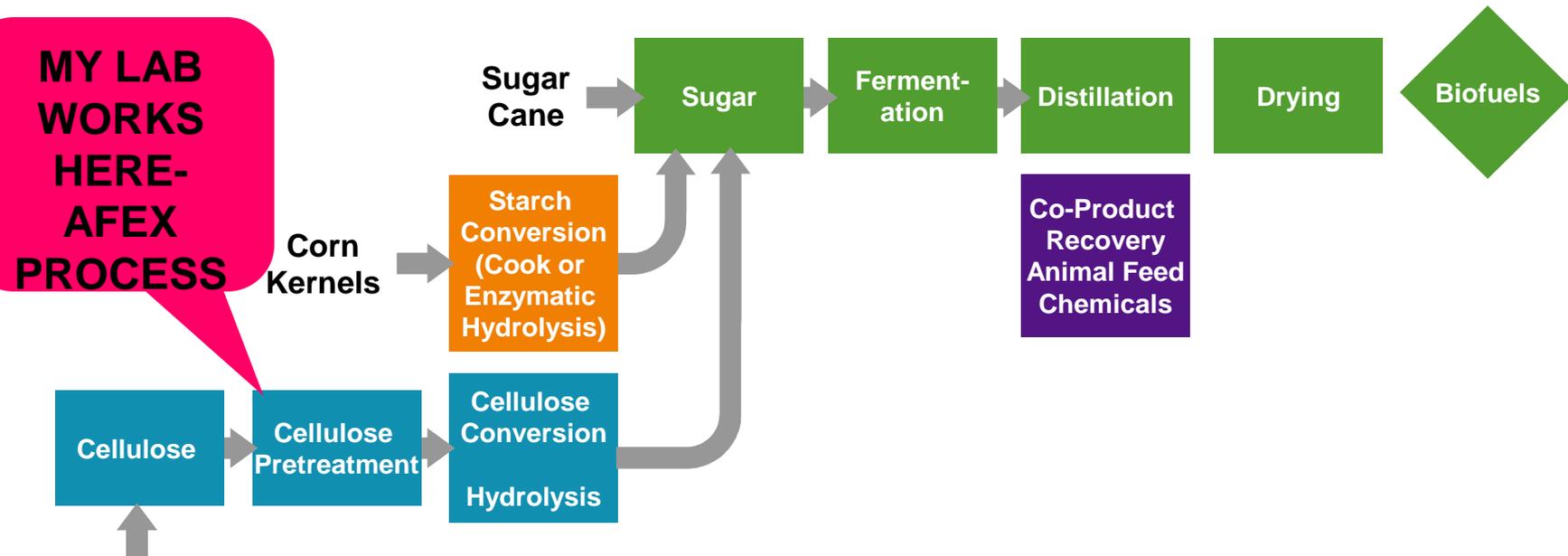
Biofuel Production Flowchart: Sugar Platform

Cellulose Process

Corn Process

Sugar Cane Process

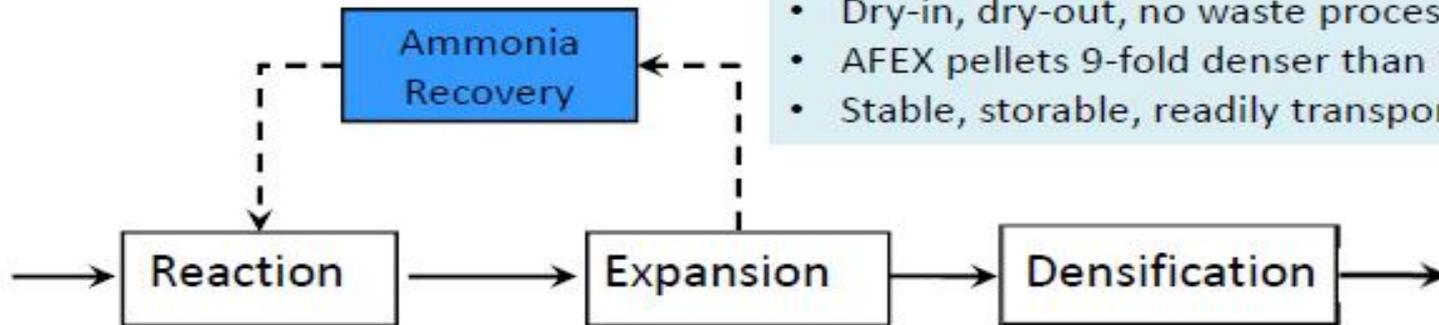
MY LAB WORKS HERE- AFEX PROCESS



- Corn Stover
- **Grasses**
- MSW
- Forest Residues
- Ag Residues
- Wood Chips

AFEX™ Biomass Pretreatment

- Applicable to variety of ag residues
- Dry-in, dry-out, no waste process
- AFEX pellets 9-fold denser than biomass
- Stable, storable, readily transportable



Raw Biomass



Treated Biomass



AFEX Pellets

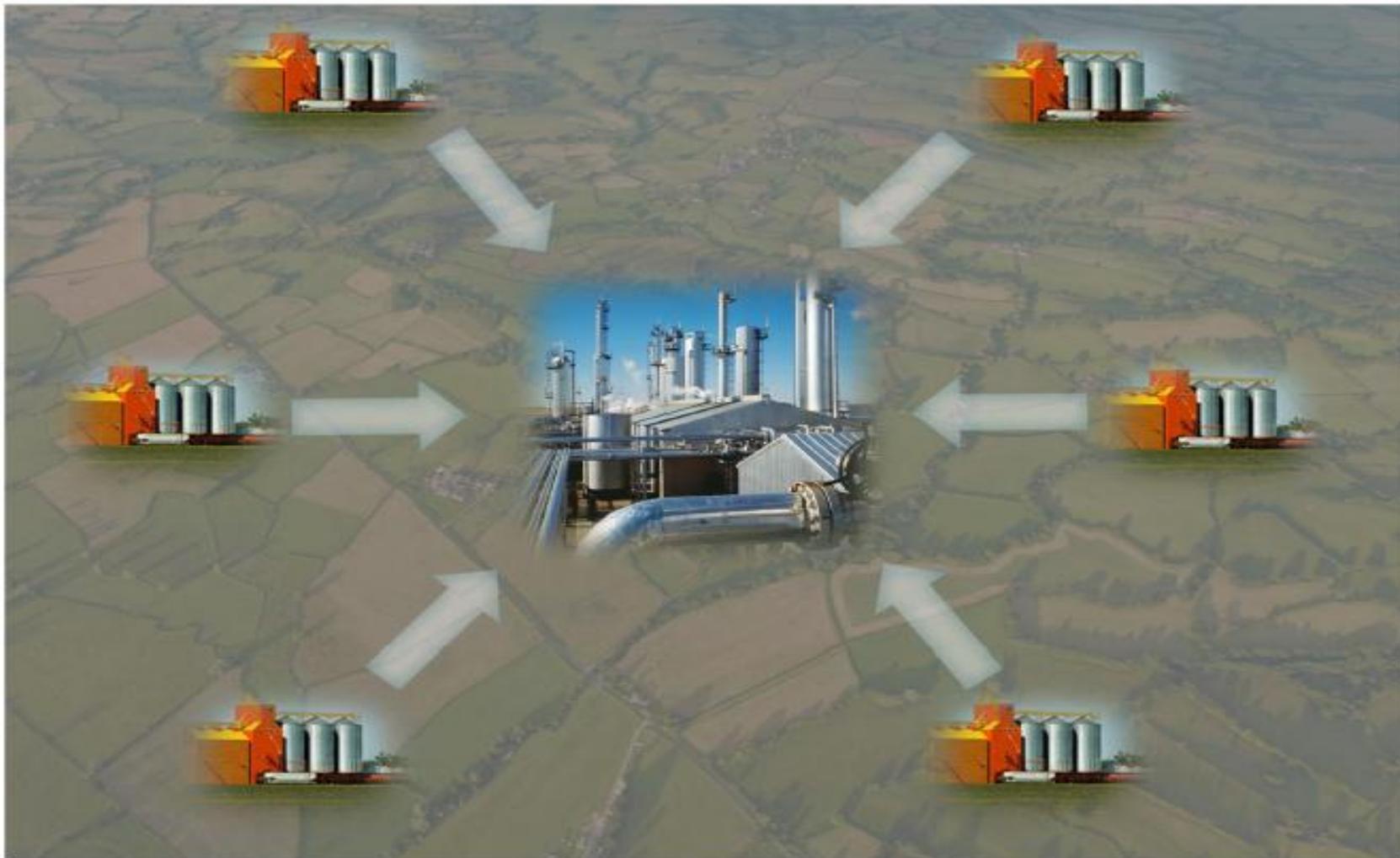
AFEX™ Pellets: A Versatile Biomass Commodity



- Biorefinery sugar feedstock
- Releases 75+% of sugars for fuels and chemicals

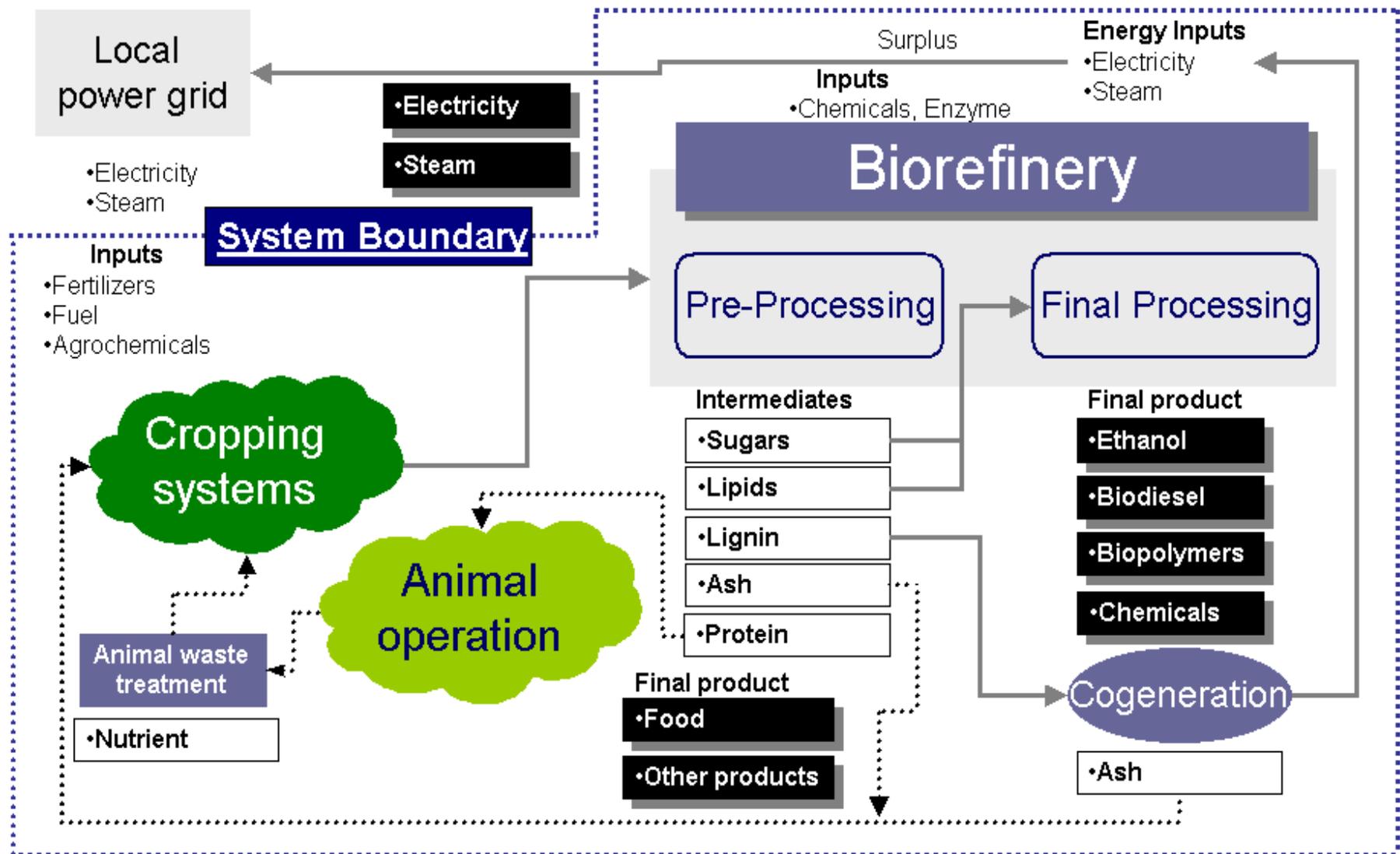


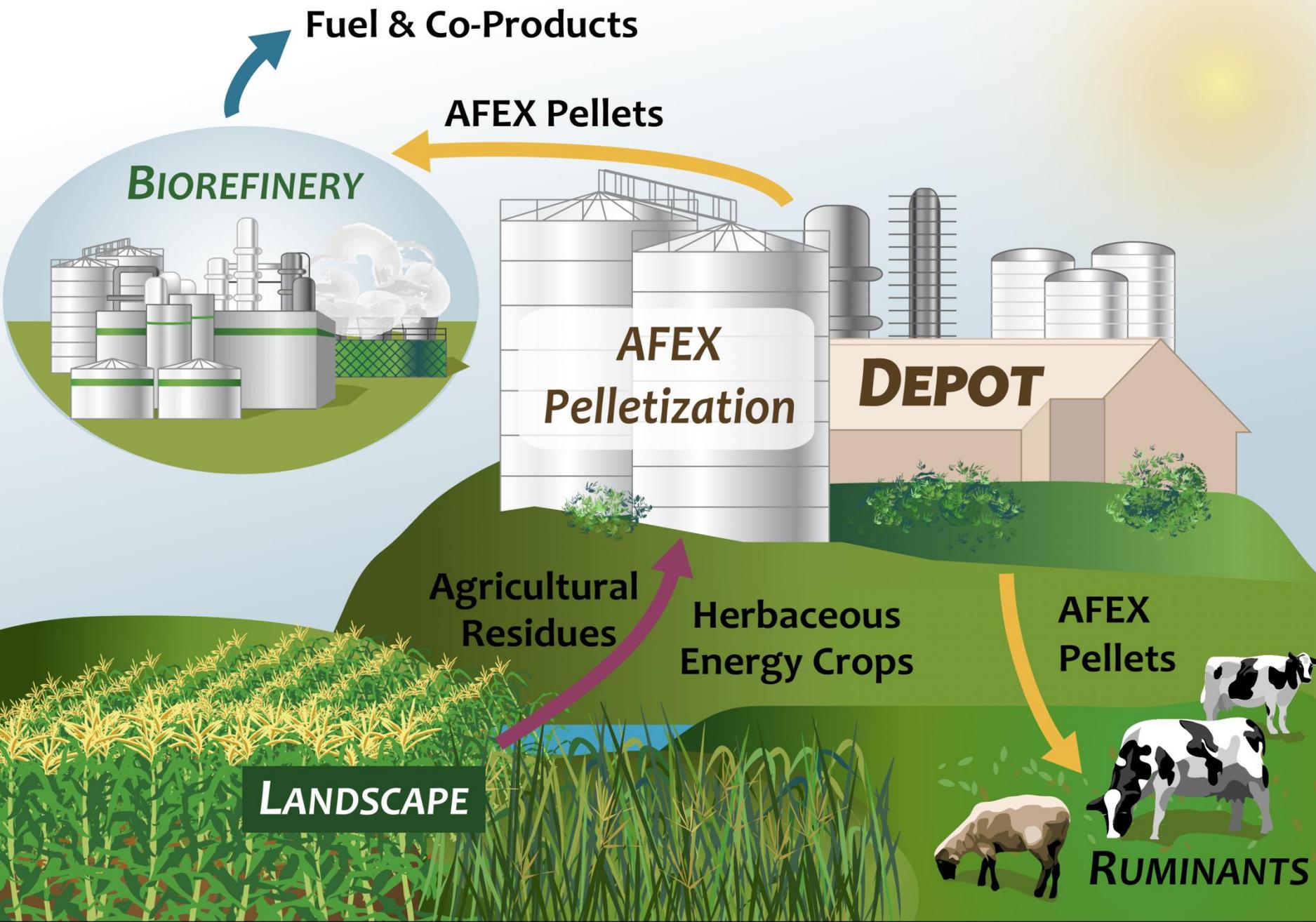
- Ruminant animal feed for beef and dairy cattle
- Potential to displace corn grain

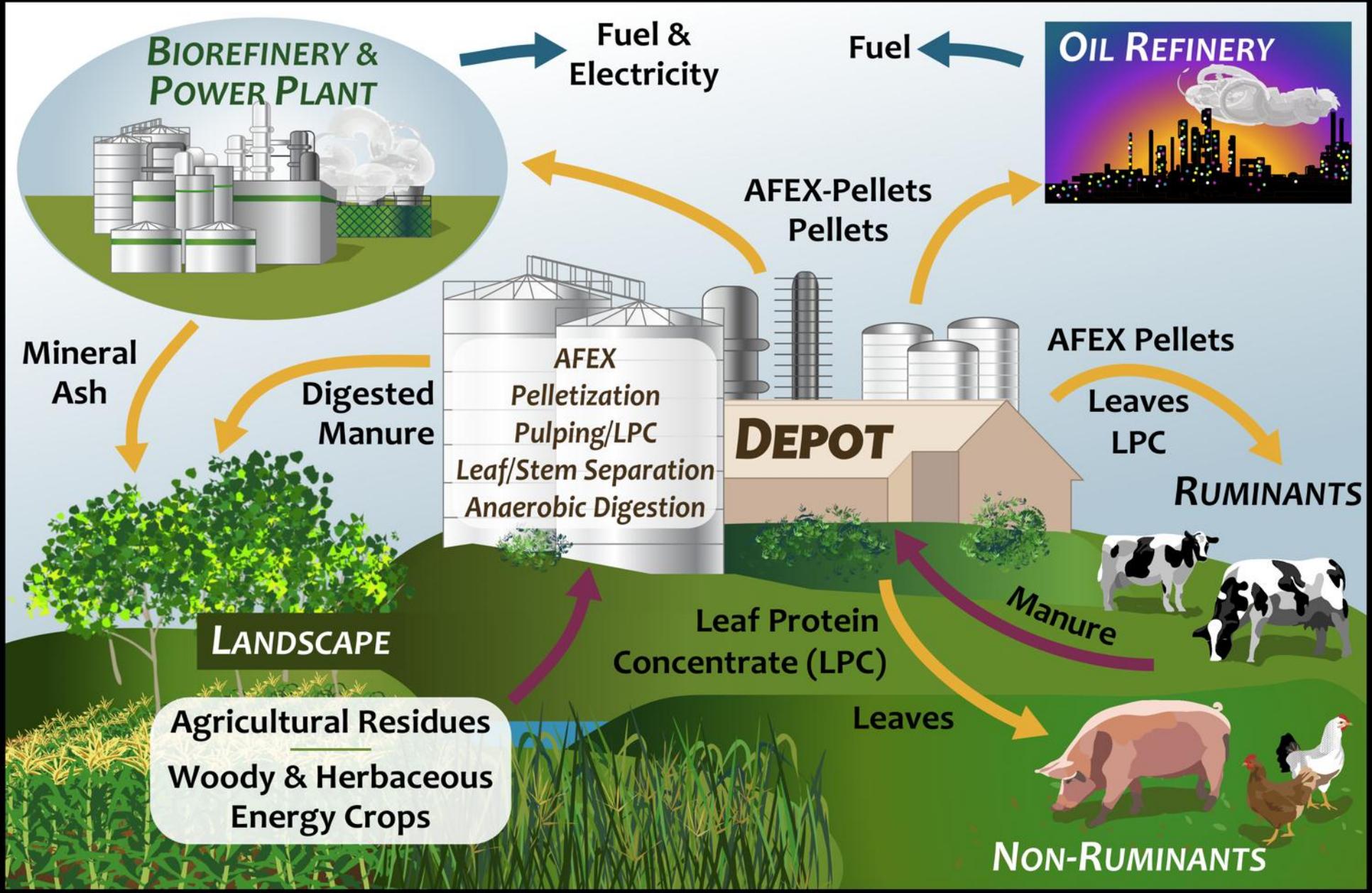




ALL BIOMASS IS LOCAL





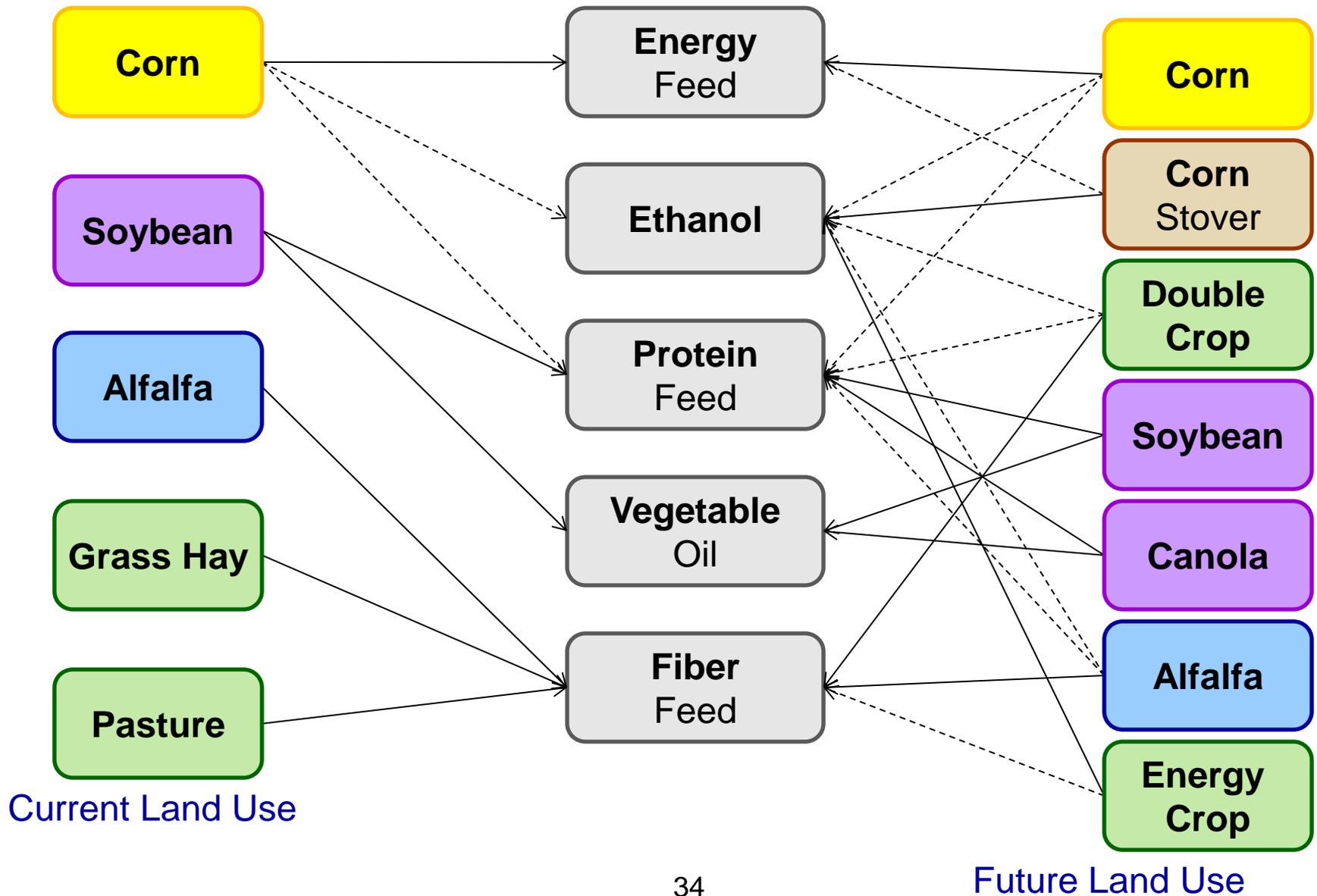


Double Cropping

- Grow crops (grasses) over winter & spring on corn or soy land while still growing corn/soy
 - Does **NOT** require new land
 - Increases sustainable corn stover harvest rate
 - Biomass can be used for biofuels, animal feed, etc
 - Reframes the “food vs. fuel” debate

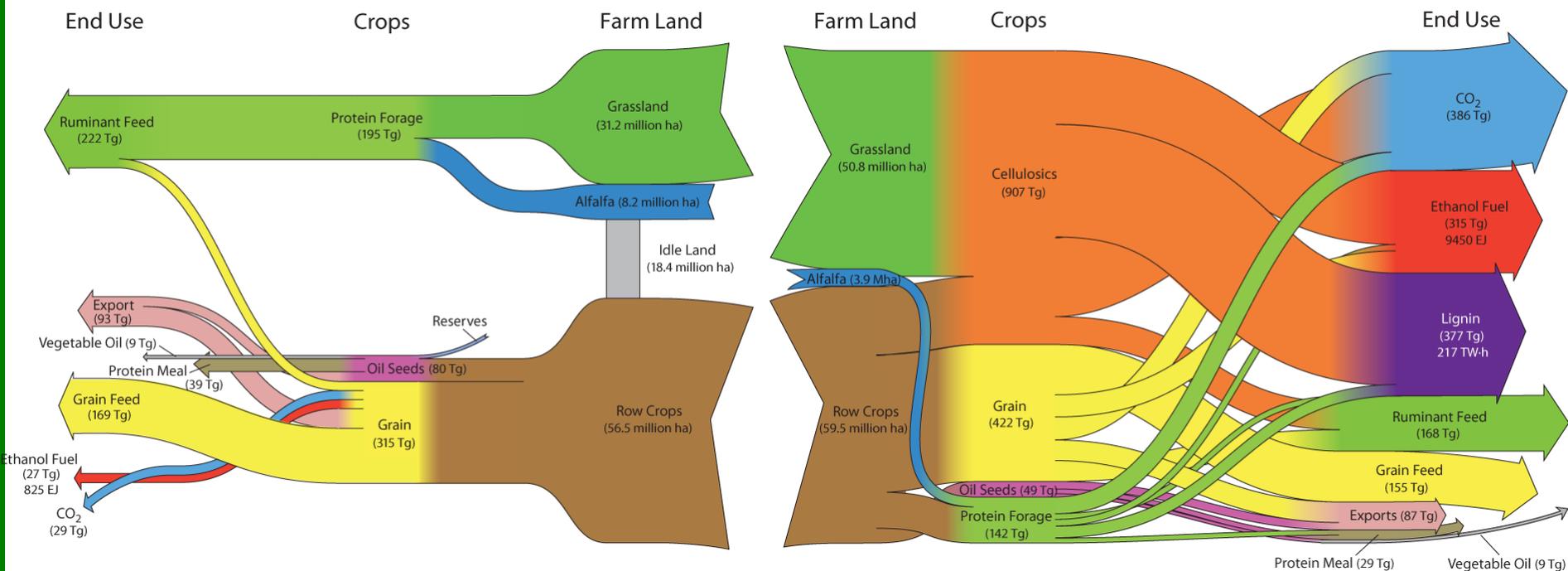


More options for end use

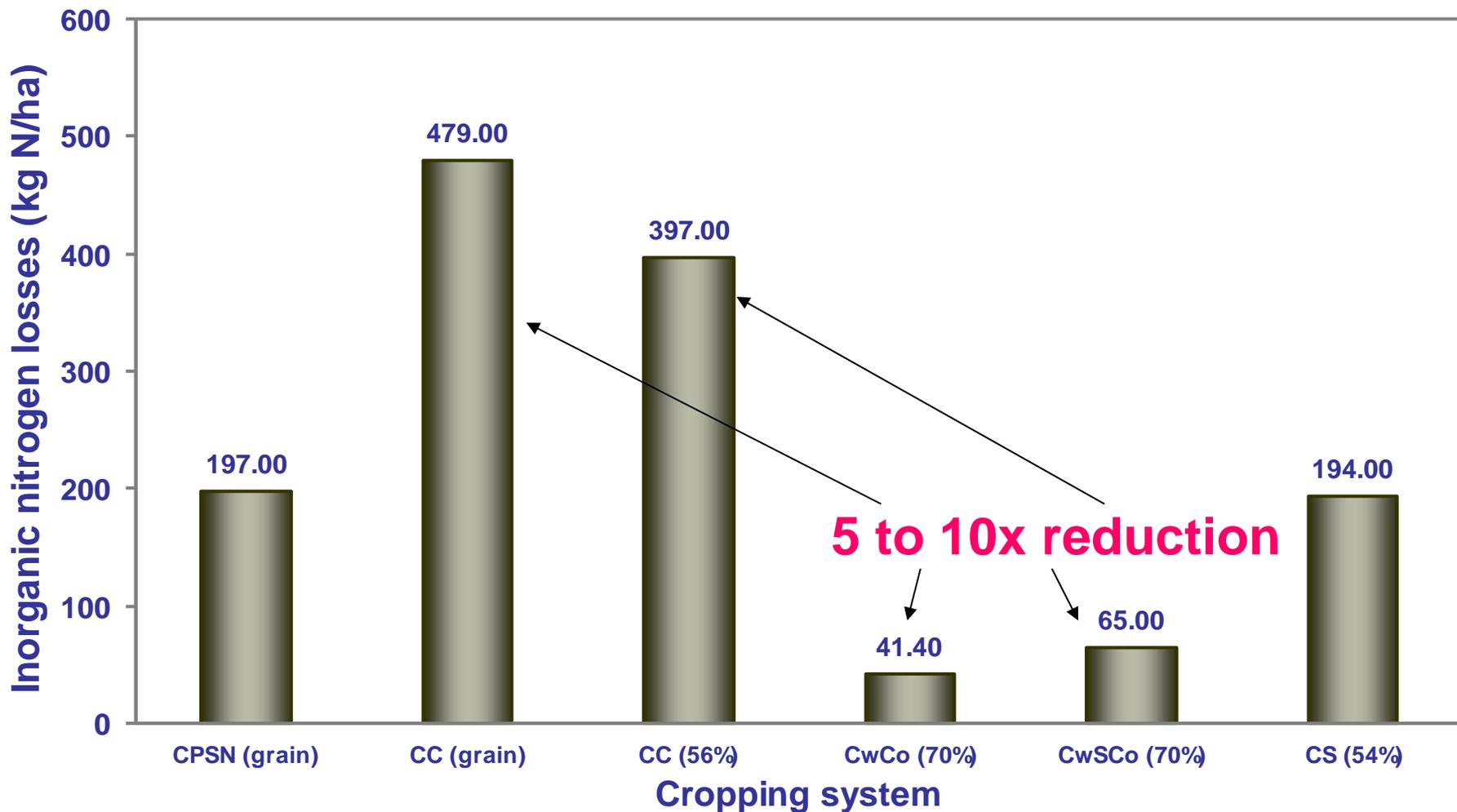


Current vs Possible Land Use

- Total biomass production increases by 2.5 fold on same land area
 - Displaces 50% of US gasoline & 5% of US electricity
 - Reduces US GHGs by over 10% & nitrate losses by 75%
 - Food & feed production remain the same- *no iLUC*

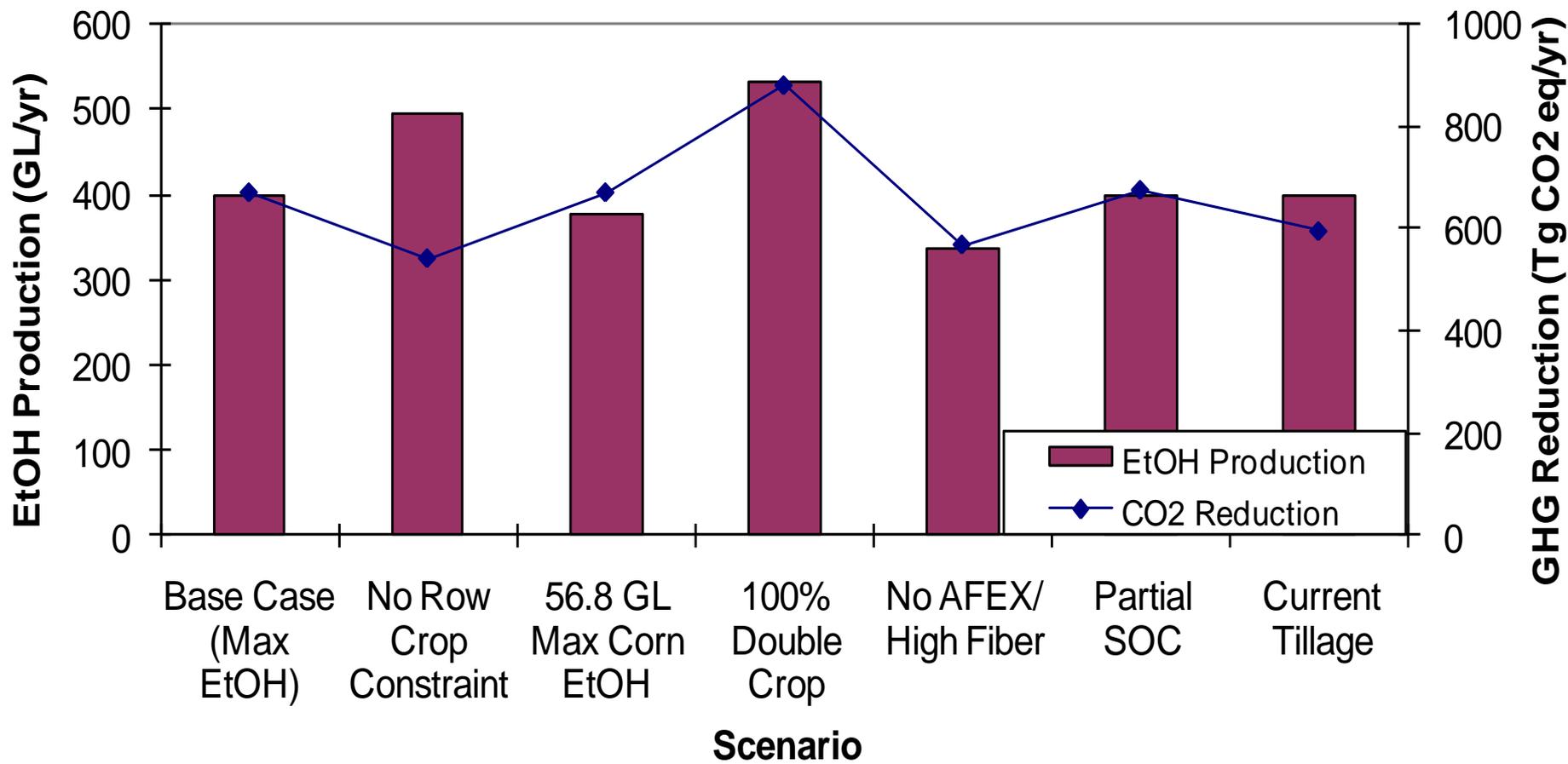


Cover Crops Reduce Nitrogen Losses Tenfold*



*40 year time scale, Washington County, Illinois

High Double Cropping gives Most Liquid Fuel & Most GHG Reductions



Some Thoughts on the Sustainability Transition

- We are in a time of profound transition in how the world will be fueled & fed— *we cannot continue much longer on our current pathways, we must change & the sooner the better*
- The changes required will be far reaching, profound, revolutionary, upsetting, painful, exciting...pick your adjective
- *Liquid fuels from plant matter (biofuels) are an essential part of the sustainability transition—this will cause a huge impact on the economic, physical & social “landscapes”*
- We should be seeking large, complementary, beneficial changes: *we need food (feed) and fuel and sustainability and rural economic development and better social outcomes*
- This will not happen by accident—we must envision (use our heads), and design (do the research) and then implement sustainable biofuel systems to achieve multiple objectives

From This “Cell Phone”



To this One



Design Criteria for Sustainable Biofuel Systems??

Biofuel systems will:

1. *increase the fertility of the lands on which they are based*
2. *produce large amounts of excess energy for the rest of society*
3. *maintain or increase nutritional services currently provided by the lands on which they are based*
4. *significantly reduce life cycle greenhouse gases versus petroleum or other fossil based liquid fuels*
5. *benefit both socially and economically the local communities where biomass raw materials are grown*
6. *be economically profitable without subsidies*
7. *improve water quality in the areas where raw materials are grown and around processing plants*
8. *enhance plant and animal biodiversity*

Biofuel systems will not:

1. *impact the quantity of local water supplies without local consent*
2. *rely on key inputs which themselves are not sustainably produced*

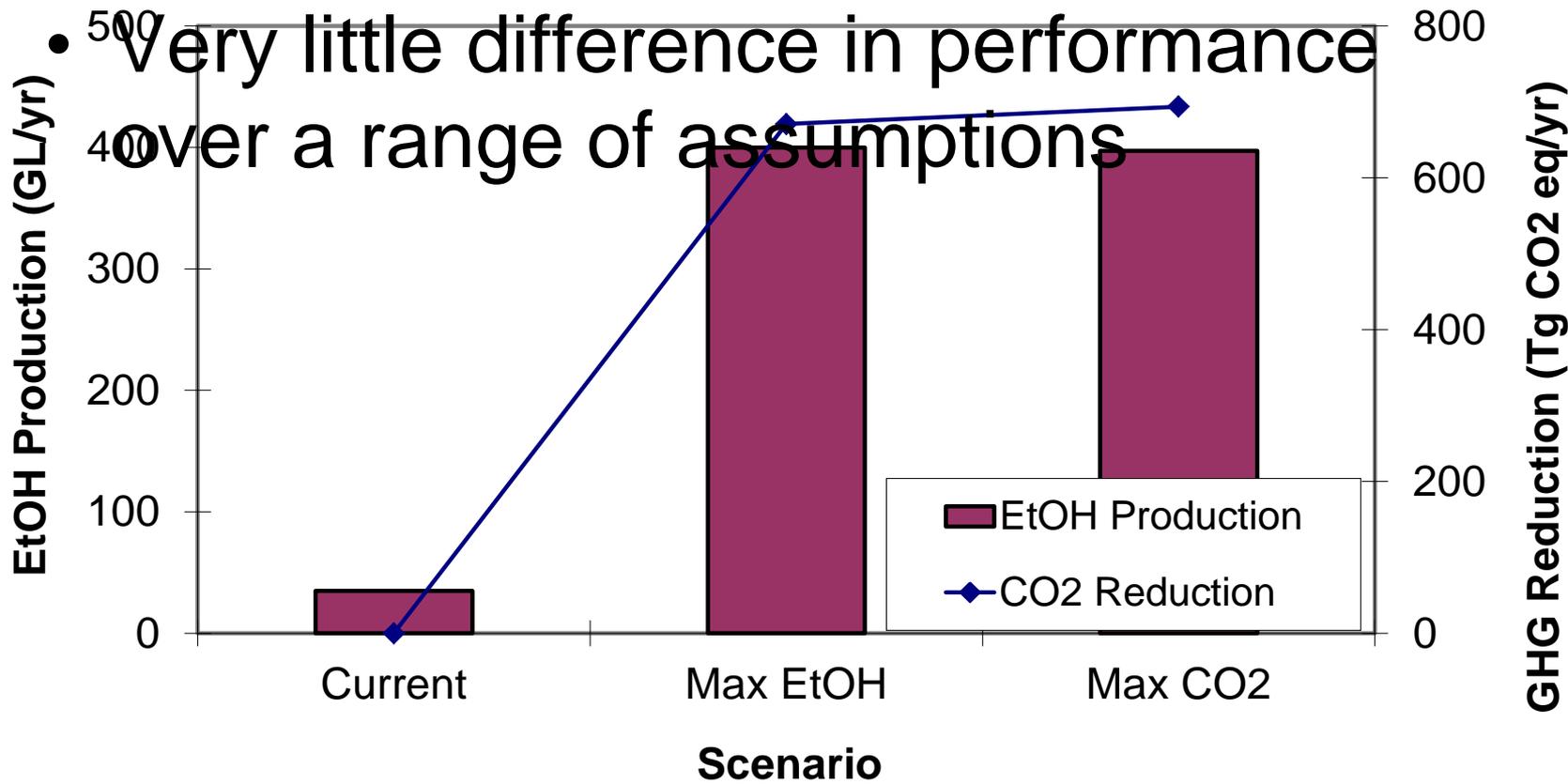
Questions ??



“Absolutely!”

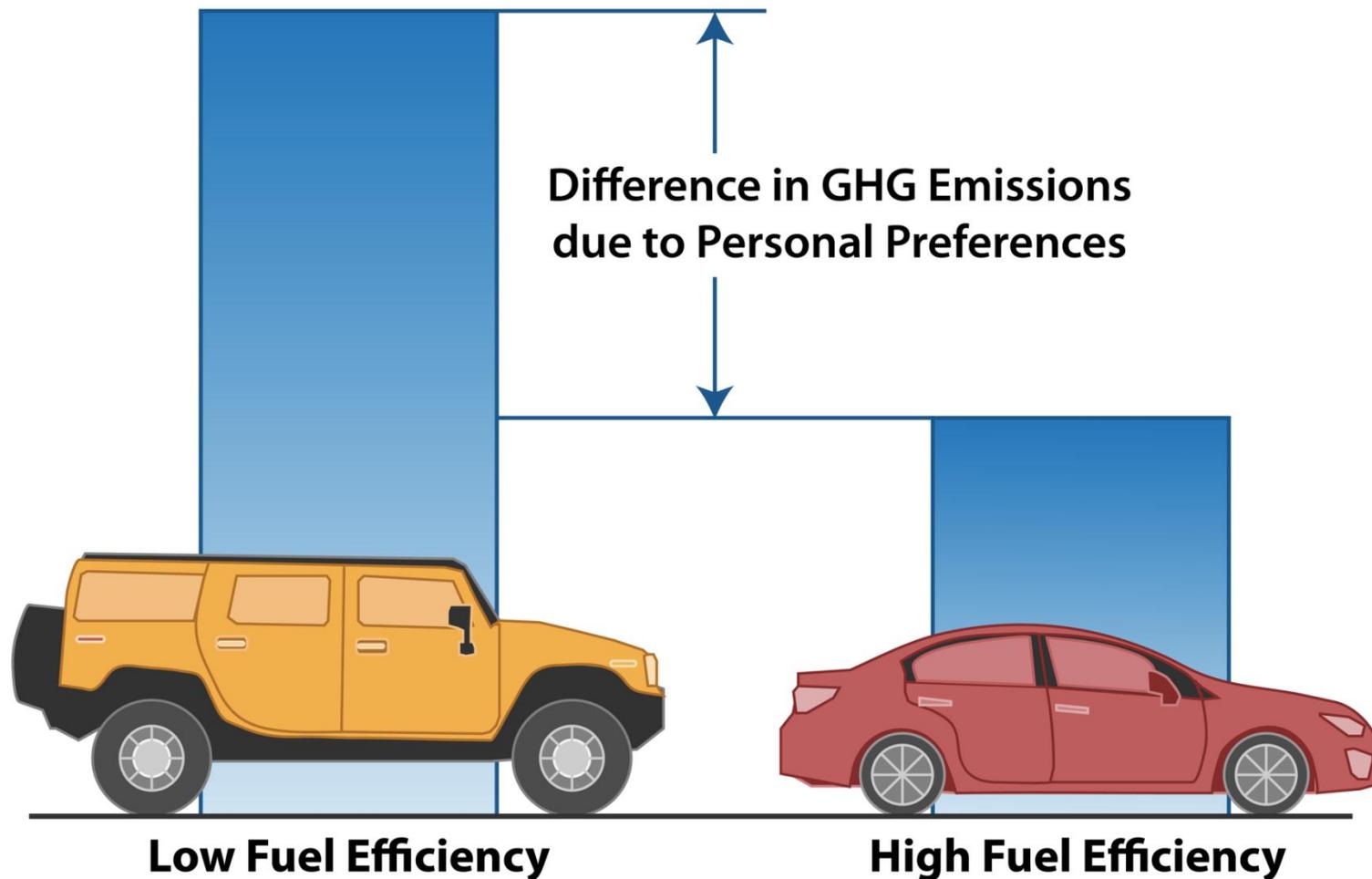


Maximum Ethanol Production Tracks with Maximum CO2 Reduction



Influence of Personal Preferences on Allocation of Impacts

LIFECYCLE GREENHOUSE GAS EMISSIONS



Influence of Personal Preferences on Allocation of Impacts

LAND USE CHANGE

