Report from the Center #4

What Every Westerner Should Know about Energy

Patricia Nelson Limerick • Claudia Puska
Andrew Hildner • Eric Skovsted

Center of the American West | University of Colorado at Boulder

The Center of the American West: Its Purpose and Vision

The Center of the American West at the University of Colorado strives to bring together, for meaningful conversation and interaction, people as diverse as the American West itself. With the participation of ecologists and engineers, poets, professors and policymakers, students and scientists, musicians and lawyers, foresters, filmmakers, and physicians, the Center's events have become a model of interdisciplinary debate. Issues long held to be black and white reveal their nuanced shades of gray when examined from these multiple perspectives. Minds change, information is exchanged, and conversations begin. To understand the region, we believe that the exploration of the minds of its residents is as important as the inquiry into the workings of its cultures and ecosystems.

The Center of the American West is the region's most creative and innovative organization in identifying and addressing such crucial issues as multiculturalism, community building, fire policy, and land, water, and energy use. We do this through programs of research, public outreach, and engagement meant to help Westerners think about their region and their role in its sustainable future.

Enterprising and inclusive in its embrace of a wide range of disciplines and strategies of communication, the Center strives to illuminate the challenges and opportunities facing this complicated geographic and cultural area. Ultimately, we want to help citizens of the West become agents of sustainability—citizens who recognize that their actions determine the region's future and who find satisfaction and purpose in that recognition.

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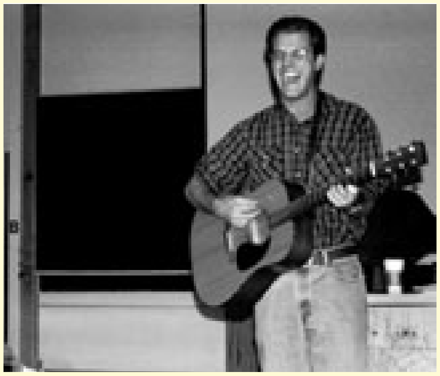


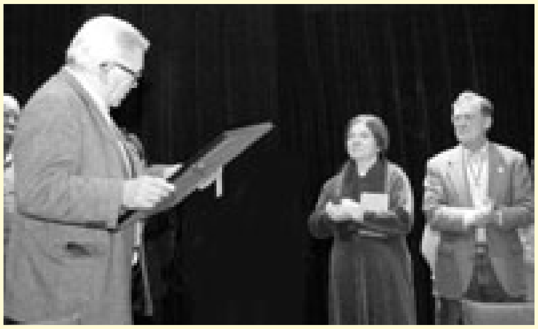

Cover photos
Above, Los Angeles major industry, 1896. *Courtesy of Denver Public Library, Western History Collection, Charles Pierce, X-22278.* **Below, Palm Springs wind turbines, 1985.** *Courtesy of Press-Enterprise.*

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**The West is the Nation's Energy Treasure Chest.
You are a Treasure-Keeper. A Steward.**

*The trouble with the future is
it usually arrives before we're ready for it.*
—Arnold H. Glasgow

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Center of the American West

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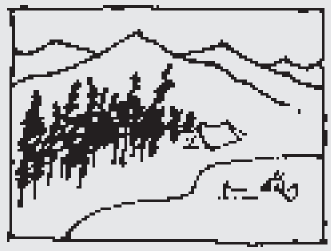

We offer every Westerner a rewarding new job:
Energy Expert.
Why?

The West is the nation's energy treasure chest.
You are a treasure-keeper. A steward.

When it comes to the nation's decisions about its energy future, the West is the linchpin. With riches in conventional fuels as well as an abundance of sun and wind, the West can play the key role in shaping America's energy future.
Since energy use connects to every feature of our lives, focusing on the West's energy resources allows you to engage in "One Stop Worrying." Instead of having to choose which of many regional challenges you will think about, choose energy, and you've covered them all.

The history of the West holds crucial lessons about energy.

A lot of future American energy development will occur in the West.

And yet trying to become an Energy Expert can make you feel as if you are searching for a path through an unmapped landscape, while everyone in the world converges to give you conflicting directions. Optimists, pessimists, scientists, economists, environmentalists, utility managers, businesspeople, politicians: everyone tells you something different. As our colleague, physicist Al Bartlett, puts it: "For every PhD, there is an equal and opposite PhD." Who to believe?

This report from the Center of the American West is the result of our own venture into this important dimension of regional life. As part of that venture, the Center of the American West hosted a two-day workshop, "Energy in the West: What Every Westerner Should Know," and we have used the workshop as a springboard into this vast and critical topic. We have read and listened carefully, and checked our conclusions with experts in various territories. As interested, and sometimes confused, citizens and consumers ourselves, we have tried to use our status as newcomers in the field of energy as an advantage. We hope to provide a useful and clear roadmap to Western regional energy issues.

We invite your comments, suggestions, and responses. This is a very complicated issue, and we would not try to fool ourselves into thinking that we figured it all out. If you want to applaud us, condemn us, or correct us, please write to

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Somewhere in your book, if there's any way you could mention it, I'd love for you to tell everybody that we're all in the oil business. Everyone on the face of this earth is at this time. . . . Sometime, if you can, sit down and name ten things that aren't petroleum related. . . . Everything in this room is petroleum related. It took petroleum to bring it to us for us to enjoy. People just don't realize.

—Tom Wilmeth,
retired oil industry worker[1]

To live in the 21st century West is to benefit every day, every hour, every minute from the unrestricted use of fossil fuel. We are, as Tom Wilmeth put it above, "all in the oil business."

Might as well make our peace with that, and decide where we ought to go from here.

When novelist and reformer Upton Sinclair watched Southern Californians go wild over the oil boom of the 1920s, he explained to his wife why he had decided to write a novel called *Oil!*: "Don't you see what we've got here?" Sinclair said. "Human nature laid bare!"

However you react to seeing human nature unclothed, you can't say it's boring. Measured for amusement and human interest, the story of Western energy, in the past and the present, can hold its own against all the usual tales and stories of Western adventure. Stick with us.

What Is Energy? Why Should We Care?

So, You Want to Make Toast

What happens inside that little metal box, attached to the wall by a black tail, when you stick two slices of bread inside? The mysteries of the bread-to-toast phenomenon will now be revealed.

First, we will assume that you made the bread, and raised and ground the wheat, which will allow us to leave aside for now the discussion of the role energy plays in food production.

Most probably, coal is the reason your "slice of bread" becomes a "piece of toast."

When you depress the lever on the side of the box into which you placed your bread, several rows of small wire coils, made red-hot by the conversion of electric energy into thermal energy, heat the bread. The electricity comes to the toaster through the power cord attached to the wall. Inside the wall is a set of wires which—traced far enough through electric meters, distribution lines, transformers, substations, and transmission lines—lead back to a power generation plant. The connection between a wall outlet and the power plant supplying the electricity is as short as a mile or as long as several hundred miles and sometimes crosses state lines and tribal lands. The electricity is generated by burning the fuel that enters the plant. More precisely, the electricity (electrical energy) is generated by large, spinning turbines of wound copper wire (mechanical energy), spun by high temperature and high-pressure steam (thermal energy). The steam is produced by burning fuel (turning potential chemical energy into thermal energy) to boil water. The chain doesn't end here.

So far, browning your bread to crispy perfection has required the help of several different companies and the conversion of chemical energy to thermal energy (to produce steam), thermal energy to mechanical energy (to spin the turbines), mechanical energy to electrical energy (to produce an electric current), and electrical energy back to thermal energy (to toast the bread). These conversions have not occurred without losses.

By the First Law of Thermodynamics, energy is a constant and can neither be created nor destroyed. But it can (and does) change form. The Second Law of Thermodynamics dictates that while the amount of energy in a closed system remains constant, the quality of that energy deteriorates over time. Basically, as energy changes form, the amount of *usable* energy in a closed system (say, our universe) decreases. Our troubles begin.

The only 100 percent efficient form of energy conversion is from potential or kinetic energy to thermal energy. All other forms of energy conversion occur at significantly lower efficiencies. Power plants, for example, convert the potential chemical energy of coal or other fuels into thermal energy at 100 percent efficiency but have typical thermal energy to electrical energy conversion efficiencies of only 33 percent.[3] The remaining thermal energy (67 percent) is discharged into the environment as low temperature, and therefore unusable, thermal energy. Energy loss ("entropy" in scientese) continues to occur after the electric energy leaves the plant. Transmission lines do not conduct electricity with 100 percent efficiency. Ninety-two percent[4] is the average; longer power lines have lower transmission efficiencies. Compounding the conversion and transmission inefficiencies is the net energy loss that occurs between the extraction of the fuel resource and its arrival at the power plant. The Goliath-sized draglines, bulldozers, and dump trucks that extract the coal, and the railroads that transport the coal (over an average distance of 483 km[5]) are heavy users of energy themselves, which has to be subtracted from the net production of usable energy. Some coal draglines are powered by an "extension cord" six inches in diameter and require a separate, smaller onsite power plant just to supply enough electricity to the dragline.

It is nearly four times more efficient to just burn a lump of coal and place your bread over the flames.

What's Hidden in Oil?

Petroleum is a key ingredient in many everyday products. Almost nine out of every 10 barrels of oil in the United States are used to produce gasoline, diesel fuel, and jet fuel. But petroleum also goes into many common non-fuel products. Here's a sampling:

Guitar Strings	Petroleum Jelly
Crayons	Paraffin Wax
Brassieres	Asphalt
Deodorants	Tape
Sunglasses	Mascara
Frisbees	Lipstick
Tennis Balls	Acrylic
Hair Coloring	Nylon
Tires	Polyester
Shoes	Latex
Insect Repellant	Tents
Toilet Seats	Toothpaste
Telephones	Computers
Bubble Gum	Shampoo
Antiseptics	

AND a multitude of plastic and pharmaceutical products. [2]

Review this list, and you can begin to grasp why many have said that "oil is too valuable to burn."

Walsenburg mine, Walsenburg, Colorado.
Courtesy of the Colorado Historical Society, CHS.X6634.

Pilgrimage to the Power Source

Mike Hannigan

Visit your local power plant. Seriously, call and set up a tour. The plant engineers and operators love to show off their amazing facilities. OK, now you are asking, why tour some big industrial complex? What's so amazing? One dollar buys you about 15 kilowatt hours of electricity delivered to your home. To produce those 15 kilowatt hours, the power plant burns 15 lbs of coal. Your dollar not only buys you 15 lbs of coal, but all the expertise to convert that pile of rocks to electricity. Trust me, go to the power plant and see what you are paying for. Our local power plant burns 19 train car loads of coal per day and produces enough electricity for 180,000 homes. The furnace is four stories high and the inside looks like the surface of the sun. The equipment used to control the air pollution created by burning all that coal occupies more space than the power generation equipment, and has added substantial operating expense to the power plant. You will be awed by the scale; incredibly fast conveyer belts piled with coal, 16,000 fiberglass bags to collect the ash, small lakes of warm water. Ask the operators how they power your power plant. A power plant equipped with air pollution control equipment uses 10 percent of created electricity inside its own walls. My power plant needs the electricity of 18,000 homes to work. You will leave the plant shaking your head, hopefully more aware of what happens when you hit that toast button and open the electricity faucet. As you drive home, think about the scale of what you just saw, and then think about the power requirements for Los Angeles. Before leaving those thoughts, remember that you only saw the tip of the iceberg—you use almost as much petroleum as coal.

Energy Fatties: Sweatin' to the Oldies

Josh Joswick, La Plata County Commissioner, Colorado

"Have you ever tried to quit smoking or drinking alcohol or eating sugar or just tried to diet? Even though we know that smoking, drinking, sugar or too much food is just not good for us, these are extremely difficult things to give up. So how do we get people to go on an energy diet? Will some Richard Simmons of Energy emerge to lead the way, appealing to our national vanity, to coax, cajole, and shame us into not being energy fatties? If you keep hammering at people, they will, at the very least, shut you out and at the very most, do exactly the opposite of what you want them to do, just to show you that they can."

What does this mean for our piece of toast? Let's add up the efficiencies. Between the amount of energy invested in the equipment used to extract and transport the energy resource, the Second Law of Thermodynamics, and transmission losses, only 26 percent of the energy extracted from the ground reaches your toaster.[6] It is nearly four times more efficient to just burn a lump of coal and place your bread over the flames.

There is nothing direct and linear in the modern chain of toast production. At each stage, some energy produces work, and a significant amount of energy is also lost. There is, decidedly, no free lunch, or breakfast. The processes of extracting, transporting, and processing oil and coal into energy usable by consumers require fuel to run railroads, pumps, refineries, and generating plants. When you look at the numbers on your monthly energy bill, you are seeing the *Cliff Notes*, the *Reader's Digest*, the telegraphically brief plot summary of a much larger story of the movement of matter around the surface of the earth.

Externalities, and Why They Matter

Economists urge us to calculate in the "externalities" when we declare what a particular commodity costs. Calculate the cost of coal-generated electricity, and you have to include the money put into improving air quality, as well as the money that goes into the care of people with asthma and other respiratory problems aggravated by coal's emissions. Calculate the cost of nuclear power, and you have to include the money required for constructing and maintaining permanent nuclear waste storage sites. Calculate the cost of wind or solar power generation, and you have to include the money that goes into research and design, advanced materials, and construction.

The issue of "externalities" leads us, as well, to the West's problems with water. The interior West has a significantly lower rainfall than the rest of the country even in normal years, and it is also subject to prolonged drought. When Westerners think of what they must do in a time of drought, the wisdom of conserving water comes to mind, but the wisdom of conserving energy rarely gets attention. Don't water the lawn, think twice about washing the car, give up your dreams of summer afternoons spent on well-tended golf courses. But many forms of energy production require lots of water. In times of drought, thoughtful use of the electrical switch can be nearly as important as thoughtful use of the water faucet.

In this region, on average, we use one gallon of water to produce one kilowatt hour of electricity.

In the United States, on average, we use 18 gallons of water to produce one kilowatt hour of electricity (electricity production is the biggest water user in the United States, ranking slightly ahead of irrigation at 38 percent). (This one kilowatt hour is the energy used to power the two light bulbs that you accidentally left on last night in your basement. Oops, 18 gallons of water.) In the West, we are so water-limited that we already have done a bunch of work to reduce the necessity of water in energy production. In this region, on average, we use one gallon of water to produce one kilowatt hour of electricity. Of that one gallon, half returns to the lake, stream, river, or reservoir slightly hotter than when it was pulled out, and the other half is evaporated and will end up in someone else's watershed. So, you actually only wasted half a gallon of your watershed's valuable allotment last night.

Think about how many buildings have lights on all night. Anyone beginning to see dried-up stream beds?

Energy and water are linked in another way. Hydroelectric power uses the natural energy in flowing water to give us electricity. In the United States, we have tapped this energy supply heavily. In fact, more than three trillion gallons of water a day flow through hydroelectric power generation systems. That is 2.6 times the total water that flows in the nation's streams and rivers, which means that, in the cause of hydroelectric generation, we use each gallon of water 2.6 times from where it lands till it reaches the ocean. What does this mean? Not only does energy conservation pay big dividends during a drought, but less water flow means less hydroelectricity and then a corresponding increase in fossil-fuel powered electricity. This qualifies as a vicious circle.

The real cost of fossil fuel use far exceeds the price we pay at the pump, or the total on our electricity or natural gas bill.

Changing the Air

Jana Milford

What are the consequences of burning fossil fuels to supply 100 million households with electricity across the United States?

Much of the discussion about energy centers on whether we have enough of it. But from another perspective, the problem may be that we have too much. Burning all of the coal, oil, and natural gas we can find may turn out to be an environmental catastrophe.

Burning coal to produce electricity for a community the size of Boulder, Colorado (i.e., about 40,000 households, or 100,000 people) adds approximately 1,000 tons per year of nitrogen oxides; 2,000 tons per year of sulfur oxides; 400,000 tons per year of carbon dioxide (CO_2); and 16 pounds per year of toxic mercury into the atmosphere.[7]

On local and regional scales, nitrogen oxides and sulfur oxides contribute to the formation of fine particles that impair human health. In the eight states that comprise the Rocky Mountain West, from 1,200 to 5,200 premature deaths per year are estimated to occur because of exposure to these fine particles.[8] The health effects are worst in urban areas, where levels of these pollutants are highest and people are most likely to be exposed. Nitrogen oxides also react in the atmosphere to produce ozone, which exacerbates asthma and other respiratory problems in humans and also damages crops and natural vegetation. And the same fine particles that damage human health also degrade visibility in national parks and wilderness areas such as the Weiminuche Wilderness area in southwestern Colorado, where scenic vistas are a main attraction. About half of the visibility degradation at Weiminuche is attributable to sulfur and nitrogen oxides from fossil fuel burning.[9]

We are making progress in controlling sulfur and nitrogen oxides from coal- and natural-gas-fired power plants and from gasoline and diesel-fueled motor vehicles. Over the next two decades in the western United States, emissions of these pollutants are projected to decline. But carbon dioxide (CO_2) is another matter. The United States as a whole is making little progress in reducing emissions of CO_2, a greenhouse gas with global consequences. Because of our heavy dependence on fossil fuels for transportation and electricity generation, the United States contributes about one-quarter of the CO_2 emitted worldwide.

Does increasing CO_2 in the atmosphere matter for the West? Scientists currently project that over the next century, climate in the western United States will change dramatically if concentrations of CO_2 and other greenhouse gases continue to increase.[10] Higher temperatures and wetter winters are projected for the Rocky Mountain West. But wetter winters aren't necessarily good news for this drought-prone area. Climate scientists predict that more of our winter precipitation will come in the form of rain rather than snow, mountain snowpack will melt earlier in the season, and summers will be dryer. So the moisture will come, but not when we need it most. In addition, wildfire incidence and photochemical air pollution levels are expected to increase. Finally, with increased temperatures, subalpine and alpine habitat and species may disappear in many areas.

To avoid these consequences, we need to reduce our fossil fuel use now, whether or not we think we're running out.

Navajo generating station, Arizona. *Courtesy of Dr. Martin Pasqualetti.*

The View from Youth

Three young people participated in writing this report. Let's take a middle-of-the-road estimate on the timing of the peaking of world oil production, and place it at 2035. Our coauthors will be, respectively, 65, 57, and 55. Only the eldest will be close to retirement.

It makes you think.

Here are some reflections from our youngest teammate, Eric Skovsted:

"To be honest, I have difficulty imagining this future. Perhaps I am overly optimistic or stubborn, but when I wonder how society will weather the transition, my expectations seem a little too rosy. Part of me expects effortless adaptation, such that many won't notice it until the era is encapsulated in a history textbook, The End of the Oil Age. *But in starting to take this future seriously, I scare myself. The word 'impossible' seems to describe a purely renewable energy scenario pretty well.*

"Though I don't know the outcome of future energy, I do know where I will observe the effects: my barometer for change of any sort—Boulder, Colorado, my hometown. What will it be like to walk through my childhood home in 20, 30, even 40 years?

"In the end, whether the transition is smooth, rough, or something much, much worse, my generation will be driving the change, documenting it, and experiencing history. I hope we rise to the challenge."

Return to our toast example. If you were to eat one piece of toast a day, then in 10 days you would have used one pound of coal (nice size lump) and about a gallon of water. These numbers may seem scary, but they are just the tip of the iceberg (a water source in itself, but out of our reach).

The point here is that the real cost of fossil fuel use far exceeds the price we pay at the pump, or the total on our electricity or natural gas bill.

A reckoning with externalities can figure in your new life as a Western Energy Expert. When buying an appliance, ask yourselves two questions: "How cheap is this to buy?" and "How cheap will this be to own?"

Then, saying to yourself, "Externalities—always have to think about externalities," try to shift the weight of your decision to the answer to the second question.

The cheap, incandescent light bulb will use electricity inefficiently, and it will wear out fast. The expensive, compact fluorescent light bulb will lower your electricity bills, and it will last. Which is the better deal? Which "costs" more?

The West and the World— Headed for the Yellow Zone, Ready or Not

The world's supply of fossil fuels has laid out a test for human nature in the surprisingly short-term future. Since energy does not defer to national, geographic, or political boundaries, we have to think about the West and energy within a context of global energy reserves and production, as well as world population and industrialization.

Using current reserve data, reserve growth projections, and anticipating technological development, the United States Geological Survey, the Department of Energy, and the energy company BP America agree on a forecast: world energy production from oil will peak sometime between 2020 and 2050. As demand increases, prices will inevitably increase, which will induce producers to increase their production of the increasingly smaller supply of easily exploited reserves. Prices *will* go up, and fewer people will be able to afford to drive their SUVs or otherwise consume fossil fuels with abandon. The question is not *if*, but *when*.

World energy production from oil will peak sometime between 2020 and 2050.

Approaching the Yellow Zone

John D. Edwards

The world must prepare for the transition from fossil fuels to renewable, non-polluting energy sources by 2020. This is a huge job because fossil fuel now supplies 86 percent of both the United States' and the world's energy.

The expected growth of oil demand is 2 percent per year. In 2003, oil production is 77 million barrels per day. By 2020, over 100 million barrels per day will be needed to meet demand. The change to alternative energies will ensure a continuous flow of energy to the increasing world population and the industrial growth in the developing world.

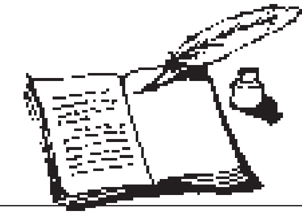
Total world oil supply is estimated to be more than two trillion barrels. One trillion barrels have been consumed during the past 150 years. Proved reserves are one trillion barrels, and about one trillion barrels are anticipated to be available in the future from new discoveries, Canadian tar sands, Venezuelan heavy oil, and field growth.

The energy gap between decreasing supply and increasing demand will develop when peak oil production occurs (the "Yellow Zone" on my graph). Peak production is estimated to occur between 2020 and 2040. We must develop alternative, clean, renewable energy sources to fill the supply gap after 2020.

The long-term solution to energy supply will be conversion to nuclear, solar, and hydrogen power. New technologies and population controls can help reduce energy demand. Conservation and improved energy efficiency must also be implemented.

After 37 years in the profession of petroleum exploration, I believe the time has come for big changes in our thinking, and in our actions.

See inside back cover for the Yellow Zone graphs.



Chicken Little's Mood Swings

Although Chicken Little began as a symbol of unnecessary and hysterical alarmism, she ended up as a symbol of indifference and inattention. Applied to Western energy issues, Chicken Little #2 makes as bad a role model as Chicken Little #1.

Chicken Little #1
"Once upon a time, there was a tiny chicken named Chicken Little. One day, Chicken Little was walking through the woods when, all of a sudden, an acorn fell and hit her on the head—KERPLUNK! 'Goodness gracious!' said Chicken Little. 'The sky is falling! I must warn the king.'"

Chicken Little #2
"After that day, Chicken Little always carried an umbrella when she walked in the woods. The umbrella was a present from the king. Whenever an acorn fell—KERPLUNK!—Chicken Little didn't even flinch. In fact, she didn't notice it at all."[11]

When geologist Kenneth Deffeyes remarks that "The public attention to the predicted oil shortfall is essentially zero," the lesson seems to be that the king has indeed been generous in passing out umbrellas.[12]

The difference between fossil fuel production and consumer demand will leave a gap to be filled by new technologies. In his graph, Dr. John D. Edwards, from the University of Colorado's Geological Sciences Department, portrays the "Yellow Zone" like this: as demand continues to grow, and as fossil fuel production falls off, then Edwards' "Yellow Zone" stands for the demand that cannot be filled with fossil fuel supplies and will require, instead, a supply from renewable energy. The color that Dr. Edwards uses to mark this zone on his graph is entirely appropriate: yellow is used on signs to get people's attention and to communicate information about potential hazards and issues of concern.

Yellow usually means, "Proceed with caution, since the next color after this will be red."

Understand, we are not talking about a simple matter of "depletion." Fossil fuel energy does not just "run out"; it gets more expensive to produce. Anyone convinced that we are about to run out of energy needs a little sedation, and a moment to think about the bad example set by Chicken Little.

Alarmists declaring that we are about to run out of fossil fuels have done a great deal to undermine the credibility of calls for conservation and development of renewable energy sources. Having been hit in the head by an acorn, Chicken Little wildly overstated the dimensions of her problem. And even though such agitation does not achieve much more than getting all the other animals stirred up, Chicken Little has served as a role model for various prophets looking into the future of energy.

Reproductive Energy

If you start thinking about the future of energy in the West, within a moment or two, you will also be thinking about the future size of the Western population. How much energy will Westerners use in the future? The question divides into two of equal importance: 1) How much energy will each individual consume?, and 2) How many individuals will there be?

Even if the public makes breakthroughs in conservation and efficiency, those gains could be offset by ever-rising numbers of consumers. In the next two passages, we defer to two of our Energy Workshop participants, a physicist and a biologist, who offer forceful reminders that the issue of energy cannot be separated from the issue of population. The number of people is unquestionably important, but the degree of consumption practiced by each of these individuals still matters a lot. With or without effective growth control in the West, we cannot evade the questions, "How much energy will each individual consume, and how will that energy be produced?"

Breaking the Report-Writing Habit: Facing Up to Our Problem with Numbers

Albert A. Bartlett

As you read this pleasant, chatty account of the hundreds of peripheral problems associated with energy in the West, you may end up wondering: "Where's the beef?" Where does the report identify the underlying cause of the energy problems of the West, and then offer recommendations for addressing this cause?

Population growth is, essentially, the source of all the problems of energy. In the decade of the 1990s, the total consumption of energy in the United States grew 13.1 percent. In that same time period, the total population of the United States grew by 13.1 percent. Per capita annual energy consumption in the United States remained constant through the decade, a remarkable achievement in itself. Thus the increase in U.S. energy consumption in the 1990s can all be attributed to population growth.

Population growth is driving the increase in energy consumption, and that increase, in turn, is driving the ravaging of many rural and wilderness areas of the West.

So what will happen to this readable report? It's like dozens produced year after year by university groups and non-profit organizations. These reports deal with various societal problems that are caused by population growth. But population growth is rarely mentioned, unless it is in a sidebar like this one. Universally, the reports ignore the fact that population growth is the fundamental cause of the problems they address. The writers convey the impression that we can solve our problems by brute force (build more dams or highways), by conservation (use less), by technology (science will save us!), or by democracy (let's vote to determine the resources of the future).

Here is a working definition of insanity: "Doing the same thing over and over, hoping each time that the result will be different." Insanity inhabits not only the world of our political and business leaders, but also the rarified realm of report writers.

The Ecology of Energy, OR Why the Discovery of an Endless, Clean Supply of Energy Would Mean Trouble

Kailen Mooney

Energy from the sun sustains life on earth. Of the sun's energy that reaches us through space, 99.7 percent is reflected back into space or absorbed by the surface of the earth. The remaining 0.3 percent of this energy is taken up by plants and bacteria in the process of photosynthesis. Carbon dioxide and water are broken apart and their elements recombined to make glucose, which is in turn used to build more complex organic molecules.

Through this process, the plants occupying an average square kilometer of the earth's surface produce 720,000 kilograms of tissue each year. The sun's energy, now contained in the chemical bonds of this plant tissue, continues to move through the biosphere as herbivores consume plants, and predators consume herbivores. At each step of this food chain, there is a great inefficiency. Herbivores and predators must consume 10 grams of food in order to add one gram to their own weight. With this one-tenth efficiency in energy transfer, the 720,000 kilograms of plant tissue in turn supports 72,000 kilograms of herbivore mass, and only 7,200 kilograms of predator mass.

When animals and plants die, the majority of their tissues decompose, but some portion becomes preserved within the earth's crust and, over time, transforms into coal, oil, and natural gas deposits. The heat produced by the oil and natural gas in our home furnaces and stoves, and the light emitted by bulbs powered by coal-fired electric plants, are the final releases of the solar energy that was first absorbed by plants growing in past millennia.

All life on earth is limited by its resources. Plants are limited by space to grow, soil nutrients, water, and light. Herbivores are limited by the availability of edible plants, and predators by catchable prey. This interplay of supply and demand generates stability within ecological communities. When a species in a community over-exploits its resource base, its population by necessity declines, and in doing so allows this over-exploited resource to recover.

Humans are a part of the earth's ecological communities. And yet our use of technology makes our effects fundamentally different from any other organism. Fossil fuels provide us with an input of energy beyond that obtainable from the natural food webs within which all other life must subsist. By boosting human population growth, this subsidy of external energy has, at least temporarily, decoupled our population cycle from the living resources we use. The energy subsidy from fossil fuel allows us to over-exploit other resources to an extent not possible for other organisms.

Food technologies also separate us from other organisms. Agriculture operates as the redirection of energy flow from natural communities to human-constructed communities where we occupy the top of the food chain. In some instances, we feed as herbivores on monocultural communities of plants such as corn, wheat, or rice. In other instances, we feed these plants to herbivores such as cattle, and we in turn feed as predators on those animals. Because of the inefficiency in energy transfers up the food chain, when we feed on meat, we redirect 10 times the energy away from natural communities, as compared to when we feed on plants. Our ability to redirect energy flow through the use of fossil fuels and agricultural technologies has allowed humans to have far-reaching and often damaging effects on the earth's biota.

Cheerful prophets sometimes propose that a limitless supply of cheap, clean, and renewable energy could provide a solution to our ecological problems. Far from a solution, such a discovery could exaggerate and extend those problems. While cleaner, renewable sources of energy would alleviate global warming and the pollution associated with fossil fuels, *all sources of energy* decouple the size of human populations from the natural resources we exploit. A shift from fossil to renewable energy will still leave us facing the impacts and consequences of our own population growth.

Giving Prediction a Bad Name

In *The American Petroleum Industry,* several authors sum up some far-too-cautious estimates of American oil reserves, made in the early 20th century. "The first attempt to estimate the overall crude oil reserves in the United States was made in 1907–1908 by David T. Day, Director of the Petroleum Division of the United States Geological Survey"; other estimates were made in 1915, 1916, and 1918. "Measured against actual production over the succeeding years, had these various estimates been correct, domestic oil reserves would have been exhausted" as follows:

Day (1908) in 19 years, or by 1927
Arnold (1914) in 12 years, or by 1926
USGS (1915) in 13 years, or by 1928
USGS (1916) in 11 years, or by 1927
USGS (1918) in 10 years, or by 1928

This series of numbers probably gives us a leg up in understanding why declarations of impending scarcity have not carried a lot of weight in shaping popular opinion.[13]

Doomsdayers and Deniers

For many decades doomsdayers and deniers of doom have made bold statements and with a few exceptions, they have been wrong. But one among them got it very right.

In 1956 in San Antonio, at a meeting of the American Petroleum Institute, the geologist M. King Hubbert, an employee of Shell Oil, "predicted that U.S. oil production would peak in the early 1970s." As geologist Kenneth S. Deffeyes writes, "Almost everyone, inside and outside the oil industry, rejected Hubbert's analysis. The controversy raged until 1970, when the U.S. production of crude oil started to fall. Hubbert was right."[14]

Recent efforts to apply Hubbert's methods to predicting the peak in world oil production remind us that foretelling the future does not rank high among humanity's talents. Hubbert's approach was, after all, not entirely systematic and reproducible; as Deffeyes acknowledges, Hubbert's prediction "was as much an inspired guess as it was hard-core science." Hubbert, in any case, had the right temperament for taking a controversial stance and enduring years of criticism. He had "an exceedingly combative personality"; around the Shell research lab in Houston, the saying was "Hubbert is a bastard, but at least he's *our* bastard."[15]

The author of the oft-cited book, *The Coming Oil Crisis,* Colin Campbell has assumed Hubbert's mantle as the most prominent source of conservative assessments of fossil fuel reserves. With his PhD in geology from Oxford University and experience working as chief geologist for Texaco and Amoco, Campbell forecasts a rapidly approaching date for the peak of non-coal hydrocarbon fuel production, but even he has been flexible. In 1989, Campbell predicted the peak would occur that same year; in 1994 he predicted it would come before the year 2000; and in 2002, he predicted that the peak will occur in 2010.

At the opposite side of the prediction field, another set of experts assert that technology and innovation will assure us infinite fossil fuel resources. In a widely read and controversial book, *The Ultimate Resource*, the late economist Julian Simon argued that human ingenuity ensures that the human race will never run out of natural resources, including fossil fuels. The title of the third chapter sums up Simon's forecast for the future, "Can the Supply of Natural Resources Really Be Infinite? Yes!" "There is no reason to believe that at any given moment in the future," Simon declared, "the available quantity of any natural resource or service at present prices will be much smaller than it is now, or non-existent."[17]

Mark Sagoff, a Senior Research Scholar at the University of Maryland's Institute for Philosophy and Public Policy and author of *The Economy of the Earth: Philosophy, Law, and the Environment,* has carried on Simon's crusade. "The idea that increasing consumption will inevitably lead to depletion and scarcity, as plausible as it may seem," Sagoff asserts, "is mistaken both in principle and in fact."[18] Simon and Sagoff represent an extreme version of the view of some economists that fossil fuel resources, like many resources (money, agricultural products, etc.), are not fixed in quantity, but vary according to market demands.

Economists, by and large, are practical people who steer by numbers and calculations and verifiable data. For all their rationality, they retain the right to dream. When it comes to energy, the economists see a future of necessary change: prices will rise for oil, and that transformation in the market will place renewable energies in a competitive status. We will never run short of energy because movements in the market will mean that other forms of energy will come forward into viability, as the "traditional" forms become more expensive. And yet the market operates in a network of subsidies, tax arrangements, and exclusion of externalities that reshape and reconfigure its effects in consequential ways.

The economists are certainly right in telling us that we are not approaching the cliff-edge of depletion. Civilization is not going to run out of gas on one blessedly silent, though economically alarming, day. But we are within hailing distance of a future world in which renewable energy must play a central part. We need to get from *here* to *there*—from energy use defined by fossil fuels, to energy use defined by renewable sources.

Currently, the percentage of energy produced from solar, wind, hydroelectric, and geothermal sources thoroughly qualifies for the adjective "miniscule." The American West has some distinctive advantages when it comes to edging that percentage up from "tiny" to "significant" to "substantial." This may seem like a tall order, but folklore says that Westerners like challenges, and don't want to be coddled or treated like weaklings. Just as important, history has given Westerners an unusual heritage in the production and consumption of energy, one that could help us chart a distinctive and precedent-setting path from *here* to *there*.

Wouldn't it be wise to anticipate the challenge, invest in the research needed for renewables to be truly competitive, and design a transition that will keep pain and disruption to a minimum? Why not research the hell out of renewable energy technology sooner rather than later, before the need becomes pressing and urgent?

A Cheerful Fellow Denies a Bugaboo

Utah Governor William Spry, 1911

"I have absolutely no sympathy for the bugaboo of mineral exhaustion. Not until the surface of the entire United States has been honey-combed by the prospector and miner will any thoughtful man attempt to approximate the mineral resources of the nation, and then no man will have the temerity to fix a limit to which the sciences may go in discovering new processes of extracting and making useful the mineral deposits of Mother Earth."[16]

The Burdens of Maturity

Rick Bass

"After a while, of course, the saturation point is reached; it gets harder to find new fields. Because finally a large percentage of the fields *have* been found. It is so like middle age that it is depressing. Basically, one day you just notice—though it may have been going on for quite some time before you admit it—that you are not finding oil wells as frequently or with the success rate that you once were. It's not an immediate thing, but it's part of the phase too, part of the cycle. 'Overmature' is the term for it.

"There is always hope of rejuvenation, however; hope for a comeback, once the glory days are gone. . . . A basin is always capable of making a comeback, as is a geologist down on his luck. . . .

"Oil is maturing as an energy source. Someday it will be too old or too scarce, but right now it is the best, and, as is always the case, it would be wise to appreciate and take advantage of its maturity, however brief, however extended. But to also admit, when the time eventually does come, that it is overmaturing. . . .

"The fat and easy areas have been discovered. . . .

"How many traps of ancient reserves are left, and how long will it take us to use, at our known rate, our known requirements, this projectable quantity? You hit zero, every well in the world a dry hole, in about sixty-five years. Do not think it will be a pretty sight."[19]

An Economist's View

Jim Marlin, Visiting Professor of Economics, University of Colorado at Boulder

Economics 101 discusses supply and demand in some detail. It can help us to understand and deal with the "energy crisis." No matter how much coal, petroleum, or any other energy resource is available, it is inevitable that sooner or later we will use up most of it. But basic economics will then start to ration this scarce resource.

As consumers want to use more energy (both because there are more consumers and each consumer wants more energy), demand increases. Initially, there will be an unfulfilled desire for energy. But producers, those canny capitalists, will realize they can earn more by raising their prices. When the prices increase, consumers will scream and howl, but some of them will be willing to pay more. In a very short time, supply will equal demand again. There will be more produced and consumed, but at a higher price for consumers and more profits for producers. As the price increases for one kind of energy resource, say coal, alternative energy resources will become more desirable, providing an incentive for greater investment in their development.

The point is that the market, all by itself, will ration the scarce resource, and produce the conditions that will make the alternative resources economically viable.

Mystifying Term Explained: Reserve Growth

As soon as you take up the project of becoming a Western Energy Expert, you encounter puzzling new terms. Newcomers to the topic find their confusion peaking with the phrase "reserve growth." How can reserves *grow*, while pumps pull oil from the ground and draglines scoop out coal? Is this a Lewis Carroll design, worked out in a collaboration between the Mad Hatter and Humpty Dumpty, for estimating energy holdings?

Actually, there's a logic to this.

According to the United States Geological Survey (an agency that would deny any tie to Lewis Carroll), reserve growth is "the observed increase in reserves for a particular field over time. That is, the initial estimates of reserves in many fields are lower than the ultimate volume of oil produced from that field."[20]

Which is to say: the initial estimators of a field's holdings sometimes come in with low numbers, and then the field delights everyone by exceeding those numbers. You could say the reserve grew, or you could say the initial estimates were themselves "reserved" and cautious.

Reserve growth can occur for several reasons: inaccurate or conservative reserve estimates, insufficient information, technological advances, and the discovery of new reservoirs. New technology in exploration, drilling, and production increases the capacity to recover resources.

People have been forecasting the shortage of fossil fuel supplies for more than a century, and none of these predictions have come true. Reserve growth is the reason that estimates of peak carbon-based energy supply have consistently turned out to be too low. Some people take this proposition and run off the edge of the earth with it, claiming that fossil fuel has no limits. Although the total resource availability is finite, reserve growth can increase a given region's known amount of extractible fuel, even after recognizing the reduction of the reserve through production. Fluctuations of reserves aside, there is only so much oil on (or in) the earth. What varies is human knowledge of where it is, and human capacity to capture it.

Tank hauling fuel: capacity 17 barrels; total load 3.5 tons. *Courtesy of the Bancroft Library, University of California, Berkeley 19xx.129—ALB, container 4, Image 35.*

Why the Fight Focuses Here: The West's Holdings in Energy

The West sits at center stage because the region had and has such rich fossil fuel resources and because it is so well supplied with sunlight and wind.

Geology's Gift to the West

One hundred million years ago, this was the Soggy West, not the Arid West. A shallow inland sea stretched across North America, cutting a swath through Canada and covering much of what is now Montana, the Dakotas, Wyoming, New Mexico, Colorado, Nebraska, Kansas, Oklahoma, and Texas and connecting with the Gulf of Mexico. The ancient ocean, now known as the Great Cretaceous Seaway, generated much of the fossil fuel reserves which now make the West a linchpin in the global energy picture.[21]

Throughout most of the Cretaceous period, organic matter built up on the sea floor and along its shore. In the ocean, single-celled organisms settled on the bottom where they combined with sand and clay particles to form a mix of sediment and organic matter. Other microorganisms converted the proteins and carbohydrates of the decaying single-celled creatures into fulvic and humic acids. As more sediment built up, heat and pressure gradually changed the acids into kerogen, a substance that yields petroleum when heated. As the sea retreated east over a period of 30 million years, it left a wake of marshes and bogs along its contracting shore. These marshes supported an abundance of trees and plants. Layered and decayed, this vegetation formed peat. Sedimentation buried the peat, and over the course of millions of years, tremendous heat and intense pressure came to bear on it. Gas (methane and carbon dioxide), water, hydrogen, and oxygen were squeezed free. The end result would be coal. As the sea shrank, vast river systems drained into the smaller body of water, called the Cannonball Sea by geologists. The valleys and marshes of the rivers supported an abundance of vegetation, which over time was converted to coal by the same geologic forces of sedimentation, heat, and pressure. The processes that occurred in and on the shores of the Great Cretaceous Seaway and the river systems leading to the Cannonball Sea took place over a period of 100–50 million years ago. When an energy boom surges through a county in the West, peak production might last anywhere from a year to a few decades. Geologic time meets market time.[22]

When we rely on fossil fuels, we are dealing in a scale of time that strains the imagination.

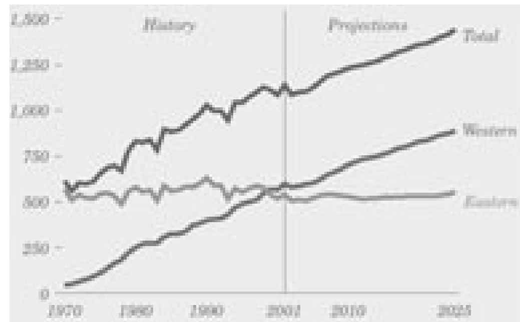
When we rely on fossil fuels, we are dealing in a scale of time that strains the imagination.

Coal

Coal mine. *Courtesy of the Colorado Historical Society, CHS.X4840, Otis A. Aultman.*

Coal is the West's most abundant and cheapest fossil fuel. The 13 mines of the Wyoming Powder River Basin produce an average of over 27 million tons of coal per year and include the 10 largest coal mines in the United States. In total, these 13 mines produce about one-third of all the coal produced in the United States. And more than 25 percent of U.S. coal production comes from 25 mines in the Powder River Basin alone. In fact, Wyoming produces roughly the same amount of coal as South America, Central America, Africa, and the Middle East combined.[23]

The West not only has abundant coal reserves, its coal is low in sulfur and is relatively accessible. These two facts partly explain the upward trend in Western coal production since the 1960s. Stricter environmental regulations throughout the 1960s, 1970s, and 1990s have made the West's low-sulfur coal a more attractive alternative to the eastern coal. And technological advances in mining techniques, particularly strip-mining, have boosted the West's coal industry over the past three decades.



Emission Caps Lead to More Use of Low-Sulphur Coal from Western Mines
Coal production by region, 1970–2025 (million short tons)
Courtesy of the Energy Information Administration.

A growing nationwide demand for electricity and a population boom in the West have also contributed to the increase in Western coal production. In the Rocky Mountain region, nearly 90 percent of electric energy production comes from coal. That percentage will change little in the coming years as the population of the mountain states continues to grow. Since 1970, the region's total population grew an estimated 50 percent. The amount of coal-fired electricity in the region has increased six-fold in the same period.[24] According to the Energy Information Administration, annual Western coal production is expected to increase steadily, reaching 887 million tons by 2025.[25]

Not Out of Sight, Not Out of Mind

In olden days, people *knew* they relied on coal because the coal man came once a month and shoveled coal into the basement. For most of its beneficiaries today, the burning of coal to produce electricity is an activity that thoroughly qualifies for the phrase "out of sight and out of mind." Environmentalists and coal producers may not have a lot in common, but they both agree on this: the "out of sight, out of mind" routine has to go. The people who benefit from the combustion of coal should know who they are.

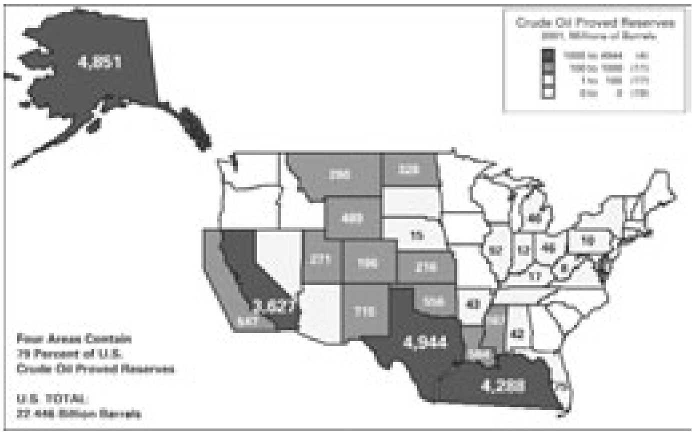
Next time you turn on a light switch, start up the computer, settle down in front of the TV, or tell the microwave what to do, imagine the coal man pulling his truck up to your curb, conjure up the sight and sound of coal going down the scuttle into your basement, and leave your innocence behind. You may miss it briefly, but when it comes to a choice between innocence and honesty, honesty makes for better conversations and a more interesting life. A chunk of coal placed by the bedside reading light of each Westerner would go a long way toward enhancing the quality of thought in the region.

Oil gusher, Yale, Oklahoma. Workers watching below. *Courtesy of the Western History Collection, University of Oklahoma.*

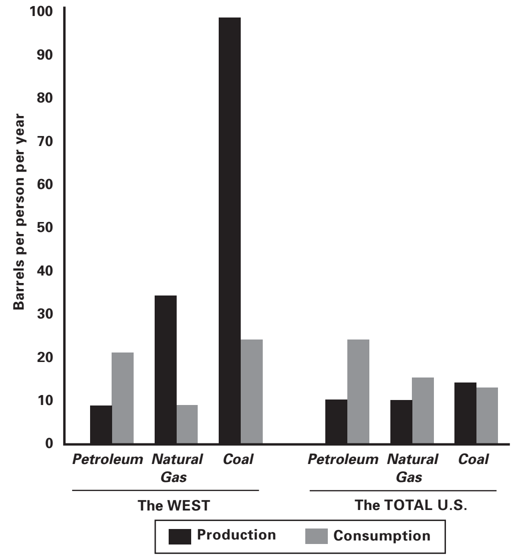
Oil

The West is the largest onshore oil-producing region in the contiguous United States. The 11 western states hold 30 percent of the proved oil reserves in the lower 48 states, including offshore reserves. California is the West's oil center, with 17 percent of the U.S. crude oil proved reserves, the third largest holdings in the nation. In 2000, California accounted for 12 percent of the nation's crude oil production.[26] New Mexico is the West's second largest crude oil producer, followed by Wyoming, Colorado, Montana, and Utah. In 2001, the West's eight oil-producing states accounted for 20.5 percent of the total U.S. crude oil production.[27]

In the West, 39 percent of our fossil fuel use is petroleum. We use petroleum primarily for transportation, while we use coal and natural gas for electricity production, heating, and cooling,



Courtesy of the Energy Information Administration.



Production and Consumption: The West vs. Total U.S.
Data courtesy of Mike Hannigan.

plus cooking. More than a third of our fossil fuel energy use goes to transporting ourselves and our material goods. We each use 22 barrels of petroleum per year. You and nine of your friends use a tanker truck each year.[28] Above is a comparison of energy production and use per capita in the United States and in the West. One important thing to observe is that the West does produce more natural gas and coal than it consumes. Actually, three states produce more petroleum, coal, and natural gas than they consume: Alaska, New Mexico, and Wyoming. Four more states produce more coal and natural gas than they consume: Colorado, Utah, Montana, and Alabama. Two things hit you: The West is still the resource frontier, and we have an oil problem.

Natural Gas and Coalbed Methane

Oil and gas are often found in the same formations, and, for over a century, the oil and gas industries have been tightly linked. In the late 19th century and early 20th century, oil producers considered natural gas a nuisance and an obstacle to production. They often flared the gas or vented it into the air. But since the 1940s, technological advances and a growing national pipeline system have enabled producers to capture, store, and distribute natural gas more efficiently. In 2001, natural gas accounted for 17 percent of the nation's electricity generation and is expected to generate 29 percent of electricity by 2025 .[30]

The intermountain West contains more natural gas than any other region in the lower 48 states. It holds 41 percent of the estimated proven and potential gas reserves in the United States and produces nearly 20 percent of the nation's natural gas.[32] Natural gas production in the Rocky Mountain region is projected to grow by 2.7 trillion cubic feet between 2001 and 2025, the largest increase in natural gas production in the United States. During that same period, natural gas consumption is expected to increase across the nation, with the largest rise occurring in states east of the Mississippi.[33]

Coalbed methane (CBM) production is a relatively new industry in the West. CBM is a natural gas that is trapped in coal seams. Water pressure within the coalbeds causes the

"The average household uses about 50,000 cubic feet of natural gas each year."[29]

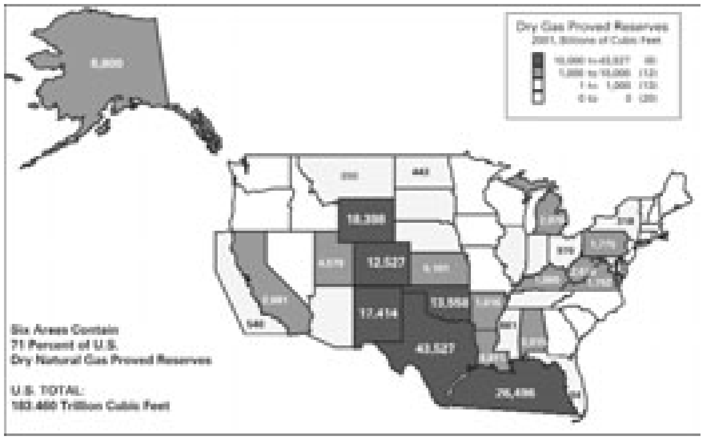
That's enough gas to fill up the Goodyear blimp in four years.

Natural Gas: the Other Fossil Fuel

Natural gas offers a number of advantages over other non-renewable and renewable energy resources. It's abundant and reliable, and nearly all the natural gas used in the United States is produced in the United States—although imports from Canada are important.

Natural gas is also the cleanest of the fossil fuels. When burned, it produces virtually no ash and emits lower levels of carbon monoxide, carbon dioxide, sulfur dioxide, and nitrogen oxides than oil and coal. But it still has significant emissions.

Natural gas production takes up less space than renewable energy resources. One 1-billion cubic feet gas well disturbs half an acre. Generating a comparable amount of energy, would require a 100–300 acre wind farm, a 46-acre solar farm, 402 acres of tall trees, or one Glen Canyon Dam.[31]



Courtesy of the Energy Information Administration.

Why CBM Matters

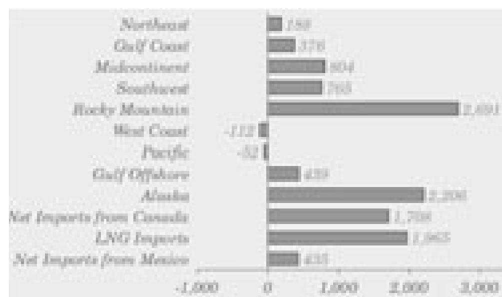
Gary Bryner

Coalbed methane is one of the most important and valuable natural resources in the western United States. The natural gas that results from CBM development is the cleanest burning fossil fuel, and the extensive domestic supply makes it a central element of the national goal of a secure supply of energy.[34]

methane gas to be adsorbed onto the grain surfaces of the coal. Since coalbeds have large internal surface areas, they can store massive quantities of methane, typically six to seven times more gas than the equivalent volume of rock in a conventional natural gas reservoir.

The West is a key region for CBM production. The most prolific CBM production in the world is attributed to the San Juan Basin in Colorado and New Mexico, and the Powder River Basin in Wyoming. In 2001, CBM production in the U.S. accounted for 8 percent of the dry-gas production in the lower 48 states.[35] Colorado, Wyoming, New Mexico, and Utah hold an estimated 47 trillion cubic feet of CBM, one-third to one-half of the nation's total estimated recoverable reserves.

Of course, the numbers can be misleading. If we use the previously mentioned annual natural gas use per household (50,000 cubic feet/year) and the number of households in the U.S. (roughly 225,000,000), then we learn that those big numbers aren't really so big. The 47 trillion cubic feet of CBM would last only four to five years.



Natural Gas Supplies from the West Are Expected to Grow

Projected changes in U.S. natural gas supply by region and source, 2001–05 (billion cubic feet)

Courtesy of the Energy Information Administration.

Wind

In the post-fossil-fuel world, the West will be wonderfully positioned. After all, the abundance of both wind and sunshine have long preoccupied Westerners and inspired many a tall tale. Chickens fated to live on the Plains, legend had it, learned to stay on their feet by leaning into the wind. On the rare occasions when the wind let up, the surprised chickens pitched forward.

The features of the landscape shape the region's resources in sun and wind. Western states are both blessed and cursed with a combination of mountain-enhanced winds and empty obstacle-free prairie space. In Wyoming, low pressure systems routinely roll over the front range where they are focused by valleys and drainages before blasting down along the eastern plains and putting tumbleweeds into vigorous motion. Writer Teresa Jordan has drawn a striking analogy to convey the reality of working outdoors in windy Wyoming: "Imagine conducting a day's business from the hood of a car traveling 60 miles an hour."[37]

Financial incentives for wind-generated electricity led to a "wind rush" in the early 1980s. "Some companies," historian Robert Righter tells us, "indifferent to quality and energy production and mesmerized by the financial stakes, put up towers and turbines fast, with little regard to quality." Some of the rushed projects were right next to major highways, where they did little to enhance public support for wind energy. Early experiments near Cabazon, in the San Gorgonio Pass in southern California, were on display for "the thousands of travelers using the highway." "The derelict site, with its downed turbines, broken blades, and general technological chaos," Righter tells us, "magnified perceptions of the

The Old West Anticipates the New West

"*When he was too old to work, [famous rancher and cowboy Charles] Goodnight liked to sit on the open gallery as the wind tore at the trees in the yard and tossed his shock of white hair like the mop of an angry buffalo bull. . . . When his wife complained of the wind, he voiced the sentiment of the pioneer plainsman: 'you get to where you don't notice it.' In truth he would not have felt right if the wind hadn't blown.*"[36]

—J. Evetts Haley

industry's problems. Cabazon became, in the eyes of one reporter, an eyesore of broken and twisted blades: more a war zone than a wind park."

The state of California provided tax credits for wind companies, but tied those credits to *investment*, not to *energy production*. Thus, as Righter observes, "whether the turbine worked or not made little difference to the manufacturer, developer, or investor: what counted was the rated capacity." A "performance-based plan" would have made for a much more solid and sensible set of incentives. Righter sums up the unhappy legacy of two decades ago: "Unrealistic predictions of economy and reliability are what ruined the reputation of the industry in the early 1980s," with "creative chicanery and outright corruption" playing a part in that ruination.[39]

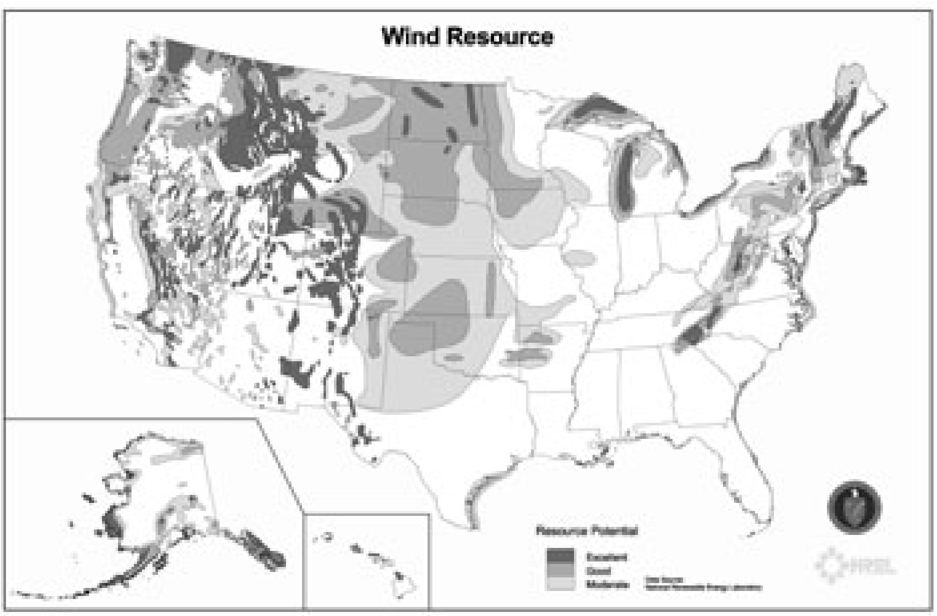
The condition of the industry is entirely different in the early 21st century, but these problems of hasty, ill-thought-out design linger in the memory and unfairly prejudice public thinking. Wind technology has undergone a series of mini-revolutions that have much enhanced the resource's potential. Costs have dropped significantly in areas of high wind speed. Advances in tower height, blade size and sharpness, internal mechanics, and assembly and manufacturing techniques have all contributed to improved turbine performance.

An expert on wind power tells the story of the change in the wind power industry. When he first started going to meetings of wind power advocates and designers, he says, the meetings were almost entirely populated by counter culture sorts in tie-dye shirts and Birkenstocks. Now, he says, people from other sectors of the energy business and the utilities are attending these meetings; the tie-dye shirts are in retreat, and suits and ties are on the rise. Perhaps some would see this shift from tie-dye to business ties as a symptom of decline, but a recognition of the necessity for investment in renewable resources makes this a story of hope. One longtime veteran of wind-power efforts now appears at meetings in a business suit and Birkenstocks, and that fellow's changing appearance alone indicates that this paradigm shift is picking up momentum.

Wind's One Big Problem

Jan DeBlieu

"Electricity produced by oil, coal, or gas has a major advantage over wind power in that it can be generated on demand. Even in the most gale-lashed regions the wind does not always blow. Unless utilities can find a way of storing large quantities of electricity, wind power will always have to be supplemented by other electricity-generating facilities."[38]



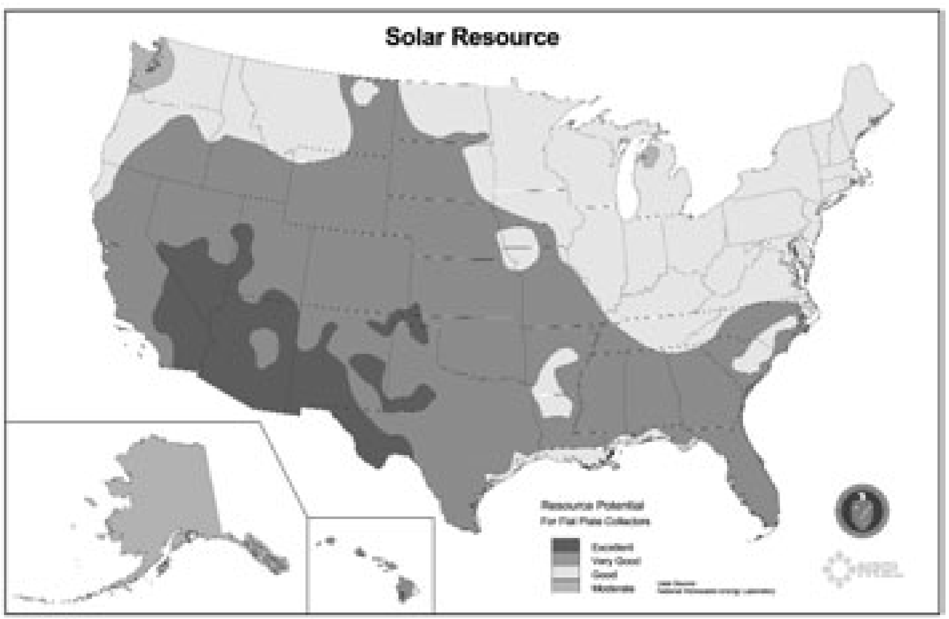
Courtesy of NREL.

Sun

Anasazi cliff dwellings, circa 1100 A.D., used passive solar design. *Courtesy of NREL.*

The West's mountain ranges also explain the many hours of sunshine. When air moves in from the Pacific and Gulf of Mexico, the Sierra Nevada and Rocky Mountains force it to drop much of its moisture. By the time the air reaches the other side of either of these ranges, little moisture remains, and as a result, precipitation and sun-blocking clouds are minimal. The sun has always been especially generous in its attentions to the West, causing pioneers to complain, crops to grow and sometimes to wither, retirees to flock to Arizona, and, most recently, energy researchers to intensify their efforts to capture the sun's energy. Beneath the exaggerations lie compelling facts: the majority of the region receives over 2,800 hours of sunshine a year, as compared to 1,400–1,500 hours in Boston or New York City.[40] Some of the nation's best solar resources are located in the Rocky Mountain and Southwest regions of the United States.

A variety of technologies allow us to draw on the sun's energy. Photovoltaic systems or solar cells convert sunlight into electricity. Concentrating solar systems use the sun's heat to generate electricity, and passive solar design uses sunlight and solar heat to warm and light buildings. Solar energy is also used to heat water, and solar process heat and space heating and cooling are used in commercial and industrial buildings. A leader in solar technology research, the National Renewable Energy Laboratory (NREL) in Golden, Colorado, sums up the importance of solar energy this way: "Most renewable energy comes either directly or indirectly from the sun. Sunlight, or solar energy, can be used directly for heating and lighting homes and other buildings, for generating electricity, and for hot water heating, solar cooling, and a variety of commercial and industrial uses."[41]

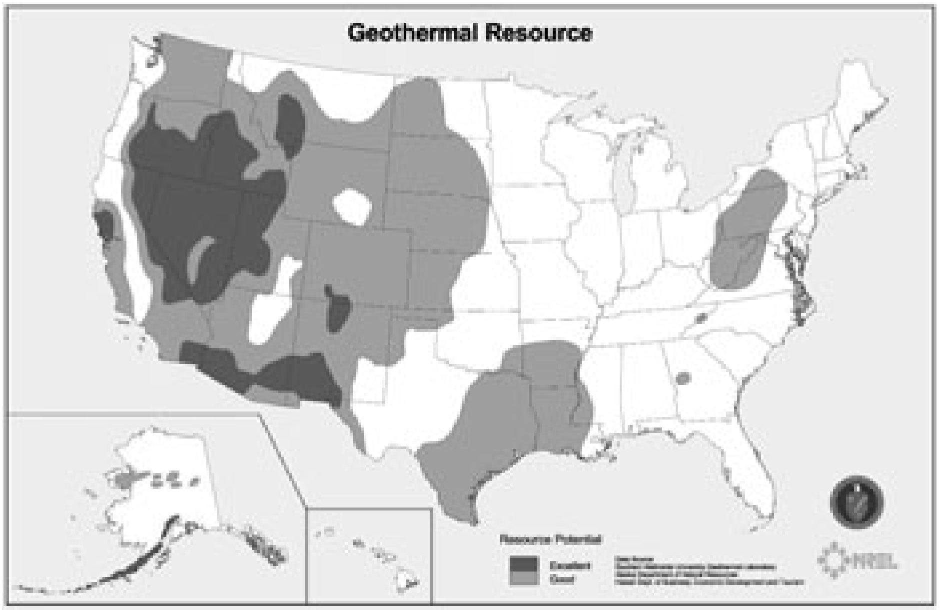


Courtesy of NREL.

Geothermal

Geothermal ponds—low grade geothermal applications in Colorado hot springs.
Courtesy of NREL.

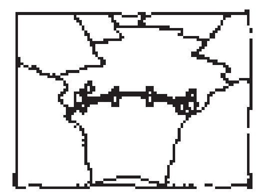
Geothermal energy is heat from the earth, and it is a clean and renewable resource. Geothermal reservoirs are found everywhere, but most of the nation's hot water geothermal resources are concentrated in the West. Over 300 Western towns and cities are located within five miles of a high-potential geothermal resource,[42] and most of the nation's 70 geothermal plants are located in California, Utah, and Nevada (the rest are in Hawaii). California generates more geothermal electricity than any other state and is home to the world's largest and the nation's first developed field, the Geysers, located north of San Francisco. Currently, geothermal power supplies electricity to more than five million people. According to the Energy Information Administration, electricity generation from geothermal sources is expected to increase to 37 billion kilowatt hours of electricity by 2025, providing 0.6 percent of the nation's electricity supply. All of that development is projected to occur in the western United States over the next two decades.[43]



Courtesy of NREL.

Water Power

Hydroelectric power accounts for 7–12 percent of the nation's electricity supply and is the most mature (i.e. developed and implemented) and largest source of renewable power in the United States.[45] A state must have a large volume of flowing water and a significant change in elevation in order to tap its hydropower resources. States such as California and Idaho have both, and hydropower is an important source of electricity for both of these states. In 1999, hydropower accounted for 21.1 percent of California's and 93.3 percent of Idaho's total power industry generation of electricity. In the Northwest, dams and "run-of-the-river" plants generate most of the electricity supply. In 1999, Washington and Oregon relied on hydropower for over 82 percent and 80.5 percent respectively of their total electricity production.[46] Yet some of the West's most arid regions are also home to its largest hydroelectric power facilities. The Glen Canyon and Hoover power plants in Arizona and Nevada are the second and third largest hydroelectric facilities in the nation, trailing only the Grand Coulee power plant in Washington. Built primarily as water storage facilities, these dams also provide electricity to the region's growing population. As of July 2002, 19.6 percent of Las Vegas' electricity comes from hydroelectric stations, most of that from the Hoover Dam.[47] While hydroelectric power provides the largest share of "renewable" energy, opposition to the damming of Western rivers grew substantially in the last part of the 20th century, and authorizing new large dams would mean a very tough fight.



Water Power

Existing U.S. hydropower capacity is about 77,000 megawatts (not counting pumped storage)—enough electricity to meet the needs of 35 million households. This represents the energy equivalent of 140 million tons of bituminous coal and the avoided emissions of roughly 400 million tons of carbon dioxide.[44]

Nuclear

Nuclear power plants provide about 20 percent of the nation's electricity, and in 1995, for which we have the most recent data, accounted for 10 percent of the electricity generated in the Southwest and in Wyoming.[49] The West is home to four of the nation's 65 nuclear generating sites: Palo Verde in Arizona, Diablo Canyon and San Onofre in California, and Columbia in Washington. Palo Verde is the nation's largest nuclear energy facility, and is currently the third largest utility plant in the United States. Its three reactors generate enough electricity for roughly four million people and supply about 34.2 percent of Arizona's electricity. Nuclear power generates roughly 17 percent of California's and 8 percent of Washington's electricity.[50]

As with hydroelectric power, public opposition to nuclear power, combined with the difficulties of opening a permanent storage site for radioactive waste, makes expansion of nuclear power look unlikely in the immediate future. While a site was chosen for storage of waste from nuclear power plants, controversy over the geological and hydrological qualities of the Yucca Mountain location makes the opening of a functioning disposal facility seem increasingly remote.

A Regional Fit?

John Findlay and Bruce Hevly

"It is fitting that the American West played such a prominent role in determining the fate of the atom. The region, like nuclear power, has generally been a realm of dramatic hopes and fears, a place often likened to hell or to heaven, and a setting shaped by collisions among deeply held expectations and between expectation and reality."[48]

The West is the focus of the energy fight for very clear reasons. The West is very rich in resources. The West is very rich in landscape beauty. As a result, the West is very rich in contention.
It's not easy being rich.

Wanted: Infrastructure for Renewables

A. David Lester

While investment in research and technological development is important for the future, it alone is not sufficient to bring about a smooth transition of these technologies into the energy marketplace in North America. Here is what is preventing the entry of larger scale renewable energy supply: the lack of political will to make the public investment in physical infrastructure. The energy infrastructure is in place to deliver fossil-, hydro- and nuclear-fired electricity to markets. No similar infrastructure exists to deliver wind-powered electricity. Where the wind resource is, the infrastructure is not. Market demand will not drive infrastructure investment. Only public policy can produce infrastructure investments through direct expenditure, following the model of the funding of the interstate highway system, the land grants to the railroads, or the support through tax policy given to the oil and gas industry. Renewable energy requires some technological innovation. Even more, it requires political innovation and commitment.

Saving the West from the Landscapes of Power

Mike Pasqualetti

In the beginning, there were only natural landscapes. Today few natural landscapes still exist.

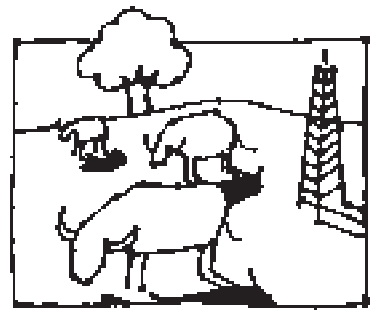
Two things account for this change. The obvious one is the increased number of people. The second is the increased power we wield through the energy we command. Together these forces have created "landscapes of power" in such number and variety that their familiarity camouflages their origins.

We started making landscapes of power as soon as we started burning wood to warm ourselves. The resulting global imprint was as small as the population. Thousands of years later, when we began wresting coal from the earth, our ability to create landscapes of power grew in variety and intensity. Later, with oil, we added to the mix of these landscapes: wells, pipelines, tankers, refineries, uncounted drilling rigs, and always more roads. In other venues we turned canyons into lakes, open spaces into generating stations, quiet shores into harbors. We then connected all of it with a million miles of transmission lines, railroads, and pipelines. What we had produced was a complex, interdependent network, a "mega" landscape of power.

Many of the landscapes of power are less obvious. Exclusion areas around nuclear plants, abandoned lands above mine fires, and dead zones where toxic spills have contaminated the soil all create blank spots on the map. Forests lost to acid rain, beaches lost to global warming, sandbars lost to dams, vistas lost to power plant emissions, rural areas lost to boom towns.

We have lost count of the landscapes of power, dulling ourselves to our responsibility in their creation. That we reshape the landscape for energy is nothing new. It is just nothing we think about.

While the Intermountain West has landscapes of power, they are relatively limited compared to the size of the region. Although the interior West is still inspiring and sparsely populated, little time remains to hold back the forces of civilization that seem destined to render this statement out-of-date.



What can we do?

First comes awareness. We must recognize the values and vulnerabilities of Western landscapes. What is the value of red rock buttes, deeply twisting canyons, blue skies, wildlife habitat, limitless vistas, absolute quiet, and the majesty of open space? How tenuous and irredeemable are these qualities? And how rare? Awareness is the beginning.

Second comes planning. It is unrealistic to believe that such a stunning and fragile area, even with the ostensible protections afforded its national parks and wilderness tracts, will avoid the many demands for the energy resources it shelters. Relying solely on a strategy that raises public awareness and hopes for the best is fraught with uncertainty and risk. If the natural qualities of the region are to be maintained, it will only come through careful consideration and action. The question is, what plan can simultaneously develop the region's resources and preserve its qualities?

Third comes the plan. The energy resources of the Intermountain West, except one, all impose substantial burdens. Only solar energy avoids these objectionable impacts. It is silent, clean, abundant, viable, and ubiquitous. Using it pollutes no air, requires no water, burns no fuel, creates no waste, and produces no irreversible changes. In the Intermountain West, solar development could contribute to the energy we need, maintain the qualities we cherish, and do so without producing the landscapes of power that have plagued all energy development in the past. Solar energy is the West's most abundant resource. It is the one energy resource that would allow us to develop the West and save it at the same time.

The Energy-Driven West

The West is at center stage because its history is so intertwined with and shaped by energy production and consumption.

In 1893, historian Frederick Jackson Turner made an influential statement about the history of the nation and the history of the West: *"The existence of an area of free land, its continuous recession, and the advance of American settlement westward, explain American development."*

Rewritten and revamped for 2003, Turner's declaration benefits from an overhaul: *The existence of an abundance of cheap energy, its continuous extraction, and the advance of American material comfort ever upward, explain American development.*

> *The existence of an abundance of cheap energy, its continuous extraction, and the advance of American material comfort ever upward, explain American development.*

Prolonged Sunset for an Energetic Industry

The discovery and development of the West's oil, coal, and gas resources required courage and enterprise from the industry's leaders, and equal courage and enterprise, along with enormously hard work, from miners, roughnecks, and roustabouts. For a significant number of working class Westerners, the energy industry has been an important source of jobs, opening up for immigrant families a set of options and opportunities that gave them a stake in society. The story is, of course, mixed in its meanings—options and opportunities came in the same package with risky and dangerous work and episodes of grim exploitation. In our times, mechanization and automation have much reduced the numbers of workers required to mine coal or drill for oil or gas. As these jobs shrink, and as we move toward "the yellow zone" of renewable resources, an industry of enormous importance to the West begins to approach sunset.

The boom and bust cycle that has so shaped the economic history of the region has intertwined itself with a cycle of rise and fall and rise in the nation's use of energy sources. Through the 19th century, coal was the key fuel. In the early 20th century, oil came to the fore with the rise of the internal combustion engine. Increasingly, by mid-century, natural gas was gaining importance. At the same time, enthusiasm for nuclear power, as well as the building of nuclear weapons, inspired uranium booms in various Western sites. By the 1970s, coal was coming out of its prolonged recession and rising steadily as a fuel for the generation of electricity.

Coal, oil, natural gas, oil shale—all have had their day in the sun, and all have risen or fallen with the entry or resurgence of other energy resources. Market forces, international events, government policies, scientific discoveries, shifting social values, and technological advances have all had a say in picking the region's energy resource du jour. For Western energy towns, decisions on nearby Indian reservations or distant cities such as Washington, D.C., or Riyadh, Saudi Arabia, can have swift and sometimes devastating effects.

When we focus our attention on the environmental impacts of the West's fossil fuel industry, we can lose sight of the tremendous social impact that this industry has had on Western communities. To make wise decisions about the West's energy future, we should also look at the human face of energy development in the West.

Nature wasn't thinking of user-friendly access when it distributed fossil fuel resources across the West. Remote locations have posed a major burden for energy development and help explain some of the most troubling impacts of energy production on Western communities.

Energy booms have fueled and been fueled by dramatic population growth. They have generated tremendous economic opportunities for Westerners, and have paid for improvements in infrastructure and services in remote rural Western towns. Booms have also confronted communities with pollution, traffic congestion, crime, and noise. Booms have taxed the civic resources of small Western towns, not to mention the nerves of unsettled and irritated old-timers.

The Archetypal Westerner Moves into Energy

Owen Wister's book, *The Virginian* (1902), played an enormous role in shaping images of the West and Westerners. The Virginian is the archetypal cowboy, noble and handsome and very, very capable. But once he gave in to civilization and married the schoolmarm, well, what then? Could an archetypal cowboy find a way to support a genteel family?

Very few readers remember the last paragraph of the book, a paragraph that is its own fine testimony to the central role of energy in Western history. Recognizing his employee's capabilities, Judge Henry makes the Virginian into his partner. The Virginian thus becomes a property-owner, and a foresighted one at that. As the open-range cattle business comes to a close, he shifts to other enterprises:

"But the railroad came, and built a branch to that land of the Virginian's where the coal was. By that time he was an important man, with a strong grip on many various enterprises, and able to give his wife all and more than she asked or desired."

The cowboy became the coal operator. As The Virginian said to Trampas in the famed bar scene, "When you call me that, *smile*."[51]

If anyone holds the rights to update *The Virginian* for the 21st century, we recommend having the foresighted Judge Henry and the Virginian consider a shift to wind power.

The World's People Converge

Westerners who celebrate ethnic and racial diversity may look wistfully back at the energy booms of old. The West's coal camps were among the most ethnically and racially diverse communities in the region. The earliest coal miners were often Welsh or English. Mexicans were among the first to work the mines of southern Colorado and New Mexico. Miners from almost every European nation—Italy, Austria, Germany, Greece, Hungary, Ireland, Bulgaria, to name a few—labored in the Western mines. Add to that Chinese, Japanese, and African Americans, and you have communities more diverse than those of many eastern seaboard towns. In 1900, Colorado Fuel & Iron Company in southern Colorado employed nearly 9,000 coal miners. Of those, two-thirds were immigrants from southern and eastern Europe. The company's payroll showed 32 different nationalities, and camp residents spoke 27 different languages.[53]

Nostalgia may die down, though, when contemplating the fact that strike-breaking explains some of this diversity. Strikes were common in the Western coal mines. To get around them, coal companies such as CF&I hired labor agents to recruit workers wherever they could find them. Black miners were brought to break a Colorado coal strike in the 1880s. Bulgarians and Greeks were used as scab labor against American, English, Welsh, Italian, and Slav strikers in Colorado in 1910. In the coal camps as elsewhere on the planet, people of diverse origins had remarkable moments of neighborliness, and equally remarkable moments of friction.[54]

The Spirit of Coal Miners in Southern Colorado

Thomas Andrews

"I don't know how to put it," Lawrence Amicarella explained to an interviewer, "just that it grows on you, just grows on you, being a coal miner." His brother Claude agreed: "It's challenging and it's an honorable occupation." For his part, Tony Hungaro "always figured a coal miner was a goddammed good man." . . . "I worked the mine 50 years," Lawrence Amicarella recalled. "[E]ach day I worked I learned something. I learned to tell the boss to kiss it."[52]

Men and coal tram. *Courtesy of the Colorado Historical Society, CHS.X4847, Otis A. Aultman.*

Busts have left their own imprint on the Western psyche. Busts have thrown thousands out of work seemingly overnight. They have saddled Western communities with debt, yanked the rug out from under real estate prices, and whittled away at personal savings. Busts have also been the West's most effective, if also most graceless, form of control of population growth.

Located in remote regions of the interior West, far from urban centers and from transportation routes, coal deposits were the basis of the West's earliest energy booms and busts. Coal companies not only had to build roads and persuade railroad companies to lay track to their mines, they had to convince miners and their families to move to—and to stay in—these isolated, and often, unappealing areas.

Many early Western coal camps were rowdy, ramshackle, temporary settlements. Companies and miners alike found few reasons to invest in community infrastructure and social services. Miners were usually single men who built their own houses on company property, a jumble of tarpaper and clapboard shacks, adobe ranchitos, and dugouts. Primitive sanitary conditions, noise, and pollution from the mines were constant features of life.

Near the turn of the 20th century, Western coal towns underwent a shift in character. Miners brought their families, and the presence of women and children gave these camps a hint of permanence. The need to maintain a reliable labor force encouraged companies to invest money in infrastructure and town planning. Larger coal companies began replacing dilapidated houses with company-provided homes, financing new community buildings, and improving sanitation and other civic services. Of course, living in such a town required miners and their families to accept a significant degree of company control and supervision.

Energy boomtowns later in the 20th century bore some resemblance to the communities of the previous century. Energy companies recruited workers from other parts of the United States, fostering explosive population growth in remote locations. Locals and newcomers confronted familiar problems of housing shortages, overburdened sanitation systems, inadequate schools, insufficient water supplies, pollution, traffic congestion, and noise.[55]

The town of Gillette, Wyoming, came to stand for the whole, broad pattern. Established in 1892, Gillette began as a small railhead town on the dry, rolling plains of the Powder River Basin. For most of its history, Gillette was a quiet ranching community. Everything changed in the 1970s, when energy companies moved in to mine the Fort Union formation, a coal seam 60 miles wide, 100 feet thick, and 200 miles long. By 1973, Gillette's energy boom was in full swing. In just 10 years, the town of 3,000 grew to 17,000 attempted residents. Newcomers lived in their cars or in tents on the edge of town. Hotel rooms were rented out in 12-hour shifts.[56]

Sociologists who studied the 1970s energy boom in Gillette found increased rates of crime, drug abuse, domestic disturbances, delinquency, and suicide. Gillette, they said, was a public health disaster, its problems summed up in what became known as the Gillette Syndrome, or the Four Ds—drinking, divorce, delinquency, and depression. More recent sociological studies have questioned the findings of these earlier studies, but the Gillette Syndrome had become a matter of local, regional, and national folklore.

The Oil Well at Home

Matt Silverman

Boulder Oil Field. *Courtesy of the Denver Public Library, Western History Collection, Charles Pierce, X-22278.*

Energy resources are where we find them, like gold and silver. Not where we expect them to be, not where it may be geographically convenient, not where it may be environmentally expedient. Even in Boulder, Colorado—green, politically correct Boulder—an important oil field has been producing for over one hundred years.

In 1901, the Boulder Oil Field was discovered just northeast of town. It is the second oldest field in the state and the first in the vast Denver Basin. The field was discovered the same year as Spindletop in Texas, and its early development shares some of that boomtown excitement. Surprisingly, the site of the discovery now boasts the only well still producing in the field. The McKenzie Well (continuously producing since it was drilled in 1902) has been designated a landmark by Boulder, and National/State Registry has been applied for.

The Boulder field represents a forgotten boom, a lingering bust, and a unique opportunity for historic preservation. No other remnants of the 200-well field are evident, suggesting the short-term impact of most energy development. Open space, recreational facilities, and upscale residences now cover nearly all of the old field.

This offers Westerners an extraordinary lesson. Energy production has always been a key part of the tale of the West—even in places like Boulder. It will continue to be a significant part of our story into the future.

Where There's a Boom, There's (Usually) a Bust

The oil shale boom and bust in Colorado in the early 1980s is a good example of the impact that shifting energy markets can have on Western communities. In 1980, Exxon, along with its partner, The Oil Shale Company, began developing the Colony Project, an effort to tap Colorado's rich oil shale deposits on the Western Slope. In 21 months of intensive development, Exxon spent an estimated $5 billion on the Colony Project and then abruptly closed the operation in May of 1982, when the price of oil dropped below $30 a barrel, the lowest price that would make oil shale profitable.[57]

Nearby Grand Junction, the urban center of western Colorado, underwent dramatic change during the boom. A new airport was built to handle the business traffic that swamped the region. A new shopping mall went up just west of town. Finance companies, law firms, and department stores set up shop, and the school district quickly built five new schools to accommodate the growing number of school-age children. The town of Parachute, just south of Exxon's operations, rode high on the boom as well.[58]

Locals called the end of the operations on May 2, 1982, "Black Sunday." Exxon's about-face on its Colony Project put at least 2,500 people out of work in Parachute alone. Within a year, foreclosures in Grand Junction and Mesa County soared. In 1981, there were 107 foreclosures in Mesa County. That number jumped to 157 in 1982 and nearly tripled to 465 by 1983. In 1984, foreclosures totaled 1,042. Bankruptcies in the two counties increased dramatically, and the new office buildings and hotels that had gone up in Grand Junction during the boom were not even at 50 percent occupancy. The population also dwindled as unemployed workers and their families salvaged what they could of the personal finances and headed for larger urban areas on Colorado's front range. Around Parachute, local residents sported T-shirts that summed up the mood: "EXXON SUCKS ROCKS."[59]

And then things changed.

The pattern had seemed set: a locality would become the site of an energy boom; strangers would flood in to take the expanding number of jobs; the locals would be overwhelmed; and then the bust would hit; the jobs would disappear; and the community would be left reeling.

But now things are different, and this pattern of Western history begins to look increasingly irrelevant to our times.

Calmer Times, Better Image

The city of Gillette conducts an ongoing public relations counter-campaign against its image problems, as its web site indicates:

Unfolding from a heritage of ranching and rail, we envision Gillette as an energetic and dynamic community of 40,000. Our healthy and diversified economy is anchored in high tech energy development. This community of scenic vistas will strive to become the regional center for a variety of activities serving all of northeast Wyoming. This includes regional shopping, medical services, transportation hub, cultural and recreational activities, higher educational opportunities, and tourism.

The Four Ds of the 1970s are now notably absent, transformed into the Two Ds: "dynamic" and "development."

Oil drilling rig, 1974, at Barron Ranch Ellenburger Field, Garza County, Texas. *Courtesy of the Western History Collection, University of Oklahoma.*

Side Effects

Sometimes the appeal of economic good times has overruled caution in community decision-making. The situation could justify a public service advertisement modeled on ads for prescription drugs.

If you suffer from a lethargic economy, a dwindling county budget, and limited employment opportunities, talk to your city council members, geologists, and energy executives about ENERSAV. ENERSAV has been shown to stimulate local business opportunities and reinvigorate sagging economies. Possible side effects may include: depression, disorientation, and delinquency. Some users experience mild to severe housing shortages, inadequate water supplies, overburdened sanitation systems, pollution, traffic congestion, and noise. ENERSAV is not for everyone. In many cases, heavy dependence on ENERSAV has led to economic collapse and calamitously high unemployment. In rare cases, ghost town conditions have resulted.

"The meek shall inherit the earth, but not the mineral rights."
—J. Paul Getty

Intense Complexity

Arizona Land Ownership Status, Arizona Department of Mines and Mineral Resources

"Ownership of land and mineral rights in Arizona and its related mineral entry status is complex. It is impossible to make a general statement that will provide a key to the surface and subsurface status of lands. The complex nature of land and mineral entry status is further intensified by the fact that in many areas the surface and mineral rights are under separate ownership."[61]

Part of the change comes, actually, from learning the lessons of history, especially in anticipating and planning for boom/bust rhythms. That awareness has made it possible for Western communities to cope with the strains of growth and, in some cases, has led to efforts to control and shape that growth.

Let's return to Parachute, Colorado, where the oil shale bust in the 1980s left an indelible mark on local attitudes about energy development. In 1996, Royal/Dutch Shell began explorations near Parachute, Colorado, and depending on the result, its operation may revive the oil shale boom that proved so disappointing in the 1980s. But residents are wary. As Parachute Mayor John Loschke put it, "In the Unocal-Exxon oil shale boom, Parachute was impacted most and got the least out of it. I think Parachute is not going to be walked on again."[60] Parachute's town planners are now working closely with Royal/Dutch Shell to try to anticipate and steer clear of the problems of the 1980s. Since the bust, Parachute and nearby Battlement Mesa, built by Exxon for its Colony Project, have also developed a new economic base. Parachute serves as a bedroom community for many who work in Aspen and Grand Junction, and Battlement Mesa is home to a comfortable retirement community and to a top-notch golf course.

But the biggest change comes from the increasing mechanization of energy extraction. Fewer workers can produce a lot more oil, gas, or coal, thereby reducing the suddenness and scale of population increases. Rather than history repeating itself, current energy booms reveal a different configuration of labor relations and community growth. In this territory, we may have parted from our past. And yet the core dynamic of a resource bust—the affordable recovery of a resource reaches its limits, and the wages, tax revenue, and commerce made possible by that industry plummet—will not be so easily exorcised.

Local Costs/Distant Benefits

Abundant energy may be one zone where "trickle down" economics sometimes works. A rich supply of fossil fuels has truly expanded the sphere of American opportunity, giving citizens of modest economic stature considerable freedom of movement and access to appliances and vehicles that have eased the burdens of life. And yet energy development has also shown a pattern of pushing the costs for these benefits disproportionately onto communities with little or no power. "Out of sight, out of mind" has applied to social, as much as environmental, consequences.

This pattern has been at its clearest in the experiences of rural communities situated on land with rich underground resources in energy. Leasing subsurface mineral rights has provided an important income supplement for lots of Western ranchers and farmers. In times when cattle prices are down or drought cuts into crop production, oil and gas revenue can keep an agricultural enterprise afloat. But the production facilities can disrupt the landscape and threaten water resources, making the benefits available at an uncomfortably high price. Most important, given a widespread practice of separating surface ownership from subsurface ownership, it is quite possible for a rural landowner to get the disadvantages of energy development, without any of the revenue.

How does one claim ownership of a resource below the earth's surface? In the West, the federal government owns the rights to all subsurface minerals unless they have been specifically transferred to state or private entities. During the 1860s and 1870s, prompted by Westerners and their representatives in Congress, the federal government offered ownership of mineral resources to its citizens in legislation based on local Western mining codes. The landmark 1872 General Mining Law, the "Miner's Magna Carta," guaranteed a miner's right to have access to public lands and to initiate claims to federal mineral holdings. The 1872 law specifically included fuel minerals (coal, gas, oil, and oil shale) on the list of minerals to which miners could lay claim.

A century ago, as gasoline-powered cars entered the picture and the pace of industrialization accelerated, oil, gas, and coal companies responded by claiming and developing millions of acres of Western lands, until some public officials reached a state of alarm. By 1912, coal production had increased to levels 25 times greater than production during 1872, the year of the General Mining Law, and oil production had multiplied to a level 70 times greater than production 15 years earlier. President William Howard Taft, like President

Theodore Roosevelt before him, withdrew millions of acres of federal holdings from coal, oil, and gas development to ensure that the nation retained a share of the nation's energy reserves. Energy companies sued, arguing that the president did not, under the 1872 law, have the right to infringe on their access to mineral resources. The Supreme Court upheld the presidential actions in the important 1915 "Midwest Oil" case, ruling that President Taft had acted within the law. Congress took the next big step toward increasing control of the nation's energy reserves by passing the Mineral Leasing Act in 1920, which allowed access to federally held fuel-minerals rights through a controlled leasing program.[62]

The right to conduct mining and drilling on public and private lands remains a great point of contention. Four years prior to the Mineral Leasing Act, Congress passed the Stock-Raising and Homestead Act, granting "split estates" land patents to Western settlers. In granting homesteads under this law, the federal government gave up surface rights to property while keeping the rights to the minerals below. The minerals remained subject to the 1872 General Mining Law and, for fuel-minerals, to the terms of federal leasing in place once the Mineral Leasing Act was passed. The Stock-Raising and Homestead Act followed the trend set by the Coal Lands Acts of 1909 and 1910, which reserved federal mineral rights to coal deposits under land sold or deeded by the federal government.

Today, there are nearly 60 million acres of Western lands that are "split estates" in which the federal government retains the subsurface rights to privately held lands.[63] Legal scholar Charles Wilkinson, in *Crossing the Next Meridian,* ponders this scenario:

> Pausing for a moment, one can envisage an entire residential subdivision on Stock-Raising Homestead Act lands. There are many such developments today, and more are being built. In come the prospectors, bearing not only their 1916 picks and shovels, but their modern day bulldozers and draglines.[64]

Indeed, Wilkinson's imagined scenario is not a world apart from what is happening in some communities in the Rocky Mountain West in the coalbed methane boom. Mineral rights are just as much a "property right" as surface rights. As a result of the "right to mine" clauses in federal mining legislation, mineral property rights take precedent over surface property rights.[65] The result is that landowners have little say over where well-heads, access roads, or surface structures are located on their property. Surface owners do retain some rights: the inviolability of their permanent improvements (houses and structures) and entitlement to financial compensation for damages to crops. Ranchers are especially vulnerable to the negative effects of CBM development, as a high percentage of ranchlands are split estates.

Federal mining laws did leave a door open through which landowners can control some aspects of subsurface development on their lands. The phrase, "subject . . . to the local customs," permits states and counties to enact property laws that regulate mining practices in their jurisdiction, as long as the laws do not interfere with federal legislation. Landowners can sometimes also negotiate surface use agreements (SUA) that direct the siting of surface roads and structures, and provide compensation for any property damage.

Most of the people who benefit from the use of the West's energy live at a very comfortable distance from the site of production. For a significant number of Westerners though, the phrase "out of sight, out of mind" no longer applies, as they face energy development in their immediate neighborhood. As joint stewards of the Western energy treasure house, these two segments of Western society—those who look directly and daily at the landscapes of energy development, and those who simply enjoy the benefits of the process—might want to spend a little more time getting to know each other's situation

Powering the West's Future

When it comes to coping with the effects of energy development, perhaps the most vulnerable rural communities have been Indian people on reservations. Thirty percent of the region's coal is located on tribal lands. Six percent of oil reserves underlie Indian lands, and about 20 percent of the natural gas reserves are held in tribal ownership. Indian-owned coal, natural gas, and water produce one quarter of all the electricity consumed in the Southwest. Tribal resources are likely to make up an even larger share of the West's energy future. Indian lands hold strong geophysical prospects for oil and gas discovery, second only to federal lands. In March 2003, the

Loud Messages

Josh Joswick, La Plata County Commissioner, Colorado

"As [energy development] comes into their communities, people need to understand that while they will in all likelihood not be able to stop it, they can have some control of development through the political process. This control will have to be local because that is the level where things are most effectively politicized and the level which problems are most easily understood. 'It is happening in my backyard and what are you going to do about it' is a very loud message for a local elected official to hear from his neighbors."

Looking Out for Number One (and Number One's Land))

If you are in the awkward situation where you don't know who owns the mineral rights below your house, there are several things you can do to figure this out. Start with the title to your house or property. It should specify the type of land you own and whether or not you own the subsurface rights. If you do not own the subsurface rights, you can find out who does through public records. If subsurface development does come to your land, document the baseline conditions on your property by taking pictures and gather other kinds of records before development begins.

BIA Division of Energy and Minerals testified to the Senate that production on Indian lands would exceed the higher predicted production from the Arctic National Wildlife Refuge.[66]

Energy development on Indian lands began in the late 19th century with the discovery of substantial fossil fuel deposits in Oklahoma, on Choctaw, Chickasaw, and Osage lands. But it was the energy crisis of the 1970s that brought a major expansion of fossil fuel production on tribal lands. Since then, some Western tribes have welcomed energy development, hoping that it would help to relieve some of the nation's energy woes and stimulate local Indian economies at the same time. Revenue from oil, coal, gas, uranium, and other natural resources now make up a significant portion of many tribal budgets and have helped to expand employment and business opportunities on reservations.

The adverse environmental effects of energy development on Indian lands and cultures in the past few decades have led some tribes to look critically at overtures in this territory. Moreover, federal mismanagement of funds generated by Indian mineral leases has added to the long-standing tribal distrust of the Department of the Interior and its Bureau of Indians Affairs. Accordingly, in the past three decades, Native American tribes have sought and gained more control over tribal natural resources.

In 1975, leaders of 25 Western Indian tribes came together to form the Council of Energy Resource Tribes (CERT). CERT adopted an aggressive business approach for bargaining with energy companies on behalf of tribes. It also set out to educate tribes about their natural resources and to advise them on the best ways to protect those resources. Today, CERT comprises 50 federally recognized American Indian tribes and four Canadian First Nations. CERT provides tribes with assessments of their natural resources, advises them on new mining technologies, and assists tribes in training their members for work in various mining labor and management positions.[67]

CERT's efforts have given Native Americans a larger role in the nation's energy policies and have helped tribes take charge of resource development. Nevertheless, many residents of reservations still lack basic energy services. An Energy Department study conducted in 2000 found that 37 percent of homes on the Navajo Reservation did not have access to electricity.[69] Native Americans pay a higher percentage of their disposable income for electricity than any other group, and they have the least reliable service, experiencing more service interruptions, blackouts, and brownouts.[70]

Recently, tribes and corporations have joined forces to develop the West's energy resources. In May 1998, the Fort Mojave Tribe negotiated a fixed 50-year lease with Calpine Corporation for the development of the South Point Energy Center. Calpine's facility is a natural gas-fired power plant, capable of supplying 540,000 homes with electricity. It is also the first facility of its kind to be developed on tribal lands. Power companies have every reason to reach out to Indian tribes. Compared to the same process on federally owned lands, the approval process for power projects on tribal lands is efficient and cost-effective. In its project with the Fort Mojave Tribe, Calpine estimates it will save $20 million from a federal tax incentive that allows for accelerated depreciation on its reservation-based assets.[71]

For their part, tribes have plenty of reasons to pursue partnerships with energy companies. Some, like the Fort Mojave Tribe, view energy development as way to diversify their economies and ensure a more stable financial future. The 555-megawatt South Point Energy Center not only delivers cheap and reliable electricity to the reservation, it supplements the tribe's income from tourism and gaming. So far, the power plant's impact on local employment opportunities has been limited. But the power plant pumps some $4 million per year in taxes and lease payments into the local economy.[72]

Some tribes have not only sought more control over the development of natural resources on their lands, they have turned the profits from non-renewable resources into financial plans that will serve their tribes for generations to come. Take the Southern Ute. Their venture into the energy industry has proved remarkably successful. In fact, the tribe's bonds were the first ever issued by an American Indian tribe to earn a triple A rating, the highest rating given.[73] And, their energy operations have contributed handsomely to the tribe's annual income. The Southern Ute have invested that money wisely. They have set up a permanent fund for the tribe's governmental operations and a growth fund for its business investments outside the reservation boundaries. In 1992, the Southern Utes started their

Reservation Power

CERT and the Inter Tribal Energy Network developed the National Tribal Energy Vision in 1999. The goal is to provide a sufficient and reliable electricity supply at a reasonable cost to each self-governing Indian tribe by the year 2010. The federal government is also taking steps to power Indian reservations. The Energy Policy Act of 2002 calls for the establishment of an Indian Energy Office within the U.S. Department of Energy. The new office would fund Indian energy programs and aid the development of Indian utilities, provide planning and management assistance to tribes seeking to develop their energy resources, and help tribes plan the construction and installation of generating facilities and transmission lines. The proposed office would also fund the further electrification of Indian reservations and streamline the approval process for energy projects on Indian-owned lands to help tribes attract energy companies.[68]

own oil and natural gas operating company, Red Willow Production Company. Red Willow's achievements have attracted the attention of many tribes who look to the Southern Ute/Red Willow enterprise as a model for economic growth and self-sufficiency. [74]

Tribes across the West are also enjoying success with renewable energy projects. With the high potential for solar and wind development in the region, many tribes are now exploring their renewable resources, and some are already using renewable energy to power their communities. A 750-kilowatt wind turbine, installed on the Rosebud Sioux Reservation in February 2003, will provide an estimated 80 percent of electricity for the reservation's casino and convention center. The tribe also anticipates selling any excess energy from the project to off-reservations users.[75]

Of course, it is not always smooth sailing for energy companies or tribes seeking to develop natural resources on tribal lands. Many tribes aim to strike a balance among economic development, cultural preservation, and environmental protection. In this framework, power companies do not always get what they want. In October 1995, tribal leaders of the Confederated Salish and Kootenai tribes on the Flathead Indian Reservation in southwest Montana turned down a lease to renew the Yellowstone Pipeline Company's easement for a petroleum pipeline though the reservation; the leaders took this action in response to what they saw as the company's poor environmental record.[76]

In southeastern Montana, the Northern Cheyenne have resisted energy companies who seek to develop coalbeds on the reservation, possibly the largest tribal coal reserves—20 to 50 billion tons. The Northern Cheyenne Tribal Council responded to the energy boom in the 1960s and 1970s and signed six leases. As the environmental and cultural impacts of energy development became apparent, tribal leaders sought to regain control of the reservation, managing to cancel all the coal leases and forcing the energy companies to pay some $10 million in damages. Recently, economic stagnation, poverty, crime, high unemployment rates, and inadequate public services on the reservation have provoked some tribal members to wonder if the tribe should be more receptive to energy development. Opinion is divided.[77]

Many sacred sites appear on the land that energy companies seek to develop, and this weighs heavily on the minds of many tribal members. In New Mexico, the Zuni organized to block the opening of the Salt River Project's Fence Lake Coal Mine. SRP, the nation's third largest utility company, projected that the mine would produce over 80 million tons of coal over the next 50 years for its Coronado Generating Station in St. Johns, Arizona. The operation would pump 85 gallons of water per minute from the desert aquifer that feeds the lake. The Zuni feared that mining in the area might destroy the Acoma Pueblo Salt Trail and drain the Zuni Salt Lake, the tribe's most important religious site and a place of worship for the Zuni and Acoma pueblos, the Ramah Navajos, the Mescalero Apache, and the Laguna pueblo for centuries. Over the tribe's objections, New Mexico granted SRP a permit to operate the mine in 1996, but the federal application languished during the Clinton administration. That changed in July 2002 when the Department of the Interior approved SRP's mining plan.[78]

With the shift in energy markets from regulated monopolies to more open markets, every tribe is becoming an energy tribe. Across the West and the nation, tribes participate at every link and on every level of the energy industry, from exploration and extraction to transportation and distribution, and that participation has given, and will continue to give, tribes more control over their energy future.

Misunderstood Leases

A. David Lester

The other important component of development of energy resources in Indian Country is restricted lands that are owned by individual Indians. The lease bonus, royalty, and rentals income from this development are an important part of the family income base. This is particularly true for the Eastern Navajo around Crown Point and Farmington, New Mexico, for Indian lands in Oklahoma and on many reservations of the northern plains of Montana, and North and South Dakota. The government conducts lease sales on behalf of these individual Indian landowners, collects the royalties due them from the energy companies, and remits the proceeds to the Indians. It is the mismanagement of these individual Indian accounts that is the basis of the *Cobell v. Norton* lawsuit that we have read about in the papers. These monies have other import as well. They are a major source of income that supports the merchants of the reservation border towns. And, because the money that the government collects from the oil companies for the individual Indian is remitted to the Indian by a government check, it has fed the legend that Indians get money from the government just because we are Indians. That legend fuels resentment and hatred in the non-Indian communities that are economically dependent on the tribes and on individual Indian families.

The Consuming West

Some patterns of Western energy history continue, unchanged, into our times. In other areas—in tribal control over energy resources, in the much reduced work force in coal mining, and especially in the area of concern over the environmental impacts of development—the patterns are remarkably changed. The importance of energy to the basic workings of Western life is, if anything, always expanding and never diminished. Cheap and abundant energy is the explanatory keystone for the development of the West as we know it. Even more than energy *production*, the *consumption* of energy shaped the West. In that historical context, the choices that 21st century Westerners make in energy consumption will resonate with significance and consequence.

Ranching and Farming

Jeffersonian Expectations

David Nye

"Thomas Jefferson . . . expected the settlement of the West to take hundreds of years. But the West was not settled slowly by small groups of farmers relying on muscle power; it was rapidly assimilated to the nation, first through military conquest and then through ranching and farming. All the while, this assimilation was aided by powerful technologies—particularly the railway, telegraphy, irrigation, and (after 1880) electrification, natural gas, and oil."[80]

Modern field machinery. *Courtesy of USDA.*

The average United States farm now uses three calories of fossil fuel energy to produce one calorie of food.[79] We put in more energy than we get out.

Champion of the American farmer, Thomas Jefferson would have an interesting reaction to today's agricultural producers, piloting 14-foot-tall, 30-foot-wide, 325-horsepower combines, sitting in air-conditioned cabs with CD players, lumbar support, and air suspension.[81] Agriculture's reliance on other-than-muscle energy sources and eager adoption of new technology has profoundly affected the West's economy and geography. During the 19th and 20th centuries, American farmers increasingly relied on non-human sources of energy. These changes accelerated the pace of Western settlement and quickly connected the West to world markets.

In the early 1800s, crops were harvested by hand, by teams of men who harvested an average of two to three acres per day. Mechanical reapers, introduced in the 1830s, could harvest three to five times as much as human teams.[82] By the late 1800s, harvesting machinery could cut, thresh, clean, and sack grain all at once. These "combines" (combining many processes into one machine) required as many as 40 mules or horses to pull them across the grain fields. According to the Department of Labor, it took 61 hours in 1830 to produce 20 bushels of grain, but by 1896 the time required had dropped to three hours.[83] Today's diesel-powered combines mow, process, and unload wheat at an astonishing rate. The amount of time taken to harvest 20 bushels of grain has fallen from 61 hours in 1830, to three hours in 1896, to just a matter of minutes today.

Other areas of agricultural industry display a similar increase in productivity and a similar increase in energy use. The introduction of gasoline-powered tractors in the first decades of the 1900s brought another great shift in farming practices. For every tractor introduced, 10 draft animals were replaced, which made available one-quarter of the farmed land once used to feed horses and mules. Tractors could be operated at faster speeds than draft animals as well, which allowed farmers to plow, plant, and harvest greater areas of land in the same amount of time. This switch-over from draft animals to gasoline-powered tractors, in conjunction with the widespread use of petrochemical fertilizers after World War II, challenged the Jeffersonian ideal of self-sufficient small family farms. Between 1940 and 1989, farms doubled in size to average 460 acres, while farm populations dropped by 83 percent.[84]

Farmers made their lives both easier and more difficult by relying on fossil fuels and new technology. Mechanization eased domestic workloads on the farm, provided greater reliability, and increased productivity and yields. Using fossil fuels, railroads and highways spread from population centers to encompass rural and agrarian areas, making possible the purchase of many items that formerly had to be made on the farm. Connecting to the electricity grid allowed farmers and ranchers to use washing machines and other labor-saving devices. Tractors were more reliable than horse or mule teams; tractors did not need to be fed or rested and did not need attention during inclement weather. The use of petrochemical fertilizers increased crop yields. Irrigated farming presented its own energy demands. Irrigating a 960-acre farm requires five well pumps, which require 125 gallons of diesel a day to operate. Five irrigation wells can burn through nearly 18,750 gallons a month.[85]

In the central irony of agricultural economics, greater productivity and yields increased supply, which lowered prices. Lower prices meant that more crops had to be grown to maintain profits. More crops meant farming more acreage, which required larger, faster, more productive machines. Larger, faster, more productive machines cost a lot of money, which cut into profits and required taking out loans. The price of grains and produce has changed very little as technology and fossil fuels have continued to get more expensive. Tourists visiting Western farms and ranches may feel that they have come to a part of the world far from the fossil-fuel-driven world of industry, but a closer look will remind them that they have not gone so far at all.

Cars and Roads

The distributing, marketing, purchasing, and utilizing of fossil fuels have exerted great power over the design of the West. In the very recent past, the interior West was characterized by its remoteness; many areas in the West seemed permanently consigned to having small populations because they were simply too difficult to reach.

That changed, didn't it?

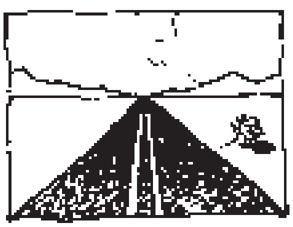
Petroleum gave Americans nearly unlimited access to the West's open spaces. A century of automotive travel has had an enormous influence on both the landscape and ideology of the West. Automobiles have brought sprawl, smog, and congestion, while also reinforcing and ratifying dreams of freedom and individuality. From the beginnings of the automotive industry in America, the West has played a big part in the popularization of cars as *the* form of transportation. Early in the 20th century, the automobile and its "enabling" roads began to spread through the West, reshaping habits of both settlement and recreation.

The automobile and the Western landscape have become even more closely associated in the last few decades. In advertisements, automotive companies mingle cars, canyons, mesas, and mountains. Even the vehicle names invoke the ambience of the West, particularly in the marketing of sport utility vehicles and pickup trucks. Today's car companies market their SUVs and trucks as vehicles for rugged, adventurous, and independent living. Many of the most popular trucks and SUVs sold today have names that correspond to Western places, features, occupations, identities, and cultures. Some take advantage of the appeal of specific Western places: the Dodge Durango, Chevrolet Tahoe, GMC Sonoma, and the Hyundai Santa Fe. Other SUV models try to harness the romance and nobility of Western occupations and identities—the Chevrolet Trailblazer, Jeep Cherokee, Nissan Pathfinder, Mercury Mountaineer, Ford Ranger, Dodge Dakota, and Jeep Wrangler, for example. The Isuzu Rodeo, the Nissan Frontier, and the Buick Rendezvous appeal to Western cultural imagery.

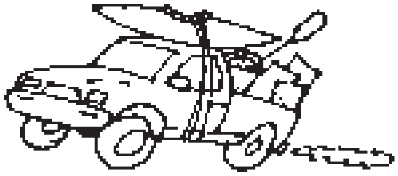
First published in 1925 and bearing a quintessentially fossil-fuel-era name, the magazine *Arizona Highways* celebrated the virtues of cars and the wisdom of government funding in providing roads for those cars to travel. The magazine's motto sums up the meaning of fossil-fuel-based transportation for the West: "Civilization Follows the Improved Highway."[88] True enough, but maybe, in the next decades, civilization will show a little more flexibility in the route it chooses to travel.

On the Road

Mike Hannigan



Americans do equate freedom with their ability to go anywhere (in their cars). We drive more miles per person than any other country. We drive 15 percent more than Canadians, who are ranked second in the miles-traveled race. We drive almost twice as much as the average European and nearly threes times as much as the Japanese. Interestingly, if you plot total vehicle miles traveled per year in the United States alongside the gross domestic product, the two lines look like one. As our economy goes, our miles on the road follow. Or, maybe it is the other way around. It's not hard to see why we equate freedom with ability to log miles in our cars. In the West, people and destinations are more spread out, so logically we log more miles than the typical American, logging 10 percent more miles per person. Cars and roads have opened up the West, and we are enthusiastically taking advantage of that opening.[87]



The West and the SUV Image

Eric Papacek

"Advertisers have positioned SUVs and trucks as the 'go anywhere, do anything, no boundaries' vehicles. People have bought SUVs and trucks because they want to project the image of free-spirited, active, outdoor adventurers that won't let anything get in the way of a weekend getaway. In other words, advertisers have been selling the image of the SUV/truck *driver* more than the actual *vehicle*.

"They've captured trucks and SUVs 'conquering' nature by showing them driving over rocks and through streams. They want to show that trucks/SUVs are rugged, durable, and unstoppable and that you will have all of these attributes too, if you buy one. With this vehicle, you can do anything you want. So even if you never leave your neighborhood streets, you have the capability to climb a mountain on any given weekend.

"The use of Western settings is a function of the positioning of the vehicles and the type of attitude the advertisers want to project. Of course, some of the best scenery and landscapes for this purpose are in the western states. Advertisers wouldn't be as effective in portraying the same image if they showed an SUV driving down a crowded city street, unless it ended up scaling a building."[86]

Air Conditioning

Every year, one-sixth of the nation's electricity is used to keep us cool. The air conditioner has become so much a part of our lives that during peak summer hours, it can consume more than 40 percent of produced power.[89] Throughout the West, and in particular in California, Nevada, New Mexico, and Arizona, air conditioners are a 24-hour phenomenon during the late spring, summer, and early fall. In the Southwest, air conditioning has crossed over from luxury to necessity.

Phoenix, Albuquerque, Las Vegas, and a host of Western cities all share a deep dependence on mechanically cooled air. Before refrigeration technology and the modernization of the swamp cooler, the heat profoundly discouraged the settling impulse. Once air conditioning entered the picture, the population boom—a boom the Southwest is still experiencing—was unleashed.

Throughout the West, the number of residences with air conditioning has more than doubled since 1978,[90] significantly increasing residential energy demand. In the years since its invention,

Image Problem: Cowboys Don't Wear Cardigans

"Energy conservation" became a political buzz-word at the beginning of Jimmy Carter's presidency, when he gave his first fireside chat. The nation needed, he said, a new, comprehensive energy policy to address the oil crisis that had paralyzed the nation, causing long lines at the pump and at unemployment offices, and conservation would be a big part of this policy. "Our decision about energy," he said during a speech in 1977, "will test the character of the American people."[91]

For a fireside chat on February 2, 1977, President Carter wore a tan V-neck cardigan sweater and sat next to a warmly crackling fire in the White House library. The plan was to establish a greater personal connection with American citizens, who were presumably sitting in their living rooms, in sweaters and sweatshirts, with televisions in the place of the hearth. The result was an indelible linking, in the minds of the American public, of the term "energy conservation" to the image of a likable, not particularly forceful man in an unmanly sweater. (Imagine the late and much missed Mr. Rogers as your neighborly president.)

Courtesy of the Jimmy Carter Library.

The reaction to President Carter's speech was initially positive. He even sparked a minor trend in winter fashion, with men wearing cardigans as formal business attire.[92] But political support quickly waned as President Carter issued proposals to alleviate the energy crisis by imposing taxes and strict regulations on energy use in both the business sector and residential sector, causing his popularity to drop 10 points in three months. Trying to rouse the public to support his policies, President Carter started referring to efforts to end the energy crisis as the "moral equivalent of war." Political pundits quickly noticed that the statement, when shortened into an acronym, became MEOW. Again, President Carter's attempts to interest the public in conservation were undermined by the intrusion of "soft and fluffy" imagery.

Much of the nation refused to believe that an energy crisis existed. Many politicians in Congress recognized, and followed the lead of, the public's disbelief. Carter's experience made the political crusade for energy conservation a topic that spelled political suicide for anyone who took it up.

The peculiar pundit John Mihalec, writing at the end of President Carter's term, summed up the weird gender attitudes at work in this episode:

"Jimmy Carter first presented himself to the nation as a masculine personality. Naval academy. Submariner. Nuclear Engineer. Farmer. Loner. Tough governor. But once in office, he lost no time revealing his true feminine spirit. He wouldn't twist arms. He didn't like to threaten or rebuke. He wore sweaters, and scrupulously avoided the trappings of power. So, in a sense, we've already had a 'woman' president."[93]

But we can't help wondering: what if Jimmy Carter had taken horse-riding lessons, acquired a modest and understated outfit of Western wear including a cowboy hat that looked comfortable and well-used, and given his "energy conservation" speech while mounted on a handsome horse next to a crackling campfire, with a soaring Western mountain range behind him? The image of the tough Western man is so entirely opposite to that of the gentle soul by the fireplace in his cardigan, you have to think that invoking it might have paid off. Any reader who knows Clint Eastwood should plead with him to become the spokesman for renewable energy. Tell him he could save the world.

Courtesy of the Center of the American West.

air conditioning has transformed settlement patterns and energy use across the West. Sunbelt residents divide their "lifestyles" on strictly seasonal terms. For several months, they celebrate the sun and the moderate temperatures so different from winters elsewhere in the country. And then for much of the year, they depend on a machine that, so long as the electricity flows, lets them evade the consequences of having settled in the nation's hot belt.

Every aspect of our lives today makes the same historical point: no profligate use of fossil fuels, no West as we know it. Nineteenth-century Americans who thought that some parts of the West were—because of altitude, remoteness, or aridity—uninhabitable were not entirely mistaken. A number of the West's places only became livable for sizable populations with the expenditure of lots of energy. Perhaps of greatest consequence was the role that fossil fuel energy played in maintaining the classic Western attitude of treasured independence and hostility to regulation and restriction. Abundant energy from fossil fuels provided the foundation for the "don't fence me in" Western attitude. Ironically, this attitude then became a key force resisting change in energy use. To travel freely through the West's wide open spaces, Westerners assumed the right to well-placed gas stations and cheap gas.

Change the West's energy habits, and you will have the world's finest and most convincing demonstration that humanity's habits, developed over the last century, are susceptible to rethinking and positive change.

Don't change the West's energy habits, and you will provide the world's finest and most convincing demonstration that habits lie beyond reach of the human will.

Calming Down: Alternatives to Agitation

A New State of Scarcity: Aren't There Any Unloved and Unlovely Places Left?

A century ago, majority opinion appraised many parts of the West to be too high in elevation and too low in rainfall to count for much. When open grasslands or deserts were taken to be wastelands, the existence of subsurface minerals seemed to be only good news: since the surface of the land was useless, how lucky to find that something of value lay underneath! How could economic use injure a landscape widely known as "desolate"?

The times are entirely, wildly changed. In the American West in the 21st century, nearly every square foot of the land has someone's memories, emotions, sense of roots, or aesthetic joy invested in it. We have run out of unloved and unlovely places, and that might well be our most urgent crisis in natural resource supply. The development of the "New West" economy adds to the tension of the situation; with tourism, recreation, and second-home development resting on the attractions of the natural environment, a well-pad or excavation can threaten a place's charms for this rising economy in which "pretty" and "undisturbed" count for a lot.

Energy producers find this situation hard to believe. How did expanses of sagebrush, populated by jackrabbits and rattlesnakes, become valued ecosystems and sensitive habitat? Is every place of value? Could such comparatively featureless terrains, apparently lacking in beauty or sublimity, really be objects of love for articulate and influential individuals and organizations?

Yes.

Here are what environmental groups have to say about the inherent value of the West's more empty landscapes.

> These lands are the last remnants of the arid Wild West that still exist in the State. These lands convey a sense of the wide open[sic], untrammeled country that existed here before settlement, of the vastness of the land and the sky. And they are incredibly beautiful—not the same kind of beauty one experiences looking at a snow-capped peak, but a beauty associated with natural simplicity, openness, and desolation.
>
> —Biodiversity Conservation Alliance, speaking of BLM lands in Wyoming[94]

The Oil and Gas Accountability Project has this to say about the Powder River Basin:

> This 13 million acre area is the quintessential wide-open West. . . . It is a land of sweeping shortgrass prairies that once was home to vast herds of bison and is still home to huge herds of deer, elk, and pronghorn antelope, as well as other wildlife such as golden eagles, sage grouse, and prairie dogs. The Basin is ringed by the Rockies in many places, giving meaning to the line "purple mountains majesty above the fruited plain" in *America the Beautiful*. It is a ranching country where many farmers and ranchers have worked hard to earn livings for generations.[95]

One key to understanding this wild shift in public opinion is dealing with the fact that so much of this land is under federal management. Public lands are a place where multiple use interests and environmental concerns intersect and, at times, clash. These lands are sites for grazing, forestry, recreation, wildlife habitat, open space, wilderness, and tourism as well as mineral exploration and production. It's no wonder that unused and unneeded places are in such short supply.

Wind turbines, Palm Springs, California.
Courtesy of NREL.

There is some irony in the fact that this state of popular opinion also presents great challenges for renewable energy development. The value system that celebrates the uninterrupted landscape—of terrain spreading out to an open horizon—makes wind turbines and solar panels look nearly as ugly as oil derricks and strip mines. Thus, environmental groups have sometimes led the opposition to the development of renewable energy in particular sites.

"I plan to fly to the nation's capitol," Palm Springs Mayor Sonny Bono announced in 1989, "to do battle as Don Quixote did against windmills." A previous Palm Springs mayor, Frank Bogert, had been less poetic, but even clearer in his opposition to the wind farms at the edge of town: "We don't think tourism and industry go together, and all those windmills look like industry."

Some of the discontented in Palm Springs objected to the visual appearance of the wind turbines, and some objected to their "whooshing noise." Elsewhere in California, environmental groups led the opposition to wind-generation. A group devoted to the preservation of open space, the Save the Mountain Committee, opposed the Tehachapi development. Most strikingly, "opponents claimed that the visual blight" of the windmills "would ruin 'the freeway experience' through Tejon Pass."

At Altamont, too, "it was environmental groups who were most vehement in opposition." To a group called "People for Open Space and its Sierra Club and the Audubon Society supporters, wind turbines were industrial culprits, imposing on a pristine environment." As a wind industry expert said in astonishment, "Wind energy used to be the darling of the environmental movement."

As writer Todd Wilkinson observed, responding to a campaign against a wind project in Livingston, Montana, "Harnessing the wind in the right places would relieve the pressure to drill oil in the wrong ones."[96]

Where Seldom Is Heard an Encouraging Word: An Appreciation of the Bush/Cheney Energy Plan

In May of 2001, the Bush administration presented its *National Energy Policy Report*, with Vice President Richard Cheney as its principal spokesperson. Environmentalists hated it. It paid insufficient attention to energy conservation and efficiency; it had been produced under circumstances of some secrecy (the fight to obtain the records of who attended the planning meetings has been ongoing); it called for and justified further development of oil, gas, and coal on the public lands. Environmentalists' response to the Cheney Report was agitated and angry.

And yet, if you take the time to read this much-discussed report, you find it is more complicated than it seemed when you were reading angry denunciations of it in the newspapers.

Here are components to consider, even appreciate:

- **The calls for long-term, comprehensive thinking about energy.**

  We need "a long-term, comprehensive strategy. Our energy crisis has been years in the making, and will take years to put fully behind us."[97]

  "Unfortunately there are no short-term solutions to long-term neglect."[98]

- **The recognition that oil's role in the American energy supply will soon shrink.**

  "U.S. oil production is expected to decline over the next two decades. . . . Remaining U.S. oil reserves are becoming increasingly costly to produce because much of the lower cost oil has already been recovered. The remaining resources have higher exploration and production costs and greater technical challenges, because they are located in geologically complex reservoirs."[99]

  "The United States is the most mature oil-producing region in the world, and much of our easy-to-find resource base has been depleted."[100]

- **The acknowledgment that the supply of natural gas is limited.**

  "While the resource base that supplies today's natural gas is vast, U.S. conventional production is projected to peak as early as 2015."[101]

- **The attention to the problems posed by emissions from power plants and automobiles.**

  "[F]ossil fuel fired power plants, other industrial sources, and vehicles remain significant sources of air pollution. . . . To meet public health and environmental challenges, power plants, industrial sources, and vehicles will need to produce fewer potentially harmful emissions."[102]

  "Energy-related activities are the primary sources of U.S. man-made greenhouse gas emissions."[103]

- **The repeated declarations that environmental concerns must figure in planning for energy production.**

  "We will insist on protecting and enhancing the environment, showing consideration for the air and natural lands and watersheds of our country." "Energy policy goals must be carefully integrated with environmental policy goals."[104]

- **The recognition that conservation and efficiency can play an important role in reducing future energy demand.**

  We must "promote energy conservation, and do so in environmentally responsible ways that set a standard for the world."[105]

  "Public policy can and should encourage energy conservation."[106]

  "Conservation and energy efficiency are crucial components of a national energy plan."[107]

- **The attention paid to recent technological improvements and improved costs for renewable energy—wind, sun, geothermal, and biomass.**

  "[R]enewable and alternative fuels offer hopes for America's energy future."[108]

  "We must "increase funding for renewable energy and energy efficiency research and development programs that are performance based and cost-shared."[109]

  "Through improved technology, we can ensure that America will lead the world in the development of clean, natural, renewable, and alternative energy supplies."[110]

  "Renewable and alternative energy technologies . . . could be significantly expanded, given today's technologies."[111]

- **The multiple reminders that higher energy costs fall hardest on lower income consumers, especially the elderly, and their interests must be represented in national policy.**

  "The low-income elderly are particularly vulnerable to disruptions in energy supply. If they keep their homes at reasonable temperatures the high cost of electricity may make it difficult for them to pay their higher electricity bills. This could further result in an elimination of service."[112]

What charmed us less in the report was its fatalism and resignation, and its unwillingness even to raise the question of whether American citizens could "sacrifice" even a little of their comfort and convenience. Despite frequent references to the can-do spirit and the human capacity for innovation, the Cheney Report treats rising energy demand as an inevitable, unchangeable, destined fact of life.

Why be so certain that our current practices in energy use are set for the ages? How about a little faith in the human will and its power to choose?

Hate the Cheney Report or love the Cheney Report, you have to say this for it: it performed an important service in bringing energy issues to the center of public attention. The greatest obstacle to problem-solving in energy is the "out of sight, out of mind" syndrome. A loud and public shouting match can only be the first step in a productive discussion of energy, but it functions like a very flashy sign, letting people know that there's a show worth attending.

"An additional impediment to a policy of national energy self-sufficiency was the reluctance of the American people to make short-term sacrifices in order to secure long-term gains."[113]
—Lee Scamehorn

Blaming the Suppliers

"This is not your grandfather's coal company or industry."
—Janet Gellici, Executive Director, American Coal Council

Inflexible Demand or Negotiable Desire?

Consumer demand runs this show. In truth, the use of the word "demand" is its own odd habit; we have chosen to feature a word that implies an extreme, non-negotiable, "gotta have it" stance. And yet much of what we refer to as "demand" for energy might be accurately be called "desire" for energy. Call it "desire," not "demand," and an intractable situation begins to reveal a wider range of possibilities. There's no restricting or restraining of *demand,* but there's a lot you can do to moderate and reconsider *desire.* Just as an experiment, the next time you hear or read a reference to the American public's energy *demands*, substitute in the word *desires*, and see if the world doesn't begin to seem a more manageable, livable place.

Speaking of shouting matches, the Energy project team at the Center of the American West comes now to a confession that may alarm some partisans: we think that the planning of the West's energy future would improve if we put some limitations on our condemnation of the energy industry.

Overheated anti-corporate rhetoric obscures our own responsibility for our energy-indulged ways. Condemning industry fudges our own complicity. We Westerners are the eager purchasers of just about anything that industry wants to sell us, in the way of energy-squandering appliances, vehicles, and equipment.

While preparing this report, our team spent time in conversation with men and women who work in the production of coal, oil, and natural gas. We found them to be human beings, impossible to demonize. Moreover, we found them to be understandably frustrated human beings. Everywhere they look in American society, consumers are engaged in a carnival of energy use, driving big cars and living in houses that are often unnecessarily large, taking an abundant supply of energy thoroughly for granted, grousing when the price of that energy inches up, *and then* condemning the people and enterprises that provide them with this comfort and luxury. The word "hypocrisy" would come to mind, if it didn't seem too mild and understated for the situation.

In recent years, independent oil and gas companies have increased their share of the global and domestic energy markets, and are a driving force in the industry.[114] Many of them have programs and goals that could disarm, and disorient, even the most ardent anti-corporate critic. One of the nation's largest independents, Calpine Corporation, has received applause from the Sierra Club, the NAACP, and the American Lung Association for its natural-gas-powered Metcalf Energy Center near San Jose, California.[115] Most independents are small, local companies who see themselves as energy farmers rather than oil tycoons, harvesting a crop that everyone needs and selling it in an unpredictable and erratic market. Recognizing that not all energy companies are polluting, power-hungry giants may enhance our ability to work constructively with the industry.

It will be difficult, under any circumstances, to improve our operations in energy production and consumption. It will be especially difficult if we act as if we are negotiating with devils and demons, as if Albert Fall and Kenneth Lay were the representative and typical figures in the energy business. The Falls and Lays are real and consequential, but their typicality is open to question. Focusing our attention on their wickedness, we turn our attention away from our crucial role as consumers in driving the whole energy carnival.

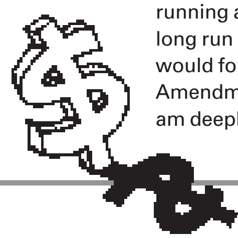
Fall and Lay: Energy's Bad News Guys

Albert Fall and Kenneth Lay are both very famous figures in the history of energy; they both have surnames that seem, somehow, to fit their sad life trajectories; and they are, more or less, equal achievers in the enterprise of undermining public confidence in governmental and corporate operations in energy.

The first cabinet official to go to prison for a crime committed while in office, Secretary of Interior Albert Fall arranged for the lease of the naval oil reserves at Teapot Dome in Wyoming (and, less famously, at Elk Hills in California) and accepted a payment of $404,000 from the two businessmen who secured those leases. Fall never admitted wrongdoing; his generosity with the leases was fully in keeping with what his biographer David Stratton calls Fall's "economic philosophy," supporting the full development of natural resources, and Fall always maintained that the money had come to him as a personal favor or loan from friends. Fall was convicted of accepting a bribe, but Edward Doheny and Harry Sinclair were both acquitted of giving Fall the bribe, which does make you wonder a little about the solidity and sense of criminal justice.

Teapot Dome gas station. *Courtesy of the Office of Archaeology and Historic Preservation, Washington State Department of Community Trade and Economic Development.*

Eighty years later, Kenneth Lay built Enron, an energy trading company that turned into the largest bankruptcy in American history. Only two or three months after the bankruptcy, the word "enron" had become "slang for slippery accounting, leaving employees in the lurch and other unsavory conduct," as in "to enron people" or to be "enronish." Lay had to resign; his reputation took a beating; and he had a tough time testifying (or, actually, not testifying) before a Senate committee. Senators had a field day, conveying their low opinion of Lay. "Mr. Lay," said Senator Peter G. Fitzgerald, Republican of Illinois, "I'd say you were a carnival barker, except that wouldn't be fair to carnival barkers. A carnival barker will at least tell you up front that he's running a shell game." Lay responded to a long run of these comments by saying that he would follow his counsel's advice, take the Fifth Amendment, and not respond to questions. "I am deeply troubled about asserting these rights," he said, "because it may be perceived by some that I have something to hide." To date, Lay has not been prosecuted and certainly not convicted or imprisoned, which also makes you wonder a little about the solidity and sense of criminal justice.



Thousands of women and men who work in the energy business do not have Fall's or Lay's "character problems," but they have had a tough time divorcing themselves from associations with these two burdened, and burdensome, fellows.[116]

Conclusion: Now That You're an Energy Expert, Now What? "Just Say No" to Drift

> ***"When a country considers oil more important than the spirit of man, it's a lost country."***[118]
> **—Edna Ferber**

> *"The discourse about oil was seldom just about oil. It usually encompassed more general questions that involved moral judgments about public welfare . . ."*[117]
> —Roger M. Olien and Diana Davids Olien

Energy is the economic, the environmental, the political, the social, and the cultural issue of our time. The West is the place where we will make key decisions about this issue. Changes in the Western economy have made undisturbed landscape an economic asset; with this new allocation of value, we have to rework the calculations behind decisions to drill and to mine. To extract fossil fuels, to erect solar and wind energy units, to build electricity generation plants, to string high voltage lines, and to store the byproducts of energy production (whether spent nuclear fuel or mine tailings), energy development requires the use of open spaces. Westerners want energy, and they want open spaces. Tourists and promoters of tourism, real-estate developers and owners of second homes, environmentalists, and ranchers express their dismay when the development of oil, gas, and coal from beneath the ground scars the ground's surface.

Western public officials occupy an unenviable position at the point of decision where these two sets of values clash. The attempt to find a balance between these two constituency preferences, we feel qualified to assert, can give a person fits. It is hard to hold to a steady policy in the middle of the energy tug-of-war. Our political lives are short; our energy use long. Why should public officials risk their political lives by asking Westerners to give up comfort? The pressures of the short-term election cycle work against the serious need for long-term commitments and plans. As David Nye says, "Politicians found it was suicidal to propose gasoline taxes, and few challenged the technological momentum of the high-energy regime."[119]

Funding for research in renewable energy sources is as fickle as fashion. In tough economic times, asking public officials to make serious and substantial investments in research in renewable energy seems to fly in the face of common sense. But if we look at it another way, getting a head start on energy's future is the most basic manifestation of common sense. Put simply, we have the choice of two scenarios: in one, we anticipate troubles ahead, and we support the research that will ease our passage into the Yellow Zone; in the other, we take advantage of the present abundance of fossil fuel energy and leave our descendants to make a rough transition into the age of renewable energy. Politicians willing to push for that first scenario deserve our admiration and support.

Because the political choices are so hard, little wonder that politicians are tempted to transfer custody of the energy problem to the engineers. But technological innovation cannot substitute for the wisdom of long-range thought, of a true recognition of the rights of posterity. Engineers will provide the technologies that will transform our sources of energy. But engineers cannot change our habits. They cannot engineer the political will necessary for the enormous economic investment we will need to put into practice less environmentally burdensome ways of producing energy. As historian David Nye says, Americans "can choose to believe in technological determinism, which will apparently absolve them from any responsibility to make choices." Better to hold on to that responsibility, as much of a burden as it can sometimes be.[120]

For every form of energy production, the era of the 1970s energy crisis was not exactly reputation-enhancing. The OPEC boycott put a premium on the domestic production of energy, and good judgment was widely suspended. The promise of renewable energies was exaggerated and overstated; new production technologies involving oil shale launched booms that soon became busts; natural gas producers drilled widely and wildly, and often futilely. Even in conventional fossil fuel production, operations often proceeded at a fierce pace, as the phrase "Gillette Syndrome" reminds us. The legacy of those years weighs on all the sectors of the energy industry, reminding us to proceed today with appropriate deliberation and forethought. "Act in haste; repent at leisure" was the lesson of the 1970s, and a lesson we do not need to repeat.

It is a big mistake to think that there are utterly clear divisions on questions of the value of renewable resources. People in the natural gas industry refer to gas as a "bridge" fuel. But in energy time, the bridge is short; the supply of natural gas is probably sufficient for two or three decades at current rates of use. As we start over that quarter-century bridge, we should direct our attention to the other side. Where does this bridge lead? Many in the industry say that natural gas is a bridge to renewable energies. Gas will get us from a fossil-fuel-dominated *here* to a renewable-energy-dominated *there*. Energy companies know it is in their interests and in the interests of their shareholders to support the development of natural gas reserves *and* to invest in research in renewable energy sources. In other words, there is no reason to pit advocates of fossil fuels against advocates of solar or wind power. A bridge that takes people nowhere is a bridge with a certain design flaw, and natural gas proponents have every reason to be hearty supporters of renewables research.

In his portrait of Wright, Wyoming, a company town created by ARCO in Wyoming in the 1970s, historian Robert Righter describes coal miners who were also enthusiastic about projects designed to take advantage of Wyoming's abundant sunlight. As Righter puts it:

> The idea of houses that take advantage of some form of solar energy has been warmly received. Many residents are genuinely excited about the possibility of a solar-assisted home. They understand that the combination of cold temperatures and extensive sunshine—so representative of the basin's weather patterns—is ideal for solar heating. "It surprises me," stated one [coal] miner, "that in an area like this, where we have so much natural energy—the wind and the sun—that we don't see more solar homes." . . . "If we had been able to build our own home," [said another miner], "we would have gone toward solar energy."[121]

Coal miners and natural gas producers have had "double identities" as enthusiasts for renewable energy.

The habits of energy use that we take for granted are very recent arrivals. "The United States has been industrialized for a much shorter time than most people realize," David Nye points out, "and the high-energy society that seems natural to its citizens today is a relatively recent invention."[122] Our great passion for free and unrestrained use of the internal combustion engine is barely a century old. Our assumptions that electricity is available whenever we need it are equally recent. How hard can it be to change habits so young? We are not attempting to uproot the habits of centuries or millennia, which would surely be a discouraging prospect. On the contrary, the habits that need to be changed only coalesced, in the scale of human life, the day before yesterday.

We have many alternatives to fatalism.

The West is the nation's energy treasure house. The decisions of Westerners carry weight and consequence. Western Energy Experts (and, remember, you now register in those ranks) can make a difference.

Synonyms for Energy, and Qualities Westerners Will Have a Chance to Exercise As They Plan Their Energy Future

Activity
Nerve
Verve
Vim
Animation
Hardihood
Dash
Dynamism
Stamina
Intensity
Efficacy
Force
Might
Power
Strength
Push
Drive
Life
Spirit
Vigor

And now, at long last, our recommendations:

Westerners who want the best for their region should consider supporting:

1. **An open, lively, and long-running discussion of the West's past, present, and future in energy production and consumption.**
2. **Substantial and sustained public and private investment to support research in renewable energy technologies.**
3. **Prices that reflect the full cost of production and use, including externalities, for gasoline and electricity.**
4. **Good habits (your father turns out to have been entirely right when he used to say, "For Pete's sake, turn off the lights if you're not even in the room!").**
5. **A willingness to invest in public transportation even if it hurts.**
6. **Housing developments that encourage the use of public transportation and reduce reliance on cars.**
7. **Public investment in infrastructure for the delivery of renewable energy.**
8. **A recognition that some reconciliation must happen between support for renewable resources and desire to keep all the West's open spaces undisturbed and intact. Wind turbines and solar collectors disrupt a landscape, reminding us that no energy source comes without its own disadvantages.**

The pleasures of simplicity: early car camping. *Courtesy of Denver Public Library, Western History Collection, Ford Optical Company, X-27710.*

Solar collectors. *Courtesy of NREL.*

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Helpful Energy Web Sites

Energy Information Administration, U.S. Department of Energy **www.eia.doe.gov**

U.S. Department of Energy **www.energy.gov**

Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy **www.eere.energy.gov**

Office of Fossil Energy, U.S. Department of Energy **www.fe.doe.gov**

National Renewable Energy Laboratory, U.S. Department of Energy **www.nrel.gov**

Tribal Energy Program, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy **www.eere.energy.gov/power/tech_access/tribalenergy**

Energy Resources Program, U.S. Geological Survey **www.energy.usgs.gov**

U.S. Environmental Protection Agency, Office of Transportation and Air Quality **www.epa.gov/OMSWWW**

Office of Surface Mining, Western Region, Department of the Interior **www.wrcc.osmre.gov**

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Independent Petroleum Association of Mountain States **www.ipams.org**

Renewable Energy Atlas of the West **www.energyatlas.org**

International Energy Agency **www.iea.org**

Center for Energy and Economic Development **www.ceednet.org/essential.asp**

American Coal Council **www.westcoal.org**

American Association of Petroleum Geologists **www.aapg.org**

American Gas Association **www.aga.org**

American Petroleum Institute **http://api-ec.api.org**

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Geothermal Energy Association **www.geo-energy.org**

National Petroleum Council **www.npc.org**

U.S. Department of Energy fuel economy information **www.fueleconomy.gov**

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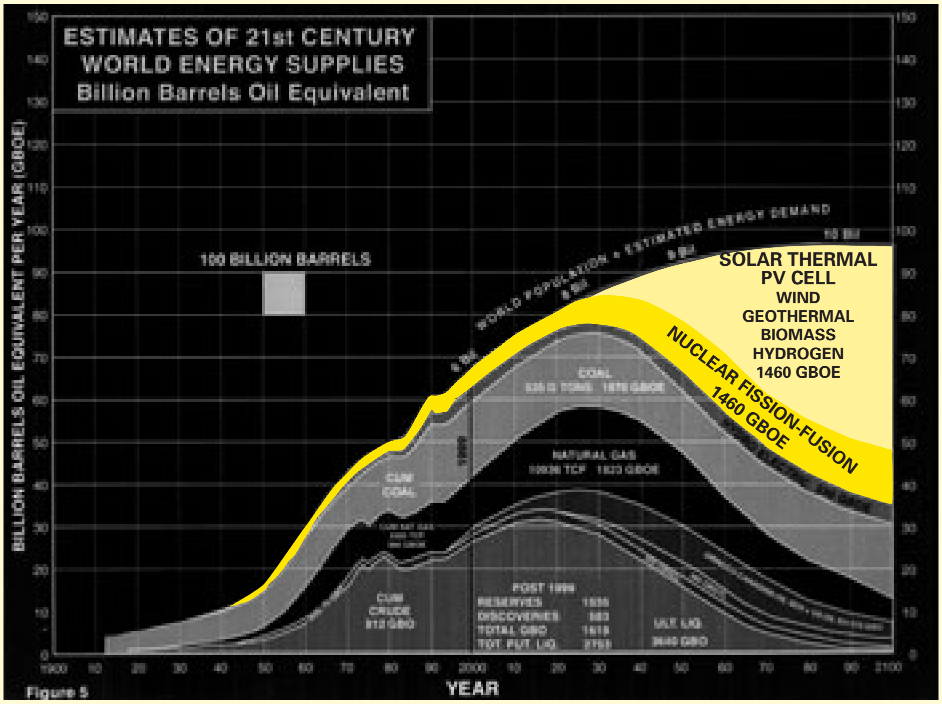

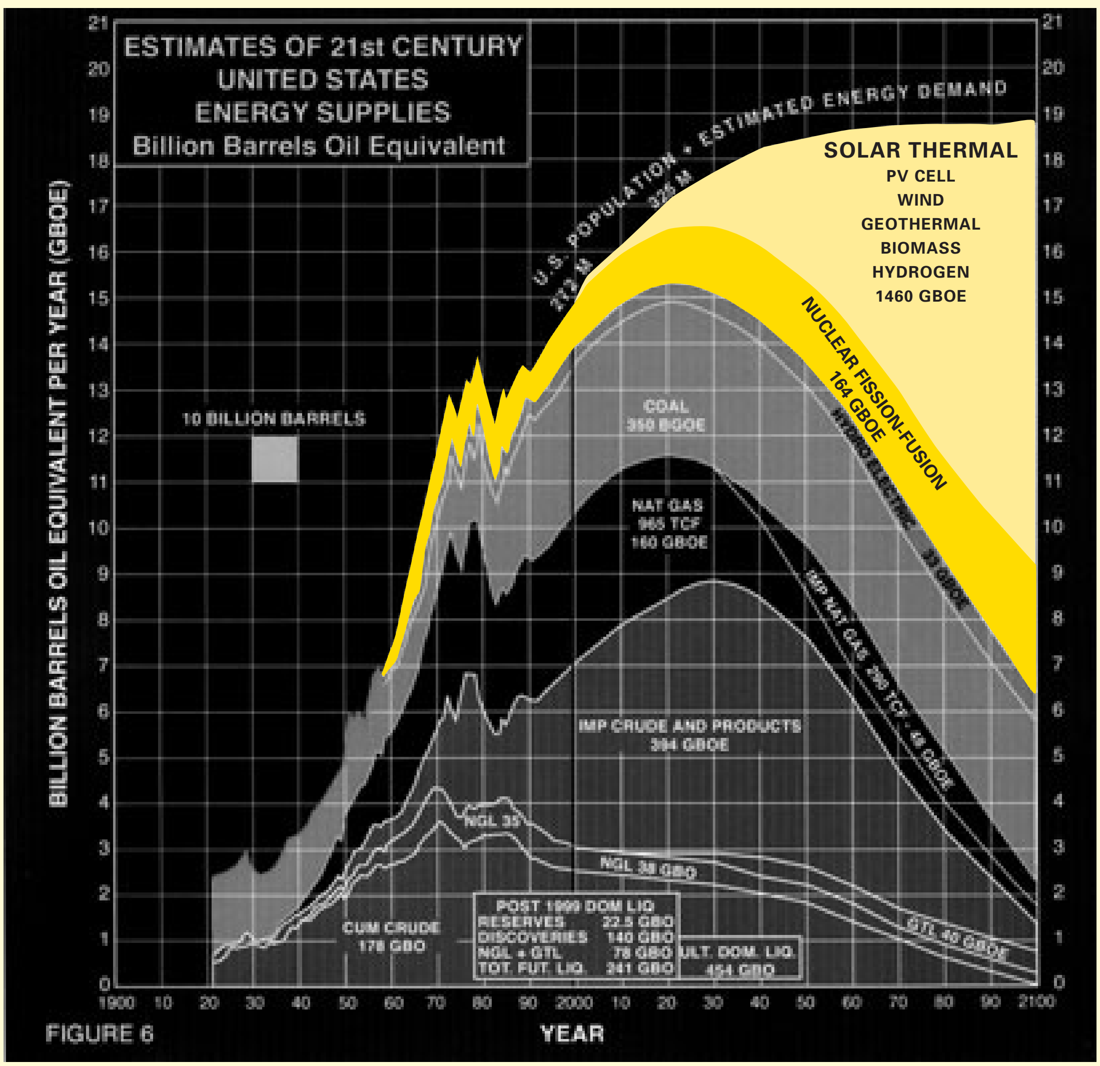

The Yellow Zone

The energy gap between decreasing supply and increasing demand will develop when peak oil production occurs sometime after 2020. At that point, the long-term solution to energy supply will be conversion to nuclear, solar, and hydrogen power.

Graphs courtesy of John D. Edwards.

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