CHAPTER 3:
Homegrown Fuels

GOAL: BY THE YEAR 2020, AS ENERGY EFFICIENCY AND CONSERVATION PRACTICES LOWER PER CAPITA DEMAND FOR FUELS, TO SUPPLY UP TO 50% OF MONTANA'S TOTAL TRANSPORTATION FUEL NEEDS (ON ROADS AND FARMS) WITH ETHANOL OR BIODIESEL PRODUCED IN-STATE IN DECENTRALIZED FACILITIES; TO CREATE A VIABLE SYSTEM FOR DISTRIBUTING THESE FUELS IN-STATE; TO PHASE OUT COAL-GENERATED ELECTRICITY AS A "BASELOAD" SOURCE FOR IN-STATE ELECTRICITY CONSUMPTION; TO HARVEST AND USE FOREST-BASED FUELS SUSTAINABLY; TO SET UP A PILOT PRODUCTION FACILITY USING RENEWABLY GENERATED ELECTRICITY TO ELECTROLYZE WATER AND PRODUCE HYDROGEN FUEL.

A VARIETY OF FUELS—AND USES

The majority of fuels used today in Montana are fossil fuels: coal, oil, natural gas. With rising costs and declining availability, and with the inherent problems with burning such fuels—pollution and global warming—it's time to look at some homegrown alternatives for transportation, electricity production and heating. Montana's agricultural base and the common sense ingenuity of the people who live here offer fertile ground for developing clean, sustainable options.

Fuels include liquids (such as gasoline, heating oil, diesel fuel, biofuels), gases (natural gas, hydrogen, biogas) and solids (primarily wood and coal). Fuels are often used to produce other forms of energy, such as electricity. In conventional power plants this process remains rather simplistic: coal or natural gas or wood is burned to heat water to steam which then spins turbines. In Montana the primary fuels used today are coal (mainly for electricity generation but in some places for space heating), petroleum distillates like gasoline, diesel fuel, aviation fuel, lubricants, etc (used for transportation and heating) and natural gas (used in Montana primarily for space heating and cooking).

Many of these fossil fuel uses could be readily replaced by biofuels or other renewable alternatives—for example, biodiesel instead of petroleum-based diesel or electricity generated not by coal but by wind, solar, small hydro, or by methane derived from anaerobic digestion of organic materials.

Fuels Producing Electricity

Electricity generation and consumption are discussed in Chapter 4 of this *Blueprint*, but it is useful here to note that nearly two-thirds of Montana electricity today is produced from the burning of fuels. In 1986 coal overtook hydropower as the number one source of electrical generation, and since then coal has gradually risen to hover around 60 percent of Montana's generation, with petroleum and natural gas accounting for less than 3 percent.[45] Large scale hydropower now ranges between 33 and 38 percent, and wind power suddenly became a factor in 2005, as the Judith Gap wind farm and several other smaller installations came online.[46] From almost zero, wind power suddenly accounts for 2.5 to 3 percent of electrical production in Montana.

However, wind power needs "firming"—that is, backup power for when the wind is not blowing. Natural gas is a responsive fuel that can be used for quick activation so it has been used frequently for that purpose. There are scattered local projects underway in Montana designed to "firm" small scale wind power as well as small scale solar with micro-hydropower facilities or with generators powered by a renewable fuels such as biodiesel. (Firming is discussed in greater detail in Chapter 4.)

Fuels for Heating

Heating is critical to life; people heat water to steam not only to spin turbines, but also to send steam hissing through pipes and radiators in buildings; we heat water for baths, showers, to wash clothes and dishes, to cook; we heat spaces; we use heat in industrial processing. We do all this with a variety of fuels.

Natural gas is the main fuel used in Montana for space and water heating and for cooking, but since it is also in greater and greater demand for fueling power plants, its price has risen sharply. Propane is widely used in rural areas or towns lacking natural gas lines.

Biogas can replace natural gas in space heating for homes and businesses or provide process heat for industry. Biogas is produced by bacteria in anaerobic (without oxygen) fermentation of organic matter in a very simple process. Anaerobic bacteria digest just about anything containing carbon: manure, human waste, lawn clippings, agricultural and food processing residues—even automobile tires. Converting septic tanks to biogas digesters could supple-

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45 Montana Public Service Commission sources and "Energize Montana" <www.deq.mt.gov/energy/index.asp>, 2006.

46 Montana Public Service Commission sources, various news reports, and "Energize Montana" <www.deq.mt.gov/energy/index.asp>.

ment ever more expensive propane or petroleum-based diesel fuel for space heating in thousands of rural and suburban homes. A homegrown industry could result from manufacturing and installing biogas digesters geared to individual homes or to larger commercial buildings.

> Every ten-cent increase in the price of gasoline or diesel costs the Montana economy $87 million. We could stop sending these payments out of state and invest them in fuels grown here at home.

Many Montanans still heat their homes with a renewable resource: wood. However, this practice has dwindled in recent years, in part due to restrictions in valleys such as Missoula where smoke from wood fires can lower air quality. A number of schools in Montana are realizing significant savings by converting heating systems to burn residues from logging or forest thinning. U.S. Forest Service grants helped pay for the installation of a number of wood-fired boilers, which is a significant public subsidy, but one that arguably could improve public forest lands, and certainly can help communities and schools in forested areas. The abundance of woody material that must be removed from the forests to reduce fire risk and improve forest health suggests a long-term supply, abundant and cheap. Much of this "wood slash"—the material now being used as fuel—formerly was considered waste and was simply burned on site.

Fuels for Schools

The full name of this program, run in six states by the U.S. Forest Service, is Fuels for Schools & Beyond.[47] Its purpose is to encourage not only schools but prisons and other public institutions to install heating and sometimes power systems that use woody biomass as their fuels.

Twelve Montana locations by 2006 had Fuels for Schools projects in various stages. Darby, Montana, was one of the first schools in the program, and Darby Mayor Rick Scheele projects that burning around 750 tons of wood chips will cut the local school district's heating costs by 82 percent, down to $18,000 a year.

Depending on the site, installation costs can be recovered within three to 15 years.

The program cuts down on some of the smoke and other pollutants that fill the skies from the burning of an estimated one million tons of logging waste and other woody biomass in Montana each year. That's enough to fuel 1,300 Darby-sized projects.

47 "Fuels for Schools...and beyond: Woody Biomass Utilization Program". DNRC Forestry Division. <www.dnrc.mt.gov/forestry/Assistance/Biomass/default.asp>.

The program has attracted controversy. Some forest experts believe that too much thinning has occurred, and they question the long-term sustainability of this fuel resource. Missoula forester Dave Atkins addressed these concerns like this: "We want to manage forests to retain woody debris as habitat for forest creatures and as nutrients, but not let it build up in ways that lead to atypical fires"—fires can get so hot that the duff, the partly decayed organic matter on the forest floor, also burns.[48] That puts vast amounts of CO_2 into the atmosphere, adding to global warming, and erosion is greater after a fire if the duff burns. More stream sedimentation and landslides generally occur where the forests that have not been thinned catch fire and burn intensely.

"Since the duff has a lot of the nutrients, we want to keep those nutrients from flowing (or burning) out of the system," Atkins said. These days Forest Service crews typically leave some dead snags, woody debris, larger trees, and other materials that hold moisture longer during the summer. Trees also hold moisture which, when released, creates rain in areas downwind from a forest. This helps prevent those areas from becoming overly dry. Tree roots also clean sediment salts from the ground water, helping to keep it usable for drinking and irrigation.

"Sustainability is the name of the game," according to Atkins. He believes that "we can sustain our forest eco-systems through prudent thinning, which in turn reduces the amount of high-severity fires. We can use the material removed to sustain our communities and economy." Assuming it is not overdone, Atkins hopes Fuels for Schools will provide renewable energy from a reliable source for years to come.

Fuels for Transportation

The present source of liquid fuels used in Montana is primarily petroleum. Set against the Test Criteria for Energy Resources (see Chapter 1, page 6), petroleum is unsustainable, polluting, and its economics (controlled by large multi-national corporations) place Montana in a less than tenable position as net financial benefits travel a one-way freeway out of state.

Transportation is the largest consumer of petroleum in Montana and in 2003 was the second largest sector of all forms of energy use in Montana. In 2004 gasoline sold in Montana totaled about 500 million gallons, with diesel sale totaling 220 million highway gallons (taxed) and 153 million "farm"

48 Doty, Russ. "Sopris Conference Highlights Fuels For Schools Program". AERO Commentary on KUFM public radio, Missoula. July 27, 2006. <www.aeromt.org/kufmDoty%20July06.php>.

gallons (untaxed).[49] Gasoline and diesel sales include all retail sales to Montana residents, to visitors, and to truck and railroad traffic passing through the state.

Consumption of transportation fuel in Montana has fluctuated with changes in the national economy, prices, and energy policy. For example, gasoline sales peaked in 1978 at about the same level as in 2004. **Figures show that nearly $1.5 billion leaves Montana's economy yearly to pay for petroleum-based fuel**.[50]

Oil companies in Montana pump about 19 million barrels of crude oil per year (one barrel of petroleum, abbreviated bbl, is 42 gallons)[51]. Montana experienced its "Peak Oil" moment in 1968, when crude oil production peaked at 48.5 million bbl and has been declining since, despite higher prices. Four Montana refineries, three in the Billings area and one in Great Falls, process about 181,000 barrels of crude oil per day. Because of the location and destinations of pipelines carrying crude oil and pipelines carrying finished product, most of the crude pumped in Montana actually is refined out of state, while most of the crude supplying Montana refineries comes from Alberta (75 percent) and Wyoming (20 percent). Of the crude oil refined in Montana, oil companies ship 55 percent of the final product out of state.[52]

Despite this state's oil pumping and refining industry, multinational corporations, foreign countries and our own federal government operate in global markets to determine the prices that Montanans pay for transportation fuels. Increasing prices drain the Montana economy, especially the agricultural sector. Price increases in gasoline and diesel during the year 2005 drained an additional $375 million dollars out of the Montana economy[53]. This transfer of wealth is the same as a tax that creates no jobs (except for a small increase in oil exploration), that funds no public services, that builds no roads. Over the course of 2005, the average gasoline price in the Rocky Mountain region in-

49 Figures on gasoline and diesel sales are from the Montana Department of Transportation; links on their website get you to gasoline and diesel sales numbers.

50 This is a simple calculated value: gasoline and diesel sales times price increase. Calculations by Cliff Bradley.

51 "Petroleum and Petroleum Products in Montana". Department of Environmental Quality Report. <www.leg.state.mt.us/content/publications/lepo/2005_deq_energy_report/petroleum.pdf>.

52 "Understanding Energy in Montana: A Guide to Electricity, Natural Gas, Coal, and Petroleum Produced and Consumed in Montana" and "Petroleum and Petroleum Products in Montana". Department of Environmental Quality Report. <www.leg.state.mt.us/content/publications/lepo/2005_deq_energy_report/petroleum.pdf>.

53 U.S. Department of Energy, Energy Information Administration. <www.usdoe.gov>.

creased by 47 cents and the average diesel price by 38 cents.[54] Prices continued to rise briskly throughout most of 2006**. Every increase of one dime in the price of gasoline and diesel costs the Montana economy $87 million.**

Instead of sending our fuel payments to multinational oil companies, out of state, we instead could spend that money at home, buying renewable fuels derived from plant material – biofuels[55] —to the benefit of Montana's economy.

THE CASE FOR BIOFUELS

Two liquid fuels are derived chiefly from plants: ethanol and biodiesel. Since they substitute almost directly for fossil-based liquid fuel, they are used for agricultural and industrial processes and for space heat, but most prominently for transportation.

ETHANOL is produced from any carbohydrate: sugar, starch or cellulose. Starch or cellulose is first converted to simple sugars using enzymes, then ethanol is produced by fermentation with yeast and distilled to purify the final product. Most gasoline engines can be readily converted to run on E85 (85 percent ethanol, 15 percent gasoline) and many new cars come with dual fuel capability. Brazil is the unquestioned world leader in the use of ethanol, made chiefly from sugarcane, and in Brazil virtually all vehicles now are built to run on 100 percent gasoline, 100 percent ethanol, or any combination in between. Fueling stations offer all these choices.

BIODIESEL can directly substitute for petroleum diesel. Biodiesel is produced by extracting the oil from oil seeds. In Montana we use canola, safflower, flax or new crops such as camelina, and then convert the triglycerides in the vegetable oil to single chain fatty acids in a very simple process. Thus, ethanol and biodiesel can replace gasoline and diesel as primary transportation fuels and—properly implemented—could comply with AERO's Test Criteria.

Replacing gasoline with ethanol. Replacing all of the gasoline sold in Montana in the year 2004 with E85, a blend of 85 percent ethanol, 15 percent gasoline, would require about 425 million gallons of ethanol per year.[56] A significant fraction of this ethanol can come from starch or sugar based feedstocks. Current levels of feed barley production and low value starch (off spec

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54 Ibid.

55 See <www1.eere.energy.gov/biomass/abcs_biofuels.html> for more information on all biofuels.

56 This is calculated from gasoline and diesel sales data from the Montana Department of Transportation (see footnote 49) and from price data for the Rocky Mountain region from U.S. DOE (see footnote 53). Calculations by Cliff Bradley.

malt barley, malt house residue, grain elevator screenings, etc.) could supply about 80 to 100 million gallons.

If the price of sugar in the U.S. declines to world levels because of implementation of the Central American Free Trade Agreement (CAFTA), current Montana sugar beet production could supply an additional 50 million gallons. (For a sugar beet farmer, the per acre return of sugar beets for ethanol is about the same as the current, pre-CAFTA value of sugar beets for sugar, when ethanol is at $1.70 per gallon.)

Where could the rest of the ethanol come from? Over the past twenty years, a number of studies in Montana and neighboring states have evaluated the availability and conversion cost of cellulosic biomass[57]. Potential Montana sources include pulp and paper mill waste, agricultural residues (sugar beet pulp, etc.), wheat and barley straw, forest residue and perennial grasses grown as energy crops. The principal limiting assumption in all of these studies is the cost of collecting this biomass, evaluated against retail gasoline prices of less than $2.00 per gallon.

One half of the wheat and barley straw in Montana could produce 280 million gallons of ethanol per year. On most grain farms, half of the straw is now removed from fields for disease management, which would not affect its potential use for biofuels. Perennial grasses grown on Conservation Reserve Program (CRP) land with minimal inputs and with net improvement of soil fertility and erosion control could provide twice as much.

> Biofuels can be produced sustainably and profitably on a family farm or a community scale that can boost rural economies.

Replacing petroleum diesel with biodiesel. Biodiesel yields vary with the crop and climate, but Montana has sufficient land in current production to supply the state's entire diesel demand. Montana has about five million acres in wheat production in any given year and at least an equal acreage in rotation crops. In many cases, oil seed crops provide an excellent rotation crop. Montana used to grow two million acres of flax for fiber and linseed oil. At $2.50 per gallon to a farmer, crops grown for biodiesel would exceed the income from dry land wheat in a typical year.

Co-ops or other farmer-owned groups could set aside a certain fraction of their land for biodiesel crops to displace petroleum-based diesel for on-farm use. (By 2006 many individual farmers around the state were doing just that.) It makes economic sense.

57 Cellulosic biomass—plant material that previously was considered too difficult to break down into simple sugars for biofuels production. See Chen, Chengci. "Cellulosic Biomass for Ethanol and Cropping Systems for Bioenergy". Montana State University. <www.harvestcleanenergy.org/conference/HCE5/HCE5_PPTs/Chen.pdf>.

Here is why Biofuels should assume a prominent—and immediate—role in Montana energy policy:

- Biofuels can replace a significant fraction of petroleum fuels in the short term—certainly in a much shorter time frame than coal-derived synfuels[58]. The technologies are proven, immediately available, can be brought on line in manageable increments. They are not capital intensive and employ more people per unit of capital investment than fossil energy technologies, and employment is not restricted to large centralized production sites. (See case study in Chapter 5.)
- Montana has sufficient resources to replace all of the retail gasoline and diesel fuel sold in the state in 2004 without adversely affecting soil fertility or cropping practices.
- Currently, biofuels compete economically with gasoline and diesel at retail prices (including taxes) above $2.50 per gallon. Well designed ethanol projects using low value or waste carbohydrates and biodiesel from waste cooking or processing oil are fully competitive at even lower retail prices.
- Burning biofuels does not increase greenhouse gases. Biofuels are made from real time carbon fixed by crops from atmospheric CO_2. Biofuels do not release fossil carbon that has been stored underground for millions of years.
- Integrating biofuels with agriculture will strengthen Montana's rural economy by adding value to Montana crops and keeping the value added from energy production in the local economy. A bushel of barley sold for feed brings about $2.00; converted to ethanol and high protein livestock feed it is worth over $5.00.
- Biogas and biomass fuels are cost competitive with natural gas as boiler fuel at many locations in Montana.

CELLULOSIC ETHANOL CONVERSION TECHNOLOGY IS HERE

- Iogen Corporation has proposed a 50 million gallon per year straw-to-ethanol plant in eastern Idaho.
- Montana Microbial Products (a Missoula based company) with funding from the Oregon Office of Energy has developed a process for ethanol production from grass seed straw—which in the past has simply been burned. The company estimates that this process could produce about 20 million gallons of straw-derived ethanol per year at an operating cost of about $1.20 per gallon.

58 Synfuels—in this case, diesel fuel derived from coal by the Fischer-Tropsch process of gasification and catalytic conversion.

BIOFUELS: ANSWERING THE CRITICS

Critics contend that biofuels (1) require more energy input than they yield; (2) divert crops from food production to fuel production and promote unsustainable industrial agriculture; (3) subsidize large agribusiness companies such as Cargill and Archer Daniels Midland (ADM).

And the critics may be right, if we simply replace Exxon-Mobil with ADM in fueling freeways full of single passenger SUVs. However, there is a fundamental difference between fossil fuels and biofuels. Unlike fossil fuels, biofuels can be done right without huge expense and without environmental degradation. With an efficient transportation system and sound energy policy, biofuels can replace fossil fuels, and do so sustainably.

Net energy? The debate about the net energy yield of ethanol is based on studies by two researchers, studies which have received a lot of publicity, but which used faulty assumptions and old data to conclude that ethanol's energy yield was negative. Other studies by, among others, the U.S. Department of Agriculture (USDA), U.S. Department of Energy (DOE), Argonne National Laboratory, and the Rocky Mountain Institute all show strongly positive energy yield.

Energy quality is the real issue: internal combustion engines won't run on straw, canola, unrefined crude oil, or lumps of coal. Mobile engines require high density liquid fuels, and low value fuels cannot be converted to high value fuels without expending energy. **The Rocky Mountain Institute estimates fossil energy input per unit of output for gasoline at 1.23 to 1.00, corn-based ethanol 0.74 to 1.00, and cellulose-based ethanol at an impressive 0.20 to 1.00.**[59] Biofuels have an advantage: their primary energy input is solar, in the form of fixed carbon in sugar, starch or cellulose, and production processes require only relatively low quality energy inputs which can come from non-fossil fuels such as biogas, process by-products or integration with co-generation or other process sources.

Displacing food crops? Biofuels production does not do this. This is not a simple issue of corn-to-ethanol taking away corn-as-food for poor countries. Hunger in the world is a function of poverty, not lack of food. Poverty is a misallocation of resources; in poorer countries much of the land that could grow food for local people instead is devoted to growing export crops. Meanwhile, in wealthier countries much of the land is devoted to crops grown for livestock feed—which is true of corn in the United States.

Montana does not grow much corn, but does grow a lot of barley, which also is used mainly for livestock feed. Thus, barley-to-ethanol has a similar

59 Glasgow, Nathan and Lena Hansen. "Setting the Record Straight on Ethanol: Focusing on the Nexus of the Agriculture and Energy Value Chains." <www.rmi.org/sitepages/pid1157.php>.

minimal impact on the human food supply as corn-to-ethanol. Converting sugar beets to ethanol would displace sugar produced in Montana for human consumption; however, as previously pointed out, if the rules of CAFTA are actually enforced, this would reduce government subsidies to the U.S. sugar industry. If this happens, converting sugar beets into ethanol may be the only way for certain Montana farmers to make a living.

Other issues are embedded in this discussion: low commodity prices, overproduction of certain crops in the U.S., subsidies for crops like corn, and the U.S. practice of dumping commodities on poor countries. A Mexican agricultural economist recently wrote an article contending that if the entire U.S. corn crop were converted to ethanol, this would be the best thing that could possibly happen to rural Mexico, because the U.S. would stop dumping its subsidized corn on Mexico. This occurs under the rules of NAFTA, the North American Free Trade Agreement, and unintended consequences result from this practice. The flood of U.S. corn undercuts the price of Mexican corn; this forces Mexican farmers to leave their land to find work in cities, and many of them head north looking for work in the U.S.

This analysis holds true for a number of U.S. crops—cotton, for example. If farmers in the U.S. replanted their cotton land with perennial native grasses, as feedstock for ethanol, this would end the dumping of government-subsidized cotton. World prices for this commodity would not be forced down, and cotton farmers in Africa and India would benefit. So would the American taxpayer.

Montana grows no cotton, but taking marginal lands now producing annual monoculture crops like dryland wheat, and replanting them with mixed native perennial grasses, could work to Montana's advantage. The land could be used for livestock grazing, which properly done will stimulate plants to grow, and then in a rotational regime the plants could periodically be harvested as cellulosic feedstock for ethanol.

A ten-year, on-the-ground study[60] led by David Tilman, professor of ecology at the University of Minnesota, shows that mixed native perennial grasses and other flowering plants growing on degraded lands could provide more usable energy per acre than either soybean-based biodiesel or corn-based ethanol.[61] Perennial prairie plants have many benefits. They require little energy to grow, and all parts of the plant above ground are usable. They reduce global

60 Reported in the December 8, 2006, issue of the journal, Science. This research was supported by the University of Minnesota Initiative for Renewable Energy and the Environment and by the National Science Foundation (NSF) and since 1982 has been conducted at Cedar Creek Natural History Area, an NSF Long-Term Ecological Research site (<www.lter.umn.edu/>).

61 Considering inputs, perennial plants on this marginal land are producing 51 percent more energy per acre than corn on fertile land. But this, of course, is Minnesota, with differnt soils and climate than Montana.

warming by removing carbon dioxide from the atmosphere, and do so far more effectively than annual crops like corn and soybeans. They store far more carbon in their roots and in the soil than is released by the fossil fuels needed to grow them and convert them into biofuels. And they renew soil fertility, clean up surface waters, preserve wildlife habitat, and yield higher net income for farmers and ranchers.

Industrial agriculture? Replanting marginal Montana crop lands to perennial grasses would signal a movement away from, not further into, fossil-fuel intensive, chemical-intensive industrialized agriculture. It would re-value Montana grasslands that have been devalued as sources of high quality livestock feed by subsidized crops, like corn. However, Montana farmers will continue growing grains, legumes and oilseed crops on both irrigated and dryland acres, and more and more are likely to convert a portion of these into biofuels. The impact on food production will be minimal and besides, farmers need rotation crops to keep their soils healthy. They also, arguably, need livestock.

Integrating livestock and crops is crucial to the economic viability of biofuels production, and again, this moves away from the monoculture patterns of industrialized agriculture. Ethanol production removes the starch, leaving a product containing the original protein and therefore, the livestock feed value. Converting corn, barley or other crops to ethanol depends on obtaining value from this protein co-product by feeding it to livestock. (See diagram: Integrated Agriculture Biofuels System, page 45). None of these actions subsidize large agribusiness corporations, if done on an appropriate local scale.

Undercutting Corporate Control

Large agribusiness corporations receive massive subsidies, and because they exert enormous control over agricultural policy in the United States, they could end up controlling biofuels. But this does not have to happen.

Minnesota enacted policies that effectively limited the size of ethanol plants, and promoted farmer-owned cooperatives for ethanol production. This prevented a single large ethanol producer such as Archer Daniels Midland from monopolizing ethanol production in that state.

Now farmers are making money, rural economies are growing, and more than 200 gas stations in Minnesota are selling E85 (85 percent ethanol, 15 percent gasoline) at the pump. Citizens can ally themselves with family farmers and demand public policies that work for a sustainable future.

As noted before, most corn grown in the U.S. is used as livestock feed. The second biggest use of corn is corn sweeteners, the high fructose corn syrup in soda pop and a variety of other products. The primary use of ethanol from corn is to replace MTBE (methyl tertiary butyl ether) as the octane and pollution control additive in gasoline. MTBE pollutes ground water and causes cancer. It seems reasonable to argue that replacing a toxic compound with ethanol is at least as useful as producing sweeteners for soda pop.

Critics of biofuels are right on two points:

(1) In the long run, the subsidies and high-input agricultural practices used to

grow corn in the U.S. are not sustainable. This is true regardless of whether the corn is used for cattle feed, high fructose corn syrup or ethanol. As part of energy and agriculture policy, sustainable agricultural practices and an economy where farmers can make a living are both crucial.

(2) Corn-based ethanol cannot replace the 20 million barrels of oil consumed per day in this country. However, more public transportation, more energy-efficient vehicles, more localized production and consumption of food, more clustering of residential areas and workplaces all would combine to reduce this high demand, and this would allow ethanol made from cellulose to meet most of the revised demand for transportation fuels. Perennial grasses and shrubs can be grown sustainably as energy crops, without soil erosion and without massive inputs of fossil-fuel-based fertilizers and pesticides. In Montana, converting marginal dry land wheat ground to perennial grasses would improve the soil and provide a greater return to farmers.

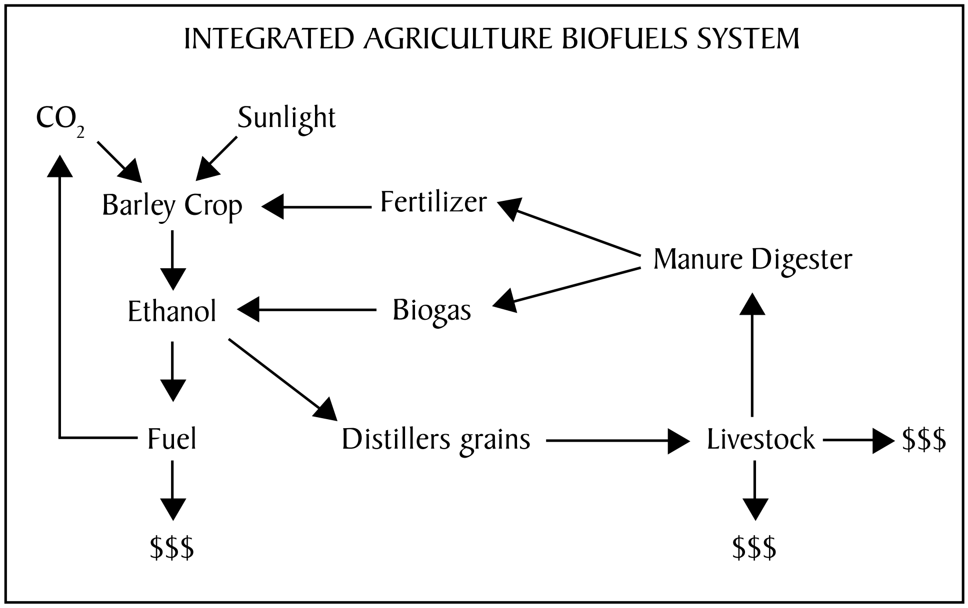
INTEGRATING AGRICULTURE AND BIOFUELS

Biofuels can be produced sustainably and profitably following the principals set out in this *Blueprint*. This can happen on a scale that fits community or farmer-owned production, boosts rural economies and does not deplete finite resources nor increase global warming. The accompanying diagram depicts an "Integrated Agriculture Biofuels System" that is technically feasible and economical using existing proven technology. Details may vary with specific sites, especially if there are local sources of low value ethanol feedstocks such as grain elevator waste, or the ability to integrate straw or other cellulose into the process. However, the basic principals of integration and appropriate scale apply across a wide range of situations that fit local resource bases in rural Montana.

Ethanol production elegantly fits the sustainability model where, emulating nature, the output from one process is not waste, but rather is feedstock or building blocks for the next process. Sunlight, the principal energy input to this system, is captured by the barley and stored as starch. The starch is converted to ethanol and sold by the farmers as an octane booster in gasoline or as E85 transportation fuel. Producing ethanol converts the barley starch but leaves the high protein distillers grains, a valuable livestock feed. Manure from the livestock feeds a biogas digester generating the fuel for process energy to distill the ethanol. The biogas does not provide all of the process energy for the ethanol; some additional energy in the form of wind or small hydro generated electricity to run pumps would be necessary. The residue from the digester provides fertilizer for the crop.

The benefits continue, since burning the ethanol in a car and burning the biogas for process energy generates CO_2 but it is "current" CO_2, fixed from the atmosphere by the barley, rather than stored CO_2 from fossil carbon in petroleum or coal thus not adding greenhouse gases that cause global warming.

In summary, ethanol and biogas can integrate in energy efficient and value added processes: high protein distiller grains, a by-product of ethanol is fed to livestock, whose manure makes biogas, supplying process heat for the ethanol distillation.



Farmers could also add biodiesel to this integration, setting aside a portion of their land to grow oil seeds to supply enough biodiesel to fuel tractors and trucks. The residual "meal" after the oil is extracted also makes excellent high protein livestock feed.

Most Montana barley is grown for livestock feed with a market value of about \$2.00 per bushel less freight[62]. Converted to ethanol and distillers grains, the market value is about \$5.00 per bushel. Producing ethanol and feeding livestock in-state would add value to rural economies and provide high-quality feed for livestock, reducing the need to send animals out of state for finishing. Local processing to sell steak instead of feeder steers would add more value.

Biofuels provide an opportunity for finance and ownership structures that keep the value added in the local Montana economy. Biofuel production can be diverse and scaled to match locally available feedstocks and capital resources. With this flexibility, farmers and people in local communities can own biofuel production facilities. There is also no reason why local ownership structures can't operate retail fuel sales networks. The state could support financing and receive a return on investment through loan guarantees or as an equity investor. Montana also has the expertise to help evaluate technology and provide technical support.

62 USDA National Agriculture Statistics Service, Montana Department of Agriculture. State and county data accessed through <www.nass.usda.gov>.

BIOFUELS ENERGY POLICY RECOMMENDATIONS

Policy recommendations must begin with the recognition that all energy sources, in particular petroleum and coal, receive taxpayer subsidies in many direct and indirect forms. **As taxpayers we should have the choice of subsidizing the energy supplies we want and penalizing or taxing those that are not sustainable**. Truly clean, renewable energy sources are technologically feasible and cost competitive with fossil fuels, so these are political choices on how we will spend our money.

FINANCE is the most critical issue in energy policy. Energy corporations and financial institutions (both public and private) have the mechanisms to finance big, capital intensive and centrally controlled energy production. To create a future of renewable energy benefiting the Montana economy, mechanisms that finance appropriately-scaled, diverse and locally-owned energy production are needed.

Until lending institutions are comfortable, the state should create a capital pool to provide equity capital and loan guarantees for financing renewable energy projects. A tax of 10 percent of the incremental increase in gasoline, diesel and natural gas costs, above the average 2002 prices, would be more than adequate. In 2005 this would have generated more than $50 million.

MARKET TRANSITIONS—these comprise the second most critical policy issue. Energy users need to see assured supply, and lenders need to see markets. State and local governments can spur markets by using biofuels in most government vehicles and in public buildings where feasible. Minnesota, North Carolina and New Mexico have such programs. Besides creating markets, it will save taxpayers money.

ELIMINATING SUBSIDIES FOR PETROLEUM AND COAL is policy issue number three. Oil companies do not need tax breaks, especially as they reap record profits in the tens of billions of dollars per quarter. Nor do oil companies need incentives to drill for oil, and the government does not need to fund research and finance pilot plants for coal synfuels. The tax codes already include huge subsidies and perverse incentives for petroleum such as depletion allowances. Simply by removing industry subsidies and adjusting the tax code to a level playing field, Montana and the federal government could generate significant savings which could be applied to biofuels and renewable, sustainable energy. This would keep the investment local in order to strengthen and sustain our communities.