The Energy Foundation

Toward a sustainable energy future

THE NEW HARVEST:

Biofuels and Windpower for Rural Revitalization and National Energy Security

PREFACE

This report is a product of The McKnight Foundation-Energy Foundation Upper Midwest Clean Energy Initiative. Funded by The McKnight Foundation of Minneapolis, Minnesota, this initiative is focused on helping the Midwest become the world leader in state-of-the art wind power and advanced technologies for producing biofuels—liquid fuels from crops and agricultural waste.

Managed by the Energy Foundation, this initiative supports policy analysis, model policy development, and decision-maker education efforts that advance clean, renewable energy technologies. The goal is to bring the rural economic development, oil security, and environmental benefits of such clean energy technologies to the Midwest, and, by example, to the world.

For more details and grant guidelines, see www.ef.org

THE NEW HARVEST:

Biofuels and Windpower for Rural Revitalization and National Energy Security

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INTRODUCTION:

GROWING U.S. AGRICULTURE INTO A LEADING ENERGY PRODUCER

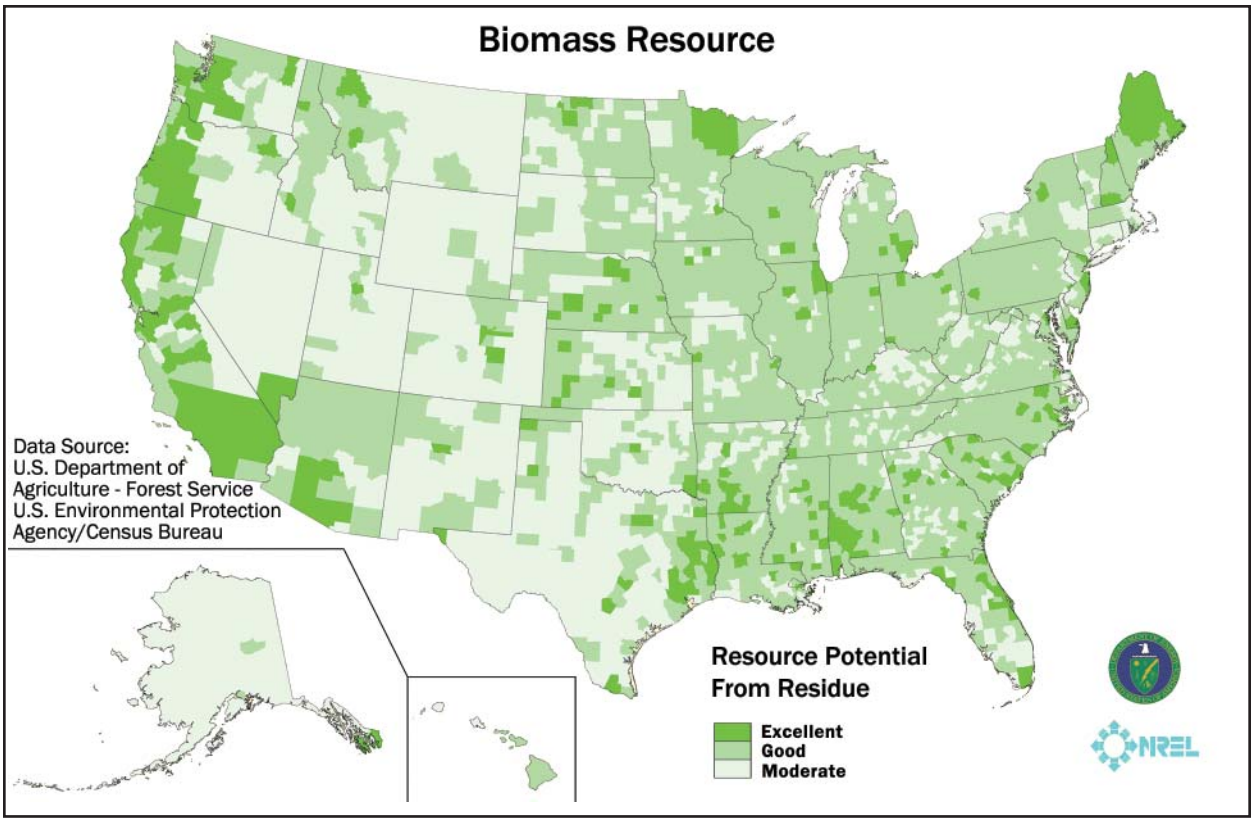
Providing liquid fuels and electric power from American farmlands is a win-win-win for rural economies, national energy security, and the environment.

Rural America needs new economic development opportunities. At the same time, America faces the challenge of obtaining the affordable, reliable, and clean energy needed for economic growth. Global oil supplies are stressed, increasingly costly and, coming substantially from volatile regions, subject to both natural and human-caused disruptions. Natural gas, which has provided clean electrical power generation over the past decade, has recently tripled in price. Fast-growing economies like China and India are increasing world-wide oil and gas demand, suggesting that oil and natural gas prices will not return to their low 1990 levels. And with only three percent of world oil and natural gas reserves, America has no long-term prospect to produce its way—through drill rigs or off-shore oil platforms—out of dependence on increasingly tight world energy markets.

America's rural landscape is the place to substantially address both rural economic and national energy challenges. Clean energy development produces new income streams for farm communities and, by displacing oil and natural gas imports, improves U.S energy security. Renewable electrical power generated by wind farms and clean biofuels derived from crops, now just niche players in the U.S. energy picture, can provide a significant share of American energy demands.

Royal Raymond's Eastern Oregon wheat and cattle ranch now also produces a harvest of wind power. Credit: Don Cresswell, East Oregonian

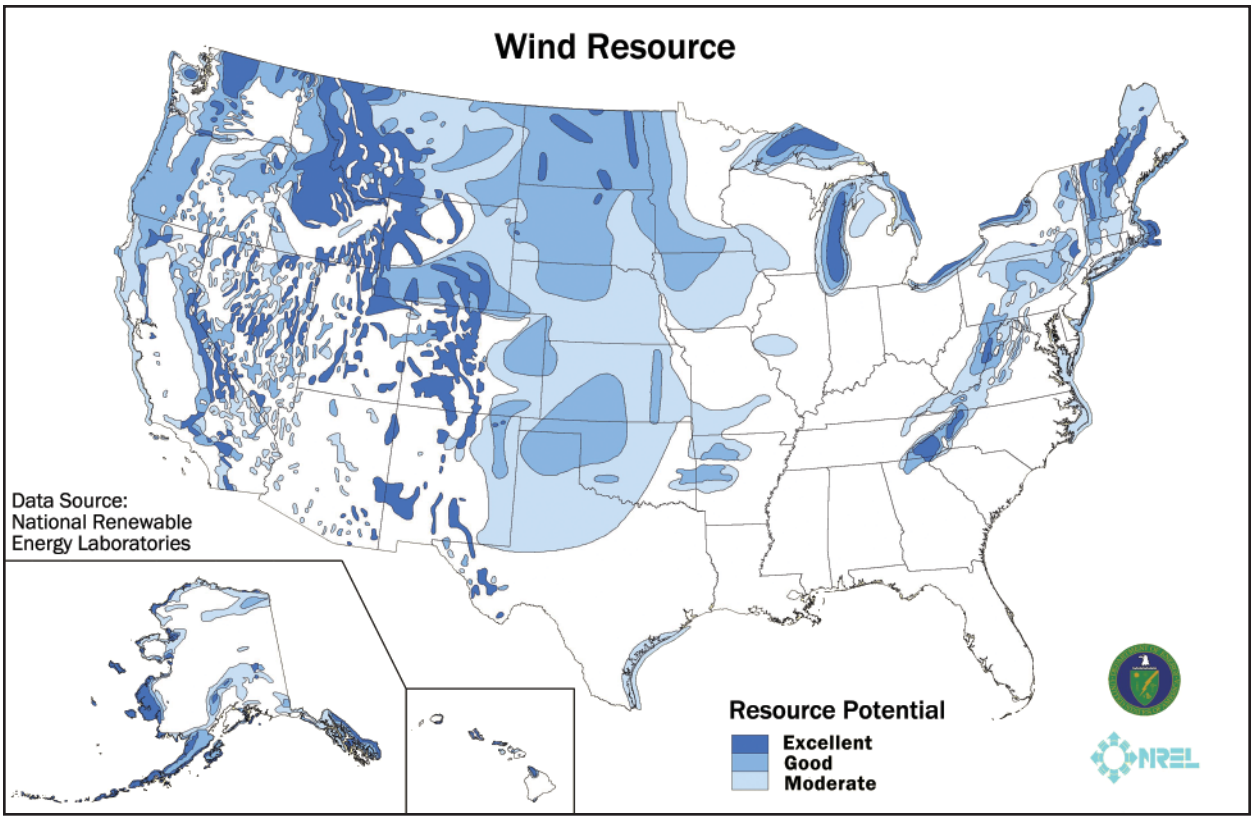
These advanced clean energy technologies can make the Ag-Energy sector a new engine of economic growth, tipping rural economies from economic stress to prosperity. This paper outlines the promising new technologies—and policies to rapidly commercialize them—that can grow a new Ag-Energy harvest that benefits the whole nation, especially farm communities.



Abundant, economical biomass resources are available across much of the U.S.
Credit: DOE/NREL

Two new markets show the most promise for transforming America's fertile and productive farm belts into national energy suppliers:

Biofuels made from grains and vegetable oils now supply around two percent of the nation's light-duty vehicle fuel. Studies by leading national research institutions show that biofuels, when teamed with more efficient vehicles and smart growth, could virtually replace gasoline use in light duty vehicles by 2050. That would displace nearly eight million barrels of oil daily, more than three times our current Persian Gulf imports. This could be accomplished with only a modest increase in cropland as part of a system that also generates the food and fiber America needs. Advanced biofuels made from cellulose, of which most of the plant world is constituted, will unlock this promise. Cellulose offers vastly larger and less expensive feedstocks than grains. With policies to commercialize the first billion gallons of capacity on the ground by 2015, a burgeoning cellulosic ethanol industry could add $5 billion to farmer profits by 2025.



Map shows major U.S. land-based wind power reservoirs on the Great Plains and in mountainous regions.
Credit: DOE/NREL

Wind Power, still generating under one percent of U.S. electricity, is the world's fastest growing energy source with vast, untapped potential. Rural landowners are earning around $2,000-$5,000 per turbine annually leasing land to wind developers and even greater returns are possible with local ownership. Wind farms are also a tax revenue and employment boon to rural counties. New research shows vast areas of the U.S. could produce wind power at costs competitive with coal and natural gas electricity. With the right policies, wind growth could provide 10 percent of U.S. power supplies by 2020. Key policies include renewable energy standards, production tax credits, and policies to ensure adequate transmission as the *"road to market"* for new wind power. The Great Plains have the largest land-based wind prospects, but wind farms now operate in 26 states from Vermont to Tennessee to Oregon.

The agricultural and environmental communities, sometimes at loggerheads, are converging on a vision for the farm sector as a major energy producer. Farm leaders

"The development of alternative energy sources is not only significant to the advancement of American agriculture, but also is vital to enhancing our nation's security."
—American Farm Bureau Federation President Bob Stallman

understand Ag-Energy represents a major new market opening for U.S. agriculture.

"*Renewable energy means new commodities, whether it's ethanol, biodiesel, wind or methane,*" Iowa Farm Bureau Commodity Services Coordinator Denny Harding says. "*We look on energy as a growth sector for agriculture. The technology just keeps getting better. The economics are looking better all the time.*"

"*When we look at what renewable energy can do for the rural communities we see it as a great economic development factor,*" Rocky Mountain Farmer's Union President John Stencel notes.

Colorado Farm Bureau National Affairs Director Tracee Bentley comments, "*Our farmers are interested in diversifying, and most of our renewable energy potential is on farm land.*"

"*Idaho would see a tremendous benefit from generating our own electricity with the abundant wind, geothermal and biomass resources we have right here,*" Idaho Farm Bureau Federation President Frank Priestley says. "*Not only are these clean, renewable ways to provide for our future needs, but they will allow farmers and ranchers the opportunity to receive benefits.*"

Farm groups have long engaged in political efforts for public policies to build the Ag-Energy sector. From their beginning ethanol incentives have drawn vital support from the agricultural community. Recently farm support for clean energy has witnessed a significant upsurge. Over the last two years a long list of farm groups has stepped up to support renewable energy policies, including Farm Bureaus, Farmers Unions, and commodity groups.[1]

The American Farm Bureau Federation and National Farmers Union, along with commodity groups representing corn, soybean, sorghum, sunflower and canola producers rallied behind 2005 Energy Bill passage of a national Renewable Fuels Standard (RFS). The RFS requires 7.5 billion gallons per year in the national fuel mix by 2012. At the state level farmers have united with nontraditional allies such as environmentalists to pass such policies as a Minnesota RFS, increased in 2005 to an unprecedented-for-the-U.S. 20 percent. Farm groups are central to national and state coalitions for the renewable energy standards, productions tax credits, and other policies to commercialize wind.

But for the most part these efforts have taken place in different silos, and have focused on immediate policy gains rather than a longer-term vision. Now many both from and beyond the farm community have sighted the opportunity to take farm-produced energy to the next level. For instance, the Ag-Energy

[1] *Farm Groups Pushing for Renewable Energy Standards*, Harvesting Clean Energy Issue Brief, Climate Solutions, August 2004, www.harvestcleanenergy.org

Working Group, a gathering of U.S. agricultural leaders assembled by the Energy Future Coalition, is calling for 25 percent of the nation's energy to be farm-generated by 2025. The group's views are worth quoting at length.

" . . . *the agricultural community as a whole has not developed, embraced or marketed a shared comprehensive vision for the role the sector can play in helping the nation achieve energy independence. While energy issues are rising on most organization's priority lists, much of the current discussion is focused on cost and availability concerns and production incentives, rather than on the opportunities which could develop for agriculture and rural America if energy production was embraced as a primary objective.* (The Working Group's) *conclusion: the time has come for the agricultural community to define the role the sector can play in moving the nation towards energy independence."*[2]

This paper outlines the progress and the path toward a similar goal: transforming the ag industry from a minor player to a major provider of U.S. energy supplies. The next chapter outlines the energy security challenge as we face a rapidly expanding world oil and natural gas market. Chapters two and three explore, respectively, the opportunities for sustained growth in biofuels and wind markets, and the menu of policies that will rapidly commercialize these technologies.

A farmer and scientist examine switchgrass.
Credit: Warren Gretz, DOE/NREL

[2] *25x25: Agriculture's Role in Ensuring U.S. Energy Independence–A Blueprint for Action,* Ag-Energy Working Group, Energy Future Coalition, August 2004

CHAPTER ONE:

THE ENERGY SECURITY CHALLENGE

Energy is the source of a complex series of economic, national security and environmental difficulties confronting America as a whole. Farm-produced clean electricity and fuels provide comprehensive solutions.

The war in Iraq, staged as it is on the world's second largest remaining oil reserves, makes clear the danger of the U.S. economy's dependence on oil. With three percent of the world's remaining oil reserves, the U.S. uses about a quarter of world production. In 2004, the U.S. used 20.7 million barrels of oil per day. Around half was imported.[3] *America's Energy Outlook 2004,* the most recent U.S. government projection, predicts a 70 percent dependence on imported oil by 2025.[4] Passenger vehicles are the largest contributor to the U.S. oil habit with a 40 percent share of total national consumption. Even with new oil fields opening in the Caspian Basin and increased production from Russia, Africa, and South America, the Persian Gulf will still produce most of the world's oil—it sits on about three-quarters of the world's known oil reserves.

World oil production is expected to peak in the next 10 to 20 years. Ensuing production declines will collide with rapidly growing demand. China's automobile market, for example, is growing at almost 35 percent per year. The International Energy Agency report *China's Worldwide Quest for Energy Security*, projects oil imports increasing to eight million barrels per day (mbd) by 2020, from 0 mbd in 1993.

THE WALL STREET JOURNAL
May 5, 2004

ASIA'S THIRST FOR OIL

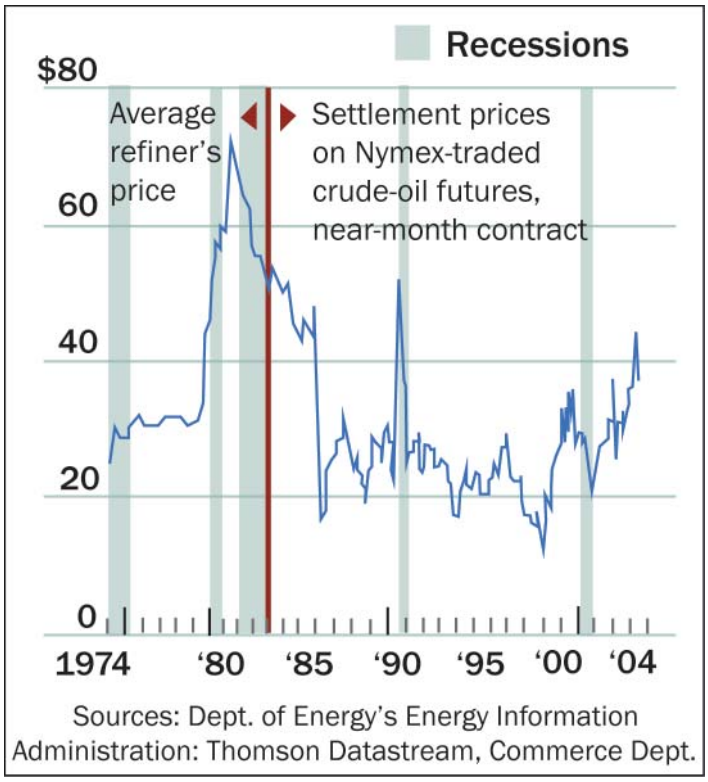
As the global economy roars ahead with more factories churning out consumer goods and more cars hitting the streets, demand for oil may outstrip supply. World-wide use is forecast to rise more than 50 percent to 121 million barrels a day by 2025, from 80 million barrels a day now. In China and India, the world's most populous countries, economic growth is powered by and in turn fueling a thirst for oil. Experts warn that without alternative fuel sources, the need for oil could pit massive consumers such as the U.S. against China and India.

Demand is also growing rapidly in the rest of the developing world, particularly India. The inevitable result will be sharp increases in oil prices, and more intense competition for remaining supplies (see text box).

North America is currently entering a similar level of dependency on natural gas supplies. Dwindling reserves in the U.S. and Canada mean that the nation is poised to begin importing large volumes of liquefied natural gas along extended and vulnerable supply lines from the Middle East, fragile rainforest and Arctic regions, Russia, and East Africa.

[3] Petroleum Quick Stats, U.S. Energy Information Administration
www.eia.doe.gov/neic/quickfacts/quickoil.html

[4] Annual Energy Outlook 2004, Energy Information Administration, early release. Available at
www.eia.doe.gov/oiaf/aeo/

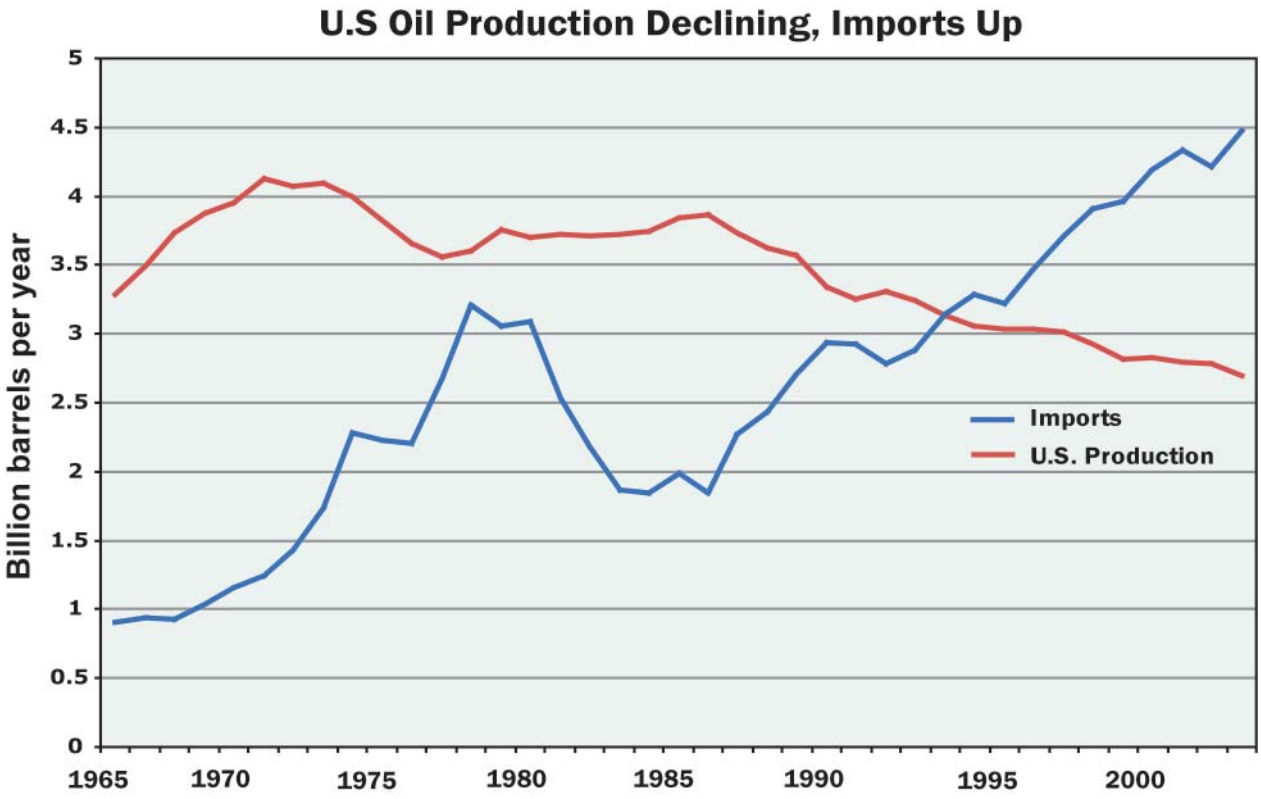


Every major recession in the past three decades was preceded by a spike in oil prices.

Recent spikes in oil and natural gas prices give us a hint of the economic dangers from overdependence on dwindling fossil resources. Oil prices, adjusted for inflation, are nearing 1970s oil crisis levels. Natural gas prices have tripled in just a few years. Supplies continue to tighten, to the point that spikes in oil or natural gas prices follow even relatively small supply interruptions—whether natural upheaval in the Gulf of Mexico or political upheaval in the Persian Gulf.

Such spikes have substantial costs for the U.S. economy. As the graphic shows, every major recession in the last three decades was preceded by a spike in world oil prices (data is 2004 dollars). The threat of recession remains real and the implications for the American economy are profound.

As global competition for the remaining oil intensifies over coming decades, so will price spikes, supply disruptions and financial crises. With only three percent of world oil and natural gas reserves, even our most valiant efforts to produce more domestic oil supplies will have little impact on world markets. Without question the United States



Domestic oil production peaked in the early 1970s and has declined since, resulting in increasing imports to meet demand. Source: Department of Energy, Energy Information Administration, Annual Energy Review 2004, Report No. DOE/EIA-0384 2004, Table 5.1, Petroleum Overview

and other countries will be driven to find options to petroleum. It is only a matter of how expeditiously we undertake the challenge.

Farm-grown biofuels offer serious options to cut America loose from overseas oil supplies and their accompanying economic and security threats. Wind power generation directly displaces natural gas, reducing demand pressure and, as analysis reported in the wind power chapter shows, overall prices.

As an extra benefit, farm-generated energy can also provide significant pollution reductions. Wind power effectively generates electricity while reducing acid rain, smog, air toxics like mercury, and global warming pollution. Biofuels, with the right pollution control technologies, are as clean or cleaner than gasoline and offer significant reductions in global warming pollution.

WTO AND FARM SUBSIDIES: FROM THREAT TO OPPORTUNITY

Converging needs for rural economic revitalization and national clean energy development offer a significant opportunity to address a prospective crisis in U.S. farm programs. The subsidy system that underpins farm incomes took a serious hit on April 26, 2004 when the World Trade Organization (WTO) ruled that U.S. cotton subsidies provide an unfair trade advantage to U.S. farmers and are thus illegal.[5]

Farm supports are under the gun as other products including rice, sugar, and dairy products are expected to face similar WTO challenges.

Loss of supports would be a grave matter for farmers. From 1995-2004 direct government payments averaging $14 billion annually provided six percent of gross and 23 percent of net farm income. In 2005 payments of $24 billion are expected to provide nine percent of gross and 31 percent of net cash income.[6]

The danger that farmers could lose traditional subsidies is matched by a 2007 Farm Bill opportunity to re-target agricultural supports toward building Ag-Energy into a major player. The seeds were planted with the 2002 Farm Bill Energy Title IX, which created a new set of programs to support farm-produced energy. Funding has been relatively modest. The major element of the title, Section 9006 Ag-Energy financial supports, received only $23 million in 2005.[7]

Energy payments are an alternative to traditional commodity subsidies that could pass WTO muster, creating new domestic markets for farmers. Today, farmland conservation subsidies are considered by WTO as "green box" programs, meaning they are not subject to international trade sanction. Recent legal analysis concludes that energy programs also fall in the "green box". "*Although all energy efficiency and renewable energy payments to farmers under Title IX and related clean energy provisions likely qualify as green box payments, those payments that provide and leverage the greatest environmental benefits are most assured to withstand challenge to their green box status*".[8] Increased support for biofuels and wind power offer new options to shore up farm incomes and rural development while meeting a host of other crucial national objectives. For example, subsidies to upland cotton in Texas are at risk under the WTO ruling. But that region has tremendous wind resources and support of new wind development for farmers would fall under "green box" protection. With a concerted effort from a broad, national alliance for Ag-Energy, Congress could well move in this direction.[9]

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[5] U.S. Farmers Get a Lesson In Global Trade: Cotton Ruling Demonstrates WTO's Power Over Markets Paul Blustein, *Washington Post*, April 28, 2004; Page A01

[6] Confronting the Issues: The 2007 Farm Bill, AFBF Policy Development, American Farm Bureau Federation, May 2005, www.sdfb.fb.org/backgrounders/2005/pdfarmbill05426.pdf

[7] Ibid

[8] WTO Legal Impacts on Commodity Subsidies -- Green Box Opportunities in the Farm Bill for Farm Income Through the Conservation and Clean Energy Development Programs, Environmental Law and Policy Center, July 2004, pg. 2 www.elpc.org/energy/WTO.Farmpercent20Billpercent20Paper.Julypercent2020.2004.pdf

[9] *Preparations for 2007 Farm Bill Begin*, National Cattlemen's Beef Association, July-Aug. 2005, www.beefusa.org/uDocs/farmbill.pdf

CHAPTER TWO:

BIOFUELS—THE NEW GASOLINE

Ethanol's Phenomenal Growth Curve

By 1925 auto pioneer Henry Ford had built more gasoline engines than anyone on Earth. Yet Ford had another prospect on the eventual automotive fuel of choice.

"*The fuel of the future is going to come from apples, weeds, sawdust—almost anything,*" Ford told the *New York Times*. "*There is fuel in every bit of vegetable matter that can be fermented.*"[10]

Ethanol, now around two percent of U.S. light duty fuel sales, could substantially replace gasoline by 2050. Credit: Warren Gretz, DOE/NREL

Ford, of course, was pointing to ethyl alcohol —ethanol. But for many decades the ethanol future seemed ever receding into the distance. Then the oil shocks of the 1970s opened new doors for ethanol with a new federal tax credit. In the 1990s federal requirements for cleaner burning fuel built markets for oxygen-rich ethanol further. Emerging concerns over groundwater pollution from the other major fuel oxygenate, MTBE, led to bans and rapidly growing ethanol markets in the 2000s. 2004 fuel ethanol production of 3.4 billion gallons represented a 21 percent increase in a single year and 109 percent since 2000.[11]

Still, even with this phenomenal expansion, ethanol in 2004 remained a bit player compared to gasoline's 140 billion gallons that year.[12] Because ethanol has a slightly lower energy density than gasoline, ethanol fuel equaled only around two percent of gasoline consumption.[13] The other major emerging biofuel, biodiesel derived from vegetable oils and waste greases, despite near vertical growth from 500,000 gallons in 1999 to 25 million by 2003, was only 0.06 percent of U.S. diesel consumption.[14]

While today's biofuel shares may be small, they are only at the start of a tremendous growth curve that could see Ford's vision substantially realized by mid-century. The technical potential exists for farm fields to largely replace drill fields in supplying the vast majority of all of U.S. light vehicle fuels. A set of related studies is building highly credible scenarios that detail how this biofuels revolution can be accomplished and the rural economic development benefits it will bring. The studies all share one conclusion:

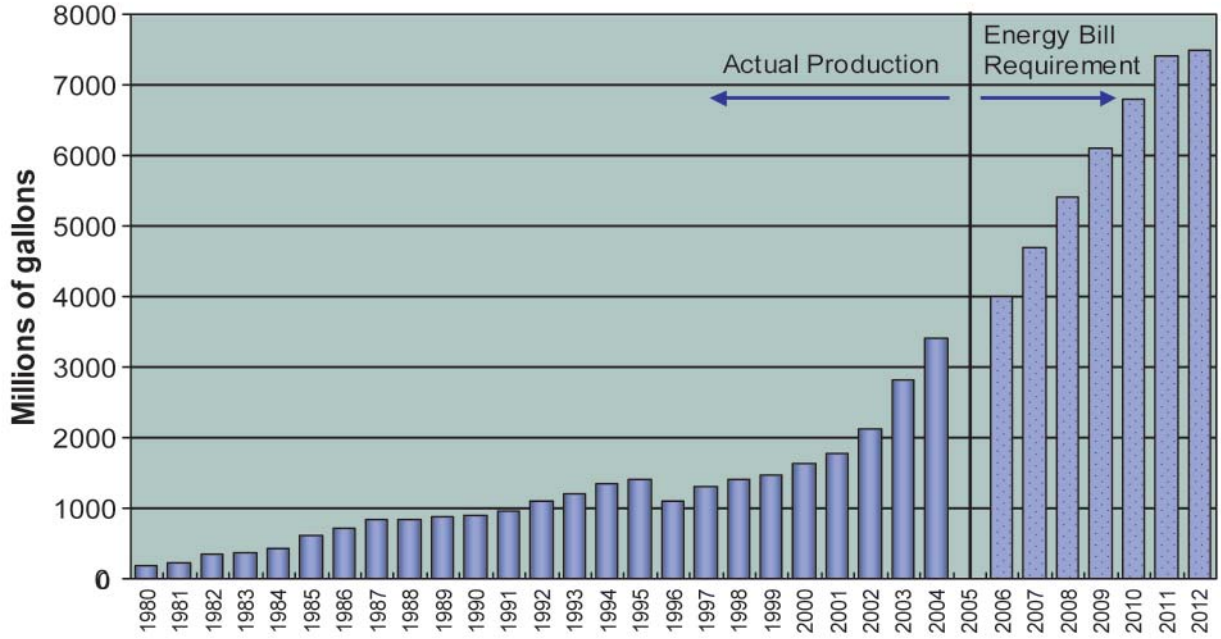
[10] Bill Kovarik, "Henry Ford, Charles F. Kettering and the Fuel of the Future," *Automotive History Review*, Spring 1998, No. 32, p. 7 – 27, www.radford.edu/~wkovarik/papers/fuel.html

[11] *Homegrown for the Homeland: Ethanol Industry Outlook 2005*, Renewable Fuels Association, p3, www.ethanolrfa.org/objects/pdf/outlook2005.pdf

[12] Petroleum Quick Facts, U.S. Energy Information Administration, www.eia.doe.gov/neic/quickfacts/quickoil.html

[13] Figures from Michael Wang, Argonne National Laboratory

[14] Figures from www.biodiesel.org/resources/faqs/default.shtm. Diesel share from Michael Wang, Argonne National Laboratory. Though biodiesel based on soy and other vegetable oils is growing, this paper focuses on cellulosic biomass-based fuels due to their much larger feedstock potentials.



Ethanol production will continue its rapid growth, spurred by a new national Renewable Fuels Standard.
Credit: Renewable Fuels Association

only new public policy will rapidly commercialize these new technologies and unleash market opportunities for farmers.

The key is to build on the success of corn ethanol and expand into cellulosic ethanol. Cellulose is the most common cellular component in the plant world, and makes up much of the stem and leaves of many plants. By tapping the energy in cellulose, the farm community opens a vastly expanded supply of low-cost feedstocks from which to make fuel. Today over 90 percent of ethanol is made from corn kernels. 2004 production took 1.26 billion bushels of corn for 11 percent of the U.S. crop.[15] However, grains have many competitive, high-value uses that limit the ultimate production of grain-based ethanol to around 8 billion gallons per year, which could consume more than 20 percent of U.S. annual corn production. The Governors' Ethanol Coalition, a mainstay of support for the grain-based industry, notes that ". . . *production significantly above that amount may impact corn prices and livestock feed costs.*"[16]

When the U.S. reaches the 2012 RFS goal of 7.5 billion gallons, ethanol production will have almost reached feedstock limits and still remain only around six percent of light duty vehicle fuel consumption. For ethanol to significantly reduce oil imports and improve national oil security, feedstocks must shift from grains to cellulose such as corn stover, wheat straw, or rice husks. That will require improved technologies to economically break down the stubborn molecular bonds of cellulose so that it can be easily fermented into ethanol.

[15] Also employed was 11 percent of the sorghum harvest.

[16] *Ethanol From Biomass: America's 21st Century Transportation Fuel*, Governors' Ethanol Coalition, April 2005, p2, www.ethanol-gec.org/GEC_biomass_rept_4-12-05.pdf

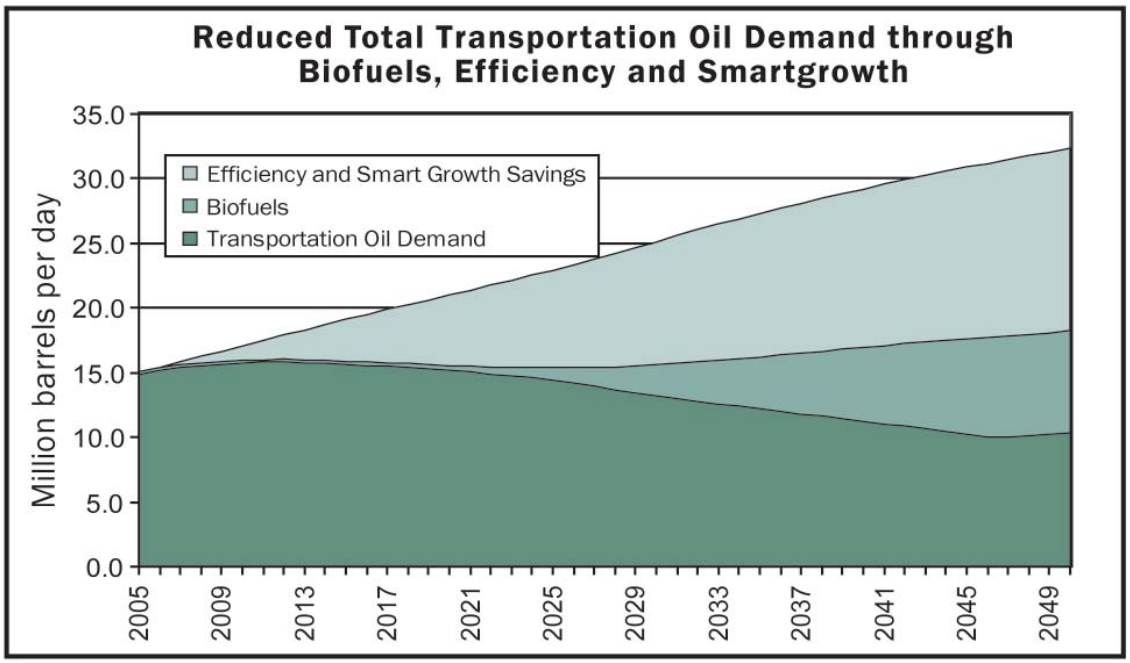


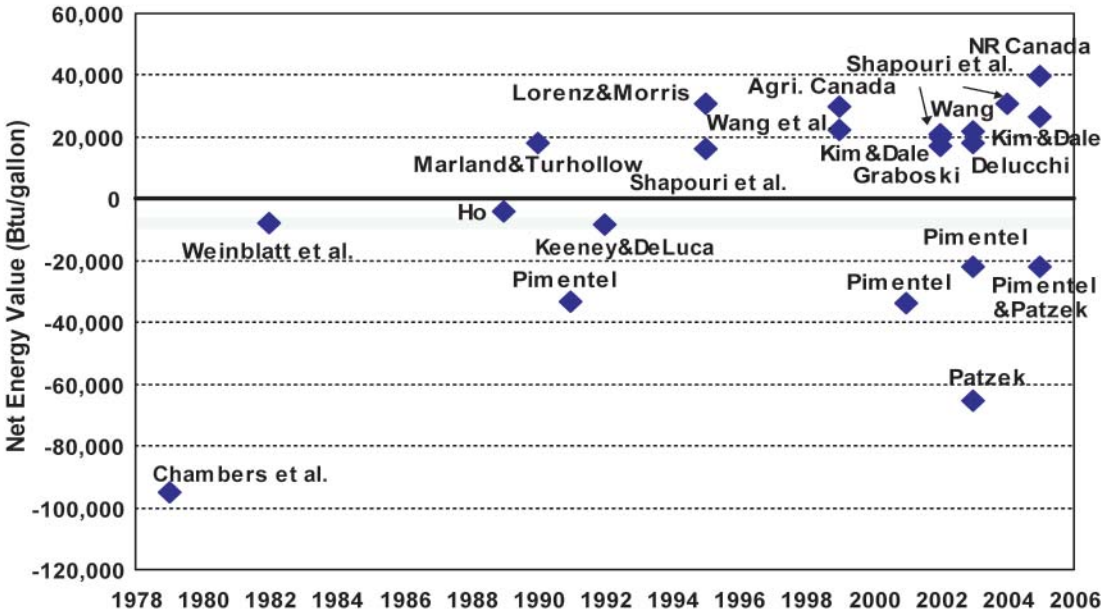
Chart shows how a package of cellulosic ethanol promotion and transportation efficiency can largely replace gasoline by 2050 and eliminate 8 million barrels a day of oil use. Credit: Natural Resources Defense Council, "*Bringing Biofuels to the Pump*"

SCALE-UP SCENARIOS

Just such advanced scenarios are the subject of a national project called the Role of Biomass in America's Future (RBAEF) joining a series of key biomass research organizations. From the federal government came Oak Ridge National Laboratory, Argonne National Laboratory, National Renewable Energy Laboratory, and USDA Agricultural Research Service. Princeton, Dartmouth, and Michigan State brought the universities to the table. Natural Resources Defense Council and Union of Concerned Scientists contributed the environmental perspective. The U.S. Department of Energy supported the technical analysis while the National Commission on Energy Policy and The Energy Foundation backed the associated environmental and policy study.

The RBAEF team looked at the synergies of rapid growth in cellulosic biofuels production and aggressive improvements in light duty vehicle efficiency and land use changes that reduce the need to drive, (e.g. smart growth). Their analysis, presented in the report *Growing Energy: How Biofuels Can Help End America's Oil Dependence*, estimates American farmers "could produce the equivalent of nearly 7.9 million barrels of oil per day by 2050. That amount is equal to more than 50 percent of our current total oil use in the transportation sector and more than three times as much as we import from the Persian Gulf alone."[17]

[17] The initial RBAEF analysis is presented in the report, *Growing Energy: How Biofuels Can Help End America's Oil Dependence*, by Nathanael Greene, Natural Resources Defense Council, December 2004, p. v-viii., www.nrdc.org/air/energy/biofuels/contents.asp



Energy balance here is defined as BTU content a gallon of ethanol minus fossil energy used to produce a gallon of ethanol

With the increasing efficiency of ethanol production since the modern ethanol industry was born in the 1970s, most studies show that corn-based ethanol generates more energy than it uses in production. The exceptions are based on pessimistic efficiency statistics and failure to count the energy value of coproducts.
Credit: Michael Wang, Argonne National Laboratory

THE ENERGY DEFICIT MYTH

Opponents of biofuels argue that it takes more energy to produce them than they deliver. Recent analysis by Argonne National Laboratory, including examination of 22 studies performed over the last two decades, concludes otherwise. Argonne finds that, even though the biofuels production cycle burns fossil fuels in growing, transportation, and manufacture, the end products provide more renewable energy than the amount of fossil fuel energy consumed. In essence, the solar energy collected by photosynthesis during feedstock crop growth more than makes up for the fossil energy used.

Argonne calculates that one unit of corn-ethanol energy delivered at the pump requires 0.74 units of fossil energy. The remainder is solar energy in liquid form delivered free to the farm field. By contrast, because energy is needed to process petroleum, it takes 1.23 units of fossil energy to deliver 1 unit of gasoline at the pump. Cellulosic ethanol based on switchgrass has an even better energy balance. It takes less energy inputs (fertilizer, tilling, etc.), plus a given unit of land can produce more cellulose. Delivering 1.00 unit of cellulosic ethanol energy at the pump takes only 0.10 units of fossil energy.[18]

Most ethanol energy balance researchers in recent years have arrived at similar conclusions. The major exceptions are David Pimentel and Tad Patzek whose studies indicate both corn and cellulosic ethanol have negative energy balance. Pimentel and Patzek generally employ pessimistic statistics for ethanol cycle productivity and do not credit the energy value of co-products such as fuels for electrical generation. For example, proposed cellulosic ethanol plants would employ energy generated using the lignin coproduct to drive operations. Yet Patzek and Pimentel assume plants will be run with fossil fuels. If this mistaken assumption is corrected, then even Pimentel and Patzek's analysis would conclude that cellulosic ethanol contains about five times as much energy as the fossil fuels used in its production.

[18] Michael Wang, *An Update of Energy and Greenhouse Gas Impacts of Fuel Ethanol*, Argonne National Laboratory, Feb. 2005, www.ethanol-gec.org/netenergy/UpdateEnergyGreenhouse.pdf

Harvesting corn and stover. Credit: Jim Yost, DOE/NREL

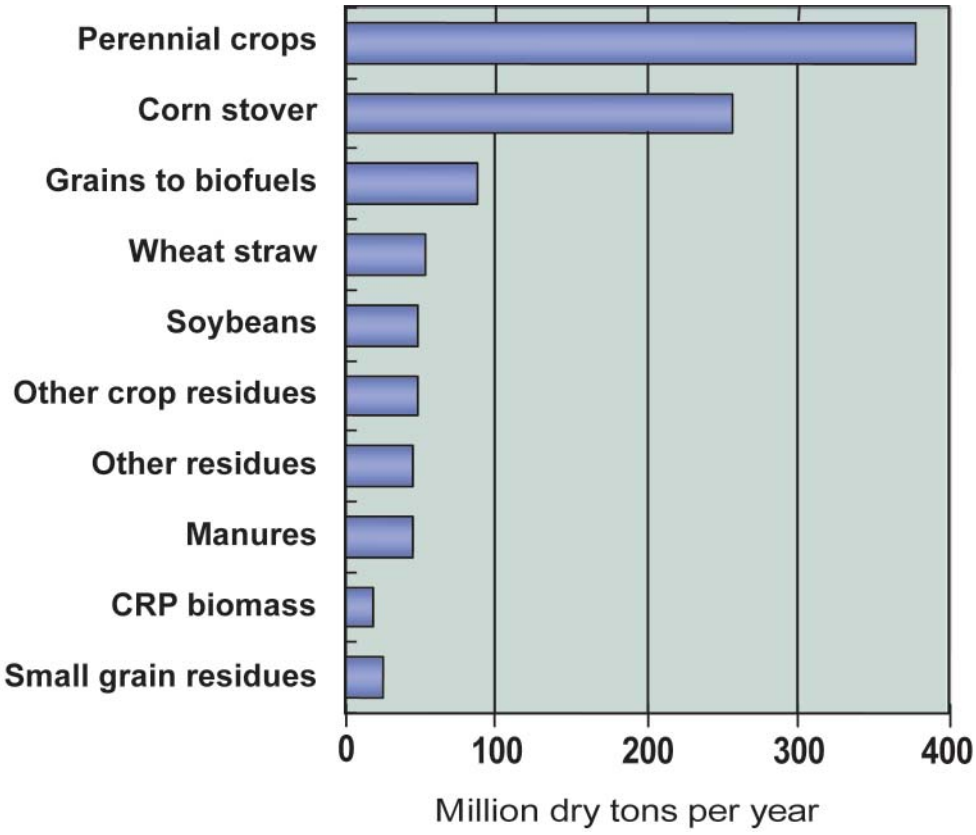
FEEDSTOCKS ARE ABUNDANT

When projecting a transportation future run to a great degree on biofuels one of the primary issues is whether enough cropland exists to serve the demand. Several recent studies indicate the answer is yes. Enormous national resources of cellulosic biomass are documented in a recent report from the Departments of Agriculture and Energy. The study was done by Oak Ridge National Laboratory (ORNL) through the Biomass R&D Technical Advisory Committee, created to advise the secretaries of agriculture and energy. The committee set a national vision that by 2030 the nation would replace an amount of petroleum equivalent to 30 percent of national use, with biomass supplying 20 percent of vehicle fuels, five percent of electricity and 25 percent of chemicals.

Accomplishing those goals will require around one billion tons of dry biomass each year (see chart on the next page). ORNL found the nation's farmlands alone could accomplish the task by 2030, with cellulosic stocks accounting for over 80 percent. *"The biomass resource potential identified in this report can be produced with relatively modest changes in land use, and agriculture and forestry practices."* All ORNL scenarios show the nation's agricultural land base holding steady around 450 million acres. Those lands can yield one billion tons of dry biomass annually within 40 years compared to 194 million tons sustainably available today. ORNL based this five-fold growth on higher crop yields, better crop residue collection technologies, increased no-till cultivation, and a shift to perennial crops such as switchgrass. Envisioned are 40-60 million acres of perennials on current croplands and 10 million acres of the Conservation Reserve.[19]

The *Growing Energy* report also concludes that land availability is not the limiting factor in scaling up cellulosic biomass. Their scenario for replacing 7.9 million barrels of oil per day would require 1.4 billion tons of

[19] *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply*, U.S. Departments of Agriculture and Energy, prepared by Oak Ridge National Laboratory, April 2005, Executive Summary, Introduction, p29, 32, www.woodycrops.org/reports/Billionpercent20Tonpercent20Supplypercent20-percent20Finalpercent20.pdf



Graph shows Oak Ridge National Laboratory estimates for one billion dry tons of farm-generated biomass available by 2030.

biomass by 2050. This assumes a doubling of switchgrass productivity to 10 dry tons per acre and improved efficiency of converting biomass to biofuels. The scenario would require 48 to 114 million acres—12 percent to 25 percent of America's crop acreage—depending on:

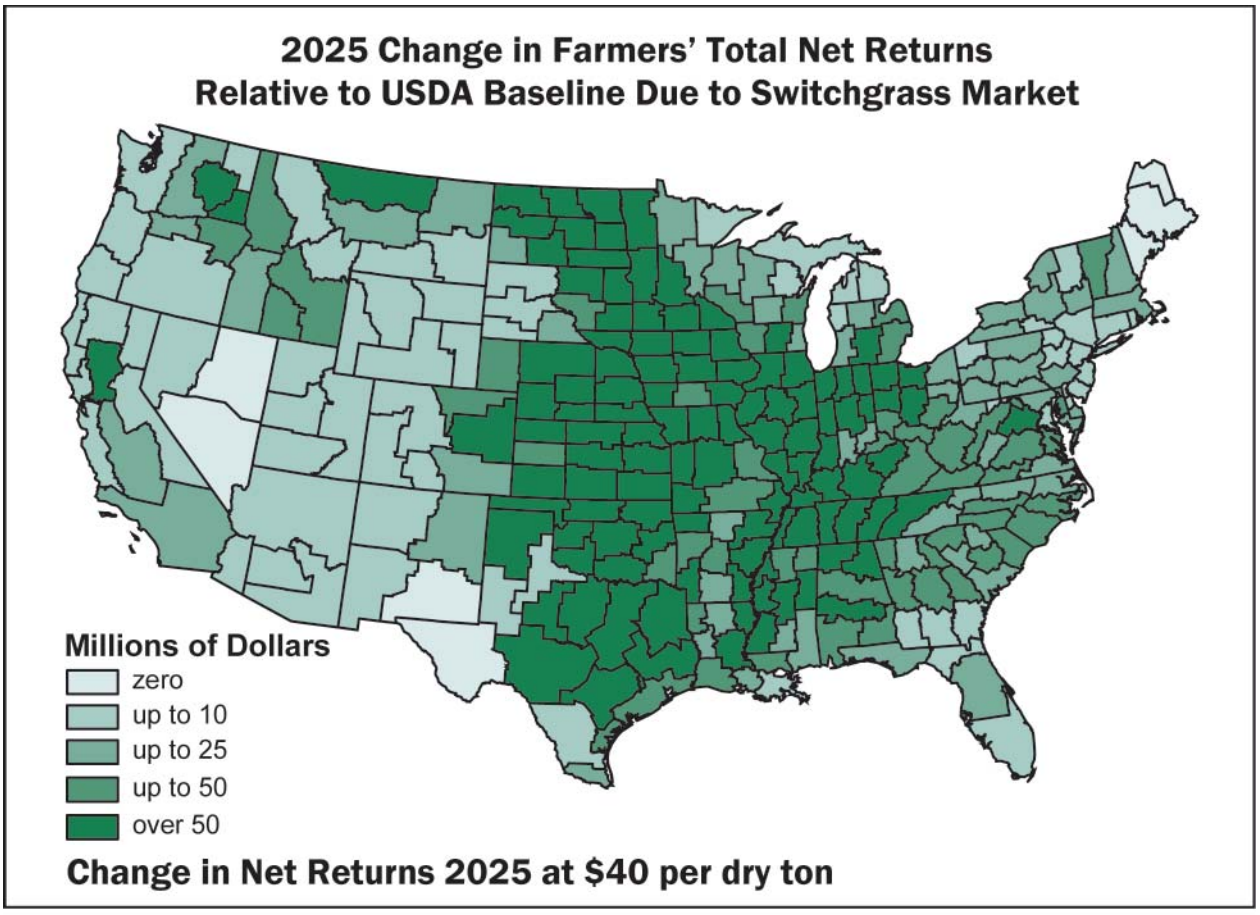
1. much animal feed production can be covered by protein production from switchgrass, thus displacing soybean acreage;

2. the percentage of corn stover collected from existing fields; and the percent of conservation reserve acreage converted to growing switchgrass.[20]

Switchgrass production economics would tend to favor the South—Texas, Oklahoma, Tennessee and Kentucky particular—and Midwest states, notably Missouri, Kansas, Nebraska and North Dakota. Northeast states also have economical harvest potential.[21]

An additional advantage is improved environmental performance. Cultivating switchgrass results in less water pollution and soil erosion and more soil carbon buildup and wildlife habitat than any of the major crops it would displace. Compared to an average for corn, wheat and soybeans,

[20] *Growing Energy: How Biofuels Can Help End America's Oil Dependence,* p34-7
[21] Ibid, p29



Estimated increase in farmer incomes with a mature switchgrass market. Credit: Growing Energy

switchgrass uses 3.9 times less fungicide, 6.8 times less herbicide and 9.4 times less insecticide. Erosion per switchgrass hectare is 0.2-2 tons/year, compared to 22 tons for corn. Nitrogen runoff is 10 grams/hectare each year from switchgrass, 16 for soybeans and 79 for corn.[22]

BUILDING THE FIRST BILLION GALLONS OF CAPACITY

At the crux of scenarios for massive cellulosic ethanol scale-up are detailed plans to jumpstart the cellulosic ethanol industry through concerted efforts to build the first billion gallons of production capacity by 2015. Recent estimates from the Governors' Ethanol Coalition (GEC) and Natural Resources Defense Council (NRDC) estimate a 10-year price tag of about $2 billion—less than five

[22] Ibid, p29-31

days U.S. oil import bill.[23] Scale-up efforts would take place along parallel tracks:

(A) research, development and demonstration (RD&D); and

(B) deployment. The effort is projected to reduce the wholesale cost of a cellulosic ethanol gallon 50 percent to $0.63, leveling the playing field with gasoline.[24]

The proposals converge on three primary research needs:

1. Develop technologies to reduce the costs of breaking down cellulosic biomass, including biological processing and gasification.

2. Develop processes for diversified co-products to improve plant economics. Co-products include electricity, diesel fuels, animal feed protein, and chemicals.

3. Improve productivity of feedstocks, including greater crop yields.

GEC notes the opportunity to geographically diversify an industry that has largely been centered on the Midwest corn belt.

Iogen Corporation

"*A theme that should be stressed in research and development efforts is the expansion of ethanol production capability to all regions of the country through the use of agricultural and non-agricultural biomass.*"[26] Opportunities abound, among them corn stover from the Midwest, wheat straw from the Northwest and rice husks from California and the South.

The next phase, deployment, would actually put the first billion gallons of capacity on the ground. GEC underscores why concerted public support for early plants is needed: "*One of the most significant barriers to commercialization of biomass ethanol*

First Billion Gallons Budget Proposals[25]

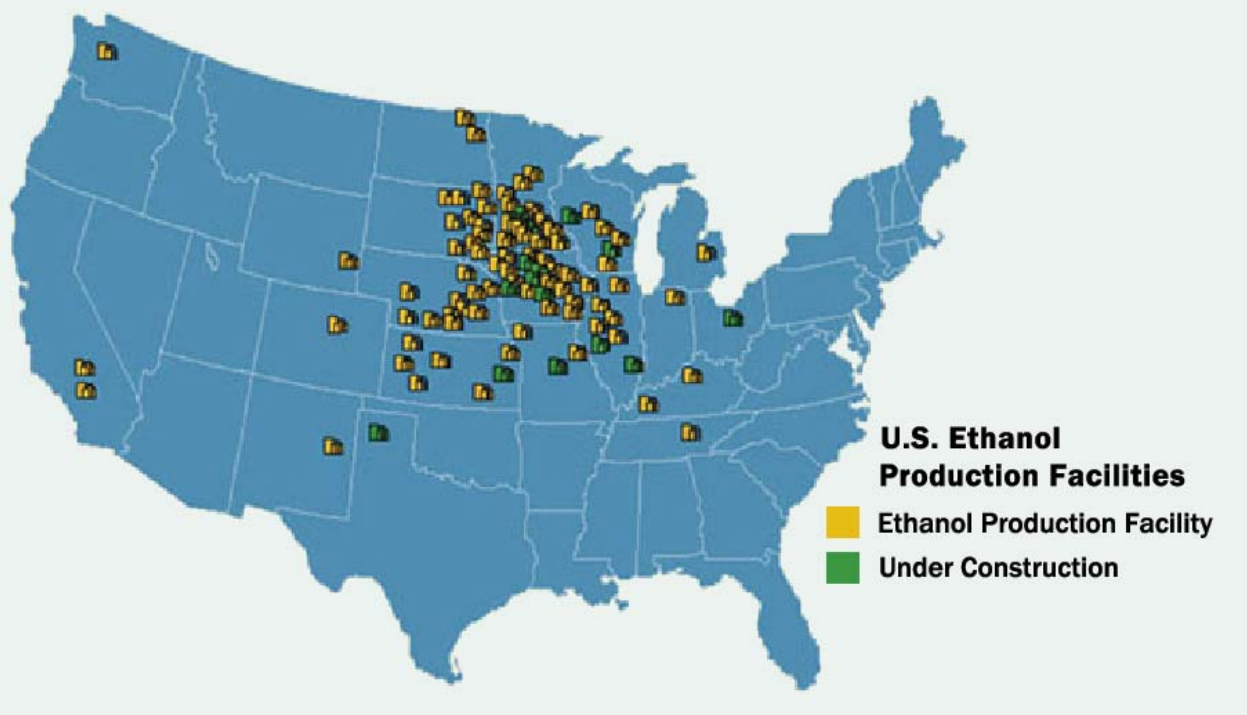
	RD&D	Deployment
Governor's Ethanol Coalition	$800 million	$800 million
NRDC: Bringing Biofuels to the Pump	$1.1 billion	$1 billion

[23] In 2004 the U.S. imported roughly 11 million barrels of oil daily. (U.S. Energy Information Administration, Petroleum Quick Facts) At $50/barrel that would be $550 million. At the time of writing, when prices were hitting a record $68/barrel, the daily cost would be $750 million. At that level scale-up plans at $1.5-$2 billion would be equal to 2-3 days of oil imports.

[24] *Bringing Biofuels to the Pump: An Aggressive Plan for Ending American's Oil Dependence*, Natural Resources Defense Council, July 2005, p6

[25] *Ethanol From Biomass: America's 21st Century Transportation Fuel, Governor's Ethanol Coalition*, April 2005, www.ethanol-gec.org/

[26] *Ethanol From Biomass: America's 21st Century Transportation Fuel,* p9



Ethanol plants so far are concentrated in the corn belt. With a shift to cellulosic feedstocks ethanol production will diversify to every corner of the nation. Credit: Renewable Fuels Association, January 2005

technology is the unproven nature of the technology in large-scale commercial facilities and the inherent reluctance of the financial markets to risk capital." [27]

Proposed for the deployment phase are a sophisticated series of incentives designed to avoid "picking winners" or "one size fits all" solutions in a technological field still in flux. Among proposed incentives are insurance to cover gaps in feedstock supplies, product deliveries and technology performance; production incentives paid at a fixed rate per gallon over the first five years; partial and limited loan guarantees; and tax-exempt financing. From a menu of incentives developers would craft proposals that best fit their economic and technology needs. GEC recommends an auction format to uncover which proposals will produce the most production for the least incentive.[28]

CO-PRODUCT POTENTIALS

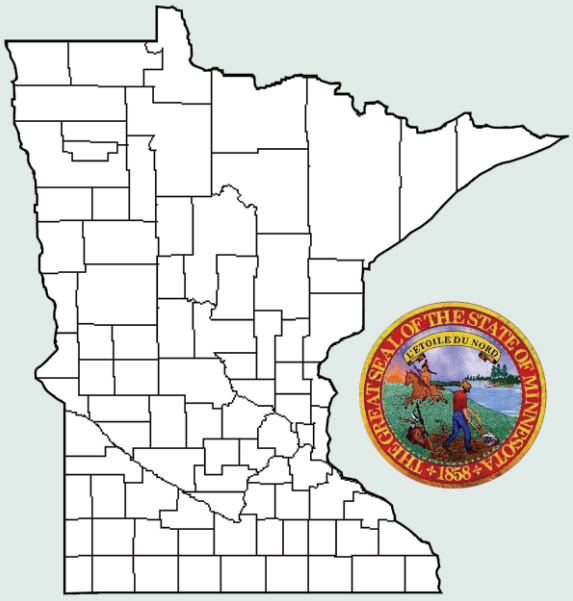
Today's ethanol industry generates a range of products beyond fuels, a reason many use the term "biorefinery" as a synonym for ethanol plant. In 2004 ethanol dry mill process plants produced 7.3 million metric tons of distillers grains, a highly nutritious animal feed that retains the protein, minerals, fiber, and fat of the original feedstock. One bushel of corn yields about 18 pounds of distillers grains and 2.7 gallons of ethanol.[29] The feed finds

[27] Ibid

[28] For detailed discussions on these proposals see NRDC - *Bringing Biofuels to the Pump: An Aggressive Plan for Ending American's Oil Dependence* and *Growing Energy: How Biofuels Can Help End America's Oil Dependence, p12-18;* GEC - *Ethanol From Biomass: America's 21st Century Transportation Fuel*

[29] Figures from Michael Wang, Argonne National Laboratory

MINNESOTA BUILDS FARMER-OWNED BIOFUELS INDUSTRY



Minnesota has developed a uniquely successful model for building an in-state ethanol industry, and one owned largely by Minnesota farmers. From 1994 production of 23 million gallons per year (mgy), output by 2004 had grown more than 17 times to 400 mgy, one third more than Minnesota's demand. For the first time in its history the North Star state has become a net energy exporter. The industry in 2004 employed 5,300 and generated $1.6 billion in economic benefits. Minnesota ethanol plants in 2004 absorbed 149 million bushels of corn, about one-sixth of the total state crop.

Around 90 percent of 2004 production was shipped from 11 coop-owned plants with over 5,200 farmer-members. Coop ownership provides an important hedge against crop price volatility—when corn prices are low, ethanol production costs are reduced so profits and returns to coop members increase. If a 20 percent RFS approved by the legislature in 2005 passes various technical tests and receives a needed federal waiver, Minnesota ethanol demand is projected to increase to 574 mgy by 2010, further spurring this growing market.

Minnesota's success is the outcome of a determined effort to build new markets for state farmers, reduce import reliance, and clean up air pollution. The state passed the nation's first RFS in 1991 in the form of an oxygenate rule that effectively required around 7.5 percent ethanol. (It was raised to 10 percent in 2003.) To ensure that the rule would not simply increase imports from states with established ethanol industries, state law enshrined the goal of 240 mgy in-state production per year, Minnesota's annual consumption. This was met by 2000. To build local ownership Minnesota enacted a Producer Incentive Payment of 20 cents per gallon limited to the first 15 mgy production for 10 years. That framework offsets capital costs for smaller producers.[30] Minnesota is proving that by setting goals and implementing the right policy framework, biofuels production can grow rapidly and in ways that provide the most economic benefit to farmers.

[30] The Minnesota Ethanol Program, www.mda.state.mn.us/ethanol/about.htm#ngcnote
Presentation by Ralph Groeschen, Minnesota Department of Agriculture, at Harvesting Clean Energy Conference 5, Great Falls, Mont., www.harvestcleanenergy.org/conference/HCE5/HCE5_PPTs/Groschen.pdf
Ethanol Plants in Minnesota, Minnesota Department of Agriculture, Jan. 2005, www.mda.state.mn.us/ethanol/plantsreport.pdf

markets throughout North America and Europe.

Cellulosic biomass primarily directed at vehicle fuel production has its own set of opportunities, depending on feedstock. Switchgrass leaf protein makes a rich animal feed. The grass has around 10 percent protein content, while corn stover, rice straw and wheat straw hold four to six percent. Prior to the fuel production cycle, feedstocks would be soaked in warm water and filtered through membranes to extract 60-80 percent of protein. Co-producing animal feeds could reduce ethanol costs 13-20 cents per gallon, making the fuel more competitive against gasoline.[31] Another advantage of this arrangement as global agricultural demand increases is that it releases starches for use in potentially higher value products.

Cellulosic biomass can also feed electrical power generation and synthetic petroleum fuels manufacture. The source is lignin which represents approximately 15-25 percent of cellulose mass and 40 percent of energy content. Lignin is not practical to ferment but it can be burned directly to generate electricity or gasified into syngas. Syngas can drive combined cycle turbines to generate power. Electricity and steam from lignin coproducts would drive cellulosic ethanol plants themselves, replacing the coal and natural gas that run today's typical grain ethanol plants with enough energy left over to sell as an additional coproduct. Syngas can be converted to diesel and gasoline substitutes through the Fisher-Tropsch process.

BIOFUELS FOR NEW RURAL PROSPERITY

Biofuels represent an opportunity for a large share of the billions of dollars now flowing to the Mideast to instead roll towards the Midwest, South, and other farm belts. When farm fields replace drill fields and agricultural America becomes a net energy exporter, new revenue flows will reach farmers and biofuels plant owners and workers, and then circulate and multiply throughout the rural economy.

Today's ethanol industry already offers evidence for the significant economic opportunities biofuels open in rural America. An AUS Consultants study shows an ethanol plant producing 40 million gallons per year creates $142 million in local economic activity during the construction phase and buys $56 million in goods and services annually, almost all from local suppliers. Of those purchases 71 percent goes to farmers for grain. Corn-based ethanol plants typically raise crop prices five to ten cents per bushel in a 50-mile radius around the plant. That means $10 more per acre planted at average national yields. Overall, the economic boost provided by one plant adds $110 million to the local economic base and at least $1.2 million to local and state tax revenues.[32]

"The ethanol industry is one of the most significant success stories in American manufacturing over the past quarter century," says industry analyst John Urbanchuk. *"From a cottage industry that produced 175 million gallons in 1980, the American ethanol industry has grown to include 81 manufacturing facilities with an annual capacity of more than 3.6 billion gallons. Total ethanol*

[31] *Growing Energy: How Biofuels Can Help End America's Oil Dependence,* p41-42, 57-58

[32] John M. Urbanchuk; Kapell, Jeff, *Ethanol and the Local Community*, AUS Consultants, SJH & Company, June 21, 2002, www.ethanolrfa.org/Ethanol_Local_Community.pdf

WORLD'S FIRST FULL-SCALE ADVANCED ETHANOL PLANT IN WORKS

Iogen, a pioneering Canadian cellulosic ethanol company that since April 2004 has marketed the fuel from its test-scale facility in Ottawa, is laying the groundwork to build the world's first full-scale advanced ethanol plant.

The company has developed enzymatic processing that breaks down biomass into fermentable sugars and is demonstrating the technology in its one-million-gallon-per-year (mgy) test plant using wheat straw crop residues. Now it is exploring sites in Alberta, Saskatchewan and Idaho for a 50-60 mgy plant. Farmers in the Idaho Falls area have already contracted 400,000 annual tons of wheat and barley residues. Shell, a minority partner in Iogen, plans to sell the product in expanding West Coast markets.

Iogen is currently in talks with the U.S. and Canadian governments to gain public financing support for the first-of-a-kind plant expected to cost over $300 million.

"The passage of the Energy Bill is a great encouragement to us," says Iogen Marketing Director Maurice Hladik. He notes the bill authorizes up to $250 million in loan guarantees for each of up to four advanced ethanol plants. *"But that's authorized and not appropriated—They're two different things."* Guarantees will require a funding allocation of around 10 percent of the loan, or $25 million. Though the money is not yet secured, Hladik is optimistic. He notes that Sen. Larry Craig (R-Idaho) and his staff *"have been really superb"* in supporting advanced ethanol.

Fermenter at Iogen's test-scale cellulosic ethanol plant in Ontario, Canada. Credit: Iogen Corporation

Hladik points out that while capital costs are two to three times those of a conventional ethanol plant, feedstock costs will be substantially lower. Energy, a big cost at conventional plants, will be supplied cheaply by burning lignin coproducts of the ethanol process. Once the first shovel is turned it will take 18-24 months to bring the plant on line. Iogen estimates the economic impacts at:

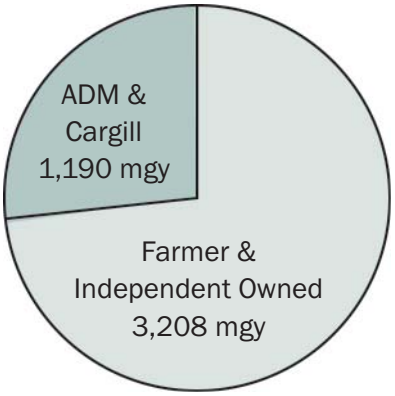
- 100 permanent jobs in the plant
- Nearly 100 job equivalents for straw collection and preparation
- 450 additional multiplier effect jobs
- 1,000 job years during construction
- $30 million annually into the local economy from straw purchases.

production for 2005 is estimated at more than 3.9 billion gallons on a year-end capacity base of 4.3 billion gallons."

If the ethanol industry is a shining light at two percent of the light duty vehicle fuel market, scaling it up will make it an economic superstar and place rural America at the center of the national energy economy. One indication of the resulting rural economic boost comes in a University of Tennessee study. It assesses the impact of the $40 per dry ton biomass market projected with a large-scale cellulosic ethanol industry. That would create incentives for planting 28 million acres and harvesting 200 million dry tons by 2025. Total net farm income would grow $12 billion, 32 percent more than it would be without the biomass market. Net farmer returns would total $5 billion. And by 2050 biomass production could grow six times from 2025 levels. All portions of the U.S. will benefit, the vast midsection of the country the most. Meanwhile, the nation as a whole will be saving $20 billion annually because biofuels will be less expensive than petroleum fuels.[33]

MEETING THE ENVIRONMENTAL CHALLENGE

A massive scale-up in biofuels can be a win-win-win for rural economic development, national energy security, and a healthy environment. To achieve all three, the emerging industry must address the health and environmental issues across the entire life-cycle of biofuels use, from seed generation to final consumption. Biomass energy crops must be grown and harvested in ways that embody best stewardship practices to maintain or improve air, water and soil quality,



Farmer & Independent Owned 73 percent

ADM & Cargill 27 percent

FARMER COOPS AND SMALLER OPERATIONS BECOMING LARGEST PLAYERS

Ethanol industry ownership is vastly more diversified than in the 1970s and 1980s when larger players such as ADM dominated. Today nearly three-quarters of the industry is owned by farmer cooperatives and other independents.

Source: Renewable Fuels Association Ethanol Industry Outlook 2005

[33] These results come from analysis using the POLYSYS econometric model and are reported in *Growing Energy: How Biofuels Can Help End America's Oil Dependence, p.iv, v, 5.* For more details on the model, see, De la Torre Ugarte, et. al., "Biomass and Bioenergy Applications of the POLYSYS Modeling Framework," *Biomass and Bioenergy (2002)* 18:291-308.

wildlife habitat, and biotic diversity. One of the potential advantages of cellulosic ethanol is that different agricultural regions can supply the most appropriate and environmentally sound energy crops. In the nation's prairies, perennial native grasses like switchgrass offer environmental advantages. They are mown, not tilled, thus reducing erosion. They also require less fertilizer and pesticides. In the South, short rotation coppice trees (e.g. willow and poplar) can reduce soil erosion and pesticide use. Wheat straw and corn stover, if utilized with attention to nutrient cycling demands to maintain soil quality, can also be sustainable harvested in the Midwest and Upper Plains. However, the optimal sustainable level of biofuels crops will be highly specific to local conditions, growing cycles, and topography. New standards of stewardship must be built as the industry grows in size.

Air quality challenges must also be met to scale up biofuels. There is no debate about ethanol's air quality benefits in terms of reducing carbon monoxide (CO) and air toxics. With respect to smog precursors like oxides of nitrogen (NOx) and volatile organic compounds (VOCs), leading air quality regulators, including the U.S. Environmental Protection Agency, the California Air Resources Board, and the Northeast States for Coordinated Air Use Management, predict that using a 10 percent blend of ethanol with gasoline (E10) results in small increases in smog.[34] Some experts argue that the benefits of CO and air toxic reduction outweigh the costs of such small increases in smog. The more important point is that, for the long term, ethanol can be as good or better than gasoline with respect to smog formation if the industry addresses three issues:

1. increased volatility leading to more evaporation of volatile organic compounds;

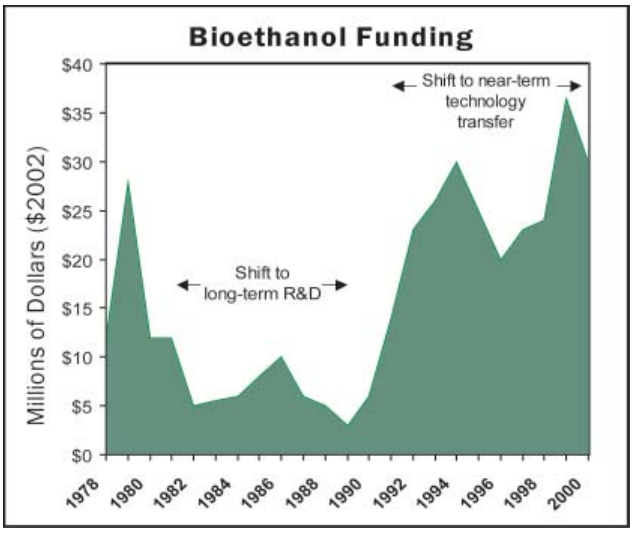
2. permeation emissions from vehicle hoses; and

3. small increases in nitrogen oxide formation during combustion.

All of these challenges can be solved with flexible policies and readily available technology:

- To grow new ethanol markets and meet air quality goals in urban areas, new vehicles with better catalysts and permeation-free fuel systems are the long-term solution; policies should commercialize such flexible fuel vehicles as soon as possible.
- Expanded E85 (85% ethanol blended with 15% gasoline) vehicle use is a win-win near-term option—E85 has low evaporative emissions and does not produce extra nitrogen oxide in combustion compared to E10 .
- Low-level blends under 5.7 percent are another interim solution. Such blends do not suffer the volatility concerns of E10.
- Cities with smog problems can adopt flexible air regulations that sensibly adjust ethanol blends during critical summer smog season.

[34] Northeast States for Coordinated Air Use Management, "Health, Environmental, and Economic Impacts of Adding Ethanol to Gasoline in the Northeast States, Prepared by the New England Interstate Water Pollution Control Commission, Lowell, MA, 2001; *Growing Energy: How Biofuels Can Help End America's Oil Dependence,* p15



A stop-start pattern of federal funding for cellulosic ethanol development must be replaced by more certain funding stream to assure rapid commercialization. Credit: Department of Energy

POLICIES TO GROW THE BIOFUELS HARVEST

Over the next two decades, cellulosic ethanol can fulfill its promise and move well on the way to replacing gasoline. The farm community has a crucial role to play in sighting this opportunity and working with allies to put in place the public policies that will launch a large-scale, environmentally sustainable, cellulosic ethanol industry. The menu of policies to jumpstart the advanced biofuels industry include:

Put the first billion gallons of capacity on the ground through expanded federal R&D and deployment for 21st Century biorefinery plants

Earlier sections outline a $2 billion investment in R&D and deployment over 10 years to build the first billion gallons of cellulosic ethanol capacity. The ideal model policy to accomplish this is a standalone rural economic development/energy security bill which both authorizes and appropriates the funding, with adequate controls to ensure the funds are guided by the best science.

The alternative is to use existing policy vehicles including Farm Bill Section 9003 Biorefinery Development grant program, which is so far unfunded, and Section 9008 Biomass R&D Program which is expected to get an appropriation of only $12 million in 2006. These should be significantly expanded in the 2007 Farm Bill. Further, the 2005 Energy Policy Act authorizes $4.2 billion for cellulosic ethanol, including grants of $1.2 billion for R&D, $975 million for demonstration and $1.8 billion for commercial projects, as well as $250 million in performance incentives. While this substantially exceeds budgets in the scale-up scenarios discussed in this paper, the challenge is to transform authorizations into actual cash appropriations. These funds should be employed to launch new plants targeted on preeminent regional feedstocks. One plant should use corn stover to tap the nearly free fuels on the cornfields of Illinois, Iowa, and Indiana. One should the wheat straw and hay potential of Idaho and Montana; another should be designed to use perennial crops and forestry waste from the South. Every part of agricultural American can benefit.

Whatever the policy vehicle, expanded and stable funding is critical. Past biofuels R&D is plagued with stop-and-start funding, severely hampering progress. Developing this technology requires thinking in terms of decades, not years.

Enact and strengthen Renewable Fuels Standards

The new national RFS builds a strong foundation for a growing biofuels industry, requiring four billion gallons per year (bgy) ethanol use by 2006 and 7.5 bgy by 2012. The bill recognizes cellulosic ethanol's superior environmental and energy qualities by requiring 250 million gallons per year cellulosic production by 2013. Given its importance in creating a market demand, thus driving new private sector investment, the national RFS should be amended to require production of one billion gallons per year of cellulosic ethanol by 2015.

The Governors Ethanol Coalition proposes the national standard move to 10 percent as soon as practical (the current standard will result in roughly six percent biofuels by 2012). States can also set more ambitious goals. Montana and Hawaii both have set 10 percent standards. Minnesota's new 20 percent standard will go into effect with a needed waiver from the U.S. Environmental Protection Administration. RFS bills introduced in Oregon and Idaho in 2005 will return in coming legislative sessions, and RFS legislation is being examined in Washington state. The Montana standard, geared to kick in only when enough in-state capacity is on line to meet it, provides a model that promotes local crops and feedstocks.

Improve financial incentives at state and federal levels

The ethanol industry can rapidly grow if it receives support to make new capital investments. A number of examples are already on the books;

- Producer Incentives enacted by Minnesota reported above are a successful example. They are also in place in Indiana, Kansas, Maryland, Mississippi, Missouri, Montana, North Dakota, Pennsylvania, South Dakota, Texas, Wisconsin and Wyoming.[35] These incentives can be enacted in other states and at the federal level.
- Low-cost loans for ethanol plants are offered by a number of states including Minnesota, Iowa and Oregon.
- Tax exemptions for ethanol plants, fuel sales and installation of fueling equipment are on the books in many states. At least nine states exempt all or part of fuel taxes–Maine provides a 100 percent exemption. States including Colorado, Hawaii, Kansas and Washington provide tax breaks on purchase of fueling equipment. Oregon offers property tax exemptions on new ethanol plants.[36]

Improve vehicle fuel economy

Increased vehicle efficiency is an essential part of any federal policy package to make U.S. farm lands a major energy supplier. If U.S. oil consumptions grows as currently projected, not only will we be importing 70 percent of our oil by 2020, but the prospects for American farms to significantly supply the country's fuels are much diminished—we do not have the land base to meet such enormous oil demand. On the other hand, by improving fuel efficiency we reduce the land base required and increase the percentage share that farmlands can supply.

[35] State Incentives for the Production and Use of Ethanol, National Conference of State Legislatures, www.ncsl.org/programs/energy/ethinc.htm

[36] The U.S. Department of Energy Alternative Fuels Data Center maintains a database of State and Federal Incentives and Laws at www.eere.energy.gov/afdc/laws/incen_laws.html

We have the technology today to dramatically and cost effectively improve vehicle efficiency. The National Academy of Sciences concluded in 2002 that new vehicle fuel economy could be improved substantially over the next 10 to 15 years. Their technology and cost analyses show that fuel economy for cars and light trucks could be raised to 40 mpg (double the current average) at no net cost to consumers and with no loss of performance. This could be accomplished with existing and near-commercial technologies, and without down-sizing the fleet.[37] Their analysis did not include hybrid gasoline/electric vehicles, like the five passenger Toyota Prius which gets 50 mpg in city driving.[38]

Spur market demand for E85 vehicles with government procurement

Government fleets are a good place to build early demand for E85 and to install E85 fueling infrastructure. Government fleets, from states to municipalities to the defense department, can specify flexible fuel vehicles (FFV) that run on E85. Matched with E85 fueling infrastructure built into fleet operations, governments not only reduce petroleum use, but spur local demand for ethanol.

Make all new vehicles Flexible Fuel, capable of operating on E85 and above

Most ethanol sold today is in a 10 percent blend with gasoline, E10. But a small percentage is sold in an 85 percent blend, E85. Flexible Fuel Vehicles (FFVs) are capable of operating on both, and the costs of making new vehicles flex fuel-ready is under $150. For ethanol to grow into a significant vehicle fuel, all cars and light trucks should become FFVs, and the fueling infrastructure for them should be rapidly built. A federal requirement to this end would cost very little but substantially expand consumer fueling options and create a vast new market for farmers. As discussed earlier, running a FFV on E85 solves the air quality problems associated with low ethanol blends while offering significant reductions in per-vehicle global warming pollution. In short, requiring FFVs would simultaneously reduce U.S. oil consumption and build new markets for American farmers.

[37] Effectiveness and Impacts of Corporate Average Fuel Economy (CAFE) Standards, Transportation Research Board, National Academy of Science, 2002, www.nap.edu/books/0309076013/html

[38] David Friedman, *A New Road: The Technology and Potential of Hybrid Vehicles,* Union of Concerned Scientists, Jan.2003, www.ucsusa.org/clean_vehicles/cars_pickups_suvs/the-technology-and-potential-of-hybrid-vehicles.html

The Stateline Wind Plant along the Oregon-Washington border has been the largest land-based wind farm in the world. Larger plants are in the works. Credit: FPL

CHAPTER THREE:

WIND POWER— A PROFITABLE NEW CROP

Wind power is the fastest growing energy source in the world.

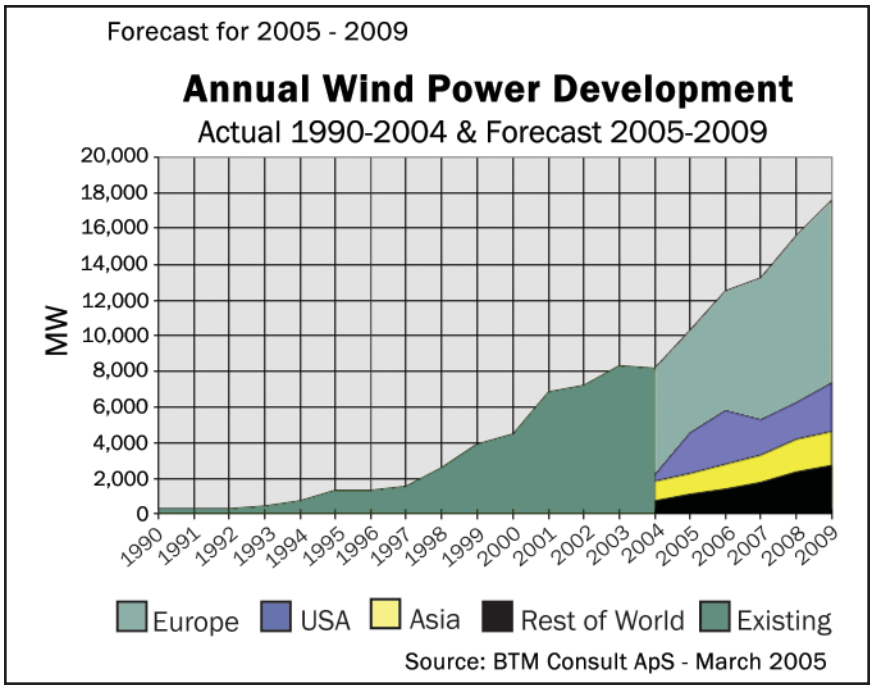
Windmills, a common energy source in American farm areas before rural electrification and gasoline-powered water pumps, are in the process of rebirth as mass-scale electrical power generators. With advanced lightweight materials, computer-assisted design, electronic controls and blades longer than 747 wings spinning at skyscraper heights, today's wind turbines transform air currents into electricity at costs competitive with the cheapest new fossil-fired generation.

At four to six cents per kilowatt-hour (kWh) the cost of wind generated electricity has gone down over 80 percent since the emergence of modern wind turbines in the 1980s.[39] One two megawatt wind turbine produces six million kilowatt-hours per year, enough to run 600 average U.S. homes.[40]

World wind power grew 28 percent annually for the past five years to reach 48,000 megawatts (MW) by the end of 2004. The U.S. share was 6,750 MW, with 2005 additions projected at up to 2,500 MW. While still under one percent of U.S. power generation, wind energy grew more than four times since 1990.

[39] *Wind Energy and Economic Development: Building Sustainable Jobs and Communities*, American Wind Energy Association, www.awea.org/pubs/factsheets/EconDev.PDF

[40] *Renewable Energy; Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities*, General Accounting Office,p1, Sept. 2004, www.gao.gov/new.items/d04756.pdf



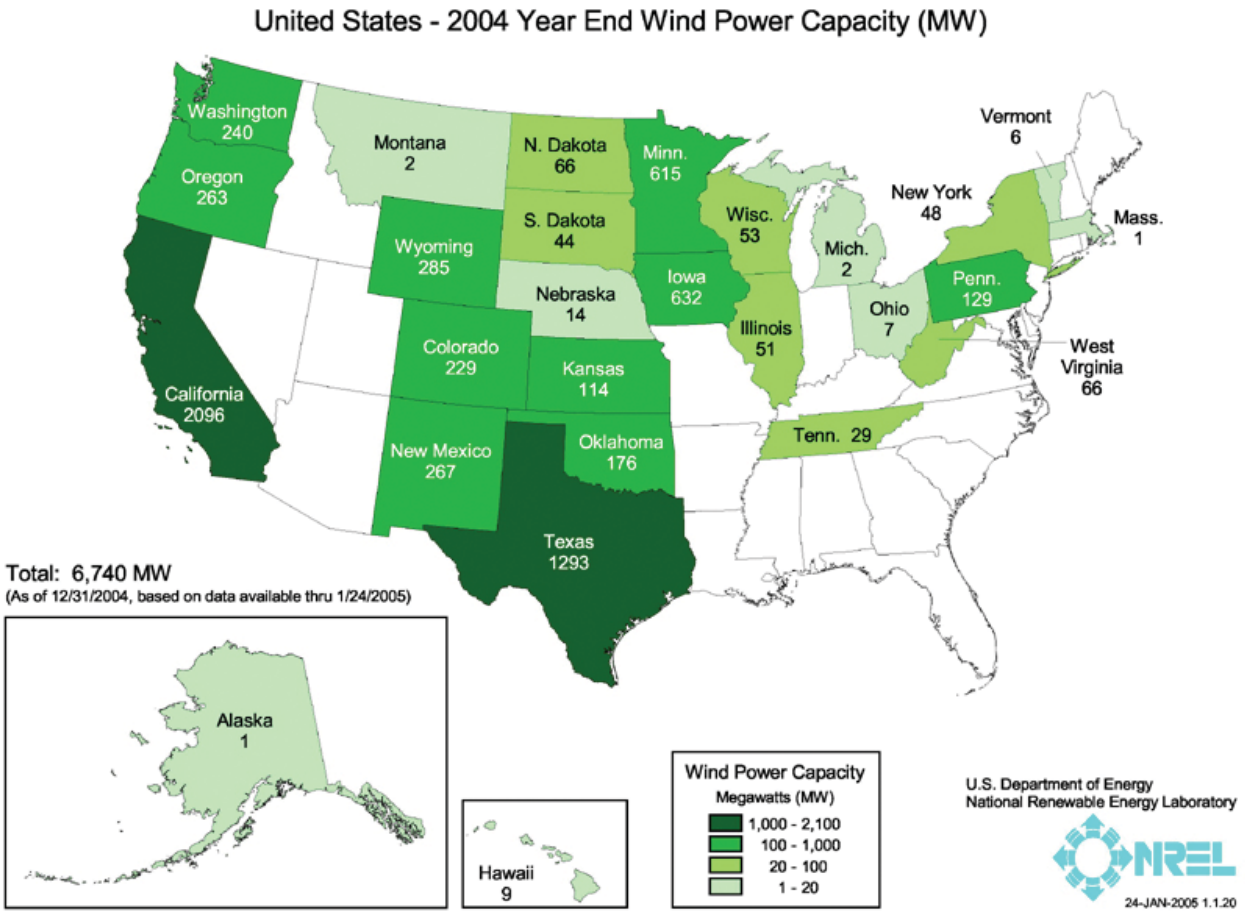
Wind power generation has dramatically accelerated over the next decade and growth curves will ascend over coming years. Credit: BTM Consult

The American Wind Energy Association (AWEA) estimates that 2005 growth alone will bring $2-3 billion in power sector investments.[41] More than 50 U.S. utilities now deliver wind energy to their customers. To date, twenty one states have adopted renewable energy standards requiring a minimum percentage of power to be generated from renewable energy resources. The Union of Concerned Scientists projects that these policies will drive new markets for 32,000 MW of new renewable power by 2017—$32 billion in new investments.[42]

Major U.S. growth is projected, although new policies are required to drive it. AWEA has set a U.S. 2020 wind power goal of 100,000 MW for six percent of national electricity use, around the amount supplied by hydroelectric dams today. A recent analysis by the Union of Concerned Scientists, *Renewing America's Economy,* found that under a renewable energy standard of 20 percent by 2020, renewable energy power capacity would grow nearly 11 times over present levels. Wind alone would produce 10 percent of electric demand in 2020, with the remainder supplied from bioenergy (e.g. electricity generated from crops and ag waste) and geothermal resources. By that time, the analysis estimates that renewable energy development would create more than 30,000 new jobs in

[41] Global. Growth–BTM Consult, www.btm.dk; US growth; *Wind Power Outlook 2005*, American Wind Energy Association, www.awea.org; "Annual Rankings Demonstrate Continued Growth of Wind Energy Industry in the United States," www.awea.org American Wind Energy Association; *Renewable Energy; Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities*, General Accounting Office, p1-9, Sept. 2004, www.gao.gov/new.items/d04756.pdf

[42] Union of Concerned Scientists, *Fact Sheet: Renewable Energy Standards at Work in the States,* September 2005, www.ucsusa.org/clean_energy/clean_energy_policies/res-at-work-in-the-states.html



Wind power generation spread across 26 states by the end of 2004. U.S. capacity of 6,750 MW is projected to grow as much as 2,500 MW in 2005. Credit: National Renewable Energy Laboratory

agriculture, deliver $15 billion in payments to farmers, and boost property tax revenues in local communities by $5 billion.[43]

The wind rush is attracting new corporate players. GE Energy projected more than $2 billion in 2005 turbine sales, a 300 percent growth rate from 2002 when it entered the field. GE has already sold out of turbines for 2005. *"Wind power continues to be the fastest growing segment of the global energy industry, and it certainly is a very significant part of the diverse energy solutions portfolio we offer to our customers around the world,"* notes GE Energy Vice-President Power Generation Mark Little.[44] Other corporations have major wind acquisitions in the past two years, Siemens of turbine-maker Bonus, Goldman Sachs of wind developer Zilkha (now re-named Horizon Wind Energy), and AES of developer SeaWest. John Deere Credit in June 2005 announced investments in locally owned

[43] Union of Concerned Scientists, *Renewing America's Economy,* www.ucsusa.org/assets/documents/clean_energy/Renewing-Americas-Economy-2005.pdf. See also, *Clean Energy Blueprint Benefits Farmers and Rural Economies,* www.ucsusa.org/clean_energy/clean_energy_policies/clean-energy-blueprint-benefits-farmers-and-rural-economies.html

[44] "GE Energy 2005 Wind Revenue to Increase 300 percent over 2002, Its First Year of Wind Operations," General Electric press release, June 28, 2005

wind farms (see sidebar), while Shell was the second leading owner of U.S. wind farms.[45] MidAmerican Energy, controlled by billionaire Warren Buffett, planned 2005 completion of the world's largest land-based wind farm, a $323 million, 310 MW plant in Iowa.[46]

WIND POWER POTENTIAL

The Plains of America have often been referred to as the *"Saudia Arabia of wind power."* Air currents have phenomenal power generation potential of which only the smallest sliver has been tapped. Numerous Department of Energy and National Renewable Energy Laboratory studies have quantified America's great wind potential. Recent Stanford University studies provide new estimates of U.S. and world prospects. Researchers found, *"U.S. wind power . . . may be substantially greater than previously estimated."* Wind speeds clocking an annual mean rate of 14 mph can be found over as much as one quarter of the United States. These "*are strong enough to provide electric power at a direct cost equal to that of a new natural gas or coal power plant*." [47]

The two great reservoirs of wind power potential identified in the Stanford study are off U.S. Atlantic, Pacific and Gulf coasts, and in the north- and south-central plains. States with stations reporting the greatest representation of economically competitive land-based wind are Oklahoma, Nebraska, Kansas, North Dakota and South Dakota. Earlier studies have also uncovered big wind generation potential in Iowa, Illinois, Minnesota, Texas, Montana, and Wyoming. While the Dakotas plus Texas alone are theoretically capable of generating as much power as the U.S. consumes, three-quarters of the states ranging from coast to coast have commercial wind potential. From California, birthplace of the modern wind industry and still the top U.S. wind power producer, to the Heartland, to upstate New York, large commercial wind turbines were operating in 26 states at the start of 2005.[48]

ECONOMIC BENEFITS OF WIND POWER

For American farmers and rural areas the wind boom opens new opportunities. Regions where constant gusts were once mostly a window-rattling nuisance are now finding that steady wind currents spell reliable cash flow and employment:

- Farmers who lease land to wind developers typically are paid two to three percent of revenues, around $2,000-$5,000 per year per turbine depending on the amount of power production. Each turbine takes only around one-half acre, mostly in access roads. Sights of

[45] "Annual Rankings Demonstrate Continued Growth of Wind Energy Industry in the United States," American Wind Energy Association, www.awea.org

[46] "MidAmerican Energy Announces Sites for its Wind Generation Project," MidAmerican Energy press release, Sept. 24, 2005, www.midamericanenergy.com/wind/html/news_details.asp?id=252

[47] "Harnessing the Wind," *Stanford Report*, May 21, 2003, www.news-service.stanford.edu/news/2003/may21/wind-521.html; Cristina L Archer and Jacobson, Mark Z, "Spatial and temporal distributions of U.S. winds and wind power at 80 m derived from measurements," *Journal of Geophysical Research*, Vol. 108, no. D9, 4289, 2003; Cristina L Archer and Jacobson, Mark Z, "Evaluation of Global Wind Power," *Journal of Geophysical Research*, Vol. 110, D12110, 2004

[48] *Wind Energy Potential,* American Wind Energy Association, www.awea.org/pubs/faq/tutorial/wwt_potential.html; *Wind Energy and Economic Development: Building Sustainable Jobs and Communities*, American Wind Energy Association, www.awea.org/pubs/factsheets/EconDev.PDF; *Wind Power Outlook 2005*, American Wind Energy Association, www.awea.org; www.awea.org/pubs/factsheets/EconDev.PDF

cattle grazing or crops growing right up to turbine towers are a commonplace. Local ownership offers even greater local economic benefits.

- Each 100 MW adds $500,000-$1 million in annual property tax revenue.
- During construction each MW generates one to two jobs. Operation and maintenance requires two to five permanent jobs per 50-100 MW.[49]

While total U.S. farm income from the infant wind power industry still ranges only in the tens of millions annually, this harvest is expected to grow dramatically over coming decades along with the job and revenue benefits for rural counties.[50] New public policies have been, and will continue to be, the major force to commercialize this new market for farmers.

Direct employment in the U.S. wind industry is around 2,000.[51] The Union of Concerned Scientists projects that a 20 percent renewable energy standard by 2020 would create more than 355,000 new jobs in manufacturing, construction, operation, maintenance, and other industries.[52] Many of those employers, such as Fargo, North Dakota-based blade maker LM Glasfiber, will be located close to rural wind farms.

U.S. wind power already is establishing a proven rural economic development track record documented in a number of studies. One of the most comprehensive showed total local annual economic impacts of three working wind farms:

- 107 MW, Lake Benton 1, Lincoln County, Minnesota, on line since 1998
- 25 MW, Vansycle Ridge, Morrow and Umatilla Counties, Oregon, on line since 1998
- 30 MW, Delaware Mountain, Culberson County Texas, on line since 1999

Annual land owner revenues, after taxes, ranged from $50,000 to $500,000. Annual tax revenues ranged from $242,000 to $611,000. Concluded the researchers, Northwest Economic Associates, *". . . the annual income received by households in all of the areas was a significant source of household income and had a significant total effect on local economies. In all cases, the cost of foregone opportunities from farming and livestock grazing was small compared to the revenues obtained from leases for wind power. Tax effects, particularly property taxes that support local entities, were important in all cases . . . there is a redistribution of the local tax burden from residents to outside owners. This, in effect, shows up as an increase in household income, which can directly affect the local economy."* [53]

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[49] Larry Flowers, U.S. Department of Energy, *Wind Power Market Update*, presentation to Harvesting Clean Energy Conference3, Feb. 10, 2003, www.harvestcleanenergy.org

[50] *Renewable Energy; Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities*, General Accounting Office, Sept. 2004, p6, www.gao.gov/new.items/d04756.pdf

[51] *Wind Turbine Development: Location of Manufacturing Activity,* Renewable Energy Policy Project, 2004, www.repp.org/articles/static/1/binaries/WindLocator.pdf

[52] Union of Concerned Scientists, *Renewing America's Economy,* www.ucsusa.org/clean_energy/renewable_energy_basics/renewing-americas-economy.html

[53] *Assessing the Economic Development Impacts of Wind Power*, Northwest Economic Associates for National Wind Coordinating Committee, Feb. 2003, p.ES-1–ES-6, www.nationalwind.org/publications/economic/econ_final_report.pdf

Texas is a good example of the economic benefits from wind. Texas adopted a renewable energy standard under Governor Bush in 1999. It required 2,880 MW of renewable energy, or about three percent of the state's electricity, by 2009. Texas is ahead of schedule in meeting this goal. The resulting wind boom spurred over a billion dollars in new investment in rural areas, delivering $13.3 million in tax revenues to local schools and counties.[54] Backed by strong support from rural communities, in 2005, Texas doubled its renewable energy standard to 5,880 MW, or about five percent of the state's electricity by 2015.

Tax benefits vary greatly from county to county, depending on assessed value, abatements, tax rate, and exemptions. For example:

- In Iowa, three wind plants totalling 320 MW deliver $2.5 million per year
- In Wisconsin, a 20 MW wind farm in Kewaunee County delivers $200,000 per year in property taxes—about 50 percent of county's budget
- The Oregon/Washington 300 MW Stateline project delivers $1.2 million per year
- In Wyoming, the 85 MW Carbon County wind farm delivers $480,000 per year [55]

Because wind power uses a local resource as "fuel," often displacing imported energy, it can have better direct economic impacts than investments in either coal or natural gas. A recent National Renewable Energy Laboratory (NREL) analysis compared economic benefits from equivalent investments in coal, natural gas, and wind power in Arizona, Colorado, and Michigan, concluding that "*equivalent generation of wind power will bring the highest direct economic benefit to the state.*" [56]

An analysis of the net economic benefits to Nebraska from a 10 percent renewable energy standard confirms NREL's conclusion. Investments in renewable energy will deliver 360 more jobs, $8 million more in income, and $35 million more in gross state product than equivalent investments in coal or natural gas power. Further, the renewable energy standard results in $2.2 million in royalty payments to farmers and landowners ($2,000/turbine/year) and $5.2 million in property tax revenues for rural communities.[57] These case studies look at wind owned by corporate developers. Local ownership, where feasible, would retain more of this income in the local area and increase the economic benefits. A study by NREL for the Government Accountability Office documents just how large these impacts can be. NREL compared the effect of a 40-MW corporate wind farm owned out of area and 20 two-MW wind plants owned locally. Looking at 11 locations, the study found local ownership yields an average of $4 million in local income annually, over three times more than $1.3 million produced with out-of-area control. Job creation in the

[54] SEED Coalition, Public Citizen Texas, *Renewable Resources: The New Texas Energy Powerhouse,* September 2002

[55] Steve Clemmer, *Wind Power and Economic Development: A Comparison of Recent Projects*, Union of Concerned Scientists, Windpower 2003 Conference, May 21, 2003

[56] S. Tegen, *Comparing Statewide Economic Impacts of New Generation from Wind, Coal, and Natural Gas in Arizona, Colorado, and Michigan*, Preprint Conference Paper, NREL/CP-500-38154 August 2005

[57] Steve Clemmer, *Strong Winds: Opportunities for Rural Economic Development Blow Across Nebraska*, Union of Concerned Scientists, NWCC Wind Energy and Economic Development Workshop, March 15, 2001

local model was more than twice as large, 41 compared to 18 for the corporate model.[58]

TWO CHALLENGES TO SCALING UP WIND: TRANSMISSION AND INTERMITTENCY

America has the wind resource and the mature wind turbine technology to convert it to clean electricity—wind is poised for tremendous growth. To spur this growth, policies must simultaneously build new markets and enable wind farms to access those markets.

Proven policies like a strong renewable energy standards, ideally at the federal level, coupled with the long-term renewal of the production tax credit, state production incentives, and expanded incentives for farmer-owned wind in the next farm bill, would go a long way toward building the needed market for wind. Enabling wind farms to access that market requires overcoming two other challenges. The most fundamental is transmission. The nation's transmission grid was built to move electric power from large fossil power plants to population centers. To tap the tremendous potential for wind and unlock it's economic benefits for rural communities, existing transmission must be managed in "wind-friendly" ways and new transmission must be built. Throughout the country, small and large windfarms need standardized connections procedures, simple contracts, and fair transmission charges. The models to do this right exist, but some utilities and rural cooperatives continue to resist new wind farm development due to reliability or safety concerns. They need to be educated on the benefits of wind to their community and on the ways to ensure safe integration into the system, as over 50 utilities across the country and hundreds around the world have already done.

To take the next big leap in scaling up wind, America's wind-rich areas need to be connected to the nearest population centers. The Upper Midwest's vast wind resources need to be connected to population centers in Minneapolis, Chicago, and St. Louis. Wind on the Wires, a Minnesota-based group dedicated to building the "*road to market*" for wind in the Upper Midwest, identified 10,000 MW—$10 billion in new regional investments—of wind development potential. Transmission upgrades and new transmission investments are the means to unlock this economic potential.[59] Similarly, Montana, Wyoming, and Colorado wind farms need access to West Coast markets. Texas's vast wind reserves, situated in depleted oil country, need access to Dallas and Houston markets. These are multi-billion dollar investments, but as described earlier, their returns in increased farm income, rural revitalization and energy security are large compared to their cost.

The other challenge is intermittency, or the variability of wind. Wind farms typically feed energy into the electric grid about 60 percent of the time, the best sites as high as 70 percent. On an annual and even seasonal basis, wind energy production is fairly steady, but day-to-day production varies with local weather conditions. Thus utility systems must maintain the capacity to adjust other power generation to compensate for wind's volatility. Throughout the world, this challenge as been carefully examined, and met. Denmark, for

[58] *Renewable Energy; Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities*, General Accounting Office, Sept. 2004, p82-3, www.gao.gov/new.items/d04756.pdf

[59] Wind on the Wires, 2002 Midwest Wind Development Plan, www.windonthewires.com/reg_resource.cfm. Wind on the Wires is currently updating this 2002 Midwest Wind Development Plan.

example meets 20 percent of its demand with wind power and the Danish Windpower Association is aiming for 50 percent by 2025. Especially for smaller rural cooperative and municipal utilities, however, the costs and approaches to integrating wind need to be carefully analyzed. A recent report from the Western Governor's Association Wind Energy Task Force is useful here:

"A growing body of studies and experience in different parts of the world confirms that large amounts of wind can be integrated into utility systems without detrimental effects on system reliability. The evidence suggests that the cost of integrating wind generation increases as the percentage of wind in the system increases. However, on average the cost of integrating wind at levels of 10-20 percent of system capacity is small compared to the price of power according to studies performed to date." [60]

Minnesota farmers gather in December 2004 to dedicate Minwind III-IX, one in a series of locally-owned small wind projects. Credit: Sarah Johnson, Windustry

PROMOTING LOCAL OWNERSHIP

Leasing to wind power developers produces huge benefits to landowners. Farmers would be hard pressed to find a better deal than $2,000-$5,000 a year for setting aside one-half acre of farm land without having to plow, plant, fertilize or harvest. The one exception, as documented above, is local ownership. Earnings can be several times as great, but it requires risk taking as well as supportive policies like those in Minnesota. Landowners must secure financing, oversee installation and maintenance of turbines, and find market outlets for electrical generation. It can take two years or more to move a project from conception to commissioning. With wind installation costs around $1 million per MW, landowners may not have financial ability to fully utilize wind resources.[61]

The situation is a sharp contrast to Europe where large shares of wind capacity are owned by farmers and other landowners. *"Traveling through the Danish countryside, one cannot help but notice the myriad large, utility-scale wind turbines that dot the landscape, either singly or in small clusters of several turbines,"* notes local ownership expert Mark Bolinger of Lawrence Berkeley National Laboratory. *"This is clearly wind power development on a different scale from what one typically encounters in the United States, where a single wind farm might stretch on for miles and be sited far from load centers. In fact, it is an altogether different type*

[60] Draft Wind Task Force Report, prepared for the Western Governor's Association, September 2005, note that this report has yet to be adopted as a formal report of the Western Governor's Association, www.westgov.org/wga/initiatives/cdeac/wind.htm

[61] *Renewable Energy; Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities*, p38-9, www.gao.gov/new.items/d04756.pdf

of wind development and ownership model than typically found in the U.S.: most of those Danish wind turbines are owned by one or more local residents, rather than by commercial investors, independent power producers or utilities. And Denmark is not unique in this regard; 'community wind power' has also played a large role in Germany, Sweden, and, to a lesser extent, the Netherlands and the United Kingdom." [62]

Bolinger ascribes the differences to supportive policies advanced in Europe. To encourage clean energy production, European nations guarantee stable high payments for feeding wind energy into the grid. These feed laws essentially provide an assured revenue stream to turbine owners, allowing them to seek financing. The U.S. federal government primarily supports wind with the Production Tax Credit, which suffers from two problems. First, the PTC is not stable—its renewal is subject to annual political battles. Second, most small landowners do not have the tax liabilities that let them benefit from the PTC. Many states across the U.S. are stepping in to overcome those local ownership hurdles.

By far, the preeminent example is Minnesota, home to a large share of the nation's locally owned turbines. Minnesota has provided per kWh production incentives which act much like a European feed-in law. In 1997 the state passed an incentive capped at 100 MW, which took five years to subscribe. A second 100 MW authorized in 2003 was fully allocated in

JOHN DEERE INVESTS IN LOCALLY OWNED WIND POWER

Where John Deere tractors harvest crops on the ground, John Deere's financial clout is now harvesting the wind that blows above. Deere in July announced equity investments in wind farms in Minnesota and Texas, and creation of John Deere Wind Energy to provide financing and wind development services to local partners.

"*We at Deere have studied the wind industry for several years*," says David Drescher, vice president for John Deere Wind Energy. "*It's strategic for our customer base, and goes right along with the growth of biofuels, ethanol and biodiesel.*" Deere is "*staffing a fairly considerable effort*," and could partner in 60 MW by the end of 2005 and "*significantly*" more beyond that. The company has no plans to enter turbine manufacturing.

In most cases Deere plans to work directly with local partners with a focus on its existing customers. "*Local ownership is important for a number of reasons,*" Drescher says. "*It leaves more money in the agricultural community and helps farmers stay in business.*" Local owners also build connections between Deere and local communities that help with siting and contacting. "*Local owners can get the benefits and share them with us.*"

[62] Mark Bolinger, *Community-owned Wind Power Development: The Challenge of Applying the European Model to the United States, and How States Are Addressing that Challenge*, Presented at Global Windpower 2004, Chicago, Illinois, March 30, 2004, p1, www.repositories.cdlib.org/lbnl/LBNL-55139/

six months. That is ascribed to development of ownership structures that enable small projects to capture PTC benefits.[63] [64]

Minnesota has implemented other policies to promote local ownership through regulatory requirements to Xcel Energy. Those include standardized purchase and interconnection agreements, which reduce transaction costs, and a state renewable electricity standard which requires a 160 MW share for projects under two MW. Put together, Minnesota's policies are expected to spur development of 460 MW of locally owned turbines.[65]

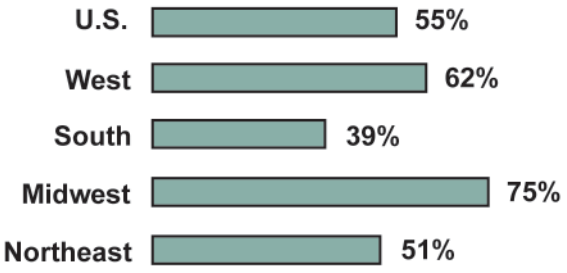
Other states with initiatives to build local ownership include Iowa, Illinois, Oregon, Washington, New York, Colorado, and Massachusetts. The Bay State, for example, provides assistance for local wind development to municipalities through the Massachusetts Technology Collaborative. The package includes technical assistance to assess wind resources and plan projects, and low-cost development and operations services aggregated through the state.

WIND GROWTH DAMPENS NATURAL GAS PRICES

Natural gas prices have tripled in the last three years and high demand for this relatively clean fuel—for electric power plants, home heating, and industry—will continue to exert upward price pressure. As with oil, the U.S. is a customer of the world natural gas market: we have only three percent of world reserves and our demand is growing even as our domestic productions trends down.

Natural Gas Heating Bills are Projected to Rise by Between 32 % and 61 %

Households using natural gas as primary heating fuel



Percent Change from Last Winter (Projected)

	Consumption	Average Price	Total Expenditures
West	+ 4 %	+ 29 %	+ 34 %
South	+ 5 %	+ 48 %	+ 56 %
Midwest	+ 4 %	+ 55 %	+ 61 %
Northeast	- 1 %	+ 33 %	+ 32 %

Source: Department of Energy, Energy Information Administration, Short Term Energy Outlook, October 2005

[63] One invented in Minnesota is the "flip" structure under which landowners financially own only around one percent of their project for the first 10 years, the time the PTC is effective. Investment capital comes from a corporate owner who can use the tax credit. The landowner gains a small management fee. After 10 years debts are retired and ownership flips. The landowner then earns all returns for the remaining life of the turbine, typically around 10 years.

[64] For a thorough discussion of options see Mark Bolinger and Wiser, Ryan, *A Comparative Analysis of Business Structures Suitable for Farmer-Owned Wind Power Projects in the United States*, Lawrence Berkeley National Laboratory, Nov. 2004, www.eetd.lbl.gov/ea/ems/reports/56703.pdf

[65] *Community-owned Wind Power Development: The Challenge of Applying the European Model to the United States, and How States Are Addressing that Challenge*, p6-7

High natural gas prices hurt the economy as a whole, but they are doubly harmful to farmers because natural gas is the source of anhydrous ammonia that goes into nitrogen fertilizers. Eighty percent or more of ammonia cost is in natural gas feedstocks.

Wind power generation helps solve both problems by displacing natural gas power generation, reducing demand, and thereby putting downward pressure on prices. Lawrence Berkeley National Laboratory recently prepared a synthesis of 13 studies examining the impacts of rapid wind and energy efficiency development on natural gas prices. The studies varied, but generally showed that each one percent reduction in national gas demand would lead to a long-term (effectively permanent) average reduction in wellhead natural gas prices of 0.8 percent to two percent. Projected consumer savings are sizable, between $10 to $40 billion by 2020.[66]

For example, the Union of Concerned Scientists analyzed a 20 percent national renewable energy standard by 2020. Compared to business-as-usual in 2020, the 20 percent renewable standard would save the equivalent of 27 percent of the natural gas consumed by U.S. households today. Most important, the Union of Concerned Scientists estimates that consumers would save $13.8 billion cumulatively on their natural gas bills and $34.9 billion cumulatively on their electric bills.[67]

WIND POWER ENVIRONMENTAL CONCERNS

If sited properly, wind power is one of the cleanest power sources in the world. Care must be taken, however, to avoid impacts to wildlife, especially migrating birds.

Lessons from one of the world's first modern wind farms, Altamont Pass in Northern California, are useful here. Unfortunately, Altamont is located along a migratory route for raptors, including eagles, hawks, and kestrels. Wildlife groups like the Audubon Society and the Center for Biological diversity quickly pointed out that the level of bird kill, although small relative to other human-related causes, needed to be reduced.[68] Scores of studies, by the wind industry, the Department of Energy, and wildlife groups points to a set of approaches to mitigate wildlife impacts. First and foremost is site location. New wind energy projects should be reviewed for bird abundance, migration and use patterns, and wind farms should be designed and operated to prevent or minimize bird mortality. Some windy sites may not be suitable for development. In others, blade and tower design, as well as the pattern of wind turbine deployment, can mitigate wildlife impacts.

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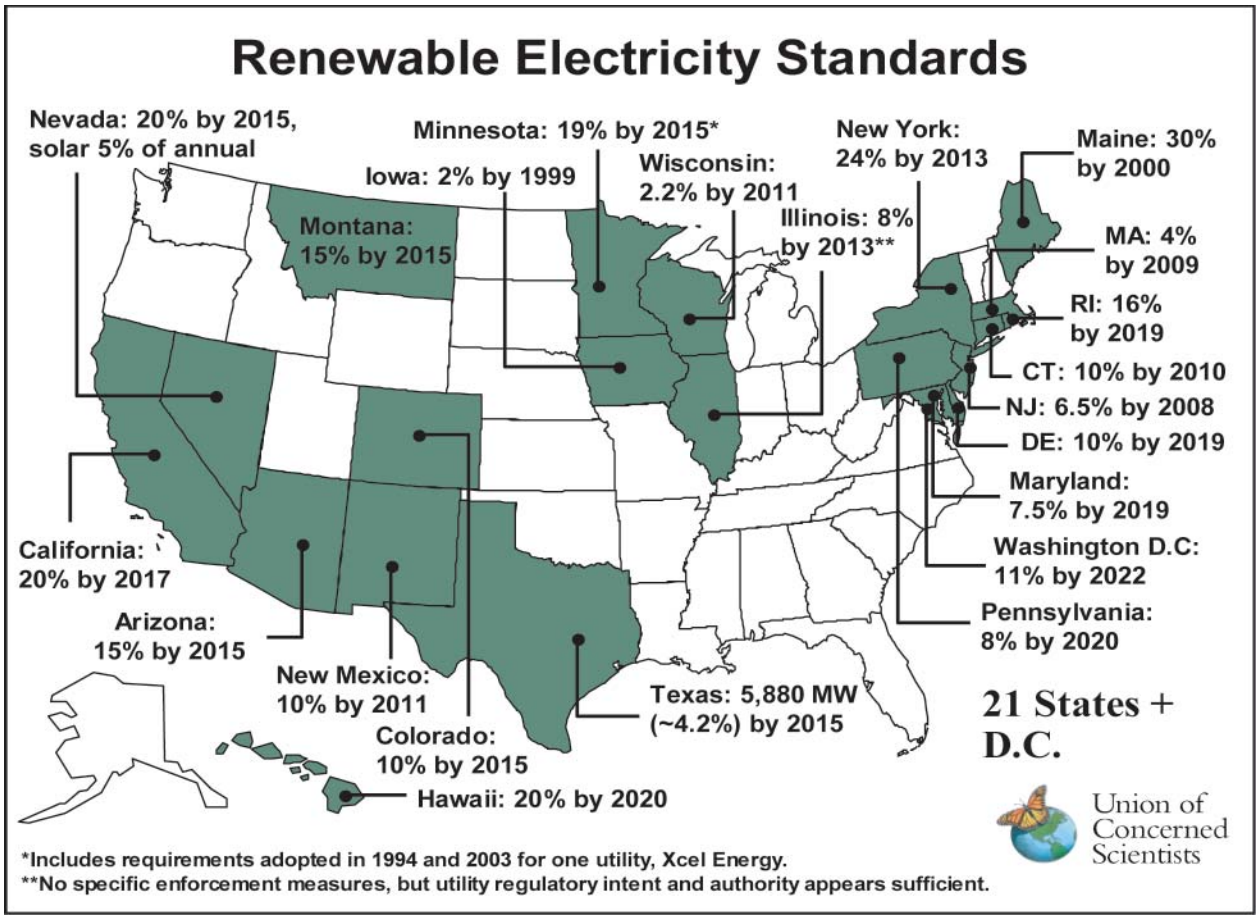
[66] R. Wiser, M. Bolinger, M. St. Clair, *Easing the Natural Gas Crisis, Reducing Natural Gas Prices Through Increased Deployment of Renewable Energy and Energy Efficiency,* Lawrence Berkeley National Laboratory, January 2005

[67] According to UCS, a 20 percent renewable energy standard would result in 10 percent of U.S. electric generation coming from wind by 2020. Source: Personal communication with Steve Clemmer and Union of Concerned Scientists, *Renewing America's Economy,* www.ucsusa.org/assets/documents/clean_energy/Renewing-Americas-Economy-2005.pdf

[68] According to the National Wind Coordinating Council, raptor deaths average 0.033 per turbine per year in California and 0.0006 nationally. Wind turbines cause only one out of every 5,000-10,000 bird deaths and are under one percent of the total. By far the bulk of deaths are caused by collisions with buildings, communications towers, cars and power lines, and by housecats. Source: *Avian Collisions With Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States,* National Wind Coordinating Council Resource Document, August 2001

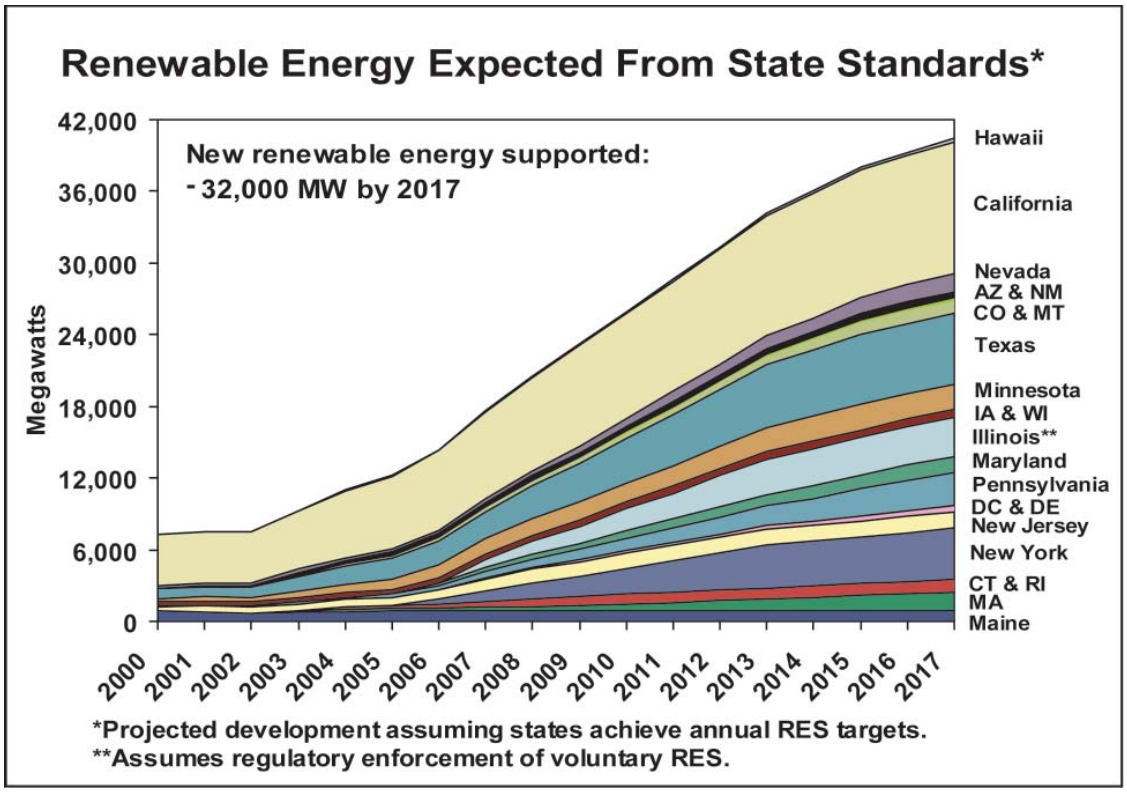


Map shows spread of Renewable Electricity Standards throughout the U.S. These standards drive wind power growth. Credit: Union of Concerned Scientists

Today's much larger wind turbines show promise for reducing avian mortaility. When Altamont was first developed most wind turbines were under 250 kilowatts in size, with blades that spun very quickly, and tower heights under 100 feet. Today's turbine are six to eight times larger, often with towers above 300 feet and blades that spin relatively slowly. All of these factors reduce the risk of bird kills. A Bonneville Power Administration report, summarizing extant studies on avian mortality, concluded:

"Raptor mortality has been absent to very low at all newer generation wind plants studied in the U.S. This and other information regarding wind turbine design and wind plant/wind turbine siting strongly suggests that the level of raptor mortality observed at Altamont Pass is quite unique (e.g., unique likely because of the number and arrangement of turbines in small area, turbine types, prey availability, raptor use) and can be avoided at other locations." [69]

[69] Bonneville Power Administration, Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments, West, Inc., December 2002, pg 7



Graph shows how Renewable Electricity Standards and state funds dedicated to clean energy development are growing wind power and other renewables. Credit: Union of Concerned Scientists

POLICIES TO GROW THE WIND HARVEST

Wind power—farmer and non-farmer owned—could grow even more rapidly with supportive policies. The most important are:

Guarantee a market with federal and state renewable electricity standards

The United States should take a world leadership position on wind power and renewables by adopting a goal of generating 20 percent of our electricity from renewables by 2020. This guarantees a market for farmers which in turn enables low-cost financing. Wind power would be at least 10 percent of our generation in this scenario, and America's farmers, ranchers, and rural economies would see a tremendous wind boom. Twenty one states and the District of Columbia now have an RES, the federal government should follow these state leaders.

States should continue their leadership efforts to secure the economic and energy security benefits of wind. Texas just doubled its RES to nearly 6000 MW, and is poised to become the largest wind generator in the country. Illinois is implementing its recently adopted RES. Governor Schwarzenegger in California has set a goal of 33 percent renewables by 2020 and is examining the best policies to achieve it. Oregon, Washington, and many other states

FARM GROUPS BACK ELECTRICITY STANDARDS

Farm groups increasingly are swinging behind Renewable Electricity Standards (RES). A milestone came in 2004 when the American Farm Bureau Federation (AFBF) endorsed a 10 percent RES. The American Corn Growers Association has also endorsed a national RES.

At the state level the North Dakota Farm Bureau has taken one of the boldest positions of any farm group in the nation. In 2002 the organization called on state government to set a goal of installing 10,000 MW of wind capacity by 2020. Estimated benefits include $6 billion in construction activity, $23 million for annual landowner payments and an additional $59 million pumped into local economies each year to operate and maintain wind farms. The South Dakota Farm Bureau has also set an 8,000 MW goal for wind energy production there by 2020.

"*Renewable energy is an opportunity for farmers and ranchers to make a little money for a change*," NDFB Vice President for Public Policy John Mittleider comments. Notes SDFB Administrative Director Mike Held. "*Clean energy production provides a tremendous economic boost, and rural areas are looking for added opportunities for economic development*."

Other state farm groups supporting RES include Farm Bureaus in Iowa, Illinois and New Hampshire; Farmers Unions in Iowa, Minnesota, South Dakota and Nebraska, and the Ohio Family Farm Coalition. In Colorado most farm groups supported RES legislation that preceded successful 2004 ballot passage of an RFS.

Iowa Farm Bureau backs RES, Commodity Services Coordinator Denny Harding says, "*basically to support development of the renewable energy industry. It stimulates economic activity in the countryside. It's returning money back to the farmer's pocket*."

are considering expanding renewable energy standards as farmers and rural communities join in the call for wind power development.

Enact a long-term extension of the production tax credit including revisions so it will benefit small farmers, public utilities, and rural cooperatives

The production tax credit (PTC) expired in 2003 but was renewed for two years in the 2005 Energy Policy Act. The PTC should be extended for 10 years, and revised so that its tax credits are tradable on a secondary market. Small farmers, rural cooperatives, tribes, large utilities, and ultimately, all American consumers, would benefit.

The PTC helped launch the wind industry in the U.S. but it is far from optimal. The on-again, off-again status of PTC has been the bane of the wind industry. Expiration at the end of 2003 led to suspension of $2 billion in investments and a 2004 in which only 389

new MW came on line compared to a nearly 2,500 new MW expected in 2005. *"The cycles of short-term extensions and then expirations of the production tax credit play havoc with industry planning and increase company costs,"* AWEA observes.[70] Further, in the past, only entities with a large tax burden could take advantage of the PTC. Small farmers and public utilities (rural cooperatives and municipal utilities) with little or no tax burden could not use it. A new provision in the Energy Policy Act of 2005, the Clean Renewable Energy Bond (CREB) program, attempts to correct part of this deficiency, allowing cooperatives, municipal utilities, and governments to borrow funds at zero interest.[71] The approach shows promise, but it is too early to tell if it will spur serious investments. Unless a farmer is part of a rural cooperative or municipal program, it does not give support to farmer-owned wind.

Expand successful farm bill policies to accelerate wind power growth

For the first time, Title IX of the 2002 Farm Bill recognized the economic potential to farmers from energy development. Section 9006, which offer grants and loans guarantees, is a model program. This year, USDA awarded 154 grants to 32 states totaling $22.2 million and two loan guarantees totaling $10.1 million. When completed, these projects will leverage total clean energy development project investments of close to $200 million.

Successful Farm Bill provisions should be expanded in the 2007 Farm Bill, including:

- Section 9006 funding should be increased to $250 million per year and targeted to the rural economies hardest hit by changing farm subsidies;
- Section 9005, the Energy Audit and Renewable Energy Development Program, should be funded to allow small farmers and rural cooperatives in windy areas to perform feasibility assessments and energy audits. Many profitable projects are not developed for lack of feasibility assessment funds. Section 9005 can put more farmer wind projects into the "pipeline."

Offer state production incentives and standardized contracts to support locally-owned wind development

Minnesota was an early leader with this policy and as a result has more farmer-owned wind than any other state. As mentioned earlier, Minnesota provided a 1.5 cents per kilowatt-hour production incentive which acts much like a European feed-in law—it creates a reliable revenue stream which allows farmers to obtain financing. Further, Minnesota required standardized power purchase agreements for wind projects under two MW. The latest Minnesota policy innovation is the Community-Based Energy Development Tariff, which pays small, locally-owned wind projects up to 2.7 cents per kilowatt-hour over the 20 year life of the power purchase agreement.

Other effective policies here include set asides within a RES that stipulate a certain share be filled with locally-owned wind. Montana's renewable energy standard includes a set aside for community based renewable energy projects that amounts to at least 75 MW by 2015.

[70] *Wind Power Outlook 2005*, American Wind Energy Association, www.awea.org

[71] The American Public Power Association is a good source for explaining CREBs www.appanet.org/research/index.cfm?itemnumber=13896

Net metering provisions, where a locally owned wind farms are paid retail rates, effectively "spinning" the utility meter backwards, can also spur local ownership.[72] Tax credits, while not as effective as production incentives, can also spur new development. Iowa, for example, offers a tax credit of 1.5 cents per kilowatt-hour for wind projects under 2.5 MW.

Build the road to market by ensuring transmission access

The immediate goal is to fully utilize the existing transmission system to maximize wind development. The longer-term goal is to build new transmission to mine America's wind-rich regions.

With respect to the first, states can:

- require wind integration studies detailing where and how much wind can be added to the existing system with minor upgrades. These studies should examine how other generating choices affect opportunities to add large amounts of wind.
- Follow Minnesota and Texas precedents and explicitly urge that transmission policy support and prioritize new renewable energy investments required under a new RES.
- Urge regional transmission planning entities and the Federal Energy Regulatory Commission (which regulates interstate transmission) to adopt more flexible transmission tariffs that do not penalize wind.
- Urge federal power marketing agencies like the Western Area Power Administration and the Bonneville Power Administration to use their significant power resources to ease wind power access to publicly owned transmission.

For the American Plains to truly become the world's "*Saudi Arabia of wind*," and for Montana and Wyoming to connect to West Coast markets, the nation must invest in new transmission. Just as public investments in paved roads created a "road to market" for farm products in decades past, the rural revitalization, energy security, and environmental benefits of farm energy justify significant new public investment today.

[72] For a summary of state policies to advance locally-owned wind, see www.windustry.com/community/policy.htm

America's farmlands can become a major new source of energy. Credit: Bob Allan, DOE/NREL

CONCLUSION:

A NEW OPPORTUNITY FOR AMERICA'S FARMERS

American farmers have played a central role in the national story from its inception—from the citizen farmers who took up arms to win American independence, to the pioneering homesteaders who led the way west, to the productive modern agriculturalists who feed America and export to the world. Now in the early years of the 21st century, America's farmers have a new role and opportunity: to grow a new harvest of biofuels and wind power as a major domestic energy supply for the nation. America's farmland can take on this new task while still filling its traditional role as primary supplier of food and fiber.

The benefits in terms of increased farm income, rural revitalization, national energy security, and a cleaner environment are great, but so are the challenges. Transforming agriculture into a major 21st century energy supplier, like virtually all emerging industries, requires public policy support. The agricultural community is already a vital part of Ag-Energy coalitions that have passed state electricity standards and national and state fuel standards. Now is time to take the work to the next level.

The key is to shape broad alliances with a vision for agriculture as a major national energy player and a focus on the most promising Ag-Energy opportunities. Such alliances can join farmers, rural development organizations, national security experts, and clean energy advocates as they jointly offer solutions to energy security and rural economic problems. Such a wide ranging national partnership can assemble the bipartisan political clout needed to pass the policies that will launch a rapidly growing Ag-Energy sector.

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Toward a sustainable energy future

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