CHAPTER 4:

Homespun Electricity

GOAL: BY THE YEAR 2020, HAVING IMPLEMENTED CONSERVATION MEASURES THAT HAVE REDUCED MONTANA'S ELECTRICAL SALES BY 30% (FROM 1,560 AVERAGE MEGAWATTS TO 1,092 AVMW), TO BE MEETING ALL OF MONTANA'S IN-STATE ELECTRICITY NEEDS WITH DIVERSIFIED CLEAN AND RENEWABLE SOURCES, INCREASINGLY DECENTRALIZED, INCLUDING HYDROPOWER, WIND, SOLAR, GEOTHERMAL, SOME BIOFUELS, AND ADVANCED METHODS OF STORING AND DISTRIBUTING ENERGY.

Montana's total electrical generating capability fluctuates seasonally between 5,370 megawatts (see sidebar for an explanation of electrical units) and 5,200 MW—although the dams, thermal power plants and wind generators in this state never generate this amount of power at one time. Between 2001 and 2005, Montana generators produced 3,000 average megawatts annually, of which 1,450 avMW was consumed in state. The remaining portion was transmitted to markets out of state. Forty-four entities are currently involved in providing electricity to industrial, agricultural, commercial and residential customers around the state. Four investor-owned utilities serve approximately 63 percent of these customers while 30 electric cooperatives serve approximately 33 percent[63].

Over the past 15 years electricity consumption in the state has decreased overall by an average of about 0.1 percent per year, but this is primarily due to a decrease in electrical use by large industries (including aluminum refining), with the big dive occurring in 2000-2001. (That was when electrical rates rocketed into the stratosphere during an "energy crisis" that wasn't—deregulation of electricity markets allowed a handful of electricity merchants like Enron to manipulate supply and create artifi-

Electricity Units Explained

Kilowatts (kW, one thousand watts) and megawatts (MW, one million watts) are used to measure the electric production capacity, capability or size of a generator (coal-fired power plant, wind turbine, solar panel, etc.). On the other hand, kilowatt-hours (kWh) or megawatt-hours (MWh) are both used to measure electricity output or consumption. When a 1 MW generator runs for one hour, it will produce 1 MWh. A 1 MW generator running for all the 8,760 hours in a year produces 1 average Megawatt (avMW). A residential customer typically uses 10-60 kWh per day—your utility bill shows how many kWh you used in a month. Helena and the Helena valley in 2000 used around 700,000,000 kWh, or 700,000 MWh, or about 80 avMW (700,000 MWh divided by 8,760 hours). (Source: Understanding Energy in Montana, MT Dept. of Environmental Quality, 2004.)

63 "Electricity Tables Workbook—2007 Update", Montana Department of Environmental Quality, 2007 <http://deq.mt.gov/Energy/HistoricalEnergy/index.asp>

cial shortages.) Over that same 15-year period, both commercial and residential consumption rose, commercial at a rate of 2.1 percent per year and residential at a rate of 1.4 percent per year.

Conventional projections forecast an annual rise in commercial use of 2.2 to 2.9 percent through 2010 and an annual rise in residential use of 0.02 to 1.5 percent through 2010, followed by slight decreases projected in each sector for the decade from 2011 through 2020[64]

In 2006, residential electricity customers in Montana used an average of 800 kWh/month in their homes. Total electricity consumption in Montana currently is about 13,653,000,000 kWh per year (or about 1,560 avMW). Approximately one-third of this consumption is residential, one-third commercial and one-third industrial. For the past 15 years Montana has exported between 37 percent and 47 percent of the electricity produced in the state.[65]

Some 60 to 65 percent of Montana's electricity is provided by burning coal, with 33 to 38 percent coming from hydroelectric dams. Only two decades ago, in 1986, coal and hydropower were even. Before that, hydropower had always been the leader. The other three main sources are petroleum, natural gas, and wind.

Until 2005, windpower in Montana contributed a miniscule amount of electricity. This is ironic, in a state once dotted with wind machines such as the Jacobs Windcharger—but that was before the Rural Electrification Administration extended its lines across the landscape in the 1930s and 1940s. Since 2005, however, windpower has seen a resurgence in Montana. The upper Musselshell Valley has become a favored spot, sprouting clusters of second-hand, refurbished wind generators in the 65 to 100 kilowatt range and, on another scale altogether, seeing 90 imposing towers rise into the sky at Judith Gap, each tower topped by a 1.5 megawatt turbine. That single leap of 135 megawatts at Judith Gap moved Montana from last place to 15th in windpower production among the 50 states.

Montana's hydroelectric dams and windfarms do not pollute the air. For that, we must turn to the burning of fossil fuels and, to some degree, wood. Not surprisingly, the largest quantity of greenhouse gas emissions in Montana comes from coal. The power plant complex at Colstrip alone is responsible for 82 percent of all GHG emissions in the state[66]. Colstrip's four units have a

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64 "Understanding Energy in Montana: A Guide to Electricity, Natural Gas, Coal, and Petroleum Produced and Consumed in Montana: Summary". Montana Department of Environmental Quality, October 2004. <www.leg.mt.gov/content/publications/lepo/2005_deq_energy_report/summary.pdf>.

65 Ibid. "Understanding Energy in Montana".

66 Op.cit. "Understanding Energy in Montana" and Climate Change Strategies 2006.

combined capacity of nearly 2200 megawatts, which is approximately 40 percent of the total electrical generating capacity in Montana.

Electricity is used primarily for lighting and running motors and switches. It is also used for space heating and for heating water. Heating is a very inefficient use of electricity, and therefore some of the quickest gains in conserving electricity come from changing to compact florescent light bulbs (which are much more efficient than incandescent bulbs, and do not produce nearly as much heat), and switching to other forms of space and water heating. In many cases, space heating can be produced or augmented through intelligent design (passive solar heating), and the same is true of heating water ("waste" heat can be captured, for instance, and used for this purpose).

Electricity in the modern era typically has been produced in large power plants in central locations, and transmitted to end users often hundreds of miles away (this is mostly the case in Montana today, and certainly is the case with excess Montana electricity that is exported out of state). There are significant losses of power the farther electricity is transmitted. On the other hand, electricity is well suited to decentralized production and consumption, from the community level to the individual level. This localized approach is often referred to as "distributed generation".

> The electrical grid is like a giant lake with inflows and outflows, charges and discharges. Montana renewable resources like windpower, dispersed widely, could be refilling this 'lake' nearly all the time.

To accomplish the goals cited at the beginning of this chapter—a 468 avMW decline in consumption, along with an increase in generation from renewable sources such as wind, solar, small hydro and others—Montana would have to produce approximately 1,092 avMW of clean, renewable electricity for use each year in this state. Currently hydroelectric production amounts to less than 40 percent of Montana's total electricity production, including exports. Assuming that large hydro could supply 20 percent of Montana's in-state electricity needs, could the remaining 874 avMW be produced each year using clean, renewable energy sources?

The answer is yes, and this chapter will demonstrate how.

BLOWIN' IN THE WIND

Wind power is the fastest growing energy resource in the world. The market for wind turbines in Europe is growing 40 percent per year (Denmark and Germany are world leaders: Denmark gets 20 percent of its electricity from wind and now is aiming for 30 percent.) The price per kWh of wind-electricity has been dropping constantly, as wind turbines of all sizes have become more efficient, and as the market expands. In fact, wind can compete directly with existing coal-produced electricity today, and is considerably cheaper than new coal power. Coal power costs are trending upward (even without factoring in the "externalized" costs of air and water pollution, carbon emissions, and threats to human health) while wind power costs, despite the rising cost of materials, are increasing less rapidly than coal. This is likely to continue.

In Montana, besides Judith Gap and the clusters of smaller wind turbines in the upper Musselshell, six large turbines now overlook Great Falls, and more are appearing elsewhere, including 13 turbines near Baker, a 19.5 MW capacity windfarm owned by Montana-Dakota Utilities. But Montana has only begun to take advantage of its tremendous wind resource.

In 2002 the *Renewable Energy Atlas of the West* estimated that Montana had the highest windpower potential of seven states in the intermountain west, totaling more than 114,000 avMW of potential annual production. Yet, in the scenario set forth in this chapter, with Montanans acting to reduce by 30 percent the electricity now consumed in-state, and with improvements in our grid and windpower storage systems the 1,092 avMW of renewable energy required to serve in-state needs constitutes less than 1 percent of this huge windpower potential. (Since that study was released, the National Renewable Energy Laboratory has increased the land area in Montana considered windy enough for electricity production by another 7 million acres.) Clearly Montana has a nearly untapped energy resource "blowin' in the wind".

However, before envisioning phalanxes of wind towers marching across Montana skylines, scooping up air and converting that motion into static on a TV set in Seattle or the hum of a refrigerator in Portland, let us return to the present.

THE CASE FOR TRANSMISSION BOTTLENECKS

While in theory Montana can produce about 5,300 megawatts of electricity at any given time, this would happen only if every turbine were spinning in every coal-fired or other fossil fuel generating plant, every hydropower dam and wind generator, with full sunlight agitating electrons on every solar photovoltaic collector. Rarely is this the case. Large coal plants such as those at Colstrip are typically shut down for maintenance about 12 percent of the time. Reservoirs behind Montana's dams are rarely full—especially during the last 20 to 25 years of lower than average rain and snowfall. And everyone knows how fickle the wind is.

Between 2001 and 2005, all the generators combined in Montana produced about 3,000 net avMW annually (net production excludes electricity that is used to run the power plants) and despite official statistics that say 37 to 47 percent of Montana-produced electricity is exported, other indications are that more than half of those 3,000 avMW, about 1,500 avMW, are going somewhere else. Since 1,770 avMW is the average output of the Colstrip coal-fired power plants, one can envisage Colstrip essentially handling all Montana's export markets, while in-state use is covered by clean sources.

The electrical grid, of course, does not distinguish between "green" electrons from dams or windfarms and "black" electrons from coal. Nonetheless, these figures suggest how feasible it is to see renewable energy sources very soon being able to handle all of Montana's in-state electricity needs.

Those 1,770 avMW of excess power essentially fill the power lines that head out of state. If only we had more space on those lines, some people lament, or if only we built more power lines, then more coal could be mined and burned, more wind turbines raised to spin, and Montana could ship more electrons out of state.

Complaints have filled the air about this lack of transmission capacity, these "bottlenecks" in the power grid west, south and east out of Montana. There is also a lack of transmission capacity to the north, into and out of Canada, but a Alberta-Montana power line is being promoted to make that connection. (This line would terminate near Great Falls. From that point, however, more lines would have to be built to ship Alberta and Montana coal- or wind-generated power out of state.) These bottlenecks are portrayed as an unfortunate restriction on Montana's ability to export power to supposedly growing markets in California, the Southwest and the Pacific Northwest.

On the contrary, this *Blueprint* argues that these transmission bottlenecks actually constitute an advantage for Montana. The reasons are threefold:

(1) The demand for exported power may not be there. This is true particularly for coal-generated electricity. Wyoming has virtually no transmission bottlenecks and has taken advantage of this to sell a great deal of its coal- and wind-generated electricity beyond its borders; however, Wyoming and also Nevada recently were forced to scale back plans to sell more coal-fired power to California because California now officially balks at buying "dirty" electricity, as from conventional coal plants or any source that emits more carbon dioxide than a modern natural gas plant.[67] However, even "clean" electricity, like that generated by the wind, must travel hundreds or thousands of miles with massive leakage of power along the way—up to 25 percent loss at those distances.

There is now a serious internal discussion among utilities, regulators and other key players in California (and other areas with high electricity de-

67 "California Bans Buying High-Pollution Power", Associated Press story in Billings (MT) Gazette, January 26, 2007, page 3A.

mand) whether to invest in (a) long-distance power from places like Montana, (b) building generating facilities nearer to where the power actually will be used (which would allow smaller facilities to be built due to less "line loss") or (c) cutting demand and obviating the need for new power.

On that last point, Californians have demonstrated their ability to reduce their electricity demand rapidly, by as much as 10 percent, as they did during the "energy crisis" of 2000-2001. This was when the state's deregulation law led a handful of energy suppliers such as Enron to shut down power plants and artificially reduce supply to raise prices.

Further evidence of a lack of demand for power exported from Montana came in October 2006, when the Northwest Power and Conservation Council announced an unexpected 2,400 MW surplus of generating capacity going into the winter of 2006-07. Adding this to an existing 1,500 MW "buffer"—the Council's term—brought the actual surplus in the Pacific Northwest to nearly 4,000 MW. This excess capacity came from implementing cost-effective conservation measures and also from some recently built natural gas power plants and windfarms coming online.

In short, out-of-state demand for newly generated Montana electricity, from whatever source, appears to be weak or even non-existent.

(2) **It is to Montana's advantage to meet its own power needs first, as reliably, as cleanly, and as inexpensively as possible.** Instead of counting on exporting electrons through very expensive new high voltage transmission lines, why not build enough local capacity to avoid having to "bid" against the low cost—but now higher priced—hydro and "old" coal power that PPL-Montana now is exporting?[68] This could encourage all Montana consumers, large and small, to find the most cost-effective and environmentally benign ways to meet our needs.

First, as outlined in Chapter 1 of this *Blueprint*, reduce demand by financing smart and aggressive energy conservation measures. Next, meet any legitimate new in-state power needs by favoring co-generation and renewable energy over the construction of large, expensive, centralized thermal generating plants (coal or natural gas). At this point, aside from certain local micro-hydropower opportunities (used very effectively in towns like Philipsburg), windpower is the cheapest form of new electrical generation. And in the future, as the costs of solar photovoltaic systems keep coming down, more and more electricity can be generated, building by building, directly from the sun.

One advantage of generation from wind, micro-hydro, solar and other lo-

68 New powerline construction costs average one million dollars per mile.

calized renewable energy sources is that generating capacity can come online incrementally, as needed. Therefore, smaller capital investments are required at a time—and over time—as opposed to a massive capital investment all at once for a large centralized power plant. Another advantage is that renewable sources can be widely distributed.

(3) Distributed energy systems are more resilient than centralized systems. Scaled to local needs, these systems are less vulnerable to disruption from natural disasters (high winds, ice storms, etc.) or from human intervention (accidents at power plants, manipulation of energy markets with resultant price hikes, or deliberate sabotage). "Renewable energy is homeland security" reads a popular bumper sticker. Placing the word "decentralized" in front of "renewable" clarifies this Montana advantage even more.

THE CASE FOR TAKING OVER THE DAMS

One way to make certain that Montana's own electricity needs are met first would be for citizens to take public ownership—or at least public control—of the privately owned hydroelectric dams within our borders. It is true that this has already been tried. A citizen initiative to "Buy Back the Dams" failed in the 2002 general election. However, early opinion polls that year showed voters favoring the idea by about 2 to 1. Only after the owners of the dams, PPL-Montana and Avista, waged an expensive advertising campaign in the months before the election did those figures flipflop: the initiative lost by a 2 to 1 margin.

Still, the idea has merit. The dams, after all, are a renewable energy source and could form a foundation for Montana to handle all its in-state electricity needs with renewable energy, backed up by sensible conservation incentives (for example, charging customers less for power used during "off-peak" demand periods).

Montana's large hydroelectric dams formed the basis of our state's historically inexpensive power, what economists call a "competitive advantage". Montanans lost this advantage after 1997, when deregulation of electric utilities resulted in the breakup of the Montana Power Company, its dams and coal plants sold to PPL and its distribution system sold to NorthWestern Energy (NWE).

Are there potential drawbacks to Montanans' taking over these dams? Yes. For one thing, citizens would be acquiring an aging resource in need of maintenance and repair. Moreover, the dams are a resource that customers already have purchased several times over, during decades of paying their Montana Power Company electrical bills. Another downside is that if current

Water and Climate Change in Montana

Water is the lifeblood of the land, especially in semi-arid Montana.

Every time someone talks about building a new coal-fired power plant like the proposed Highwood facility east of Great Falls or, more recently, a proposed coal-to-liquid-fuel plant in the Bull Mountains south of Roundup, someone else asks: "Where's the water coming from?"

This a realistic question and—since Montana is not rich in surface water where coal is abundant—it is one more reason for Montanans to step away from long-term commitments to coal,

To be specific:
(1) Mining coal means mining the aquifers for most of eastern Montana.

(2) Coal bed methane extraction means pumping the water out of that aquifer to release gas "trapped" by water pressure.

(3) Coal-fired power plants (and any thermal power plant fueled by fossil or radioactive fuels) require large amounts of water, as do facilities that first gasify then liquefy coal to produce synthetic fuel. (See Chapter 5 for case studies on the Highwood and Bull Mountain proposals.)

In the longer term, "Where's the water coming from?" takes on urgency because of possible climate changes associated with global warming. A November 2006 press release from Montana State University begins: "Montana will become a desert by 2100 if nothing is done to slow global warming." The story cites research by four MSU students (from Montana, South Dakota, Oregon and Turkey) that spurred their request that the local City Commission in Bozeman endorse "The 10 Percent Challenge", a voluntary program to reduce carbon dioxide emissions by 10 percent. (Among other measures, this program recommends that businesses turn down thermostats by one degree, turn off office equipment when not in use, replace incandescent bulbs with florescent bulbs, and use ENERGY STAR appliances.)

Not all climate change projections for Montana are so dire. A few actually foresee a slight overall increase in precipitation; however, most projections see longer periods of drought (especially east of the Rockies) punctuated by rain or snow coming in bursts; less snow accumulation in the mountains; earlier and quicker run-off in spring, and consequently reduced flows in streams and rivers come summer—conditions most Montanans have been experiencing since the early to mid-1980s.

The impacts of this scenario are widespread and include more forest fires; more insect invasions in trees stressed by drought and disease; more erosion; diminished wildlife habitat; diminished fishing, boating and other recreational opportunities; and less water for municipalities and—most tellingly—for agriculture.

Impacts of energy development extend beyond less available water to pour into coal facilities. Hydropower capacity would decline with less water behind the state's large dams. This would also mean less water in the future to electrolyze into hydrogen. Less infiltration by rain or snow could reduce the flow of geothermally heated water. And even if Montana farmers focused on non-irrigated, dryland "energy crops"—oilseeds for biodiesel; barley, grains and native forbs and grasses for ethanol—less, or more erratic, precipitation would reduce production of those feedstocks.

Wind, solar and some forms of geothermal energy, once installed, are among the few systems requiring virtually no water to produce or consume.

climate change trends continue (see "Water and Climate Change in Montana" in this chapter), there may be less precipitation to fill the reservoirs, and less hydropower capacity than in the past.

The upside of taking over the dams—or at least those dams best suited to the task—is that their relatively low cost hydropower immediately could be dedicated to serving Montana consumers as a baseload supply. Then as other clean, renewable generating sources continue to come online, the dams could gradually be converted from providing baseload power to providing "peaking" power (during times of high demand) and back-up or "firming" power for the mix of electricity flowing into the system from intermittent wind, solar and small hydro sources. Geothermal energy, by the way, is also renewable but generally is not considered intermittent, so that most geothermal power plants could join the dams in acting as "firming" power sources. (See "The Case for Geothermal" in this chapter.)

In practice, taking over the dams could happen in a number of ways. It could mean forming a statewide public entity, perhaps a utility or a cooperative, to buy suitable dams from their current owners. Alternatively, taking over the dams could mean not buying them but empowering the existing regulatory system to monitor production and distribution of electricity from the dams with an eye to ensuring that Montana consumers benefit.

In any event, public control should ensure that the dams are managed in a more balanced way, not only to benefit Montana consumers but also to preserve and enhance Montana's environment. Generating electricity would be just one factor that is weighed among others, including maintaining adequate streamflow for wildlife, fisheries, agricultural, municipal, industrial and recreational purposes, and, in the future, maintaining adequate storage of water from which to produce hydrogen fuel by electrolysis.

Taking over the dams is not an indispensable step toward achieving the goal of this *Blueprint for Homegrown Energy Self-Reliance.* However, done in the right way, it could enhance Montana's progress toward that goal.

'FIRMING' RENEWABLE ENERGY

Whenever someone advocates using more renewable energy sources to generate electricity, skeptics ask, "What do we do when the wind does not blow or the sun does not shine?" The same question, however, can be asked about hydro or coal or nuclear power. In China, in October 2006, water levels at key hydropower reservoirs were down 12 percent from a year earlier, substantially cutting production. In India during a recent drought, when water stopped flowing over a dam, more than 200,000 people were left without electricity. As mentioned earlier, large coal-fired plants typically are shut down 12 percent of the time for maintenance or other reasons. And as for nuclear power, 41 U.S. plants have experienced 51 shutdowns that each lasted more than a year, due to safety concerns.[69] Every method of electric generation requires "backing" or "firming". This is why the best policy is to diversify generation sources.

Generating no power of its own, and tied to buying the majority of its electricity from a single supplier, NorthWestern Energy chose to diversify its sources by buying windpower. This decision led to the creation of the windfarm at Judith Gap and NWE's 20-year contract to buy that power at an average price of $31.16 per megawatt hour (or 3.116 cents per kilowatt hour). This is an excellent price. In 2006, Judith Gap produced about 40 percent of its capacity of 135 megawatts, which is outstanding performance for a windfarm.[70] Nonetheless, backing up or firming windpower must always be considered in the overall price, and in the case of Judith Gap this has sent the price from $31 to between $36 and $41 per megawatt hour.

This firming cost is likely to move downward as power dispatchers become more familiar with the generation characteristics of Judith Gap (and with windpower in general). But for the moment, windpower skeptics have pointed out NWE's passing onto its customers the price of 25 more megawatts of firming windpower, and have blamed fluctuating winds for $4,000 in fines paid by NWE for not balancing electrical load on the grid.[71]

Handling $4,000 in fines is a minor issue. If NWE apportions this amount among its more than 300,000 electrical customers, the average share comes to about $0.0133—a mere penny and one-third per customer. The larger question is the cost of firming windpower, but even when NWE adds between half a cent and one cent to Judith Gap's contracted price, the result is still a bargain—3.6 to 4.1 cents per kilowatt hour. At that price Judith Gap still is providing NWE's least expensive new source of electricity, and at the prices currently charged by PPL and various "spot market" suppliers, Judith Gap likely is providing NWE's cheapest electricity from all sources, old or new.

For NWE, wind, though, still serves a relatively small portion of its total

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69 See <www.ucsusa.org/clean_energy/nuclear_safety/unlearned-lessons-from>.

70 Testimony in the 2007 Montana legislature gave a figure of 37 percent; other sources have said 38, 40, and even 42 percent. Whatever the final performance figure for 2006 turns out to be, in a 2006 Montana public television program, Judith Gap's project manager stated that this windfarm was the best performing facility in the entire United States.

71 Newspaper article in Choteau (MT) Acantha, Jan. 11, 2007 at <www.choteauacantha.com/articles/2007/01/11/news/news2.txt>.

load. What happens when a utility like NWE begins to rely heavily on windpower and the wind simply stops blowing?

For starters, it is highly unlikely that wind will stop blowing everywhere at once. To quote a Utility Wind Interest Group (UWIG) report by three major electric utility industry groups: "A sudden loss of all wind power on a system simultaneously due to a loss of wind is not a credible event".[72] Rarely is the wind consistent in velocity or direction (this is especially true in Montana's varied terrain) so at least some of the wind turbines dispersed around a region should be able to catch a breeze. This is even true on a single windfarm such as Judith Gap where 90 turbines are dispersed over an area of more than 8,200 acres of state and private land. Rarely does one pass by this site without seeing at least a few of these turbines revolving.

The UWIG report states that in any system where "wind capacity is properly discounted in the determination of generation ... no additional generation needs to be added to provide back-up capability." Such "proper discounting" would seem appropriate for NorthWestern Energy's present system, where the amount of windpower feeding the grid cannot be considered anything more than an additional energy source—not yet a "capacity source" capable of contributing to the system's ability to serve peak times of maximum demand.

For utilities with a higher percentage of windpower than NWE at present, the Utility Wind Interest Group reports that "requirements for additional reserves will likely be modest....In two major recent studies, the addition of 1,500 MW and 3,300 MW of wind (15 percent and 10 percent, respectively, of system peak loads studied) increased regulation requirements by 8 MW and 36 MW, respectively, to maintain the same level of...control performance standards."

On average, according to the UWIG report, when windpower provides up to 20 percent of a system's peak-level electricity on a grid, firming power adds another 1/2 cent per kilowatt hour. As previously noted, NWE's cost of firming Judith Gap power has been ranging from 1/2 cent to 1 cent per kilowatt hour. NWE now buys windpower not only from Judith Gap but from smaller "qualified facilities" for about 3.27 cents per kilowatt hour. If these smaller dispersed sites as well as new larger windfarms perform even close to the level of Judith Gap—and if NWE moves toward 20 percent windpower in its system—Montanans could see NWE's windpower firming costs come down.

Forecasting when winds are likely to blow and trying to match a system's demand with those windy times is crucial. When the wind does not blow,

72 Utility Wind Integration Group. "Utility Wind Integration State of the Art." May 2006. <www.uwig.org/UWIGWindIntegration052006.pdf>.

"existing dispatchable generation" must compensate. Power dispatchers adjust supply with fluctuating demand over three periods:

(1) regulation (day by day, 24 hours and beyond),
(2) ramping (hour by hour, from 1 to 24), and
(3) load-following (minute by minute, 0 to 60).

For each of these periods, dispatchers use different mixes of what are called **spinning reserves** or **non-spinning operating reserves** to firm the power or to make the power quality acceptable. Spinning reserves come from increasing the output of power plants where generators are already turning. Non-spinning reserves are idle power plants that can be "ramped up"[73].

Many reserves can be ramped up quickly. These can include turbines in hydroelectric facilities and geothermal power plants; conventional generators burning diesel, biodiesel, natural gas, or methane from anaerobic digesters; and compressed air storage or hydrogen fuel cells used to produce electricity. These sources can firm windpower during the shorter "ramping" and "load following" periods. Other reserves, such as thermal power plants fueled by radioactive ore or pulverized coal, take longer to ramp up and are suitable for firming windpower during the longer "regulation" period.

There is one type of coal technology called Integrated Gasification Combined Cycle (IGCC) which gasifies coal then burns the gas and thus, like a conventional natural gas power plant, can be ramped up fairly quickly. IGCC plants also produce less toxic pollutants and use less water than conventional coal plants and would therefore be more suited to "firming" wind electric generation during both shorter and longer periods.

Despite these advantages, IGCC is more complicated and expensive than conventional burning of pulverized coal, and actually results in more carbon to be dealt with, either to be released into the air or—at significant additional cost—captured and sequestered underground. For these economic and environmental reasons, this *Blueprint* contends that any new coal generating facility, including IGCC, is inappropriate for Montana. There are simply too many cleaner, cheaper and faster options than coal.

Some predict that solar power from large new plants coming online in Colorado, Nevada and elsewhere could work well with windpower. Each could, in a sense, help "firm" the other because the sun often shines when the wind does not blow, and vice versa. However, while centralized solar facilities have their place, and are a definite step up from centralized fossil fuel or nuclear facilities, solar electricity ultimately will be utilized most effectively in decen-

73 "Ramped up" means the power generation sequence is initiated, brought up to production level and begins generating electricity at a level ready for distribution.

The Case for Geothermal Power Plants

The entire eastern part of Montana north and east of Billings has geothermal potential, as well as sites near Bozeman and several other Montana cities. Of the three types of geothermal power plants, Steam, Flash, and Binary, the last is probably most suitable for Montana.

Binary plants rely on relatively low temperature hot water (100° to 300° F), which is much more common than geothermally heated water at higher temperatures. This hot water passes through a heat exchanger along with a second fluid that has a lower boiling point (usually a hydrocarbon such as isobutane or isopentane). This secondary fluid vaporizes, which turns turbines and creates electricity. Both fluids are recycled, the remaining secondary fluid through the heat exchanger and the geothermal water condensed and returned to the reservoir. This self-contained cycle means that nothing is emitted or wasted.

According to the National Renewable Energy Laboratory, energy produced by binary plants currently costs about 5 to 8 cents per kWh. Almost certainly this is less than the cost of power from an IGCC coal plant, particularly if the cost includes sequestrating carbon emissions.

Geothermal potential is high all over the western United States. The Western Governors' Task Force on Geothermal Development excluded seven states (Montana, Wyoming, the Dakotas, Nebraska, Kansas and Texas) and still came up with almost 13,000 MW of geothermal energy that could be developed within a reasonable timeframe.[74] The geothermal industry considers 5,600 of these megawatts viable for commercial development within the next 10 years, at prices ranging from 5.3 to 7.9 cents per kilowatt hour (assuming continuation of a production tax credit). Eighty-eight sites in California and Nevada contain 3,900 potential MW close to areas of large demand. Many more geothermal sites are yet to be discovered.

Water use by geothermal plants would be far less than in other thermal plants. According to A Guide to Geothermal Energy and the Environment (Kagel et al, April 22, 2005, pages 43-47), "Comparing two recent power plant applications in California, a new geothermal flash plant would use 5 gallons of freshwater per MWh, while a new gas facility would use 361 gallons per MWh.

Alternatively, a binary, air-cooled geothermal facility would consume no water. Also, the fluids used to generate geothermal power are kept separate from drinking water and are continuously recycled through the geothermal system, so they are not depleted through geothermal use."

Land use is minimized—up to nine times less than a coal fired power plant of equal capacity—and geothermal facilities generate not only electricity but taxes, royalty payments and jobs. Twenty-one geothermal steam-generating plants at the Geysers Geothermal Field in California together can produce almost 1,000 MW of electricity and employ 425 people full-time plus 225 additional full-time equivalent contract workers; in 2003 the plants paid more than $11 million in property taxes to Lake and Sonoma counties.

To view a map of Montana's geothermal potential see http://geothermal.id.doe.gov/maps/mt.pdf.

74 See <www.westgov.org/wga/initiatives/cdeac/Geothermal-full.pdf>.

tralized ways, produced on rooftop after rooftop and, with minimal to zero transmission losses, used on site.[75]

NEW BATTERIES TO BACK UP RENEWABLE ENERGY

New developments in battery technologies give promise of storing the intermittent energy of the sun or wind, economically, on both large and small scales.

For example, a "flow" battery now in use on King Island, between Australia and Tasmania, is explained in an article in *The New Scientist*.[76] King Island has no connection to a mainland power grid, so it relies its own small wind farm along with diesel generators for electricity. In 2003 the local utility company installed a mammoth rechargeable battery that can deliver 400 kilowatts for two hours at a time. This reserve power has increased wind-derived electricity on the island's grid from 12 to 40 percent, and has cut diesel consumption nearly in half, saving money and avoiding carbon dioxide emissions of 2,000 tons per year.

For decades electricity generated by wind or sun has been stored in chemicals inside batteries, the most common being the lead-acid battery. What's different about the system on King Island is that, when the wind is blowing, the energy-enriched chemicals don't remain inside the battery but are pumped into storage tanks. Fresh chemicals in the battery then can soak up more charge. When the wind stops blowing, the flow is reversed: the energy-enriched chemicals are pumped back into the battery.

Though more complex than conventional batteries, flow batteries last far longer and their storage capacity can be expanded simply and inexpensively by building larger tanks and adding more chemicals. This technology is still being refined, but is now in use in a variety of applications from the King Island power grid to electric golf carts. Ultimately the flow battery could supplant many conventional electricity storage systems—from batteries in electric cars to large-scale hydroelectric pumped storage reservoirs.

Installing a type of "flow" battery allowed PacifiCorp, an Oregon-based utility operating around the western U.S., to avoid millions of dollars in costs and still achieve its aim. The story (according to Jon Coney, spokesman of PacifiCorp) is that the company's power transmission into Castle Valley, Utah,

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75 Energy consultant and windpower entrepreneur Russ Doty, based in Billings, Montana, provided much of the information in this chapter and in the Blueprint as a whole. More can be learned by visiting his website at <www.newworldwindpower.com>.

76 Thwaites, Tim. "A Bank for Windpower", The New Scientist, January 13, 2007. <environment.newscientist.com/article/mg19325861.400>.

was operating at full capacity, and the utility faced building a new substation and 16 miles of transmission lines through environmentally sensitive lands at a cost of $5.6 million. Instead, the company brought online the first Vanadium Redox flow battery to be used in North America. This utility scale battery, which stores energy and offers it back to the grid when the time is right, balanced power loads in the valley and cost just $1.3 million. The savings: $4.3 million.

On a smaller scale, William Von Brethorst of Ennis, Montana, installs renewable energy systems in homes and says he always backs them up with sealed, dry batteries, even when they are tied into the electrical grid. “When the sun goes down or when the wind is not blowing the entire electrical load is picked up by the utility,” he writes. “Massive amounts of power must be generated continuously. The grid cannot be throttled back as a result of a slight decrease in demand resulting from small scale renewable energy production…. Battery based, grid-tied home systems do not just sell back power to the utility, but reduce the overall home load profile permanently and decisively.”

The way these systems are wired is key to their efficiency, Von Brethorst says, with all critical loads placed on the inverter/battery system rather than returning to the power grid when the sun is not shining or the wind not blowing.

To critics who claim that battery systems reduce overall efficiency and burden owners with maintenance and disposal problems, Von Brethorst replies that AGM (dry) batteries perform well, are long-lived and maintenance-free, can be easily recycled, and “fit in any home safely without concerns about leaking chemicals or venting gases.” In ways not possible with non-battery grid-tied systems, he says, homeowners become aware of their overall energy consumption patterns and adjust them, often reducing their electric loads by 50 to 80 percent.[77]

THE CASE FOR DECENTRALIZED GENERATION

A giant rechargeable battery: this is one way to think about the electrical grid, that network of power lines and substations transmitting electrons from place to place. The analogy is not exact, since the grid by itself is a “real time” supply-demand network with no actual storage capability, but it is suggestive.

Better yet, think of the electrical grid as a giant lake: it has inflows and outflows, charges and discharges.

One interesting feature of windpower in Montana is that, if it were widely

77 E-mail communication with AERO Energy Blueprint authors, December 3, 2006, from William Von Brethorst, Planetary Systems, Inc., Ennis, Montana.

enough dispersed, it could be recharging this battery nearly always, re-filling this lake.

In many other states graced with rich windpower potential, the wind tends to be more uniform. North Dakota is an example. When the wind blows in one part of this relatively flat state, it probably is blowing in all parts—but the reverse is also true. As previously pointed out, thanks to Montana's widely varying terrain, the wind may not be blowing at Judith Gap (as difficult as this may be for local residents to believe) but likely could be blowing at Big Timber or Plentywood.

This is a prime virtue of decentralized generation. All our windpower "eggs" would not reside in the baskets of a few giant windfarms. And our other means of generating electricity would not be reduced to a few centralized power plants.

Some argue that "economies of scale" dictate construction of large centralized generating facilities, be they coal-fired power plants or windfarms. It is true that purchasing steel, concrete, wire, meters, transformers, etc. is cheaper in large quantities, or renting a giant crane and raising not nine towers but 90, brings down the cost. If you divide total cost by total output, a single 400 megawatt facility would generate electricity more cheaply than four 100-MW facilities.

But what happens when that 400 MW facility shuts down for maintenance or repairs? This is what a 2005 study asks. Answer: the utility needs 400 megawatts of "reserve capacity" to replace it. The study, "Z Method for Power System Resource Adequacy Applications",[78] moves beyond cost per kilowatt hour to examine the total cost of serving customers reliably in a number of scenarios.

For example, the study asks if it is likely that all four of those 100 MW plants would shut down at the same time? It is not likely. It is not even likely that two would shut down at the same time; however, if they did, then just 200 MW would be needed, and the study indicated that this amount of reserve capacity should suffice. So, while those four 100 MW plants do produce power at a higher kilowatt-hour cost than one 400 MW plant, in the end the utility likely would save a lot of money building and running four smaller plants instead of one large one, because it would not need so much reserve power.

"The lesson to be drawn," according to the Northwest Energy Coalition's (NWEC) report on this study, "is that it's often cheaper to use several small plants than a few large ones, even if the larger plants cost less to operate."

78 Prepared for PacifiCorp by Ken Dragoon and V. Dvortsov.

NWEC concludes: "This effect is even more dramatic for small, distributed resources such as solar power on roofs and geographically diverse wind farms. As utilities develop plans and review portfolio options for serving load growth, they must seriously consider the economy of small scale."[79]

One virtue of windpower (pointed out earlier) is that it can be added gradually, as need arises, a megawatt or two at a time. Windpower doesn't have to come only from large, centralized windfarms like Judith Gap.

There are very effective wind machines of all sizes, including your backyard. Southwest Windpower in Flagstaff, Arizona, designed a 1.8 kilowatt machine in collaboration with the U.S. Department of Energy's National Renewable Energy Laboratory. It's called the Skystream, a backyard machine that can sit on a 35 to 50 foot free-standing tower or on guyed towers up to 105 feet. Company officials say it can quietly produce power for 5 to 10 cents per kilowatt hour and that it works best on property greater than 1/2 an acre with wind speeds above 10 miles per hour. Installed, the turbine costs from $9,000 to $12,000. Company officials say it can trim $500 to $800 off an average home's yearly electric bill, and pay for itself in 5 to 12 years—but this depends on wind speeds in the area, local prices of electricity, and various rebate programs. (The company figures may be optimistic. Payback time in Montana could be considerably longer. And there are other challenges like local zoning rules that prohibit wind turbines in backyards or restrict a tower's height.)

Green Electric Buying Cooperative (GEBCO) of Billings, Montana, is promoting the idea of neighbors getting together, about 30 of them, to purchase a 100 kilowatt machine—as opposed to each family's buying a 3 kW machine. They could place the machine on a favorable site, arrange with the utility for net metering (when the wind blows the meter turns backward) and, as GEBCO's CEO Russ Doty says, "This distributed generation would keep the tax base of energy generating units close to home (where the energy is used) rather than having the folks pay for centralized power plants based in a few places."

Some laws might have to change to allow this to happen. Current Montana law allows net metering only up to 50 kW. Doty suggests this be increased to 2 MW as it is in Colorado, New Jersey and Pennsylvania. "This would allow a school like Rocky Mountain College in Billings or the St. Labre Indian School in Ashland, Montana, to aggregate their individual loads and own a utility scale windmill."

79 "Small is Beautiful: When it Comes to Utilities, Economy of Scale Sometimes Works in Reverse", The Transformer, Volume 3, Issue 5, December 21, 2006. Published by the Northwest Energy Coalition, Seattle, Washington 98104; <www.nwenergy.org>.

Or there is this scenario sketched by (among others) Windpark Solutions, LLC, the firm that developed the Judith Gap windfarm before selling it to Chicago-based Invenergy Corporation. Windpark Solutions CEO Bob Quinn now wants to work on a smaller scale and is interested in keeping ownership of windpower facilities in local hands. An organic farmer from Big Sandy, Montana (also active in biodiesel production to handle the fuel needs for his own farm operation), Quinn has suggested that windpower entrepreneurs should set a goal of installing 3 megawatts of windpower capacity at every electric power substation in the state where there is a decent breeze.

Financing mechanisms to accomplish this include attracting investors who need tax write-offs for a period of years—usually ten—after which ownership of the windpower facilities would revert to local community members or co-operatives. This arrangement is working well in places like Wisconsin and Minnesota, as well as Germany and Denmark. Montanans in both the private and public sectors would need to work together to find the best financing mechanisms to provide for as much local control as possible.

PHOTOVOLTAICS: OBSTACLES AND OPPORTUNITIES

Local control is what photovoltaic technology—electricity directly from the sun—is all about: control not just community by community, but household by household. However, there are still some real financial obstacles to widespread adoption of photovoltaics (PV).

Solar electricity was first developed widely as part of the space program. The panels used today on space satellites are about 35 percent efficient. Those used in homes are generally of a lower quality; they cost far less but are only about 15 percent efficient.

Although costs have been coming down, a PV system is still expensive unless you can garner subsidies from certain utility or government programs, or are pumping water for livestock in remote locations, or have built a house at least a mile from the nearest power line. In the latter two instances, paying to construct feeder lines is so expensive that "going solar" makes sense. In the case of a home electric system, one might combine PV with small scale windpower, a battery storage system, and perhaps a biodiesel powered generator.

At an AERO solar workshop back in the 1970's, it was suggested that the U.S. military invest a billion dollars a year to install PV panels on the roofs of buildings on military bases. This technology could have evolved in a similar way that microchips subsequently evolved: with "economies of scale" kicking in to reduce manufacturing costs, by now many if not most of the homes in the U.S. could have been energy independent. This sort of intervention by government, to create a market, could still happen.

In the meantime, with or without government aid, private industry has been making great strides at bringing PV costs down. In August 2006 researchers at the University of Johannesburg and at Nanosolar[80], announced major breakthroughs in solar electric cell technologies using an alloy of copper-indium-gallium-selenide deposited in an extremely thin layer on a flexible surface. Both companies claim the technology reduces solar cell production costs by a factor of 4 to 5. This would bring the cost to or below that of delivered electricity in a large portion of the world.

Half a dozen competitors are working along the same lines. As Dave Freeman and Jim Harding wrote in the August 10, 2006, *Seattle Post-Intelligencer,* "Thin solar films can be used in building materials, including roofing materials and glass, and built into mortgages, reducing their cost even further. Inexpensive solar electric cells are, fundamentally, a 'disruptive technology'…Much like cellular phones have changed the way people communicate, cheap solar cells change the way we produce and distribute electric energy."[81]

While we wait to see if such breakthroughs are not too good to be true, there are a number of current programs aimed at dipping the toes of the consumer into the PV world. The State of Montana, through money derived from the Universal System Benefits (USB) charges on electricity bills, sponsors a 50 percent discount on approximately 20 two-kilowatt PV systems per year for residential use. Henry Dykema of Sundance Solar Systems, near Red Lodge, Montana, points out that if the cost of a system is $15,000, then the discount reduces the net cost to the consumer to $7,500.

Note that the average Montana home on the NorthWestern Energy grid uses approximately 750 kWh per month; a two-kW system can provide about 300 kWh per month. Here is one more example of the wisdom of investing in conservation first—such as energy-efficient lighting and household appliances—before, or while, investing in PV systems, even discounted ones.

The State of Montana also sponsors PV systems for fire stations (which include a stand-alone battery system) and for schools.

Beginning in 2006 and through 2007 there is a federal solar tax credit for 30 percent of the cost of a PV system up to a maximum of $2,000, and various

80 A private company in Palo Alto, California.

81 Dave Freeman and Jim Harding, "Solar Cells Change Electricity Distribution" Seattle Post-Intelligencer, Seattle, WA, August 10, 2006. <seattlepi.nwsource.com/opinion/280625_solarcell10.html>.

states also offer solar tax credits. Oregon, for instance, offers a solar tax credit of $6,000. The State of Montana could provide more incentives in this area.

Low interest loans are a way for governments to stimulate the market for clean energy. In Germany, the Credit Agency for Reconstruction offers low-interest loans for energy efficiency measures in residential buildings and also for solar PV systems. In 2005, with interest rates for PV at 4.1 to 4.4 percent, the Agency accepted more than 17,000 funding requests for a total of 139 megawatts. Germany now has passed Japan as the leading nation in installing new PV systems.

Creative new approaches are popping up to accommodate people who simply want reliable clean energy, and do not necessarily want to install and own these systems. One example: "distributed energy utilities" where a company owns the renewable hardware, say a solar array on a block of apartments in Missoula or on the roof of a large shopping mall in Billings, and sells the electricity to local residents or businesses on a long term contract. Such newly forming associations could provide innovative ways to distribute decentralized energy systems.

THRIVING WITH THE SMART GRID

New technologies are becoming available to create a "smart grid" that will allow utilities to move electricity from producer to consumer in ways that conserve energy or use energy at times when it is least expensive. Grid congestion can be diminished, blackouts and brownouts avoided. This can save communities and businesses money while reducing the need for costly new generation and politically contentious new transmission lines. The energy delivery system can become more reliable and resilient, and therefore less prone to system-wide disruptions and fluctuating voltages.

Rewiring the grid with advanced computer controls can allow power to be distributed more efficiently, safely, and reliably, and it also can help allay utility concerns about the complexities of bringing power onto the grid from smaller, dispersed sources.

According to a recent report by the Seattle, Washington-based group, Climate Solutions [82]:

> "The smart grid will...offer new capabilities to bring on-line varying power flows from wind farms, solar panels and other renewable power sources, and to integrate vast numbers of small-scale localized generators such as

82 Mazza, Patrick. "Powering Up the Smart Grid: A Northwest Initiative for Job Creation, Energy Security and Clean, Affordable Electricity". Climate Solutions. July 2005. <www.climatesolutions.org/pubs/pdfs/PoweringtheSmartGrid.pdf>.

fuel cells and micro-turbines. The diversification of power sources plus the capability to manage end-use demands provides new security against blackouts. A RAND Corporation study found smart grid technologies could reduce power disturbance costs to the U.S. economy by $49 billion per year."

Besides the obvious potential to save money, a further catalyst for the growth of smart grid technologies in Montana, Idaho, Oregon and Washington is the Northwest Power and Conservation Council's Fifth Power Plan, which has called for 700 avMW of conservation between 2005 and 2009 in this region.[83] Advanced metering infrastructure and meter data management are among the promising smart grid tools that send signals to the market encouraging

83 One avMW equals 8,760 megawatt hours per year.

The Power of CHP—Combined Heat and Power

Now on the market are products which can replace the conventional natural gas powered furnace or boiler with a unit that generates electricity while heating the house or building. Combined Heat and Power—or CHP—units can dramatically lower overall energy use while reducing environmental impact. Efficient, quiet, and as clean burning as the best gas heaters on the market, CHP units are particularly effective in places where coal-fired electricity predominates, and where full-retail-value net metering is in place.

One example: Climate Energy's Micro CHP System in Massachusetts where, for the average user, as much as 4500 kilowatt hours of electricity can be generated annually, saving approximately $600 on one year of electrical bills. Displacing this much electricity otherwise generated by coal-fired power plants yields a 30 percent reduction in carbon dioxide emissions.

Coal-fired power plants have a net efficiency of about 35 percent due to waste heat of 61 percent added to transmission losses of at least 4 percent (much higher for long distance transmission). That means that such centralized power plants must burn the equivalent of 285 watts of fuel to light one 100-watt bulb.

With CHP, the "waste" heat warms the house, raising efficiency to 81 percent. Thus, the equivalent of 123 watts of fuel would light that same 100-watt bulb.

A California company, Capstone, has installed more than 3,500 CHP units worldwide in hotels, office buildings, health clubs—and to generate electricity during the burning-off of landfill methane or sour gas from oil drilling.

More than 23,000 homes in Japan use CHP. More than 40 percent of Denmark's electrical production is said to come from CHP (with another 20 percent coming from windpower).

In 1998 the U.S. Department of Energy launched the CHP Challenge to remove market barriers.

More information about CHP and other energy efficient systems is available from the Northwest Energy Efficiency Alliance. See "Alliance targets industrial efficiency" (May 3, 2005) at www.nwcurrent.com.

energy efficient appliances; energy conserving building design and management; and facilitating real-time and time-of-use pricing for customers at all levels, from residential through commercial to large industrial.

Another smart grid catalyst in this region is a program of the Bonneville Power Administration (BPA) called the Non Wires Solution which seeks to provide "the most cost-effective solution to the region's transmission problems from an engineering, economic and environmental standpoint...before proceeding with the construction of transmission projects."[84] This effort supports numerous research and demonstration projects employing smart grid technologies and using real-time energy data.

Transmission systems fully and effectively utilized can mean that many expensive new generating plants and transmission lines will not need to be built. It will make sense for urban areas and manufacturing or industrial parks to utilize combined heat and power (CHP) facilities and micro-generators which get vastly better efficiencies than stand-alone power plants. For example, Portland General Electric (PGE) runs a Dispatchable Standby Program in which the company installs communications, control and switching equipment on customer-owned generators, and provides maintenance and fuel. In return, customers allow PGE to run these generators up to 400 hours per year. The goal of this program is to supply 100 megawatts of peaking power capacity; 38 MW are now online or under construction (contact PGE's Mark Osborne, 503-464-8347, for more information).

For both urban and rural areas, the smart grid makes the "practical vision" of this *Blueprint* even more practical: solar rooftops in cities and towns, wind turbines on farms and ranches, micro-hydro systems in the mountains, all contributing to Montana's energy supply and making large centralized power plants a thing of the past.

THE MODERN GRID INITIATIVE

The call for a smarter grid is coming not only from the conservation community but also from business, industry and the federal government. The Modern Grid Initiative is "a collaborative effort to integrate the resources and expertise of many contributors and create a comprehensive approach to modernizing the national electricity infrastructure."[85] Members include utilities, technology providers and researchers, consumers, regulators and government officials. Its web site offers links to resources including Power Point presenta-

84 Bonneville Power Administration. <http://www.transmission.bpa.gov/PlanProj/nonwires.cfm>.

85 For more information see <www.themoderngrid.org>

tions from a regional summit on these topics in Portland, Oregon: *Modernizing the Grid Northwest Regional Summit*, April 18–19, 2006.

Smart grid infrastructure is more than just advanced metering and switching technologies. In the words of Alison Silverstein[86], "not just power plants and transmission lines, but also reliability rules, demand response, market rules, information technology, and even meters are part of infrastructure. The smart grid itself is new technology, another form of infrastructure that we really need to have." (Silverstein was speaking in Atlanta, Georgia, at an April 2006 meeting of the newly formed Advanced Metering Infrastructure—Meter Data Management Working Group.)

To achieve increasingly sought after "demand response" solutions to electricity needs, smart grid technologies are critical. Silverstein has criticized the 2005 Energy Act as not going far enough to "give the industry adequate incentive and motivation to act on demand response".

Silverstein argues that utilities and regulating bodies need to take the modern grid seriously—in particular, she says, "We should take to heart the value of demand response for risk management, for making customers happy, and for peak price mitigation and volatility reduction. I'd like to see regulators mandate that 15 percent to 20 percent of load {customers} gets access to interruptible and curtailable programs, or time-of-use and critical pricing rates… Demand response is grossly under-valued and under-employed at this time and every utility should be doing it.…A healthy dose of demand response is the single most valuable element in a 'no regrets' electricity portfolio because it reduces risk, costs, and volatility."

ECONOMIC VITALITY AND CLIMATE CHANGE

A worldwide consensus has rapidly developed about the need to restrict and reduce greenhouse gas (GHG) emissions because they are the single greatest factor in our planet's current, dramatic climate change. The urgent need to design an economy that drastically reduces contributions to the buildup of GHG in the atmosphere is a key motivation for developing this *Blueprint*. A slowly dissolving myth is that curtailing GHG emissions will hurt the economy. Efforts taken by certain states and by other countries demonstrate that just the oppo-

> COSTLY CENTRALIZED POWER PLANTS AND LONG DISTANCE TRANSMISSION LINES ARE LIKELY TO BE A WASTE OF TIME AND MONEY, AS 'SMART GRID', ENERGY CONSERVING, AND LOCAL RENEWABLE ENERGY TECHNOLOGIES COME ON LINE.

86 Alison Silverstein was the Senior Energy Policy Advisor to Chairman Pat Wood,III, at the Federal Energy Regulatory Commission, from July 2001 through July 2004.

site is true. Cost savings from implementing solutions to save energy and reduce GHG are fast outstripping investments in those solutions.[87]

Some of those solutions revolve around the smart grid, and much of the innovative work in this area is happening in the Pacific Northwest. Oregon and Washington are already hubs of such activity, but the entire region can benefit economically from the growth of many local companies developing and selling smart grid technologies and software.

And for the nation as a whole, the Climate Solutions report, "Powering Up the Smart Grid," sums it up:

> "Tens if not hundreds of billions of dollars will be invested in the U.S. power grid over coming decades. Sixty percent of our energy system's aging infrastructure will need to be replaced in the next 10-15 years. A Pacific Northwest National Laboratory study shows that the smart grid's capability to smooth out peak power demands alone could eliminate the need for $46 billion to $117 billion in power plant and power line investments over the next 20 years."

This should help keep the lid on power bills, create new job opportunities and preserve jobs in all industries dependent on reasonably priced electricity. It is only prudent to recommend that the State of Montana cooperate with private electric utilities and rural electric cooperatives—and with economic development promoters, colleges and universities, residential and commercial building associations, and local government officials—to look for opportunities and funding to expedite the use of smart grid technologies in Montana.

Doing so can help Montana avoid making risky, costly commitments to power plants and long distance transmission lines, under the guise of solving the energy problems of other states. Such commitments are likely to be a waste of time and money as more and more investments are made, instead, in smart grid technologies, cost-effective energy conservation, and, locally available, clean and renewable energy.

87 McFarling, Usha Lee, "Studies Support California Emissions Plans: Effort to Cut Greenhouse Gases could be Beneficial for California's Economy"; The Los Angeles Times, January 23, 2006.