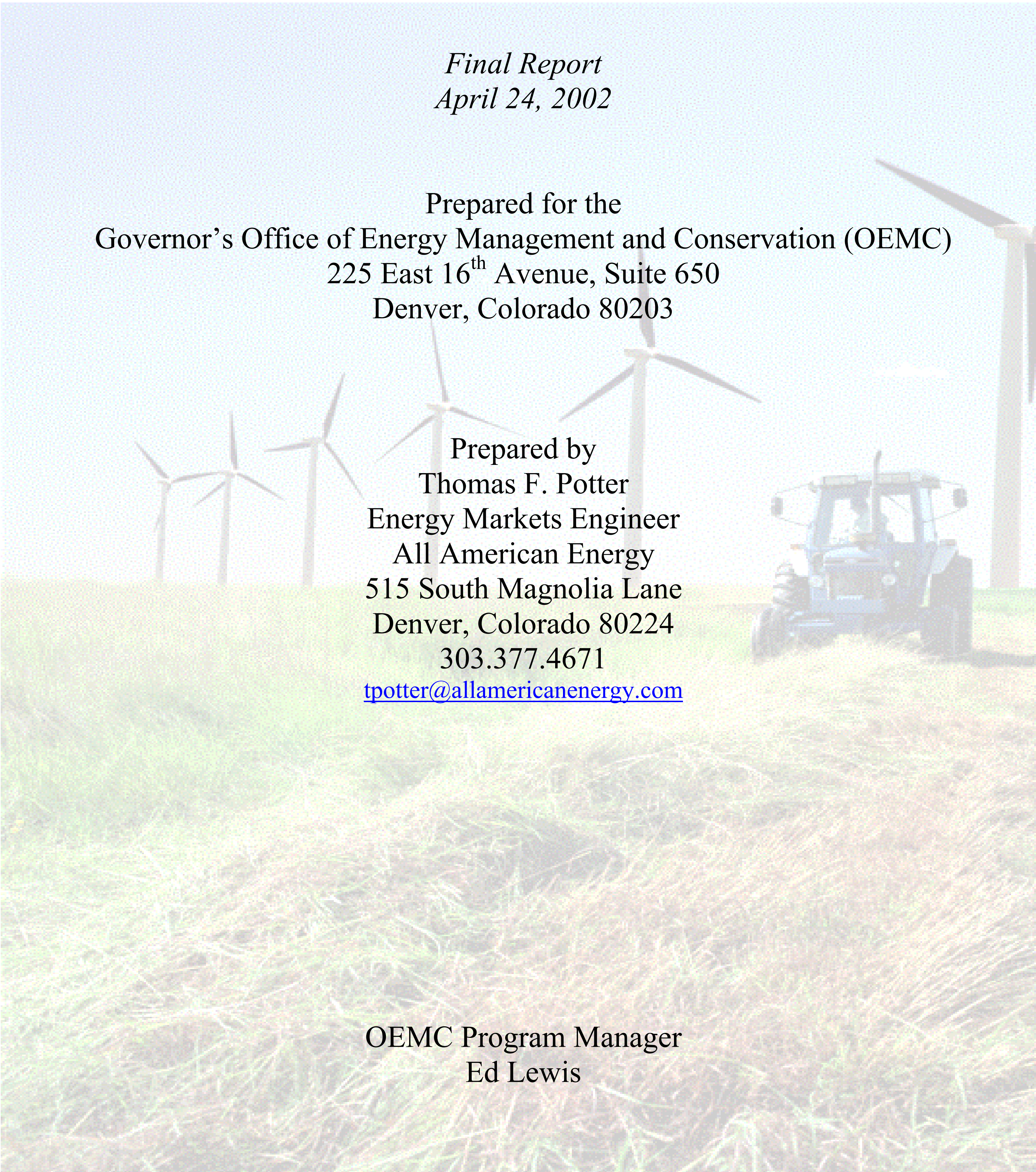
Map for the Development of

Rural-Empowering Action (*R-E Action)*

In Colorado



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EXECUTIVE SUMMARY

Faced with economically difficult times and sharing the nation's new anxieties about energy security threats, the rural sector is looking for options to improve its cash flows, its energy balances, the reliability of its power, and the sustainability of its lifestyle. The *Rural-Empowering Action* (*R-E Action*) Plan has the potential to provide all of those improvements. This report defines the initial technical and conceptual underpinnings of *R-E Action*, and describes the benefits that could accrue to much of Colorado from its further development.

Simply put, *R-E Action* is a new compilation of existing and near-term products and methods, which will better control energy use for the benefit of rural Americans. It is composed of profit-making contributions to the rural energy mix, and these contributions are expected to pay for themselves by reducing energy operating costs and increasing energy-related income. Its unique integration of these demand-side and supply-side resources will act as a powerful long-term economic stimulus for the rural sector, but its components are simple and cost-effective energy measures already used in many other applications today, including:

1. Energy cost saving retrofit of energy-using facilities and hardware,
2. On-site/near-site generation with existing equipment,
3. Net power aggregation from widely separated small-to-medium facilities, and
4. Energy performance contracting to enable risk-free implementation.

The major differences in the economics assumed for *R-E Action* are based on the beliefs that

- business-as-usual with regard to urban and rural energy flows is changing even as we watch, and
- these changes provide win-win opportunities for innovative programs that did not exist previously, like the "New Energy Farming" proposal described here.

For example, the previous assumption that lowest cost service is the determinant for electric end-users is turned on its head when over 17,000 customers in Colorado agree to pay $5-$15 per month more for the privilege of supporting generation by Wind. Not a single Wind-generated electron can be traced to a single one of these customers; the growing "green" ethic that drives the contribution is a relatively new phenomenon in electricity pricing. The flip side of urban growth in "green" markets is the realization of these market demands mainly in the rural sector. Farmers and ranchers who host the wind machines that supply the "premium" power, for example, gain annual payments of $1000 to $4000 per turbine, with a loss in cropland of no more than one-fourth an acre for each turbine.

A basic tenet of *R-E Action* is that markets for this kind of premium-priced "green" product, including Wind, Solar, and Renewable Fuels, will grow at an accelerated pace, with or without the increase in mandates now appearing for carbon-neutral energy solutions. The urban sector will provide the major growth in these markets, to satisfy mainly environmental concerns.

A parallel tenet of *R-E Action* is that these rapidly growing markets will be satisfied with wind turbines, solar collectors, and farm fuels developed, processed, and operated mainly by new and existing businesses in the rural sector. This evolution into our vision of New Energy Farming will likely raise the standard of living and increase the sustainability of the rural way of life.

This initial scoping report maps a reasonable development path for *R-E Action*, identifies the Plan's specific stakeholder interests, initially quantifies the Plan's benefits to those interests, and defines the next steps needed to accomplish the Plan's challenging objectives.

Background materials supporting *R-E Action* have been derived from literature published by the agriculture sector, the affected industries, the advocates, and the policy-makers. In addition, alternative options have been solicited from and presented for review to representatives of each of the interests and stakeholders. According to these sources, the Plan has an excellent potential to:

- Increase revenue streams to rural communities
- Improve the productivity of existing rural enterprises
- Diversify the rural economy and improve energy consumer education
- Enhance living conditions in rural housing, better incorporating the excellent work of DOE's Building America, EPA's Energy Star, and Colorado's E-Star and Built Green Programs
- Empower rural residents with broader economic and career choices, and
- Ease rural constraints in power generation, transmission, and distribution by augmenting rural peak power capacity with resources that can be activated quicker, cleaner, cheaper, and safer than alternatives.

In implementing *R-E Action*, program leaders will likely:

- Integrate rural energy efficiency, reliability control, and distributed generation fueled by existing and future farm resources;
- Reduce environmental impacts to the air, the land, the watershed, and the underlying water resources;
- Provide alternative grid support and access alternative energy income sources, such as
  a. Dispatching integrated demand/supply megawatts at peak for a fee
  b. Offering a 100%-capacity "boutique" power product to satisfy growing demands for "green" power
  c. Shedding loads on command to minimize metered peak or maximize end-user contribution to the local/regional grid at peak
  d. Operating existing "standby" generation with renewable fuels to improve reliability and "firm up" the variability of other renewable (e.g., wind) generation, and
  e. Providing spinning reserves to bring rural grids up more quickly after an outage.

Rural stakeholders and associated collaborative interests will be needed to support field data collection in *R-E Action*'s follow-on demonstration effort. They've been found in a number of fields besides Agriculture itself, including non-profits, public agencies, for-profit enterprises, power/emission brokers and other power interests, rural economic development interests, and elected officials.

In this report we've also compared the features of prospective *R-E Action* demonstration site options on Colorado's eastern plains in Weld County (Greeley), Yuma County (Yuma), and Bent/Prowers Counties (Lamar).

We conclude that the prospective benefits of *R-E Action* are likely to be far-reaching for farmers, ranchers, and others in Colorado's rural sector. Even in this brief scoping study it has become clear that this is an excellent time to demonstrate existing and emerging technologies that will increase rural productivity and support the local grid at peak. It is also clear that we can at the same time better utilize economically viable renewable alternatives to increase the reliability and sustainability of the rural lifestyle, and decrease its present vulnerability to a range of economic pressures.

BACKGROUND

Rural Energy Problems and Opportunities in Colorado

Rural Americans face an array of pressing economic, energy and environmental challenges. For example

1) Rural areas have not benefited from the longest peacetime expansion of the U.S. economy [Johnson, 2001];

2) The explosive growth in urban high-tech jobs has not been matched outside the suburbs [McDaniel, 2001]; and

3) Funding for infrastructure improvements has been heavily oriented toward urban growth and development. As a result of these and other trends, many rural communities are economically "flat," suffering from low crop prices [Barkema, 2001], high petroleum product costs and labor prices, and farm population losses [Rathge, 1998].

These economic conditions exacerbate the more traditional challenges associated with farming such as uncertain weather, environmental conditions, uncertain regulations and subsidies, marginal profits, and an evolving multi-year Farm Bill. They have contributed to what can now be seen as a threat to a traditionally independent group of Americans who are of vital importance to our domestic food production. Less tangibly, farming also represents for us a long-admired way of life, provides a buffer to urbanization, and sustains an open space quilt-work offering visual relief to constraining and synthetic urban/industrial perspectives.

Farmers, with less than 2% of the population, take rightful pride in feeding the vast majority of the country, but that accomplishment takes more than human energy. Energy in one form or another accounts for more than half of farmers' underlying cash production costs [Robinson, 2000], and imported energy in the form of fossil fuels and fossil fuel-generated electricity is an increasingly expensive component in the process of converting natural resources into agricultural products. **Figure 1** shows one breakout of operating costs budgeted for fuels, fertilizers, and pesticides made from petroleum and electricity generated increasingly from coal and natural gas.

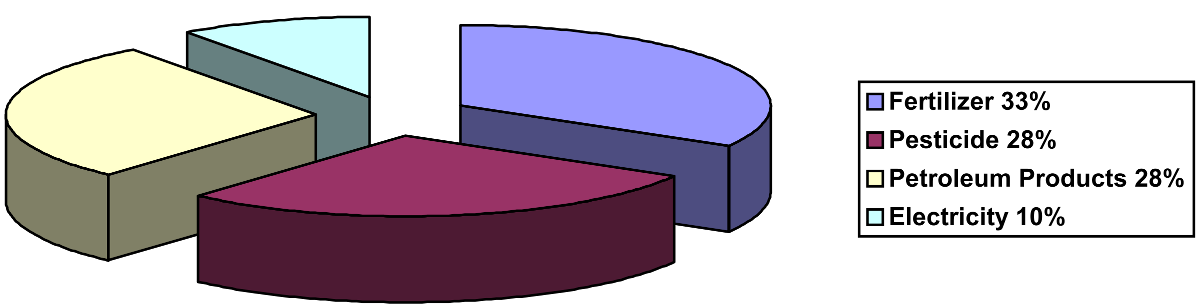


Figure 1. A Rural Energy Budget [American Farm Bureau, 1999].

The continued use of old technologies and planning paradigms has meant "business as usual" with regard to energy use in most rural locations, and little attention has been given to "clean energy" alternatives. One reason is that the general information infrastructure of agriculture is moving slower than events to convey 1) the higher values and availabilities of renewable resources, and 2) the practical advances also made by *other* new energy technologies. *R-E Action* will offer alternative ways for the agricultural community and other interests to communicate on these topics, and will provide the focused information needed to ease the transition to stronger rural economies based on ag-based energy production and uses.

In the past, sector-wide prospects for increasing the use of energy conversion crops and for more broadly accessing rural efficiency, solar and wind resources have not been seriously examined in an integrated fashion. But farmers today have outstanding resources and skills, and unparalleled access to improved products. They could harness these elements to dramatically reduce their reliance on high priced petroleum products and enhance their own commercial solvency by replacing or reducing the use of fossil-based fuels in their operations. They also can do this in part by offsetting peak demand energy use and in part by using locally produced energy resources to generate reliable, long-term income.

Farmers also recognize that the rural economy is more than any other sector dependent on the health of our natural resources. In the author's conversations with rural leaders the theme was often repeated that farmers would like to see practical alternatives to putting the rural lifestyle and natural resource base at risk, as could be the case with an increasing pollutant burden on the earth, water, and air. **Table 1** shows the diversity of this challenge. In addition to the breadth of the issue shown in the table, recall that methane, a common farm by-product, has twenty times the infrared absorption of CO_2. The table suggests that better energy science and engineering solutions are needed to balance rural energy needs with other aspects of a sustainable rural environment.

TABLE 1. Possible Environmental Risks from Rural Operations

Air	CO, NO_x, SO_x, H_2S, ammonia, particulates, and odors
Water	Pesticides, fertilizers (especially nitrates), organics, heavy metals, and ammonia
Soil	Pesticides, fertilizers, and heavy metals
Climate	CO_2, methane

On the *Opportunities* side of the equation, the American farm can be a positive force for cleaning up the environment. For example, with regard to atmospheric contributions, agriculture can help reduce the net rate at which CO_2 is being discharged into the air and, more importantly, agriculture can increase the rate at which the gas is removed from the atmosphere by storing it. Growing crops fix atmospheric carbon above and below the ground in a process called carbon sequestration. This sequestration can be aided by modern farming practices like conservation tillage (or "no-till"), in which the ground is left relatively or nearly undisturbed, increasing the proportion of organic matter under the ground [Erickson, 2001]. Along with our forests, our farms are major carbon "sinks" that can help us manage the mostly urban human's contribution to increased carbon dioxide buildup in the atmosphere, as pictorially shown in **Figure 2**.

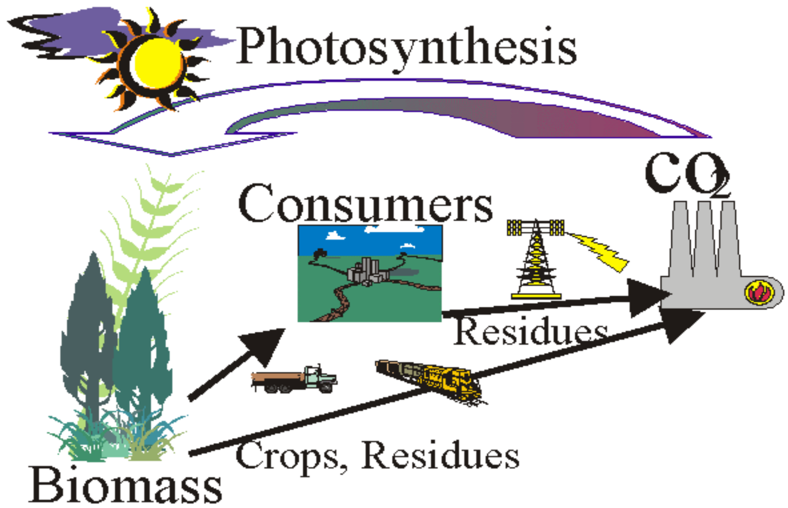


Figure 2. The Carbon Cycle, involving biomass from farm and forest to convert man-made carbon dioxide from the atmosphere [Overend, 2001].

R-E Action seeks to address these opportunities, and the associated energy challenges and economic issues endemic to the rural sector, by developing practical energy alternatives for rural enterprises. These alternatives will primarily help alleviate the cost burden associated with farm operations, but will more broadly help revive a rural lifestyle now practiced by more than 50 million Americans, and can significantly improve the management of our carbon emissions.

Existing Energy Infrastructure and Use Patterns

The greatest energy use on a typical farm (33% of the total [American, 1999]) comes from a product used to make the farm more productive. Manufactured nitrogen (N) fertilizers are most often made with fossil fuel feedstocks, specifically natural gas. This process yields a product that has had significant energy embodied in it during its off-site manufacture. Given the relatively low first cost of manufactured fertilizer compared to the payoff in increased production, little attention has been paid to its reduction or elimination on energy-cost or energy/environmental grounds. But it's clear that in some locations, its reduction could be accomplished with crop choice and other farm practices. For example, certain crops are not as needful of N fertilizers, and some crop rotations already rely instead on replenishment of soil nutrients with nitrogen-fixing cultivars. Some farmers also get better fertilizer use from livestock waste and compost.

Another option is to obtain soil amendments from new processes applied to primary or residual crop outputs, in a manner equivalent to making silage, mixing feed, or blending compost. Again looking at local resources and processes, it may also be possible to cost-effectively generate such soil amendments with solar- and wind- generated electricity [Duke], directly converting atmospheric nitrogen to oxides of nitrogen, urea and ammonia (as happens naturally during lightning storms). Such speculation needs confirmation of its technical promise and practicality.

A second major energy input to the farm (28% of the total, according to the American Farm Bureau) is also delivered as a commercial product: pesticides. Also often manufactured from natural gas feedstocks, they embody significant energy inputs added during their off-site manufacture. And as with fertilizers, in some locations pesticide use can be reduced with crop choice, rotation practice, and targeted equivalents that are not produced with fossil fuels. Integrated Pest Management, for example, is a federal-state extension partnership program that minimizes pesticide use and promotes sustainable systems with environmentally and economically sound field practices. Featuring a variety of well-established concepts, the program has the potential for greatly reducing energy inputs embodied in pesticides.

A range of liquid petroleum fuels accounts for another 28% of the energy input to an average farm. Diesel fuel is used in tractors, heavy and medium-weight trucks, prime movers on the farmstead, and specialty harvesting equipment brought in by contractors. Sold at commercial or co-op service stations, it is also delivered in bulk to many farms for storage and dispensing as needed. Currently in Colorado, diesel fuel is a 100% processed petroleum product. In other states like Minnesota, Iowa, Nebraska and Kansas, farm interests have encouraged the requirement of a 5% renewables fraction in all diesel fuels, with mixed success.

Resistance to renewable diesel (with typically a 20% to 100% renewables fraction) has been on two fronts: cost and performance. Developers expect that improved types of oil-producing crops and better processes for cultivating and converting them may provide B100 (100% biodiesel) at costs close to petroleum diesel costs in five years, according to some experts [Tyson, 2001].

According to a study by a University of Minnesota professor, a mandatory formulation of B20 in that state would raise diesel costs only 2 – 6 cents a gallon [Equipment, 2001], a difference small enough that it is often exceeded by the monthly variability of fuel in most parts of the country. Volume is one of the major factors that will reduce the prices, and factors as unexpected as America's changing diet could contribute to that volume. In this case, the reason is that as more soybean flour is used for heart-healthy food items, more of its oil becomes available as a less-expensive byproduct [Science, 1998]. The industry also anticipates replacing some or all of the relatively expensive food-grade oils with cheaper inedible oils in future formulations of biodiesel. Such inedible oils are available today from animal rendering, food processing, food preparation, and other waste oil streams, with cost reduction prospects as shown in **Figure 3**.

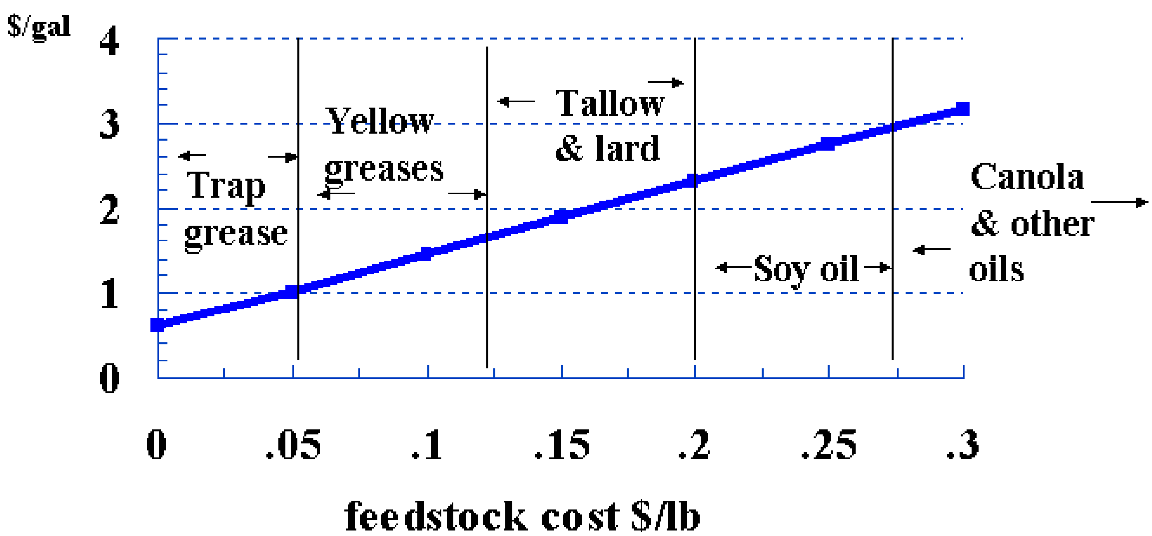


Figure 3. Biodiesel Cost Factors. Assumes a 3 million gallon per year plant. Total cost at the plant gate, not including transportation and handling [Tyson, 1999].

The biodiesel *performance* issue may be more perception than reality, since biodiesel is actually cleaner burning than petroleum diesel while providing about the same power from the engine. With special treatments, cold weather starting and running can be similar to that of petroleum diesel, meaning that temperature control is useful for both fuels in colder climates. The Minnesota Highway Department uses a B20 biodiesel blend in its snowplows, identifying three factors that support its effectiveness:

1. A proportion of kerosene is added to the fuel to minimize the tendency to gel at lower temperatures;

2. Such a high-load, high-heat operation allows the circulating fuel to be heated continuously, minimizing gelling; and

3. Garages moderate the low temperatures to which the plows would otherwise be exposed when they're not operating

The use of gasoline is also common in the rural sector, due to the significant physical distances in rural communities and the perceived inconvenience and first cost of diesel or other alternative-fueled automobiles. A low-blend mixture of renewable ethanol has been a wintertime component of urban Colorado gasoline for years, and may become a year-round additive before long in many farm states, to support the rural economy while reducing mainly urban emissions from gasoline-burning vehicles.

A new Colorado agricultural product has the potential to further improve the performance of gasoline engines. It is a crop feedstock oil from Agro Management in Colorado Springs, and others, that improves the lubrication of spark-ignited engines and reduces by 30%-50% the harmful emissions from those engines. Tests by the U.S. Postal Service and the EPA have confirmed both sets of performance, and process plants and marketing plans are now being assembled [Allen, 2001].

Another rural fossil fuel commonly used in Colorado is bottled, tank or LPG gas, used mainly for space heating and water heating. Its use is also an artifact of the extensive distances involved in rural areas, being cheaper to deliver periodically than the alternative of burying miles of natural gas lines. With the prospect of economy-altering alternative farm power sources, renewable energy in the form of crop feedstock oils soon may be economically competitive with LPG or other fossil heating fuels. In states with a longer history of broad biomass use, there are actually catalogs for biomass combustion equipment [Minnesota, 1992]. But with renewable agricultural oils in the form of biodiesel, the replacement for petroleum fuel oil on the farm is not nearly as complicated, being a straight substitution that actually burns cleaner. The main obstruction, where fuel oil is not used, is the cost of conversion from bottled gas storage and combustion equipment.

The final 10% of purchased energy used on a typical farm is in the form of electricity, according to the Farm Bureau. This power is delivered through wires from central power plants sharing the economies of scale of large, heat-engine driven generators. It energizes most lighting, motors, domestic appliances, and productivity equipment. Since the heaviest concentration in rural areas is on residential loads, agricultural process loads can very easily create peak conditions on the regional grid. For this reason, peak-reducing processes or systems will be beneficial to all rural grid customers, increasing their reliability and reducing the costs otherwise necessary for distribution upgrades.

While not appearing as the major energy cost factor for the farmstead, the combination of electric end-use and electric supply appears to provide the largest immediate target for new systematic savings and income in the rural sector. In addition to current opportunities, a broader vision must include the prospects for low cost, highly efficient fuel cells operating in the mid-term future on farm-derived fuels that can provide the hydrogen input [Brand, 2001]. And with the new V2G (Vehicle to Grid [Gage, 2001]) concept, rural ag-fuel hybrid or electric vehicles could provide distributed capacity and voltage maintenance for the grid whenever they're not driving down the road.

An example of the impact of reasonable market penetration and peak power use of hybrid and electric vehicles is shown in **Figure 4.**

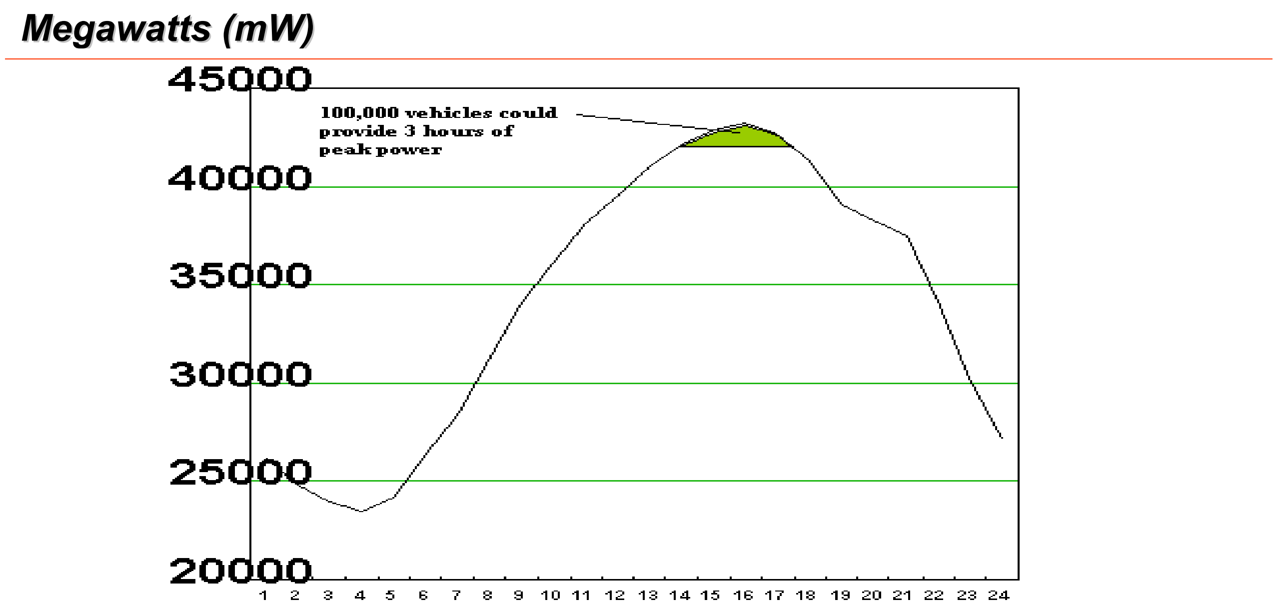


Figure 4. Simulated Electric Vehicles as a Peak Power Resource in California [Gage, 2001].

These and other forms of distributed generation will provide support to spiking electric peaks in a reinvigorated rural economy, in a manner described in **Figure 5**. Our work in *R-E Action* will define ways in which that goal best can be accomplished.

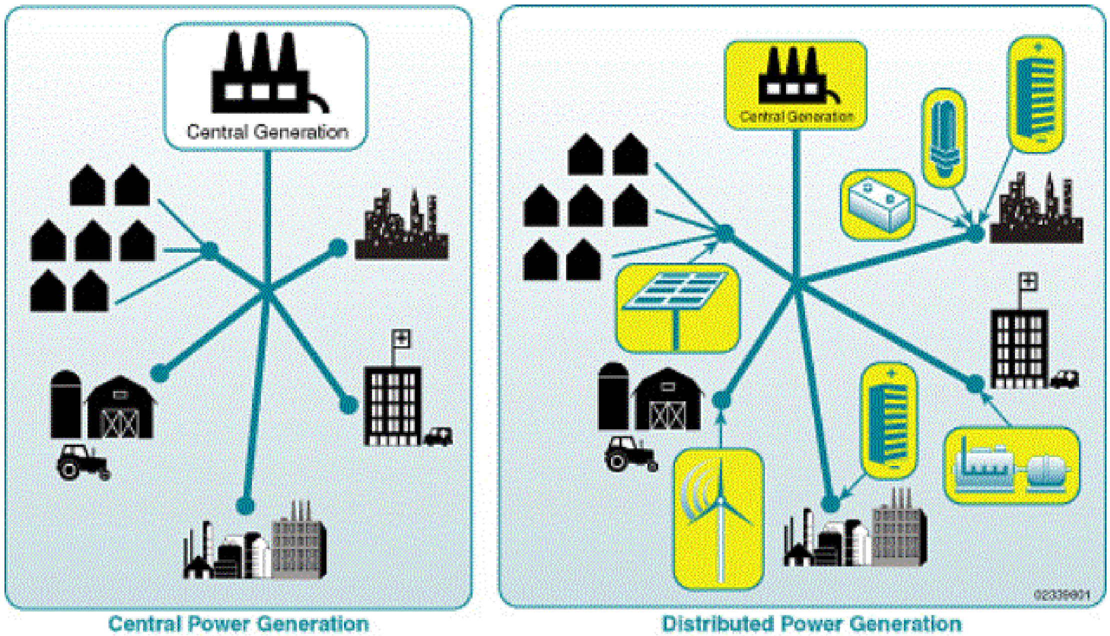


Figure 5. Central vs. Distributed Generation (DG) systems [Overend, 2001].

Energy Alternatives in Rural America

Many have described how energy alternatives abound in the rural sector, but these resources are still vastly under-utilized for many reasons. For example, perhaps the most cost-effective solar applications are the simple building design modifications known as "passive solar energy" and "daylighting design". With those considerations in mind, a new building's energy consumption can be halved with little or no extra initial cost. Moving a window from the north side layout to its south side is an example of this kind of consideration, as is the consideration of mass effects and thermal insulation. Net costs of solar-conscious new construction or major retrofit actually can be less than the cost of "standard" design and construction, since heating and air-conditioning equipment can be down-sized [Larson, 2001]. Yet such simple design techniques have largely eluded builders in the rural sector, also, despite the attraction of far lower lifetime utility costs. In this section we will examine a number of other promising rural energy resources.

Biological resources are the "natural" stock in trade of the farm sector, and virtually all plants and organic wastes can potentially be used to produce heat, power or fuel. In addition, *demand-side management* [Funk, 1993] and *distributed generation* [Gas Research Institute, 2001] are proven concepts with economically and technically sound applications in many other sectors. Individually, these concepts have been generally disregarded as infeasible propositions for smaller, rural applications. However, in aggregate, these three components (biological resources, demand-side management, and distributed generation) will in *R-E Action* provide a comprehensive alternative energy supply system with multiple economic advantages for farmers, ranchers and rural businesses.

Integrating *demand side management* and *distributed generation* with farm-based energy use patterns and energy resources provides powerful synergistic benefits to the rural economy.

Implementing these energy conservation and supply applications will yield increased rural income, new job and career opportunities and increased energy independence for rural populations as well as reducing pollution and revitalizing the rural economy. However, no hard data exist on the feasibility of integrating such demand and supply side resources in a rural setting, or on the prospective benefits to the rural economy. *R-E Action* proposes to develop that data, with the collaboration of private sector enterprises, the rural cooperative system, and program interests from the government and non-profit sectors.

<u>The Economic Payoff Potential in Colorado</u>

Vendors – One of the primary impacts of *R-E Action* in Colorado is expected to be an increase in income streams to rural communities. The basis for that will be increased demand for a variety of rural products and services. The Plan will help to stimulate that demand, which can enhance the local, regional and national economy. Private sector Colorado implementation partners in the following fields will feel particularly strong benefits:

1. Natural fuels feedstock cultivation and conversion, in the form of
    a. Greater acreage of existing energy feedstock crops like corn, wheat, soybeans, sunflowers and canola. A gallons-to-acreage metric is that between 400 and 1000 gallons of ethanol can be produced from one acre of corn, with the proper mixture of water, nutrients and sunlight, and reasonable weather. Another is that 100 gallons of vegetable oil (the main ingredient of biodiesel) can be produced from one acre of sunflowers. An economic metric is that the value of such high-lubricity vegetable oils as a premium lubricant can be 7-10 times the value of raw sunflowers, an example of how energy crops can pay off in value, not volume.
    b. New fuel feedstock crops like hybrid mustards and high-oleic soybeans
    c. Farmstead conversion into fuels of starches, sugars, oils and biomass with crushers, oil extractors, fermenters, blenders, and the like. The opportunities for improving the business climate for farmers can be substantial: farmer co-ops own and operate 12 of 15 ethanol plants in Minnesota, all three under construction in Iowa, and two new ones in Missouri [Guthmiller, 2001]. In Colorado, Agro Management also plans to operate an ag-oil production facility as a farmer co-op.
2. Natural oils/fuels vending, distribution, and equipment services, in the form of
    a. Modification of current services that sell and deliver fossil fuels, to sell and deliver larger quantities of farm fuels to the region, augmenting fossil fuel use
    b. New techniques, processes and equipment specific to new markets opening over time to natural fuels
3. Energy retrofit systems and services, in the form of
    a. Increased staff work by rural utilities and private contractors that currently facilitate energy retrofit in farms, homes and businesses
    b. New companies formed to serve expanded markets for the full range of energy retrofit services, from auditing and data processing through system commissioning and savings verification
4. Energy efficient products and thermal storage, in the form of
    a. Increased sales of energy efficient products like insulation and weatherstripping from co-ops, hardware stores and other current rural vendors
    b. New distribution channels opened to serve market demand for bulk sales of specialty insulations and energy efficient light fixtures and lamps

   c. Varieties of thermal storage systems based on simple thermal capacitance or phase change materials, with special relevance to the volumes and temperature ranges common to a range of rural applications
5. Power demand controls and service, in the form of
   a. Increased sales of controls by rural electrical contractors
   b. New contracting entities that specialize in packaged systems to control loads common to a variety of rural enterprises
6. Distributed generation sales, installation and service, in the form of
   a. Increased sales of equipment and service contracts by existing vendors of diesel gensets, and their modification to run well on high proportions or "neat" (pure) biodiesel
   b. New service entities that specialize in the maintenance of intermittent generator (genset) operations
   c. New sales and service entities that specialize in renewables generation of electricity in rural areas, including photovoltaic, wind, and low-head hydro
7. Power integration and aggregation controls and service, in the form of
   a. Companies with expertise and experience in electronically optimizing resource integration on-site, and aggregating peak power resources between sites
   b. Telecommunications expertise that plans and installs upgrades to allow two-way communication with and control of the geographically isolated components of a "virtual peak power utility"
8. Rural financing services, in the form of
   a. Increased markets for existing financial institutions with a "rural operations" mission and capability, to support the sector's need to improve operational costs
   b. New markets for entrepreneurial financing of low-risk energy retrofit ventures with reasonable energy-cost paybacks

Productivity – A second major type of *R-E Action* impact is expected to be the increase in productivity of rural enterprises. The most direct way will be the reduction of energy costs per unit of production. While energy costs only account for a small percentage of the operating costs of most rural enterprises, saving those costs reflects immediately on the profit of the enterprise and those savings can be significant. This Plan proposes to achieve the savings by means of performance contracting, where the vendor advances the capital investment based on energy cost saving payback. This allows the participant to enjoy a positive cash flow from the first day of the energy retrofit with little or no up-front investment, by costing less per month than the utility savings.

Productivity will also be raised with the economies of scale that come from higher demand for natural fuels. *R-E Action* will improve demand for natural fuel feedstocks grown on farms, facilitate the development of a natural fuels delivery infrastructure for distributed generators, and demonstrate the fit of natural fuels for heating and transportation. Significant acreage of potential natural fuel feedstock is grown every year. With output of conservatively 400 gallons of ethanol coming from an acre, even reasonable uptake as a fuel modifier in Colorado (which burns 1.2 billion gallons of gasoline a year) will translate to the planting of thousands more acres.

Economic Diversification – *R-E Action* will facilitate the development of sustainable agricultural production systems. The Plan will

1) Assist emerging markets in the creation of long-term demand for agricultural based energy products (often called "farm fuels" or "natural fuels") and the infrastructures needed to deliver those products
2) Enhance the global competitiveness of America's farmers. Rural enterprises will be better able to compete and will increase their economic stability by processing under the Plan non-food agricultural materials that meet specific demands in the marketplace
3) Diversify the local economy with the range of energy, telecommunications, and financial employment opportunities described above. For example, upgraded building weatherization will need larger crews with more training on rural building specifics.

With specific regard to telecommunications, such improved job and career choices will arise with the development of advanced rural communication and information systems already being developed in Colorado (e.g., the Governor's Multi-Use Network Initiative) to better serve the rural sector [Grice, 2001]. The upgraded *R-E Action* energy control network will also yield improved rural opportunities in Internet education and training, e-commerce and enterprise management. Some examples of job specialties that could result from these improved telecommunications opportunities include, e.g., communications system planning, physical upgrade of the existing communications infrastructure, building new communications capacity, and operation and maintenance of sophisticated information and control systems. Yet another grouping of jobs will be related to e-commerce (including telemarketing jobs, auctions, and internet marketing of craft and specialty products), and enterprise management (e.g., improved coaching and "lessons learned" on the specific area of farmstead interest, fast-breaking crop or livestock news, and access to data necessary for better decision-making).

Individual Energy Use - In addition, the general consciousness-raising regarding energy sources and uses under *R-E Action* will have a long-term beneficial effect on individual energy-use behavior, at home and at work. One direct benefit expected from improved energy-use behavior will be the thermal improvement of rural housing, since it will not only make good economic sense, but will be easier to accomplish with the improved understanding of specific measures for these specific rural applications. On larger farmsteads, participants will also benefit directly from the bundling of commercial and residential savings and income opportunities under *R-E Action*.

Career Choices – The broader career choices that come from *R-E Action* will derive from the stimulation of increased revenue described previously. A broader diversity of income and of energy sources means that more rural citizens will be doing new and different things to make a living, creating a diverse marketplace that attracts and retains talent. Retention of rural youth has always depended on improvements in both career choices and access to consumer goods. Both could be improved with *R-E Action*, as will outreach to rural youth, to involve them in the planning for and growth of both new career opportunities and the consumer goods and services that these jobs will yield. More broadly, enhancing economic opportunity has always had a positive effect on the quality of life.

Further, we can expect creation of a range of new career opportunities in rural natural energy-related fields. Besides increasing income streams from "natural" fuels and making existing enterprises more profitable by reducing unneeded utility costs, *R-E Action* also will improve the selection of jobs and careers in the rural sector, including new high-tech positions in energy and communication networking.

There are many precedents for career opportunities that have developed from the diffusion of new technologies and business models. From these precedents we can project energy-related growth due to *R-E Action* in the following specific areas:

- Cultivation of natural energy crops
- Seed oil crushing
- Oil extraction and blending
- Renewable fuels processing
- Wind measurement
- Energy auditing
- Modification of existing distributed generation (DG)
- Installation of new DG
- Operation and maintenance of DG
- Power system control
- Business management and coaching
- Risk assessment and resolution
- Contracts and legal work
- Rural energy specializations (for example, biomass conversion and thermal storage), and
- Financial services.

Grid Support – *R-E Action* will support the local electric grid during peak periods, reducing stresses on the central generators, transmission lines, and distribution systems. Because of the low efficiencies of heat-engines and unavoidable line losses, total average efficiency of the central generation, transmission and distribution systems in the U.S. today is less than 30%. This means that every kilowatt of electric energy saved at the end of a rural line translates back to about 3.5 times that amount of fuel energy (in coal or gas) entering a central generation station. That scale of multiplier makes the end-of-the-line contribution very valuable when the system is constrained during peak periods, yet these new rural peak resources can be activated very quickly under *R-E Action* and at less capital cost per kilowatt than new peak power capacity. Specific advantages to the grid of dispatchable peak power resources that include a renewables generation component could be [based on Gage, 2001]:

1. Extra no-net-carbon power for the grid during demand peaks
2. Spinning reserves of renewable power as insurance against unplanned outages during peak periods
3. A contribution toward grid regulation through automatic generation control provided by each of the distributed gensets
4. A contribution toward active stability control of transmission provided by each of the distributed gensets
5. Standby power for interruptible customers (voluntary or under tariff)

Natural Energy – *R-E Action* will develop value-added non-food products from agricultural and other rural feedstocks (including crops and agricultural/woody residues). The Plan will demonstrate methods for increasing the value of these materials by better realizing their energy potential (captured in the photosynthesis of sunlight), and increasing their market demand as well. Surveys have shown significant resources available from the *agricultural* sector, as referred to elsewhere in this report.

A still more detailed survey of Colorado's *wood* biomass resource is under way today [Larson, 2001b, Lewis, 2001]. But new policies will be needed to bring together many stakeholders (land management agencies, land owners, fire departments, insurance companies, water and electric utilities, waste disposal authorities, homeowners, etc.) to address the economics of a forest biomass harvest. The prospective payoff is attractive, based on the national experience of the pulp and paper industry, where 56 percent of the electricity and heat used comes from biomass process streams and residues [Biomass, 2001].

Today, no single group can seem to find the economic rationale for using forest-thinning residues (which seem destined to increase at an exponential rate under the Forest Service's new National Fire Plan) for energy production, but cumulatively the rationale is persuasive, if accomplished responsibly. For the reason that many interests will be simultaneously served, however, the use of forest residues is very likely to increase in the future, for on-site power generation, composting, or new product streams. Simply burning the slash in place or burying it (the next most common suggestion) are clearly not the best procedures with regard to Colorado's air quality or Colorado's economy, even if apparently "cheap" [Larson, 2001].

Another *R-E Action* impact will be the diversification of the rural economy with these natural energy resources, in ways that resonate with rural constituencies and enhance the competitiveness of all rural products. An interesting parallel to the development of widespread support for "natural" energy could be the existing organic movement, which has grown to be a solid contributor to the Colorado economy. As with the benefits from *crop* diversity, we can expect the development under *R-E Action* of a healthy kind of resilience in the production and processing infrastructure that comes from diversifying *fuels*. Such diversity of *income* from energy can also take the profit pressure off other crops, giving the rural producer better options for balancing his or her profit portfolio.

Reduction of Environmental Stressors – Implementing this Plan can provide relief for the cumulative stresses on rural lifestyles, lands and watersheds caused by regional air emission impacts. This is likely to improve the health and well-being of affected rural citizenry and make a positive impact on the overall environment. By increasing over time the proportion of farm-fueled electricity generation and transportation energy use, reducing the resulting emissions impacts during peak demand periods, the Plan will reduce the burden on rural air, ground, and water. Specific benefits will depend on the mix of alternative fuels actually used in a particular locality, for example, whether gasoline is augmented with ethanol, diesel with biodiesel, petroleum oils with ag-oil lubricants, coal- or gas-fueled power with biodiesel or wind power, or LPG heating with biodiesel. Altogether, though, the Plan will increase the productivity of the land without generating additional hazardous wastes or depleting our shared heritage of non-renewable resources.

Another positive environmental addition will come about as the strategic planting, harvesting, and integrated pest management (IPM) scheduling of energy crops improves the accessibility to forage and cover for many species.

Energy Security – *R-E Action* will help to improve the energy security and economy of not only the rural citizenry, but by extension the nation. This will come about not only by broadening the nation's energy diversity but also by shortening the access path to usable energy sources. These factors reduce rural dependence on long distribution lines that are more subject to accidental, weather-related, or intentional disruption. *R-E Action* will reduce the risk to our electricity infrastructure by improving its reliability, resilience, and robustness, while improving the energy productivity of rural enterprise directly through better control of energy and indirectly by increasing the production and use of particularly rural energy resources.

Such alternative energy resources are expected to be saleable outside the region, which also improves the region's energy economy. Region by region we will build more robust and resilient natural energy resource networks that add up to a stronger *national* energy resource network. The *R-E Action* Report is more a view of how better rural energy and economic futures could come to be, and less a discussion of why they have not and will not, given current economics.

This section has described a range of benefits to accrue from *R-E Action*. The purpose of the developmental phases described in this report is to demonstrate those benefit to key stakeholders, who include:

- Rural citizens, with the objectives of demonstrating improved sustainability of their lifestyle, and of increased opportunities for individual responsibility and stewardship
- Electric co-op ratepayers, with an objective of reducing the costs to maintain and upgrade transmission and distribution lines, transformers, and voltage-control equipment
- Economic development interests, with the objectives of providing better rural power options, and improving the business health of a broad range of rural enterprises
- Renewable energy advocates, with the objectives of showing the practicality of renewable fuels and other rural energy resources as energy system solutions, and of helping to more clearly define the role of renewable products in providing no-net-carbon peak power
- Environmental advocates, with the objective of providing cleaner and greener energy choices
- Community leaders, with the objective of facilitating revitalized rural economies and new business growth opportunities, and
- State, regional and local policy interests, with the objective of providing more equitable growth in rural areas

CONCEPT UNDERLYING *RURAL-EMPOWERING ACTION* (*R-E Action*)

***R-E Action* as an Economic Driver**

Simply put, *R-E Action* is a new compilation of existing and near-term products and methods, which will better control energy use for the benefit of rural Americans. It is composed of profit-making contributions to the rural energy mix, and these contributions are expected to pay for themselves by reducing energy operating costs and increasing energy-related income. Its unique integration of these demand-side and supply-side resources will act as a powerful long-term economic stimulus for the rural sector, but its components are simple and cost-effective energy measures already used in many other applications today.

Energy retrofits – The first major existing component is a package of energy cost saving retrofits that satisfies site-specific payback criteria. The objective of energy retrofits has traditionally been to optimize and minimize the use of primary energy resources to make goods and perform services. In *R-E Action*, this package could be targeted toward base load reduction, peak load shaping, peak load shedding, or some combination of the three. Typical energy retrofits today include improvements in the energy efficiency of lights, motors and the thermal shell of buildings, and the peak control of heavy energy using equipment like compressors. Numerous companies provide these services today in Colorado, and further details on specific retrofits will be found in a following section titled *Products and Services*.

On-site/near-site generation – The second existing component of *R-E Action* is the operation of on-site/near-site generation, which could be either existing standby/emergency gensets or renewables generation. For the purpose of providing diversified energy resources, we propose two modifications to the standard operation of the diesel standby/emergency gensets:

1) Rather than being fueled with petroleum diesel, gensets in *R-E Action* will be operated with renewable fuels, preferably some higher blend of biodiesel (e.g., minimum 20% to 100%, the balance being petroleum diesel); this is increasingly common practice among genset operators to reduce emissions and increase lubricity, and will become more so as sulfur is removed from petroleum diesel, increasing engine wear unless other additives are used. Such new markets for oilseed crops "will drive up commodity prices, increase net farm income, and reduce the (farmer's) dependence on…the safety net," according to the president of the Illinois Farm Bureau [Warfield, 2001].

2) In addition to planned operation when grid power is not available, *R-E Action* gensets will be operated parallel to the grid or fed into the grid during other economic dispatch periods (e.g., customer-defined peaks, grid-defined peaks, wind turbine or PV output valleys, or when "green" power bids are sufficiently high). Experiments with coordinated delivery of the power from such separated gensets have had positive outcomes [Goldberg, 2001].

Further discussion of on-site generation will be found in the section below titled *Products and Services.*

Power aggregation – The third existing component of *R-E Action* is the aggregation of peak load resources from many small contributors. Though the underlying process can be similar to the aggregation of resources from large power plant contributors, its application to small generators can be complicated by many factors (e.g., lack of dedicated communication and control circuits, wide variance in power characteristics, and the range of operating protocols used by different genset manufacturers)

This is a relatively young industry, with only a handful of companies developing the technologies and offering the service in the U.S. They are demonstrating the practicality of linking distant generators to form a "virtual utility" which can ease peak grid constraints.

Energy performance contracting – The fourth existing component is energy performance contracting. This process integrates the custom on-site energy improvements via energy cost savings and revenue streams, and offers financing for the project based on payback out of those savings. Many entities have found that another major impact of energy performance contracting is on the availability of capital funding. Turning the savings of energy retrofit projects into new or improved assets has been a much-appreciated budget solution for corporations, the federal government, and the State of Colorado. An example of an energy retrofit package suited to energy performance contracting; where the contractor pays the up-front costs (and is paid back though the savings) will be found in Appendix C

R-E Action compiles these components in such a way that energy cost savings and power generation revenues are augmented by crop revenues and other on-site benefits to provide rapid payback of the capital improvements. This translates to reduced-risk performance contracting, positive cash flows to the participant from the start of the project, and larger, more comprehensive energy retrofit projects that yield higher profits to the participant, and multiples of those higher profits to the rural community, after the payoff period.

BUSINESS CONSIDERATIONS AND BENEFICIARIES

Energy Market Trends

Nationwide, peak electric loads have grown by about 2% per year in the recent past, while generation and transmission capacity have grown on average less than 1% in the same period. So we stand at a point in time where the electric grid system has less reserve margin than ever before, and that shrinking margin has caused reliability to slip in many places. While recent outrages remind us how vulnerable our key infrastructure facilities are to acts of vandals, criminals and terrorists, historically it has been the accumulation of little faults that has proven more costly. Cascading failures, exacerbated by peak load stresses, have led to the isolation of key substations, wide-area voltage collapse, and large-scale transient instability of the grid, with minor events contributing to the bulk of system failures, and extreme events appearing but rarely (Mili). Still, energy infrastructure security is being increased, of necessity, raising the costs of all forms of central energy generation, transmission, and distribution, and accelerating the rate at which energy efficiency, distributed generation and the use of rural energy feedstocks and renewables become cost-effective.

In addition to cost considerations, distributed energy resources of the sort we advocate under *R-E Action* are far less vulnerable to immediate and widespread disruption than are centralized energy resources and their widespread and highly accessible energy distribution systems. Distributed generation (DG) with rural energy feedstocks will “naturally” increase the resilience and robustness of the electric grids to which it contributes. It should also reduce peak power costs for all system customers, provide voltage and capacity support, and help the utility avoid or defer distribution system upgrades, all of which are beneficial attributes [Eicher, 2001].

There is a growing trend of end-user support for clean energy alternatives, even at a premium cost. For example, Xcel’s WindSource program in Colorado has attracted over 17,000 customers willing to pay a premium on their utility bill every month for power from wind farms. One subgroup of meters on that list of residential and commercial/industrial customers is found at the University of Colorado. In April, 2000, students at the university in Boulder voted by a 5-1 margin to increase student fees by a dollar per semester for four years to purchase wind power for the school. According to the report in the Rocky Mountain News, the resulting $50,000 was enough to buy the entire output from one large wind turbine.

The University of Colorado is one of the founding members of the national Green Power Partnership assembled by the Environmental Protection Agency. The national partnership hopes to buy more than 280,000 megawatt hours of green power, produced by renewable energy sources such as solar, wind, water, geothermal, or biomass, over the next year (Rocky).

In addition to Xcel’s highly successful Windsource program, 19 other utilities in Colorado also have green pricing tariffs in place [Guidry, 2002], with a reasonable uptake despite little or no formal marketing. With such a broad range of Colorado consumers willing to pay a premium for wind power, we should be interested in reasons for the demand and the premium. One reason could be as noted by the Chief Economist for USDA on a related topic: “the issue of nonmarket benefits comes up with respect to (renewables) because these products may have environmental benefits when compared to products derived from fossil fuels. However, the value of these environmental benefits may not be fully reflected in the market prices in a free, competitive marketplace. That is, the use of (renewables) may produce public goods. Products that benefit society and generate public goods may be under-produced because the benefits to society cannot be obtained by the seller in the market place. The benefits that are not capable of being captured in the market price are sometimes used as the basis for government regulations to mandate a product's use or for financial incentives, such as subsidies, to encourage its use" [Collins, 2001]. As with the demand and premium paid for wind power, we expect that *R-E Action* will assist the development of other "public goods" associated with rural power that become valued beyond the simple cost of energy.

Increasing income from Colorado's current and prospective energy crops

In 2001, Colorado farmers planted millions of acres of crops that use the sun's energy to convert atmospheric carbon and soil nutrients into carbohydrates and fats via photosynthesis. Those mostly food crops readily can be converted further to more usable forms of thermal resources or liquid fuels, often increasing their value to a level beyond their worth as food commodities. Three of these conversion end-products describe a progression that may be the basis of Colorado's energy crop future: Electricity, Liquid Fuels, and Hydrogen.

A good fuel for direct conversion to electricity may be the millions of pounds of forest residue developed annually under modern forest management to reduce the destructiveness of forest fires. This is not additional logging detritus, but natural waste that can often be co-fired with coal, reducing the net carbon dioxide output and other emissions of such plants.

Colorado agriculture crops also offer good prospects for conversion. They include about 2.5 million acres of wheat (a potential feedstock for ethanol), 1 million acres of corn and 300,000 acres of sorghum (both also potential ethanol feedstocks), and lesser acreage of barley (another ethanol prospect) and canola (an oilseed that is a potential biodiesel feedstock, with excellent oil production of more than 100 gallons per acre). While not yet a major crop in Colorado, about one million acres of canola were grown in the U.S. in 2000. As an idea of the demand for canola oil, imports of canola oil (mainly from Canada) were equivalent that year to another 2 million acres of canola production.

In terms of specialty crops with particular relevance to energy sustainability, Colorado harvested 9 million pounds of sunflower seeds (accounting for one-third of China's sunflower seed imports in 2000, according to Colorado's Office of International Trade). The availability of federal oilseed loan deficiency payments (LDP's) to farmers in 2000 boosted the total income from sunflowers by 40% to 50%, making them competitive with traditional commodity crops. Another federal program that encourages greater use of farm energy feedstocks is USDA's Bioenergy Program, which offers cash payments to renewable energy companies, including biodiesel producers, that increase their purchases of oilseed and other commodities to expand their renewable fuel production [Collins, 2001].

To gauge the volume fit of these existing Colorado energy crops with the state's fuel needs, we calculated the conversion of the above feedstocks to 'associated' renewable fuels. We used conservative (to include dryland yields) ethanol multipliers of 400 gallons per acre for corn, 300 gallons per acre for wheat and 250 gallons per acre for sorghum. Total ethanol derived from this batch of three Colorado crops would be 1.2 billion gallons of pure ("neat," 100%, E100) ethanol. Strictly by coincidence, that is exactly the total for all uses of gasoline in Colorado: 1.2 billion gallons a year. To replace that gasoline usage with a more-typical E85 alcohol fuel (85% renewable ethanol, 15% petroleum) we'd need to back out some of the sorghum conversion to avoid an excess of this biofuel compared to Colorado's consumption.

For biodiesel, we used a very rough biodiesel multiplier of 1/3 the current sunflower seed weight in oil, yielding 3 million pounds of oil, or about 340,000 gals of B100 (100% renewable diesel), or 1.7 million gallons of B20 (20% renewable diesel, 80% petroleum diesel). This would be a miniscule contribution to the 438 million gallons of diesel now burned in Colorado in a year, but could be a reasonable alternative to the confectionary sale of sunflower seeds if the price is right.

Better crop choices for oil output, and new technologies for making ethanol and biodiesel from other energy crop and inedible sources, will improve these numbers, but the key observation now may be that climate, soil, water, and existing farming practices all support the notion that energy crops in Colorado could contribute in a large way to Colorado's future fuel demand and emission equation. Also note that the EPA's estimation for diesel fuel use, which includes locomotives, attributes 36% of the resulting emissions to the Denver area. Cleaning those emission up with biodiesel would provide a shared urban-rural benefit: the rural folks would get new income streams, the urban folks cleaner air. The key to any such expanding markets could be "documenting and marketing value" as has been suggested by analysts with the Colorado Department of Agriculture [Carlson, 2002].

The Agriculture sector is by far the largest user of non-road (rail, farming, industry) gasoline in Colorado, with agricultural use estimated at 15 million gallons per year. Agriculture's contribution to the use of non-road diesel is not as clear, given the high volume burned in rail transport, but diesel use on the farm must also be very high. With *R-E Action*, we'll begin the renewable fuels transformation to offset petroleum gasoline and petroleum diesel right where the renewable fuel feedstocks are produced, on the farm. The vision with *R-E Action* is that first we'll exercise distributed generation (DG) with renewable fuels, then we'll fuel the on-farm vehicles and processes with them, and finally we'll sell farm fuels for transportation on any road or railroad that runs through Colorado's large cultivation and processing regions.

As this discussion has shown, *R-E Action*'s version of energy self-help really can start at home on the range in Colorado, with excellent prospective economic impacts from the processing of millions of gallons of renewable fuels: for example, rural sector benefits have been estimated at $26.70 a gallon, including community multipliers, from the cultivation and processing of a vegetable oil product in Colorado [Allen, 2001]. Even if we reduce that multiplier significantly by using a stricter definition of tangible value, we're in any case left with a benefits total that is a multiple of the cost of the fuel itself. To summarize, this kind of energy crop production will clearly provide outstanding economic benefits to the farm community, and that rural development payoff should encourage a skeptical look at the concept of "lowest cost electricity at peak" within the broader context of practical rural economics.

On the subject of future Colorado crops, we note that many years of analysis and testing at Oak Ridge National Laboratory (ORNL) has resulted in the definition of trees and grasses that are highly productive for cropping as energy resources. The trees include poplar, willow and sycamore, which grow biomass fast and reliably without excess water. One of the grasses with the most promise is switchgrass, a Colorado native, and important contributor in centuries past to America's Tallgrass Prairie, which thrived without irrigation. It produces energy biomass on marginal land today in Colorado (where it's grown as a ground cover without consideration of its energy prospects). It will do even better where water equivalent to 15 inches per year is present, though we must keep in mind the impact of potential future water shortages. These clearly affect the optimization question: how can we still grow food while improving rural economics with energy crops? Such biomass sources can be co-fired with coal in central generating plants, and may also heat homes in the form of compressed pellets and logs.

These biomass crops are good examples of New Energy Farming choices that don't detract from the rural sector's critical delivery of nutrients as human food and animal feed. Another example, and one that supports the nutrient-delivery responsibility, is the possible use of an energy crop like canola to *increase* the productivity of food crops like potatoes and barley. Because plants in the mustard family develop chemicals toxic to bothersome underground pests like nematodes, we may find that a rotation of the oil-seed crop canola with potatoes and barley increases the yield and decreases the need for pesticides in the crop following the canola. Canola planted in such a natural cycle could be doubly beneficial when the value of the vegetable oil is counted. Tests of this idea are being considered now in the San Luis Valley.

We also should note that significantly more energy resources could be developed from Colorado's livestock industry, with major contributions possible from beef, pork, and poultry. Everything from manure to slaughter trimmings has potential in the conservation and control of energy scheme proposed by *R-E Action*.

Products and Services of *Rural-Empowering Action* (*R-E Action*)

1) Energy-efficiency retrofit (objectives: load reduction and load shaping)
Controlling energy costs is one way to help Colorado rural enterprises stay competitive. Since the costs of natural gas and electric energy in Colorado are among the lowest in the nation, we must examine the elements of energy cost for guidance on where retrofit funding best would be spent. Typically energy audits have concentrated on identifying opportunities to reduce heat transfer by conduction and convection. But the rules of the game are changing, and better results may be obtained by looking at details of energy use, for example, farm energy bills suggest that low-cost control of peak electric power use may yield the most rapid payback of an investment in energy cost improvement. This is because the utility company must charge for the maximum load on the grid to account for the cost of properly sized generators, transmission lines, distribution lines, transformers, and service loops. So while we also look at all electric energy and natural gas use for long-term conservation savings opportunities, we're especially mindful of the coincidence of electric loads in ranking energy retrofit opportunities for payback.

Before further examining peak electric loads, we note that overall thermal losses in winter should be addressed with simple retrofits like weather-stripping and increased insulation. These low-cost retrofits are nearly always cost-effective on farms. Making the built environment much more comfortable for humans and animals, they also greatly reduce the two primary heat loss mechanisms of convection and conduction. Complementing these reductions in heat loss should be an effort to increase usable heat gain in homes and other buildings by capturing more of the thermal energy generated as the low-lying winter sun strikes south-facing surfaces. Combining these two strategies could reduce heating loads by at least 20%.

Examples of energy retrofits in urban environments, where peak control of electricity has been practiced longer, provides a template of current opportunities that often parallels those in the rural setting of farm, ranch, or town business. In a large urban office building, for example, we would first look at the efficiency of the existing lighting system. These lights make up the major part (as much as 50%) of the electric load of such a building, directly using energy to provide illumination and indirectly requiring cooling energy to remove the heat generated by the lighting fixtures. This major building load of lighting is directly related to the productivity of the building, so lighting is considered a likely part of a building's peak load.

On a typical farm, there may be similar opportunities for reducing lighting loads with more efficient light sources, and with the broader use of natural daylighting.

A second major electric load in urban buildings is space cooling, typically achieved with refrigeration compressors. After the heat generated by the lighting and office equipment, the other major heat load on the building is from the outside: air temperature and solar heat gain. Since those generally peak at the same time the offices are occupied and lighted, the cooling load is often a big contributor to the summer peak load of the building.

On a typical farm, space cooling also may be accomplished with refrigeration compressors, by fan power alone, or by a combination of the two. Reducing cooling loads on this equipment will reduce the amount of energy used, and make an impact on the peak load as well.

An additional measure that makes economic sense for many office buildings, and is likely to be applicable in some rural locations as well, is thermal storage. Such cool storage is chilled during the off-peak hours, when electric rates are lower (often effectively half as high). Then the stored ice and chilled water either is used to

1) Subcool the 95F working fluid to 40F upstream of the expansion valve, or

2) Remove heat from the condenser (e.g., taking it from 115F to 50F).

Either way may be the more practical, in one application or another, for cooling the air economically during on-peak hours, and saving the cost of operating the compressors during the highest-cost periods. Rural locations have two advantages over most urban sites in the placement of thermal storage systems: more space is typically available within which to locate the thermal storage tanks, and there are often other cooling loads (like milk or produce) that also can take advantage of a thermal storage system.

Two loads that are seen on the farm far more often than in the city are irrigation water pumping and stock water pumping. Opportunities exist for reducing the coincident peak on the utility grid by operating these pumps off-peak and using the earth or stock tanks as the (water) storage medium. This may be healthier for the crops, too; disease management advice for barley suggests watering early in the day and allowing the field to dry out. Another option is to operate DC pumps directly with wind or photovoltaic electricity, again using water as the storage medium, not electricity, in the latter case from panels mounted on a wheeled rig that can be moved with the need (now being tested by K.C. Electric in Colorado).

Other loads like space heating or water heating are most often met with the direct combustion of fossil fuels, which could be replaced with renewable fuels. It is also important to find and control miscellaneous electric heaters that may be contributing to higher energy bills.

2) Load Shedding (Objective: peak demand reduction)

During a peak load period, there may be electric loads in an office building or on a farm that contribute to the peak but are not critically important at that particular time. Examples could be certain lighting, pumping, or electric water heating loads. Controls are available that allow an electric customer to reduce peak load costs by identifying those loads in advance of the peak period, and prioritize their operation so that some functions are automatically disabled for a critical period (if it's done manually, it's also called "load shedding"). This could mean a lower lighting level in one area, or a pump that will not operate until after the peak load period. Little or no energy is saved with these controls, since the lost output must often be replaced during off-peak hours, but the high cost of coincident peaks can be greatly reduced.

3) Exercise of Standby Generation (Objectives: peak load support & revenue)

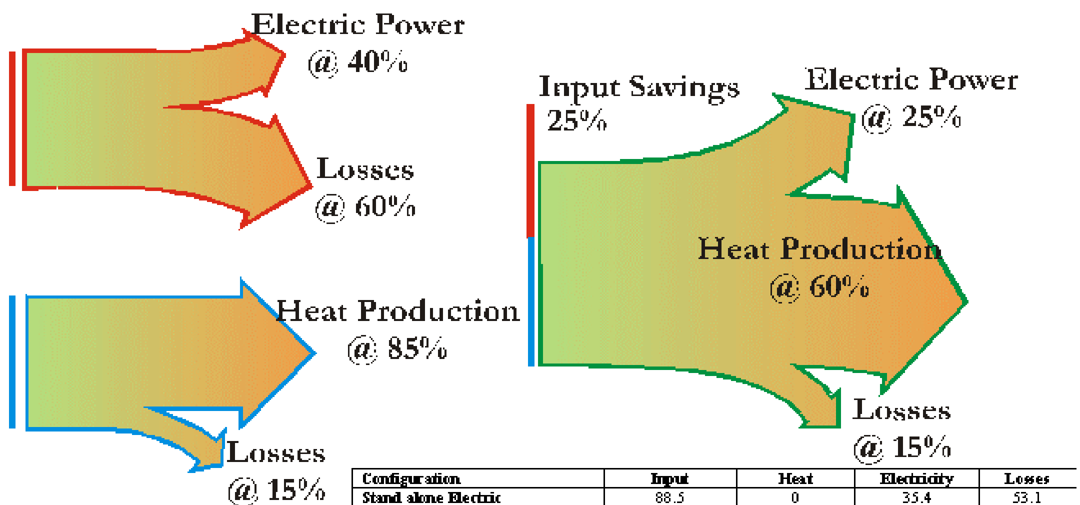
Many commercial buildings, farms, and rural health care facilities have access to emergency or standby power from on-site generators. These gensets usually operate in the absence of grid power to maintain critical loads on the property. In a commercial building, these loads might be the elevators and emergency lighting. On the farm, they could be the cooling fans for livestock.

These gensets are often operated just a few hours a year, when outages threaten safety and health. But the investment in the gensets could be classified as "sunk cost," meaning that no matter whether or not they are used, the major capital costs of purchase and installation has already taken place. And there are other uses for them. Consider that they could provide peak power by being operated at times that the utility may be stressed with large peak power use. Such extended operating hours (perhaps 500 hours to 1000 hours a year) aren't a viable option today in urban areas, because operating generators with standard (high sulfur) petroleum diesel produces emissions impacts that are not allowed. But in rural areas, which are typically not out of compliance with air quality limits, control of emissions from such small generating units may not be required, and the use of biodiesel reduces the impact considerably.

By operating the gensets with renewable fuels (like biodiesel), post-treatment of the emissions is possible without poisoning the emissions apparatus with the sulfur found in today's petroleum diesel. In addition, the rural electric grid is supported at the same time farm fuels are being consumed. The grid, the environment and the rural economy are the instant winners.

The regional advantages of using such existing distributed generation, fueled with regional renewable fuels, to support the grid at peak include:

- An immediate operating saving of the 10%-16% line losses estimated as the average from central generating station transmission and distribution in the U.S.; during grid capacity constraints at peak these losses will be higher (as high as 35% in rural Australia, for example)
- A prospective generating station saving of another 20% to 40%, given heat-engine conversion efficiencies, if local use can be made of the waste heat of combustion generation, usually lost to the atmosphere (e.g., for pasteurization, incubation, crop drying, water or space heating, thermal mass loading for livestock comfort, seedling or greenhouse heat, etc.). **Figure 6** describes the power plant savings prospects visually, and suggests the importance of identifying such cogeneration (often called combined heat and power, or CHP) prospects, either existing or co-located, in rural regions.



Configuration	Input	Heat	Electricity	Losses
Stand alone Electric	88.5	0	35.4	53.1
Stand alone Heat	100	85	0	15
Stand alone total	188.5	85	35.4	68.1
CHP to provide same heat and e	142	85	35.4	21.25
Input Energy Saved	46.9			
Perecntage of Stand Alone	25			

Figure 6. Plant Efficiencies from Combined Heat and Power (CHP) [Overend, 2001].

- A further saving of the 10% to 15% devoted to central heat-engine "house power," the energy used in the plant itself and not available for sale
- A capital cost saving, as these existing distributed gensets cost nothing additional to build, and very little to modify and maintain to get the extra power
- An economic driver, as the use of regional fuels yields excellent in-sector multiples (i.e., payments are re-circulated more times through the community than are payments for imported energy of any kind)
- Higher overall payments, credits, and tangible benefits for self-generated power than the operating costs (or the units will remain on voluntary standby status)
- Construction lead time of effectively zero, since these distributed gensets already exist
- Lower overall emissions contributions from renewable fuels for electricity generation, with an output that may offset some of fossil fuel's contribution at peak

- Safer and more secure operations; the operation of these gensets with regional renewable fuels could be considered safe from virtually any perspective (in contrast to generating systems using higher temperatures, higher pressures, or radiation), and are too dispersed to present an attractive target for major power system disruption
- System benefits, as the infrastructure created to supply regional fuels for power generation can be used to supply the same or similar fuels for transportation, heating and rural industry.

4) Dedicated renewables generation (Objective: offset of fossil fuel sources & new revenue)
Another energy management option that can be economically viable and environmentally sound is the use of dedicated gensets made specifically for a plentiful renewable energy resource like wind, solar energy, or methane. While the environment is the immediate beneficiary of renewables, they could also improve the energy security of the region, since "there are no…(fuel-associated) military expenditures, no vulnerable pipelines that require security surveillance, (and less) need for… transmission lines that could also be terrorist targets" [Asmus, 2001].

Gensets using the power of the wind have found wide acceptance in California and across the Great Plains. They trade the advantage of "free" power for the disadvantage of the free power's variability. But they provide other advantages over conventional fossil fuel power, mainly because the power they produce is associated with neither significant emissions nor other hazardous output, and uses little or no water. And the variability of wind output has been shown in practice with large grid systems to be far less an issue than originally thought. Even when wind constitutes up to 20% of the grid supply, the fact that it is very predictable hours in advance allows it to be treated much like other cumulatively large, variable loads on the grid (e.g., street lights or television sets).

Capturing the wind's power is often done with arrays of many towers and turbines stretching over the prairie, called wind farms, where the infrastructure costs of roads, construction, and maintenance can be shared among many machines. But there are many examples of cost-effective singletons or clusters on farms in Iowa and Minnesota, where there is even less disruption of traditional row cropping. Colorado also has local areas on the eastern plains where the existing wind resource is encouraging for either large wind farms or clusters of wind machines. Advantages of installing a small residential-size turbine:

- First cost is lower
- Tower is more easily sited and built, and
- Performance is better at the lower wind speeds more commonly encountered.

Advantages to a larger, co-op size turbine, of the sort shown on the cover of this report: it can serve larger co-op and other light rural industrial loads, making a more efficient contribution to the grid, and parts and service may be easier because the machine could be identical to those installed by the hundreds or thousands on regional wind farms.

The photovoltaic panel is also gaining growing acceptance as a distributed generation technology. These panels convert sunlight directly into electricity with no moving parts. While their first cost is higher, their operating costs are much lower than conventional fuels. As with the other renewable energy sources, their payback of first cost, often calculated for photovoltaics in decades absent market-leveling subsidies, must be calculated with comprehensive benefits in mind, or they just don't make economic sense. Also as with the wind, electrical output varies from PV panels, in this case depending on the availability of sunlight at the site, though statewide Colorado enjoys one of the better solar resources in the nation, as shown in **Figure 7**.

Other renewable resources that are plentiful in many rural locations include methane gas (from the breakdown of livestock wastes) and biomass, including agricultural and woody wastes that are combustible or convertible to alcohol or biodiesel.

Another particularly rural renewable resource could be power generation from the release of impounded water. Colorado has hundreds, perhaps thousands, of such impoundments, mainly used as capacity reservoirs for city supply or irrigation. We should look at the cost-effectiveness of gaining power from some or all of these rural water impoundments, and how it can be done in an environmentally responsible manner [Lehr, 2001].

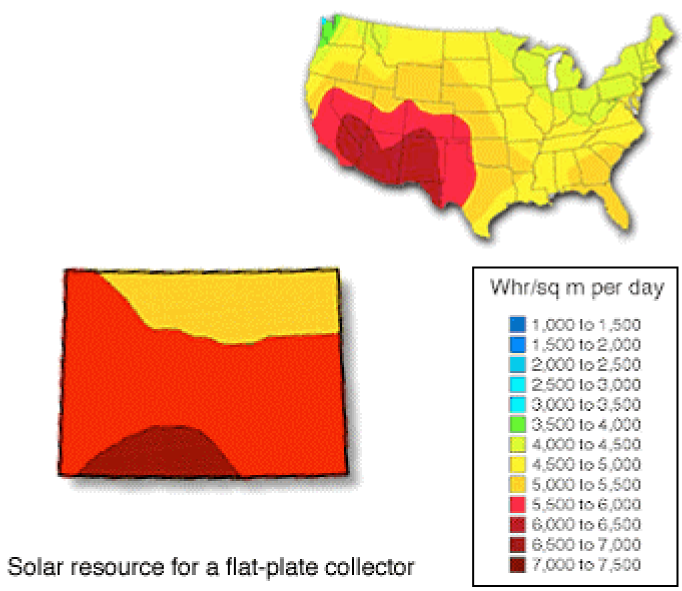


Figure 7. The Solar Resource. An excellent energy alternative in Colorado [Interstate].

As with the use of gensets fueled with renewables, the grid itself can be used to transfer the electrical output of renewable power from areas of abundance to areas of need. It has been shown in recent studies that the appropriate sizing and placement of distributed renewables generation can offset concerns that the grid would need upgrading to accept significant amounts of support [Wind, 2001].

5) Control, sale, and dispatch of energy resources (Objective: maximizing control and revenue)

One important aspect of *R-E Action* is the development of a market for power generated at peak. For full value to the generating participant, proper accounting must be made for the value of this renewable power. Accounting considerations include ownership and operating characteristics of the equipment, and the more valuable of such power resources will be those that can be best controlled, and that are the most reliable. *R-E Action* expects to benefit from a form of control and aggregation now being field-tested with independent diesel gensets on Colorado's eastern plains [Goldberg, 2001]. Sale of premium-priced "green" power may be possible with such aggregation, distribution to the buyer being through and out of the local utility grid. It may also include (whether connected to the grid or not) green tags or other environmental benefit certificates that have sales value or trading worth.

Various economic dispatch modes could be useful to the generating participant in *R-E Action* to either reduce energy costs or to prompt a revenue stream. Sophisticated controls and expert systems software can be used to maximize the benefit to the participant with little or no active involvement. Five typical dispatch modes are described here, several of which could be integrated with controlled demand-side reductions to increase their impact:

1. Peak-shave on-site to reduce metered peak loads for the facility. This means offsetting peak loads with generation, to reduce the spike peak demands otherwise felt by the grid and recorded on the customer's meter. Such peaks can occur during normal operations when loads coincide, and often account for one-third or more of the monthly bill. Much more level measured demand can be expected when generation picks up that spiking load, with a corresponding reduction in the utility bill.

2. Peak-shave at the utility's request, or under the utility's control, to relieve transient distribution or transmission constraints during peak periods, using the same procedure outlined above and being compensated in an agreed-upon manner by the utility (possibly in the $0.15 to $0.20 per kilowatt-hour range for relatively short time periods, if constraints are severe).

3. Provide distributed voltage support, reactive power, spinning reserve, or "black start" capability to increase the quality and reliability of the local/regional grid. The value of this service will depend on the utility's need, but could also amount to $0.15 to $0.20 per kilowatt range, if those types of constraints are severe.

4. Operate existing "standby" generation with renewable fuels to "firm up" other more-variable alternative resources, like wind or photovoltaics. By increasing the availability of these variable resources to near-unity for the renewable total, renewable power becomes a kind of premium commodity, with the wind providing the least-cost but variable portion and the alternate-energy-fueled genset providing the more costly portion that fills in the valleys of the power output curve. Xcel in Colorado now sells such premium power for 2.5 cents per kWh more than the cost of their other power.

5. Operate the generator with renewable fuels to produce a "green" power product that can be sold into the growing market for such premium power. With or without integration with wind-power integration, the output of biofueled generation may be salable to buyers of tradable certificates, sometimes called "green tags." Such sales can take place even though the power itself may never leave the premises of the generator participant in *R-E Action*, with partial credits often available even when it is "blended" with higher-emission sources.

Bundling of Products and Services

R-E Action could provide a "one-stop shop" for putting the demand-side/supply-side package together, from the energy-user's perspective. Some options, from the simplest to the more comprehensive:

- A single entity audits the enterprise, then gives the customer a list of "approved" companies that can do the retrofit work in each of the four categories of 1) base load reduction, 2) load shaping, 3) load shedding, and 4) load matching with renewables generation, or booklets of self-help instructions, if requested.
- Add to the above a contracts facilitation role, in which the customer asks the entity to contract for the selected retrofit package, with options of a warrantee on the energy performance, and/or an energy performance contract that advances the cost of the retrofit package for repayment out of future energy cost savings or receipts, with the risk being carried by and reasonable return going to the financing entity.
- Add to the above a bundling of the service cost into a package for a co-op or other economic development interest, then sold to a lender willing to accept periodic payments from the co-op or utility company based on new energy cost savings or revenues. Another option could be the rural set-aside of Colorado's unique CAPCOs, which could be used as a funding backstop if traditional funding was not available and the venture wasn't eligible for revolving loans from the state.

Grid Support Value

The distributed energy delivered under *R-E Action* should be recognized for the value it provides to the grid at the time of peak. The value to the grid is not simply the removal of load or the provision of distributed supply when the grid is near capacity. In addition, the utility industry generally recognizes the value of distributed generation in voltage regulation and stability. Both benefits are especially applicable to rural grids, where long distances and relatively light loads exacerbate the problems for the power supplier. Coming to agreement on the fair value of these benefits will be one of the great opportunities and challenges of *R-E Action*.

Optimizing Beneficial Environmental Outcomes

Environmental outcomes will be an important Plan consideration by

- Screening program elements for environmental issues or opportunities
- Making environmental quality a selling point for this emphasis on improved demand-side and supply-side energy control
- Selecting recommended product or service vendors based on "clean, green" qualification
- Looking for ways to provide biological diversity, nesting and cover habitat for wildlife with alternative energy feedstock crops
- Selecting energy crops for their reduced requirements for water and energy-weighted inputs like fertilizer, pesticides, and tillage.

Future Benefits from Development and Expansion of Initial *R-E Action* Services

Biofuels infrastructure – We propose to use the upgraded ag-based fuels infrastructure developed under *R-E Action* to support renewable feedstocks for lubrication and transportation fuels (e.g., for NAFTA trucks traveling Highways 287 and 385, railroad engines crossing eastern Colorado, and school bus fleets), farm industry (trucks, tractors, combines), and space heating (vs. propane). The operation of a network of small "starter" facilities (e.g., oil-seed crusher, oil extractor, biodiesel blender; or the equivalent facilities for processing of ethanol from starch and sugar feedstocks) would be a workable solution to the dilemma that occurs because farmers are not interested in growing crops for which there are few buyers, and process plant investors are not interested in building process systems without a ready supply of appropriate crop feedstocks. This project could provide the necessary stimulus to initiate action. Over 80 national fleets have already converted to one blend or another of biodiesel, and readying the natural fuels infrastructure in Colorado will make such conversions much easier in support of plains agriculture. Additionally, co-products of farm fuel processing are already economically viable in other markets for applications as diverse as livestock feed and bridge de-icer.

Upgraded communication infrastructure – We can use the *R-E Action* communications upgrade, necessary in some locations to reliably link separate demand/supply resources, to support other rural services and opportunities. The relative geographic isolation of rural dwellers has always encouraged an independent mindset and the self-starter production of a range of agricultural and non-agricultural products, but these efforts often have suffered from the lack of rapid and reliable market connections needed to make the effort financially worthwhile. With the improvements derived from *R-E Action* and other sources, we expect better telecommunications to facilitate high value service delivery, fitting several observable market trends:

- Companies are tending to outsource more non-core services
- 24-hour/7-days-a-week international service requirements are improving the prospects for part-time and flexible hours
- The number is growing of both independent contractor assignments and occupations not requiring face to face contact
- There are more opportunities and support every day for telecommuters and other independent workers. Such opportunities could include:
  - ❖ Internet education and training (e.g., guided GED study, online testing, student performance tracking, instructor training and support, interactive laboratories, access to specialized computer software, and programming instruction)
  - ❖ Special Internet careers (e.g., remote personal computer hardware/software support, development of educational and informational content like risk assessment and co-op basics, software development, business and life coaching, internet research)
  - ❖ E-commerce (e.g., contract order-taking, consumer counseling, auctions, arbitrage, or selling on-line the farmstead production of specialty food and handicraft products)
  - ❖ Enterprise management via the internet (e.g., assistance provided to the job of farming or ranching via real-time or FAQ coaching that supports success factors, weather and economic data support and economic assessment methods, "lessons learned" archives and case histories on key rural topics, targeted response to topical human health, safety, or stock concerns, financial management and market research, list-serves on rural topics)

Technology Transfer – clean and green generation methods and technologies developed under *R-E Action* (e.g., post-treatment emission reductions possible with zero sulfur ag-based genset fuels) can be transferred to urban centers, offsetting the planned increase in urban peak demand requirements with much cleaner distributed generation

Alternative Energy in the Rural Sector: The use of alternative energy crops will be facilitated by *R-E Action*, and their use will in turn fulfill a number of rural enterprise needs: products to satisfy a growing consumer demand for "green" energy; a reasonable response to society's changing energy security perceptions, and the higher margins that farmers can realize from a products that are in greater demand.

The *R-E Action* concept provides an energy-based economic driver for rural America, derived from the main attribute of the rural sector: its citizens' ability to efficiently convert natural resources into other useful forms of energy. Biomass energy has the potential to supply a significant portion of rural energy needs, giving farmers a valuable new outlet for their products. Rural communities could significantly enhance their energy self-sufficiency, particularly during times of peak demand when system reliability is at its most vulnerable. When combined with the conservation measures discussed above, the use of locally grown energy crops and residues to power cars and tractors, and to heat and power homes and buildings can be just as thermally effective as current fuels, but far more economically sustainable for the rural sector.

Examples of successful experiments with energy conversion include extensive experience over the years with biomass and biogas [Klass, 2001] bioethanol and the more recent market entry of biodiesel [Lynch, 2001], and geothermal heat pumps [International, 2001]. The use of these resources for electricity generation has been accelerated by the success of projects such as those by Northern States Power, with large scale examples of generating energy from poultry waste, sugar beet pulp, and wind farms, made in response to conditions of the 1994 Prairie Island Agreement (allowing nuclear storage in exchange for development of a renewables portfolio).

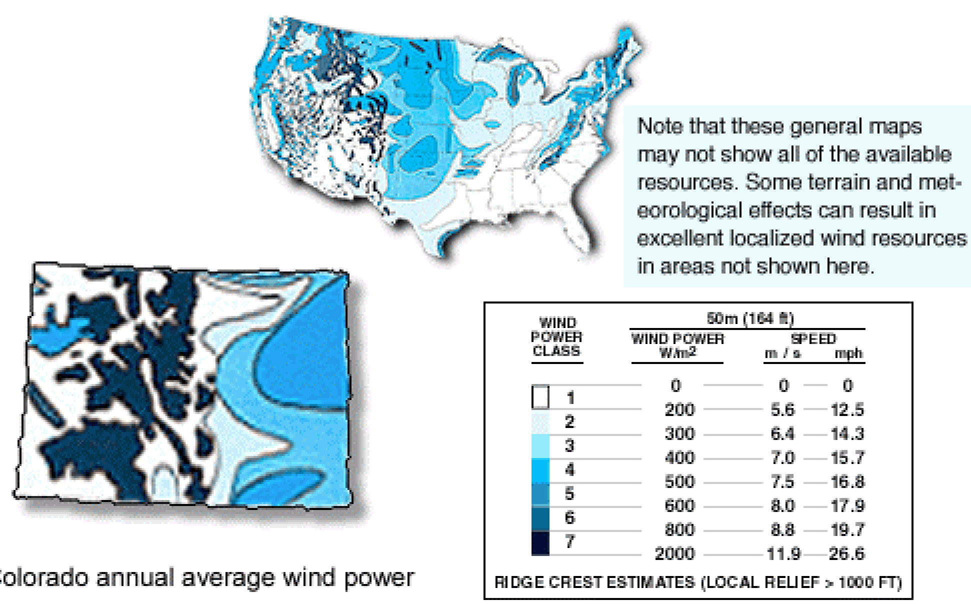


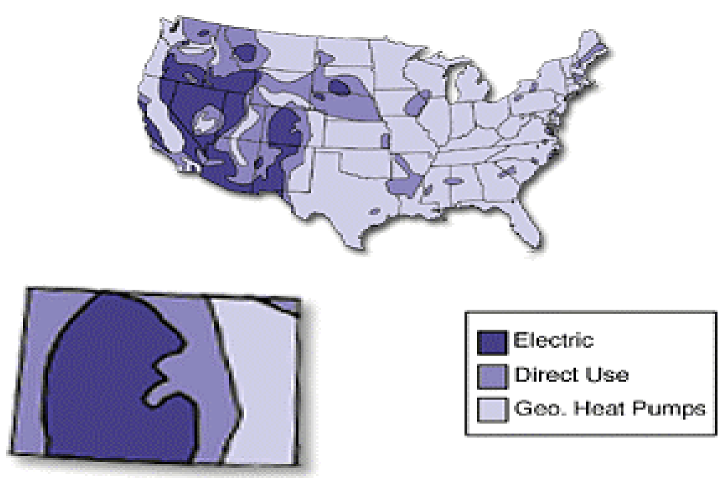
Figure 8. The Wind Resource. Colorado has the 11th best in the nation, according to the American Wind Energy Association. The eastern plains have especially good annual wind speeds [Interstate].

In addition to these biological resources, the direct use of rural America's abundant solar energy and wind resources is well known for applications ranging from photosynthesis, soil warming and crop drying to plant pollination and pumping water. In fact, solar and wind are taken for granted as reliable, traditional elements of farm life. Today, wind and solar resources are considered viable inputs for advanced energy generation to power any number of rural electrical applications, with, interestingly, some of the same siting considerations of visual impact and noise that were associated with the original windmill towers and turbines.

Wind power, though, now is experiencing rapid growth and commercialization in the U.S. and around the world due to improvements in blade design and operation [Bergey, 2001]. It is the fastest growing form of electric power generation in the world, and on America's Great Plains is likely one day to be a large contributor to the grid, if the excellent potential shown for Colorado and the Midwest in **Figure 8**, are even partially captured.

Alternative fuel crops have been shown to be economically viable and environmentally sound. Advanced energy-conversion methods using agricultural/woody residue or waste and other clean resources has resulted in demonstrated reductions in operating costs, improved income, decreased local pollution and generally increased prosperity and self-sufficiency for farmers and ranchers [Tyson, 2001]. Additionally, surrounding local and regional areas enjoy broader economic impacts as more dollars are retained and re-circulated in rural communities rather than being spent once on imported fuels.

One resource that is especially prevalent in Colorado is often overlooked, though it is the basis for unique heating systems at many popular resorts. That asset is our excellent geothermal resource, a legacy of the relatively recent uplifting of the Rockies. The chart in **Figure** 9 shows that significant thermal energy is available in many rural areas of the state, and that the entire state offers the prospect for applications of bulk heating and cooling directly from the thermal



mass of the earth.

Figure 9. The Geothermal Resource. All of America has a reasonable resource for geothermal heat pumps, with many locations in the West having higher stable working temperatures [Interstate].

During this period in which our national leadership has declared an energy crisis, [Novak, 2001; Nighthorse-Campbell, 2001] *R-E Action* offers a range of supply-side income and demand-side cost reduction opportunities that will contribute to rural economic development and self-sufficiency. It addresses the flow of energy into and out of the rural sector with an eye toward making better use of existing grid power as well as the abundant natural resources available in rural areas.

By integrating energy efficiency and load control with distributed generation using local energy resource inputs at discrete rural locations, *R-E Action* allows farmers to reduce the burden on utilities during peak periods and permits those aggregated resources to be applied to new markets for "clean" power in the sector and the nation. Several observations support this view:

1. The rural sector's unique demand side electric loads offer opportunities to implement existing methods for reducing energy use, shaping power loads at peak periods and shedding discretionary loads on command [Crossman, 2001]. Utilities have shown themselves more open to such program proposals if the energy interventions will increase off-peak (winter) energy revenues while simultaneously reducing peak (summer) compressor loads. Just a part of *R-E Action*'s demand-side package (capitalizing on energy efficiency opportunities, some of which will meet the utility's test) could cost less than 3 cents per kilowatt-hour, if the research done for the Midwest's Clean Energy Plan is any indication. Their calculations show a payback of $1.80 over 20 years for each dollar invested in energy efficiency [Environmental, 2001]. That sum, while not large, is at least positive, confirming that with sufficiently low delivery costs demand-side savings can be a reasonable investment for end-users and of benefit to the utility, also.

2. Exercising customers' distributed generators for the benefit of increasing system reliability has been so successful that Florida rural cooperatives now use the method regularly for peak shaving [Holt, 2001], with a growing capacity now totaling 125 megawatts (mW) in one part of Florida alone.

3. The value of distributed generation is highest to the utility (e.g., more than $6.50/W for installed PV, according to PG&E's Kerman study, reducing the net cost of a $10.00/W PV installation to $3.50/W "in a perfect world") where the distribution lines from central resources are longest and the loads lightest [USDA, 2000], precisely the situation for the majority of rural energy users.

4. The use of renewable fuels for supply side contributions demonstrably improves the energy balance and emissions equations for all rural enterprises [Union, 2000].

One of the renewable fuels with the longest records of success is ethanol. Made now mainly from corn (foremost among 20 crop sources that are possible), this fuel alternative will in the future more often be made from other lignocellulosic materials such as agricultural residues (including hardwood and softwood wastes), and other forms of biomass waste (e.g., even grass clippings and waste paper). The cellulose and hemi-cellulose components of these materials can be viewed as essentially long molecular chains of sugar-like structures, the stuff of which ethanol is made. However, these "sugars" are protected by lignin, a natural polymeric 'glue' holding all the material tightly bonded.

Because of the vast potential for biomass-derived alternatives to petroleum oil products, considerable research at the National Renewable Energy Laboratory (NREL) and other government and private laboratories is underway to develop processes (often using enzymes and/or acids) to break down lignin. Ethanol from corn, our source for virtually all the 1.4 billion gallons of ethanol produced in the U.S. in 1998, is thought by some to have too many issues to significantly displace oil [Environmental, 2001]. However, rather than upsetting the farm applecart by not allowing corn to make ethanol, lignin-dissolving technologies should further benefit farmers since their corn (or wheat, etc.), and more particularly its residue, will have world markets; one as food, the other as fuel. Forecasts predict that biomass-derived ethanol will be produced in the future for as little as $0.57 (US) per gallon [Ibid].

Ethanol production facilities, with their high steam demand, would make good host sites for electricity co-generation (CHP) facilities. Distributed generation plants, many of which can also provide hot water for process uses, appear to be environmentally and economically sustainable as well as being far less prone to terrorist attacks than conventional power plants.

5. The “bootstrapping” effect of producing and using agricultural based fuels has been shown to have particularly strong and beneficial multiplying effects on typically more-isolated rural economies [Collins, 2001].

Key elements of *R-E Action* have already enjoyed niche successes in other fields, and we will now combine these elements in ways unique to the rural sector. Our technical approach will involve engineering, economic and market assessments of existing technologies and methods that can be altered and combined in new ways to be most effective in rural applications. Parallel investigations will address potential barriers to implementation of the program as well as explore existing rural institutions, commercial practices and entrepreneurial enterprises that will support the program.

While the main output of *R-E Action* is expected to be economic improvement in the rural sector, there will be at least one other major set of impacts: We will reduce constraints now existing in the provision of rural electric service during system peaks, while expanding markets for ag-based fuels developed on those affected farms. This combination of impacts will serve as a transition to a future that better uses farm fuels. In this prospect, we’ll see the broad use of fuel cells operated with hydrogen-rich ag-based fuels all across the Great Plains.

PROSPECTIVE BUSINESS PLAN FOR *R-E Action*

We believe that the two strategies needed to successfully introduce the elements of *R-E Action* to the rural sector are to

> 1) Phase the approaches to full program implementation, incrementally adding technologies and partners to develop a workable process step by step, and
>
> 2) Minimize programmatic risk by fully involving rural participants in *R-E Action's* development and implementation.

By focusing initially on less difficult technical issues and resolving them early with our rural partners, the *R-E Action* team will accumulate in-field experience and credibility and reduce the implementation risks. This approach essentially means that we will begin with "off-the-shelf" energy control products and services, and existing rural cooperative participants.

Existing Energy Concepts **–** *R-E Action* will integrate proven energy conservation approaches (energy efficiency, load control, and distributed generation) in a rural setting with alternative supply resources. Each of these demand reduction approaches have been demonstrated in urban settings, and some rural settings as well. Energy efficient lighting, for example, is now "expected" in city office buildings, with retrofits meeting strict payback requirements [Crossman, 2001]. The operating characteristics of the equipment are well known, and delivery is immediate from multiple vendors. Similarly, electric demand management is now common in hospitals, banks and schools across the country, taking advantage of utility tariffs that recognize the peak value of power distribution.

Cities as varied as New York and San Diego have implemented programs this year to use existing, installed distributed generation (which in the form of existing standby/emergency generators can today account for 5% or more of the utility grid capacity) to reduce constraints and shortages at peak times [Brooks, 2001]. Examples of large energy users integrating these elements in one location, so that load shedding and generation take place simultaneously when they economically benefit the operator most, have been successful in urban settings].

More refined methods for controlling discrete demand side and supply side resources developed in the last few years have resulted in substantially reduced costs to utilities for upgrading generation, transmission and distribution facilities, and with better system power quality and reliability. In this evolution, disparate power resources from different customers at geographically distant locations are combined and controlled centrally to act like a larger generating station [Goldberg, 2001].

We'll modify these existing products and services according to the guidance of our rural participants and our field demonstration experience, and compile them into an integrated energy resources package.

Rural Cooperatives **–** *R-E Action* proposes to advance the "rural cooperative" model, now supporting telephone and electric utility systems (25 million co-op customers), hospitals and schools, and bulk buying services. Co-ops have traditionally provided a way to help rural citizens control their own destiny, without depending on urban vendors to extend services unprofitably far. They apply the strength of numbers marketing, resource acquisition, and leadership/governance. We expect that the Rural Cooperative model will allow accelerated development and implementation of *R-E Action*, while increasing the exchange of ideas, operating methods, and other key information. All that we know about tech transfer suggests that successful implementation depends on such groups of local people making pioneering decisions and becoming “champions” for change.

On a continuing basis, *R-E Action* Co-ops could make a critical difference in implementation success; their unique position allows them to

1. Reduce energy price volatility risks, by supporting improved energy management and energy crop alternatives to imported fuels

2. Reduce energy management time, attention, and effort required by individual farmers by fielding rural energy specialists, knowledgeable people who can show how these new energy opportunities can be used to initiate, maintain, grow, and leverage profitable rural businesses.

3. Improve the management of energy investments, by offering
   - energy investment payback guidance specific to rural energy uses and rural financial resources,
   - a structure under which participants can obtain easier standard financing of qualifying cost-reducing energy upgrades, based on the co-ops access to low-interest rural development funds,
   - alternative “energy performance” financing with little or no capital expenditures and positive cash flow from the start, and
   - energy contract templates, suggestions, and assistance to cut through the confusion and reduce the resistance to legal forms, both of which often dissuade prospective energy program participants

R-E Action will support the co-development of future and ancillary markets for renewable, ag-oil-based products. These could include higher-lubricity oils and greases used for engine lubrication, transmission and gears, polymers with outstanding biodegradability, and cleaner, greener inks made from corn, soy, and linseed oils. All of these products have attributes that give them particular advantages in the growing market for safer, healthier solutions, including shorter environmental persistence, lower toxicity to humans and animals, and reduced solvent evaporation to the atmosphere than their petroleum-based equivalents.

We’ll provide this support by building and optimizing the renewable fuels processing and delivery infrastructures in ways that are useful, *as is*, for other developmental product needs. This co-development is important to the overall objectives of *R-E Action* since further infrastructure development will not be affordable for every new renewable product application.

An example of co-development anticipated in *R-E Action* is the advantage gained by using the same type of crop feedstock oil for biodiesel that is already under development as a premium lubricant by Agro Management in Colorado Springs, among others [Allen, 2001]. The Plan expects to leverage the development of this lubrication product by processing the oil into biodiesel for use as a distributed generator fuel in rural markets. To follow the example one step further, the intent is that the infrastructure elements will then have immediate utility in delivering a biodiesel transportation fuel. With a sound “natural oil” processing and delivery infrastructure in place, expansion of the processing, delivery, and marketing infrastructure can more easily take place from *R-E Action*'s early small-scale roots, greatly reducing business risks for the renewable energy fuels entrepreneur. To recap, the Plan expects to accelerate the commercialization of renewable diesel in three steps:

1. Develop a crop feedstock oil as a Colorado premium motor lubricant product (currently underway in parallel with *R-E Action*);
2. Use Colorado's new and developing ag-oil processing infrastructure to initiate the manufacture of biodiesel for fueling diesel gensets under *R-E Action*; and
3. Improve the economics of Colorado's new renewable diesel by extending the market to the fueling of trucks and locomotives as they wheel through the cultivation and processing regions of the state.

The tactical elements of the *R-E Action* concept rely on the author's experience with energy services companies (ESCO's) and energy performance contracting. Integrated demand-side/supply-side packages for rural participants are expected to closely resemble commercial demand-side retrofit packages, so the same type of bankability and loan structures will apply.

For example, a package of energy-saving measures like lighting fixtures and solar film in a large office building in Denver could be quoted to the building owner at $450,000, with a three year "simple" payback from annual energy cost savings of $150,000, out of which the capital costs and carrying charges could be deducted over time with no up-front investment necessary. Similarly, our example in Appendix C describes a combination of demand-side and supply-side retrofits for Ohl McDonald's hypothetical farm in which only 42 months of new cost savings and revenue pay for the $144,000 package.

Potential Barriers*:* Several barriers exist to integrating rural power resources cost-effectively. The overall relationship of their impact and importance is shown in **Figure 10**. [Overend, 2001].

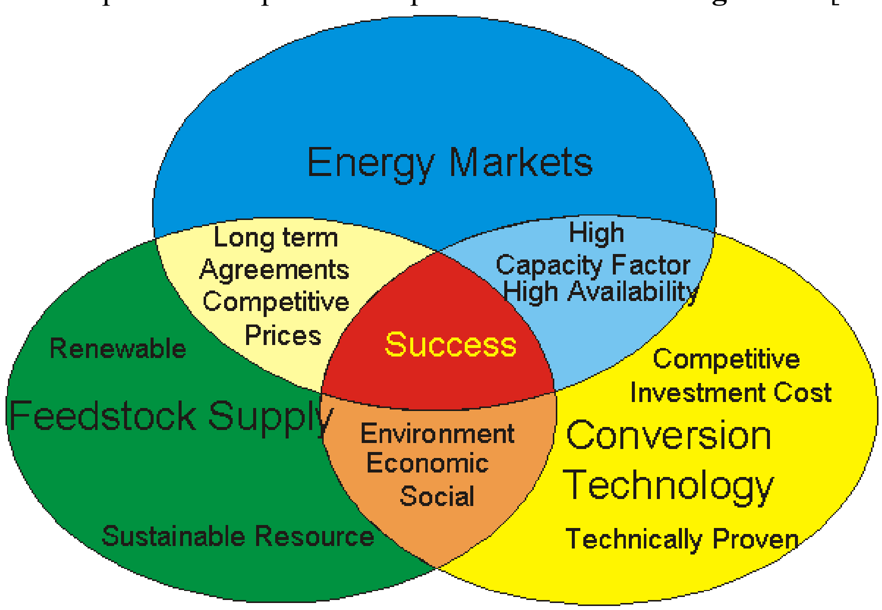


Figure 10. Renewable Project Requirements [Overend, 2001].

Cost of electric power, which is relatively very low – The most important barrier to energy control and the use of renewables in Colorado is the low cost of electricity, but cost is not the only factor that should be considered. For-profit companies financed by investors typically own electric utilities, or they are publicly owned. Public ownership means nonprofit entities owned by the community they serve, and operated by municipalities, counties, states, public power districts, or other public organizations. The utility systems in most of rural Colorado are owned by the citizen participants in the rural electric co-op. Working and living in the community, they have more of a direct interest and voice in decisions and policies about rates, services, generating fuels, and the environment than do shareholders of an investor owned utility. Therefore, the rural economic development benefits of *R-E Action* should resonate with them differently than with others.

Today, an additional and growing motivation to improve energy use is the desire to be involved and make a difference in the reliability of the rural energy delivery infrastructure, as vulnerable as any other to intentional damage. Such attention recognizes that low power costs may be a relatively minor consideration in planning and operating the grid at peak. *R-E Action* will highlight the energy security challenges we face and the prospective rural contribution, demonstrating a variety of different forms of energy system diversity and resilience.

Finally, there is little expectation that the historically low system costs will be met with new sources of electricity supply. Continued load growth can be expected in Colorado, and with the higher market penetration of air conditioning we will see exacerbation of the traditional summer peak and eroding load factors. Dispatchable distributed generation and demand side management will compete much more effectively in this changing distribution climate.

High transaction costs relative to energy savings associated with geographically distributed rural energy-use – "Large distances between small opportunities" describes a classic situation leading to "high transaction costs." That is, it could cost much more per kilowatt or kilowatt-hour saved in the rural setting than if the loads were relatively heavy and relatively close together, as is more common in an urban setting. Methods to address this obstruction include

1) Developing short-hand methods to assess common rural features by general size discriminators, a key issue to "qualifying" contacts as likely cost-effective beneficiaries of a program like *R-E Action*. For example, perhaps the average number of gallons of milk produced and chilled per day could be calculated roughly from the size of the herd. Other more general questions that could be used to qualify customers are listed in Appendix E.

2) Concentrating in one locality to optimize time spent on-site rather than on the road.

3) Developing farmer-aided audit methods, possible mailed or otherwise centrally distributed, with central processing that allows development of farm-specific retrofit strategies based on regional factors that are similar

4) Implementing more effective distance learning on energy and cost-effective retrofit topics specific to farms, ranches, and rural businesses

5) Repeating notification cycles to account for changing end-users, energy use patterns, and transience of retrofit impact; and

6) Bundling the non-technical, business portion of the energy retrofit transaction to reduce transaction costs.

Poor information in the rural community about unfamiliar energy alternatives and systems – Poor communication combined with cultural or economic factors could keep the Plan from achieving a profit-making status, risking the developmental costs of the public and private sector interests involved. For example, the resistance to changing existing patterns of energy-use behavior is well known. Unless the "energy" portion of a person's business and personal life can be related to what they perceive as key aspects of their well being (e.g., finances or health), there is little chance of gaining sufficient attention for approval of an improvement [Savage, 2000]. With this in mind, we will focus the benefits of *R-E Action* on energy costs, regional economic improvements from renewable fuels, environmental sustainability of the rural lifestyle, and personal health and comfort benefits. We'll also increase the credibility of the message by

- Identifying credible community leaders who can lead the uptake of these new technologies,
- Communicating with rural communities through media they identify as most important for defining the acceptability of new technology,
- Documenting and publicizing success stories on each of the technologies to more effectively spread the word to others, and
- Working with rural community members one-on-one through town meetings, club and association meetings and other mostly informal gatherings.

Helping our credibility will be the fact that many of the feedstocks proposed for *R-E Action* are very familiar to the farm community. **Figure 11** shows the recent U.S. production of mostly agricultural oils that could be converted to biodiesel, yielding prices dependent on the specifics of the mix (as previously described).

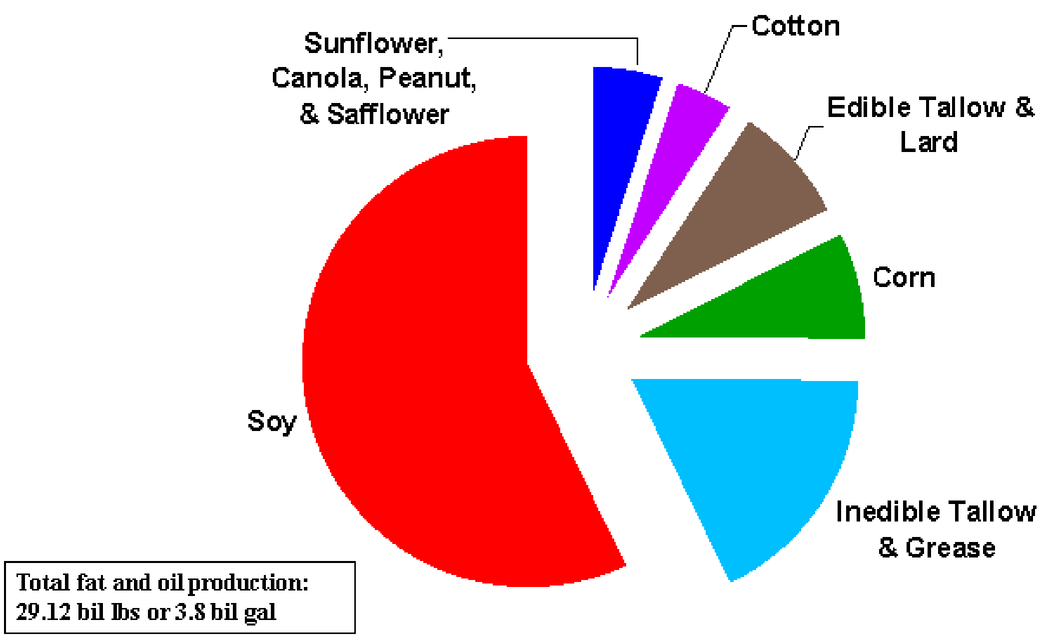


Figure 11. The Renewable Oil Resource. U.S. production in 1997 [Tyson, 1999].

Uncertainty with regard to new energy technologies and their related products, energy and environmental regulations and near-term economic conditions – The newest of the technology set proposed for *R-E Action* is power aggregation, which itself consists of bi-directional power interface and metering, and communication and control via the Internet. Few if any systems of the size envisioned in *R-E Action* have been built and operated, creating the main technical uncertainty in the Plan. The vendor who has agreed to participate in the demonstration of the *R-E Action* concept, though, believes that the current aggregation work they're carrying out on the eastern plains of Colorado will make a major difference in *R-E Action*'s prospects by lowering the risk significantly. In addition to those developments, plans are under way to examine the two-way communication component usable in power aggregation at the massive re-development site at Denver's former airport.

To the extent that *R-E Action* is promoted as a boon to the environment, because it facilitates compliance with existing regulations and improves the current environmental status, there may be passive resistance. Surveys have shown that presenting a program as "environmental" loses the interest of a large proportion of mixed audiences [Savage, 2000]. Even the 33% of the population that could be interested in a strong "green" case must be able to see answers to questions they have about personal reward, convenience, visible impact, and cost [Ibid].

Besides the targeted communication described in the section above, *R-E Action* will develop with a rural Steering Group of varied interests, ways to communicate the unique benefits of *R-E Action* to prospective participant in terms and language that is known to be effective. This dialogue should also include frank and knowledgeable discussion of regional rural economic conditions, and how *R-E Action* technologies could be expected to improve them.

***Conflicting rural economic development agendas* –** The most pro-active way to address this hypothetical barrier is to make *R-E Action* an all-inclusive program, assisting other rural economic leaders in meeting challenging joint objectives. *R-E Action* will only succeed with realistic objectives, so that re-casting the program may be necessary if cooperation is not possible, and competing agendas threaten.

The main prospective conflicting agenda may come from competing energy suppliers in the sector. To the extent that *R-E Action* challenges revenue streams without correspondingly reducing the overall cost of operation, it will be resisted. Such operational cost reductions are very likely, but will completely depend on the location, size, and other characteristics of the distributed generation proposed, and how those characteristics relate to details of the local and regional grid. They could include system specifics like:

- Displacing the production of peak power with more desirable (i.e., cleaner and greener) energy resources
- Delaying or eliminating the need for new peaking generation capacity
- Reducing or eliminating the need for high-cost purchased power at peak
- Supplying ancillary services at peak (like voltage support) that otherwise would have to be provided or purchased elsewhere by the utility
- Delaying, modifying or eliminating the need for transmission and distribution improvements

Fortunately, the *R-E Action* economic dispatch modes most likely to be employed are related to peak-only generation by the distributed power resources. Since this corresponds to the time of the utility's highest cost of service, revenue losses without significant system cost offsets are not likely. However, easy and safe interconnection amounts to a predictable institutional issue that will take special effort to resolve reasonably without pricing simple rural DG installations out of economic reach.

The resolution may result in higher costs for the prospective participants of *R-E Action*. An implementation plan must clearly define the system-wide benefits with which those higher utility costs finally must be balanced. They might include:

- Better diversity of supply, resulting in a more resilient power system
- More-stable energy prices, more specifically offsetting the variability of imported fuel costs
- Broad economic benefits directly to the rural sector
- Reduced generation of every pollutant of earth, water and air, and
- Increased sustainability of rural enterprises and the rural way of life.

Immature markets for "green" energy products **–** Several methods will be used to break the "chicken and egg" quandary, whereby green products are not made available in large quantities because markets are not demanding them, but markets are not demanding them because neither quantity prices nor the knowledgeable recommendation of experienced peers are available. *R-E Action* will help develop the market by riding Colorado's growth in its "natural" lube oil infrastructure, now underway, then growing the market beyond oils into first genset fuel, then transport fuel. *R-E Action* will help with knowledgeable recommendations by focusing on information dissemination that has been effective with and is most appropriate for the rural citizenry.

COMPARISON OF *R-E Action*'s PROSPECTIVE COLORADO DEMONSTRATION SITES

In *R-E Action*, we desire and expect to develop a "critical mass" of energy fuel producers and processors in one rural region, rather than slowly building broad capacities over a large area. This will

a. Provide better control of energy resource stability and quality
b. Reduce the parasitics of feedstock and fuel transport costs
c. Facilitate vertical integration and cooperative activity in that rural locale
d. Leverage cooperative market pull by encouraging a variety of end-uses, and
e. Increase the attractiveness of the bundled project to regional project champions (some of whom are funders), resulting in lower interest rate parasitics on participant profits.

Three locations proposed by a range of interests are

- Weld County, with a nominal activity center of Greeley
- Yuma County, with a nominal activity center of Yuma, and
- Bent/Prowers County, with a nominal activity center of Lamar

Relevant information for each is briefly capsuled in the section that follows.

Weld County (Greeley)

a. Prospective major partner is Con-Agra, looking to grow uses for inedible tallow generated in livestock slaughtering; speaks to the increasingly difficulty food-chain disposal of bovine wastes in this era of more-communicable diseases and increased costs of carcass rendering

b. Access to plentiful manure waste (also Con-Agra) for biogas production

c. Nearness to Denver means minimal local travel for interviews and project oversight

Yuma county (Yuma)

a. Good wind resource

b. Most active co-op system (per local energy program resource: 13 locally, with annual revenues of $1M)

c. Good mix of production crops, including

i. Corn (#1 in Colorado, #5 in nation; candidate for ethanol or oil feedstock)
ii. Winter wheat (ethanol feedstock candidate)
iii. Alfalfa (nitrogen-fixer, ethanol candidate)
iv. Sugar (or fuel) beets (consider ethanol from sugar and from waste)
v. Sunflowers (better energy-in figure of merit than soybeans for oil)
vi. Dry beans (mainly pinto, a nitrogen fixer; consider reductions in process energy use)
vii. Soybeans (also nitrogen fixer; could be a good crop if processing facility was nearer; nearest today is in Goodland, Kansas – 120 miles)

viii. Potatoes (Larsen Farms has collection/packaging facility near Wray; consider waste for ethanol)

d. Most progressive energy resource leadership (per local energy program resource)

e. First ethanol (E85) station in the state (Yuma)

f. Mid-future water problem with the drawing down of the Ogallala Aquifer (one million Ogallala acres in Texas are out of irrigation already); dryland and marginal-lands production of low-input energy crops may be one of the elements that could moderate the effects on Colorado's rural economy [Shively, 2001]

g. Good mix of medium-size electric loads, with dispatch shedding options that could include

- East Yuma County Schools, West Yuma County Schools
- Government (Yuma County, Yuma and Wray municipals)
- Great Plains Co-op (possible elevator and other small industrial loads)
- ConAgra Cattle Feeders
- JW Operating (oil and gas wells), Wray
- Well Drilling Outfit (water)
- Yuma District Hospital, Wray Community Hospital
- 2 confined swine operations (including Alliance Farm, part-owned by Farmland Industries; pig gas prospects)
- 2 dairies (1700 and 2000 head; manure conversion to energy)
- Downtown Wray: main street retail, printer and banks, new hospital, new recreation building, new eldercare facility; recently selected as an All-American City, Stan Holmes is City Manager ("progressive") 970/332-4431; power is taken down by storms and by winter ice on lines; power supplier may be a municipal
- K.C. Electric is currently testing portable irrigation water pumpers powered by DC PV pumps
- However: nearest existing oilseed processing plant is the ADM hexane facility at Goodland KS

h. GIS systems already set up for satellite crop imaging

i. Moderate travel distances for local interviews and project oversight

Bent/Prowers Counties (Lamar)

a. Good mix of existing rural enterprise, including
   - Significant amounts of ranchland
   - Crops: some oil-seed crops already grown
   - Livestock: pigs, cattle
   - Oil-seed crushing, extraction already in place in Lamar, oil blending in Eads; capacity of 330,000 gallons of oil per year could be doubled with a further investment of only $100,000 [Allen, 2001].
   - Progressive small town management
   - "Pig gas" being tried for generation at the 50kW level (supported by OEMC)

b. Good transportation fuel market potential
   - Directly on the proposed north-south NAFTA route, giving it access to 2K-4K additional commercial trucks/day
   - Near east-west U.P.R.R. route (just north at Eads), giving it access to diesel trains

c. Hard-hit by current farm economics

d. Vigorous grass-roots support for 'bootstrapping,' as in, for example, the Kiowa Country Growers Co-op, 396 shareholders raising $700,000 to initiate oilseed extraction and blending

e. Best known eastern plains wind resource, with winter and spring high wind periods, and Lamar City interested in 5 mW; August is typically period of doldrums

f. Wind farms under construction (162 mW between Lamar and Springfield at Gobbler's Knob; 108 1.5mW Enron turbines over 3000 acres)

g. Arkansas River Power Authority serves Lamar, Trinidad, La Junta, Las Animas, Springfield, Holly, and Raton

h. However, much of SE Colorado is native ranchland (though in the Arkansas River Valley it's high value crops from truck farms)

i. However, this site is farthest to travel for local interviews and oversight

STATUS AND FUNDING OF THE *R-E Action* CONCEPT

Table 2. *R-E Action* Schedule

A realistic schedule of development over the next 42 months is as follows:

Key: PI = Principal Investigator, Tom Potter; PM = Project Manager, Tammy Fiebelkorn

Stage	Time Period	Funds ($K)	Notes
Phase IA	8-11/01	10	PI prepares report scoping overall *R-E Action* effort
Phase IB	1-6/03	40	PI initiates parallel *R-E Action* tech support efforts (rural fit of demand/supply and aggregation)
Phase IC	1-6/02	58	PI and PM initiate stakeholder collaborative
Phase ID	6/02-5/03	40	PM leads development of stakeholder collaborative
Phase IIA	6/03-11/03	132	Econergy leads USDA proof of concept by analysis
Phase IIB	5/02-4/04	60	PM and PI continue parallel *R-E Action* support
efforts			
Phase IIIA	6/03-5/05	520	Econergy leads USDA field demonstration
Phase IIIB	5/04-5/05	120	PM and PI continue parallel *R-E Action* support
efforts			
-------------------FUTURE-------------------			
Phase IV	6/05-5/08	1120	*R-E Action* team replicates the Plan across
	Colorado, the		Midwest, and the nation

<u>Next Steps for *R-E Action*</u>

As the table suggests, the work plan for Phase I is an extended scoping effort designed to preliminarily evaluate the feasibility and complete the structuring of *R-E Action*. The need for early parallel efforts in support of the overall Plan became obvious in the writing of this report. Discussion with prospective funders will be needed to further develop the technical and programmatic questions and gain funding support for the answers.

Phase II will result in better identification and definition of program elements, by means of a "table top" analysis of:

1. Cost-effective methods to reduce utility costs by integrating rural power demand reduction opportunities and farm-based power supplies. Typical energy and demand components on a farmstead will be better identified, as will experience revealing which of the energy efficiency and power shaping/shedding retrofits are most likely to be cost-effective (by "shedding power," we mean not using power, as in the case where specific loads that are not essential can be "shed," or "turned off" during peak periods, saving operating costs).

2. Profitable systems for using, bundling and selling "green power" from disparate and geographically separate rural sources. For an example of common-sense Renewable Distributed Generation uses, consider the use of direct-current (DC) pumps running only when the wind blows. Since numerous observers have noted the coincidence of wind speed during the growing season with evapo-transpiration that dehydrates plant life,

wouldn't this use the wet earth as a form of energy storage, keeping the plants appropriately watered while reducing the balance of system costs otherwise required for inversion and distribution? Other ideas proposed to better use wind power generation involve producing N fertilizer right there on the farm [Duke, 2001], or dissociating water for hydrogen. Without extensive DC or gaseous fuel systems to "un-do," retrofit, or dismantle, the rural sector can more easily take the lead with such new concepts and exploit unique business niches.

In Phase II, a team of experienced energy engineers and economists will conduct preliminary research and evaluation in order to demonstrate the technical and economic feasibility of the integrated concept that is proposed here. Phase II will define the "fit" of this concept in an assigned rural setting, through definition of a specific demonstration scenario that will include confirming data. Such a credible field demonstration will allow the results to be assembled into a credible and comprehensive concept. The result of Phase II activities will be a comprehensive plan designed to establish the feasibility of *R-E Action* and serve as the basis for Phase III implementation/demonstration activities.

The following Primary Objectives will be the main focus of the Phase II investigation, a proof-of-concept by analysis exercise, and its follow-on Phase III, a field demonstration:

1) Investigate with commercial vendors the cost-effective prospects for four practical options that can control rural electric loads, improving the productivity and reducing the operating costs of rural enterprises:
    - Load reduction, in collaboration with a Boulder, Colorado, firm with extensive experience in the analysis and application of load reduction retrofit (**Econergy International Corporation**).
    - Load shaping, in collaboration with the Denver licensee (**Trane**) for a national thermal storage system manufacturer (**Calmac**). These systems offset the peak compressor loads of air conditioners and refrigeration plants by making ice during the cooler nighttime hours and storing it for use during daytime peaks.
    - Load shedding, in collaboration with a Denver manufacturer of load shedding equipment (**Dencor**). These products allow a client to shed discretionary loads during times of heavy on-site peaks, reducing the measured peak demand.
    - Load matching with distributed generation driven by farm fuels, in collaboration with the Denver representative (**Wagner Equipment**) of the largest manufacturer of reciprocating gensets (**Caterpillar**). This company has warranted their reciprocating gensets for operation on 100% biodiesel, and has expressed great interest in supporting further application of ag-based fuels.
2) Develop methods to optimize the site-specific integration of rural electric demand and supply side resources, to achieve the shortest energy performance contract period using energy resource retrofit financing. This effort will build on the experience of energy service companies, which now reduce the risk and initial financing requirements of energy retrofits by taking payment over time from the resulting energy cost savings. In a parallel manner, we believe that we can assemble elements of both demand-side and supply-side resources into a package that meets a client's performance and payment requirements.

3) Study and quantify prospects for aggregating the output from separate rural energy nodes to cooperatively increase income streams, improve competitiveness and maximize the use of rural grid support resources during regional grid peaks. We plan to have multiple collaborators in this effort, including:
   - ❖ A Windsor, Colorado, firm expert in load-transfer hardware (**Encorp**)
   - ❖ A Fort Collins, Colorado, firm expert in load-transfer and aggregation software (**Sixth Dimension**)
   - ❖ A Golden, Colorado, firm expert in power conditioning (**UQM**)

The information and other preliminary research conclusions gathered in Phase II will be used directly in Phase III, where plans are to proceed to field implementation of the comprehensive concept developed in Phase II. Demonstrations will be implemented to define practical paths to commercialization of *R-E Action*. Phase III will result in:

- Field data and analysis to shape and guide *R-E Action* based on experience with participants and hardware; and
- Further definition of *R-E Action's* overall potential from the perspectives of economic development, energy security, and environmental benefits, and the developmental requirements to achieve that potential.

Subsequent development of *R-E Action* will involve replicating the demonstration success of Phase III to other parts of Colorado, the Plains, and the nation.

CONCLUSIONS

The time is ripe for introducing known energy control technologies to a troubled rural economy, with the goal of improving the sustainability of rural America with energy crops and other economically viable products and services. We have shown that there is a place for such alternative energy resources, and that these resources are a “natural” fit for rural enterprises. *Rural-Empowering Action* will, with the guidance of rural cooperatives, support the local grid at peak and lower participants’ production costs at the same time.

This report concludes that a combination of demand-side and supply-side resources can meet large portions of peak power demand while greatly increasing markets for rural products. And it shows how this can be done by 1) making the overall economic benefits to the rural sector the overriding consideration of the *R-E Action* Plan, in balance with other considerations of cross-sector equity, and 2) assuming no subsidies that would distort a “level playing field” of rural energy sources, all factors considered.

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APPENDICES

A – References and Related Websites
B – Advisory Resources for *R-E Action*
C – Ohl McDonald’s Farm: A “Strawman” Sketch of *R-E Action*
D – Model Framework: Colorado Partners for Energy Efficient Renewal (CPEER)
E – *R-E Action* Stakeholders and Other Interests
F – Qualifying Questions for Prospective *R-E Action* Sites

Appendix A – References and Related Websites

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Center for Resource Solutions www.igc.org
Climate Solutions www.climatesolutions.org
Colorado – Governor's Office of Energy Management and Conservation www.state.co.us/oemc
Colorado Coalition for New Energy Sources www.ccnet.org
Colorado Energy Science Center www.energyscience.org
Colorado Public Interest Group www.copirg.org
Colorado Renewable Energy Society (CRES) www.cres.gen.co.us
Colorado Sierra Club www.rmc.sierraclub.org
Colorado Solar Decathlon www.solar.colorado.edu
Community Power Corporation www.cpc.com
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- National Renewable Energy Laboratory www.nrel.gov
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- Western Area Power Administration www.wapa.gov

U.S. Environmental Protection Agency - Agricultural Efficiency www.epa.gov/outreach/agstar
Western Interstate Energy Board www.westgov.org
World Resources Institute www.wri.org
Union of Concerned Scientists www.ucsusa.org

Appendix B – Advisory Resources for *R-E Action*

The following individuals have commented on aspects of *R-E Action*, and have expressed their interest in supporting elements of *R-E Action* in an informal advisory role. However, responsibility for the concept and the content of this report is solely the author's.

- Larry Barrett – former utility marketing director, now utility systems consultant; Colorado Springs CO
- Benjamin Brant – President and CTO of Microgy Cogeneration Systems, "Bio-Energy and Distributed Cogeneration for Agriculture and Utilities;" Golden CO
- Ellen Drew – executive director of the Colorado Environmental Business Alliance; Boulder CO
- Tom Duke – rural power researcher and entrepreneur; Burlington IA
- Larry Flowers – national program leader of the Department of Energy's (DOE) Windpowering America Program at DOE's National Renewable Energy Laboratory (NREL); Golden CO
- Dennis Kaan – Agriculture and Business Management Regional Specialist with Cooperative Extension, Colorado State University; Akron CO
- Ronald Lehr – former Colorado Public Utilities Commissioner and Denver Water Board Commissioner, now legal advisor to the Colorado Renewable Energy Society; Denver CO
- Gary Nakarado – former Colorado Public Utilities Commissioner, now head of the Distributed Power Program at NREL; Golden CO
- Peggy Plate – Energy Services Representative for the Western Area Power Administration (WAPA), and recipient of WAPA's 2001 Exceptional Service Award; Loveland CO
- Paul Polak – CEO of International Development Enterprises, implementer of low-tech village level power and water programs in developing countries; Lakewood CO
- Ronal W. Larson, Ph.D. – secretary of the Colorado Renewable Energy Society; Evergreen CO
- Carol Tombari – former director of the Texas Energy Office and of NREL's State and Local Programs Office, now an energy programs consultant; Evergreen CO
- K. Shaine Tyson – national program leader for the renewable diesel program at NREL; Golden CO
- Heidi VanGenderen – Senior Associate to the Wirth Chair in Environmental and Community Development Policy at the University of Colorado/Denver; Denver CO
- Robb Walt – President of Community Power Corporation, implementer of village power systems using gasified biomass; Littleton CO
- Morey Wolfson – former Colorado Public Utilities Commission staff, now analyst with the Federal Energy Management Program at NREL; Golden CO

Appendix C – Ohl McDonald's Farm: A "Strawman" Sketch of *R-E Action*

Any hypothetical site example applying a new paradigm to existing energy users is bound to stumble on the peculiarities of different sites. In this example we have taken some likely energy inputs and farm lifestyle factors, and applied *R-E Action*'s complete package of demand-side and supply-side interventions. We call it a "strawman," especially appropriate to the rural sector, because it is not intended to stand up to much attack, but is rather intended to stimulate discussion on what should be a practical level of effort, and to clarify the overall, integrated vision for *Rural-Empowering Action*.

Explanatory notes on the table that follows:

- Although the *embodied energy* represented by fertilizer and pesticide purchase could amount to over 60% of the total energy used on a farm, we haven't addressed it here because the inputs and reductions are so crop specific, and this scoping study won't venture that deeply into such details.
- For similar reasons, though liquid petroleum fuels are a large energy input, we don't propose liquid fuel substitution in this strawman in any detail, but will look at the prospects on real farms as the demonstration planning for *R-E Action* proceeds. Addressing specific farmstead opportunities for renewable liquid fuels is a good subject for future investigation.
- It's reasonable to consider forced convection and evaporative cooling as transient alternatives to compressor chilling. Rapid chilling to retard metabolic activity, though, as in the case of milk or some other agricultural products, will require thermal energy storage (TES).
- Wholesale lighting fixture change-out is assumed, some of it HID (high intensity discharge)
- We must examine specific operating hours for some motor loads (e.g., vacuum pumps, bin dryers, manure pit agitators, feed mills and conveyors) to justify high efficiency replacement
- Diesel generator fuel substitution with biodiesel is assumed, with 500 peak hours compensated at $0.20/kWh
- Annual electric bill assumed is $50,000 per year, and the end-user allows the cost of an integrated retrofit package to be no higher than 3.5 times annual savings (which allows a 50% split of the savings between the lender and the participant over 7 years [yielding an energy bill reduction of 40% from the start], after which the participant farmer pockets all the savings)

Key: Entries are $*x*1000; *Xn* = existing energy cost; *Xd* = existing demand cost; *Nn* = new energy cost; *Nd* = new demand cost; *Ts* = total annual savings; *Retr* = retrofit cost; TES = thermal energy storage; DG = distributed generation

Component/Item	***Xn***	***Xd***	***Nn***	***Nd***	***Ts***	***Retr***
Base Load Reduction						
Cooling	17	8	15	6	4	12
Lighting	7	3	5	2	3	10
Motors	6	2	4	2	2	6
Heating	2	0	2	0	0	0
Other	3	2	2	2	1	3
Load Shaping						
Cool TES	0	0	1	-5	4	25
Load Shedding						
Fixtures	0	0	0	-2	2	5
Controls	0	0	0	-3	3	8
Load Matching (200kW DG)						
X-Upgrade	0	0	-1	0	1	2
Controls	0	0	-1	-5	6	8
Natfuels	0	0	5	0	-5	0
NewNat (wind)	0	0	-3	-2	5	40
Aggregation						
Comm/Control	0	0	0	-15	15	25
TOTALS	35	15	29	-20	41	144

This strawman shows one retrofit scenario for a project costing about three times the annual electric bill for the farmstead. The scenario has not been optimized for balance or overall cost-effectiveness, but offers a simple payback to match the end-use customer's stipulated criterion of 3.5 years. It is an example of how *R-E Action* proposes to integrate demand-side and supply-side measures in a package that pays for itself in a relatively short period of time from energy cost savings and energy income.

Appendix D – A Model CPEER* Framework for Use in *R-E Action*

CPEER: Colorado Partners for Energy Efficient Renewal
(fashioned after the State of Texas' Energy Efficient Partnership Program

Colorado's Office of Energy Management and Conservation (OEMC) has helped Colorado school districts identify millions of dollars in potential annual utility savings through participation in the *Rebuild Colorado* and other programs. Annual savings range from hundreds of thousands of dollars for large urban school districts to less than a thousand dollars for small eastern plains districts with fewer than 300 students. Some alternative of the same program could be used to implement the Colorado Partners for an Energy Efficient Renewal (CPEER) program. This document describes the elements and relationships that could be present in such a Colorado program.

Partner Eligibility
Eligibility for one phase or another of the CPEER program is open to any member of a Colorado statutory rural cooperative (e.g., rural electric cooperative or rural elevator cooperative).

Measure Eligibility
Energy cost savings is the prime determinants. Measures with cost savings include:
1. Improved equipment installation, such as:
   * Energy efficient lamps, ballasts, and fixtures;
   * High efficiency motors and other equipment;
   * Thermal storage systems that shape diurnal loads;
   * High efficiency space cooling equipment, including evaporative chillers;
   * Electric load interlocks; and
   * Computerized energy management systems.

2. More efficient maintenance and operation methods, such as:
   * Turning off lights in unoccupied areas,
   * Changing filters and gaskets on a regular basis, and
   * Cycling equipment to take maximum advantage of utility demand rates.

3. Operating new and existing distributed generation equipment with renewable energy sources.

The CPEER program delivers a range of technical assistance to Partners, depending on the stage of assistance for which the Partner qualifies. Partners usually pay no fee but agree to institute energy efficient maintenance and operation procedures and pursue financing for capital energy projects which yield a "simple" return on investment meeting the program criterion (currently 1 year for Stage One assistance, 3 years for Stage Two assistance, and 10 years for Stage Three assistance).

Stage One assistance consists of utility bill analysis and recommendations based on similar rural enterprises in the region.

Stage Two assistance is available for all rural enterprises with electric utility bills greater than $20,000 annually. This assistance consists of energy audit assistance and recommendations specific to the enterprise.

Stage Three assistance is available for rural enterprises with electric utility bills greater than $50,000 annually, and existing standby/emergency diesel generation equipment nameplate rated over 50kW (or plans to install such units). This assistance consists of utility bill analysis, energy audit assistance, and on-site inspection followed up with energy strategy meetings and targeted assistance. Program deliverables include:
* individual energy performance assessments of each facility,
* energy saving maintenance and operation recommendations,
* identification of cost effective capital projects, and
* assistance in financing identified projects.

<u>Partnership Collaboration</u>
Stage One – Utility Bill Analysis

1. The Partner provides square footage for each structure and authorizes CPEER's contractor to access their utility data directly from utility companies.

2. The CPEER contractor calculates the general energy performance of each facility, and advises the Partner of the prospects for facility performance improvements, based on cost payback estimates for similar facilities.

Stage Two – Energy Audit Assistance
In addition to the initial collaboration described for Stage One, if the size of the electric utility bill justifies such additional effort and the Partner is receptive to a further level of energy cost saving:

1. CPEER sends an energy audit data collection set to the Partner.

2. Upon receiving sufficient data back from the Partner, CPEER calculates the equipment-specific cost and savings of prospective energy retrofit measures, and advises the Partner of specific retrofits that may be cost-effective for this facility.

Stage Three – Integrated Supply/Demand-Side Energy Recommendations
In addition to the collaboration described for Stage One and Stage Two, if the size of the electric utility bill justifies such additional effort and the Partner is receptive to a further level of energy cost saving:

1. CPEER proposes a more formal Partnership. A Memorandum of Understanding is sent to the Partner for signature, partnership is established, and a date is set for an on-site visit to inspect the selected facility.
2. The Partner designates an individual to work with the CPEER Program and its contractors throughout the Partnership.
3. The CPEER contractor conducts an appropriate number of individual facility assessments

(made by walk-through observations).
4. Based on the initial assessments and walk through findings, CPEER's contractor prepares a report identifying energy cost and utilization indices for each facility, recommended operation and maintenance procedures, energy retrofit projects which yield an attractive payback, and available options for financing the projects.
5. A Partner presentation highlighting on-site findings and recommendations is conducted by CPEER and its contractor for the enterprise's management team.
6. CPEER and its contractor remain technical resources to the Partner in implementing recommended actions and projects for one year from the time the report is complete.

In addition to identifying and quantifying major cost-saving opportunities, the Partnership Program works with the Partner to identify and evaluate appropriate financing options to finance the projects. CPEER may offer pre-qualification access to limited Rural Economic Development funds for qualifying facilities, with the advantage of guaranteed positive cash flow from Day One of a CPEER project.

<u>Performance Contracting Guidelines and Reviews</u>

Energy Performance Contracting is a financing method that allows a facility to complete energy-saving improvements within an existing budget by financing them with money saved through reduced utility expenditures and/or received through sale of energy, power, or environmental credits. Facilities make no up-front investments and instead finance projects through annual energy cost savings and net energy revenues.

To enter into an energy savings performance contract (ESPC), an enterprise will negotiate a two-part performance contract. The first part of the contract authorizes one of CPEER's contractors, an energy service company (ESCO), to proceed with a detailed, finance quality, audit. The second part of the contract sets out the general terms and conditions for the ESCO to proceed with the project once the enterprise and the contractor agree upon a scope of work and budget.

The Energy Assessment Report (EAR), and the specific project proposal that grows out of it, will generally become an attachment to the general contract, thus providing the details with respect to what is proposed to be installed, project costs, and savings to be expected. Normally this contract will provide that the enterprise reviews the detailed audit and determine to their own satisfaction if a viable project is possible. If the EAR does not confirm the savings initially identified by the ESCO, the contractor should not charge for this effort. If the EAR confirms savings initially identified by the ESCO, but the enterprise does not go forward with construction, the enterprise will have to pay the ESCO for the costs of the EAR.

If the enterprise moves forward with energy efficiency projects, the cost of the EAR should be rolled into the cost of the full project. The EAR should contain a minimum savings amount, requirements relating to time of completion by the ESCO, cost of the EAR, and scenarios requiring or not requiring payment to the ESCO for the EAR.

As part of the final contract, the contractor must submit a Monitoring and Verification Plan

(M&V), a sample quarterly periodic energy savings report and a contract proposal with all required insurance and sample bond certificates. The enterprise and the contractor should review and agree to the contents of all of the above prior to finalizing the contract.

The final steps in this process are to execute the contract, oversee construction and commissioning, review the annual savings reports, and make contractor payments.

Guidelines for contracts:

- The contract term should not exceed 10 years beginning after the final date of completion/installation.
- The enterprise should use the total of all financed costs under a project divided by the "savings" (the total of annual savings and new revenue) to determine the project payback.
- Construction period savings, utility rebates, and enterprise contributions of budget or equipment directly used for the project, may be used to lower the total financed cost of the project.
- The average annual contract obligation should not exceed the total estimated "savings" divided by the term in years of the contract.
- All energy conservation measures must comply with current local, state, and federal construction and environmental codes and regulations.
- A contract for energy conservation measures should not include improvements or equipment that allow or cause water from any condensing, cooling, or industrial process or any system of non-potable usage over which the public water supply system officials do not have sanitary control, to be returned to the potable water supply.
- Contractor proposals should contain four principal documents for review by the enterprise. They are the contract, the energy assessment report, the measurement and verification plan and a sample periodic energy savings report. Other elements such as bonds and certifications should be incorporated within or attached to the four principal documents. The documents must be complete and internally consistent, and prepared according to these guidelines to be considered ready for review.

Appendix E – *R-E Action* Stakeholders and Other Interests

Non-profit Interests **–**American Bioenergy Assn, American Gas Assn, American Lung Assn, American Rivers, American Solar Energy Soc, American Wind Energy Assn, Aspen Inst, AT&T Fdtn
Biobased Products Coord Council, Bioenergy Coord Off, Blue Water Network, Bonneville Envir Fdtn, Boulder Energy Conservation Center, Bullitt Fdtn,
Calif Alliance of Distrib Energy Resources, Campaign for Human Devmt, Center for Applied Research, Center for Energy & Climate Solutions, Center for Resource Solutions, Center for Rural Affairs, Center for Waste Reduction Techn, Chariton Valley Biomass Proj, Clean Air Council, Clean Energy Funds Network, Clean Energy Gp, Clean Fuels Devmt Coalition, Clean Power Markets, Climate Solutions, Coloradans for Clean Air
Colorado Coalition for New Energy Technologies, Colorado Counties, Colorado Energy Science Center, Colorado Environmental Business Alliance, Colorado Public Interest Research Gp, Colorado Renewable Energy Soc, Colorado Solar Energy Industries Assn, Colorado Sustainability Project, Community Off of Resource Efficiency, Conservation Fund, Consumer Energy Council of America, Council of Churches
E & Co., Energy Conservation Assn, Energy Fdtn, Environmental & Energy Study Inst, Environmental Defense, Environmental Law & Policy Center, Environmental Resources Trust, Episcopal Power & Light, E-STAR Colorado, Ethanol Producers & Consumers
Farm Aid, Ford Fdtn
Geothermal Energy Assn, Global Resource Action Center for the Environment, Green Power Market Devmt Gp, Gp Against Smog & Pollution
Hearst Fdtn, Heller Fdtn
Institute for Local Self-Reliance, Inst of Gas Technology, Integrated Bio-Systems Network, Intl Council for Local Environmental Initiatives, Intl Ground Source Heat Pump Assn, Interstate Renewable Energy Council, Iowa Energy Center, Izaak Walton League
Joyce Fdtn
W.K. Kellogg Fdtn, Kettering Fdtn
Land & Water Fund of the Rockies, Land Trust Alliance, League of Conservation Voters, Lincoln Inst of Land Policy
John T. & Catherine T. MacArthur Fdtn, McKnight Fdtn
Natl Assn of Conservation Districts, Natl Assn of Devmt Orgs, Natl Center for Appropriate Tech, Natl Council of State Legislatures, Natl Hydropower Assn, Natl Research Inst, Natl Wind Coord Committee, Natural Resources Defense Council, Nature Conservancy, New Uses Council
Oak Fdtn
PennFuture, Pace University Energy Project, Pew Charitable Trusts, Prudential Fdtn
Rahus Inst, Regional Air Quality Council, Regulatory Assistance Project, Renewable Energy Devmt Inst, Renewable Energy Action Proj, Renewable Energy Policy Proj, Renewable Fuels Assn, Renewable Northwest Proj, Republicans for Environmental Protection, Resource Conservation & Devmt, Rockefeller Brothers Fund, Rocky Mountain Inst
Sierra Club, Solar Energy Industries Assn, Sonoran Inst, SW Energy Efficiency Proj, Sustainability Inst, Sustainable Agriculture Coalition, Sustainable Business Inst, Sustainable Devmt Fund, Sustainable Energy for Economic Devmt, Sustainable FERC Proj, Sustainable Futures Soc
Turner Fdtn
Union of Concerned Scientists, Utility Wind Interest Gp, U.S Energy Assn, U.S. Renewable Fuels Assn
W. Alton Jones Fdtn, Western Biomass Council, Western Interstate Energy Bd, Western Regional Air Partnership, Windstar Fdtn, Winrock Intl, World Business Council for Sustainable Devmt, World Council of Churches, World Resources Inst, Worldwatch Inst

Utilities, Power and Emission Credit Brokers, and other Electric Power Interests – American Electric Power, American Public Power Assn, Arkansas River Power Auth, Atlantic Renewable Energy Corporation, Automated Power Exchange, Bonneville Power Admin, CSG Services, Colorado Assn of Municipal Utilities, Colorado REA Assn, ComEd, Competitive Utility Strategies, Electric Power Research Inst, Energy Co-Opportunity, Enron Wind Devmt, Foresight, FPL Energy, Green Marketer, Highline Electric, Ed Holt & Assoc, Holy Cross Energy, K.C. Electric, Morgan County Rural Electric Assoc, Natl Rural Electric Cooperative Assn, Natsource, Navitas, Pacificorp, Peak Load Mgt Assn, PGE Natl Energy Gp, Platte River Power Authority, Remote Power Gp, Pendergast Sarni Gp, San Isabel Electric Assn, Seminole Electric Cooperative, Sterling Planet, Tennessee Valley Authority, Texas Renewable Energy Credit Trading System, Tri-State Generating & Transmission, United Power, Utilicorp Gp, Volt, Western Area Power Admin, Western Regional Transmission Assn, Xcel Energy, Y-W Electric

Public Sector Interests – Colorado: Dept of Agriculture, Dept of Local Affairs, Dept of Natural Resources, Dept of Public Health, Div of Wildlife, Off of Econ Devmt & Intl Trade, Off of Energy Mgt & Conservation, Off of Business Devmt SE, Small Business Devmt Center
Co-op Centers, Environment Canada/Environmental Choice Program, KTH, Nebraska Energy Off, UN Food & Agricultural Org
U.S. Dept of Agriculture: Agricultural Research Service**,** Appropriate Tech Transfer for Rural Areas, Colorado Farm Service Agency, Natl Center for Agricultural Utilization Research, Natl Resource Conservation Service, Rural Devmt, SE Colorado Resource Conservation & Devmt, Small Farm Advisory Committee;
U.S. Dept of Commerce: Small Business Admin
U.S. Dept of Energy: Golden Field Off, Lawrence Berkeley Natl Lab, Natl Renewable Energy Lab (NREL Programs – Bioethanol Tech, Buildings & Thermal Systems, Distrib Energy, Renewable Diesel, State & Local, WindPowering America), Oak Ridge Natl Lab/Biofuels Feedstock Devmt Program, Off of Energy Efficiency & Renewable Energy – Agriculture, Biofuels & Energy Crops, Biomass Power, Forest Products, Indl Technologies;
U.S. Dept of Interior: Bureau of Land Mgt
U.S. Environmental Protection Agency: Agstar, Climate Protection Partnership, Energy Supply & Industry, E-Star, Green Power Partnership, Pollution Prevention Partnership, Sustainable Communities
Universities: Colorado College, Colorado State U – Dept of Agricultural & Resource Economics, Co-op Ext Serv, Rangeland Ecosystem Sciences, Wildlife Habitat Mgt Inst; Iowa State U, U of North Dakota, U of Colorado/Wirth Chair, U of Montana, U of Wisconsin/Center for Cooperatives, Western Governors Assn

Rural economic development agencies and interests – Agricapital, Colorado Cooperative Council, Colorado Rural Devmt Council, Community Energy, Costilla County Commissioners, Farm Aid, Farm Fdtn, High Plains SEED (Sustainable Energy for Economic Devmt), Independent Bankers of Colorado, Inst for Agriculture & Trade Policy, Inst for Local Self-Reliance, Intertribal Council on Utility Policy, Jobs for the Future, Kerr Center for Sustainable Agriculture, Lamar Chamber of Commerce, Greg MacLeod, Natl Committee on Small Farms, Natl Congress for Community Economic Devmt, Natl Cooperative Business Assn, Natl Council of Farm Cooperatives, Natl Farmers Union, Natl Food & Energy Council, Natl Rural Funders Collaborative, Natl Rural Utilities Cooperative Finance Corporation, Oglala Commons, Org for Competitive Markets, Northern Plains Resource Council, Northwest SEED, Plains Org for Wind Energy Resources, Rocky Mountain Cooperative Devmt Center, Rural Community Assistance Corp, Rural Economic Area Partnership, Small Farm Energy Proj, Southeast Colorado Power Assn, Urban Farm at Stapleton, Winrock Intl, World Business Council for Sustainable Devmt, Yuma County Economic Devmt

***Farmers, ranchers, rural/agricultural organizations, and existing rural vendors* –** Agricultural Research Inst, Agricultural Utilization Research Inst, Alternative Agriculture Research & Commercialization Corp, American Corn Growers Assn, American Farm Bureau Fedn, American Farmland Trust, American Soc of Agricultural Engineers, American Soybean Assn, Archers-Daniel-Midland, Biodiesel Industries, BioEconomy Partners, Biox Corp, Calif Inst of Food & Agricultural Research, Cargill, Cenex, Clean Power Markets, Colorado Agriculture Assn, Colorado Agricultural Devmt Auth, Colorado Assn of Wheat Growers, Colorado Beef Council, Colorado Cattlemen's Assn, Colorado Corn Admin Committee, Colorado Corn Growers Assn, Colorado Dry Bean Admin Committee, Colorado Farm Bureau, Colorado Grain & Feed Assn, Colorado Hay & Forage Assn, Colorado Livestock Assn, Colorado Open Lands, Colorado Pork Producers Council, Colorado Pork Producers Council, Colorado State Grange, Colorado Sugar Beet Growers Assn, Colorado Wheat Admin Committee, Colorado Young Farmers Educ Assn, Dairy Farmers of America, Far West Equipment Dealers Assn, Con-Agra, Council of Energy Resource Tribes, Disgen, Energy Conservation for Colorado Agriculture, Farmland Ind, Great Plains Oil, Growmark, Insta-Pro Intl, Joe Kiely, Kiowa County Growers, Minnesota Soybean Research & Promotion Council, Natl Biodiesel Bd, Natl Bioenergy Industries Assn, Natl Corn Growers Assn, Natl Farmers Union, Natl Potato Council, Power System Engg, Prairieland BioProducts, Resource Recovery Gp of Nebraska, Rocky Mountain Farmers Union, SE Colorado Farmers Cooperative, Thomas Jefferson Agricultural Inst, Thunderbird Livestock & Land, United Soybean Bd

***Private Sector Interests* –** Aeromax Corp, Agro Mgt Gp, All American Energy, Anteres Gp, Steve Andrews, Arcadia Windpower, Atlantic Orient Corp, ASCO, BBI Intl, Bergey Windpower, Pete Beverly, Blue Star Sustainable Technologies, Brayden Automation, Broin & Assoc, CH2MHill, Caterpillar, Chesapeake Biofuel, Clipper Windpower, Cummins Engine, DMC2, Decision Educators, Delphi, Dencor Controls, Thomas J. Duke, Econergy Intl, Electrotek Concepts, Encorp, Energy Unlimited, Englehard Catalysts, EnXco, Environment & Energy Study Inst, eSolved, E Source, Estes McClure & Assoc, FPL Energy, Foresight, Global Energy Concepts, Green Mountain Energy, H Power, Industrial Solar, Sue Jarrett, Jacobs Wind Electric, John Deere Diesel, Johnson-Mathey, M & N Wind Power, Mark IV, McNeil Technologies, Microgy, Mitsubishi Power Systems, Mountain Energy Consultation, NEG Micon USA, Nextek Power Systems, NRG Systems, Nordex USA, Northern Alternative Energy, Northern Power Systems, OEM Devmt, Ocean Power, Onsite Energy, Pacific Biodiesel, Photosynthetic Harvest, Pinnacle Biotech, Powerlight, Pure Energy, RDI, RES (USA), Resource Dynamics, Redem, Remote Power Gp, San Gorgornio Farms, SeaWest WindPower, Shell Renewables, Shell WindEnergy, Sixth Dimension, Southwest Wind Power, Stella Gp, Sustainable Asset Management Private Equity NA, Synergy Power Corp, Tasco Engg, Texas Energy Engg Services, Sam Thiessen, Trane, UQM, Vestas-American Wind Tech, Virtus Energy Research Assn, Wagner Equipment, Western Energetix, Williams Bioenergy, Williams Distrib Power Services, Wind Turbine Co, Wind Turbine Ind Corp, Wind Utility Consulting, WindTech Intl, Windward Engg, World Energy, Zikha Renewable Energy

***Press* –** Boulder Business Journal, Colorado Springs Business Journal, Denver Business Journal, Denver Post, High Country News, Power Engg, Rocky Mountain News, Suzie Rogers

***Elected officials* –** U.S. Congress: Senators, Representatives, staff.
Colorado Legislature: particularly rural senators and representatives, staff.
Rural County Commissioners; Rural Town Officials

***Utility regulators* –** Colorado Public Utilities Comm, Natl Assn of Regulatory Utility Commissioners, Colorado Off of Consumer Counsel

Appendix F – Qualifying Questions for Prospective *R-E Action* Sites

1. In what form do you use the most purchased energy at this location?
    a. Fertilizer and Lime
    b. Pesticide
    c. Petroleum Products (Diesel, gasoline, LPG, lubricating oil, kerosene, chain saw mixtures, dust suppressants)
    d. Electricity
2. What are your associated annual energy costs? Estimate if you don't have the bills handy.
    a. Fertilizer and Lime
    b. Pesticide
    c. Petroleum Products (Diesel, gasoline, LPG or propane, lubricating oil, kerosene, chain saw blends, dust suppressants)
    d. Electricity
        i. kWh (energy charges)
        ii. kW (demand charges)
3. What kinds of energy conservation or load management do you now practice?
4. What kind of energy conservation or load management has worked best for you?
5. What is the total nameplate rating (kW or tons) of your air conditioning compressors?
6. When was the last time you purchased highly energy-efficient fixtures or equipment, and what was it?
7. How will you decide your budget for this prospective energy cost saving retrofit?
8. How soon would you be prepared to install a set of energy cost saving retrofits, if there was no question of cash outlay?
9. Who makes the buying decision for your enterprise (name or title)?
10. Who else must evaluate an energy retrofit package before the buying decision is made?
11. Would ease of financing be a requirement?
12. What financing terms would you be looking for?
13. Do you network with others who could possibly use this kind of energy package?
14. What main energy objective would you be looking to achieve?
15. How important are the following factors to you? (Must add up to 100%)
    a. Time
    b. Money
    c. Control
    d. Ease of use
    e. Social objectives (like being progressive, helping the national effort to save energy, or reducing the burden on the environment)
16. What has been your experience with power reliability at this location?
17. When the power occasionally goes out, or the voltage drops, what is usually the cause? (Must add up to 100%)
    a. Ice or snow loads on the lines
    b. Demand overloading on hot summer afternoons
    c. Lightning strikes in the area
    d. Trouble elsewhere on the grid
18. What forms of power back-up do you now use?
19. If you have a standby/emergency generator:
    a. What is its rated output in kW?
    b. How much fuel storage do you have?
    c. Where is the fuel storage located (outside above ground, underground, in a building?)?
20. Do people often comment that the wind always seems to be blowing at your place?
21. Do you pump water for crop irrigation? For home use?
22. How common are lightning strikes at this location, compared to other places you've lived?
23. Is there a manual utility shut-off for your facility on your entrance pole?