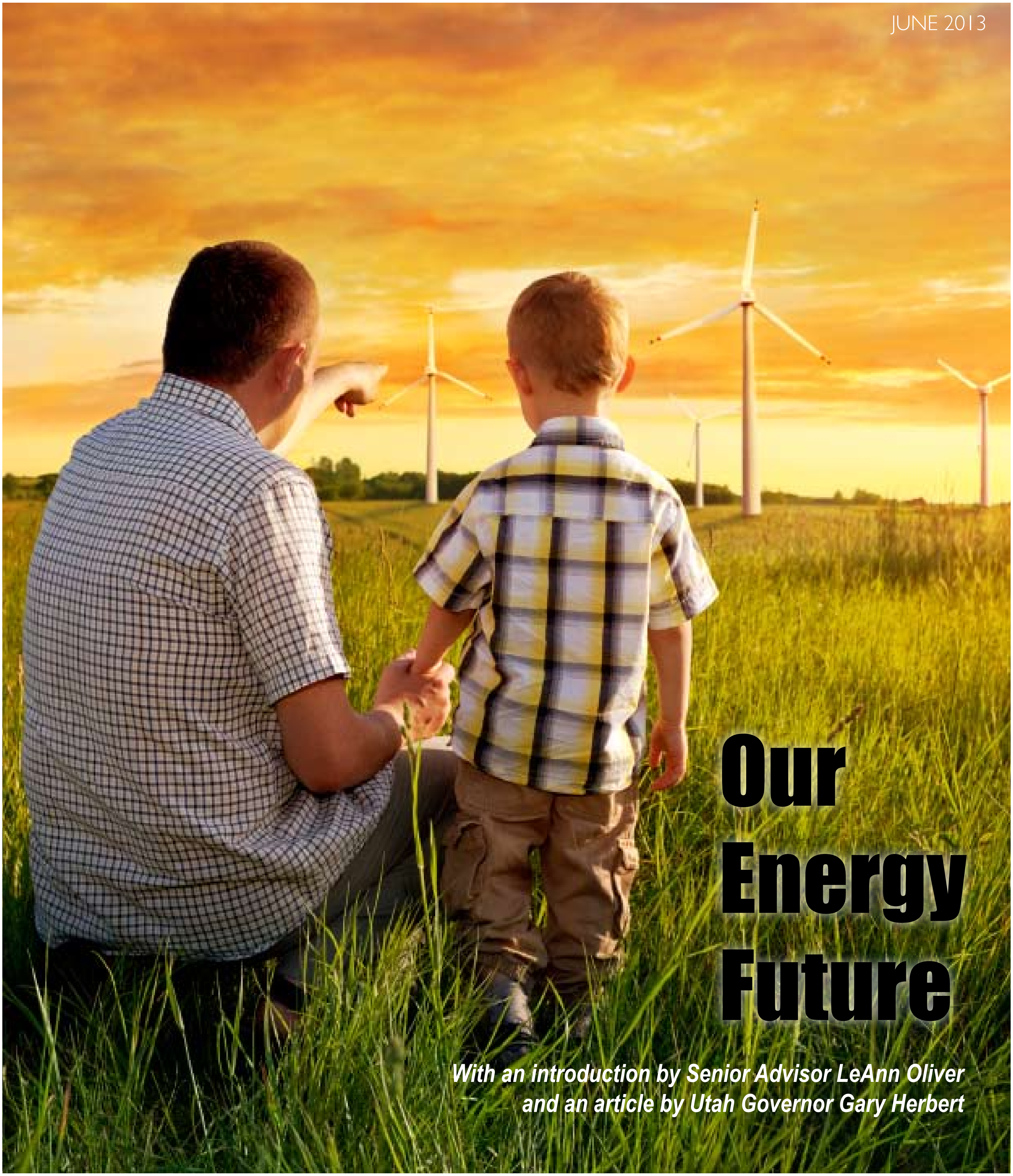
# RuralCONNECTIONS

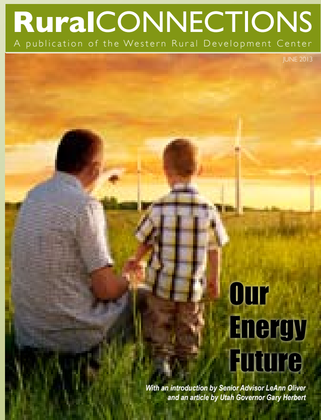
A publication of the Western Rural Development Center



JUNE 2013

# Our Energy Future

*With an introduction by Senior Advisor LeAnn Oliver and an article by Utah Governor Gary Herbert*

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Of necessity, the way we produce and consume energy in the future will differ significantly from energy production and consumption today. Because of climate change, resource depletion, foreign dependence and other factors, the extent to which we are dependent on fossil fuels must decline. Renewable and other alternative energy sources must increase. Conservation and efficiency must improve. The manner in which these changes occur is vital. Disruptions of our energy supply or increases in energy costs can have devastating implications. Significant changes in the types of jobs in the energy industry and where these jobs are located will dramatically impact individuals and communities. Yet, as LeAnn Oliver describes in her introduction to this issue, our primary source of energy has changed several times in past decades, and with careful planning and wise policy, we can make a relatively smooth transition again.

In September 2012, the Western Rural Development Center sponsored a conference in Salt Lake City, Utah, on "Our Energy Future." At the conference, experts from throughout the country presented on issues dealing with socioeconomic concerns as we strive to transition to a new energy future. The articles in this issue of *Rural Connections* were presented that day and I am pleased this issue also includes an article by Governor Herbert addressing the West's energy initiative. I came away from the conference excited about the excellence of the presentations, the range of energy-related issues covered, and the quality of the discussion regarding these issues. By no means did we have all of the answers or solve all of the problems, but the energy concerns discussed that day must be addressed if we are to effectively make the transition into the future.

It is my hope that discussions begun that day will continue as people read and contemplate these articles. I believe these articles provide insights and raise further questions that can guide future research. They provide ideas that can be used to develop extension and outreach programs. These articles can provide ideas to guide policy discussions that will move us closer to solving these perplexing problems. Again, we appreciate the contribution of the Western Governors' Association and we look forward to partnering with them to address the energy challenges we face.

--Don E. Albrecht, Director

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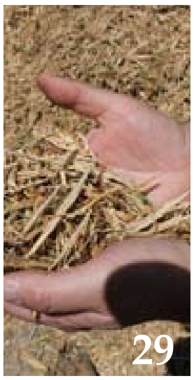
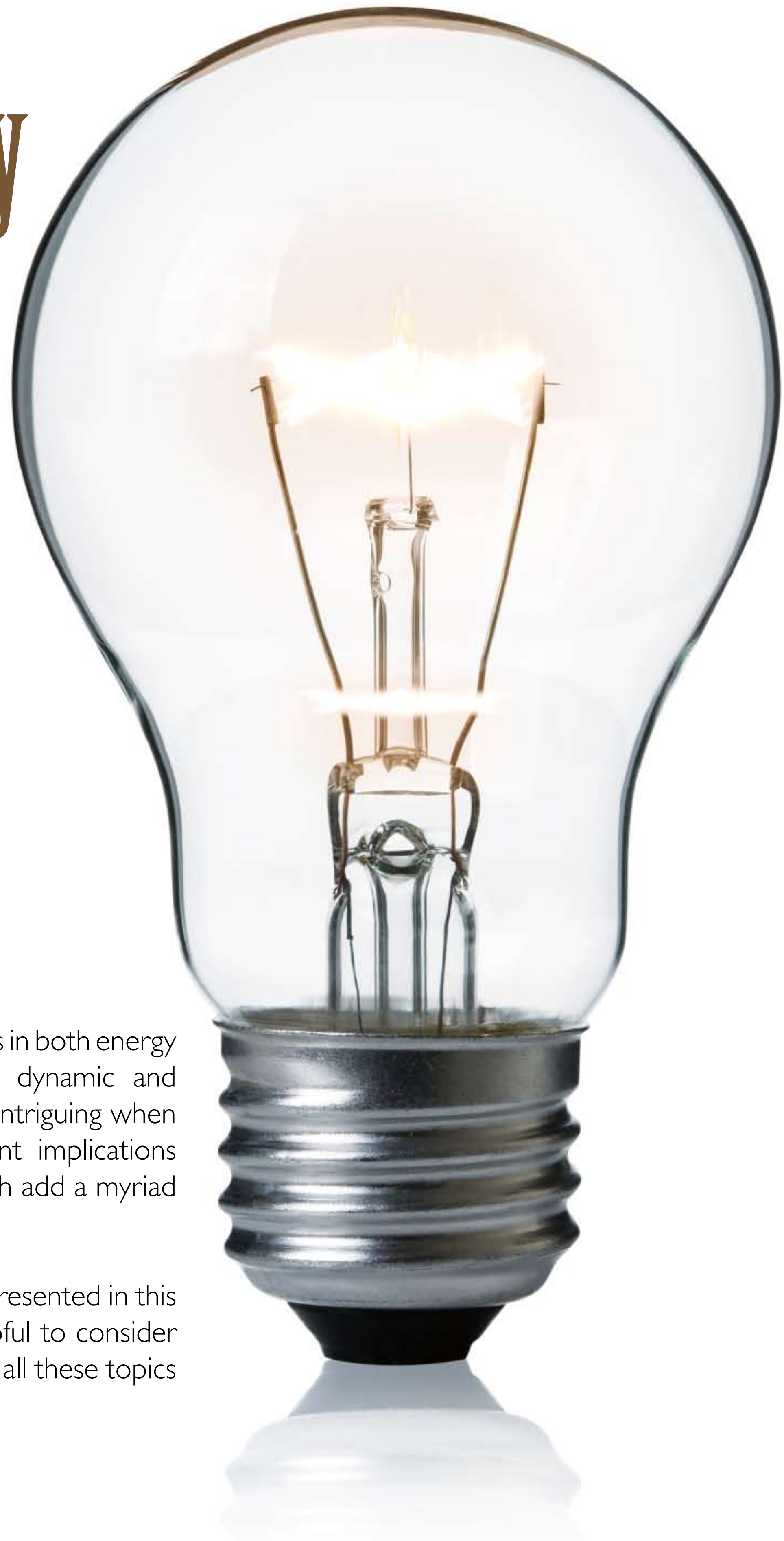



"ALLOWING OUR ENERGY FUTURE TO BE DEPENDENT ON RESOURCES EXTERNAL TO AMERICA IS COMPLETELY UNDESIRABLE. FORTUNATELY, OUR COUNTRY IS BLESSED WITH AN ADVANTAGEOUSLY LONG LIST OF POTENTIAL ENERGY SOURCES AVAILABLE FOR DEVELOPMENT." *PAGE 4.*

# The Energy Future of Rural America



BY LEANN M. OLIVER

Rural America plays varied and key roles in both energy production and consumption. These dynamic and complex relationships are even more intriguing when juxtaposed with regional development implications and global water scarcity, both of which add a myriad of significant opportunities.

As a prelude to the variety of papers presented in this edition of *Rural Connections*, it is helpful to consider the "big picture" environment in which all these topics coexist.

## Why Energy Matters to America

### *Energy Security*

Because energy is basic to every facet of both urban and rural American life, its security aspects are paramount. Lack of affordable, reliable energy has numerous consequences that may not be on people's radar on a day-to-day basis. But, consider what happens when either electricity or petroleum based fuels are unavailable; life as we have come to expect it is suddenly and jarringly disrupted, with both individual personal consequences as well as larger societal effects. (The aftereffect of "Superstorm Sandy" on New Jersey and New York where electric power and stocked/functioning gas pumps were absent for more than a few days provides a primer on just how significant a lack of energy can be.)

Allowing our energy future to be dependent on resources external to America is completely undesirable. Fortunately, our country is blessed with an advantageously long list of potential energy sources available for development. Clearly, an "all of the above" approach to energy generation and usage has the strategic benefit of ensuring that America has the greatest number of options in guaranteeing its future energy security.

### *American Competitiveness/Job Creation*

Fortuitously, America's desire to maintain a strategic lead in all types of energy is coupled with the fact that doing so will result in positive economic development potential. The need to continue to strengthen our position will serve us well by creating jobs in:

- Research and development to design new products and techniques as well as find new ways to use existing products;
- Manufacturing supply chains, especially of high tech products; and,
- Environmentally sound development of all energy sources available in the United States.

### *Saving Money*

On a more personal basis, energy matters because many people pay energy bills for home utilities and at the gas pump, and are taxpayers who cover the costs of government usages of energy. In fact, the United States military is the largest single consumer of energy. Any advances that result in lowered use or cost of energy are a huge benefit to the bottom lines of Americans, both as individuals and as citizens represented by the U.S. government. Any funds not used for the procurement of energy can be repurposed to meet other needs or wants.

## Environmental Considerations

While the usual prosaic discussions about coal-fired power plant emissions, the potential environmental effects of shale extraction, or the "visual pollution" of wind turbines may come to mind, it is beneficial to think strategically about environmental considerations in a more global frame.

### *Population Growth*

Various estimates of the growth of the world's population suggest that between now and 2050 the world will add the equivalent of two more populations of China (approximately 3 billion in total) to both feed and supply with energy. This is where the relationship between energy and agriculture gets very interesting. While there is currently some arable land that is not being farmed, the amount available is not on a scale that would be sufficient to support that population increase with current technologies and agricultural practices. Consequently, new agricultural research that will allow greater food production with lesser amounts of all inputs, including energy, is imperative.

### *Water Scarcity*

Sufficient water is essential to agriculture as currently practiced. Combined with the other water dependencies of a growing world population demanding a higher standard of living, there is the distinct possibility that water scarcity will be the "trump card" that significantly affects all aspects of future agriculture and energy production/usage. It is

"ALLOWING OUR ENERGY FUTURE TO BE DEPENDENT ON RESOURCES EXTERNAL TO AMERICA IS COMPLETELY UNDESIRABLE."

significant to note that long-range military planners consider water scarcity a major factor.

Energy is a wild card that can either be part of the problem or provide a brilliant solution. Consider the range of possibilities: if a new energy source requires vast amounts of water it contributes to the shortage of water available for other uses, possibly causing conflict with food production, but, a new non-water dependent energy source could hypothetically be used to process brackish water that would ease demand. Other possibilities include new energy saving technologies that would allow agricultural production to be completed with decreased demand for water dependency. New technologies and sources of energy are needed to reduce the costs of food production and distribution.

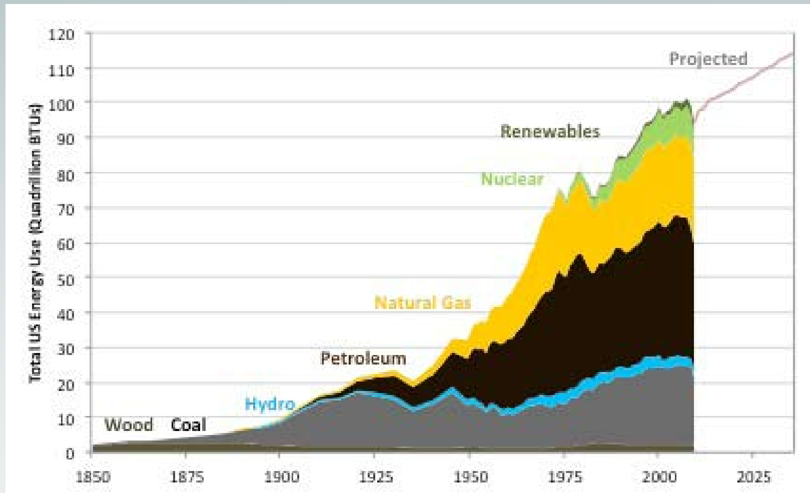



Figure 1. U.S. Energy Use: Past, Present, and Future. Source: U.S. Department of Energy, Efficiency and Renewable Energy.

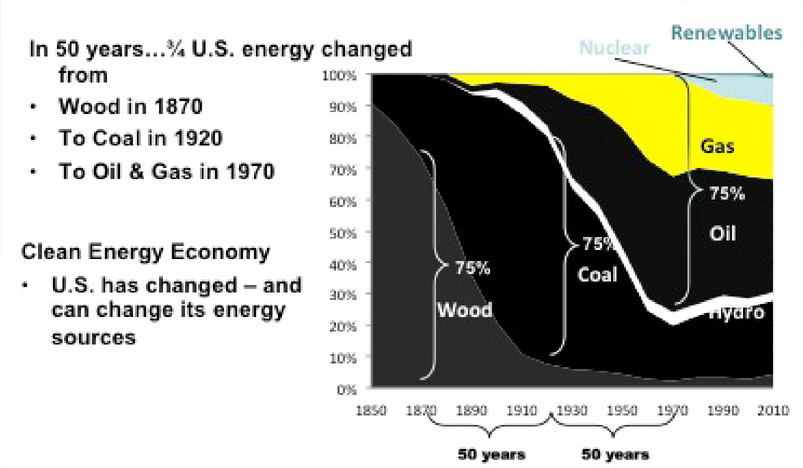



Figure 2. Transformational Change: U.S. Energy Use. Sources: EIA, Annual Energy Review: 2008 and EIA, *Annual Energy Outlook: 2009.*

## A Framework for Thinking About Our Rural Energy Future

Rural areas can benefit greatly from the economic development aspects of an "all of the above" approach to both energy sources and uses and the discussion above provides a solid context for regional and local decision makers to consider when faced with energy development decisions. These can range from wind, geothermal, and solar to both purpose grown and agricultural waste feedstock sources, with their resulting need for processing facilities. The diversity of energy sources, including the expansion of renewables and more cost effectively extracted hydrocarbons, could also present potentially unwelcome change in areas that may have remained essentially unchanged for several generations.

Consequently, the ability and effort to evaluate that impact will be key in contributing to well thought out decisions that are consistent with the intent of rural residents. In considering the implications of a proposed energy project it may be useful to employ the "triple bottom line" framework. This looks at the traditional cost/benefit analysis of the monetary factors, but also looks at the social and environmental costs, traditionally known as "externalities." Often these effects are not easy or even possible to monetize, but a full discussion helps to illuminate the potential trade offs that may be considered. It is also possible that the discussion will result in other alternatives being pursued. Being open minded about considering all the relevancies, can enhance the likelihood of making good decisions about potential development that will have long term effects on a rural area.

> "RURAL AMERICANS ARE GOING TO BE CALLED UPON TO PLAY A SIGNIFICANT ROLE IN THIS FUTURE AND THEY ARE UNIQUELY PLACED TO BE MAJOR BENEFICIARIES."

Following are factors that a rural community should think through as they form their responses to proposed energy development:

1. From a holistic perspective, what does the community want? Has it undertaken a structured community wide discussion that intentionally and carefully engaged all citizen groups in a meaningful way? Because rural geographies, topographies, economics and socio-economic circumstances are vastly different, basic energy related interests vary significantly. All should be captured and carefully considered in their entirety.

2. Using the broadest application of all the aspects of the triple bottom line framework, consider how a proposed project will affect the geographic area from a more granular perspective. For example, are the local roads going to be able to support increased traffic, will be there increased pressures on the school system, etc. The goal is to identify and address these effects constructively before decisions are made, using all leverage points available to the community.

   Rural residents have varied interests that can be competitive and not easily resolved – Even within a single rural location it is possible that deep and dividing conflicts can arise (e.g., retired residents who moved to the area because of its natural beauty and quietness vs. developer interests that would change the scenic vistas, etc.), so it is best to get these identified and addressed early on, when there may be alternative options.

3. Consider acquiring technical expertise if it is unavailable in the local community. A full understanding of all the implications, both positive and negative, is crucial to a successful implementation.

4. Keep an open mind. Unsurprisingly, new technologies can be confusing and uncomfortable. There is a tendency to think that oil is the only ingredient of our energy palate but consider that petroleum products have only been key to our society for the last hundred years. It is possible to make that kind of shift again and in fact these charts provide an interesting perspective.

America's energy future is bright because we have both broad and deep potential resources. Research is underway that will provide many opportunities for ensuring our energy security, while also reaping benefits from the industries and jobs that will be created. Rural Americans are going to be called upon to play a significant role in this future and they are uniquely placed to be major beneficiaries. By carefully considering their options and making strategically supported choices, rural America can also reduce any potential downside risks by carefully and thoughtfully reviewing what is presented to them, keeping in mind both the "big picture" and considering how their local resources and circumstances fit into that picture.


# 10-Year Energy Vision

## Western Governors' Association Energy Initiative

BY GOV. GARY R. HERBERT-UTAH
Chairman of the Western Governors' Association

The West plays an indispensable role in meeting our nation's energy needs. Awash in conventional and renewable resources, it is our country's energy breadbasket. Consider the facts:

- Western coal production accounts for more than half the national total.
- The region has provided nearly 70 percent of the nation's natural gas and petroleum output in recent years.
- The U.S. will become the world leader in petroleum production within the next five years, based on current Western regional growth (International Energy Agency, 2012).

The region's energy bounty extends well beyond fossil fuels. Renewable energy resources are distributed throughout the West in far greater abundance than in any other region in the country. Consider these facts:

- Roughly 66 percent of America's installed wind power capacity is in the West (American Wind Energy Association, 2013).
- Southwest states have some of the world's highest solar energy resource potential with national leader California's total output nearly triple that of the next largest state (Solar Energy Industries Association, 2013).
- Geothermal power is the near exclusive province of the West, with 99.5 percent of all national installed capacity in 2011 (Geothermal

Energy Association, 2012).

- The country's largest gross area of land with high biomass yield is in the Western states (National Renewable Energy Laboratory, 2012).

There's more. Clean energy sources and technology are found and utilized throughout the West. Hydropower is widespread, with the region accounting for 70 percent of national hydroelectric power generation (U.S. Energy Information Administration, 2011). The West delivered 10 percent of 2012 national nuclear power generation, much of that from Arizona's Palo Verde Nuclear Generation Station, the country's largest nuclear power facility in terms of output capacity (Mirza-Reid, 2011).

All that energy is good news for the West and its citizens. On the other hand, the broad array of resources presents a challenge. Can Western states create a comprehensive approach to energy development – taking into account the trade-offs inherent in the use of each resource and the marketplace – that delivers energy in a secure, affordable, and environmentally respectful way?

My colleagues and I at the Western Governors' Association (WGA) decided to accept that challenge by creating a "10-Year Energy Vision." The project provides an overview of the resources and technologies used in the West, the role of energy efficiency in energy planning, environmental impact associated with energy use, and the contribution and prospects for economic growth associated with energy industry activities.

The "10-Year Energy Vision" is premised on the idea that an "all-of-the-above approach" to planning our energy future is most advantageous for our region. Western Governors believe resources should compete freely in the marketplace, based on the policies and needs of our member states.

The Vision lays out the overarching goals of Western energy policy: energy security, affordability and reliability, environmental protection, a robust energy delivery system, and educational and technological development. It emphasizes the critical importance of having an effective federal-state partnership in all aspects of energy development, lands management, and environmental protection.

Western Governors consider the "10-Year Energy Vision" a first step toward a blueprint for an encompassing national energy policy that promotes economic growth while protecting our valued natural and environmental resources. We have demonstrated that states with diverse geography, resources, and politics can identify and work together toward shared goals. We hope national leaders will follow our practical, bipartisan approach.

Every vision needs a thorough grounding in the facts. So we also created "State of Energy in the West," a companion document that provides detailed background on energy resources and consumption in the West, while illustrating the importance of the West in securing energy independence for our country.

The end result: These resources provide regional energy objectives the governors can adopt to ensure future energy development is done responsibly and in the best interest of the West's citizens.

Responsible energy development in the West can drive economic growth vital to the entire country. Whether it's the extraction of conventional resources in states such as North Dakota and Wyoming, or renewable energy sources in

> "EMPLOYMENT GROWTH OF THIS KIND WILL ENSURE THE CREATION OF EVERYTHING FROM WELL-PAYING MANUFACTURING JOBS SUITED TO THE SKILLS OF WORKERS DISPLACED BY GLOBALIZATION, TO TECHNICAL AND PROFESSIONAL CAREERS FOR RECENT GRADUATES STRUGGLING TO FIND EMPLOYMENT IN A SLUGGISH ECONOMY."

California and Texas, the region's vast energy wealth will remain critical to the economy.

Our WGA vision does not dictate policy for the member states. Each will choose its own course. As each state settles on an energy strategy best suited to its population, a well-diversified regional energy development portfolio will emerge. This will lead to the addition of numerous jobs utilizing varied skill sets and educational backgrounds. Employment growth of this kind will ensure the creation of everything from well-paying manufacturing jobs suited to the skills of workers displaced by globalization, to technical and professional careers for recent graduates struggling to find employment in a sluggish economy.

Responsible development of all resources at our disposal will go a long way toward achieving energy security for the U.S., meeting all our domestic energy needs with clean, affordable and reliable North American sources. Given the vastness of the West's resources, reaching energy security is achievable.

Western states have long assumed a stewardship role for the natural environment, adapting model regulations, developing innovative solutions, and working across state lines to protect air, land, wildlife, and water. Western Governors recognize it is critical to strike balance in all activities and are committed to ensuring that energy development is done in an environmentally responsible manner.

No energy policy can succeed without broad support, so it's in our best interests to educate the public about energy, employing impartial facts and scientific evidence.

The Western Governors recognize they are in a unique position to develop broad, regional energy policies, while not impeding the ability of individual states to develop energy portfolios that meet their respective needs. As the energy breadbasket of the nation, the western states have the resources to drive job creation and economic development through broad energy industry growth while also protecting our vast and beautiful environment.

## WESTERN GOVERNORS' ASSOCIATION GOALS

1. Put the United States on a path to energy security
2. Ensure energy is clean, affordable, and reliable by providing a balanced portfolio of renewable, non-traditional and traditional resources
3. Increase energy productivity associated with electricity and natural gas
4. Establish an energy distribution infrastructure (electricity transmission and pipelines) planning, siting, and permitting system that facilitates the development of necessary infrastructure while maintaining wildlife, natural resource, and environmental protection
5. Protect Western wildlife, natural resources, and the environment
6. Make the West an international leader in energy education and the development of new energy technologies

# energy in a global world

BY DON E. ALBRECHT

Historically, the primary sources of energy for agriculture, transportation, and other human endeavors were the efforts of humans and their domesticated animals. Wood and other forms of biomass were the major sources of heat for cooking and to keep homes warm. The limitations imposed by these energy forms obviously suppressed productivity and living standards. Transportation was slow, work was tedious, and productivity minimal.

Much changed with the emergence of the Industrial Revolution. The Industrial Revolution was largely a result of the growing capacity of humans to harness and utilize fossil fuels as an energy source. Fossil fuels developed from organisms that lived long ago and over time have become transformed into coal, oil, natural gas, or other products. The increased capacity of humans to efficiently use fossil fuels as an energy source has completely transformed human life.

Fossil fuels have dramatically increased transportation speed and capacity. They are used to operate farm equipment and factories and have greatly increased the work capacity of individuals. Fossil fuels also heat and cool our homes and provide electricity to keep the lights on and to operate our televisions, radios and computers, and allow us to do so with the flip of a switch.

Additionally, fossil fuel industries provide employment for large numbers of people and contribute extensively to our economy. Yet, there are major concerns with our fossil fuel-based economy. These include:

1. The inevitable depletion of a nonrenewable resource
2. U.S. dependence on foreign energy
3. Climate changing greenhouse gasses and other forms of pollution
4. Environmental consequences of fossil fuel extraction and transport

### Resource Depletion

Fossil fuels are a nonrenewable resource. The fossil fuels we use today will simply not be available for our future generations. Resource depletion is amplified by ever increasing resource use. The world's population is growing and people are getting wealthier, both of which lead to increased consumption. As people around the world become wealthier, they desire to translate their higher incomes into an improved standard of living that includes the consumption of vastly greater amounts of energy. It is true that ever-improving technology makes it possible to use previously unusable resources. For example, recent developments in horizontal drilling and hydraulic fracturing (fracking) make it economically feasible to produce natural gas and "light tight" oil from previously unusable shale formations. While the implications of these developments are profound, fossil fuels are still a nonrenewable resource and supplies necessarily diminish when they are used.

Thus far, U.S. coal and natural gas production has been sufficient to meet demand. The same is not true of petroleum production. U.S. petroleum production increased until reaching a peak in 1970 and then began to decline as major oil fields became depleted. The amount of petroleum produced in the United States declined by 35 percent between 1970 and 2000 (Figure 1). In the past decade petroleum production in the U.S. stabilized as a result of fracking that made production from shale formations such as the Bakken in North Dakota and surrounding areas economically feasible. Until now, shortfalls in petroleum production have been offset by ever increasing oil imports. Figure 2 makes U.S. dependence on energy imports apparent. With finite fossil fuel resources, however, even international supplies must eventually become depleted.

### U.S. Dependence on Foreign Supplies

Foreign oil dependence is problematic for several reasons. First, when the U.S. imports foreign oil, it results in the transfer of massive wealth from the United States to the major oil producing countries. Furthermore, many of the oil exporting countries use oil wealth to maintain non-democratic governments and suppress human rights. Finally, for the U.S., foreign dependence means vulnerability.

A dependence on energy imports, associated with resource depletion, has led to pressure to increase production of the more abundant U.S energy resources. The U.S. has extensive known coal deposits and the emergence of fracking has allowed the production of natural gas to increase substantially (Yergin, 2011). Additionally, oil shale is a fossil fuel with massive reserves that may be critical in the future. Oil shale can be mined and processed to generate oil similar to the oil that is pumped from conventional oil wells. While oil shale is found in many places throughout the world, by far the largest known deposits are found in the Green River Formation in Colorado, Utah, and Wyoming. Estimates of the recoverable oil from the Green River Formation are three times greater than the proven oil reserves in Saudi Arabia. Extracting oil from oil shale is more complex as it has to be mined and then heated and is thus more expensive. Consequently, the utilization of oil shale is minimal. Should oil prices get high enough or extraction techniques more efficient, oil shale could play a significant role in meeting the energy needs of the future.

### Climate Changing Greenhouse Gas Emissions and Other Pollutants

Unfortunately, any energy solution based on fossil fuels enhances climate change and other pollution concerns. Increasingly, scientists are in agreement that dangerous climate change is occurring and is a result of human activities, especially the burning of fossil fuels. As fossil fuels are burned carbon dioxide, methane, and other greenhouse gasses accumulate in the atmosphere. These greenhouse gasses allow light from the sun to enter, but then trap a portion of the outward-bound infrared radiation, which makes the air increasingly warmer (Speth, 2004). Some greenhouse gasses in the atmosphere are natural and necessary. In the 19th century and before, carbon dioxide levels in the atmosphere were about 284 ppm (Emmanuel, 2007; IPCC, 2007; Speth, 2004). Carbon dioxide levels increased from 316 ppm in 1959 to 397 ppm in 2012, an increase of 26 percent in only 53 years. Also significant is that the rate of increase has become larger as progressively larger amounts of fossil fuels are being burned each year.

Evidences of climate change proliferate throughout the world. If current trends continue, the amount of greenhouse gasses in the atmosphere will continue to grow, and the consequences could be disastrous (Stern, 2007). Obviously the best way to avoid these scenarios is to reduce fossil fuel use.

### Environmental Consequences of Fossil Fuel Extraction and Transport

By its very nature, the extraction of fossil fuels is environmentally disruptive beyond simply the emissions generated. Fossil fuels are underground, and soil and rocks must be removed, tunnels dug, or wells drilled to reach them. The process of extracting fossil fuels by mining requires that the sought after resources be mixed with impurities and other unwanted materials that have to be removed. Disposing of these unwanted materials is a significant problem. Another consequence of mining for fossil fuels is oil spills. In April 2010, a massive oil spill occurred in the Gulf of Mexico following an explosion at a BP well. Estimates are that 19,000 barrels of oil per day gushed into the Gulf. Before the flow could be stopped several months later, more than 120 million gallons of oil had been spewed into the Gulf, making it the worst oil spill in world history. In 1989, the wreck of the supertanker Exxon Valdez in Alaska's Prince William Sound resulted in 260,000 barrels of oil being spilled. The implications of oil spills for wildlife and biodiversity are extensive and last for years.

### Reducing Fossil Fuel Dependence

As a consequence of these problems, there is extensive interest in decreasing our dependence on fossil fuels. Two major approaches for reducing fossil fuel dependence include increased alternative energy use and conservation.

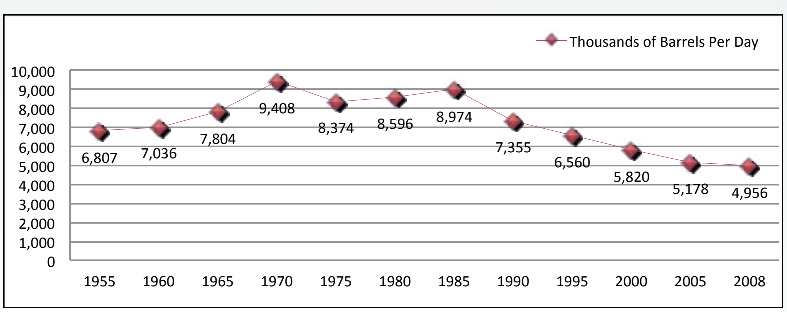



Figure 1. Crude Oil Production in the U.S. between 1955-2008.

### Alternative Energy

Two major sources of non-fossil fuel energy include nuclear power and renewable energy. Nuclear power has always been surrounded by controversy as opponents contend that it poses significant threats because of nuclear wastes which can remain dangerous for millennia; the risk that technology

“U.S. PETROLEUM PRODUCTION INCREASED UNTIL REACHING A PEAK IN 1970 AND THEN BEGAN TO DECLINE AS MAJOR OIL FIELDS BECAME DEPLETED. THE AMOUNT OF PETROLEUM PRODUCED IN THE UNITED STATES DECLINED BY 35 PERCENT BETWEEN 1970 AND 2000.”

and materials can be used to build nuclear weapons; and concern that nuclear power plants pose the risk of major nuclear accidents. Proponents of nuclear energy argue that nuclear power is sustainable, emits no climate changing greenhouse gasses, and can decrease U.S. dependence on foreign energy.

A variety of renewable energy sources represent another form of alternative energy. As opposed to the nonrenewable fossil fuels, renewable energy is generated from naturally replenishing resources such as the sun, wind, plants, and flowing water (IPCC, 2011). While the potential benefits of renewable energy are great, significant problems remain. Most fundamentally, the cost of producing renewable energy is generally more expensive than producing fossil fuel energy – unless externalities are considered. For example, producing electricity from coal is simply more cost efficient than producing energy from wind or solar – especially if the costs of greenhouse gas emissions are not considered. Also troubling are the problems of consistency and predictability. The wind doesn’t always blow and cloudy and rainy days reduce the capacity of solar energy.

### Conservation and Efficiency

An absolute necessity to assure a reasonable energy future is improved conservation. Vast amounts of energy could be saved if cars achieved better gas mileage and were driven fewer miles, if public transportation was more widely used, if we all walked more, and if homes were smaller and better insulated. While significant progress has been made, there is vast room for improvement.

### Conclusions

The utilization of fossil fuel energy has completely transformed the world in which we live. A fossil fuel economy, however, at given consumption levels is unsustainable in the long run. Thus, efforts to enhance the production of alternative and renewable energy are vital and time is of the essence. Improved energy conservation is also essential. Educational programs and policy alternatives to make reduced dependence on fossil fuels should be a top priority. By acting now, the U.S. has the potential to be on the forefront of renewable energy production, with the resulting expansion of employment opportunities and other economic benefits. The sun and wind that are so pervasive can become major economic assets. An advantage of the sun and wind, compared to fossil fuels, is that these energy sources are truly infinite.

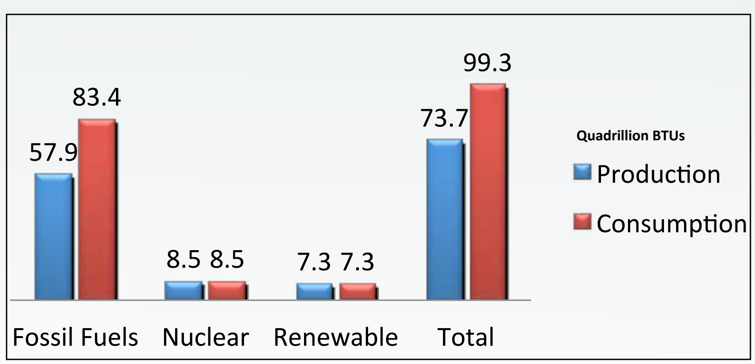



Figure 2. Energy Production and Consumption in the U.S. in 2008.

# The Sociology of Greenhouse Gas Emissions

## *A Brief Overview**

BY ANDREW K. JORGENSON AND AMANDA BERTANA

### Introduction

As noted recently in the leading scientific journal *Nature Climate Change* (Rosa and Dietz, 2012), sociologists in the past two decades have significantly increased our collective understanding of the anthropogenic drivers of greenhouse gas emissions and thus climate change. Anthropogenic, or human drivers, refers to the range of human actions that lead to the emissions of greenhouse gases into the atmosphere. In this article we briefly summarize the ways in which sociologists conduct research on the human causes of greenhouse gas emissions, and we provide a modest overview of the findings from this growing area of scientific inquiry.

We begin with a description of the different ways in which greenhouse gas emissions—specifically carbon dioxide emissions—are measured in comparative research. We continue by discussing the most frequent unit of analysis in the area of research: the nation-state. This is followed by an overview of the most common findings that concern the effects of population, economic development, and forms of globalization on national-level carbon emissions. We conclude by noting some of the likely future directions in sociological research on the human drivers of emissions.

### Different Ways of Measuring Greenhouse Gas Emissions

The dependent variable for the vast majority of sociological research on greenhouse gases is carbon dioxide emissions, measured as total emissions, per capita emissions, or emissions per unit of production (per unit of GDP). Some studies focus on one of the three carbon emissions measures, while others treat two or all three as separate dependent variables. The first measure, total emissions, focuses on scale. It is the most important measure when considering climate change, given that it is the overall accumulation of emissions in the atmosphere that contributes to global warming (e.g., U.S. National Research Council 2010). The

*The authors thank an anonymous reviewer for helpful suggestions on a prior draft.

second measure is per capita emissions. From a sociological perspective, per capita emissions assess international inequalities in carbon emissions. From this perspective, every person in the world has equal rights to the atmosphere, and the amount of allowable pollution should be determined on a per capita basis (Roberts and Parks, 2007). The third measure, emissions per unit of production (per unit of GDP), is used to quantify relative levels of ecoefficiency (European Commission, 2005).

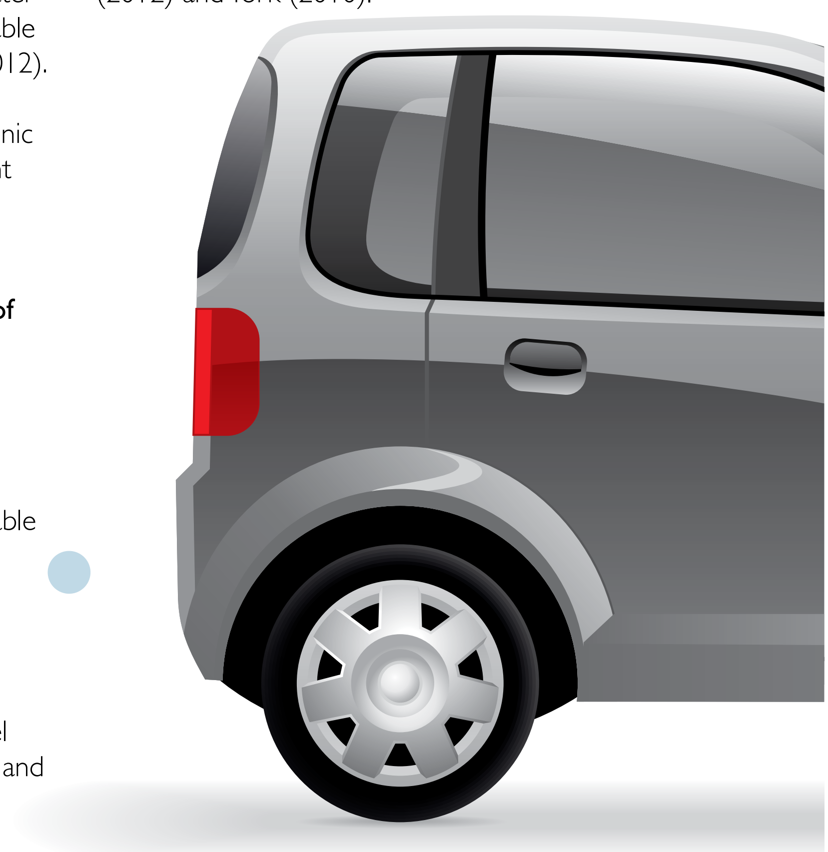
The primary reasons that sociologists employ measures of carbon dioxide emissions as dependent variables are threefold (Jorgenson and Clark, 2012). First, there is scientific consensus that anthropogenic carbon dioxide emissions are a primary contributor to climate change (U.S. National Research Council, 2010). Second, countless economic-related activities require the burning of fossil fuels, which results in carbon dioxide emissions. Third, there are much more data available for anthropogenic carbon dioxide emissions than any other type of greenhouse gas (e.g., methane) or environmental degradation (e.g., industrial water pollution, deforestation), and these data are reliable and valid for empirical research (World Bank, 2012). However, sociologists have conducted a small number of cross-national studies on anthropogenic methane emissions as well, which is also a potent greenhouse gas (e.g., Jorgenson, 2006; Jorgenson and Birkholz, 2010; Rosa et al., 2004).

### The Nation-State as the Most Common Unit of Analysis

The nation-state is the unit of analysis in the majority of sociological research on the drivers of anthropogenic greenhouse gas emissions. The primary reasons for this are twofold. First, and increasingly so, there are simply more data available for dependent and independent variables at the nation-state level to do comparative analyses of greenhouse gas emissions. Second, foundational theoretical perspectives in sociology and sister disciplines that are of relevance for drivers of emissions research largely focus on country-level characteristics and interrelationships (Jorgenson and Clark, 2012).

### Common Findings

The body of sociological research on national-level greenhouse gas emissions provides robust evidence that population size is a primary anthropogenic driver of total carbon emissions, and development is a primary driver of per capita and total carbon emissions. Further, there is mounting evidence that economic globalization characteristics increase total and per capita emissions in lower income nations while forms of political globalization have the opposite impacts. We briefly review these consistent findings in the following paragraphs. However, for emissions per unit of production the findings up to this point are quite mixed. These mixed results have led some researchers, including the first author of this article, to call into question the utility of such a measure of carbon emissions for policy-relevant research. This is a significant issue well beyond the scope of the current discussion, and will likely continue to garner attention and serious debate in academic and policy communities. For more in-depth sociological discussions on this issue, we direct readers to Jorgenson and Clark (2012) and York (2010).



In the context of total emissions, and as expected, population size is consistently found to be a key societal-level driver. This holds for both cross-sectional studies (e.g., Rosa et al., 2004; York et al., 2003) as well as longitudinal studies (Jorgenson and Clark, 2010). Cross-sectional studies are those that focus on relationships between a dependent variable and independent variable for one time point, and thus provide a snapshot of relationships. However, such modeling techniques don't focus on how changes through time in independent variables might lead to changes through time in dependent variables. Earlier sociological research on drivers of emissions tended to be cross-sectional due to data availability constraints. Fortunately, longitudinal data for most nations in the world are now readily available, allowing researchers to analyze changes through time, and such approaches are better suited at assessing causal relationships using sophisticated modeling techniques. While longitudinal studies consistently show that population size is a key factor, they also show that the estimated effect of population size on total national-level emissions has remained relatively stable through time, and this holds for both high income and lower income nations (Jorgenson and Clark, 2010), but with some moderate regional-level variation (Jorgenson and Clark, 2013).

Research also provides robust evidence that at the national level, affluence is a primary driver of emissions. More specifically, in cross-sectional and longitudinal analyses of (1) total carbon emissions (Rosa, et al., 2004) and (2) per capita emissions (Jorgenson, et al., 2007; Roberts, et al., 2003), levels of affluence or levels of economic development (measured as GDP per capita) exert positive effects, meaning higher levels of affluence/economic development, higher levels of emissions. A common explanation is that economic development is a treadmill-like process that requires ongoing and potentially increasing amounts of material inputs, which can lead to increases in levels and rates of waste, including carbon emissions (Gould et al., 2008). It is indeed empirically verified that development often involves technological advances that lead to increased efficiency in fossil fuel use (Mol et al., 2009), but the benefits accrued through such technological inputs are to some extent outstripped by the harms associated with the increasing scale and intensification of production and energy use that accompanies it (Jorgenson and Clark, 2012). In other words, technological advances by themselves that increase energy efficiency are not able to effectively lower carbon emissions associated with societal-level economic development (Polimeni et al., 2009).

Longitudinal research shows that the estimated effect of affluence/economic development on carbon emissions changes through time for some nations relative to others. For example, in a study recently published in American Journal of Sociology (Jorgenson and Clark, 2012), the authors found that for high income nations, the estimated effect of development on total carbon emissions slightly decreased in size from 1960 to 2005, while for lower income nations the estimated effect remained large and stable through time. For per capita emissions, the estimated effect of development remained large and stable for high income nations, but slightly increased in magnitude in lower income nations for the same 45-year period. Further, the effect of development on per capita emissions is much larger in high income nations than in lower-income nations and continues to be so for the entire period covered in the study. In a similar study of transition economy nations in Central and Eastern Europe for the 1992 to 2005 period, Jorgenson, Clark, and Giedraitis (2012) find that the estimated effect of development on total emissions, per capita emissions, and per unit of production emissions increased in magnitude through time, indicating that whatever development took place in these nations during this period

tended to be more energy intensive, carbon emitting, and relatively less energy efficient (see also York, 2008).

Other sociological research suggests that the non-trivial changes in the estimated effects of development on total and per capita emissions in high income nations relative to lower income nations are to some extent tied to economic globalization dynamics, especially the shifting of much manufacturing and related activities to lower income nations, with the goods largely produced for the consumer markets in high income nations and emerging economies of various middle income nations (McMichael, 2012). More specifically, research shows that the globalization of production and the globalization of trade have contributed to increases in carbon emissions in lower income nations (Jorgenson, 2009, 2012; Roberts and Parks, 2007) as well as the transition economy nations in Central and Eastern Europe (Jorgenson, 2011). Such results illustrate the growing challenges associated with sustainable development since other bodies of research suggest that economic globalization often stimulates economic development in lower income and transition economy nations, but such globalization dynamics also exert unintended environmental consequences, and in the context of carbon emissions these shifts and relationships are commonly referred to as environmental load displacements (Hornborg, 2009) or ecologically unequal exchanges (Jorgenson, 2012).

On the other hand, sociological research shows that forms of political globalization, such as the increasing number of environmental international nongovernmental organizations with members and offices in lower income nations, are able to partially mitigate the harmful effects of economic globalization on carbon emissions through the pressuring of facilities to use more environmentally friendly methods and for governments to enforce new and preexisting environmental regulations (Jorgenson et al., 2011; Schofer and Hironaka, 2005; Shandra et al., 2004). They are also likely to increase individual-level concern for the environment, and such civil society attitudes if strong enough often lead to the formation of social movement organizations and other citizen groups that can potentially influence firms to increase their environmental standards and thus reduce their carbon emissions (Givens and Jorgenson, 2013).

**Conclusion**

In the past two decades a noteworthy body of research conducted by sociologists indicates that national-level carbon emissions are largely caused by certain demographic and economic characteristics, some of which change through time. Characteristics of economic globalization contribute to increases in emissions in lower income nations, while forms of political globalization appear to have opposite effects, the latter of which is encouraging from a sustainability perspective. This research also identifies the clear limitations in focusing solely on technological solutions to reducing emissions. Without doubt, future sociological research will likely continue to identify human factors that contribute to national-level emissions. Perhaps more importantly, with increasing availability of data at smaller units of analyses, such as the U.S. State level, the city level, and even the facility level (e.g., power plants), future comparative research will begin to identify the human drivers of emissions at these smaller scales. Overall, such future studies at multiple scales will lead to a broader and deeper understanding of the human dimensions of global climate change, and this broader and deeper understanding will be critical in the formation of more effective mitigation policies and programs for dealing with reducing greenhouse gas emissions.

# Renewable Energy:

## Implications for Rural Development and Rural Policy in the Intermountain West

BY PETER G. ROBERTSON AND RICHARD S. KRANNICH

### Introduction

Perhaps you've seen them as you head down the highway or drive across the desert – the 300-foot tall, stark white towers and slowly turning blades of a wind turbine, or the glint of the sun off a field of matte black and slightly iridescent photovoltaic solar panels. If you haven't seen these signs of renewable energy development you will likely notice them soon, as wind and solar energy facilities are expanding at a breakneck pace across much of the U.S. While it still plays a modest role in overall electrical generation capacity, growth in renewable energy production has been nearly exponential over the past decade. And, if forecasts such as those developed by the U.S. Energy Information Agency (2013) are correct, the rapid growth will continue and complexes of wind turbines and solar panels will become increasingly widespread nationally and across much of the Intermountain West.

As is the case with all large-scale industrial and technological facilities, the development of utility-scale renewable energy brings with it both "opportunities" and "threats" for the rural areas and communities where these facilities are sited (see Gramling and Freudenburg, 1992). Claims and expectations regarding the presumed environmental and economic benefits of renewable energy are counterbalanced by an equal number of concerns about their potential to have negative environmental as well as socioeconomic impacts. In this article we discuss public support as well as opposition to renewable energy, and examine both opportunities and threats that help to account for varied response to such facilities. We also selectively focus on development patterns and issues that are especially relevant to the Intermountain West, a region with considerable renewable energy development activity and potential in which the presence of extensive public land areas may influence the nature of both project effects and public response.

### Opportunities and Threats of Renewable Energy Production

Future growth of renewable energy could offer economic development opportunities in places that have strong winds or many sunny days, as these facilities can create new tax revenues as well as jobs and other income opportunities. Also, with growing pressure to reduce carbon emissions from the nation's electrical generating system, renewable technologies offer a way to expand generating capacity without releasing the pollutants produced by natural gas or coal-fired power plants.

Renewable energy production is strongly supported by the public – a March 7, 2013 national poll found that 76 percent and 71 percent of respondents think the U.S. should rely more on solar and wind energy, respectively (Gallup, 2013). As indicated in Table 1, support is also generally strong among those who live in the Intermountain West – while levels are not as high as those reported in national polls, solar and wind power are the most widely supported forms of energy production among residents of this region.

Despite strong growth, forecasts of future expansion, and broad-based public support, successful siting of renewable energy facilities is not guaranteed. Indeed, a recent study indicates that nearly half of proposed wind projects in the U.S. have been blocked at the local level (Pociask and Fuhr, 2011). While renewable energy may be broadly supported as a general idea, actual renewable projects often encounter substantial opposition. Almost invariably some local residents will resist the development of wind farms or other renewable energy facilities in places near where they live (Pasqualetti, 2011). Projects are also sometimes opposed by environmental groups, as has occurred with solar projects in the Mojave Desert that could threaten an endangered tortoise species. Public concerns about renewable projects vary widely, but most commonly include fears that they will spoil views, create unwanted noise, cause harm to wildlife (especially birds) and wildlife habitat, or lower surrounding property values. Concerns about possible human health effects from low-frequency vibrations produced by wind turbines have also been raised. Opponents sometimes object to government subsidies that renewable projects receive, or argue that these facilities are an unreliable form of energy production. In addition, opposition is often linked to concerns that local communities and rural areas bear the brunt of potentially adverse effects associated with these facilities, while most economic benefits as well as newly-generated electricity are sent to other, primarily urban, places.

While opposition to renewable projects is a common occurrence, it is by no means a universal reaction. Some proposed developments are welcomed with open arms by the local community, as was the case for the First Wind project developed during 2009-2011 in Beaver County, Utah, near the town of Milford. Some residents and local officials in Milford and Beaver County actively pursued wind power, and initiated contact with potential developers after noticing and studying just how windy the area tends to be (for more on this story see the suggested links).

Renewable energy development can bring important benefits to places like Beaver County (see Figure 1 for the location of this and other renewable energy projects in Utah). The creation of many construction-phase jobs, along with expenditures on goods and services by developers and workers during the construction period, can provide a substantial short-term boost to rural economies. And, while operations-phase jobs are few in number and most often filled by workers relocating from other areas, even a handful of new jobs for local residents can be important in places where employment opportunities are limited. In addition, such facilities have the potential to produce substantial new tax revenues for counties and other local units of government (for a more detailed overview of the economic benefits of wind energy projects see "Wind Energy Development and Education in Northeastern Colorado," in the November 2008 edition of Rural Connections).

Especially significant for sparsely populated rural areas like Beaver County is the tax on capital investments and facilities. Wind turbines and solar arrays are expensive, and taxes on these facilities can, at least over the short term, provide considerable new revenue. For Beaver County,

Table 1. Responses to "Which of the following sources of energy would you want to encourage the use of here in your state?"

| ENERGY TYPE | Arizona | Colorado | Montana | New Mexico | Utah | Wyoming |
|---|---|---|---|---|---|---|
| SOLAR POWER | 74% | 56% | 29% | 56% | 39% | 21% |
| WIND POWER | 43% | 56% | 53% | 43% | 47% | 44% |
| NATURAL GAS | 20% | 24% | 33% | 31% | 39% | 42% |
| ENERGY EFFICIENCY EFFORTS | 18% | 19% | 17% | 15% | 14% | 11% |
| OIL | 8% | 13% | 19% | 18% | 17% | 21% |
| COAL | 6% | 8% | 28% | 8% | 16% | 41% |

Source: Conservation in the West Poll, 2013 Western States Survey, The Colorado College State of the Rockies Project.

in the years immediately following development, revenue from the First Wind project provided nearly two-thirds of the county's total tax income. Almost as significant as the actual revenue is that this new money generally comes with few obligations for public services. While other large-scale developments often bring an influx of workers and their families that requires increased expenditures on roads and other public infrastructure, school programs, and services like law enforcement and public health care programs, renewable energy facilities generate few such demands.

Renewable energy development is also widely perceived as creating fewer and less severe environmental problems compared to those that can accompany the extractive and resource processing industries that remain important to many rural areas. In addition, renewable facilities carry considerably less stigma than some other industries, such as landfills or waste incinerators that are often attracted to sparsely populated rural settings.

Despite assertions regarding economic and environmental benefits and generally favorable public opinion, renewable energy development faces multiple uncertainties that may limit its potential for contributing to rural economic development. Those who expect such facilities to create major new employment opportunities are often disappointed by what actually occurs. Even very large wind or solar installations need just a few long-term employees on site. And, while there can be a short-lived employment boom during the construction phase, most of the labor needed for both construction and operation tends to be imported. In most rural areas the locally-available workforce is unlikely to have the technical expertise needed to either install or operate these highly advanced energy facilities.

Another disappointment for local governments is how rapidly the tax revenue generated by renewable energy development can decline. Renewable energy projects typically offer significant new public revenues in the short term. However, because the main source of tax revenues is the value of the solar panels or turbines, a rapid depreciation in the assessed value of this capital equipment can cause revenues generated by such projects to drop precipitously over just a few years. This can pose a challenge for local governments as they attempt to balance use of an initial fiscal windfall to address infrastructure and service provision needs against the prospect of rapidly-declining revenue flows over the longer term.

The development of renewable energy projects can also exacerbate concerns over the influence of non-local decision-making authorities. While local populations and governments are most likely to experience impacts resulting from such developments, local citizens and officials often have little influence over how, where, and when project activities occur. Corporate officers make decisions about project planning and implementation, and negotiate power purchase agreements and connection to transmission infrastructure with other corporations. The federal government sets policies that determine renewable energy subsidies, tax credits, and loan guarantees that promote or constrain development of these technologies. In areas of the West where development may occur entirely on public lands, environmental review and permitting decisions are controlled by federal agencies. Also beyond local control is the rate and schedule of taxation of these projects, as those are determined by state authorities. In addition, state governments set renewable energy goals and requirements that determine future demand for renewable energy production.

Renewable energy development is also subject to a number of larger-scale external forces that make future development prospects uncertain. One such limitation is the intermittent nature of the sun and the wind, which necessitates the continued use of traditional energy sources to provide stable base-load electric power generation. In addition, technological advances involving other energy production options can undercut the financial "bottom line" of renewable energy. For example, rapid expansion of natural gas production as a result of directional drilling and "fracking" processes is one such technological development that has shifted the landscape for U.S. energy production in recent years, and probably slowed the growth of renewable energy systems. Similarly, anticipation of technological innovations that could lead to better, cheaper solar panels or wind turbines can undermine the confidence of companies considering investment in renewable energy based on technologies that are now available. The enormous size of the existing electric power production and distribution system is another barrier for renewable energy. The current electrical system has been in development for over a century, and transformation to a system powered in large part by renewable energy will take considerable time – perhaps not just many years, but many decades (Smil, 2005).

The future of policies and programs that have spurred renewable energy development is also unclear. The federal government has been unwilling to commit to an extension of favorable tax credits and other renewable energy incentives for more than one year at a time. Many of the areas with the best renewable energy potential are located at great distances from urban centers where demand for new electric power supplies is greatest, and the resulting requirement for long-distance power transmission creates several important uncertainties. High power transmission lines are expensive to construct. They also often generate substantial concern about environmental effects and spawn public opposition that extends across multiple states and localities. In addition, states like California with the highest renewable mandates and demand are shifting requirements regarding the extent to which renewable power must be derived from in-state rather than out-of-state sources, contributing to uncertainty about the viability of future renewable energy development in other western states. Also, some electric utilities have been reluctant to enter into long-term power purchase agreements with renewable energy producers, and some have sought to cancel previously-established contracts as the price of electricity fluctuates and they seek cheaper sources.

Despite these limitations and uncertainties renewable energy production is expected to continue to grow for the foreseeable future. With many ideal wind and solar resources located throughout the region, residents of the Intermountain West region will almost certainly encounter growing numbers of solar and wind energy facilities. Our research has illuminated a number of ways that renewable energy might contribute positively to rural development. However, renewable energy development can also lead to unfulfilled expectations, unanticipated effects, and adverse consequences. Although there is some uncertainty about the near-term trajectory of renewable energy development, such systems will undoubtedly become more widespread as technologies improve and electric power demand continues to increase. As renewable energy development moves forward, those responsible for decisions about facility siting and regulation should carefully consider both the "opportunities" and the "threats" that accompany these systems.

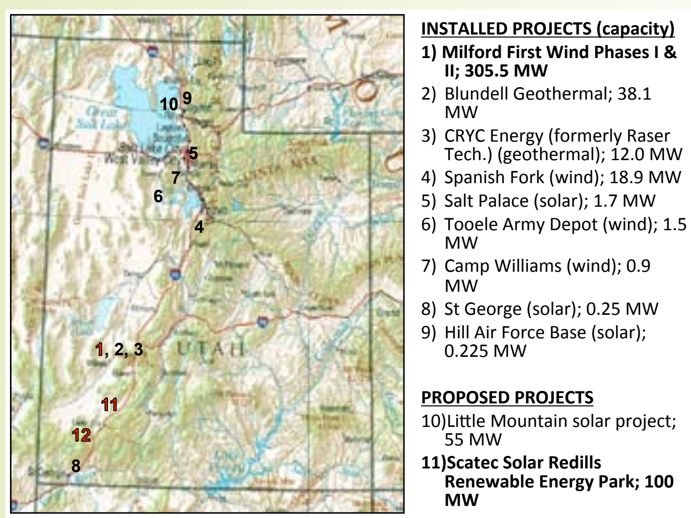



Figure 1. Current and Proposed Renewable Energy Projects in Utah. Source: U.S. Geological Survey 200. 2002: http://www.lib.utexas.edu/maps/utah.html

# WIND DEVELOPMENT AS 'SUSTAINABLE ENTREPRENEURSHIP'

BY EDWIN STAFFORD AND CATHY HARTMAN

PICTURED: Tracy Livingston at the Spanish Fork Wind Project, 2009. Photo by Michelle Nunez.

## Introduction

The public discourse about energy in the West often centers on federal government policies and their impact on economic development, land use, and protecting the environment. The issues are complex, but are often simplified into discordant narratives, such as America's need for "energy independence" and an "all of the above strategy" to "drill, baby, drill" to the "war on coal" and the promise of "green jobs" to the federal government's "picking losers," as in the case of Solyndra, a failed solar company that received federal loan guarantees. Such framing of issues into catchphrases and bumper sticker slogans ultimately proves obfuscating and politically divisive, leading to policy gridlock and uncertainty for energy markets and business development.

While federal policies are important issues, make-or-break decisions about energy development are made ultimately at the local community level in the chambers of city councils and town hall meetings. Renewable energies, such as wind, solar, and geothermal technologies, increasingly pose significant, if novel economic opportunities to revitalize Western, rural communities and steer them onto cleaner, more sustainable paths. What are often left out of public conversations, however, are how private businesses and entrepreneurs might step up and dare to navigate the renewable energy development process, especially in communities that haven't hosted renewable energy projects before. Our research indicates that it takes vision, perseverance, business and political acumen, and daredevil risk-taking to commit the time, talent, and money necessary to transform renewable energies into viable businesses.

Over a four year period, we witnessed firsthand how an idealistic entrepreneur, Tracy Livingston, and his engineering colleague, Christine Mikell, took on Utah's utility industry to build the state's first commercial wind power plant. Their efforts resulted in a small 18.9 megawatt project of nine turbines at the mouth of Spanish Fork Canyon in 2008, sufficient to power over 6,000 homes in the community annually (Hartman et al., 2011). Livingston's company, Wasatch Wind, had to not only convince skeptical utilities, policymakers, and citizens about the viability of wind energy as a cleaner, more sustainable alternative to Utah's traditional fossil fuels (coal, natural gas), but also demonstrate how the wind farm would create worthwhile local benefits, including local job creation, lease payments to local landowners, and property tax revenues for community services, such as the funding of schools, libraries, and fire protection (see Hartman et al. 2011). Some tasks were unanticipated and appeared beyond the scope of traditional business entrepreneurship, but reflect renewable energy development's on-the-ground realities.

Our case research about the Spanish Fork Wind Project has resulted in our publishing numerous academic articles, papers and educational materials as well as our co-producing the award-winning documentary, Wind Uprising (2010), with filmmaker, Michelle Nunez of GreenTech Films. We've been presenting our research to stimulate discussion in rural communities across Utah and the West.

### Sustainable Entrepreneurship

An emerging concept called sustainable entrepreneurship provides an informative lens for uncovering insights about how renewable energy development can create a "win-win" for both entrepreneurs and local communities.

Sustainable entrepreneurship is defined as the exploitation of business opportunities to create goods and services that sustain the natural and/or communal environment and provide economic and social gains for others (Patzelt and Shepherd, 2011). Whereas traditional entrepreneurship uses finance and business acumen to transform innovations into economic goods (such as new products or technologies) for business gains, by contrast, sustainable entrepreneurship leverages those business skills to transform environmentally-protective innovations (such as renewable energy) into economic and social gains for the entrepreneurs and other relevant groups, such as local host communities.

Patzelt and Shepherd (2011) assert that sustainable entrepreneurs engage in a three-step process to evaluate sustainable business opportunities: (1) recognition of environmental problems and their solutions; (2) evaluation of the market feasibility of those environmental solutions and self-assessment of one's acumen to implement those solutions as a viable business; and (3) actual implementation of the business and environmental solution. In our interviews for the documentary, Livingston explained to us that in the early 2000s, he recognized Utah's dependence on coal for electricity and air quality challenges. He also followed ongoing news reports about Utah's dwindling "economically-viable" coal reserves, and the need for utilities to diversify their electricity portfolios. With a desire to make a "difference in the world," Livingston believed he could advance wind energy as a viable business in Utah (see Wind Uprising 2010).

"RENEWABLE ENERGIES, SUCH AS WIND, SOLAR, AND GEOTHERMAL TECHNOLOGIES, INCREASINGLY POSE SIGNIFICANT, IF NOVEL ECONOMIC OPPORTUNITIES TO REVITALIZE WESTERN, RURAL COMMUNITIES AND STEER THEM ONTO CLEANER, MORE SUSTAINABLE PATHS."

Our analysis of Livingston's and Mikell's journey identified four key interrelated entrepreneurial sub-tasks or roles that were essential for establishing the Spanish Fork Wind Project. As business entrepreneurs, Livingston and Mikell had to identify locations conducive for a wind project, attract investors, and sell its energy. That, however, was just the beginning.

Livingston and Mikell found that how federal laws were going to be implemented adversely-affected wind development. Consequently, they brought their concerns before regulators to enact change, taking on the task of policy entrepreneurs, defined as individuals or organizations that operate from outside government to establish and promote policy or institutional changes (Weissert, 1991).

Additionally, Livingston and Mikell had to identify and incorporate local community benefits into their wind project to win approval, taking on the role of social entrepreneurs, defined as individuals or organizations that seek to develop opportunities to enhance social gains (Zahra et al., 2009).
Finally, Livingston and Mikell found that it literally "takes a village" to develop a wind project and playing collaborative entrepreneurs, they initiated coalitions and forged networks with other groups and supporters to tap the necessary expertise, resources, and assistance to overcome myriad political, siting, market, and social barriers facing their novel wind project. In short, sustainable entrepreneurship requires engaging successfully in multiple functions, often simultaneously, to bring sustainable innovations to market. It is through this lens that we recount some important milestones of the Spanish Fork Wind Project story to distill important lessons for entrepreneurs, policymakers, and community leaders.

### Putting a Business Together

As business entrepreneurs, much of Livingston's and Mikell's initial work focused on identifying feasible wind farm locations that had good, predictable winds and nearby transmission. An abandoned gravel pit at the mouth of Spanish Fork Canyon appeared most promising, but the city engineer wouldn't approve it given his fears that its proximity could contaminate the city's nearby water springs.

A new location for the wind turbines was identified that brought the wind plant much closer to homes. Environmental impact and noise studies were commissioned, and local residents were invited to a town hall meeting to discuss the project in

April 2005. About 60 citizens attended and were generally welcoming of the project. The city council ultimately approved the project's location in June 2005. Once an investor was procured, all that remained was finding a utility to buy the wind power.

## Setting New Pricing Rule

Livingston soon realized that he had a problem when it came to selling his wind power in a regulated market. He had only one prospective customer, Rocky Mountain Power (RMP), because the utility owned the transmission substation near the proposed project site. Under the Public Utility Regulatory Policies Act (PURPA) of 1978, RMP was obligated to buy Wasatch Wind's electricity, but only at the price of its "avoided cost" – the utility's cost to produce that power itself or buy it from another source. RMP set that cost using its existing power-generation infrastructure (derived mostly from depreciated coal-fired plants), a level that was below Livingston's break-even point.

Deadlocked in negotiations, Livingston and Mikell appealed to the Utah Public Service Commission. Playing policy entrepreneurs, they argued that basing the purchase price of new wind power on the cost of old depreciated, coal-fired power plants didn't square with prevailing competitive market prices for new energy development; even new coal and natural gas plant prices could not meet the cost function of the utility's existing power sources.

After heated debate, Livingston and other supporters convinced the Commission to implement PURPA by requiring that RMP use a "market proxy" for future wind energy purchases at the same price the utility was already paying for wind power from a larger project in another state that it had accepted previously in a competitive bidding process. Enacting this policy change not only made Wasatch Wind's project economically viable, but also established pricing certainty for future Utah wind development. The lesson here is that sustainable entrepreneurship may warrant identifying how existing local and state policies may inhibit sustainable technology acceptance and adoption, and entrepreneurs, policymakers, and community leaders may need to invest time and resources to change the implementation of those policies.

PICTURED: Spanish Fork Wind Project, 2009. Photo by Donna Barry.

### What's in it for Spanish Fork?

During the contentious Public Service Commission hearings, an unexpected uprising of citizen resistance erupted over the proposed wind project (Stafford and Hartman, 2012). Spanish Fork TV's re-broadcast of the city council meeting approving the wind project's location startled some residents. Claiming that they had not been consulted about the project, residents demanded a moratorium to evaluate how the turbines would affect nearby home values, local noise levels, and the community. "What was in it for Spanish Fork?" they asked.

Worried that their proposed project was unraveling, Livingston and Mikell raced to a city council meeting to convince residents that the wind farm would be a "positive" for the community. Taking on the role of social entrepreneur, Livingston explained to a room of over 200 fired-up residents about how the project would generate $2.4 million in tax revenues over the wind project's life, representing the single largest revenue stream for the city for the next 20 years. "This is a perpetual legacy for Spanish Fork City," he explained. Livingston also talked about a Utah State University study noting that most of those new tax revenues would go to the local school district; further, the local construction and operational jobs for the project would boost local spending in the community's restaurants, lodging, and shops.

Citizen concerns, ultimately, were resolved with a compromise to move the project away from homes back to Wasatch Wind's original site on the gravel pit near the city's water springs. This required the re-doing of several development steps at considerable additional expense for Wasatch Wind. Ironically, an independent engineering study indicated that wind turbines would do no harm to the area's water springs; had the city allowed such a study beforehand, considerable time, aggravation, and money could have been saved.

Two lessons emerged from this episode: One, entrepreneurs and local city officials need to maintain open communications with communities throughout the wind development process; and two, they also need to be cognizant of how a proposed wind project's local benefits are understood and disseminated throughout the host community. Long-term social initiatives may need to be incorporated into the wind farm's overall business plan. For example, First Wind's project in Milford, Utah, has included the funding of scholarships for college-bound high school students and sponsorship of the annual Science Bowl to demonstrate the company's commitment to local technology and science education. Developers and local policy makers may direct wind project proceeds to specific service needs, such as the construction of rural hospitals or operations of bookmobiles or ambulances so that the local social benefits of wind energy are made visible (Stafford and Hartman, 2012). In short, social benefits need to be made tangible in host communities.

### Building Coalitions and Partnerships

Much of the success behind the Spanish Fork Wind Project was the result of the collaborative relationships Livingston and Mikell forged along the way. When facing the Public Service Commission, for example, Livingston and Mikell got help from representatives of Utah Clean Energy and an economics professor who helped construct the competitive "market proxy" policy proposal and testified on its behalf. Winning community support for the project also came from engaging with local renewable energy champions and the Utah Wind Working Group, a volunteer multi-stakeholder group of supporters and utility representatives who advised the Utah Energy Office. When a key tax incentive expired during the develop process, many of these individuals testified before the Utah State Legislature to support passage of a new incentive to ensure Wasatch Wind's project remained economically-viable.

Building supportive coalitions with likely beneficiaries from the project is also important. One critical ally was the local school district. When Livingston requested his project be designated as a "community re-development area" to procure a temporary property tax reduction to cover the additional expenses incurred from the delays and relocation of the project to the gravel pit, school officials were in favor of it as they recognized the wind farm's long-term property tax revenue stream would benefit the school district's future. Proactively forging collaborative relationships to tap necessary resources and support is critical to navigate the nexus of policy, market, and social community issues.

### Wind Development Today

Wind power development continues to face challenges. Although U.S. wind power capacity grew 28 percent in 2012, representing 42 percent of the nation's new electric generating capacity, this hyper-growth was driven largely by developers racing to develop wind projects to take advantage of the federal Product Tax Credit (PTC) that was scheduled to expire at the end of 2012 (Mangalonzo, 2013). The PTC provides a 2.2 cent per kilowatt-hour benefit for a project's first ten years of operation, and Congress extended the PTC by one year at the last minute. The uncertainty of the PTC, nonetheless, forced wind developers, wind turbine manufacturers, and their supply chains to scale back operations in 2012 in anticipation of a development slow-down. The on-again, off-again nature of the PTC in the past has resulted in boom-and-bust cycles for wind energy, and critics charge this as evidence of wind energy's dependency on federal subsidies. Ironically, the vast subsidies offered to competing fossil fuels and nuclear power (e.g., drilling, water, waste management, infrastructure, etc.) are embedded in tax code and don't expire (e.g., Kocieniewski, 2010; Plumber, 2013). Consequently, such subsidies are not subject to periodic votes and debates in Congress for renewal, providing those industries a predictable and stable policy environment that wind energy does not enjoy.

Other challenges facing wind energy include low natural gas prices, which currently makes gas-fired electricity more economically-competitive (Johnsson and Chediak, 2012), growing state-level political movements to repeal Renewable Portfolio Standards that require states to procure a certain percentage of renewable energy by certain target dates (e.g., Ohio seeks to be powered by 25 percent renewable energy by 2025) (Lubber, 2013), and increasing resistance to wind farms in local communities (Stafford and Hartman, 2012). These are some of the political, social, and market forces that wind developers must negotiate while working through local development issues.

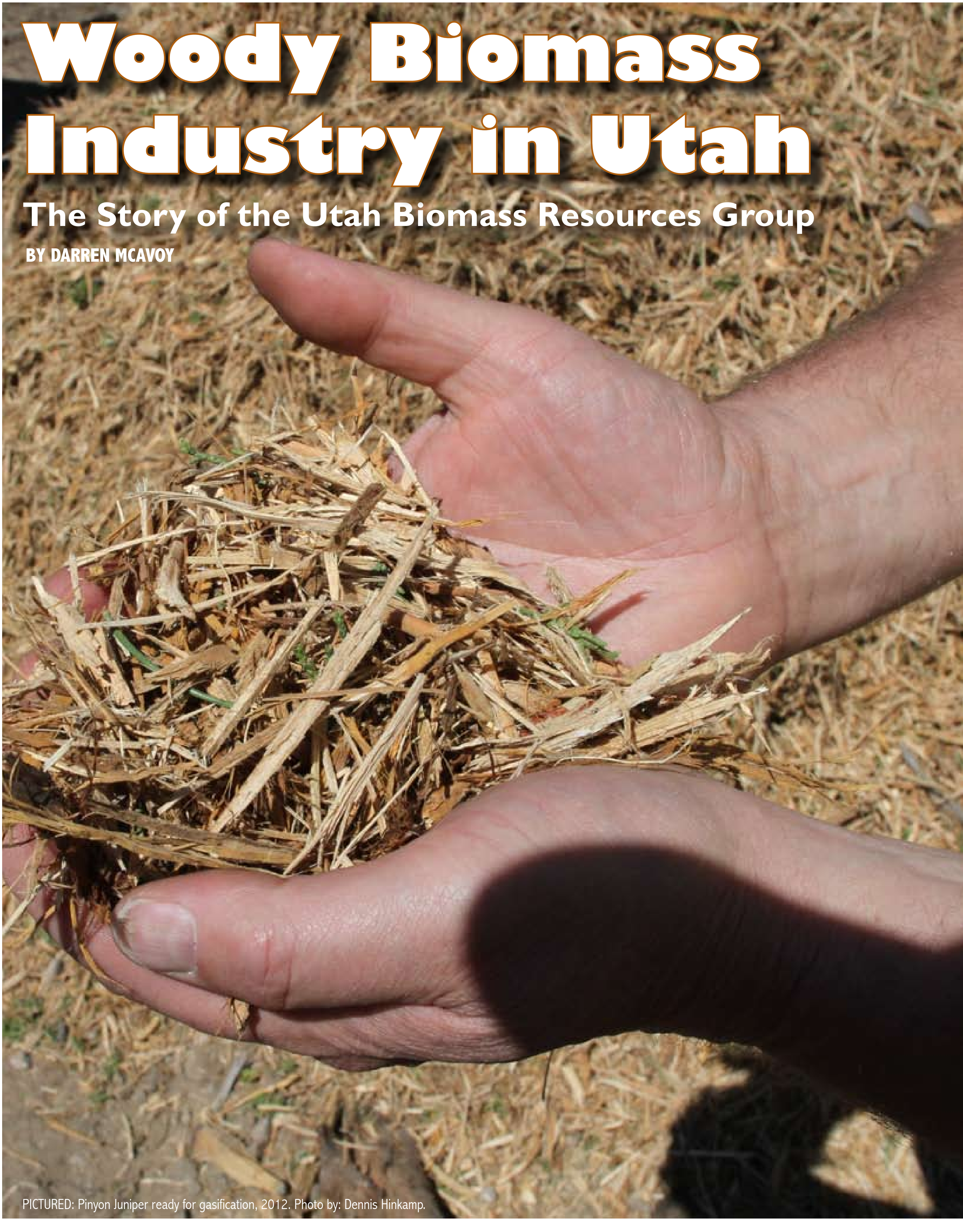
In 2008, Livingston and Mikell knew they were not just building a wind farm, but jumpstarting a new clean energy industry in the state. Analyzing their journey through the lens of sustainable entrepreneurship illuminates the multiple entrepreneurial roles that are necessary to overcome the significant policy, market, and community barriers that face the forging of sustainable innovations into businesses. While other emerging sustainable initiatives, such as solar farms, plug-in station infrastructure for electric vehicles, and electric-powered public transport, may face different hurdles and circumstances, our analysis informs and prepares developers, policy makers, and community leaders about the likely struggles they may face to launch such enterprises and achieve economic, social, and environmental gains for their communities.

PICTURED: Cathy Hartman conducts an interview for the documentary, Wind Uprising, about the development of the Spanish Fork Wind Project, 2008. Photo by Betty W. Stafford.

# Woody Biomass Industry in Utah

## The Story of the Utah Biomass Resources Group

**BY DARREN MCAVOY**



PICTURED: Pinyon Juniper ready for gasification, 2012. Photo by: Dennis Hinkamp.

The Utah Biomass Resources Group (UBRG) has a mission to facilitate the development of a woody biomass industry in Utah and to promote public biomass education and outreach. Part of that mission is being accomplished with music. The UBRG hosted Utah's first-ever wood fired concert in September of 2012 under the pavilion on Main Street in Beaver, Utah. The Dragon Wagon, Utah State University's mobile gasification demonstration unit, supplied power for the concert. The Muddy Boots Band played country rock for 150 people while USU Extension Agent Mark Nelson cooked burgers for the crowd. This was part of the third annual Southern Utah Biomass field days, co-hosted by Southern Utah Biomass, USU Beaver County Extension and the UBRG.

PICTURED: Muddy Boots Band plays a biomass-fueled concert, 2012. Photo by Darren McAvoy.

The Dragon Wagon is a former Air Force delivery van that was retrofitted to haul a gasification reactor and electric generator. This unit is designed to demonstrate how woody biomass can be converted directly into electricity. The project is funded by a USDA Forest Service "Fuels for Schools" grant that was awarded to the UBRG by the Utah Department of Agriculture and Food.


PICTURED: Dragon Wagon and the mobile gasification unit, 2012. Photo by Darren McAvoy.

In gasification, a controlled amount of oxygen reacts with the biomass at a high temperature, 800 degrees C. When the wood is cooked in this fashion, gasses are released and captured. Under these controlled conditions, there are very few emissions from the process. The gasses produced from the wood chips are piped into a standard propane generator that produces electricity. This system makes about 8 kilowatts of power, approximately enough for one or two homes, or one loud country rock band.

**UBRG Goals, Partnerships, and Strategies**

The UBRG's goals include seeing woody biomass markets established and available to Utah landowners and land managers in Utah while improving the economy of forest management activities. This will allow more acres to be restored to a more resilient form while adding jobs and value to rural economies. The UBRG is taking a variety of approaches toward meeting those goals including the development of gasification and pyrolysis technologies, promotion of biochemical and conventional products, and the advancement of cofiring and educational opportunities. Led by Utah State University Extension, the project partners include the Bureau of Land Management, the USDA Forest Service, the Utah Department of Agriculture and Food, Amaron Energy, the Utah Division of Forestry, Fire and State Lands, the Utah Office of Energy Development, and others.

Part of the UBRG's strategy is to initially focus efforts on Pinyon Juniper (PJ) woodlands and branch out to include upland forests and other biomass feedstocks. PJ is plentiful and available and currently has limited commercial value. PJ covers some 100 million acres in the Western U.S. (Romme et al., 2008), and in many cases this resource is in need of thinning. PJ covers ten times the number of acres that it did at the time of Europeans settlement in America (Miller and Tausch, 2002), due to a combination of fire suppression, grazing, and favorable weather patterns. This is referred to as PJ expansion. An additional concern is PJ densification, in which the trees fill in until there is no open space between them, the woodland growing thicker and more impenetrable all the time. This density is expected to triple in the coming decades (Tausch, 1999). The result is a less diverse and less resilient landscape that offers little in the way of biodiversity or forage but offers significant potential for a wildland fire catastrophe.

The BLM is treating 40,000 acres of PJ annually in Utah, but the pace of restoration is limited by money. If the PJ resource had value, it could finance the cost of restoration activities, allowing land managers to treat more acres. This effort will require a tremendous amount of labor, creating jobs in the process. The result can be a Great Basin landscape that is more resistant to weeds and wildfires and communities that are more resilient to economic fluctuations.

**Applying Available Technologies to the Biomass Challenge**

Perhaps the biggest challenge of working with woody biomass is its high air and water content. A truckload of wood, even when chipped up, is mostly air and water. This severely limits the distance it can be economically trucked. The challenge therefore is to densify the product before hauling it out of the woods as a valuable product. Mobile pyrolysis may be one of the keys to densification.

The UBRG is partners in a mobile pyrolysis unit: a self-contained trailer that converts woody debris into densified biomass. Pyrolysis cooks the wood in the absence of oxygen at lower temperatures than gasification to produce three products: producer gas, biochar, and bio-oil. The producer gas is used to keep the process going, sustaining its own system once up and running. Biochar is sometimes defined as charcoal engineered for agriculture and it carries a high value as a soil amendment and offers soil carbon storage potential. Bio oils can be used in traditional fuel oil heating applications and can be converted into biochemical products and fuel.

The UBRG has also contracted with two Utah entities to assess the potential of mixing wood with coal, known as cofiring, in Utah power plants. This included a series of cofiring tests and an exhaustive review of the scientific literature on the topic.

The bottom line of the potential for cofiring at Utah power plants is that it can be done physically, and PJ is a good feedstock for the purpose, but in Utah there are no economic incentives such as tax credits, nor are there regulations to encourage power production from renewable sources, as exist in some other states. Adding wood to the coal presents a wide variety of potential pitfalls, and the utility operators have little incentive to do so under current conditions.

Another path the UBRG is pursuing includes making high-value biochemical products, such as plastics and adhesives, from woody biomass. UBRG member Dr. Foster Agblevor, USTAR Endowed Professor at Utah State University, has been making plastic from wood biomass bio oils for months now and says that PJ is 'Good stuff' for making plastics.

If making plastic from wood seems like a distant goal for the UBRG, take heart in the fact that it is simultaneously promoting more conventional woody biomass products such as firewood harvesting, post and pole manufacturing, animal bed shavings, and more.

**Education**

From wood-fired concerts to presenting at a variety of scientific conferences, the UBRG is helping to spread the word about biomass utilization in Utah. The UBRG has co-hosted annual field days and biomass summits, published a variety of articles in the Utah Forest News and other publications, presented on radio and TV and hosts the website utahbiomassresources.org. In 2011, the UBRG co-hosted the Restoring the West Conference. The conference title neatly sums up the UBRG's goals and plans for promoting biomass utilization in Utah: "Sustaining Forests, Woodlands, and Communities through Biomass Use" (see restoringthewest.org).

**Comparisons Between Technologies and Renewables**

It has been our experience that gasification of wood in the field is possible but challenging. We set out with the Dragon Wagon project to demonstrate that a farmer or rancher could use this technology to create mobile, remote, economical power. We are learning however, that it requires a full time person with a wide complement of technical skills to produce consistent power. This requirement negates the economic and practical advantages of producing electricity with wood in this manner. Cofiring on one hand makes a lot of sense, especially considering the vast sums of material that could be utilized. However, it adds considerable complication to a coal based system and without external pressures to use wood, such as incentives or regulations, cofiring is unlikely to happen.

We are therefore focusing our attention on mobile pyrolysis and its ability to produce a marketable, densified biomass product in the field, such as biochar. A fleet of self-contained mobile pyrolysis trailers could largely replace the need for open burning in the forestry and agricultural sectors. This level of biomass utilization can provide other societal benefits such as offsetting the costs of wildland fire hazard reduction projects, removing nuisance smoke from the air, and improving wildlife habitat.

Even with these advantages perhaps the greatest argument for utilizing woody biomass becomes more apparent after comparing it to other energy feedstocks. Woody biomass is not a fossil fuel and it is not food. It is one of the few renewables that offers the potential to produce power regardless of whether the wind is blowing or the sun is shining. Given the energy challenges we face as a nation it makes sense to use this waste product to produce needed energy commodities such as bio oils and soil amendment products such as biochar. Woody biomass is stored solar energy – local, organic, and secure.

PICTURED: Pinyon Juniper, a plentiful biomass feedstock. Photo by: Darren McAvoy

# In the Good Times and the Bad: Shale Gas Development and Local Employment

BY JEREMY G. WEBER

*The views expressed here are the author's and should not be attributed to the Economic Research Service or the USDA.*

**Pressing Questions**

Improved drilling technology applied to shale formations has caused production of natural gas in the United States to reach historic highs. In a time of high unemployment, policy makers see development of the many shale gas formations in the U.S., mostly in rural areas, as a much-needed source of job creation. Weber (2012) assessed the local economic effects of natural gas development on counties in Colorado, Texas, and Wyoming. He found that from 1999 to 2007 gas production added 1,780 jobs or about 27 jobs per each billion cubic feet of production to the average county experiencing a boom.

The estimated employment effects correspond to a period of increasing natural gas prices and much drilling. The finitude of shale gas reservoirs and the volatility of energy prices raise questions for rural areas with shale gas development or the potential for it. Will employment opportunities from building infrastructure and drilling wells quickly dissipate as drilling slows? What happens when natural gas prices decline? Employment data from natural gas hotspots in Texas, Louisiana, and Arkansas shed some light on the answers and raise further questions.

**Natural Gas Production in Four Shale Formations**

The Barnett Shale in north-central Texas was the first shale gas formation intensely developed using horizontal drilling and hydraulic fracturing (where a mix of sand, water, and chemicals is injected into the well at high pressure). Production increased dramatically in the mid 2000s, but growth has slowed since 2008. Related to the slowdown, natural gas prices at the wellhead fell by more than 50 percent from 2008 to 2009 and have remained low through 2011. The Barnett Shale is therefore a case where lower prices accompanied a slowdown in drilling. Three other shale gas formations in the south-central U.S. – the Eagle-Ford Shale in south-central Texas, the Haynesville-Bossier Shale in east Texas and west Louisiana, and the Fayetteville Shale in northern Arkansas – have been developed more recently, with production spiking after 2008. Their development occurred despite low gas prices.

I define Barnett Shale counties to be those counties within the Barnett Shale formation where substantial drilling occurred in the 2000s as evidenced by a map of wells drilled provided by the Energy Information Administration. Eagle-Ford, Haynesville-Bossier, and Fayetteville Shale counties are defined similarly. Because of similar timing of development, I combine counties in the more recently developed formations and label them as EF-HB-F counties.

For comparisons, I first identify counties that are geographically one county removed from either a Barnett or an EF-HB-F county. Such counties are less likely to be affected by development yet they share some characteristics with shale-gas counties because of their proximity. Next, I match each Barnett county with a control county in Texas that had a similar population in 2000 but where gas production did not increase over the decade. I match EF-HB-F counties using the same approach but drawing from all three states. In total there are 13 counties in the Barnett Shale, 18 matched control counties for the Barnett Shale, 28 E-HB-F counties, and 39 matched control counties for the EF-HB-F shale formations (Figure 1). Some counties are used as matched controls for more than one county and some counties are in both matched control groups.

Natural gas production almost tripled from 2004 to 2008 in Barnett Shale counties, but from 2008 to 2011 it increased by just 23 percent (Figure 2). EF-HB-F counties, in contrast, saw modest growth from 2004 to 2008 (63 percent) followed by rapid growth from 2008 to 2011 (157 percent). Matched counties had little gas production to start with and, by design, production declined slightly from 2000 to 2011.

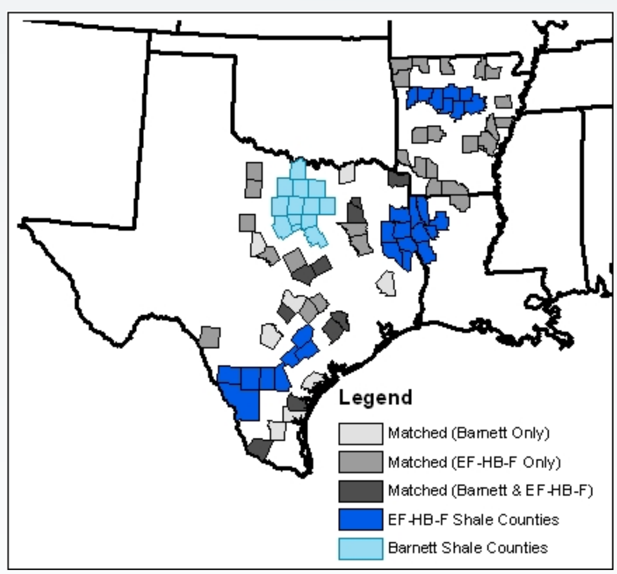



Figure 1. The Location of Barnett Shale Counties, EF-HB-F Counties, and Control Counties.

## Gas Development and Employment

I compare the annual percent change in employment in Barnett, EF-HB-F, and matched control counties using total annual employment from the Quarterly Census of Employment and Wages of the Bureau of Labor Statistics. Total annual employment represents the total number of wage and salary jobs covered under unemployment insurance in the year. It does not capture the total number of workers in a county since one worker may have multiple jobs. Also, because workers are assigned to counties based on the location of the establishment, the data do not capture those who move across county (or state boundaries) but whose employer is in another county or state. Despite their limitations, the data come from unemployment insurance administrative records and are therefore timely and more reliable than most county-level economic data.

For each group of counties I calculate the average annual percent change in total employment over three periods: 2000-2004, 2004-2008, and 2008-2011. The first period corresponds to initial development of the Barnett Shale, the second to rapid growth in production, and the third to weak production growth. For EF-HB-F counties, development began in the 2004-2008 period, but most growth in production occurred from 2008 to 2011.

## Barnett Shale Counties

From 2000 to 2004 Barnett Shale counties and their matched control counties experienced similar employment growth. In the following period, their growth trajectories diverged, with Barnett counties growing 3.4 percentage points faster per year than control counties. In the last period, 2008-2011, they experienced similar employment declines. Thus, despite continued increases in natural gas production, albeit at a much slower pace, the Barnett counties and matched control counties experienced similar employment declines over the Great Recession. And although Barnett counties did not lose all of their earlier employment gains with the slowdown in drilling, their experience is consistent with concerns that local economic growth from shale gas development dissipates when drilling slows.

Peak development of the Barnett Shale happened during the real-estate bubble of the mid 2000s and the slowdown in production growth happened during the Great Recession. Either macroeconomic event could have affected Barnett and matched control counties differently. Still, two facts suggest that the decline in drilling explains at least part of the weaker economic performance in the last period. First, housing prices in the Dallas-Fort Worth metro area and in Texas in general experienced similar declines during the recession (Real Estate Center, 2012). Second, drilling activity, as implied by drilling permits issued, dropped dramatically from 2008 to 2009, from 4,145 to 1,755. And although they increased slightly in 2010 and 2011, they remained well below 2007 and 2008 levels (Texas Railroad Commission, 2012).

## Eagle-Ford, Haynesville-Bossier, and Fayetteville Shale Counties

Despite lower gas prices after 2008, increased drilling and production spurred employment growth in EF-HB-F counties, helping them weather the Great Recession. After growing at similar rates in the first two periods, employment contracted in control counties by 0.75 percent a year in the third period but increased by 2.48 percent in EF-HB-F counties.

Assuming that control counties represent a business-as-usual scenario – and their similar growth rates in the prior periods indicate that they do – gas development caused employment in EF-HB-F counties to be 3.23 percentage points higher than it otherwise would have been. For the average EF-HB-F county the higher growth translates into about 580 jobs per year. Over the same

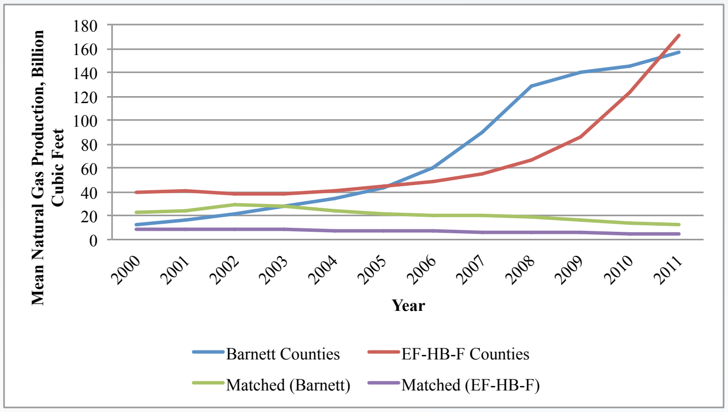



Figure 2. Production Growth Slowed in Barnett Shale Counties While EF-HB-F Counties Saw Strong Growth Through 2011. Source: Author's tabulations of natural gas production data from the Texas Railroad Commission, the Louisiana Department of Natural Resources, and the Arkansas Oil and Gas Commission.

period gas production increased by 26 billion cubic feet per year in EF-HB-F counties, implying that each billion cubic feet of gas was associated with 22 jobs. This is slightly lower than the 27 jobs that Weber (2012) estimated for counties in Texas, Colorado, and Wyoming for the 1999 to 2007 period. The difference is unsurprising – Weber looked at the total number of jobs (including self-employment) over a period with higher gas prices. Higher prices would increase royalty payments, which would likely increase consumer spending and employment.

> "ECONOMIES IN MORE RURAL AREAS MAY RESPOND DIFFERENTLY TO A SLOW-DOWN IN DRILLING. IN RURAL AREAS, BUSINESSES FORMED SOLELY TO SERVICE THE INDUSTRY MIGHT FADE AS QUICKLY AS THEY CAME."

### Further Comparisons

The largest increases in production in EF-HB-F counties occurred when gas prices were low. Despite this, the associated employment effect (3.23 percent) is similar to the effect implied by the Barnett Shale County comparisons (3.40). Because Barnett counties had much higher initial population and employment than EF-HB-F counties, similar growth rates imply very different absolute changes in employment. If natural gas development accounts for all of the higher employment growth in Barnett counties, then the absolute employment effect was several times larger in Barnett counties than in EF-HB-F counties. This may reflect higher gas prices or that Barnett counties captured more employment growth associated with development since they cover a metropolitan area at the center of the regional economy.

### Conclusion

Employment growth in Barnett Shale counties in recent years provides a first glance at what may happen as gas development matures. At the same time the simple comparisons raise further questions. Economies in more rural areas may respond differently to a slow-down in drilling. In rural areas, businesses formed solely to service the industry might fade as quickly as they came. In more urban areas they may reorient themselves: having poured concrete for drilling pads for several years, a business may find work with non-gas clients. The experience of the more rural EF-HB-F counties in the coming years will better indicate what may come for other, less-populated counties.

Growth in gas production in Barnett counties began slowing in 2009 and only declined in absolute terms in 2012 (Texas Railroad Commission, 2013). Thus, economic outcomes in Barnett counties in the last few years hardly reveal the long-term local economic effects of natural gas development. Long-term effects are important because extractive industries can cause environmental hangovers that persist for years. As the economic benefits of development fade, first as drilling slows and then as gas production declines, environmental side effects and their cost can become clearer. In the boom period, for example, demand for housing by temporary industry workers may cause housing values to exceed those of nearby areas without drilling. Afterwards, any negative side effects from extraction like gas infrastructure marring the landscape could lower property values below their pre-drilling level. (There is evidence that natural gas wells can lower property values, particularly for properties reliant on well water (Muehlenbachs et al., 2012)). A decline in property values lowers the wealth of existing homeowners, in addition to the already lower quality of life caused by side effects. Furthermore, the side effects behind the decline in values can shape an area's future by making it harder to attract talented workers, retirees, or tourists.

Oil development in the south-central U.S. in the early 20th century led in general to better economic performance over the century (Michaels, 2011). The economic performance of Appalachian counties suggests that coal mining has not had the same effect. Our current limited understanding of shale gas development's effects on human health, natural amenities, and public infrastructure makes it hard to tell where the industry will fall – closer to oil in the south-central U.S. or coal mining in Appalachia. The projected growth of the industry and the prevalence of shale formations throughout the U.S. warrants working hard to answer such questions, and in doing so, informing policies for vibrant and livable communities over the long term.

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"EMPLOYMENT GROWTH OF THIS KIND WILL ENSURE THE CREATION OF EVERYTHING FROM WELL-PAYING MANUFACTURING JOBS SUITED TO THE SKILLS OF WORKERS DISPLACED BY GLOBALIZATION, TO TECHNICAL AND PROFESSIONAL CAREERS FOR RECENT GRADUATES STRUGGLING TO FIND EMPLOYMENT IN A SLUGGISH ECONOMY."

*--Governor Herbert, 10-Year Energy Vision - Western Governors' Association Energy Initiative*

Picture from Wind Development as 'Sustainable Entrepreneurship' by Edwin Stafford and Cathy Hartman. Photo by Michelle Nunez.

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"OUR RESEARCH HAS ILLUMINATED A NUMBER OF WAYS THAT RENEWABLE ENERGY MIGHT CONTRIBUTE POSITIVELY TO RURAL DEVELOPMENT."

*--Peter Robertson and Richard Krannich, Renewable Energy: Implications for Rural Development and Rural Policy in the Intermountain West*

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