Rural Power

Community-Scaled Renewable Energy and Rural Economic Development

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Other Publications

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Since 1974, the Institute for Local Self-Reliance (ILSR) has worked with citizen groups, governments and private businesses to extract the maximum value from local resources.

A program of ILSR, the New Rules Project helps policy makers to design rules as if community matters.

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Executive Summary

The essential comparative advantage of rural areas is open space. Some communities take advantage of their scenic natural resources. Others tap into their mineral wealth by drilling or mining. Many have economies based on the cultivation of soil. A new and rapidly emerging economic foundation for rural America is the harnessing of renewable energy in its various forms: wind, sunlight, and biofuels.

The wind energy industry is growing by 25 percent a year, the biofuels industry by 20 percent. Both are projected to expand three to six times in the next 12 years. These multi-billion dollar industries have already had a significant impact on rural America. Partly as a result of the increased demand for biofuels, for the first time in a generation farmers can make a living selling their crop without government payments. Thousands of landowners are receiving significant revenue from leasing their wind energy rights to developers who use only a tiny fraction of their land and many landowners own their wind turbines outright.

Harnessing renewable energy can dramatically improve the economic prospects of many rural areas. But new rules are needed to maximize the economic and social benefits from these new industries, policies that go beyond more, to demanding better. Current federal incentives largely enable a highly centralized and absentee owned renewable energy industry concentrated in relatively few states.

The federal government, states, and rural communities should redesign these policies to encourage a highly decentralized and dispersed renewable energy industry that is significantly locally owned. Doing so would multiply the number of rural areas that benefit from burgeoning renewable energy industries, and would create a sustainable asset whose wealth and revenue will largely remain in revived local communities and regions.

This report examines the current impact of renewable energy on rural communities and identifies existing and potential policies that could dramatically expand the economic benefit this new sector can bring to these communities.

What is Rural?

Federal agencies in the United States use nine definitions of rural. Based on the variety of formulas, anywhere from 75 to 99 percent of land area and between 17 and 63 percent of the population is in rural areas.[1]

However, most observers use the term interchangeably with the term non-metropolitan,[2] the definition used by the Office of Management and Budget (OMB). All counties with a city population of 50,000 or more are considered "metro." Everything else is rural, leaving us with 49 million Americans (17%) living in rural areas, occupying three-quarters of the continental, contiguous land.

The average density of a rural county is a little under 20 people per square mile, or about one person for every 35 acres.[3] Table 1 displays the various rural definitions and the one we have selected.

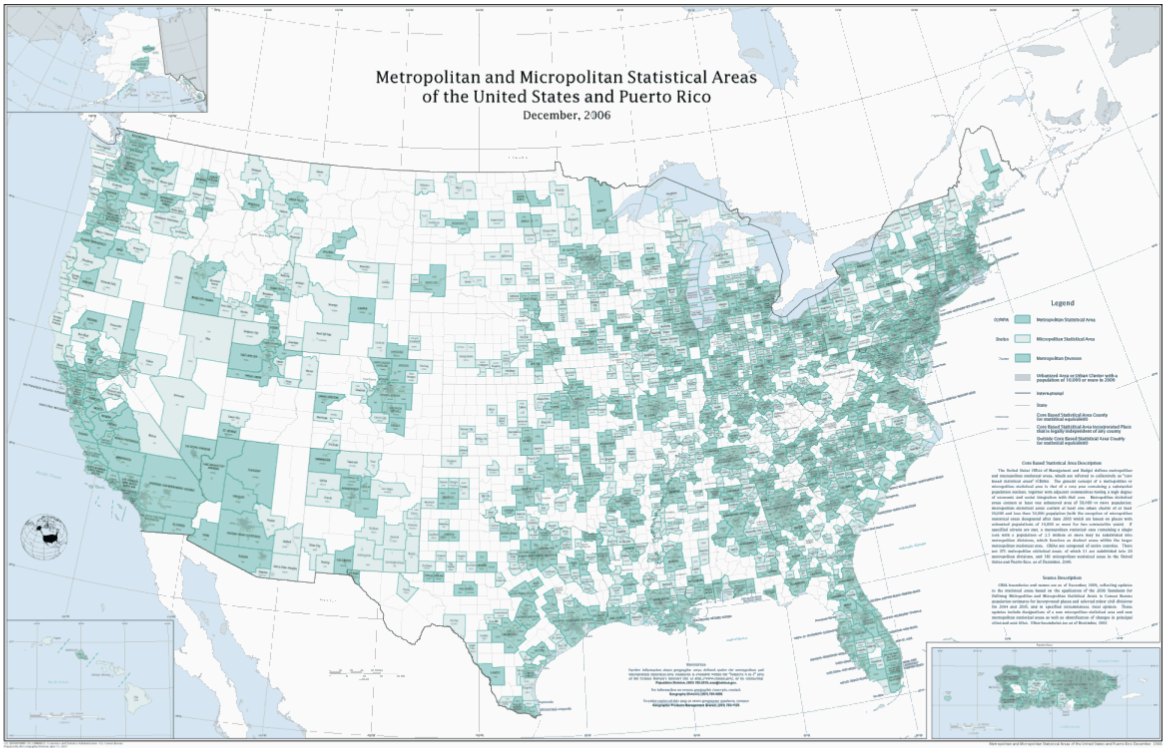
The following map (Figure 1) illustrates how much of the United States is rural by our definition. The dark-colored counties are urban, both the white and light-colored (micropolitan) counties are rural.

Table 1 – Rural Definitions

Our definition

Rural is defined as areas outside...	**Census Places with a population ≥**			**Census Urban Areas with a population ≥**			**OMB Metro Counties**	**ERS RUCA Codes 1-3**	**USDA B&I ineligible locations**
	2,500	10,000	50,000	2,500	10,000	50,000			
Population									
Total population considered rural (million)	87.7	115.8	177	59.1	70.6	89.5	48.8	57.6	101.9
Percent of population considered rural	31%	41%	63%	21%	25%	32%	17%	21%	36%
Percent of land area considered rural	97%	98%	99%	97%	98%	98%	75%	81%	98%
Population density less than... (people/ sq. mile)	25.6	33.4	50.5	17.1	20.4	25.8	18.5	20	29.4

Figure 1 – Metropolitan and Rural Counties (Office of Management and Budget, 2006)



Overview of Rural Economies

Rural areas are characterized by very low population densities and large swaths of unoccupied land. They are, in other words, population poor and sometimes natural resource rich.

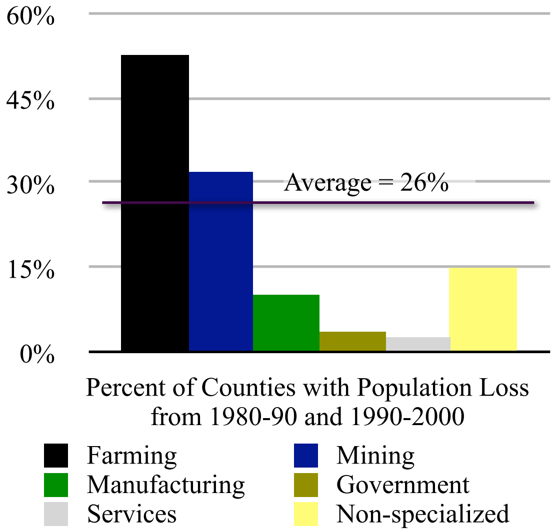
As a result, many rural areas rely on their natural resources for a significant part of their economic base. Some take advantage of beautiful scenery or temperate climate to attract tourists or retirees. Others rely on mineral and fossil fuel extraction. Many rely on agriculture and forestry.

In the past decades, rural areas have experienced significant population loss along with an exodus of jobs from extractive industries and agriculture. Employment has shifted to services or the public sector. Figure 2 shows population loss for counties, classified by their dominant industry.[4] Over half of farming-dependent counties and nearly a third of mining-dependent counties lost population from 1980-90 and from 1990-2000.[5]

Recently, sharply rising commodity and mineral prices have changed the rural economic dynamic, at least for the short run. Rapidly increasing demand for renewable energy is offering many rural areas the possibility of a long term revitalization.

This section explores the various ways in which rural economies make use of their abundance of natural resources.

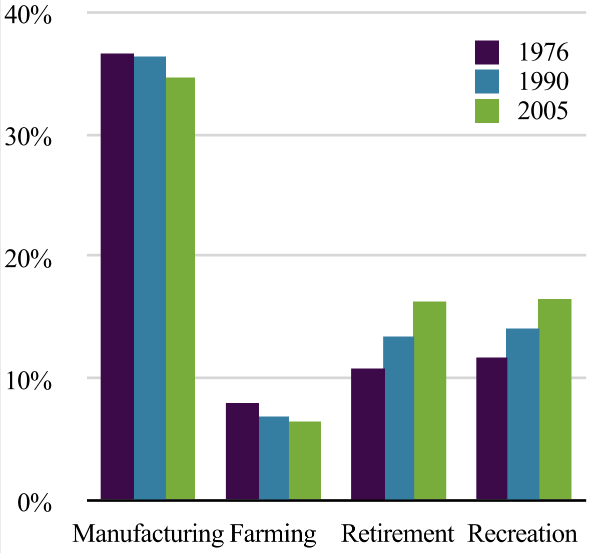
Figure 2 – Counties Focused on Farming and Mining are Losing Population



Scenic Resources

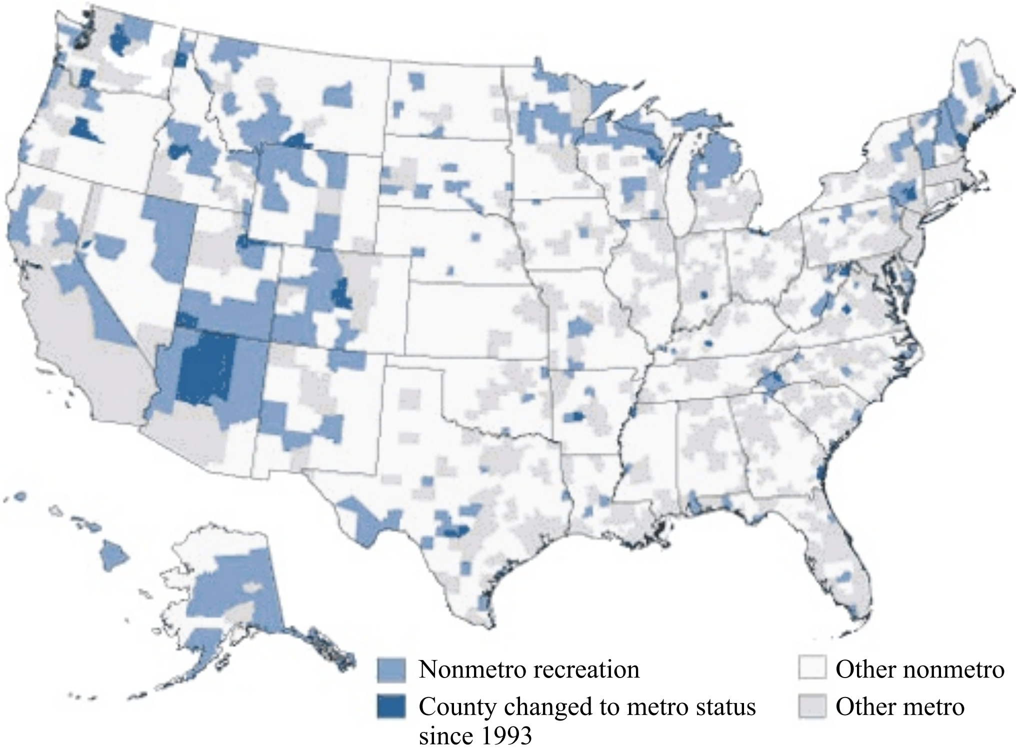
Prior to the last few years, counties where recreation or retirement communities provided much of the income for the local economy fared better than counties invested in extractive industries or agriculture (Figure 3). Unlike the latter two, employment in services has been increasing and population loss in non-metro recreation and retirement counties was substantially less than in agricultural and mining counties during the last two censuses. As the following map (Figure 4) shows, quite a few non-metro areas receive a substantial portion of their income from recreation activities.

Figure 3 – Employment Shares of Nonmetro Counties, by County Type, 1976-2005 (USDA ERS)



However, retirement communities taking advantage of temperate climates tend to locate in urban areas, not rural areas. Tourist economies are seasonal, and the jobs are often low wage. In areas of major tourist attractions, large hotels and tour companies capture a significant portion of the money spent by tourists. Thus, tourism and retirement services can't serve as an engine for rural economic growth in most rural areas.

Figure 4 – Nonmetro Recreation Counties (USDA ERS, 1999)



Minerals and Fossil Fuels

These are boom times for mineral extraction. Since 2000, prices of several crucial hydrocarbons and minerals have surged, as shown in Figure 5. But it is unclear how much this will translate into increased local economic activity and rural development. The vast majority of the nation's mineral wealth is either under land owned by the federal government or is already owned by companies who will continue mining and drilling. New finds are technically more challenging, requiring a high level of expertise that only the existing players have. There are few opportunities to enrich rural areas via the discovery of additional resources.

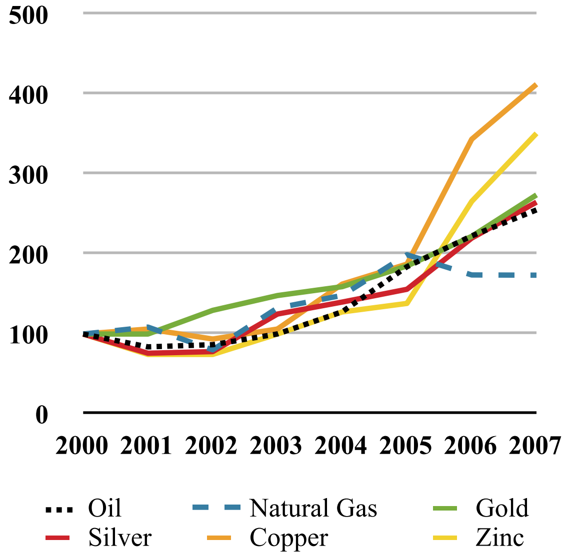
Moreover, mining and drilling jobs aren't spread evenly over rural areas. Three quarters of jobs in the oil and natural gas extraction industries are concentrated in just four states. Half of all mine employees (coal and minerals) are in just three states.[6]

Increased automation in the extractive industries also diminishes its impact on local and state economies even during the present boom times. Employment in these industries is forecast to continue to decline over the next ten years.[7]

We should note, however, that many manufacturing firms locate near their raw materials, so a decline in employment in natural resource extraction could be partially offset by an increase in resource-based manufacturing as overall production expands (e.g. steel mills near the taconite ores in northern Minnesota, flour mills near wheat regions, paper mills near forests).

A few lucky areas of the country are benefiting from the remarkable run-up in oil and natural gas prices and the development of new technologies that can economically recover more deposits. This combination has led to, at times, a dramatic increase in existing estimates of economically recoverable fuels. In North Dakota, for example, the U.S. Geological Survey recently increased its estimate of economically recoverable oil an astonishing 25 fold, to 4.3 billion barrels. A land rush has ensued as developers try to buy up the subsoil mineral rights from land owners.[8]

Figure 5 – Mineral Prices, 2000-2007 (2000 = 100)



A similar dynamic is occurring in Texas, Wyoming, and Pennsylvania. Sometimes the leases negotiated can significantly add to the wealth of a local community. Landowners who drive a hard bargain can increase the original offering by developers manyfold. For example, a small group of landowners in Texas collectively negotiated lease agreements with Chesapeake Energy that will result in their receiving a one-time $22,000 per acre with a 25% royalty. The original offer was $5,000 per acre offer and no royalty.[9]

Some states have imposed severance or depletion taxes on mineral extraction that generate significant revenues. In many cases, states funnel revenue back to those communities near where the resources are being extracted. One estimate concluded that if North Dakota's severance tax matched those in other states, the state could receive $1.4 billion per year, more than the entire state budget.[10]

Agriculture and Forestry

After decades of decline, soaring farm prices have recently lifted agricultural economies. For the first time in a generation, farmers are making a good living largely without federal support payments. While the price increases are sharp, figures 6 and 7 put the commodity price increases in perspective.[11] The first shows commodity prices in nominal dollars. The second shows

Figure 6
Nominal Commodity Prices 1960-2008
(Current dollars per bushel)

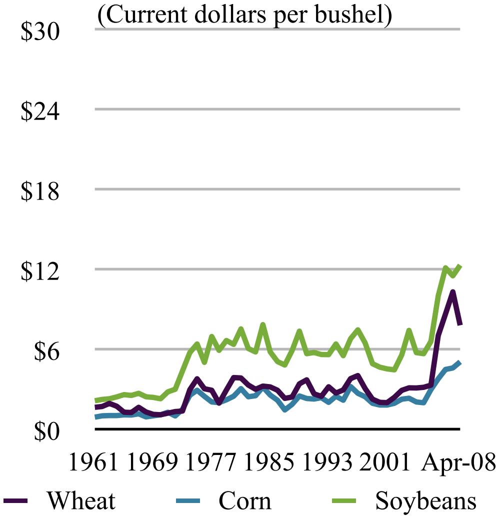
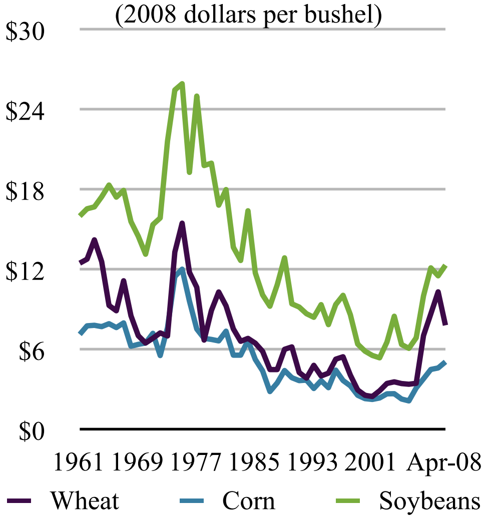


Figure 7
Real Commodity Prices 1960-2008
(2008 dollars per bushel)



commodity prices adjusted for inflation. While wheat, corn and soybeans have jumped in value, the price spikes are still lower than price peaks in the 1970s. The futures price of corn – over $7.00 per bushel in June 2008 – suggests that corn prices are, with one exception in the early 1970s, as high as they've been in 40 years. Agricultural states are experiencing localized booms as the increased wealth of farmers ripples through local and regional economies.

However, the price farmers are receiving for their crops is offset in part by the increased cost of growing and harvesting crops. Figures 8 and 9 show the sharp increase in input costs for corn and soybean farmers.[12] The price of fertilizers, both nitrogen and potash, have increased several fold in the last two years,[13] while the price of diesel fuel has doubled.

Land rents follow crop prices, and since about half of the land farmed is rented, rent increases reduces the net income of farmers. Cash rents for Iowa farmland jumped 9% from 2006 to 2007 and 18% in the last year alone.[14] At $7.00 per bushel corn (June 2008 Chicago Board of Trade price for July delivery), net income is outpacing input costs, but history indicates that farmers will respond to high prices by increasing output, driving prices back down.

Even as farming has become more profitable, mechanization has reduced its impact on the rural economy. Agricultural acreage has remained approximately the same for the last 40 years and production has soared, but employment has plummeted. Today, only 6.5% of the rural labor force works in agriculture.

Figure 8 – Negative Feedback: High Commodity Prices Eroded by Input and Land Costs

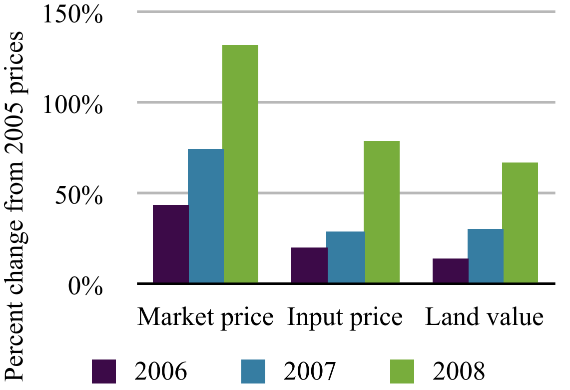
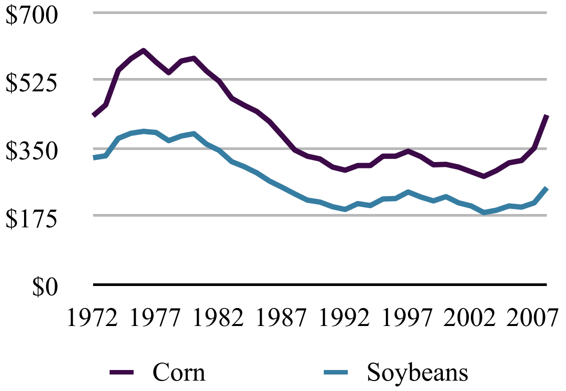


Figure 9 – Non-land Financial Costs (2008 dollars per acre)



Forestry is not seeing the same price boom as agriculture, with prices in early 2008 hitting five-year lows.[15] Furthermore, as the industry continues to compete with imports and mechanization increases, jobs in logging and forestry are forecast to decline by 10% over the next 10 years.[16]

The increased price of minerals may provide a short term, modest benefit to rural areas. The increased price of crops is in part a result of federal energy policy (i.e. the biofuels mandate) and its impact may last longer. For the present and future, however, rural America's major growth sector will clearly be renewable energy technologies. It is to this sector that we now turn our attention.

Rural Renewable Energy

This report focuses on the generation of energy from renewable resources in rural areas. We do so for a number of reasons.

1. The renewable energy industry is growing at an exponential rate and promises to do so for at least the next decade or two.
2. Renewable energy resources provide the opportunity for a more sustainable economic foundation for rural areas than do extractive industries or scenic resources. Renewable energy is a sustainable resource: it never runs out. Thus it is unlikely that communities depending on renewable energy will suffer the boom and bust cycle communities depending on mineral or fossil fuels.
3. The potential for renewable energy is vast. Renewable energy is widely available and thus could boost rural economies in most parts of the country. A fraction of rural America could generate several times more energy than is needed by the nation as a whole. By one estimate, 2,500 square miles of Nevada could generate 100 percent of U.S. electrical needs.[17] The state of North Dakota alone has wind energy potential sufficient to provide one-quarter of U.S. electricity demand.[18] Sufficient land area is available for non food crops to provide 50 percent of our transportation fuel.
4. Renewable energy can be harnessed in either centralized or decentralized fashion. However, the high cost, both political and economic, of transporting renewable fuels over long distances suggests that decentralized generation may be better. Solar energy might be greater in Nevada than in California, but the cost of transporting that electricity from Nevada to California significantly reduces the cost advantage. North Dakota has higher wind speeds than Illinois, but the cost of harnessing wind energy in the Dakotas and transmitting it to Illinois may exceed the cost advantages from the higher wind speeds.[19] Today's biorefineries are almost entirely based in the corn belt, but the next generation of biorefineries will rely on cellulosic feedstocks that can be grown in most parts of the nation (see Figure 13).
5. Renewable energy can be harvested and used locally or regionally, therefore keeping more dollars in the local and regional economy. Renewable energy collection has very few economies of scale. Modest sized generators supplying local markets can compete well with large generators supplying distant markets.
6. Modestly scaled renewable energy enables local ownership. Local ownership multiplies the benefit renewable energy brings to rural communities. For example, a landowner who leases land for wind generation makes one-tenth as much as a landowner who owns the wind turbine.

Rapidly rising fossil fuel prices make renewable energy increasingly competitive. The primacy of rural areas in the feedstocks of renewable energy (wind, solar, and biomass) make them the prime location for the power plants and biorefineries of the renewable energy revolution. In most areas of the country, economic development planners will include a serious analysis of the potential for renewable energy. Future climate change policy is making this more and more important.

Solar

Solar energy falls on almost two-thirds of the continental U.S. in sufficient quantity to support electricity generation. At present almost 90 percent of harvested solar energy is gathered in a highly decentralized fashion, primarily on building rooftops. Direct sunlight can be used in rural areas to reduce operating expenses (e.g. crop drying, hot water heating, battery charging) but it is likely that decentralized solar energy will impact urban and metropolitan economies more than rural economies.

However, a number of companies are commercializing large, centralized concentrating solar power plants like Nevada's Solar One parabolic trough generator. Indeed, it is likely that by 2012 concentrated solar power plants will be generating more electricity than all of the rooftop arrays installed prior to that date in the United States. Some of the proposed concentrating solar power plants are as large as conventional fossil fuel power plants (e.g. 800 MW).

Outside of further technological advances, centralized solar could prove economically beneficial to rural areas in only a handful of states.

Figure 10 – Rural Areas Have Substantial Solar Resources (NREL, 1990)

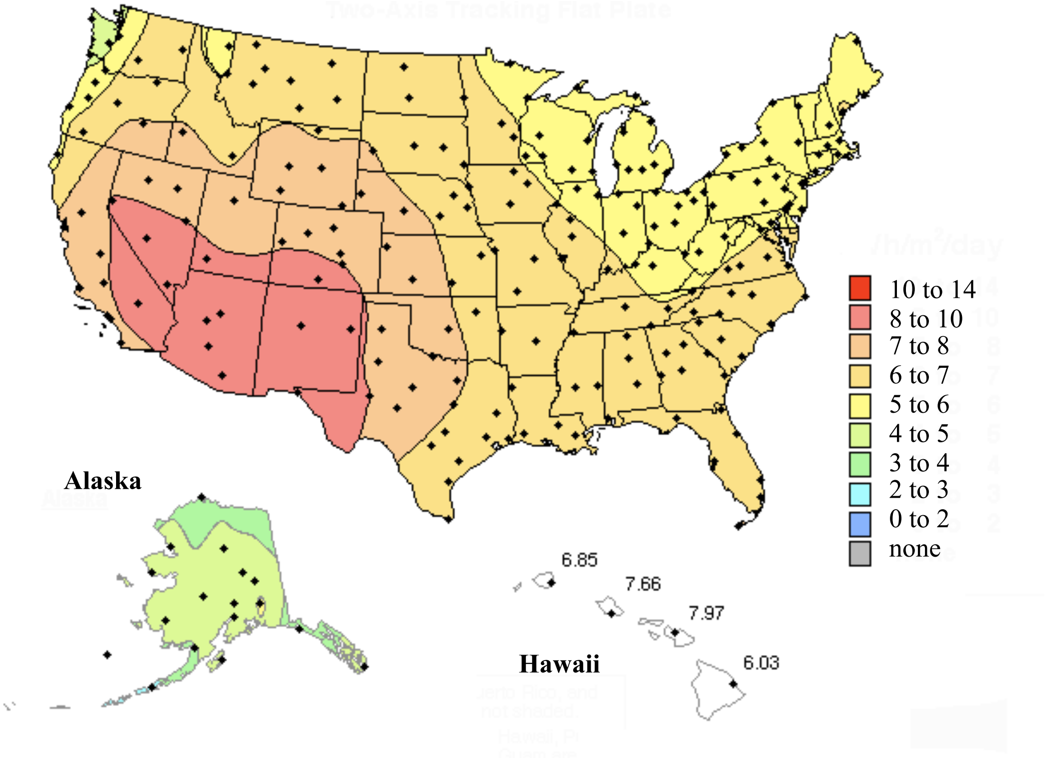


Figure 10 shows that twice as much solar energy is available annually in the Southwest as in other parts of the nation.[20]

The comparative advantage of the Southwest in solar energy is already causing a land rush. The federal Bureau of Land Management is swamped with applications to use nearly 1 million acres of public land for solar projects.[21] Opposition is beginning to form regarding the possible economic and environmental impact of such plants.
If solar power is developed narrowly in only one region of the country, the economic benefits will not be as widespread, and significant investments will be required in long-distance, high voltage transmission lines to bring the power to urban areas.

Wind

Wind energy can also be harnessed in centralized or decentralized fashion. Both will occur largely in rural areas, given the area needed for multiple wind turbines,[22] the advantages of locating in areas of higher wind speeds,[23] and the need to have setbacks from buildings and property lines. The following table and map illustrate the vast wind resource across the United States already being tapped, and how much more is available.

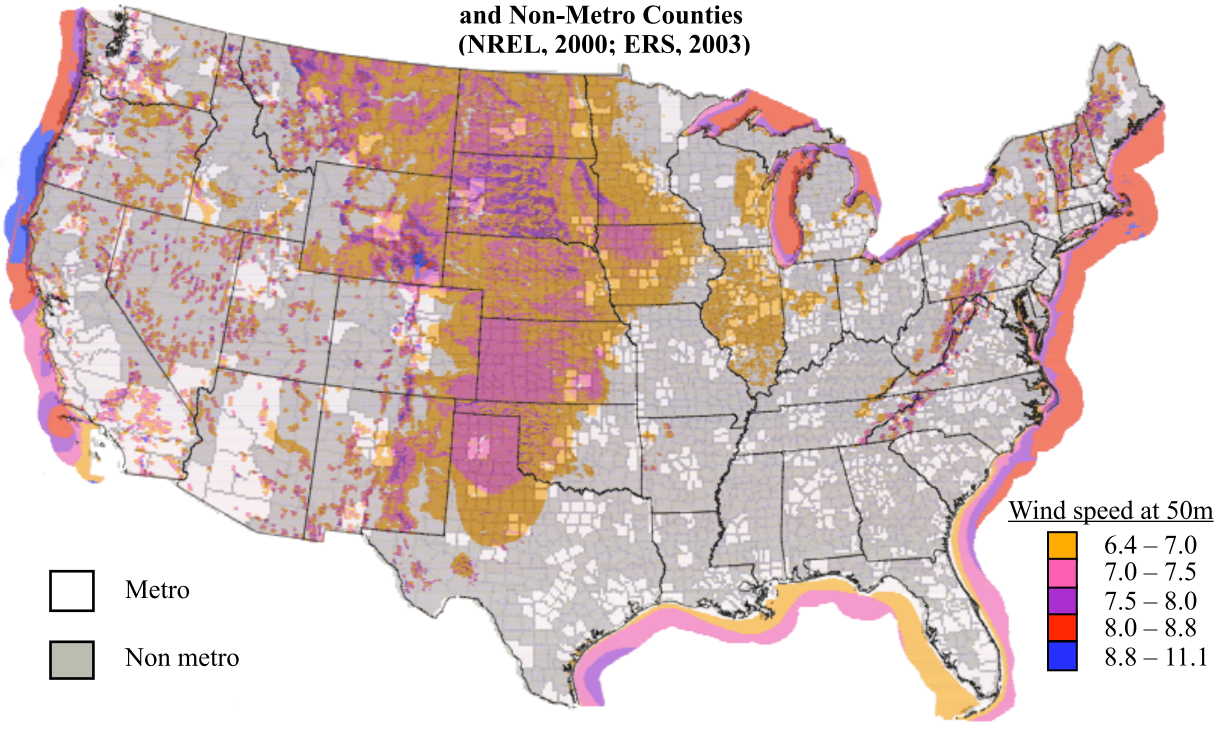
The wind speed map is already somewhat dated, as the 50-meter measurements are shorter than the typical modern turbines that often exceed 80 meters. At 80 meters there will be much more land area suitable for economically attractive wind development.

Table 2 – Top 10 States in Wind Power Capacity

State	Existing (MW)	Under Construction (MW)
Texas	5,317	1,997
California	2,484	290
Minnesota	1,300	46
Iowa	1,295	549
Washington	1,195	94
Colorado	1,067	0
Oregon	888	202
Illinois	736	171
Oklahoma	689	0
New Mexico	496	0

(AWEA, 3/31/2008)

Figure 11 – U.S. Wind Power Potential in Metro and Non-Metro Counties (NREL, 2000; ERS, 2003)



Biomass

Like wind and solar, biomass can also be centralized or decentralized, but only in rural areas can it be grown in the quantity required for energy generation. And given the bulky nature of crops, the biomass will usually be processed near where it is grown. For example, most ethanol production takes place in the Midwest, near the Corn Belt. Biomass used for heat, such as wood pellets, is typically pelletized or densified prior to marketing. In the near future, ethanol and heating fuel from biomass will be produced from other cellulosic feedstock, which will be more widely available. Figure 12 illustrates the rural areas with abundant biomass resources at present. Figure 13 shows how these could increase by 2025, as farmers increase the production of energy crops and technology expands the range of biomass that can be used for energy generation.[24]

Figure 12 – Many Rural Areas Have Abundant Biomass
(Biomass per km² – NREL, 2005)

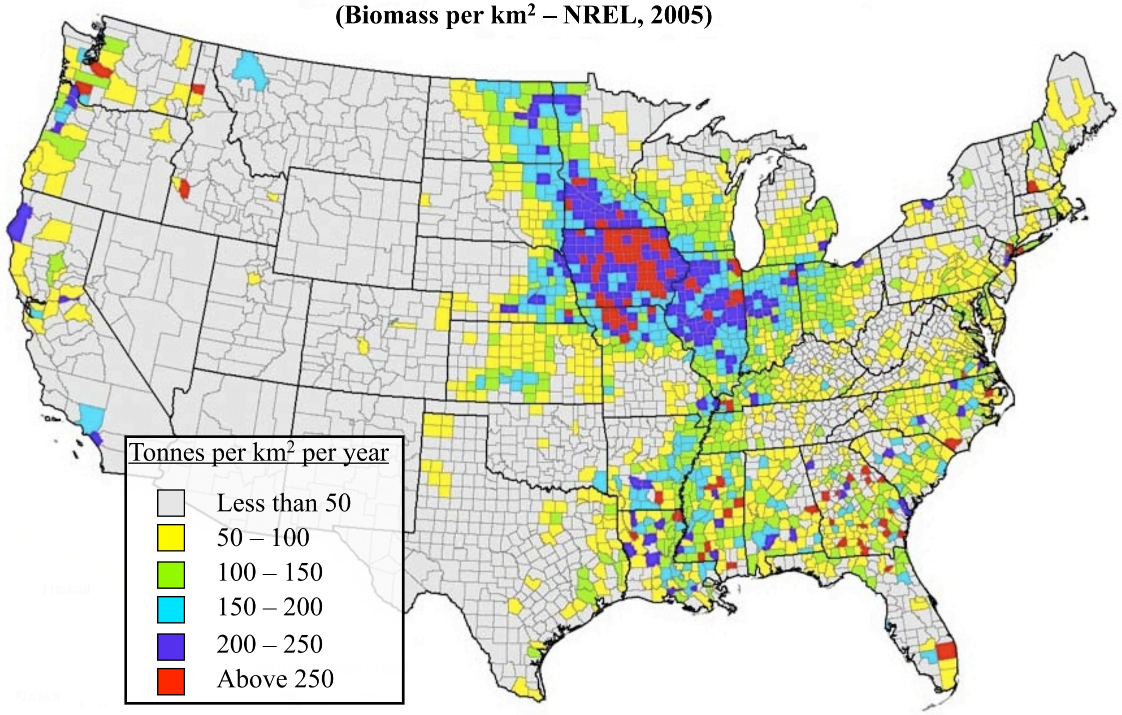
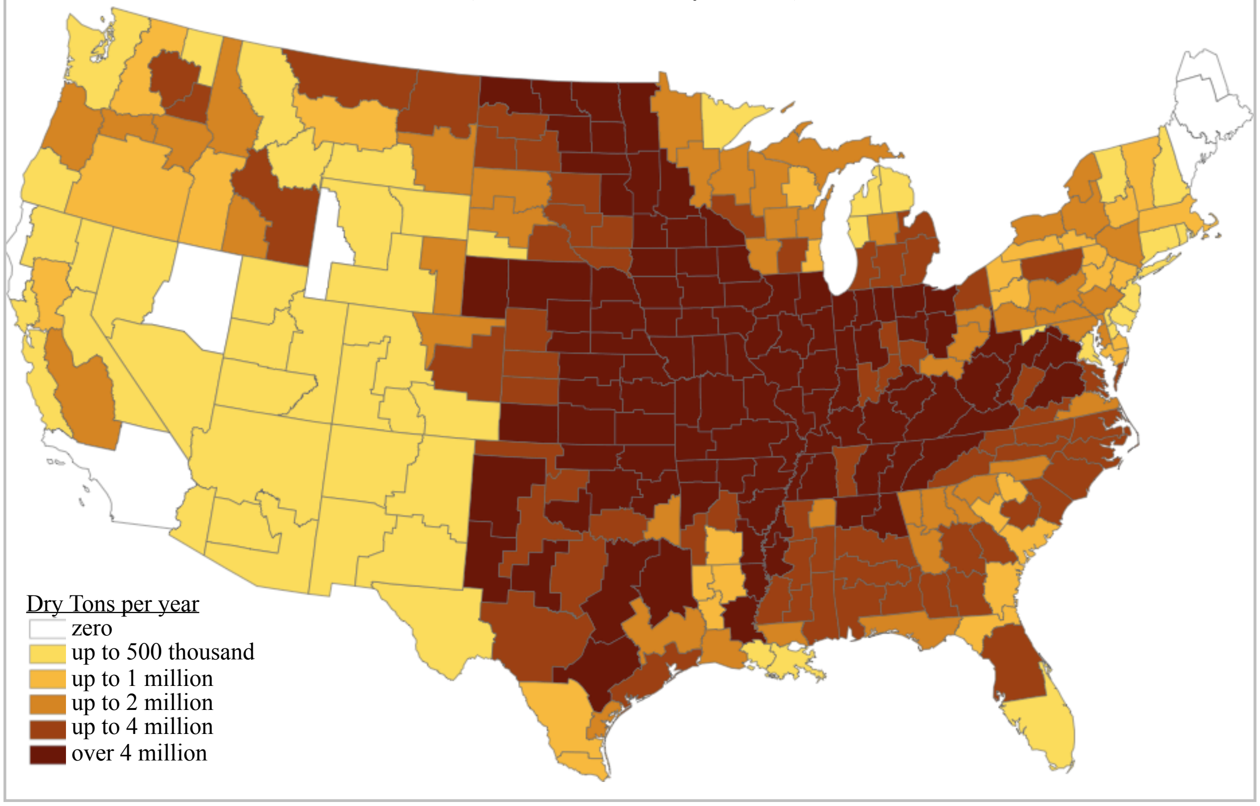


Figure 13 – Rural Biomass Resources Will Grow
(Biomass Availability in 2025)



Rural Development and Energy Policy

The renewable energy business is booming. Production of wind energy and ethanol has tripled in the past five years and promises to double again in the next two. Demand for corn for ethanol in 2006 accomplished what a generation of federal farm policy could not – a market price above the cost of production for corn farmers. In 2007, the price increases spilled over into other commodities, as well.

But the nature and duration of the renewable energy boom on rural and agricultural life will depend heavily on the nature of the energy revolution and the structure of future energy industries.

Consider the case of ethanol. By the late 1990s the ethanol industry was largely comprised of modest-sized farmer owned biorefineries. As late as 2002, the vast majority of new ethanol plants were majority-farmer-owned. These plants generated significantly more economic benefit for the community.

Farmer-owned ethanol plants also served as hedges against falling corn prices. If the price of corn went down, the cost inputs of ethanol declined and, all other things being equal, the profits of the ethanol plant increased. That meant the dividend would make up a significant part of the farmer's reduced income from selling corn. And in times of very high corn prices, farmers might be willing to accept less for their corn from their ethanol plant in order to make their cooperative ethanol enterprise more competitive.

However, after 2005 the ethanol industry structure dramatically shifted from local ownership to absentee ownership and from smaller plants serving local markets to large plants serving distant markets. Thus, the close relationship between community and manufacturing facility was severed and the percentage of the dollar that stayed in the local community dropped significantly. More information on the impact of local ownership is presented in a later section.

A similar dynamic holds true for wind energy. Farmers can earn a few thousand dollars a year per turbine by leasing their land to developers. Or they can earn ten times that amount by becoming owners of the turbines. Smaller wind farms can serve local markets. Very large wind farms will serve distant markets.

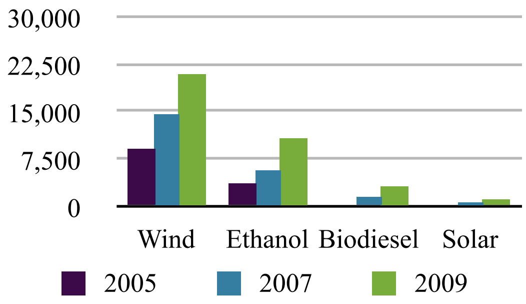
The future of rural development depends on how landowners and local residents are able to participate in their community's energy development. Will they simply observe the pursuit of more renewable energy or have an ownership stake in a better way?

Renewable Energy is Growing

Investment in rural renewable energy isn't new, but the confluence of popular interest in low-carbon and renewable energy with Wall Street investment has produced a sudden surge of development.

Production of renewable energy has increased exponentially in the past five years, rapidly expanding across vast swaths of rural America. Wind farms have sprung up from Minnesota to Texas and ethanol plants have dotted the Corn Belt from Nebraska to the Dakotas. Ethanol production has tripled in the past five years and is expected to double again by 2009 to 13 billion gallons. Wind production capacity has also tripled in the past five years to almost 13,000 MW, with planned projects likely to expand capacity to over 21,000 MW by 2009. Even though the total production of renewable energy, whether wind or ethanol, is still dwarfed by fossil fuel energy production, the scale of investment is substantial and ramping up.

Figure 14 – U.S. Renewable Energy Production Capacity (megawatts or million gallons)



From 2002-07, renewable energy investors spent $16 billion on new ethanol and wind facilities and received over $10 billion in federal incentives for renewable energy produced. States and the federal government are lending impetus to the building spree with renewable energy mandates for fuels and electricity. The federal government recently adopted an ambitious goal of 36 billion gallons of ethanol by 2022, more than half coming from cellulosic ethanol – ethanol from non-food plant material. More than 80 percent of the ethanol mandate will be fulfilled by cellulosic ethanol after 2010. Twenty-seven states have adopted renewable electricity mandates (also known as renewable portfolio standards). A national mandate is also under consideration.

The increasing focus on policies to address climate change will only add to interest in renewable energy. With either a carbon tax or carbon cap, low- or no-carbon energy technologies will sharply increase in relative value to fossil fuel energy sources. Biomass, wind, and solar power will continue to be crucial components of renewable and low-carbon energy policy. Rural America stands to benefit from future climate change policy, but only if that policy is designed to increase the focus on decentralized renewable energy production.

Renewable Energy is Rural

Renewable fuel mandates, production incentives, and carbon caps would have a substantial economic impact on rural communities, because that's where the energy would be produced. The Midwest continues to dominate renewable energy production from wind and ethanol, but more and more states are boasting wind farms and, with the advent of cellulosic ethanol, most states will have sufficient feedstock to host a biorefinery. Figure 15 shows the location of existing (black) and proposed (red/gray) wind projects across the United States.

Figure 16 illustrates the location of existing (black) and proposed ethanol plants (red or gray) by size and location. Green facilities (circles) are proposed cellulosic ethanol plants. The cellulosic ethanol plants are much more widespread than corn ethanol plants, reflecting the broader availability of biomass feedstock.

Figure 15 – U.S. Wind Power Projects (announced projects in red/gray)

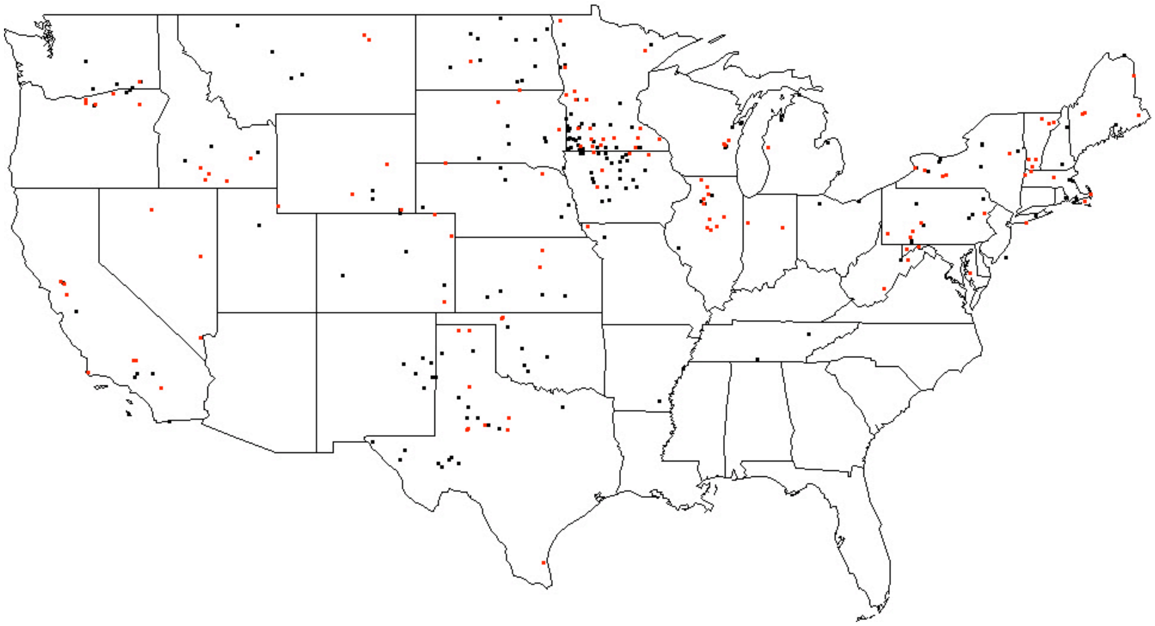
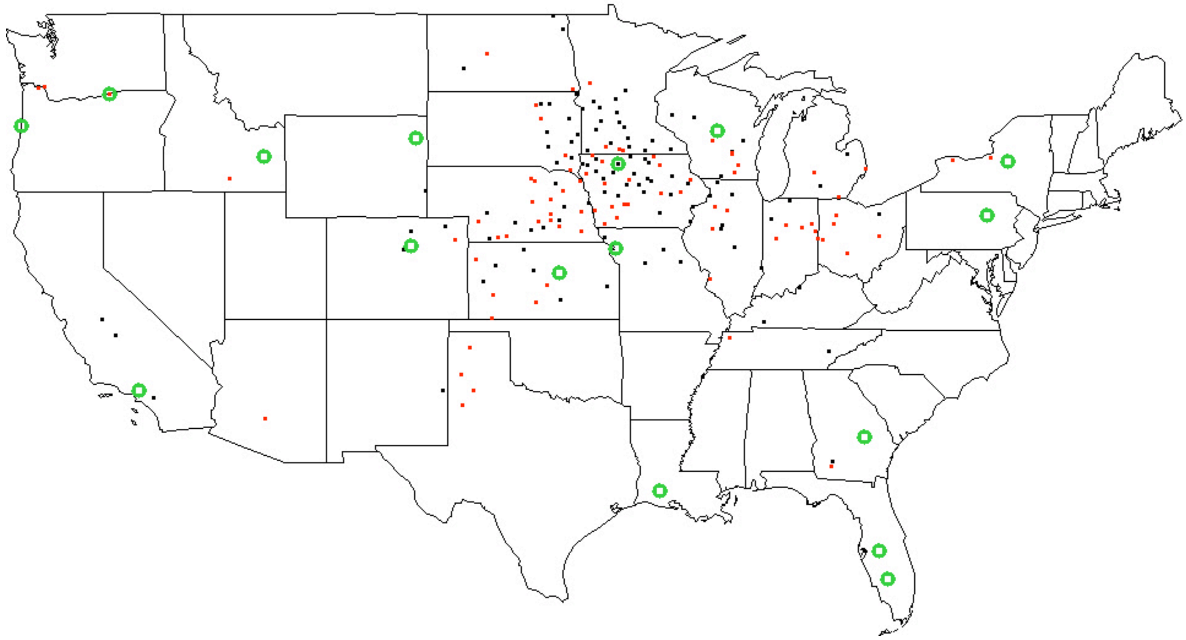


Figure 16 – U.S. Ethanol Plants (announced plants in red or green)

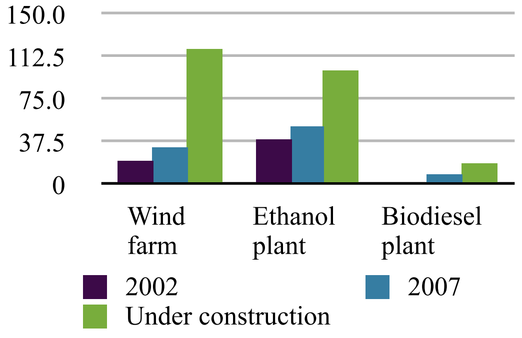


While the greatest benefits from renewable energy development in rural areas come from locally owned projects, typical state and federal policies focus almost entirely on the quantity of renewable energy. On ethanol, the federal biofuels mandate requires 36 billion gallons by 2022 and the $0.45 per gallon tax credit ($1.01 for cellulosic) provides a substantial financial incentive. For wind power, 27 states have renewable electricity portfolio standards or goals to complement the federal production tax credit of 2.0 cents per kilowatt-hour (kWh) produced.

The dramatic increase in renewable energy production has been accompanied by an equally dramatic change in the industries' structure from modest-sized production units that were largely locally owned to very large production units that are absentee owned and from facilities that serve local and regional markets to those serving national markets (Figure 17).

The average size of a wind farm has increased from less than 20 MW in 2002 to over 120 MW for projects under construction in 2008. Ethanol plants have similarly scaled up, with average plant sizes of 33 million gallons in 2002 and 100 million gallons for proposed plants. To meet the burgeoning demand, investors are continually pressing for larger and larger facilities in search of greater efficiency and economies of scale, an issue we will discuss in greater detail later in this paper.

Figure 17 – Average Production Facility Size (megawatts or million gallons)



Will Renewable Technology Benefit Rural Communities?

New technology promises to improve the cost effectiveness of renewable energy and change the way it's produced. But it's not clear if new technology will simply enable more renewable energy production or also enhance the ability of communities to benefit from their local renewable resources.

Wind

New technologies have helped reduce wind power's operating costs, increase its output, and increase the size of individual turbines. As utility-scale turbines have become standard, average wind farm sizes have also increased. Technological developments, such as higher towers, can dramatically increase the percentage of the country that could economically harvest wind energy. Figures 18 and 19 show how a 20 meter increase in tower height dramatically increases the portion of one state, Minnesota, with wind speeds in excess of 6.4 meters/second – the minimum speed required to be shown on the earlier U.S. wind map.[25] From less than 20% of the state, economical wind turbines could now be located in over 50% of the state.

Research time and money is being spent to improve smaller turbine efficiency and to improve performance in low wind speeds. Researchers at the National Renewable Energy Laboratory are focusing on developing inexpensive taller towers, more efficient generators, and larger, lighter turbine rotors to catch more of the available wind. Independent groups are working on new blade designs in hopes of increasing the ability of wind turbines to extract energy from low speed winds. The impact of higher efficiency turbines at low wind speeds could prove more important than increases in tower height, if more wind can be captured without the increased cost of a taller tower. These efficiency innovations could help restore competitive balance between the established mega-developers and the average rural farmer or entrepreneur, by opening up more land to wind power development.

Finally, as wind power continues to expand across the country, the availability and quality of service and maintenance will improve, reducing the economies of scale for large projects.

Figure 18 – Wind Speed at 50 meters

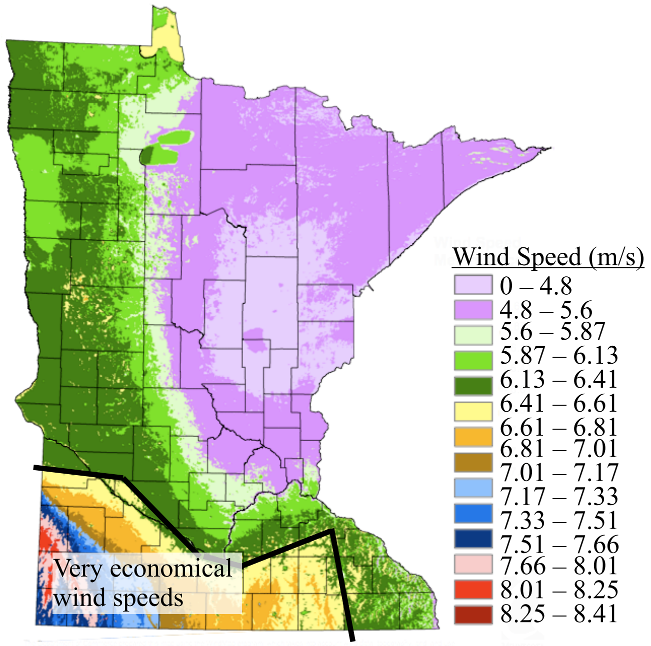
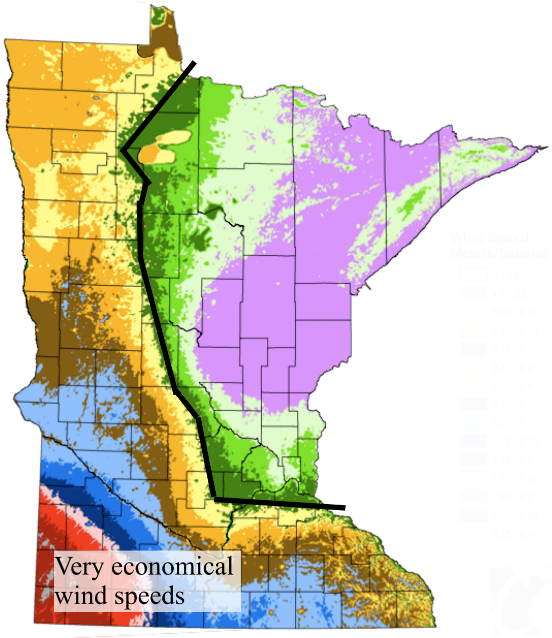


Figure 19 – Wind Speed at 70 meters



Corn Ethanol

For ethanol, technology advances may decrease costs and change the way a plant produces fuel. It's unclear how technology might impact the economies of scale or if it will change the trend away from local ownership, since the corn ethanol boom may have run its course.

Still, a few technologies may improve the economies of corn ethanol. Fractionation technology is the most market-ready, having already been installed in several ethanol plants operated by the company POET. Fractionation involves the separation of the kernel into its component parts – endosperm (starch), enhanced distillers grains, germ, and fiber.

The value of the fractionation process depends heavily on the plant's intended use of the new co-products. At a minimum, the separated fiber can be burned to displace natural gas or coal. Estimates suggest that burning corn bran could replace 20% of a plant's natural gas, for savings of around 11 cents per gallon when natural gas prices are near $11 per million Btu.[26]

Capital costs are relatively low. A new 125 million gallon plant by POET will cost $1.60 per gallon of capacity, only ten cents per gallon more than the run-of-the-mill plant in 2002.[27] Retrofitting an existing plant would cost 3-5 cents per gallon in financing costs over 10 years. Payback times vary from 2-5 years.

Other technologies, such as special membranes or evaporators, promise dramatic cost reductions in distillation by making water separation significantly more cost effective and efficient. Additionally, some producers are looking at saving on energy costs by substituting biomass for natural gas. Gasifiers operating on inexpensive wood chips or other types of biomass provide thermal energy for distillation, while other plants are investigating anaerobic digesters to turn distiller's grains into methane. Replacing natural gas with biomass derived fuel could save a plant 30 cents per gallon, equivalent to an 80 cents per bushel drop in the price of corn.

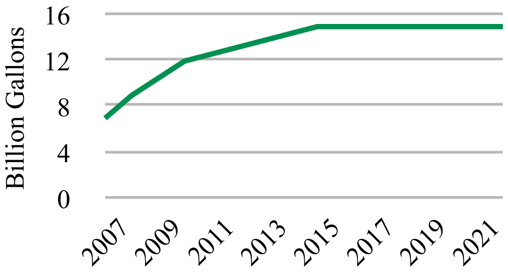
These recent technological improvements in ethanol production could potentially serve any size ethanol plant, but in the short term they may benefit smaller, locally owned plants whose capital debt has been retired. In the long run, it's not clear how improvements in corn ethanol production will change choices about the size of facilities.

Despite advances like fractionation, the era of corn ethanol is ending. As *Energy Producer Magazine*, the leading publication of the ethanol industry, reported in June 2008, "The latest corn-fed plant to break ground was Clean Burn Fuels in Raeford, N.C., in January. Will this be the last corn-based ethanol plant to break ground? Some in the industry think it's likely. 'That's probably it until the cellulosic plants start coming,' said one project coordinator."[28]

Cellulosic ethanol

Three factors have ushered in the end of the corn ethanol era. One is the 2007 Energy Bill, which mandated 36 billion gallons of biofuels by 2022, but established a cap for corn ethanol of 15 billion gallons. As of June 2008, corn ethanol plant construction underway would deliver about 14 billion gallons of ethanol by the end of 2009. This means that some 97 percent of the additional biofuels produced after 2010 will come from non food crops and an increasing percentage will come from cellulosic feedstocks.

Figure 20 – Mandated Corn Derived Ethanol



The second factor is the soaring price of corn, hovering around $6.75 per bushel in mid July 2008, double the price six months earlier. As a result, for new plants ethanol has become less competitive with gasoline, despite the similar hike in crude oil prices. Part of the reason behind increased corn prices is the increased cost of production, a result of higher diesel prices and fertilizer prices and land rental prices. Another factor behind the soaring price is speculation, with many large institutional investors adding commodities to their portfolios.

The third factor is the rapid increase in the use of corn for ethanol, which has significantly contributed to the increased price of corn. In 2007, the National Corn Growers Association had advocated for the 15 billion gallon corn ethanol mandate by noting that if increases in historical corn yields continued into the future, as they are expected to, the percentage of corn used for fuel in 2015, the end point of the corn ethanol mandate, would not be much higher than the percentage used for that purpose in 2007.[29]

However, as noted above, ethanol production has increased at an unprecedented rate and will nearly reach the 15 billion gallon level five years early. That spike has led biofuels to require, as of the end of 2008, 30-35 percent of the corn crop and that demand has contributed to the rise in corn prices.

As a result of the limitations of corn-based fuels, the cellulosic ethanol era is approaching. But there will be little commercial cellulosic ethanol production until 2010 and no significant quantities until 2012-2013. In the period 2010-2012 we will likely see only a few hundred million gallons produced. In effect, we have entered into a parenthesis in history: the end of the corn ethanol era, but not yet the beginning of the cellulosic ethanol era. This provides an opening to establish new rules for advanced biofuels that truly benefit rural communities.

The cellulosic ethanol mandate is an unprecedented federal action in peacetime. Congress has mandated the production of a huge amount of a product from an industry that does not yet exist and from feedstock supplies that largely don't exist either, at least in terms of being collected and processed for ethanol. To achieve the goals, the federal government has introduced an equally unprecedented array of incentives. These include direct grants for new plants, comprising 35-60 percent of the cost of the facilities; guaranteed loans; a mandated market; and a $1.01 per gallon tax credit, more than double the $0.45 per gallon corn ethanol tax credit.[30]

In 2006, U.S. DOE awarded $385 million to six commercial scale cellulosic ethanol projects. In 2008, it awarded grants of $114 million to four smaller demonstration projects and provided more funding for specific technology developments in mid 2008.

The new farm bill passed in May 2008 provides direct assistance to farmers planting biomass energy crops.[31] These do not include commercial crops like corn and soybeans. The program pays producers up to up to 75% of costs for establishing and planting crops, plus annual payments (amounts to be determined) to help compensate for lost opportunity costs until crops are established. The program also provides cost-share payments for collection, harvesting, storage, and transportation costs at a rate to match the biomass sale price, up to $45 per dry ton. This program is funded with uncapped mandatory funding; however, Congress estimates that it will cost approximately $70 million over five years, a pittance compared to the tens of billions in farm programs. That might provide sufficient funding for the establishment of 550,000 acres of switchgrass, which could in turn produce some 150 million gallons of ethanol by 2012.[32]

The federal investments are intended to help mature at least two significant technologies for producing cellulosic ethanol: enzymes and gasification. Enzymatic ethanol from cellulose uses enzymes to break down the cellulose in plant fibers and expose the sugars. Sugars are then converted to ethanol. Pilot projects will be testing the efficacy of existing enzymes and developing more effective ones to improve conversion rates and lower costs.

Gasification promises to simplify cellulosic ethanol production by using high temperature, oxygen-deprived boilers to turn cellulose into a synthetic gas that can be separated into ethanol and other high value products. The major advantage to gasification is that feedstocks don't need as much pre-processing and the production can be continuous flow, instead of batch by batch. However, gasification processes also use expensive catalysts that similarly need research investment to become cheaper and more efficient.

The first commercial scale cellulosic ethanol plants will not be operational until 2010. Figure 21 shows the mandated levels of renewable transportation fuel, including corn ethanol and non-food crop based biofuels.

Figure 21 – Renewable Transportation Fuel Mandate, 2007-2022

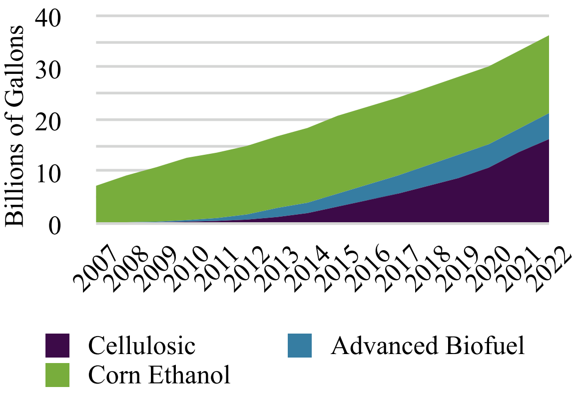


Table 3 displays the list of commercial cellulosic ethanol ethanol plants expected to be in service by 2011. Table 4 lists the additional, pilot-scale facilities anticipated in the next two years.

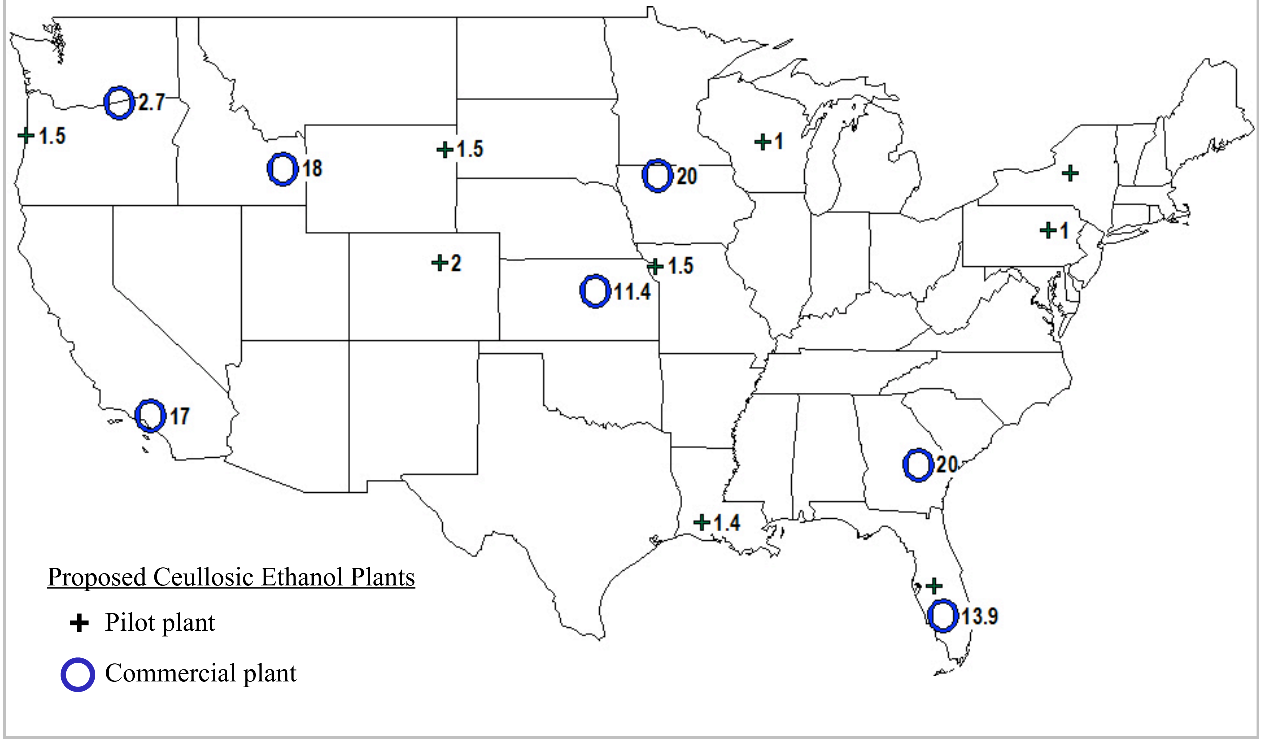
Table 3 – Proposed Commercial Cellulosic Ethanol Plants (expected online by 2011)

Owner	Location	Capacity (million gallons)	Feedstock
Pacific Ethanol	Boardman, OR	2.7	Wheat straw, corn stover, poplar tree residuals
Blue Fire	Corona, CA	17	Municipal solid waste
Iogen	Shelley, ID	18	Wheat straw
POET	Emmetsburg, IA	20	Corn cobs, corn stover (add-on to existing corn ethanol plant)
Range Fuels	Soperton, GA	20	Wood waste
Abengoa	Hugoton, KS	11.4	Wheat straw, corn stover, milo stubble, switchgrass, others
ALICO, Inc.	LaBelle, FL	13.9	Yard, wood, and vegetative wastes; sugar cane

Table 4 – Proposed Demonstration Cellulosic Ethanol Plants (online by 2009)

Owner	Location	Capacity (million gallons)	Feedstock	Output
Lignol	Commerce City, CO	2	Hard and soft wood residues	Ethanol, furfural, lignin
ICM	St. Joseph, MO	1.5	Corn fiber, switchgrass, forage sorghum, corn stover	Ethanol
Stora Enso North America	Wisconsin Rapids, WI	1	Wood waste	Ethanol
Verenium	Jennings, LA	1.4	Bagasse	Ethanol
Mascoma	Rome, NY	?	Wood waste	Ethanol
Coskata Inc	Madison, PA	1	Wood waste	Ethanol
Western Biomass	Upton, WY	1.5	Wood waste	Ethanol
Zeachem	Oregon	1.5	Wood waste	Ethyl acetate, ethanol
Losonoco	Bartow, FL	?	Yard waste, citrus residues, sugar bagasse	Ethanol

Figure 22 – Proposed Commercial and Demonstration Cellulosic Ethanol Plants (capacity in million gallons)



As can be seen from the list of feedstocks and locations of proposed plants, there are many potential feedstocks and advanced biorefineries will be located in all parts of the country. The cellulosic industry will be inherently more decentralized than corn-based ethanol production.

The first feedstocks will be the least expensive and most readily available. These include wood wastes, straw, corn cobs and agricultural residues. The quantities of these feedstocks are sufficient to provide more than 10 billion gallons of cellulosic ethanol, possibly a great deal more. Dedicated energy crops can provide substantially more, but these will have to be cultivated. Fast growing trees are optimally harvested after 5-7 years in good locations. Switchgrass is harvested two years after an initial planting. A number of companies are developing new sweet sorghum varieties, including a high sugar sorghum for making ethanol. Thus we can expect that new energy crops would provide a significant contribution to cellulosic ethanol only after 2015 or so.

The ability of cellulosic ethanol to be produced in many parts of the country means that it could be produced nearer final markets. Rising oil prices translate into rising transportation costs, especially for truck delivered products, reinforcing the economics of regionalizing the liquid fuel supply. The production of 21 billion gallons of biofuels could require upwards of 500 new biorefineries. That in turn could have a profound impact on local and regional economies.

A study by the non profit group, BIOWA, concluded that 10 new cellulosic biorefineries in Iowa alone would create 22,000 new jobs and yield $11.6 billion in economic impact a year. The Executive Director of the Biotechnology Industry Organization, Brent Erickson, has estimated that roughly 1.5% of US GDP will be required to build out the infrastructure for this industry, the equivalent of $135 billion.

The economies of scale of cellulosic ethanol plants are probably similar to those for corn ethanol plants, although the transport of cellulosic material will be more expensive than the transport of corn, and high oil prices will increase the cost of transporting both feedstock and the final product (see below). That in turn could lead to more biorefineries and more localized and regionalized markets for the fuel.

With gasoline and corn prices soaring, cellulosic ethanol also looks increasingly economical. With corn at $7.00 per bushel and ethanol selling for $2.88 a gallon, a corn ethanol plant has a pre-tax loss of around 7 cents per gallon. The following table shows how cellulosic ethanol plants – based on the best publicly available data – should be more profitable. The assumptions include a feedstock price of $70 per ton (delivered), a capital cost of $4.50 per gallon of capacity, and no sales of co-products.

Table 5 – Economics of Enzymatic Cellulosic Ethanol Production

	$ per gallon
EXPENSES	
Cellulosic feedstock (e.g. switchgrass)	-$1.00
Production Expenses (labor, maintenance, etc)	-$1.21
REVENUES	
Ethanol rack price (includes 45 cent federal incentive)	$2.88
Additional federal incentive for cellulosic ethanol	$0.56
Pre-tax profit per gallon	**$1.23**

The byproduct of converting corn into ethanol by dry mills, today's predominant ethanol production technology, is a high protein animal feed called distillers grains. When converting cellulose to ethanol, one byproduct is lignin, which can be made into higher value chemicals. Several proposed biorefineries are planning to gasify the cellulose rather than use enzymes to break the cellulose down into sugars. Gasification can provide a stream of chemicals that can find various high value markets. Thus, gasification becomes similar to oil refineries or the product mix can be altered as market prices change.

As noted previously, until 2002 most ethanol refineries were majority farmer owned. By 2007 over 80 percent of all proposed corn ethanol plants were absentee owned. The scale of cellulosic ethanol production facilities, at least in the first few years, will be similar to the scale of corn ethanol plants pre-2005 (less than 40 million gallons). This will enable the majority of these plants to be locally or cooperatively owned. However, if wood wastes are the primary feedstock, the raw material for the plant will no longer be supplied by traditional farmers, eliminating an organic connection between the producer/investor and the facility. If agricultural residues or new energy crops are the primary feedstocks, the potential for farmer ownership increases.

In a significant oversight, Congress has not designed any of its incentives to favor either smaller scale cellulosic ethanol refineries or local ownership.[33] It could. For more on incentives for better renewable energy, see our report *Energizing Rural America.*[34]

Biomass

Federal incentives only apply to the conversion of biomass to electricity or liquid transportation fuels. There is no incentive for their conversion into heat or into chemicals. This is regrettable because it encourages the use of biomass for lower value and less efficient markets.

For example, biomass electric generators operate at an efficiency of 20-25 percent, although efficiencies can be much higher if the waste heat is used, while biomass used for heat can operate at efficiencies of up to 85 percent.

A study of heating options in Ontario found that warm season grasses (e.g. switchgrass) and wheat straw were both cheaper than natural gas per Btu delivered, and about half the cost of heating oil, even without subsidies.[35] The challenge for biomass is product delivery, an area where North America lags far behind Europe because of a greater European commitment to heating buildings with biomass.

Both biomass pelletization and biomass briquetting, combined with more efficient stove designs, promise to make biomass more convenient to handle and deliver to commercial and residential users, and could make biomass competitive with all fossil fuels as a source of building heat.

Solar

Technology is already changing solar power. Until recently, nearly all solar power harnessed in the United States was from decentralized rooftops or off-grid farm lots. But in 2007, the first commercial concentrating solar power plant started operating in the Nevada desert, using parabolic mirrors to concentrate sunlight for heat, and generating power with a steam turbine. Concentrating solar power brings the traditional electric utility's central generating station paradigm to solar because concentrating solar plants mimic their fossil fuel cousins – they're large-scale, placed in remote areas, and send their power to urban areas with the help of high voltage transmission lines.

Based on current growth rates of on-grid solar photovoltaics and the list of contracted concentrating solar power plants in the United States, it will only be three years before concentrating solar power provides more capacity than the thousands of photovoltaic panels across the country.[36] Unlike solar panels and without any efforts to scale down the technology, concentrating solar power will be almost entirely absentee owned, built by large institutional investors or electric utilities.

Summary

The inevitable and rapid growth of renewable energy production promises to bring significant change to rural areas and the business of agriculture. However, the trend toward ever-larger production facilities may leave farmers as the observers of the rural energy revolution and local economies without significant economic development impact. To paraphrase a saying, "more" is inevitable, "better" is optional.

The next two sections explore how renewable energy can be harnessed in a way that bolsters rural economies. The first section explores local ownership of renewable energy, its dependence on reasonable scale, and the significant benefits it provides for host communities. The next section explores diseconomies of scale – why bigger is not always better. As it turns out, the benefits of building big (in terms of unit cost) are rather small. The benefits of building small, on the other hand, are quite large.

The Impact of Local Ownership

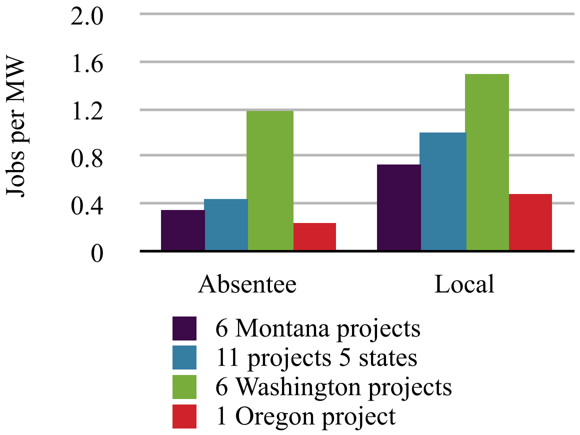
Local ownership generates many qualitative and quantitative benefits. It reduces potential opposition to renewable energy development by creating a physical and financial relationship to the project. Wind turbines that might be considered unsightly if absentee owned look quite appealing when owned by the people near the turbines. Local ownership benefits regional and local economies more than absentee ownership. Local ownership helps farmers diversify their businesses and hedge against commodity price fluctuation. And local ownership builds community, by creating a class of people who are invested financially and emotionally in its success.

Wind: Community Benefits

Several studies have investigated the difference between local- and absentee owned wind turbines and all have found substantial increases in net economic benefits when turbines are locally owned, both in jobs and in total economic output.

The first benefit of local ownership is a substantial increase in employment. As seen in Figure 23, most economic models found that nearly twice as many local jobs – in financing, maintenance, etc. – were created when turbines were locally owned than when they were controlled by an absentee owner.[37]

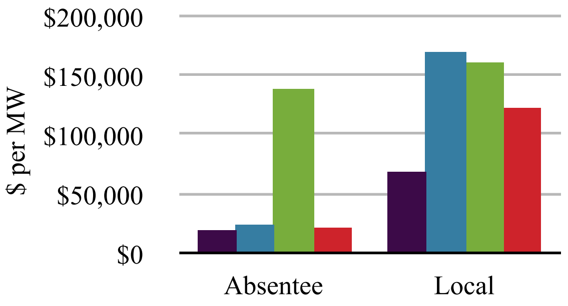
Figure 23 – Employment Impact of Absentee and Local Ownership of Wind



For example, for a 20 MW project in Cascade County, Montana, a locally owned wind project increases economic output and supports 20 jobs in the community, where an absentee owned wind project would only support 11 local jobs. Even in the more conservative Washington State analysis, the same 20 MW locally owned project supports 6 more jobs than a comparable absentee owned facility.[38]

The increase in employment is only part of the full economic impact. Figure 24 shows how local ownership also substantially increases the overall economic output of a community. In all but one of the studies, the economic impact of local ownership more than tripled that of an absentee owned wind farm.[39]

Figure 24 – Economic Impact of Absentee and Local Ownership of Wind

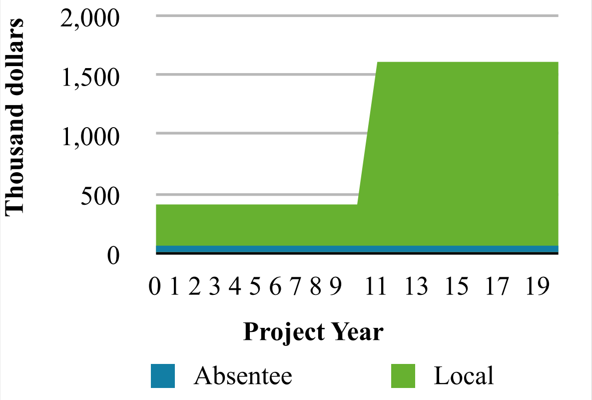


Part of the impact of a locally owned project is the economic activity created when owners finance their share of project costs at a local or community bank. A 20 MW wind farm costs around $40 million (July 2008). Borrowing 60% to finance the project at 8.5% interest would provide the bank with $550,000 per year in profit above the rate the bank paid to borrow the money. For a wind farm, financing is a large proportion of the overall project cash flow, making up 48% of money kept locally. And healthy local banks have benefits for their communities.

Wind: Individual Benefits

The benefits to local owners of wind turbines are substantially greater than when landowners lease their land to an absentee wind farm developer.[40] While a typical lease payment on a 1.5 MW turbine is around $5,000 per year, ownership in a wind project can net a farmer in excess of $30,000 per year in the first 10 years of the project (for the land lease and management service payments) and $120,000 per year in the

Figure 25 – Total Landowner Payments for a 20 MW Wind Project Based on Ownership of Project



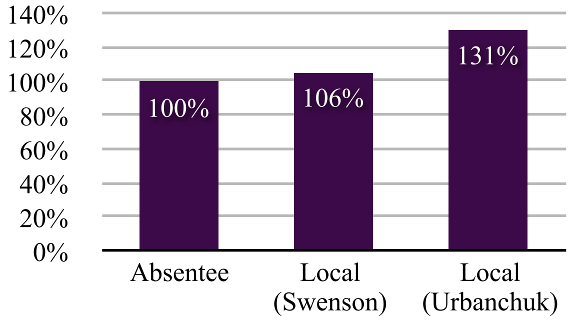
final 10 years.[41] Figure 25 shows the dramatic difference to the landowner between leasing their land to an absentee owner or having an equity stake in the wind turbine.

The local ownership scenario considered here is called a “Minnesota flip” – a common local ownership structure. In this arrangement, the farmers partner with a large investor who provides most of the equity for the wind project and retains 99% ownership for the first 10-14 years. The investor gets all the revenue and value from selling electricity and state/federal tax credits, while the farmer receives interest or “maintenance” payments. After 10-14 years, the project ownership “flips” and the farmer becomes the 99% owner and collects the power sales revenue. If the current federal wind incentives didn’t require substantial tax liability, a farmer could partner with neighbors to net even more of the project revenue. For more on this issue, see *Broadening Wind Energy Ownership by Changing Federal Incentives*.[42]

Ethanol: Community Benefits

Two major studies have compared the economic returns of an absentee owned versus locally owned ethanol plant. Both analyses found that the locally owned plants offer a greater economic impact. In the more conservative calculation, three locally owned 33 million gallon per year (MGY) plants would provide an additional 6% economic impact over one 100 MGY absentee owned plant. Another analysis concluded the locally owned plants provide a 31% greater economic impact.

Figure 26 – Greater Economic Impact from Three Locally Owned Ethanol Plants



The earlier study, done by Dave Swenson and Liesl Eathington at the University of Iowa, identified the cooperative dividend payments to farmers as the primary advantage of local ownership. The later study, by John Urbanchuk, found a greater impact from the dividend. He also calculated the impact from having the plant’s debt obtained from a local bank.[43] Figure 26 illustrates the findings.

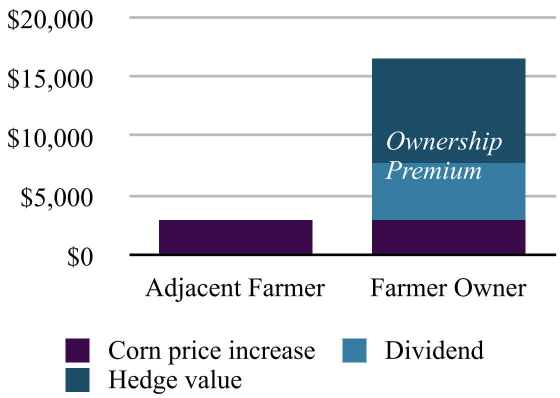
As Urbanchuk found, local ownership of renewable energy creates economic activity when farmers go to community banks to finance their share of project costs. An average ethanol plant produces around 50 MGY and costs $75 million to build. This provides the bank with $1 million per year profits on the $42 million capital loan. With a community bank, the profit on debt payments creates multiplier effects in the local economy through bank dividends – frequently paid to local owners and investors – and charitable giving.

This spending multiplies throughout the economy, increasing economic impact over an absentee owned facility. Half the economic impact of a locally owned ethanol plant comes from the debt financing (not including cooperative dividend payments).

Ethanol: Individual Benefits

An ethanol plant typically provides two benefits to individual farmers: an increase in the price of corn and an ownership premium. Figure 27 illustrates the potential difference in annual revenue for a farmer adjacent to an ethanol plant compared to a farmer-owner of an ethanol plant.[44]

Figure 27 – Annual Value of an Ethanol Plant for a Local Farmer v. Local Farmer-Owner



The presence of an ethanol plant can increase the potential revenue for all local farmers, typically by reducing transportation costs of bringing their corn to market. Several studies and economic models found price impacts between 3 and 12 cents per bushel, depending on the location, size of the plant, and distance from the plant. Since a 100 MGY plant has the same capacity as three 33 MGY plants, the total price premium to farmers near the plant(s) would likely be the same. In both cases, these price impacts may be short term, as farmers increase corn production to take advantage of price increases. The increased production would tend to lower the price per bushel.

For a farmer with 235 acres of corn and an average yield of 150 bushels per acre in the area of an ethanol plant, the price premium could increase revenues between $1,050 and $4,200 per year. This premium exists regardless of plant ownership.

The "ownership premium" can be far more valuable than the general – and perhaps fleeting – commodity price increase. Being an owner in an ethanol plant provides farmers with dividend payments and a strong long-term equity investment. At the Southwest Minnesota Agrifuels Cooperative, for example, the farmers' dividend has been worth over a dollar a bushel premium per year above the market rate they receive for delivering corn to the ethanol plant. For a typical ethanol plant farmer-investor, their 5,000 shares would be worth $5,000 a year. Most studies find an annual after-tax return between 13 and 23 percent over ten years. At the cooperative plant, farmers' initial investments in the ethanol plant nearly tripled in value from 1994 to 2002.

In addition to the dividend income, farmer-owners also benefit from the hedge value of receiving dividends that increase as corn prices fall. A farmer selling their entire crop to the ethanol plant will get back at least half of any corn price decrease via increased dividends. If faced with a 50-cent decrease in corn prices, the 235-acre, fully invested corn farmer will save $8,800 by being an owner in the ethanol plant. Once again, these benefits (as shown in Figure 27) are unavailable to farmers who simply farm near an absentee owned plant.

The Benefits of Dispersed Wind Energy Production

Local ownership tends to disperse renewable energy generation, a feature that improves the value of renewable electricity generation, such as wind power. Not only does dispersed generation take advantage of the breadth of the American wind resource, but also widespread wind generation can reduce transmission infrastructure costs and the intermittency problem of individual wind farms.

The transmission issue is a significant one, since policy, not power lines, can determine what type of electricity flows on the lines. In many states, proposed high voltage lines could carry new fossil fuel power as well as wind or solar. Richard Sergel, president and CEO of the North American Electric Reliability Corporation said this at a press conference in early 2008: "It doesn't matter if it's going to be the clean coal plant or the nuclear plant or the wind project or the solar project. The common denominator is that they are going to require transmission to move [electricity] from where it is [generated] toward the load centers."[45]

New research shows that wind power generation is commercially feasible across a much wider area than previously thought. In fact, the data show that substantial amounts of dispersed wind energy generation is feasible, requires minimal infrastructure upgrades and that a high proportion of wind power on the grid will not overburden utilities.

In Minnesota, for example, wind power used to be considered an energy industry only for the southwest portion of the state that has the state's highest wind speeds. However, the most recent wind resource data suggests that as much as half the state has wind speeds of 7 meters per second at 80 meters above ground – speeds sufficient to support a 33% capacity factor for a typical utility scale turbine.[46]

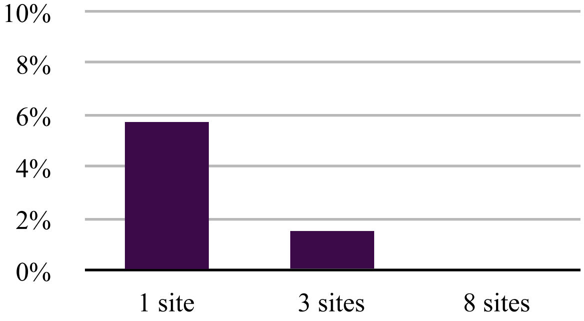
When wind resources are tapped across the state and the electricity is injected into the existing grid system, it's significantly less expensive than relying on new high-voltage transmission from only the strongest wind areas. A 2006 study found that 1,400 MW of wind – dispersed as a handful of turbines per location – could be added to the West Central region of Minnesota for less than $100 million in transmission upgrades.[47] A June 2008 study that looked statewide affirmed the 2006 regional findings.[48] Indeed, these two studies provide solid evidence that Minnesota could meet its 2025 Renewable Energy Standard without building new high-voltage transmission lines.

Studies have found that far more wind energy than had previously been supposed can be injected into the existing grid system, because far more wind energy than had previously been supposed can be used locally. One wind integration study found that Minnesota's utilities could accommodate up to 25% of their electricity from wind, for a cost of less than a half-cent per kWh of wind.[49] That means the typical utility customer would only have to pay about 1/8th cent per kWh for the wind integration, since wind is only part of the utility's electric generation. In other words, wind power can be generated much closer to demand centers at a very reasonable cost.

Other studies have found that if electric vehicles become widespread, a vision that is rapidly becoming mainstream among both car manufacturers and policy makers, sufficient electricity storage capacity will be available to also increase renewable energy's capacity to meet local energy demand. One study of the Sacramento Municipal Utility District concluded that wind energy could represent upwards of 50 percent of all electricity generated in the utility's service area without causing grid instability problems if electric vehicles provided electricity storage.[50]

Dispersed wind sites also minimize the problems attendant to intermittency. While wind speed in one particular location varies widely from day to day and even minute to minute, wind speeds averaged over dispersed geographic areas are much more level. Figure 28 shows the frequency of unproductive wind (less than 3 meters per second) for a study group of eight sites in four states examined during the year 2000. With eight dispersed wind farms, the average occurrence of unproductive wind was zero.[51] Once the intermittency issue is mitigated, wind competes favorably with fossil fuel power sources. The forced outage rate – scheduled maintenance – at fossil fuel plants was 8% in 2000, while the combination of forced and unforced outages – maintenance and calm air – for wind turbines was only 2%.[52]

Figure 28
Dispersed Wind Has Less Intermittency
(percent of time with unproductive wind speed)



Economies of Scale

There is a tendency for production units to become larger. The larger the production unit, up to a point, the lower the unit cost. This is why, for example, the rated capacity of a typical wind turbine has increased from 25 kilowatts (kW) in 1981 to 2.0 megawatts (MW) today and the output of a typical ethanol plant has increased from 40 million gallons in 2002 to 100 million gallons in 2007.

However, larger production units also impose potentially significant social costs. The most significant is that bigness encourages, and often requires, absentee ownership. This reduces or eliminates the many benefits that accompany a locally owned facility.[53] Bigness also requires much longer distribution systems for both inputs and outputs, generating environmental as well as economic and social costs.

Thus from a technological perspective, larger may seem more profitable, but from a community perspective, smaller may be more profitable. As it turns out, the benefits of building big are small, while the benefits of building small are quite large.

This section examines the scale economies of wind and ethanol and concludes that, while they do exist at the production level, they are modest and largely offset by the higher transportation costs related to bringing in the raw material (e.g. biomass) or in sending the finished product to distant markets (electricity or biofuels).

Wind: Economies of Scale

For a single turbine, the potential output and unit cost are based on many factors: turbine hub height, rotor diameter, and wind speed. Siting and design of turbines can significantly affect efficiency and, ultimately, the cost of power from a wind turbine. For wind projects of multiple turbines, other efficiency issues arise, such as distance between turbines, interconnection to the electric grid, and transmission distance to the ultimate customer.

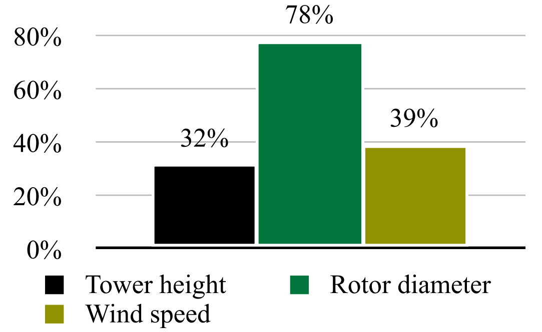
There are three ways to lower the cost of energy from a single turbine.

1. Increase the height of the turbine hub to catch faster winds. Wind speed is the primary factor in electricity production.[54] If a Vestas V66 1650 turbine produced power at 6.5 cents per kilowatt-hour (kWh), doubling the tower height would cut the production cost by approximately 2.4 cents, a 32% reduction.[55]

2. Increase the diameter of the rotor.[56] Doubling rotor diameter from 30 to 60 meters, as when changing from a Nordex N29 turbine to a Nordex N60 turbine, reduces power production costs by about 78%.[57]

3. Install the turbine in a windier location.[58] Doubling the windspeed theoretically increases the turbine power output eightfold, though in practice turbulence and other factors constrain that potential. Moving a Vestas V66 turbine from a site with average wind speed of 5 meters per second (mps) to one with average speeds of 10 mps would decrease power production costs by about 80%.

Figure 29 – Reduction in power production costs from a doubling of tower height and rotor length, and a 25% increase in wind speed.



In practice, wind speed variation between sites is usually modest. For example, the average wind speed for a Class 4 wind area is only about 21 percent higher – 6.9 mps vs. 5.7 mps – than a Class 3 wind area. That difference would reduce power production costs for the Vestas V66 by about 39%.[59]

On the other hand, higher wind speeds can be found on only a limited acreage and sections of the country. Moving from Class 4 to Class 3 might increase the amount of acreage and therefore potential sites available several fold. So there is a tradeoff between the higher cost electricity that comes from siting on lower wind speed areas versus the higher transmission costs of siting on more remote, windier areas. We explore the transmission line issue in more detail below.

The conventional wisdom also suggests that large wind projects, consisting of many turbines, will also reduce the cost of energy. Construction costs drop because larger projects can buy components in bulk and spread construction costs, legal and permitting fees, and financing over multiple turbines.[60] In 2004, Bolinger, et al, found a 30% reduction in site preparation and "soft costs" per MW for a 10.5 MW project over a single 1.5 MW turbine (Figure 30). Overall, the 10.5 MW project was approximately 10% cheaper per MW installed, with soft cost savings making up 40% of the reduction and site preparation the remaining 60%.[61] Data from 2005 (Figure 31) suggested that these economies of scale persisted even as projects grew in size.[62]

Figure 30 – Component Cost of 1.5 MW and 10.5 MW Wind Project

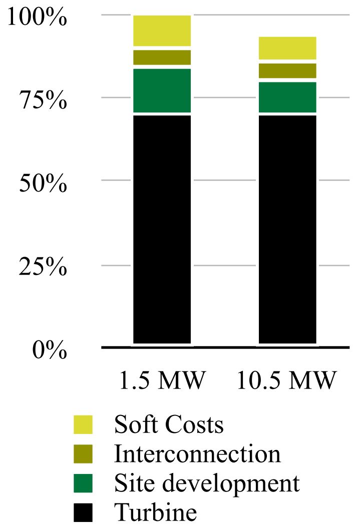
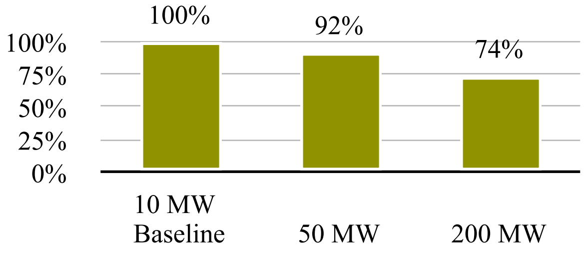
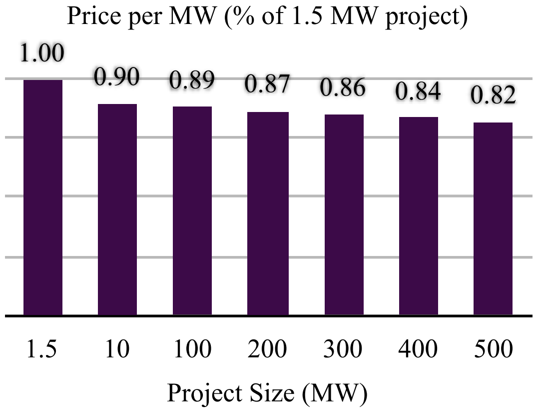


Figure 31 – Cost of Electricity Relative to a 10 MW Wind Farm (not including transmission)



However, these economies may be decreasing as the industry matures, as shown in Figure 32. A survey of wind projects in 2007 found that increasing project size from 10 MW to 100 MW reduced the "breakeven price"[63] of wind power by 2%, and that even increasing the project to 500 MW would only be a 9% reduction in the power price over a 10 MW facility.[64]

Figure 32 – Wind Project Economies of Scale are Small: Project Breakeven Price Relative to a Single Turbine Project



As wind power continues to grow in prominence, these economies continue to decrease. Data from Denmark – generating nearly 20% of its electricity from wind – suggests that the cost savings to large projects may decline further as wind power gains greater market penetration, and maintenance services are more widely available.[65] Shared cost savings can also be realized with cooperative models like the retail sector's Ace Hardware cooperative, where purchasing and advertising costs are pooled among member-owners.

A final advantage related to scale is that attracting financing and purchasing turbines may be easier for large wind farms. Corporate financiers of wind projects are not often interested in small-scale turbines or wind farms.[66] They seek projects with substantial generating capacity that can spread the risk and fixed costs over many turbines. And with wind power growing rapidly, turbine manufacturers prefer to deal in bulk orders.

Wind: Diseconomies of Scale

Perhaps the biggest single diseconomy of scale in wind projects arises from transmission costs associated with large projects. Small wind projects can use the power generated to meet on-site loads or can offset retail purchases via net metering.[67] Large wind projects almost always exceed on-site needs and net metering limits – only eight states allow net metering over 100 kW.[68] Moving power to distant customers often means constructing new high voltage transmission lines.[69] Because many projects are located in rural areas with little local demand, concentrated wind projects will often require substantial upgrades to the existing transmission system to get the power to market.

In one study modeling the connection costs for four different (2000 MW) wind farms to supply six urban areas, overall costs – including transmission and substation upgrades – increased by about 0.3 cents per kWh for every additional 100 miles of line.[70] Thus a 500 mile delivery from a centralized wind development could cost 1.5 cents per kWh more than dispersed wind scenario using the existing grid. A more recent analysis of transmission line costs found similar but slightly higher costs, showing 500 miles of line capacity to increase costs by 2.3 cents per kWh.[71]

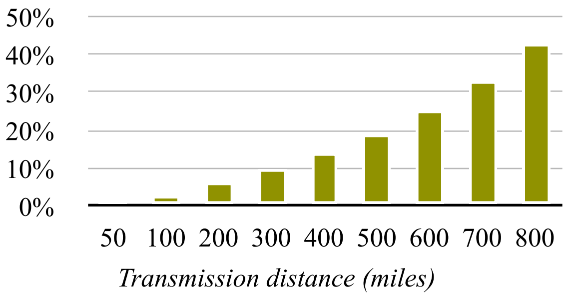
So far, few projects approach 2000 MW, making transmission upgrades relatively more expensive. For a 100 MW project, transmission costs would be around 1.6 cents per kWh for each 100 miles of line, or 8 cents per kWh to transmit power 500 miles.[72]

Long distance transmission also results in higher line losses. The combination of transmission and conversion losses reduce delivered power by approximately 1 percent per 100 miles.[73] For a typical project studied, delivered costs increased by about 0.03 cents per kWh per 100 miles of transmission, or about .15 cents per kWh for a 500 mile delivery trip, on top of the 1.5-2.3 cents noted above.

Another drawback of large, concentrated wind farms is the interference between the wind turbines. This interference, called "array loss," is caused when turbines are in the wake of other turbines. Research differs on the full effect of array losses. Recent assessments cite the losses of modern wind projects at 2-4% with properly spaced turbines.[74] The Department of Energy has the most nuanced research, estimating that turbine arrays in Class 4 wind speeds may have array losses around 5% due to effects between rows of turbines. Turbine arrays in Class 6 or higher wind speeds will have very low losses, especially in a single-file arrangement.[75] The 2000 MW transmission study uses 5-8% for array losses, higher for larger arrays.[76] Using the 5% figure, the lost generation associated with array losses increases the cost of electricity by about 0.15 cents/kWh.[77]

Overall, transmission and array losses associated with centralized wind development increase the cost of power production. A 500 MW project using 500 miles of transmission would cost 4.4 cents/kWh more than a local project serving local load. Higher wind speeds could lower generation costs to offset or exceed these higher transmission-related costs (Figure 33). A wind speed 19 percent higher would be needed to offset the 500 mile trip.

Figure 33 – Percent Increase in Wind Speed Required to Offset Transmission Losses



The second diseconomy of scale for wind farms can occur in higher infrastructure and maintenance costs. While large projects save on site development and legal costs by spreading them over many turbines, a project with one or a few turbines may avoid certain costs. Legal costs depend heavily on the number of turbines and landowners involved. A single owner-operator with one turbine can avoid legal and permitting fees (about $20/kW).[78]

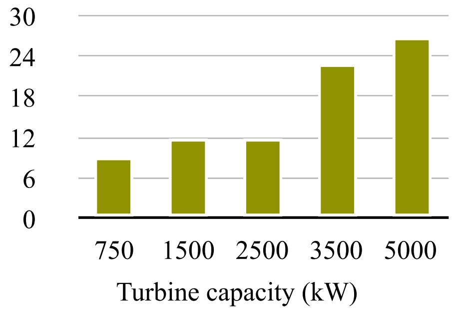
Maintenance can be both a diseconomy and an economy of scale. Larger wind installations can spread maintenance costs over many turbines and experience smaller reductions in capacity from single-turbine outages. However, these advantages are more pronounced in wind farms with smaller capacity wind turbines, because the impact of an individual turbine outage is a smaller percentage of total output. Experience in Denmark suggests that smaller turbines (in the hundreds of kW) have had fewer significant maintenance issues because the smaller components have lower loads.[79] Furthermore, smaller turbines have lower maintenance costs because they don't require a large, expensive crane to remove the turbine if repairs require it.[80]

Finally, scaling up turbine size and installing large numbers of turbines also imposes engineering, transportation, and construction diseconomies, although these tend to be modest.

Building a tower higher imposes additional costs. A typical 80 or more meter tower has a base diameter of 4.9 meters, which not only exceeds standard trailer truck dimensions but also the trigger height for police escort and/or temporary utility wire disconnection. Certain jurisdictions can simply refuse to allow such disruptive cargo, adding expense as the delivery truck must take a more circuitous route.[81]

The turbine nacelle can also be costly to ship because of the weight. The nacelle for typical utility scale turbine (80-meter tower) weighs the maximum for truck transport.[82] These transportation limitations account for dramatic cost increases when scaling up already-large turbine towers. While an 80-meter tower costs around $400,000 for materials, transportation and installation, a 120-meter tower costs nearly $1.2 million.[83] This may explain why even the largest turbines produced by GE, Vestas, and Suzlon have hub heights no greater than 105 meters.[84]

Figure 34 – Crane Costs for Constructing a 50-turbine wind farm ($/kW)



In addition to exponentially increasing transportation and construction costs, turbines also face cost breakpoints when installation becomes more challenging. Increasing tower heights create the need for substantially larger and more expensive cranes to do installation. As shown in Figure 34, crane costs triple for a 50-turbine wind farm increasing from 750-kW turbines to hypothetical 5000-kW turbines.[85] In both cases, the cost (spread over 10 years) is less than 1/10th cent per kWh.

Overall, larger wind turbines are indisputably more economical than smaller ones: doubling tower height and rotor size decreases production costs by up to 80%. The economies are less clear regarding wind farm size. Increasing a wind farm from 10 MW to a 200 MW can lower levelized costs by 3%. However, the remote location of most large wind farms incurs significant diseconomies related to the need for increased transmission – at 500 miles, the transmission costs offset the size economies.

Ethanol: Economies of Scale

As the ethanol industry expands, plants are growing ever larger, with new dry mill plants exceeding 100 million gallons per year (MGY). While larger plants enjoy some economies of scale in the production and distribution of ethanol, they are modest and likely do not affect the wholesale price of ethanol.

As with many manufacturing industries, the conventional wisdom in ethanol production is that bigger is more efficient. The first advantage of size is a reduction in capital costs per gallon. Although not as scalable as other industries, a 1% expansion in ethanol production is accompanied by a 0.84% increase in capital costs.[86] As shown in Table 6, this economy of scale corresponds to slightly smaller financing costs per gallon of ethanol produced. A 100 MGY plant will save 2.0 cents per gallon (cpg) in finance payments.

One reason ethanol plants may not scale as well as other manufacturing types is that production costs rely heavily on the cost of the feedstock – primarily corn, which has tripled in price from 2006 to 2008. No matter how big the plant, it

Table 6 – Scaling Capital Costs

Plant capacity	40 MGY	100 MGY
Capital costs (millions)	$62.8	$135.7
Debt service ($/gal)	$0.153	$0.133
Cost savings over 40 MGY	--	2.0 cpg

Table 7 – Average Ethanol Plant Operating Costs

Expense	$ per gal
Feedstock (corn)	$2.14
Electricity & natural gas	$0.35
Debt service	$0.15
Capital depreciation	$0.09
Labor	$0.05
Enzymes	$0.04
Maintenance	$0.04
Denaturant	$0.03
Administrative costs	$0.03
Chemicals	$0.02
Waste management	$0.01
Yeast	$0.004
Other	$0.004
Water	$0.003

tends to pay the prevailing market price for corn and for energy inputs (electricity and natural gas).[87] Table 7 illustrates the prominence of feedstock and energy inputs in the operating cost of an ethanol plant.[88]

There are some savings on other costs, however. Larger-scale plants may have production economies of scale from relatively lower labor and administrative costs per gallon produced. Ron Kotrba of Ethanol Producer Magazine wrote, "A 50 MGY ethanol plant on average will employ between 35 and 40 employees [one for every 1.25 million gallons], whereas a 100 MGY plant needs about 55 to 60 employees [one for every 1.67 million gallons]."[89] However, labor costs are only about 2-3 percent of total plant expenses.[90] Another study, based on engineering estimates, found decreasing production costs for ethanol plants up to 100 MGY, whether powered by natural gas, coal, or biomass.[91] Each type of plant saw a 2-3 cent per gallon reduction in production costs when scaled up from 50 MGY to 100 MGY.[92]

Once ethanol is produced, large plants may also have advantages in marketing and transportation of the product. However, there are virtually no studies of the magnitude of this advantage.

On the transportation side, larger producers may benefit from price and logistical advantages of having more product to ship. With 30,000-gallon tanker cars, a unit train (95 cars) holds 2.85 million gallons of ethanol and it takes substantial production to fill it quickly. A 100 MGY plant can fill a unit train about every 10 days.

Another advantage for plants large enough to use unit trains is the avoided cost of coordinating their shipment with other trains. Unit trains move directly from origin to destination. Unit train rates are less expensive than "mixed trains," where the ethanol may be one of several products on the train or the ethanol may come from several different plants. For a BNSF railroad shipment from SW Minnesota to Watson, CA, for example, rates are 10 percent lower for unit trains than for mixed trains.[93] "Single cars or small groups of cars are moved less consistently than large groups, taking up to twice as much time to reach their destinations."[94]

Unit trains generally offer scheduling and pricing advantages, but there are few terminals with the

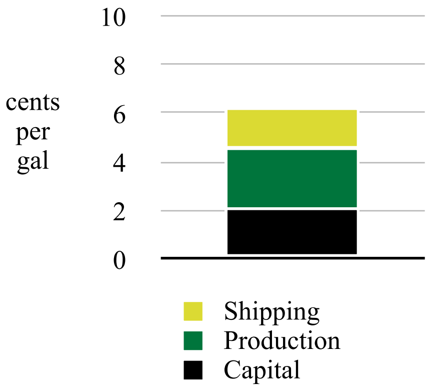
Table 8 – Ethanol Shipping Rates

	Unit Train	Mixed Train
Train cars	95	30-94
Cost/car ($)	$4,500	$5,000
Car capacity (gal)	30,000	30,000
Cost ($/gal)	15 cents	16.7 cents
Cost for 100 million gallons	$15 million	$16.7 million

capacity to rapidly unload a unit train – on the West Coast in 2007, there was only one.[95] Additionally, an ethanol plant has to build its own loading track and lease or buy its own tank cars, so a large ethanol plant will have significantly higher initial costs in preparing for unit train service.

On a smaller scale, organizations like the Renewable Products Marketing Group provide a way for small producers to combine marketing power. Additionally, the Ethanol Express by BNSF helps gather ethanol production into unit trains by region, helping improve transportation logistics for smaller producers. So, small producers may be narrowing the economies of scale with respect to transport.

Figure 35 – Cost Savings for a 100 MGY Ethanol Plant compared to 40 MGY



Overall, for each gallon of ethanol a 100 MGY plant saves 2.0 cents on capital costs, 2-3 cents on production costs, and up to 1.7 cents on shipping costs over a 40 MGY plant. These total economies (4-6 cents) are significant to the plant owner and investor, but are modest compared to the overall wholesale price of ethanol, which has ranged from $2 to $4 per gallon most of the last two years. It is doubtful that customers would see any reduction in the price at the pump if the ethanol industry were dominated by 100 million gallon per year plants.

Ethanol: Diseconomies of Scale

While plant size seems to offer ethanol producers substantial benefits, there are some aspects of production that suffer from diseconomies of scale. From limited local markets to limited water resources, building large can incur costs that smaller plants won't face.

The largest ethanol plants quickly overproduce local markets for their product. In Minnesota, domestic production exceeded the statewide 10% ethanol mandate by 2002; currently, at least half the product is shipped out of the state. Having to find distant markets can erode margins, as shown in Table 9.[96] It costs half as much to ship locally as to ship long distance.

Table 9 – Short and Long Distance Shipping Costs (from SW Minnesota)

	Distance	$ per gallon
Minnesota terminal	200 miles	$0.08
Ft. Worth, TX	900 miles	$0.12
Watson, CA	1,900 miles	$0.17

The limited local market for ethanol's co-products can create a stumbling block for larger-scale ethanol production. The most significant co-product of ethanol production is distiller's grains, which can be used as livestock feed. In some ethanol plants, these are left as distiller's wet grains (DWG) and must be sold and consumed within a few days (three days in warm weather and six in cooler temperatures).[97] Otherwise, the plant must apply a preservative – extending shelf life to 14 days for about $4/ton – or dry them with natural gas to create distillers dried grains (DDG), for an average cost of $10/ton.[98] DDG can be stored and shipped much longer distances. A 40 MGY plant will produce approximately 126,000 tons of DDG per year.[99]

There are several scale limitations on the market for DWG and DDG. First, distiller's grains are essentially corn kernels stripped of their starch, leaving a much higher concentration of protein – a key feed ingredient. However, because the processing also changes the balance of amino acids and phosphorous in addition to starch and protein, distiller's grains can only provide part of the feed for livestock.[100] "Feed inclusion rates for distillers grains are presently as high as 40 percent for cattle, 25 percent for swine and 5 percent for poultry,"[101] but farmers typically use less to avoid adverse effects on feed animals. In particular, high inclusion rates can lower the grade quality of beef.[102] On average, a cattle feedlot will provide cattle with three pounds per day of DDG (of a ten pound recommended maximum) – meaning a 40

MGY plant needs 180,000 head of cattle to use all of its 126,000 tons of DDGs.[103]

The significant number of cattle required to consume an ethanol plant's DDG means that the market for distiller's grains varies greatly. "Given the saturation of ethanol plants in many areas, feasibility studies for new ethanol plants are placing minimal value on this byproduct because of the difficulty in finding willing buyers."[104] The bigger the plant, the more buyers are needed. First, this means that more of the DWG must be dried, since DWG can only be used in nearby markets. Second, it means that the resulting DDG must be shipped further from the plant to reach available feedlots. The most pressing problem resulting from outstripping the local feed market is that DDG can clog railroad hopper cars. While this initially meant a more laborious transport process, since the DDG caked into "fine grain concrete" with high temperatures and humidity, railroads eventually made ethanol plants lease or buy their own railcars for DDG, adding $6/ton to the shipping cost.[105] Additionally, shipping DDG is more expensive than shipping corn, since DDG is less dense.

The combination of flooding the local market and increased transportation costs can create a diseconomy of scale for a large ethanol plant. Table 10 offers a simulation of how two ethanol plants – 40 MGY and 100 MGY – would operate in a regional market capable of absorbing 20 million gallons of ethanol and 50,000 tons of DDG (requiring over 70,000 head of cattle).

Table 10 – Comparative Drying and Shipping Costs for DDG and Ethanol in a Limited Local Market (per gal)

	40 MGY	100 MGY
Ethanol shipping	13.2 cents	13.7 cents
DDG drying	1.9 cents	2.7 cents
DDG shipping	9.3 cents	13.6 cents
	20.7 cents	**26.2 cents**

- Ethanol demand: 20 million gallons
- DDG demand: 50,000 tons
- Local ethanol shipped via rail to blending facility
- Excess ethanol shipped via rail to Watson, CA terminal
- Excess DDG dried and shipped via rail to Texas feedlots

As we can see, the 100 million gallon plant has an increase in shipping and DDG drying costs that come to about 5.5 cents per gallon, offsetting much of the production cost savings of the larger facility.

Some ethanol plants have found alternatives to drying and shipping DDG to avoid the cost. Burning the distillers grains to fuel the plant's energy needs can displace natural gas, and save on drying and shipping costs.

Water use is also a concern for ethanol plants. Each gallon of ethanol produced uses 5-6 gallons of water, although Minnesota ethanol producers on average reduced this to 4.2 gallons in 2005.[106] For some of the early plants producing 20-40 MGY, this meant 100-240 million gallons of water used per year.

For one plant in Granite Falls, MN, the water demand has outstripped the capacity of the local aquifer, causing plant officials to seek permission to get water from the nearby Minnesota River and to cancel expansion plans.[107] Another proposed plant near Pipestone, MN, was scrapped because the municipal water system lacked the capacity for the 100 million gallon facility.[108] The intensive water use of ethanol plants has led some states to track ethanol plant water use (Minnesota) or to carefully study local water availability before siting plants (Iowa). In some areas, such as Dodge City, KS, or Champaign, IL, local residents and municipalities have raised concerns about competing demands for water and the impact on the local water table.[109] In general, smaller plants will have a smaller impact on the local water supply than large plants.

Summary

The most significant economies of scale in renewable energy production are in individual wind turbines. Larger towers and blades capture significantly more energy than smaller machines and reducing unit costs substantially (by 32% for doubling tower height and by 78% for doubling rotor diameter). There are modest savings involved in moving from single to multiple turbines since many of the same savings can be gained from a cooperative service and maintenance arrangement among many local owners.

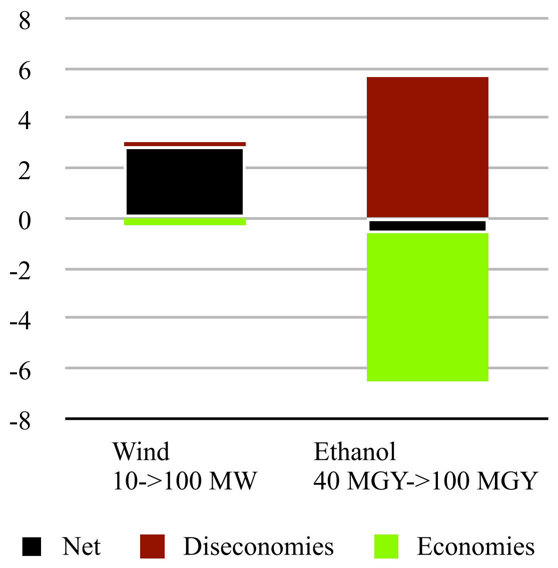
Some studies show as much as a 10% reduction in unit costs for electricity generation in large wind farms, but sending wind farm power long distances can increase costs by 10-25%. Local generation of wind power – from dispersed turbines serving a local and regional market using the existing transmission and distribution grid – can be cheaper even if there are lower wind speeds.

For ethanol plants the scale advantages are also limited. Increasing plant size from 40 to 100 MGY can reduce production costs by 4-6 cents per gallon. However, outstripping local markets and having to ship the product long distance can increase costs by 5-6 cents per gallon.

Figure 36 illustrates the net economies of scale for a 100 MW wind farm compared to a 10 MW wind farm, and for a 100 MGY ethanol plant compared to a 40 MGY one. In the case of wind, the smaller facility is more economical because of transmission costs. For ethanol, the larger facility is cheaper, but only by a half cent per gallon.

In sum, economies of scale are real, but in most cases, modest. The benefits of bigness are small.

Figure 36 – Net Economies of Scale (Cents per kWh or gallon)



And since bigness leads to absentee ownership, it significantly reduces the community benefits of harnessing renewable energy. Locally owned facilities may be smaller, but they have social benefits that are quite large.

Designing Policies to Encourage Local Ownership

Rural economies are already benefitting from the expansion of renewable energy production. Ethanol plants, wind turbines and solar projects have significantly increased economic activity in selected rural areas. But as development of each resource has matured, the ownership is increasingly absentee and centralized, robbing rural areas of the opportunity to maximize the benefit from their renewable resources.

In order to enable rural economies to benefit fully from the expected dramatic increase in renewable energy, new rules are needed to channel investment capital and entrepreneurial energy and scientific genius into different directions.

In some cases, revisions to existing policies that discriminate against local ownership and modestly scaled production facilities can help. But better in the long term would be policies that discriminate in favor of local ownership and maximize development that benefits communities.

Removing Obstacles

Federal incentives for renewable energy largely come in the form of tax credits. Wind energy developers receive a per kilowatt-hour tax credit, biofuels developers a per gallon tax credit. Solar receives an upfront capital tax credit. But tax credits preclude widespread ownership of renewable power.

To use a tax credit one must have tax liability. So the wind incentive, biofuel incentive, and solar incentive are incentives reserved for wealthy Americans or large profitable businesses. To add to the bias, the wind incentive can only be taken against passive income, that is, income from rental properties or investments. It cannot be taken against ordinary income from wages. In the case of solar, the solar tax credit is capped at a very low level for residential installations but has no limit for commercial installations.

A bill introduced in 2007 by Representative Tim Walz (D-MN) would remedy part of the problem with the wind tax incentive. The bill would broaden the production tax credit to non-passive income sources, opening up the credit to tens of millions of households.[110]

Making New Rules

There are many ways that states can assertively encourage local ownership.

One is by encouraging small and modestly scaled production facilities. In the 1990s Minnesota did this by converting its existing state tax incentive for the sale of ethanol into a direct payment for the production of ethanol. The 10-year incentive only applied to in-state producers, and only on the first 15 million gallons of production. This redesigned incentive enabled the establishment of over a dozen farmer owned biorefineries. Today there are nearly 5,000 local owner-investors – primarily corn farmers – whose plants produce close to 400 million gallons of ethanol per year.

Building on its success with ethanol, in the late 1990s Minnesota implemented an incentive to encourage local ownership of wind turbines. Initially, it was a producer payment similar to that offered to ethanol producers, restricted to in-state production and for wind farms under 2 MW in size. It went further than the ethanol incentive in that it required majority local ownership. In 2005, the legislature converted the producer payment into a favorable utility tariff for community based energy development (C-BED) projects and required utilities to purchase renewable electricity from these projects as a priority.

Over 200 MW of community-owned wind has been developed under the statute (with hundreds more MW in preliminary development stages), dispersing millions of dollars to owners around the state. Nebraska has a similar community-based energy statute, though not as powerful.

A policy that avoids the need to rely on investors with tax liability is to adopt a renewable energy payment, also called a feed-in tariff. This policy has been enormously successful in increasing renewable energy development in Europe, with Germany and Denmark both receiving more than 10 percent of their electricity from renewable sources as a direct result of their renewable payments. Most recently the Canadian province of Ontario has adopted such a policy, and

California, Minnesota, Michigan and several other states are seriously examining the concept. A feed-in-tariff, essentially, offers a price to renewable energy producers sufficient to attract investors. Thus investors make their money on the revenue earned from the project, not from the tax benefits associated with production. For example, today the federal government offers about 3 cents per kWh in tax incentives for wind energy. That allows the wind developer to sell to the utility at a lower price, usually about 7-8 cents per kWh. A feed in tariff that sets the price for wind energy at 11 cents per kWh would achieve the same ends while avoiding the need for project developers to rely on outside investors with large tax liabilities.

The other advantage of a feed-in-tariff is that it can be tailored to encourage not only more renewable energy, but also better renewable energy. Europe, for example, offers a higher price for smaller, on-site facilities. States and the federal government could offer a higher price for locally owned facilities.

Another rule that states and the federal government can embrace to maximize the benefit to rural communities of renewable energy is to give a priority to locally owned wind turbines for access to existing transmission lines. Over the last decade, the federal government has spurred the creation of multi-state transmission authorities and has given transmission builders a higher than usual guaranteed rate of return on their investment. Inevitably, these authorities have a regional, not a state or community, perspective, and their solution to all problems is to build thousands of miles of new high voltage transmission lines. They also control the queue for interconnection access and the "first come-first served" process by which developers gain such access has proven unworkable. There are huge numbers of applicants who simply submitted an application to hold their place near the front of the line. The process discriminates against locally owned and modestly scaled wind farms.

Two recent studies by Minnesota utilities examined the capacity of the existing transmission and subtransmission system to handle increased amounts of locally generated wind energy. The studies provided strong evidence that Minnesota could increase at least five fold its wind energy output and achieve its 2025 Renewable Energy Standard without building substantial new high voltage transmission lines.[111]

The boundary line between state authority over the electric grid and federal authority is unclear. The Federal Energy Regulatory Commission (FERC) has authority over bulk transfers of electricity across state lines. States have authority over locally generated electricity delivered to local customers. There is a grey area in between, that is between, say 69 kV transmission lines and 115 kV lines. A recent white paper examining the issue suggests that states could assert their authority over many of the subtransmission lines, and in doing so, could establish their own queue in which locally owned energy production systems would be given a priority.[112]

States and local governments should identify strategies they can use to eliminate existing obstacles to locally owned renewable energy facilities and to create new policies that promote such facilities as a matter of public interest.

Conclusion

The implications for the rural economy and local communities are dramatic. Primarily, renewable energy promises to provide a widely available, sustainable resource base for community economic develoment.

The crucial question is whether the development of renewable resources in rural areas will mimic their availability. Will wind, solar, and biomass be tapped by widely dispersed, locally owned wind turbines, solar panels, and biorefineries? Or will rural residents be observers to the development of their natural resources by absentee owners, as has happened with fossil fuels and even tourism.

The benefits of decentralized, locally owned renewable projects are substantial. Dispersed energy projects take advantage of the small economies of scale in renewable energy to deliver energy close to demand, reducing transmission and transportation costs. These smaller wind farms and biorefineries can be locally owned, significantly increasing the economic benefits of renewable energy development.

But the current incentives for renewable energy ask for “more,” not “better.” They focus on the sheer quantity of renewable electricity or biofuel at the cost of losing the potential benefits of dispersed production and local ownership. And they reward the existing economic winners, those who have the tax liability to use the incentives.

We need new rules and new incentives. Rules for renewable energy must ask for better energy; for energy produced by locally owned facilities that return the value of renewable resources to the rural communities; and for energy produced by widely dispersed generators, so that the benefits of the energy revolution are shared across the country.

Rural America stands at the cusp of an economic boom from its abundant renewable resources, but only if the rules are rewritten as if community matters.

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