CHAPTER 2:
Starting at Home: Conservation & Efficiency

GOAL: BY THE YEAR 2020, TO REDUCE ELECTRICITY USE IN MONTANA BY 30%, TRANSPORTATION FUEL USE BY 20%, AND HEATING FUEL USE BY 27% WHILE ADDING THOUSANDS OF JOBS AND MILLIONS OF DOLLARS TO THE STATE'S ECONOMY, ACCOMPLISHED THROUGH ENERGY CONSERVATION AND EFFICIENCY PROGRAMS AND POLICIES.

Demand Side Management of energy use and energy development in Montana is the basis of this *Blueprint*. Conservation and efficiency are the foundation. This means that any supply-side energy development, whether from finite polluting sources like coal or clean renewable sources like wind, sun and growing plants, must follow a serious commitment to energy conservation and efficiency.

Current projections are that electricity use in Montana will grow by about 1.6 percent annually. This includes a 2.9 percent projected growth rate for commercial and a 1.4 percent rate for residential sectors.[12]

Two recent studies, "A Balanced Energy Plan for the Interior West"[13] and "Repowering the Midwest"[14] suggest that a goal of a 30 percent reduction in electricity use by 2020 is reasonable. These savings result from a deliberate energy efficiency program based on the assumption that "there will be several concerted, long-term, and successful public policies and private sector initiatives to increase adoption of efficiency measures." Both studies found these efficiencies could be achieved cost-effectively, between 2.0 to 2.4 cents per kilowatt hour, which is considerably less than generating, transmitting, and distributing electricity from any source (except, possibly, existing hydropower).

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12 "Draft Montana Greenhouse Gas Inventory and Reference Case Projections." Montana Department of Environmental Quality. July 2006. <www.mtclimatechange.us/ewebeditpro/items/O127F8927.pdf>.

13 "A Balanced Energy Plan for the Interior West." Western Resource Advocates. Boulder, CO. 2004. <www.westernresourceadvocates.org/energy/clenergy.php>.

14 "Repowering the Midwest: The 21st Century: Opportunities for Clean Energy Development." Environmental Law and Policy Center. 2006. <www.repowermidwest.org/plan.php>.

The first and cheapest thing to do is reduce demand. In part, that's saying "no" to increasing supply—building new power plants, for instance—until we've said "yes" to energy efficiency and conservation. Effective and well-implemented conservation measures would cost a fraction of a conventional fossil fuel power plant. Conserving energy frees up existing energy generation to be used elsewhere. One estimate suggests that reducing energy use nationwide by just 10 percent would be equivalent to increasing our current solar and wind power output ten-fold.

Chapter 1 of this *Blueprint* stressed that to get to a specific goal, you need to know where you are starting from. The following statistics paint that picture. Despite Montana's apparent rural character and low population, this state contributes far more greenhouse gases per capita than the national average. Alarming? Read on to find out why, but first, let's put this in context.

U.S. citizens constitute 6 percent of the globe's human population yet consume 25-30 percent of the energy produced on Earth today. In doing so, each U.S. citizen generates, on average, 50,000 pounds of greenhouse gases (25 metric tons) per year. That's twice the greenhouse gases produced by a citizen of Germany and almost 20 times that of a citizen of India. When you include industrial and commercial outputs, Montanans emit about 40 metric tons of greenhouse gases per capita, which is 60 percent more than the national average! This imbalance occurs largely because such a small population (less than one million) is averaged in with large coal-fired generation plants. Montanans actually only consume about half of the electricity generated at these power plants. Long driving distances in this geographically dispersed state also contribute to high per-capita greenhouse gas emissions. Nationally, 82 percent of U.S. greenhouse gas emissions come from burning fossil fuels to generate electricity and to power trucks and cars. In Montana the figures are a little different due to agricultural emissions.

Nationally, 82 percent of U.S. greenhouse gas emissions come from burning fossil fuels to generate electricity and to power trucks and cars. In Montana the figures are a little different due to agricultural emissions.[15]

Conservation and efficiency are not primary energy sources, but they are the most cost-effective tools within the scope of any sound energy plan. They can be viewed as our cheapest "strategic energy reserves." Considered as resources, conservation practices and energy-efficient technologies also stand a chance of being our only truly sustainable actions. (Sustainable—like renewable—refers to the rate of use matching the rate of replenishment, and the

15 Methane and N_2O from manure management, fertilizer use, and livestock is higher in Montana than nationally: 27 percent compared to 7 percent.

ability of the ecosystem to neutralize or ameliorate the wastes generated from these processes.)

Integral to conservation practices and efficiency technologies is recognizing that **energy and materials cannot be written off as waste products**. Cradle-to-cradle use of resources, rather than cradle to grave (i.e. disposable waste), recognizes that there is no waste in nature. What cannot be absorbed by earth, water, or air is reused.[16]

We can transform waste to wealth by salvaging by-products from industrial, agricultural and commercial processes and re-using, recycling, or re-manufacturing them into energy or usable products. This transformation, which creates a "restorative economy" in the process, is most efficient on local and regional scales, and suggests that in Montana, remote as we are from major markets for recycled materials, we can create vibrant commercial enterprises to turn our own waste material into products or processes to be used here.

> The first and cheapest things to do:
>
> Reduce demand.
>
> Transform waste to wealth.
>
> Do more with less.

In rethinking how we use by-products from agriculture, industry and commerce we can begin to design and engineer products to be re-used or recycled with a minimum of energy and technological infrastructure.[17] We can, in some instances, ensure that manufactured items consist of materials that do not degrade the ecosystem but actually *feed* it as the item wears out (for example, plastics made of corn-based polymers). Likewise, reducing the transportation of raw materials and finished products greatly reduces embodied energy and greenhouse gas emissions. In fact, localization at all levels is a critical element in energy conservation/efficiency strategies. As much as possible we must localize and support:

- Food production, processing, transport and consumption.
- Production of building materials for homes and commercial buildings.
- Application and production of energy conservation and efficiency technologies.
- Decentralization of energy production.

In addition, an effective energy policy must apply AERO's Test Criteria described in Chapter 1 for materials necessary for energy production and conservation, such as the raw materials for wind generators and solar cells, or for double- or triple-paned windows and insulation.

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16 McDonough, William and Michael Braungart. "Cradle to Cradle: Reinventing the Way We Make Things". New York: North Point Press, 2002.

17 Buckminster Fuller described this as "anticipatory design."

1. Is the resource sustainable and renewable?
2. Does its development emphasize conservation and efficiency?
3. Does it originate from current solar energy (direct or embodied in living plants) or wind or other regenerative energy?
4. Does it avoid polluting our air, water, soil, bodies and views?
5. Does it avoid producing greenhouse gases that exacerbate global warming?
6. Is it produced close to the end user?
7. Is it scaled to allow wide participation in its production and distribution?
8. How much of it is financed, owned and/or operated by Montanans?
9. Is it priced accessibly for all Montanans?

ENERGY EFFECTIVENESS FOR ECONOMIC STABILITY

What really is the goal of a sound economic policy? From an energy perspective it is **doing more with less**: getting the most productivity from the least amount of energy with the least amount of environmental and social degradation. Before considering new sources of energy, we must take a hard look at how we can make our current use of energy most *effective*. It makes no sense to save energy at one end of the grid so that it can be wasted somewhere else. Every aspect of our economy can and must be scrutinized. The goal of this *Blueprint* is to enhance the speed at which this process takes place and to make clear the many ways this can be achieved.

There is a small window of opportunity for Montanans to respond before current escalating energy costs exceed our ability to implement the necessary changes. Add to this the specter of Peak Oil, limitations in the availability of key resources and the very real threat of catastrophic climate change, and this response must become a priority. Although some recommendations here seem challenging, each idea can play some role in helping to create a triple-win situation for our economy, our people and our environment.

There are five sectors of energy use in Montana: **residential, commercial, industrial, transportation and agricultural.** Every planning and development decision, from buying an appliance to building a subdivision, significantly affects energy use. A misplaced stop sign, for example, over its lifetime can waste thousands of gallons of fuel due to unnecessary braking then acceleration of vehicles. A dozen misplaced stop signs send ripples throughout the economy on a grand scale. Viewing energy use from a holistic perspective takes into account both upstream effects (production-processing-distribution) and downstream effects (consumption and disposal—or reuse).

We use electricity for lighting, appliances, home entertainment, business equipment, computers and their support systems, running motors, manufacturing processes, etc. We use fuels for heating our homes and buildings, for transportation and for some industrial processes. Opportunities for reducing existing and projected use of both electricity and fuels abound in all five sectors of our economy.

In 2004 electricity generation actually produced more greenhouse gas GHG emissions in the United States than cars, trucks, and planes combined. And buildings consume up to 40 percent of all electricity generated in the U.S.[18] Focusing on the built environment in Montana offers a major challenge and major opportunity to usher in a more energy secure economy.

Electricity sales in the **Residential, Commercial and Industrial** sectors in 2006 each accounted for about one-third of the 1560 average megawatts (avMW–see page 47 for definition of energy units) sold in-state: residential, 499 avMW; commercial, 527 avMW; and industrial, 532 avMW. For natural gas consumption, residential use accounted for 20 billion cubic feet (bcf), commercial 15 bcf, and industrial 24 bcf.[19]

Residential Sector

Existing Homes. Here the first place to save comes from replacing incandescent lighting with compact fluorescent or other energy-efficient light bulbs and replacing older appliances, particularly refrigerators, freezers, furnaces, air conditioners, and water heaters with those earning the ENERGY STAR rating. According to the U.S. Government's ENERGY STAR website[20], using ENERGY STAR rated lighting can deliver savings 60-70 percent over standard new products. Getting a free energy audit from one's utility company will identify the next steps to saving energy in a home. Taking advantage of Montana's Energy Efficiency tax incentives for increased floor, wall, and ceiling insulation and replacing old windows with energy efficient ones can put money back in your pocket as well as save up to 20 percent of energy costs. These are benefits that last for years, and add to the value and comfort of your home.

18 "RMI Adopts the '2030 Challenge': Carbon-Neutral Buildings in 24 Years the Ultimate Goal". RMI Solutions. Rocky Mountain Institute. Volume xxii. Fall 2006, p1. <www.rmi.org/images/other/Newsletter/NLRMIfallwinter06.pdf>.

19 "Draft Montana Greenhouse Gas Inventory and Reference Case Projections". Montana Department of Environmental Quality. July 2006. p 16. <www.mtclimatechange.us/ewebeditpro/items/O127F8927.pdf>.

20 "Compact Flourescent Light Bulbs" ENERGY STAR. <www.energystar.gov/cfm?c=cfls.pr_cfls>.

Montana offers an Income Tax Credit of up to $500 ($1000 per couple) for making new or existing Montana homes more energy efficient.[21]

New Homes. Here lies the opportunity to design buildings to use less energy from the start, using better insulation, siting to take full advantage of the sun, correct placement of windows, etc. Building in efficiency beyond current energy code requirements can reduce energy use in new homes 20-40 percent and make owners eligible for Montana Income tax credits. While investing in efficiency can increase some construction costs, other costs go down—a smaller furnace or boiler may be needed, and less air conditioning or none at all. The U.S. Energy Policy Act of 2005 includes a "$2,000 credit paid to the builder of new homes whose space heating and cooling energy consumption is 50 percent below the annual consumption of a home that is constructed to the standards of the IECC[22] and its supplements and current federal minimum equipment requirements."[23] Unfortunately few in Montana are taking advantage of this credit due to a low number of people qualified to certify buildings for the tax credit.

ENERGY EFFICIENCY MEASURES

For Residential Buildings

- Efficient lighting such as compact fluorescent bulbs
- Efficient appliances such as water heaters, refrigerators, air conditioners
- Multi-pane windows with low emissivity
- More insulation, particularly in the attic
- Shade trees

For Commercial Buildings

- Efficient lighting
- Efficient air conditioners and chillers
- Duct sealing
- Reflective roofing

Montana Energy Codes are currently being upgraded for both Residential and Commercial buildings and will be released in July of 2007 but compliance is spotty. Self-monitoring is the primary form of compliance. And even Montana's updated codes are weaker than those in Oregon and other states in the Northwest, which have a stronger public policy commitment to energy conservation. Codes for mobile homes, a national issue, must be improved. Banks are beginning to recognize that energy efficient homes and buildings cost less to operate over their lifetimes and have developed special mortgages for energy efficient houses to encourage the purchase of these types of homes.

Commercial Sector

Buildings and Operations. Office buildings, hospitals, universities, government buildings, commercial retail space, retail malls, and manufacturing plants all are major users of energy that can benefit from conservation and efficiency measures. A recent Department of Energy (DOE) funded study of "commissioning" (a highly cost-effective way to verify that a building is performing

21 <deq.mt.gov/Energy/NEEM_tax_credit.htm>.

22 International Energy Conservation Code

23 "Federal Tax Credit" Northwest Energy Star. <www.northwestenergystar.com/index.php?cID=433>.

as intended) concluded that "commissioning is indeed cost-effective for both new and existing buildings over a range of facility types and sizes, not only in terms of energy savings but also in savings from improved equipment lifetimes, reduced maintenance, fewer contractor call-backs, and other non-energy benefits". Nationally, building managers are hesitant to use commissioning because of the perceived costs. But the study showed that:

- Among existing buildings, commissioning cost a median of $0.27/sq ft, and yielded energy cost savings ranging from 7 to 29 percent, with a median savings of 15 percent, for quick payback times of 0.7 years. The median payback time for new buildings was 4.8 years, and when non-energy impacts were factored in, those payback periods were considerably reduced, often to zero.[24]
- Building design can yield great savings. A new interactive science center in Helena, ExplorationWorks!, was built to save 60 percent in energy costs. The new headquarters of the Northern Plains Resource Council in Billings is the first commercial office building in the state to qualify for Platinum Certification, the highest rating from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. This building consumes about 20 percent of the energy used by an "up-to-code" building of the same size. LEED is a voluntary certification for high-performance, environmentally friendly buildings.[25]
- Wasted energy not only adds pressure to build more polluting, centralized power stations and inefficient transmission lines, but the money that leaves a community to pay energy bills is gone forever. Investment in efficiency and conservation immediately plugs those leaks out of the local economy and creates local jobs. A serious commitment to a conservation economy would embrace and encourage the practices highlighted throughout this report.

Some of the actions that can save money and energy in the commercial sector are:

1. Computer simulation of existing individual commercial buildings, to initiate strategies for energy efficiency retrofits.
2. Efficient lamps and ballasts, including exit lighting.
3. More efficient air conditioners and chillers.

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24 Better Bricks is an initiative of the Northwest Energy Efficiency Alliance, a non-profit supported by the electric utilities throughout the Northwest. See Lihach, Nadine. "Meticulous Study Makes the Case for Cost-Effective Commercial-Building Commissioning" (Better Bricks. 2004).

25 The U.S. Green Building Council's website, <www.usgbc.org/LEED>, provides a full description of the LEED Certification Program.

4. Duct sealing and upgrading insulation.
5. Reflective roofing elements or a green roof (planted with vegetation).
6. Closer attention to heating and cooling cycles, turning systems down or off prior to a building's being vacated for the day.
7. Optimizing natural daylighting and "task-lighting" interior spaces instead of huge full-room lamps.
8. Production of photovoltaic (solar) energy in larger-footprint buildings.
9. Use of locally or regionally produced renewable resources—including foods and other materials—to minimize transportation costs and support local economies.
10. Cooperative strategies to use waste from one production stream as feedstocks for other production.
11. Government incentives for clean, energy-efficient commercial operations.
12. Landscaping around buildings and parking lots to provide shade and moderate summer temperatures.

Industrial Sector

Even though Montana does not have a huge industrial sector with respect to jobs, this sector (including coal-fired generation facilities—the largest emitter of greenhouse gases in the state) accounts for approximately one third of electricity consumption (532 avMW purchased) and a significant percentage of consumption of natural gas.

Cement production, smelting, mining, refining of silicon and various agricultural products, milling, coal burning and export, all have tremendous conservation potential. Colstrip, for example, whose coal-fired power complex is Montana's single largest emitter of carbon dioxide, could better utilize its waste process hot water to heat acres of greenhouses where food could be grown and carbon dioxide sequestered. In this case, further conservation would occur in reduced transportation costs, as the food would be grown closer to its end users.

Examples for energy saving recommendations for the industrial sector include the following:

1. Re-tooling whole industries with state-of-the-art motors, saving 10 to 20 percent in electrical consumption.
2. Altering time-of-day consumption cycles to reduce peak demand.
3. Sharing processes and off-puts (waste) internally or within collaborative

industries implementing what's known as *industrial ecology*[26].

4. Establishing and optimizing industrial waste exchange networks within the state or region, as well as co-locating facilities that may share the use of feedstocks, wastes, processes or transported goods.
5. Co-generation using waste heat to radically increase efficiencies.
6. Incorporating central district heating in areas where it is appropriate, such as industrial parks.
7. Better daylighting of industrial complexes to reduce lighting energy consumption.
8. Converting existing incandescent lighting to fluorescent or, better yet, Light Emitting Diodes (LEDs).
9. Using improved lubricants that can increase energy efficiency by 8-10 percent in motors and bearings.
10. Improving combustion technologies and fuel mixing.
11. Capturing waste or under-utilized resources that could be used as value-added alternatives for feedstock (e.g., fly-ash from coal plants that can be used as a substitute for energy intensive cement production).
12. Reducing the impact of *embodied* energy[27] in manufactured goods and construction materials by designing products for long life, durability and re-use/recycling.
13. Recycling and re-using existing process water to optimize water use in industrial applications.
14. Using concrete, asphalt or recycled glass regrind as aggregate.

Transportation Sector

Another major producer of greenhouse gases in Montana (approximately 18-20 percent) is transportation: 500 million gallons of gasoline and 373 million gallons of diesel fuel were consumed here in 2003. And transportation is expected to contribute the largest increase of greenhouse gases (GHG) by 2020, due to a projected 3 percent annual increase in vehicle miles traveled over the next 15 years especially from increased trucking of freight.[28]

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26 Industrial ecology is the shifting of industrial process from linear (open loop) systems, in which resource and capital investments move through the system to become waste, to a closed loop system where wastes become inputs for new processes. See Industrial Engineers for Industrial Ecology at <www.Ie4ie.org> or Indigo Development at <www.indigodev.com>.

27 Embodied energy is the energy consumed by all of the processes associated with the production of materials and equipment, from the acquisition of the natural resources to product delivery.

28 "Draft Montana Greenhouse Gas Inventory and Reference Case Projections." Montana Department of Environmental Quality. July 2006. p8. <www.mtclimatechange.us/ewebeditpro/items/OI27F8927.pdf>.

If American cars averaged 40 miles per gallon, which is technologically achievable and available in some cars today, oil consumption in the United States would go down as much as 3 million barrels a day from its current 21 million barrels a day. American autos are the only area of the American economy that is less energy-efficient than 20 years ago. Low gas mileage sports utility vehicles made up just 5 percent of the American fleet in 1990; today they make up almost 54 percent. Montana constitutes too small a market to directly influence decisions of automobile manufacturers, but Montanans can choose to buy the most energy-efficient vehicles available (including hybrid gas-electric vehicles and "plug-in" hybrids), reduce unnecessary travel around our vast and sparsely populated state, and maximize automobile efficiency through appropriate driving and maintenance[29].

Ultimately, the main tools for reducing consumption in the transportation sector are to **localize energy, food and materials transactions** (from production through processing to consumption and re-processing); design communities that require less driving for daily chores and job commutes; substitute ethanol and biofuels for gasoline and diesel; and make wise selections by purchasing highly fuel efficient vehicles.

Food travels an estimated 1,500 miles on average from farm to plate. Effective Buy Local campaigns can make locally grown food and other goods desirable, profitable and more available. Housing materials may travel much farther than food. Kitchen cabinets, for example, an easy product to build locally with local materials, are typically being shipped from China.

Requiring all gasoline sold in the state to be 10 percent ethanol would lead to the quickest decrease in gasoline consumption (10 percent or 50 million gallons a year) and, combined with other incentives, could stimulate a local ethanol industry (discussed in Chapter 3). Another incentive would be to require 2 percent biodiesel blend in diesel fuel (B2) be available.[30] Some cities (Bozeman, for example) have been using up to B20[31] and even B100 without ill effects in their city diesel fleet. Again, done right, this could kick-start a local biofuel industry; higher mileage diesel cars would join gas/electric hybrids as more fuel efficient choices for driving. The ubiquitous trucks, so important to Montana's agricultural and rural life style, could run, at least partially and someday completely, on homegrown fuel. Low-rolling resistance tires, properly inflated, can reduce fuel use another 5 percent or 25 million gallons.[32]

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29 Learn how to improve your miles per gallon at <www.fueleconomy.gov>.

30 Legislation first proposed in the Montana legislature, 2007.

31 20 percent biodiesel blended with regular petroleum-based diesel

32 A study done by the European Union cited by the New Mexico Climate Change Advisory Committee.

Incentives play a key role in any habit-changing scenario. Cheap oil has made us habitually inefficient drivers. How many stop to think that the fuel for a 20 mile round trip to the store for a gallon of milk can cost as much as the milk? There are a variety of incentives and disincentives, state and local government policies, that along with education about our fossil fuel use can stimulate significant reductions in consumption.

Some policies to implement:

1. Incrementally increase the **state fuel tax** across the board with revenue targeted toward travel alternatives.
2. Retrofit or replace governmental **fleets with more efficient vehicles**—hybrids, plug-in hybrids, flex fuel cars, etc.—and require use of biodiesel in government diesel cars and maintenance vehicles.
3. Inefficient vehicles could pay a **"Carbon Fee"** in addition to the state fuel tax.
4. Up-front fees charged on inefficient new vehicles or **"fee-bates"** credited to efficient new vehicles at the time of purchase would encourage sales of efficient vehicles, while discouraging sales of high fuel consuming vehicles. One example: in Washington, D.C. the City Council raised the excise tax to 8 percent on vehicles over 5000 pounds, at the same time eliminating the vehicle registration fee and 6 percent excise tax on clean fuel and electric/hybrid vehicles. Other versions give a permanent tax exemption to hybrid vehicles that get better than 40 mpg and rebates to low greenhouse gas emitting vehicles along with higher registration fees for vehicles with higher GHG emissions.
5. Require mandatory **inspections of exhaust systems** with respect to pollution and efficiency as a requirement for licensing a vehicle as is done in other states. (Not only are emission standards important for fuel efficiency, but they are becoming required by the Clean Air Act for airsheds in places such as Missoula and Flathead Counties.) An additional benefit from increased efficiency here is lower health care costs for the community.
6. Significant opportunities for reduced fuel consumption lie **in better land use planning** at the city and county level. Suburban sprawl adds a huge overall yet unspoken burden to society by sending much hard-won money to fuel producers elsewhere. For each mile a person must drive per day to town or work, there is a fuel-burden of 18 gallons per year (estimate for a 20 mpg vehicle). For a 50 lot subdivision 10 miles from town, where each household has two vehicles commuting an average of 20 miles each, this equates to a fuel-burden of approximately 36,000 gallons or about $90,000 at $2.50 per gallon. Compare this to the same subdivision placed one mile

from town or one-tenth the total at $9000 and 3600 gallons consumed. In this example $80,000 leaves the local economy. Our land use choices have large impacts, financial as well as environmental.

7. Reduce the **speed limit**. It was 55 miles per hour (mph) in the 1970s and 1980s. While it is true that some vehicles today are engineered to function very efficiently at speeds above 55 mph, it is also true that a general daytime speed limit below 70 mph could produce substantial fuel savings in the range of 15-20 percent per vehicle.
8. Provide information when registering vehicles and through driver education programs that describe the many ways paying attention to **driving patterns and vehicle maintenance** can greatly increase fuel economy.
9. Provide incentives and opportunities for people to buy vehicles with real-time **miles per gallon gauges** or to install such devices after purchase. Drivers of hybrid cars such as the Prius that show mpg in real time report they have altered their driving behavior to maximize savings. Others have reported friendly competitions with friends and family to see who can average the highest number of miles per gallon.

Neither mandates nor taxation are sufficient methods for accomplishing positive change. Education and leadership are needed. Better information showing the consequences for not taking action now will be key for encouraging positive action. Thoughtful community and statewide planning requires thoughtful leadership. The question remains, do we pay for efficiency changes now or, by doing nothing, pay an even greater price when energy costs soar?

Agricultural Sector

Cheap oil allowed farmers to buy low-cost fertilizer, pesticides and insecticides while the Farm Bill allowed them to produce below cost. But this era is ending. Agriculture is keenly impacted by rising energy costs and is a major contributor to Montana's greenhouse gas (GHG) emissions as well.[33]

Energy expenditures as a percentage of total production costs are highest in grain and oil seed production, 9 percent, and are likewise high in beef cattle ranching, 7 percent.[34]

Fertilizers and on-farm chemicals today depend heavily on fossil fuels, in both their manufacture and their delivery to farm and fields. Farms in Mon-

33 "Draft Montana Greenhouse Gas Inventory and Reference Case Projections". Montana Department of Environmental Quality. July 2006. p8. <www.mtclimatechange.us/ewebeditpro/items/O127F8927.pdf>.

34 Brown, Elizabeth and R. Neil Elliott. "On-Farm Energy Use Characterizations". American Council for an Energy-Efficient Economy. March 2005. p9. <www.aceee.org/pubs/052full.pdf>.

tana consumed 153 million gallons of diesel fuel in 2003, while electricity is a major cost in running irrigation pumps and motors used in processing.

Farm practices, inputs, tools, and machinery are all targets for improved efficiency and conservation. In the ranching community pasture and range land management practices offer opportunities for carbon capture. Conservation practices are already gaining a larger share of Farm Bill dollars. There is an increasing possibility that policies to cap carbon emissions will lead to a carbon sequestration market that provides an important role for agricultural lands.

Farmers and ranchers are quiet leaders in dispersed energy production and use. They are key members of Rural Electric coops in the state and also own land ideal for dispersed wind generation that can feed into local transmission lines. They have a wealth of experience and expertise developed from the installation and maintenance of many remote wells and livestock tanks using solar panels for pumping.

Likewise, there are many additional opportunities for energy savings and innovations.[35] Waste from livestock feeding operations can create methane which in turn can fuel small scale ethanol plants. A variety of crops can be processed for biodiesel to provide on-farm fuel and sold into local markets. If these plants are locally owned, dollars stay in the local community. (For more on this, see Chapter 3, Homegrown Fuels.)

It is well known that agriculture faces challenges attracting younger farmers and ranchers. There are many reasons but key is the difficulty making enough income to support a family while also investing in land, equipment, seed and livestock. Taking advantage of emerging social and financial incentives for low input farming and in farm-based energy production can help keep another generation to act as stewards of Montana's varied agricultural landscape, providing many other benefits to local communities, the state and the nation.

Understanding the full potential savings from efficiency in the agricultural sector is hampered by lack of data on farm energy use. One of the first tasks then is to gather more accurate data on the actual savings of installed energy efficiency measures.[36]

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35 American Council for an Energy Efficient Economy provides several publications of interest to agricultural producers. See www.aceee.org, search word agriculture. Examples include "Using GPS Guidance Products to Improve Energy Efficiency on the Farm", and "Reducing Energy Costs of Farm-Related Transportation", and "Using Solar Power in Grazing Systems and Capturing Energy Efficiency on Dairy Farms", etc.

36 Ibid, ACEEE. "Potential Energy Efficiency Savings in the Agriculture Sector", April 2005.

Other steps to take include:

1. Encourage production, and use, of **locally produced fuels** such as ethanol, biodiesel, and agricultural waste methane in motorized vehicles in the agriculture sector. Biodiesel fuel in particular, produced from local oilseed crops, is less polluting than diesel from petroleum sources, and not only could reduce farm production costs, but increase demand for an existing cash crop, and keep money in local economies. (See Chapter 3.)
2. Encourage **"no-till" or "reduced till" cropping**. This decreases the need to plow, which saves energy, builds soil health and potentially helps sequester carbon. Organic material is left in soil, thus carbon is kept in the ground instead of being released. However, energy and GHG savings are significantly lessened if chemical-intensive approaches are used rather than eliminating fossil fuels in the process. The Natural Resources and Conservation Service (NRCS) in Montana is investing $1,250,000 in no-till incentives in Fiscal Year 2007, primarily in eastern Montana.
3. Encourage **organic farming** practices, including the growing of nitrogen-fixing cover crops, which reduce the requirements of fossil-fuel-based fertilizers and herbicides. (Helping farmers switch to organic production will save even more in indirect energy consumption. Even existing organic grain production can gain efficiencies by organic minimum till methods.)
4. Determine **energy efficiency targets for irrigation pumps** and other motors used in agriculture, similar to the ENERGY STAR program. Provide policies and incentives to reach these targets. For example, an $18 million program in California focused on irrigation pump repairs led to a reduction of 83.6 megawatts of peak load. While reductions in Montana would not be this dramatic, this illustrates the potential for conservation.[37]
5. Encourage the use of smaller, more **fuel-efficient farm equipment**, such as tractors, trucks and other farm equipment where appropriate.
6. Encourage on-site **wind and solar generation** of electricity.
7. Follow the progress of research into thermal **gasification of biomass** ("wood gas" or "producer gas" which was used in Germany in WWII) for decentralized fuel/power production and search for ways to apply the research to Montana agricultural practices. Low grade grain screenings, straw, spoiled grain and other biomass sources may also expand the range of

37 Brown, Elizabeth, R. Neil Elliott, and Steven Nadel. "Energy Efficiency Programs in Agriculture". American Council for an Energy-Efficient Economy. January 2005. p 92. <www.aceee.org/pubs/ie051full.pdf>.

where this technology could be deployed. Currently, research is being conducted at Montana State University Northern in Havre.[38]

8. Research and implement **solar drying** of certain crops, instead of using natural gas.
9. A more long range goal would be **electrolysis of reservoir water** (by renewably generated electricity) into oxygen and hydrogen, once storage and effective on-site or **local use of hydrogen fuel** becomes more economically viable.

Using less fossil fuel derived inputs and creating more fuel and electricity close to the end user leaves Montana less vulnerable to oil supply and price shocks, and strengthens local economies. Of course, energy conserving practices in farm and ranch homes and outbuildings, as discussed in the Commercial and Residential sections, will also save dollars for farm families and businesses.

HOMEGROWN CONSERVATION AND EFFICIENCY

A low-profile house subtly alters a ridgeline east of Lavina, Montana. The house overlooks the Musselshell River to the south. To the north is a long view over rolling prairie toward the Big Snowy Mountains. From a distance this house looks unremarkable. Even close up it looks quite normal. But it is an example of what can be accomplished in Montana through energy efficient design.

A visitor notices that what initially looked like a one-story house is actually two stories, with the bottom floor dug into the ridge. Two stories face south, windows drinking in sunlight. On the upper floor few windows face any direction but south.

Inside the house, one notices all windows are modest in size and double paned, graced with insulating curtains or shades. The visitor must pay close attention to perceive that the walls are one foot thick. This is a super-insulated structure, from ceiling to floor.

There are baseboard electric heaters, but they rarely kick in. By day there is some “solar gain” through those south windows, but mostly what keeps this house warm is heat thrown off by electric lights, refrigerators, freezers and other appliances, and heat from the bodies of people and pets sitting or moving around —“waste heat” this is called, but the thick walls of this house do not let it go to waste.

38 Research by Ron Carter, phone 406-283-1830.

This house appeared in the 1980's on a working hay, sheep and cattle ranch. Since then many houses have sprouted on ridgetops around Montana, many of them not truly ranch houses, many of them far from modest in size, many of them inhabited only part of each year. Some of them jut up into wind, tall windows facing the view—ignoring the sun. Some give only a nod to insulation, relying instead on energy-intensive heating, usually from propane or natural gas. While this probably is not the owners' intention, consumption is conspicuous, and seems to imply that the more energy a building consumes, the wealthier its owners are.

But are people who live in a super-insulated ranch house outside Lavina, and pay virtually no heating bills, any less wealthy? There is another way to measure wealth, based not on how much is consumed but on how much is conserved. What if we refuse to be defined merely as consumers? What if, instead, we call ourselves conservers?

What's the difference between conservation and efficiency? Efficiency sounds more active. Efficient motors, efficient light fixtures, efficient vehicles, efficient heating systems all convey a sense of doing something well. Conservation conveys a sense of doing nothing—or rather, not needing to do something. Conservers are efficient consumers. Why? They have designed their houses, towns, lives effectively. If efficiency is "yes, please" then conservation is "no thanks". We need both the yes and the no.

Yes, to replacing standard incandescent light bulbs with compact fluorescent lights (CFLs). CFLs produce the same amount of light using 66 percent less energy. Even though a CFL costs more, it can last up to ten times longer. Replacing four 75-watt incandescent bulbs in your home that burn for two or more hours a day with comparable 23-watt CFL bulbs will save around $200 over the life of the bulbs. If every household in Montana would install just one CFL bulb, especially where bulbs are left on for four hours or more a day, we would conserve enough electricity to light more than 7,000 homes and prevent greenhouse gases equivalent to the emissions of nearly 2,700 cars. Just one light bulb per household![39] Imagine what we could save by using CFLs in commercial and industrial buildings too!

> THERE ARE TWO WAYS TO MEASURE WEALTH:
> BY HOW MUCH WE CONSUME
> OR HOW MUCH WE CONSERVE.

Just say no to leaving the lights on—any lights, CFLs or incandescents—when you leave a room. No to TVs, computers, etc. left on when not in use.

39 Compiled from information from the U.S. Census Bureau and the U.S, Department of Energy at <www.energystar.gov>.

Even when the power switch is turned off, TVs, VCRs, DVD and CD players, and cordless phones with built-in display clocks, memory chips and remote controls account for 5 percent of total U.S. electricity use.[40] This costs consumers more than $1 billion per year. Putting such equipment on a power strip that can turn them completely off is a great energy saver.

Yes, to installing insulated shades or curtains.

Yes, to raising them on a winter day and lowering them at night.

No, to cranking up your thermostat to 75 degrees in cold weather.

Yes, to leaving it at 65 and putting on a sweater.

Yes, to setting it at 55 at night or when you go away for a few days. (You'll save 5 to 20 percent on heating bills.)

Yes, to using ENERGY STAR rated appliances and CFL bulbs.

Yes, to using warm or cold water for your laundry instead of hot. And when it's warm outside, why not let the sun and the wind dry your clothes instead of an electric clothes dryer?

SENSIBLE SOLAR

The real lesson of the U.S. excursion into alternative energy in the 1970s and '80s was that conservation and energy efficient structures are where the real savings are. Solar heating systems are highly ineffective for heating drafty barns, but very successful in energy efficient homes.

Another lesson of the '80's is that the key component in any energy system is the user. In one study of 100 homes in the Denver area where $2,000 was spent on winterizing, more than 50 percent of the utility bills went up! The people were no longer worried about conserving energy, and became careless. Energy-conscious owners of apartments often have to plead with tenants to open the drapes on south-facing windows on sunny winter days or set their thermostats to turn down at night or when they are away from home.

> WHAT IF WE REFUSE TO BE DEFINED AS PASSIVE CONSUMERS?
> WHAT IF WE DEFINE OURSELVES AS ACTIVE CONSERVERS?

Basic education is needed in any building or energy program to help people understand the concepts of energy efficiency and conservation as well as the unintended consequences—environmental and economic—of wasting energy.

40 Alliance for Safe Energy. "Take the 6 Degree Challenge". <www.sixdegreechallenge.com>.

Passive Solar[41] combined with sensible building practices is the most cost effective use of the sun's energy in home heating. The key, at least in a northern climate like Montana's, is simply to put the majority of the windows on the south side of the building. Windows on the south gain heat (and of course with the use of insulated curtains or shutters help retain heat at night). Windows on the east and west as a rule come in about even in energy loss and gain. Windows on the north side are a net loss. Simply designing the home with this in mind can reduce energy consumption by 25 percent.

Large windows need to be balanced with an interior thermal mass system to absorb the incoming BTUs[42] so the sun's energy can be used in the evening but not overheat the home during the day. Incorporating these concepts into a "better building practice" program, perhaps based on LEED standards (see footnote 25 on page 19) combined with mortgages that reward energy efficient buildings, may be the best ways to start making passive solar design commonplace.

Passive solar is still largely ignored by builders due to their basic training to install a mechanical solution instead of accommodating to existing conditions. But passive solar is becoming more and more appealing to consumers because of its comfort and energy cost efficiency. Combine passive solar with super insulation (which means insulating the home to the point where the only real heat loss is required air exchange) and integrate other common sense strategies, such as strategically locating a water tank to preheat domestic hot water or tempering fresh air by bringing it inside only after it passes through a pipe buried in the ground, and energy bills go down as comfort goes up.

While passive solar and super insulation may not sound like strong investment incentives, the Environmental Protection Agency (EPA) has found that a home's value rises an average of $20 for each $1 decrease in the annual utility bill. Look at this situation in reverse: say that a home's value goes down $20 for every $1 rise in the annual utility bill. Recent price increases have sent utility bills up by as much as $1500 or more per year: 20 times $1500 equals $30,000. Figures like that make sensible solar and super-insulation even more attractive.

Active Solar[43] systems fall into two main categories, photovoltaic and

41 Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces where the orientation, design and materials in the home all moderate temperatures without the use of mechanical systems or non-renewable energy input.

42 British Thermal Unit—a measurement of heat.

43 Active solar systems convert the sun's energy to electricity or use various types of solar collectors that heat air, water or other fluids, and disperse this heat mechanically.

solar hot water. Photovoltaics—electricity produced with solar panels—will be discussed in Chapter 4 in more detail.

Domestic hot water (DHW) is the most cost-effective application of active solar, yet it is not used extensively. For $3,500 to $5,000 one can purchase an **evacuated tube solar hot water system** that will supply approximately 75 percent of the hot water needs of a family of four. Domestic water heating averages $350 to $450 a year, with a purchase/installation payback of 10 years or less on a typical residence. Combine this with available federal and state tax credits and the payback becomes very reasonable. Remember also the payback in real estate value, even if it's likely the home will be sold in less than 10 years.

For home heating, combining a solar hot water heating system with **floor radiant heating** can achieve efficiencies of 50 to 60 percent.[44] This is quite a high efficiency since sunlight, the resource that feeds it all, is free.

MEETING OUR REAL NEEDS

A sound economic policy recognizes that as access to energy and material resources declines, strategies for conservation and efficiency need to be already in place. Otherwise, paying for them later may be difficult or even impossible, since the cost of efficiency (for example, insulated windows) is tied to the cost of energy and as energy prices escalate, money gets tighter. It is better to invest now and live efficiently than to squander energy and pay dearly for essential improvements later.

> We need to create a sustainable way of life beyond fossil fuels. Replacing what we use now is not the question; the question is, what are our real needs and how do we fulfill them?

We must also be wary of optimistic solutions such as "the hydrogen economy" or "clean coal" technology, which may not turn out to be realistic for handling (or replacing) our current life style—nor even realistic for reducing greenhouse gas emissions. "Clean coal" has yet to prove itself, needs massive financing and is years from widespread practical implementation. Hydrogen, when derived from fossil fuels (and not from water electrolyzed via renewable energy sources), is very inefficient and ultimately polluting; cost-effective storage and transportation also are issues.

Our present excessively consumptive life style can be sustained only as long as energy is cheap and abundant. However, every indicator—especially at the gas pump and in monthly electricity and heating bills—suggests that

44 The initial cost of installing radiant heating is somewhat higher but heating solid surfaces or materials instead of air is a far more efficient heating system.

traditional fossil fuel based energy is neither cheap nor abundant. We need to find new ways to create a sustainable way of life beyond fossil fuels, and this is our ultimate quest.

Technology alone will not rescue us from our excesses; in fact, embracing technology, without considering long term consequences, is one way that we create our excesses. Therefore, replacing what we have now is not the question; the question is, what are our real needs and how do we fulfill them? How do we live in harmony with Nature, maintaining a healthy environment and viable economy, while preserving for future generations the possibility of living as well as we, at our best, live today?