# *What Future Role for Biofuels?*

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As I prepared for this meeting, I asked myself where I could most constructively contribute to an agenda that includes many accomplished scientists well versed in the scientific and technical aspects of renewable fuels. I concluded that I should focus on the political context for biofuel policy and the environmental perspective.

## Where Are We?

The 2007 Energy Independence and Security Act (EISA) that was signed into law in December of last year put the nation on a course that included a greatly expanded national renewable fuel standard (RFS). This RFS created several escalating volumetric mandates, including 15 billion gallons of corn ethanol each year by 2015, and a total of 21 billion gallons each year of advanced biofuels, cellulosic ethanol and biodiesel by 2022. For corn ethanol, the 15-billion-gallon target represents a doubling of what had been considered just 2 years earlier in the 2005 Energy Bill to be an ambitious mandate (Fig. 1). For advanced biofuels and cellulosic ethanol, the 2007 Energy Bill mandates a flourishing market 15 years from now for fuels and processes that exist only in the laboratory today (Fig. 2)

Transportation is responsible for approximately 70% of the oil used in this country. For perspective, the 15- and 21-billion gallon mandates of EISA should be compared to the much larger overall transportation sector oil demand. In 2005, the United States used 230 billion gallons (gasoline equivalent) of liquid transportation fuels (DOE, 2007). Even at the greatly expanded renewable fuel volumes of the 2007 EISA, renewable fuels will still meet only 10% of our overall transportation fuel demand by 2022.

California has adopted a low carbon fuel standard that is now being implemented by the California Air Resources Board (part of the California Environmental Protection Agency). At least eight other states have established volumetric requirements for renewable fuels, and more than thirty have adopted some combination of producer or retailer incentives for renewable fuels. The Renewable Fuels Association claims that, as of January 2008, annual corn ethanol capacity will exceed 13 billion gallons of ethanol. (This is capacity, rather than actual production.)

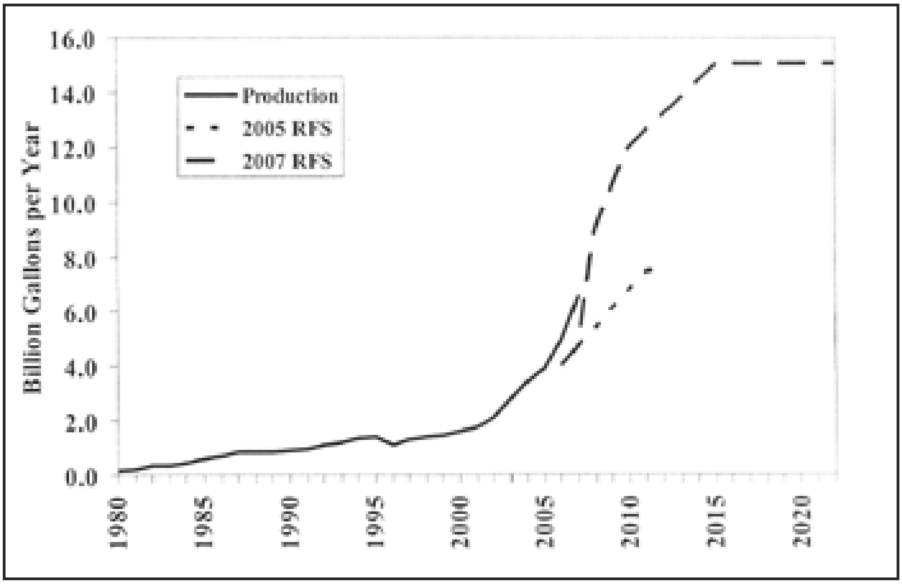

Figure 1. US corn-ethanol production and targets. The volumetric corn-ethanol mandates of the 2005 and 2007 RFS far surpassed the actual production at the time that each law was passed. The 2007 RFS mandate for 2015 is approximately twice current production.

Domestic biofuels currently enjoy direct financial supports at the federal level, including a 51-cent per gallon tax credit for blenders of corn ethanol and a 54-cent tariff on ethanol imports. Biodiesel and renewable diesel enjoy similar incentives and supports. These supports have occasionally been challenged, but their base of political support remains strong and, currently, do not appear to be seriously threatened.

Despite the generic terminology, "biofuel" in the United States is currently synonymous with corn ethanol, and corn is a major American crop. From nearly 94 million acres of corn planted in 2007, US agriculture harvested almost 13 billion bushels of corn, with a value of over $50 billion. The US corn production constitutes 43% of the global total, and approximately 25% of this was used to produce fuel ethanol (NCGA, 2008) and (USDA ERS, 2007) (Fig. 3). The Renewable Fuels Association estimates that the United States produced 6.5 billion gallons of corn ethanol in 2007. Biodiesel and renewable diesel volumes are much smaller than those of ethanol, on the order of 100 million gallons in 2007.

## How Did We Get Here?

For decades, biofuels in the United States have been proffered as a tool for energy security, inspiring slogans about relying on the Midwest rather than on the Middle East. While analyses of the lifecycle performance of biofuels have varied somewhat, there has been general agreement that use of corn ethanol slightly reduces the need for oil. The net overall

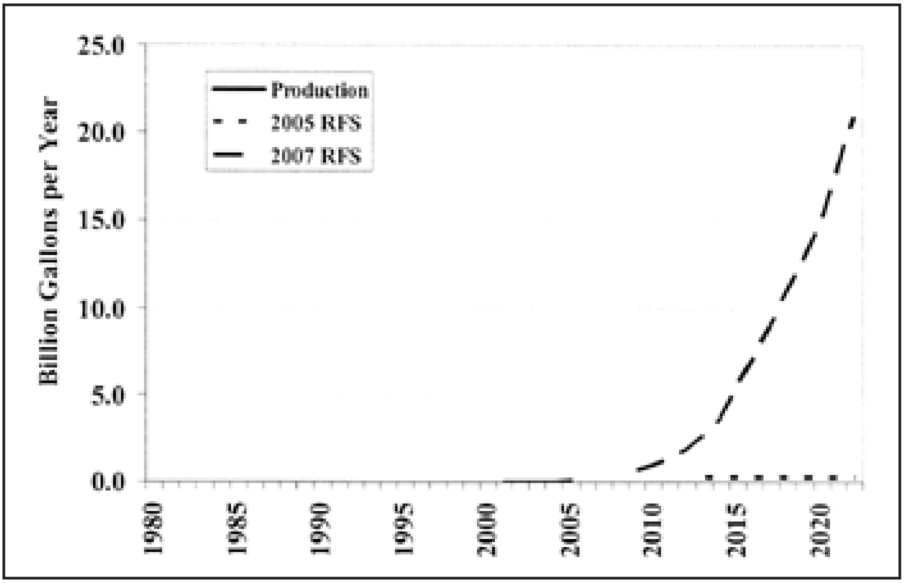


Figure 2. US advanced biofuel production and targets. The 2005 RFS volumetric mandate for advanced biofuels was modest, but the 2007 mandate for 2022 is dramatic. Current production of advanced biofuels is almost invisible in comparison with these mandates.

*energy* impact of corn ethanol has been more debatable. The ethanol production process (*e.g.*, planting, fertilizing, harvesting, distillation) entails fossil-energy inputs, but much of which is provided by forms other than oil, (*i.e.*, natural gas or coal). In this way, these other fossil-energy sources were effectively being used to produce liquid ethanol fuel, and thereby reduce the need for oil.

More recently, biofuels have been proposed not just for energy security, but also for climate policy. Like the debate over the net energy required to produce ethanol, the greenhouse-gas (GHG) analysis has been contentious. Some researchers, as exemplified by Michael Wang with the

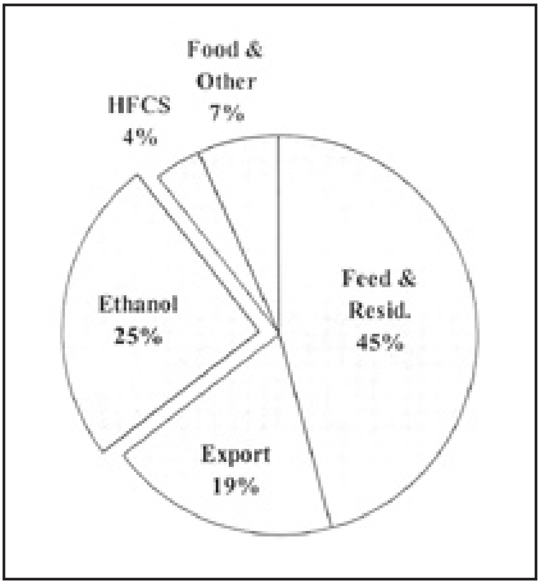


Figure 3. US corn use, 2007–2008. One quarter was used to produce corn ethanol. The largest portion was used for animal feed.

GREET model, concluded that when evaluated on the basis of its greenhouse impact, corn ethanol is modestly (~20%) superior to conventional gasoline. Others, such as David Pimentel, persistently claim that corn ethanol is inferior from a GHG perspective. Until recently, the balance of scientific opinion seemed to fall on the side of corn ethanol being slightly superior to fossil fuel when judged on its complete lifecycle emissions. One often-cited summary is that of Farrell *et al.* (2007).

This was the scientific understanding in place last year when Congress passed the 2007 EISA. As recently as December, 2007, the president, farmers, and some environmental organizations were celebrating the renewable fuel provisions of the bill as a step forward on climate policy.

## The Indirect Land-Use Debate

That celebratory euphoria came crashing down earlier this year with publication of two papers in *Science* (Fargione *et al.* 2008) and (Searchinger *et al.,* 2008). These papers, particularly the one by Princeton researcher Tim Searchinger *et al.*, catalyzed a harsh reaction to biofuels, the reverberations of which are being felt throughout the popular press. See, for example, the April 7, 2008, *Time* magazine cover story or the recent *Washington Post* series on food scarcity that examined the impact of biofuel production.

The logic of the Searchinger paper is simply the following. Cultivation of crops for fuel production makes that land unavailable for production of other crops. Therefore, commodity prices will be somewhat higher, and somewhere else in the world, new land will be placed under cultivation to compensate. A complete analysis of the GHG impacts of cultivated biofuels should account for the fact that agricultural land was converted from something else to be placed in cultivation. Of course, exactly how much land, what kind of land, and the greenhouse impacts of that land are subject to debate, but Searchinger concluded that a true accounting of the costs of corn cultivation for ethanol would give it twice the GHG emissions of gasoline.

When examined closely, the implication of the Searchinger paper is not solely that biofuel demand leads to deforestation. The paper argues that agricultural demand collectively leads to deforestation, and biofuels are one part of the demand. The conclusion that biofuel demand leads to deforestation follows only because that was the question that was asked, but exactly the same logic could have been used to assess the land-conversion implications of any aspect of agricultural demand. Some biofuel advocates have cited this broad logical applicability as evidence of flawed reasoning, but in doing so they may fail to appreciate the strength of Searchinger's argument. Indeed, the current spotlight on biofuel production may presage a much broader future debate about the collective global impacts of domestic agricultural demand more generally.

I believe that assessing the indirect land-use impact of biofuel production will be a stubborn challenge. The objective scientific and economic questions are formidable, but the challenge goes beyond that. Indirect land-use impact is not a question that can be completely resolved through science, or even through economics, because it is not just a question of *what* happens but of *why*; it entails attributing responsibility. Suppose, for example, that there is no uncertainty in the science and economics. Suppose we could calculate exactly how global agriculture would change as demand for biofuels increases and all other demands are held constant, and we could calculate exactly what that implies for GHG emissions. (I emphasize that this is only a thought-exercise because we don't actually know these things.) One might then associate that marginal change in GHG emissions with the indirect land-use impacts of increased biofuel production.

Note, however, that even this seemingly straightforward approach contains embedded assumptions about what will happen in the future for the land that is converted to agriculture as well as for the land that is not converted. How well can we predict the future use of forest land, and to the extent that we can do so, how should that affect our assessment of biofuels? Should the impacts of deforestation be ascribed narrowly to the biofuel portion of agriculture, or more generally across all agriculture? These are the kinds of questions that will need to be resolved in order to assess the indirect land-use impacts of biofuel production.

The indirect land-use debate will not be resolved quickly. Academic disputes often play out over many years, even when the economic stakes are not as high as they are in this case. Assessing the lifecycle GHG implications of renewable fuels is an accounting question, with all the attendant subtleties, nuances and ambiguities. Given that we know that GHG emissions from both fossil-fuel use and land-use change are ongoing and collectively must be greatly reduced to protect the climate, a key question is, "How do we pursue constructive and effective policies in the face of these uncertainties?"

## What to Expect for the Future?

Predicting the future in such a turbulent atmosphere is probably foolish, but I offer the following general observations.

- Oil prices may fluctuate, but driven by increasing global demand, oil will generally remain more expensive in the future than in the past. While fossil energy prices do increase the cost of renewable-fuel production, the net effect is to make the alternatives more competitive with fossil fuel.
- The problem of world hunger, even if not created by biofuel production, will continue to focus public debate on the morality of using land or anything that compromises food production for fuel production.
- Some form of climate legislation will probably be signed into law in the near future. The Lieberman-Warner climate bill has passed the Senate Environment and Public Works Committee and is awaiting debate on the floor. Similar bills have been introduced previously in the Senate and in the House, and there is nothing to suggest that climate change will diminish as a political issue.
- Oil is becoming more greenhouse-intensive as unconventional sources such as Canadian tar sands are exploited.
- In practice, virtually all biofuel in the United States is corn ethanol at the present time, and the political power of those established agricultural interests will continue to shape policy. Corn ethanol represents billions of dollars in direct federal support that will not be relinquished easily.

These general observations give rise to a number of important and, at this point, unresolved questions.

## Unresolved Questions

- How can we exploit the differences in existing fuel- and feedstock-production practices to motivate established and emerging biofuel industries to evolve in ways that minimize GHG emissions and other adverse impacts?
- How effectively can cellulosic and advanced-biofuel technologies be commercialized? This is the multi-billion dollar question. The 2007 EISA mandates 21 billion gallons of advanced biofuels by 2022, but can this actually be accomplished?
- When the United States produces 21 billion gallons of advanced biofuels, what form will they take? Ethanol? Butanol? Biodiesel? Fuel that is fungible with gasoline or diesel? Any fuel must be integrated with our existing transportation infrastructure, and that includes pipelines and distribution networks as well as more than a hundred million vehicles.
- If the fuel is to be ethanol, where can we put it all? Most ethanol today is blended with gasoline at concentrations of 5% to 10%. The 36 billion gallons of ethanol to be produced in 2022 will represent more than 25% of expected gasoline demand. Can we use it?
- Have we thoroughly explored the universe of potential renewable fuels—including those that may not take the form of ethanol or biodiesel—for the options that most robustly, cost-effectively, and sustainably reduce both oil demand and GHG emissions?
- Will a well-established corn-ethanol industry (bolstered by the RFS and various federal supports), facilitate or impede development of second-generation biofuels?

Renewable fuel policy is generally tumultuous, and this is a particularly dynamic time for it. How well we, as a society, respond to our energy and climate challenges will be dictated in part by how we answer the questions above. The policy questions will play out in Washington, but the scientific and technical questions can be answered only by researchers such as those represented through the National Agricultural Biotechnology Council. I look forward to a fruitful conversation as we address these questions together.

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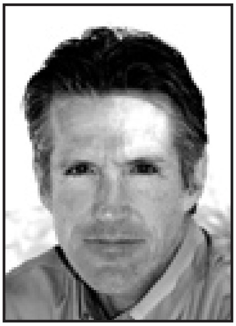

**PETER ASHCROFT** earned an undergraduate degree in applied physics from the California Institute of Technology before obtaining a PhD in engineering and public policy from Carnegie Mellon University. His graduate research addressed the use of ground-, air-, and space-based observations to characterize atmospheric methane fluxes. He worked for nearly a decade in satellite microwave remote sensing before receiving the Roger Revelle Global Stewardship Fellowship through the American Association for the Advancement of Science. With that fellowship he moved to Washington, DC, where he concentrated primarily on energy issues while working in the office of Senator Joseph Lieberman.

Subsequently, Dr. Ashcroft accepted a position with the National Climate Campaign of Environmental Defense, where his focus has been fuel and transportation policy. He has taken a leading role in coordinating a council of industrial and non-governmental organizations to develop policies to promote low-carbon fuels and otherwise reduce the greenhouse impact of vehicle fuels as part of a comprehensive climate policy.