Biofuels and the Environment: Getting from Here to There

Nathanael Greene

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Natural Resources Defense Council

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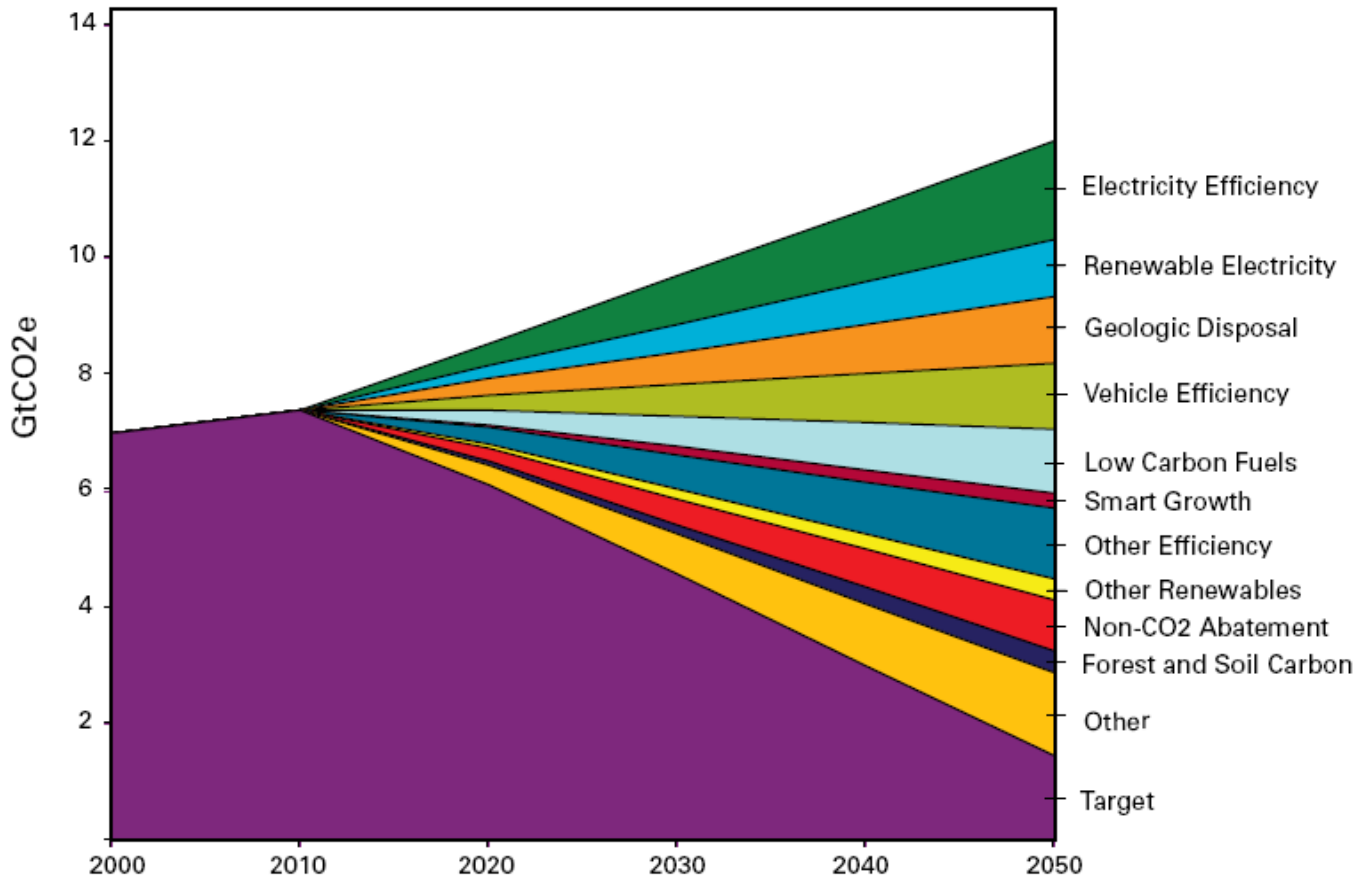
We Need Big Solutions, Fast, and Lots of 'em



- US must contribute a 60-80% reduction in GHG emissions
- Renewables can provide about 1/5 of these reductions
- Biofuels can provide about half of the renewables wedge

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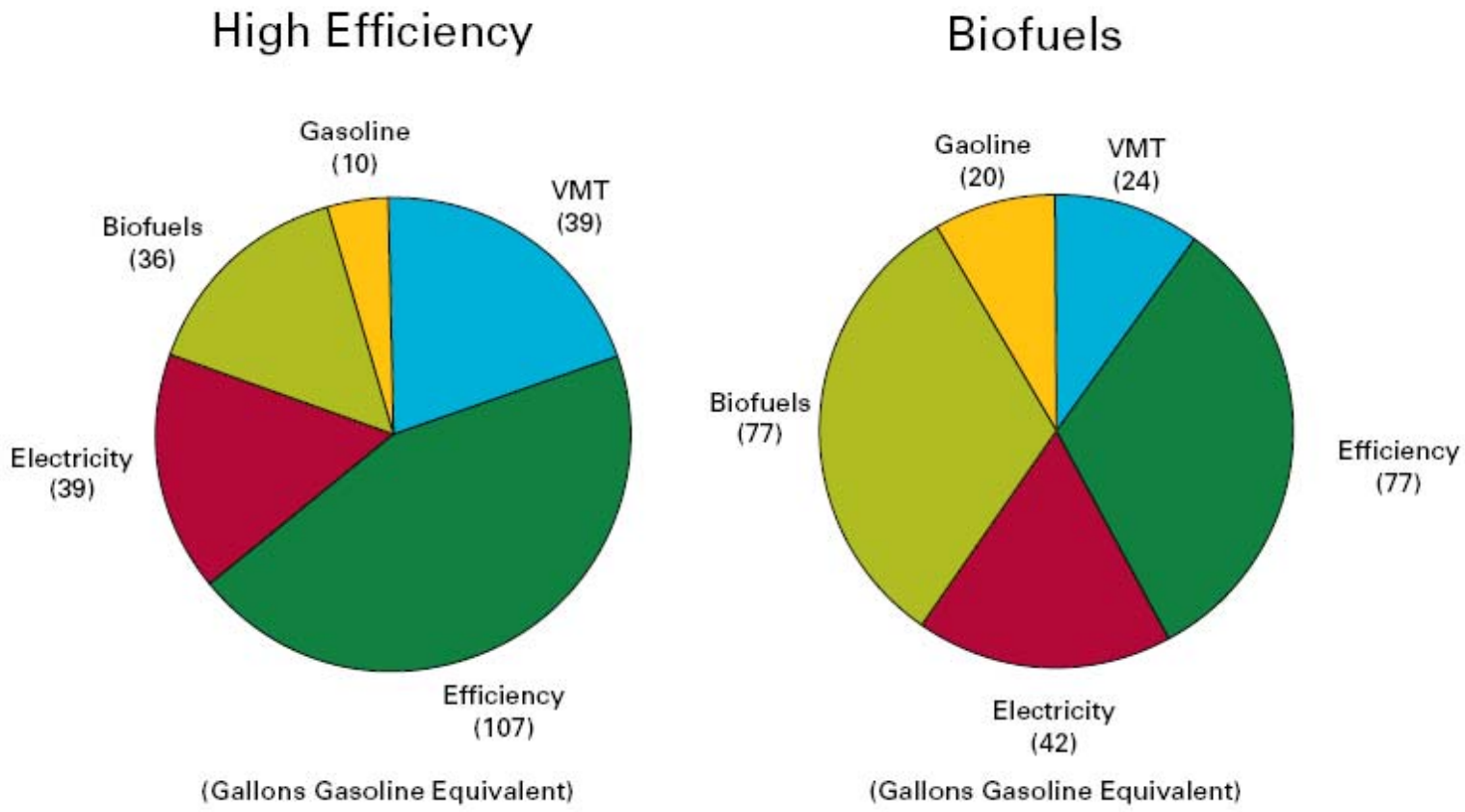
We Can Virtually Eliminate Our Demand for Gasoline by 2050



- To get sufficient GHG reductions from the transportation sector, biofuels will have to play a much larger role than they do today
  - Between 55 and 116 billion gallons etoh in our scenarios

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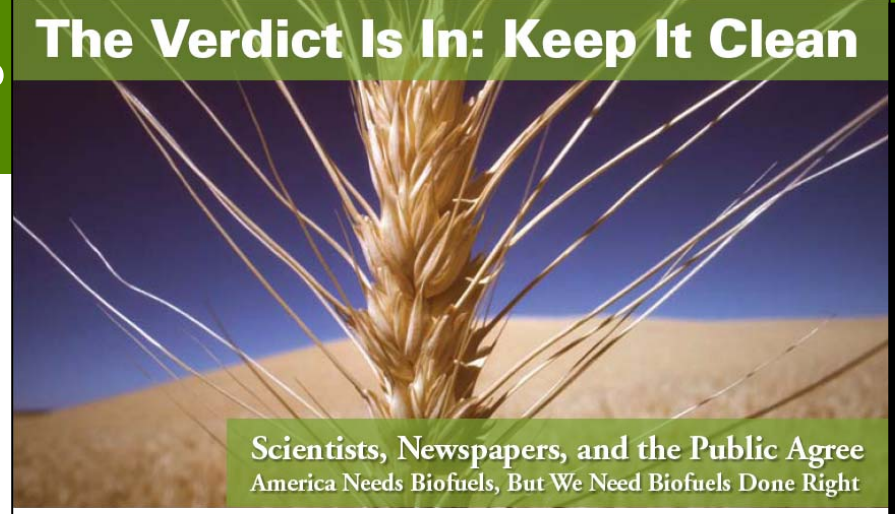
Biofuels: Good or Bad?

- *Wired*: This Plant Will Save America
- *Foreign Affairs*: How Biofuels Could Starve the Poor
- NRDC: Growing Energy, How Biofuels Could Help End America's Dependence on Oil
- Earth Policy Institute (Lester Brown): Exploding U.S. Grain Demand for Automotive Fuel Threatens World Food Security and Political Stability
- *National Geographic*: Growing Fuel: The Wrong Way, the Right Way



"Biofuel research is worth doing and may be one of many essential tools to limit damage from future climate change, but there are big environmental and social risks if it's pushed too hard and too fast,"
– San Francisco Chronicle[1]

"One of the things about ethanol and the biofuels is they impact every arena: air, water, drinking water, construction wastes. It seems like they cut across every program we have,"
– Barbara Lynch, Iowa Department of Natural Resources[2]

"The risk is that we may be trading one set of problems for another. There has been too little cost-benefit analysis of the ethanol-from-corn process, and much of what has been done has been too limited in scope,"
– St. Louis Post-Dispatch[4]

"Given current grain-based ethanol technology and in the absence of policy intervention …these benefits will come at a cost to our nation's water and soil health,"
– World Resources Institute[5]

"The switch to cellulosic [ethanol], done right, could be a boon to wildlife and to water quality, various scientists have reported. Growing switchgrass or other alternative crops to make ethanol could cut soil erosion. In addition, the year-round ground cover would reduce greenhouse gases in the atmosphere,"
– Bucyrus (OH) Telegraph[6]

"Even varied and more-sustainable crops grown for energy purposes could have negative environmental impacts if they replace wild forests and grasslands…There is still a dire need for environmental policies and regulations at the local, national, and regional levels…to ensure that bioenergy's impacts on land, wildlife, and water, air, and soil quality are minimized."
– United Nations Report on Sustainable Bioenergy[7]

"There has been almost no effort to mitigate the predictable effects — dead waters, dirty air, diminished water supplies — of a corn-based ethanol boom,"
– St. Louis Post-Dispatch[4]

"Intensified crop production also reminds us of the necessity of sound farm conservation and environmental practices,"
– Senator Tom Harkin (D-IA)[8]

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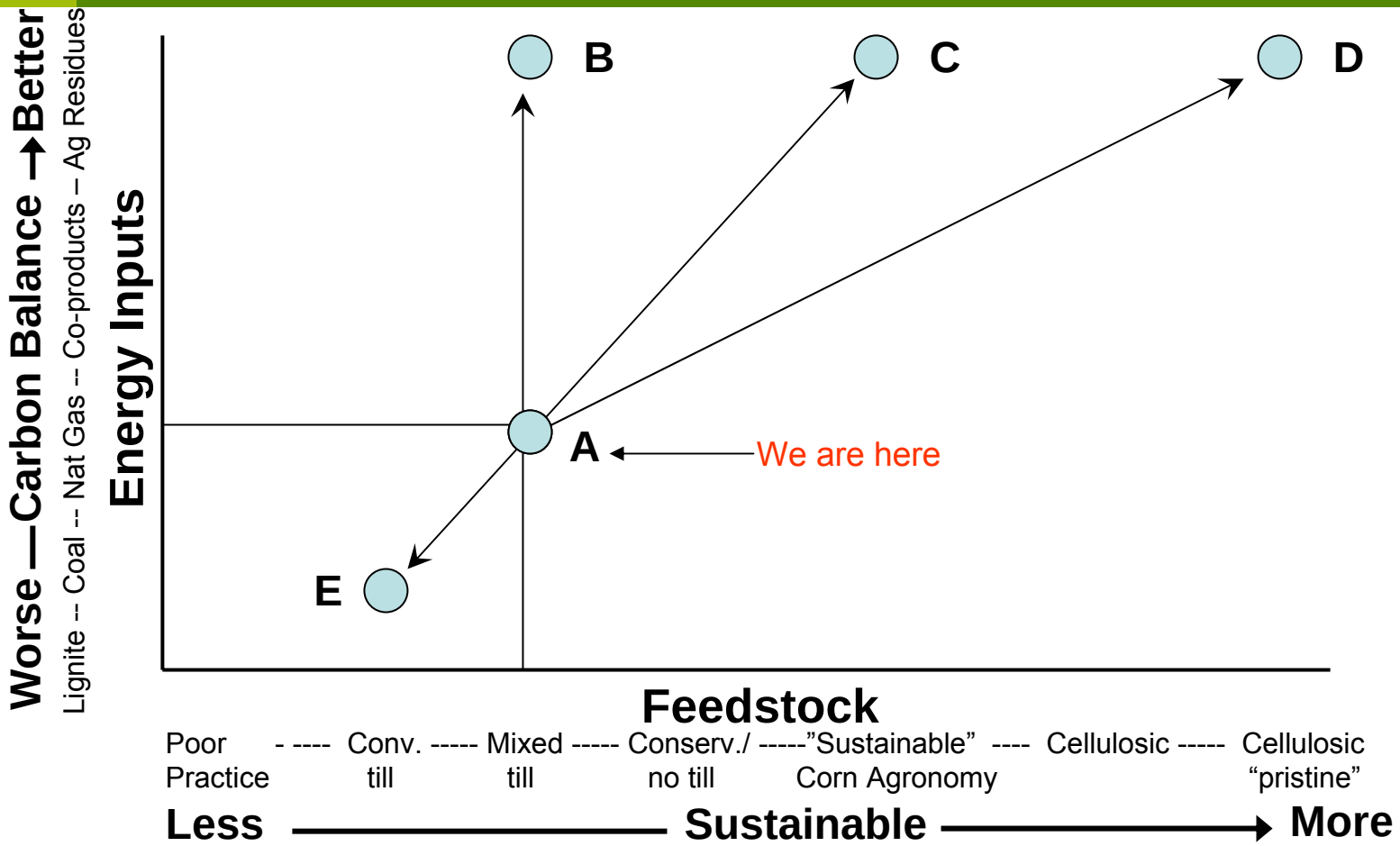
We Have to Choose Where Biofuels Will Go



A – Current state of US ethanol industry

B – A biomass powered corn ethanol plant (CVEC, CMEC, Panda, E^3)

C – Biomass-powered corn ethanol w/ improved corn agronomy practice
Question: How can grass production complement corn production?

D – Low-carbon cellulosic inputs for feedstock and energy inputs [Max GHG benefit]

E – The wrong direction

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Credit: William Lee, CVEC

Cellulose: Panacea, Fantasy, Forrest Killer?

- Easier to produce with smaller environmental footprint
  - But just because it can be doesn't mean it will be
- Will it always be 5 years away?
  - RD&D now happening in the private sector
  - 5-8 pilot scale (1-5 million gallons/yr) globally
  - At least 6 small commercial scale (13-30 million gallons/yr) through DOE grants
- The ability to convert lignocellulose opens up the forests
  - Some promising crops & residues
  - New types and levels of environmental harm
    - Potential for harvesting wild, standing carbon

Easier to Maintain Habitat with Native Grasses

Habitat Type[a]	Number of Breeding Pairs per 40 ha	Total Number of Breeding Species	Number of Sites Sampled
Dense switchgrass	182	10	8
Poor switchgrass	178	9	8
Reed canary grass[b]	246	9	6
Mixed warm-season grasses	126	13	7
Corn	32	5	16
Beans	22	2	9

a: Habitat types were categorized as follows: reed canary grass sites were not monotypes—they were fields where reed canary grass was the most common grass species (cover values ranged from 15% to 97%); dense switchgrass sites had >40% cover of switchgrass and <4% cover of other warm season grasses; poor switchgrass sites had <40% cover of switchgrass and <9% cover of other warm season grasses; mixed warm season grass sites had >72% cover of native warm season grasses other than switchgrass; bean and corn sites were on commercial bean (spy or snap) or corn fields, respectively.

b: Reed canary grass ranked highest in bird density primarily due to the influence of the large number of red-winged blackbirds (*Agelaius phoeniceus L.*) that nest in it.

- But benefits can be undermined by
  - Converting natural forests and grasslands
  - Harvesting during the nesting season
  - Growing vast monocultures

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Less Fertilizer, Better Uptake, Less Pollution

	Typical Nitrogen application (lbs/acre/year)	Percent of typical Nitrogen application lost	Nitrogen lost (lbs/acre/year)
Corn	98-162	11%-33%	15-53
Switchgrass	~110	~11%-19%	~10-17

- But pressures to maximize yields may
  - encourage non-native species that become invasive
  - shift root mass to shoot mass
  - encourage aggressive fertilization
  - encourage irrigation in less productive climates

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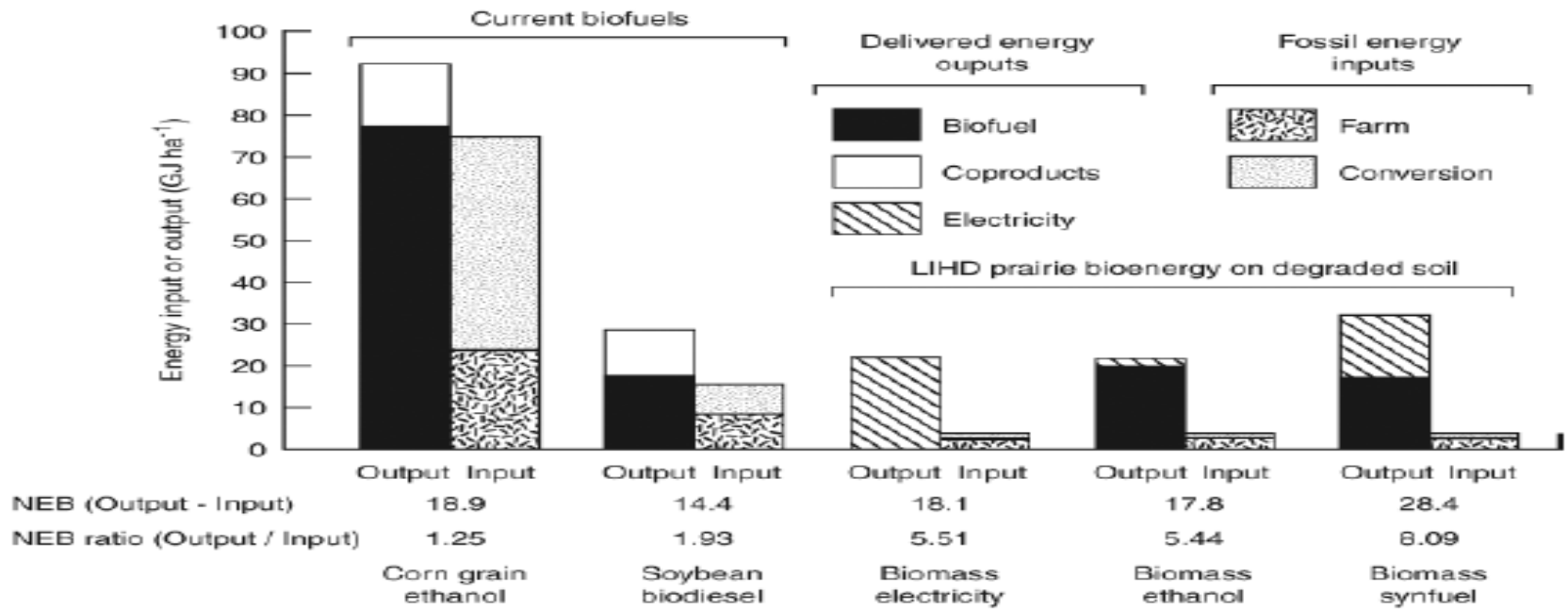
The Promise & Challenge of Low-Input, High-Diversity Perennial Grasses



- Tillman *Science* December 2006
- Same or better Net Energy Balance as corn EtOH from degraded nitrogen-poor sandy soil
- NEB ≠ high EtOH yields and need to be aware that not all forms of energy are created equal
- Shows promise of higher yields (dry tons) on better quality land

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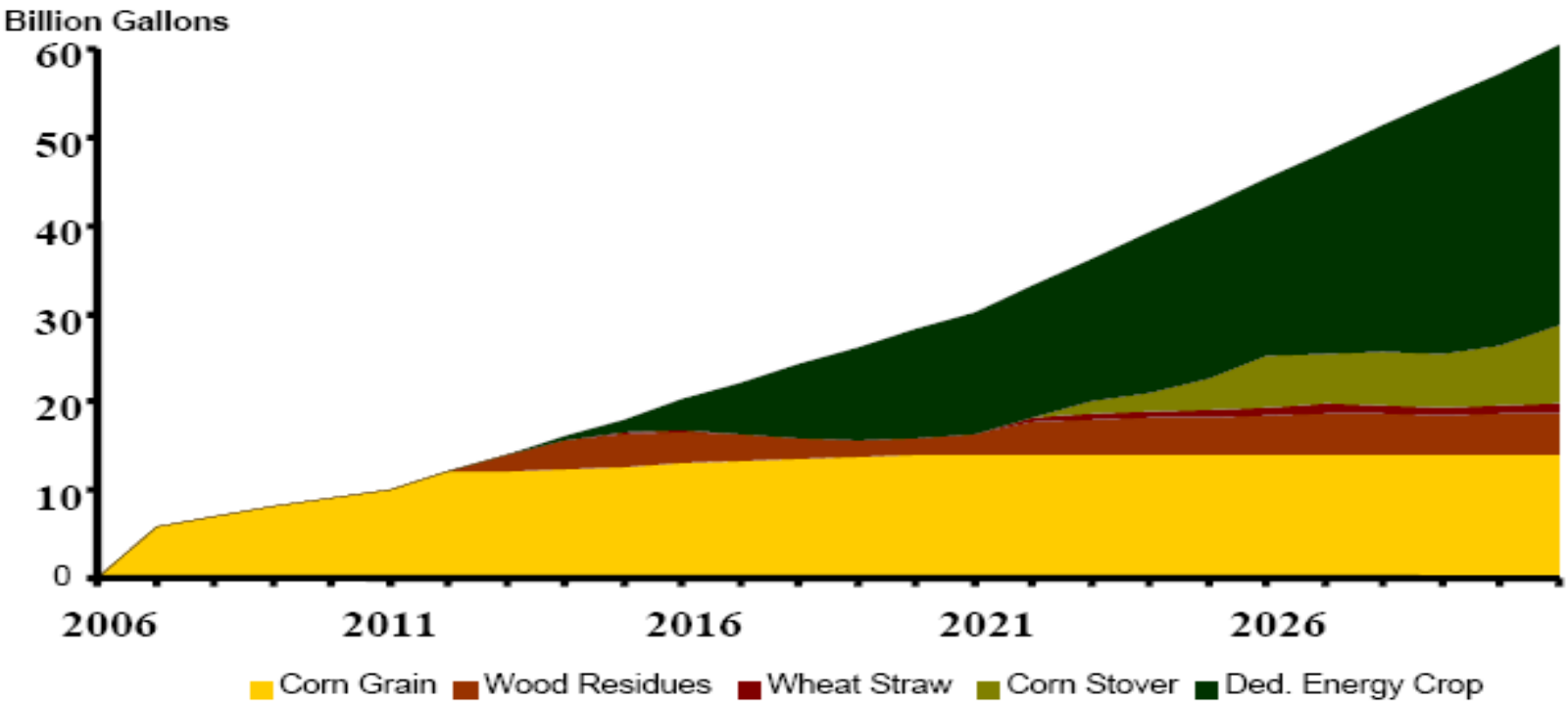
Cellulose Helps with the Environment but Is Critical to Lots of Volume



- Ugarte et al. December 2006
- Assumes cellulosic conversion technology commercial by 2012
- Assumes corn demand for EtOH never goes down
- No CRP land
- Biggest conversion is from pasture land to hay and dedicated energy crops

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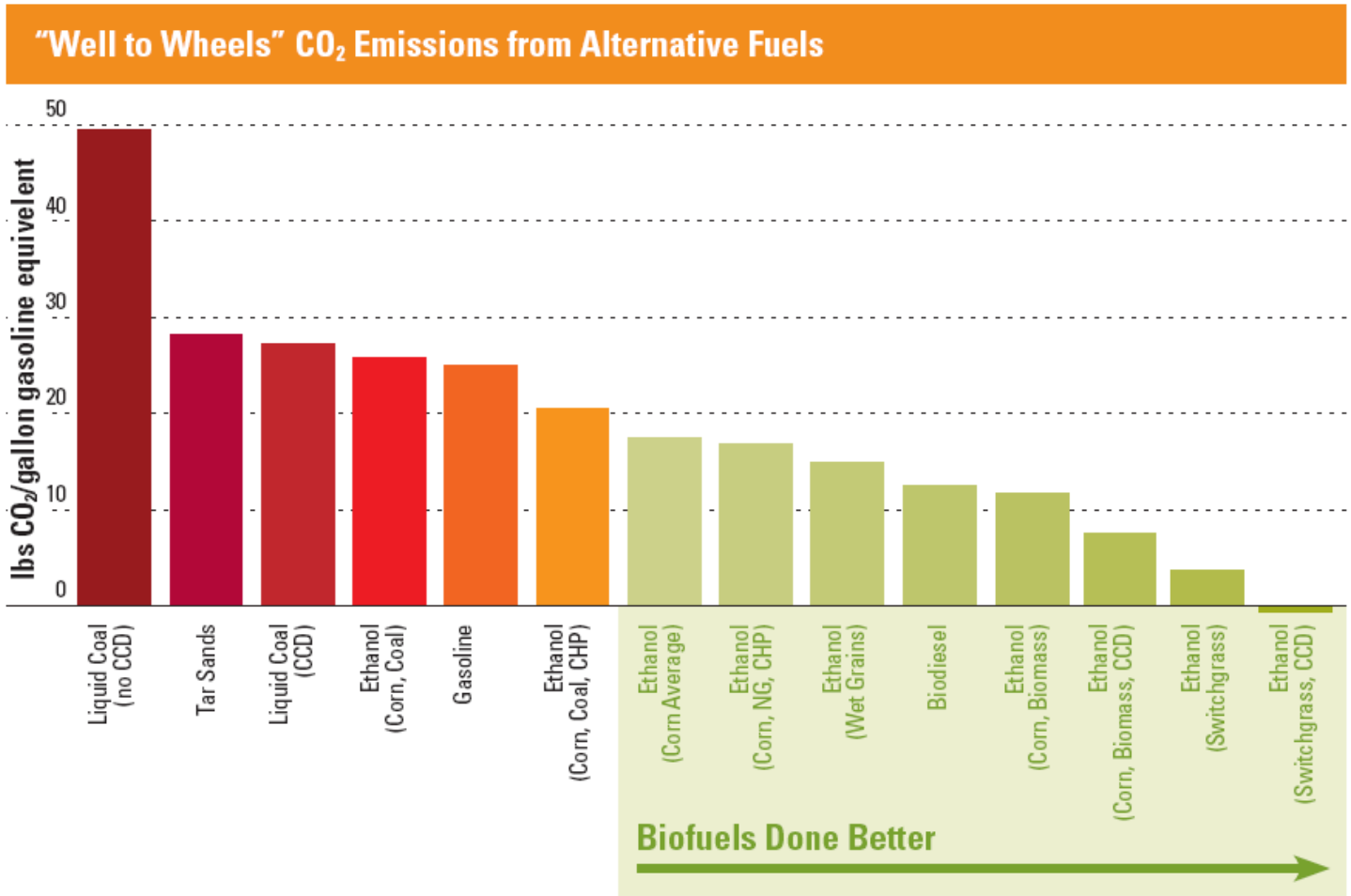
Corn or Cellulose – All Outcomes Are Possible



- Corn can get better; cellulose can be done in destructive ways
- Land-use changes will be largest factor

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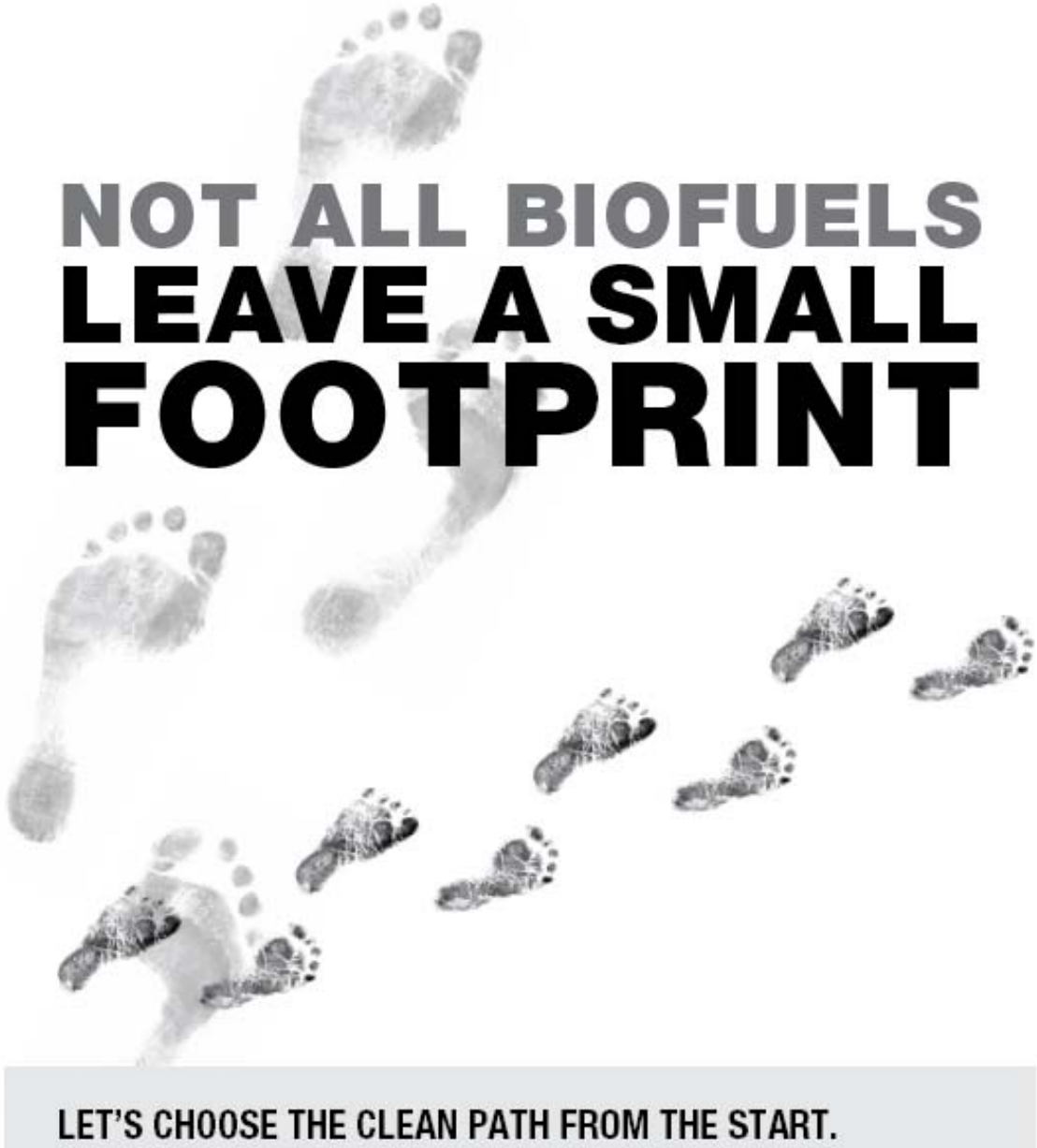
The Choice Is a Policy Choice



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The Gold Rush Is Creating a New Urgency

- Advance biofuels as part of a package of policies that starts with increased energy efficiency.
- Be technology neutral and performance based.
- Establish lifecycle emissions standards for biofuels.
- Use incentives to drive the adoption of the best voluntary management practices.
- Establish a biofuels labeling systems that shows the global warming pollution, verifies the renewability of the biomass, and reports the level of feedstock management practices.
- Exclude sources of biomass that should not be used to make energy.
- Set minimum management standards when doing renewable fuel standards.
- Safeguard public health by updating fuel and vehicle regulations and using biofuels in ways that minimize air pollution.

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Key Issues for Today to Get Biofuels Right

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Pick Performance not Technologies

- There are a lot of renewable fuel technologies being developed
  - Different crops (switchgrass, miscanthus, willows, poplars, sweet sorghum, different rotations)
  - Different conversion technologies (enzymatic, microorganism, high temp gasification, low temp pyrolysis, non-gasification catalytic)
  - Different fuel molecules (ethanol, butanol, FT gasoline, renewable gasoline)
- Even the best technologies can be deployed in destructive ways

Picking Performance Means Picking Metrics

- The best metrics are often hard to measure accurately and affordably
- Lists of “best practices” are often the best we can do
  - Useful and much better than nothing
  - A barrier to innovation
- Our metrics often determine our political view
  - Per acre vs. per bushel
  - Total impact vs. relative impact
- The right metrics and measurement technologies could help build consensus for action

Lifecycle GHG Emissions Will Be the First Metric

- Strong and growing consensus over the metric
- No consensus over the measurement methodology
- Indirect, induced impacts are the wildcard
  - land-use changes
  - Imports/exports
  - Consumption patterns
  - Impacts are real and can easily swamp marginal choices (cropping practice & process fuel)
- Accounting protocol being develop right now by CARB and EPA
  - Low-carbon fuel standard and 20-in-10 executive order

Not Choosing Is Not an Option

- Need to avoid converting natural ecosystems
- Need to recognize dynamic equilibrium nature of ag markets and land-use
- Want systems that are practical, directionally correct from the start, and regularly updated as the science gets better

Biofuels may be the most complicated GHG abatement to get right, but it can be big and we need them all

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