Greener Pastures in Colorado

OPPORTUNITIES FOR AGRICULTURE IN THE CURRENT CLIMATE

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Executive Summary

The challenge of global climate change has motivated the formulation of policies at both federal and state levels to encourage mitigation of greenhouse gas emissions. The American Clean Energy and Security Act is currently under consideration in the United States House of Representatives, and on May 21st passed the House Energy and Commerce Committee. This legislation proposes to reduce emissions to 17% below 2005 levels by 2020, and 83% below 2005 levels by 2050,[1,2] through a cap and trade policy. The legislation provides for greenhouse gas reductions from major industrial emitters and establishes a voluntary program for agricultural offsets.

Under this voluntary program, Colorado agriculture can generate "offsets" – verified and durable emission reductions in greenhouse gases – that can be sold to emitters subject to mandatory pollution reductions requirements. A well-designed offsets program can reduce greenhouse gases, cut compliance costs for the industrial sectors subject to the emissions cap, and generate economic growth in rural agricultural areas.

The American Clean Energy and Security Act is projected to spur new investments in clean, renewable energy. In Colorado, farmers have benefited from long-term lease contracts for hosting wind turbines that provide payments. The 400-megawatt Peetz Table Wind Energy Center in Logan County, Colorado, is an example of a project which provides economic opportunity for Colorado's rural communities (see sidebox).

Winds of Change for Family Farms, Excerpt from Clean Energy Pioneers: Building a Stronger Western Economy[3]

Edward Koester, 60, knows the tough life of a farmer in Logan County, a high plains frontier in northeastern Colorado. One big hailstorm can ruin a year's crop, snow can bury a building, drought sucks life from soil and he killed eight rattlesnakes in his yard last year.

The region that includes Logan County is rapidly developing into one of the largest wind energy producing regions of the country. Energy companies, farmers and ranchers have partnered to capture what the National Renewable Energy Laboratory rates as some of the nation's best wind across northeastern Colorado. The new development is creating jobs, building tax revenue and reducing global warming gases.

For clean energy pioneers like Koester, renewable energy development is key to keeping the family farm. He and his wife grow millet and wheat on 320 acres his father once farmed, but it's not enough to pay the bills. So, by day he drives a road grader for the county and his wife works at the grain elevator in nearby Peetz; they farm during evenings and weekends. He wonders how long he can sustain the workload or when he'll retire. His solution: use the land to grow windmills.

"A guy called me about 6 years ago and said, 'If you put turbines on your place, we'll pay you,'" Koester said. "It's very trying to make a living on a farm, so you got to do something else, so we wanted to look at it. Everyone I know who has the windmills likes them because they bring in a little extra money," he said.

Agricultural interests in the State of Colorado are well-positioned to benefit from national clean energy and climate policy, as a number of new state initiatives have prepared rural Colorado for these opportunities. Landmark state policies for renewable energy have brought vibrant new economic opportunity to rural Colorado, and new state policies are building the foundation for agricultural offsets. By positioning itself at the forefront of developing climate-friendly solutions, Colorado has cleared the way for rural agricultural communities to gain economic benefits while working to protect our scarce water resources from a changing climate.

Colorado's rural communities have a strong stake in mitigating the impacts of climate change. For example, studies show that climate change may adversely affect the availability of water in Colorado[4], which is vital to the economic well-being of the state.

This report focuses on two opportunities for agricultural communities to benefit from national climate and clean energy policy: voluntary carbon offsets and wind energy development. Farmers that mitigate greenhouse gas emissions can benefit from emerging offset markets. The agricultural sector has the potential to reduce greenhouse gas emissions relatively inexpensively by sequestering carbon and reducing nitrous oxide and methane emissions.

Colorado is well suited for wind energy development, and the growth of this clean energy source serves to reduce greenhouse gas emissions. With current installed wind energy capacity of over 1,000 megawatts, and an estimated total capacity many times greater, the state has great potential for further growth.

Robust solutions to enhance climate and energy security require collaboration between policy makers and stakeholders[6], and must include policies that are anchored in science. By working together, Colorado and the nation can pioneer win-win solutions, where the agricultural community gains vital protection from the threats of a changing climate, and at the same time, benefits from proposed mitigation strategies.

"It is the policy of this State to encourage local ownership of renewable energy generation facilities to improve the financial stability of rural communities." - *Colorado Public Utilities Commission Rules*[5]

Introduction

According to the most recent Intergovernmental Panel on Climate Change (IPCC) report, greenhouse gas accumulation in the atmosphere is "very likely" the cause of most of the observed increase in global temperatures[7]. Predictions are for a "probable" global temperature increase of 1.8 to 4 degrees C (3.2 to 7.2 F) by the end of the century[8]. Models estimate that temperatures may rise in Colorado by 2.5 degrees F by 2025 and by 4 degrees by 2050[9]. Of special concern to the agriculture sector in Colorado is how climate change may affect precipitation patterns, water supply and water distribution.

Currently, there is much interest in programs that address greenhouse gas emissions reductions at all scales, and many of these programs are presently taking shape. For example, national attention is now focused on Congress as it considers the American Clean Energy and Security Act that would create a market for reducing greenhouse gas emissions through a cap on major industrial sectors and a voluntary offsets program for agriculture. This legislation would allow the agriculture sector, voluntarily, to generate income by generating high-quality emissions offsets. In addition, the legislation would create incentives for renewable energy projects, bringing economic stimulus to areas rich in renewable energy resources, such as wind and solar energy.

An essential part of a national cap and trade market is the creation of an emission offset program. An offset is a "reduction, avoidance, or sequestration of GHG emissions from a source not covered by an emission reduction program"[10] which would qualify for emissions credits in the low-carbon economy currently under consideration. General activities that have offset potential include agriculture and forestry projects (e.g., land management to improve carbon storage) and non-carbon dioxide greenhouse gas emissions reductions (i.e., methane and nitrous oxide)[11]. Additionally, incentives promoted under climate-friendly policies would encourage the development of projects in renewable energy (i.e., wind, solar and/or biomass) and energy efficiency.

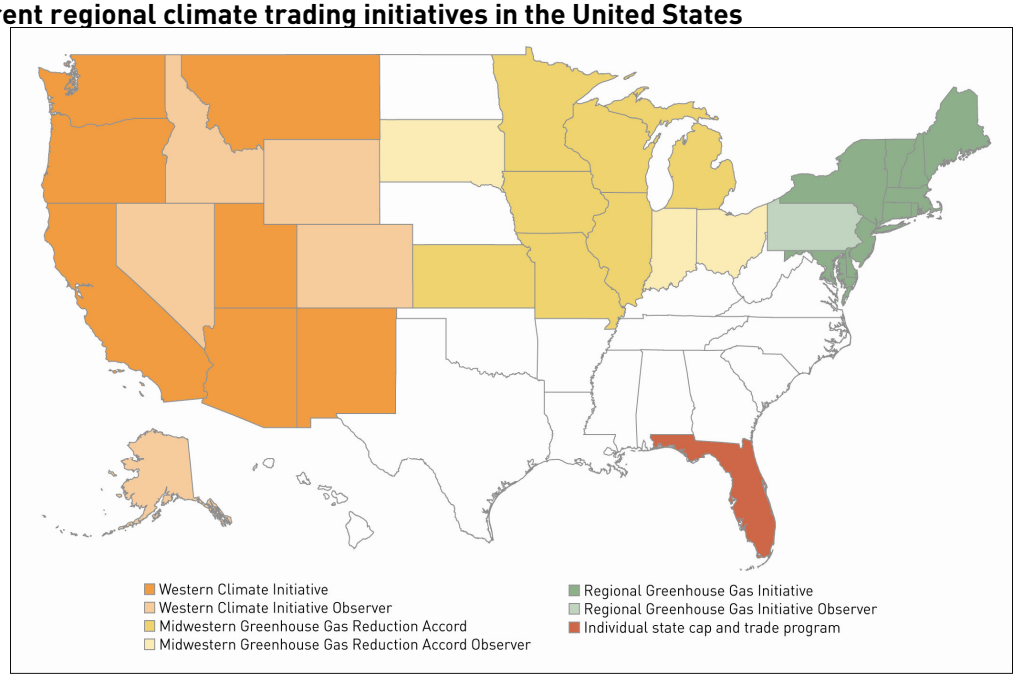
Due to the national interest in climate and energy security, and Colorado's emphasis on creating a New Energy Economy, the timing is optimal to actively initiate emissions reductions programs. The state is well suited to the development of solar and wind energy: maps published by the National Renewable Energy Lab (NREL) show high potential in many rural regions of Colorado (see maps in Appendix). As an initial step, Colorado's Governor has encouraged people to begin with "bridge" strategies[12], which are actions that can be taken immediately based on current knowledge. With over 31 million acres of farm land in Colorado[13], there is potential for the agricultural community to be directly involved in the development of mitigation efforts.

Cap and Trade in the U.S.

In 2001, the first regional cap and trade program to reduce greenhouse gas emissions was initiated in the northeastern United States[14]. Ten states compose the Regional Greenhouse Gas Initiative, the first mandatory program in the U.S. aimed at stabilizing and then reducing carbon dioxide emissions by 10% by 2018[15]: its first live auction took place in September 2008[16]. Both the Western Climate Initiative[17] and the Midwest Regional Greenhouse Gas Reduction Accord[18] were established more recently, in 2007. These programs have regional agreements to establish cap and trade markets in the near future. A number of states are officially "observing" these regional initiatives, including Colorado (see Figure 1).

FIGURE 1

Map of current regional climate trading initiatives in the United States



Source: Pew Center on Global Climate Change[19]

There are many promising offset opportunities for the agriculture sector. At lower carbon trading prices, possible offset strategies within the agricultural sector include soil carbon sequestration via changes in soil management, reduced fertilizer application, livestock diet and manure management. As prices rise, there will likely be more opportunities for offsets, depending on the region[20,21].

Programs to reduce emissions via offset strategies are currently emerging, both nationally and regionally. Optimal greenhouse gas reduction programs must consider a range of implementation and verification issues in offset projects, including: quality standards to ensure additionality (that reductions are 'in addition' to what would have happened without the project), limited leakage (that avoided emissions are not displaced to another location), permanence (to ensure the mitigation endures for the life of the offsets project), accountability, and transparency (that projects are verified, monitored, and the timeframe is clear). It is critical that projects accomplish the reductions for which credits are awarded. Policies must also allow for the possibility of new strategies to efficiently reduce greenhouse gas emissions.

Presently, there is ample opportunity for agriculture to become involved and benefit from national clean energy and climate policy, even though the sector will not be directly regulated under a national cap. This report discusses two areas that agricultural communities in Colorado can potentially benefit from: carbon offsets and wind energy development.

Colorado Climate

National Renewable Energy Laboratory

The State of Colorado has shown important leadership in authorizing the Colorado Climate Action Plan in 2007, which aims to establish a New Energy Economy and cut greenhouse gas emissions by 20% below 2005 levels by 2020[22]. Based on these goals, the Governor's Energy Office has created a number of programs intended to encourage energy efficiency and the development of renewable energy projects.

On April 22, 2008, Colorado Governor Bill Ritter issued an executive order that established the goal of reducing greenhouse gas emissions by at least 80% of 2005 levels by 2050[23]. In an effort to expedite this process, the State of Colorado also announced that the state joined the Climate Registry, a voluntary greenhouse gas reporting system, as a founding emissions "reporter".

In addition to calling for overall emissions reductions, Governor Ritter issued an Executive Order for the Colorado Department of Public Health and Environment to create an agricultural offset program[24], creating an opportunity for farmers and ranchers to become leaders in greenhouse gas mitigation and to take advantage of the opportunity to participate in carbon trading markets as they are established. Within 24 months of the executive order, a program is to be designed, with implementation beginning no later than three years from the date of the April 22, 2008 order.

The Governor's Energy Office has also established a number of innovative programs that will help the state work towards its greenhouse gas reduction goals. Some of the programs relevant to greenhouse gas mitigation include[25]:

- **The Colorado Carbon Fund**: A voluntary program which provides high quality carbon offsets to consumers as a way to support new energy efficiency and renewable energy projects in Colorado to reduce greenhouse gas emissions. The program is currently seeking offset projects to fund. Recently, the Democratic 2008 Convention Host Committee donated $100,000 to offset 5,000 metric tons of carbon dioxide at $20/ton[26].

- **The Advancing Colorado's Renewable Energy Program (ACRE)**: This program is administered by the Colorado Agricultural Value-Added Development Board, and will provide $500,000 in funding for the 2008/2009 fiscal year[27]. To date, 35 projects have been funded by almost $1.5 million[28] for projects aimed at encouraging the agriculture industry to participate in Colorado's New Energy Economy; projects are funded in several categories, including: feasibility studies, research or project participation[29]. Example projects include Brink Inc. of Lafayette, which will receive up to $100,000 to look into onsite wind resources at several livestock facilities in Colorado, and Cure Organic Farm in Boulder, which will receive a grant to evaluate a new greenhouse style capable of producing a "close-to-zero carbon footprint"[30].
- **The Anaerobic Digestion Feasibility Program**: Administered by the Governor's Energy Office, this program will share the expense of determining the feasibility of an anaerobic digester for a given farm. There are currently 125 manure livestock digesters in use in the U.S., with 26 systems under construction, and 70 more planned. For the majority of the digester systems, biogas is captured and used to generate electricity; in total, these systems generate approximately 244,000 megawatt-hours of electricity annually. Most systems are located on dairy farms in the Midwest, West, and Northeast[31].
- **The Community Woody Biomass for Thermal Usage Program**: This program supports projects that utilize community woody biomass for generating heat. Sources of woody biomass can include wood chips, pellets, cordwood, in addition to annual forest thinnings, wood waste, and urban waste; the GEO expects to fund 8 to 10 projects in state fiscal year 2009[32]. As an example, the South Routt School District in Colorado partnered with the Governor's Energy Office and the McKinstry Company to install a woody biomass boiler that uses wood pellets from beetle kill trees that are processed in a nearby town[33].

Opportunities for Agricultural Offsets

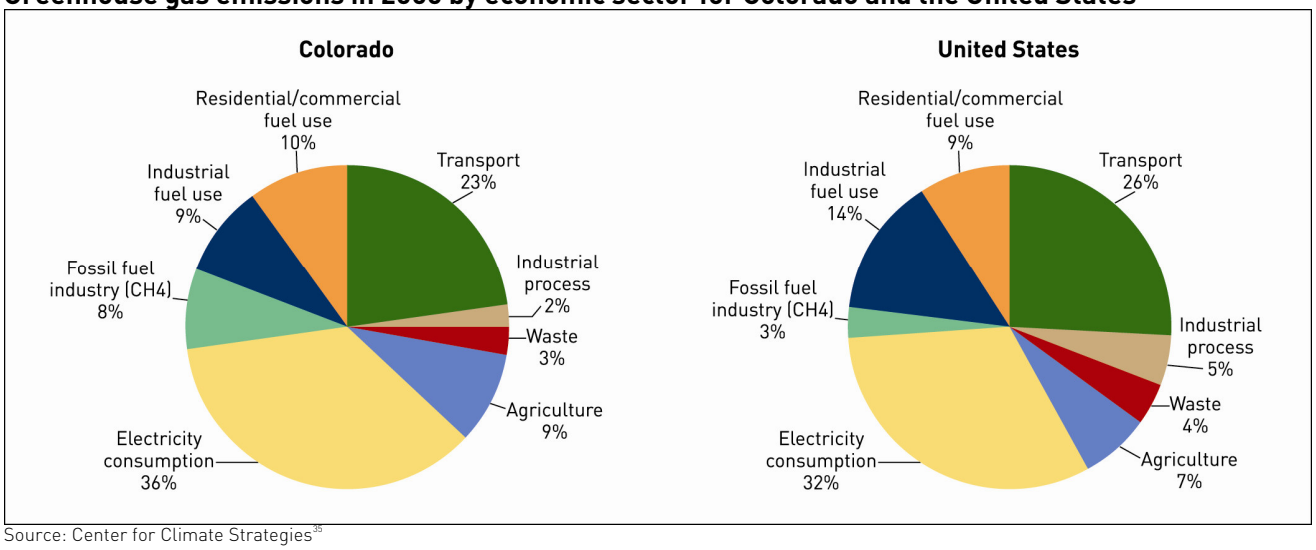
National Renewable Energy Laboratory

ROLE OF AGRICULTURE IN THE CLIMATE SYSTEM

In general, the emissions profile for the Colorado economy is very similar to that of the U.S. as a whole (see Figure 2). The largest greenhouse gas sources in Colorado (and for the U.S.) are electricity use (36%) and transportation (23%). In Colorado, and the U.S., agriculture contributes about 10% to overall greenhouse gas emissions. According to the Colorado Greenhouse Gas Inventory, gross emissions from agricultural sources were estimated at 9 million metric tons of CO_2e/year (on average, from 1990 to 2005)[34]. Although not regulated under the American Clean Energy and Security Act, reductions in agricultural sources are a potential opportunity for offset credits under proposed policies.

FIGURE 2

Greenhouse gas emissions in 2000 by economic sector for Colorado and the United States



Source: Center for Climate Strategies[35]

Agriculture and Greenhouse Gas Emissions

Globally, agricultural lands take up approximately 40 to 50% of the land's surface[45]. The net flux of carbon dioxide (CO_2) between the atmosphere and agricultural lands is approximately balanced (most of the net flux to the atmosphere is due to fossil fuel use). However, agricultural activities are responsible for approximately 60% of nitrous oxide (N_20) emissions and 50% of methane (CH_4) emissions globally[46]. In 2004, the agriculture sector contributed 13% of total global anthropogenic greenhouse gas emissions[47].

Although the agriculture sector is a moderate contributor to overall greenhouse gas emissions as compared to other sectors, the industry can play a unique role, as it can substantially decrease its own net emissions by adopting best management practices[48]. In particular, management of N_2O and CH_4 emissions provides enormous opportunity to reduce net greenhouse gas emissions as nitrous oxide is 310 times, and methane 21 times, as potent as CO_2 in terms of its warming potential (over 100-year time frame)[49]. Because of this significant difference in warming potential, methane and nitrous oxide emissions are often reported in units of CO_2 "equivalents" (abbreviated as CO_2e) in order to clearly slow the contribution of their fluxes to the greenhouse effect.

For 2007, there were over 30 million acres (out of a total 66 million acres) of land in agriculture on 36,500 farms in Colorado[36,37]. Approximately 11 million acres were utilized as cropland and 18 million acres were operated as permanent pasture and rangeland[38]. For the year 2007, the dominant crops in Colorado, based on the total value of production, were corn (for grain & silage), wheat, hay and potatoes; the dominant livestock (based on inventory) were cattle and calves and chickens[39].

In general, livestock are an important greenhouse gas source, as the largest contributors to overall greenhouse gas emissions in the agricultural sector are enteric fermentation and agricultural soil emissions due to livestock activity (i.e., manure applied to agricultural soil, or direct deposition to soil)[40]. A major source of methane from agricultural activities is livestock, from both enteric fermentation and manure management[41].

Agricultural soils are an important source of nitrous oxide emissions, which can be emitted via a number of different pathways in an agricultural system. Although nitrous oxide is a natural product of microbial activity in soils, agricultural activities (such as soil management and nitrogen fertilization) have increased nitrous oxide emissions from soils[42]. Indirect nitrous oxide emissions can also be important when increased nitrogen runoff leads to higher N_2O emissions from surface or groundwater.

Net emissions of carbon dioxide can either be positive or negative within agricultural systems, depending on how they are managed. A 2007 study by the Center for Climate Strategies[43] estimates that in Colorado, soils are a net sink of 2 million metric tons of CO_2e/year. House Bill 07-1203 provided funding for Colorado State University to assess carbon stocks and carbon sequestration potential at a county-level throughout the state; these results are expected in 2009[44].

POTENTIAL OFFSET OPPORTUNITIES

Although managing agricultural systems to minimize emissions of greenhouse gases and maximize carbon sequestration is a challenging and complex process, there are many opportunities to use well accepted practices. The effectiveness of these practices can vary both within and between climate regions and soil types, and must be adapted to local conditions[50]. There are a number of "best management practices"[51] which can be used to reduce emissions of N_2O and CH_4 and increase soil carbon stocks. Some general examples include:

- improvements in soil management to increase carbon sequestration and reduce greenhouse gas emissions (e.g. optimization of fertilization and irrigation methods),
- conversion of marginal cropland to permanent cover (e.g., perennial buffer strips),
- optimization of crop rotations (e.g., varieties with greater biomass fix more carbon),
- and improvements in livestock management, including diet, pasture management, manure management, and methane capture for use as biogas.

An estimated 70 to 220 million metric tons of carbon could theoretically be sequestered each year in U.S. soils, if currently accepted best management practices were widely used[52]. In combination with N_2O and CH_4 reductions from the agricultural sector, U.S. emissions could be reduced in a relatively cost effective manner (compared to reductions in other sectors). Recommendations by a recent agricultural mitigation study are for policy support that provides "outreach, education, and technical assistance to landowners through existing or new programs, or enhancing and structuring government support programs so that they better target the production of environmental goods, including greenhouse gas mitigation"[53]. The level of reductions in the agriculture sector will depend on the types of policies that are adopted, some of which may call for financial incentives.

Currently, there is opportunity for agricultural organizations to work with their communities to refine best management practices to reduce net greenhouse gas emissions, and in the process, create credible offsets. While methane capture from livestock operations is a relatively well-known method, programs to reduce N_2O emissions at the field level offer great potential to reduce on farm costs while receiving carbon credits. Projects that reduce emissions and conserve resources will contribute to a New Energy Economy, and will generate a positive, synergistic relationship between climate change policy and environmental quality.

GETTING INVOLVED IN CREATING AGRICULTURAL OFFSETS

Both in Colorado and nationally, the goal is to develop a science-based agricultural mitigation program[54], which works well for farmers and ranchers. Scientists at Colorado State University are currently working to develop a statewide, county-level assessment of carbon stocks, in addition to sequestration and mitigation potential[55]. As part of this project, stakeholder meetings will be held throughout the state beginning mid-2009[56].

Currently, it is possible to use an on-line tool, COMET-VR[57], for estimating carbon sequestration based on potential land use activities[58]. As a voluntary program, the tool is useful in helping farmers evaluate how a chance in activities may impact greenhouse gas emissions or carbon sequestration when assessing offset opportunities. It is critical that offsets offer verifiable emission reductions or increased carbon sequestration.

The state-sponsored Colorado Carbon Fund is currently supporting the following types of projects[59]: anaerobic digestion, biomass, commercial solar hot water heater installations, energy efficiency (with direct emissions reductions), and transportation. As national and state policy evolves, more opportunities are expected to emerge at the state level.

Currently, the State of Colorado is administering a demonstration program to evaluate the efficacy of an agricultural carbon credit program. There are over 700,000 acres of land in Colorado in the Conservation Reserve Program due to expire next fall: the program allows an evaluation of the benefits of selling offsets to keep the expiring land in grassland, rather than plowing the land and releasing CO_2. Two farms are involved in the demonstration project, which includes the opportunity for Colorado State University (CSU) scientists to conduct on-site soil sampling so that hard data can be compared with CSU's modeling numbers[60].

In Colorado, the Rocky Mountain Farmers Union (RMFU) can provide information for farmers wishing to get involved with carbon trading, through its "carbon credit" program (go to http://www.rmfu.org/co-op/renewable-energy/carbon-credits/). These opportunities will likely expand if a national cap and trade program is enacted[61].

Colorado Wind

National Renewable Energy Laboratory

In addition to exploring agricultural mitigation potential, the State of Colorado's New Energy Economy also strongly supports renewable energy programs, which have a substantial impact on rural agricultural economies. Wind energy has been referred to as the new "cash crop" for rural landowners[62]. Wind is currently the fastest growing renewable energy source in the U.S. [63]

Renewable Portfolio, or Renewable Electricity, Standards have been instrumental in supporting wind energy across the United States[64]; approximately half of the states have such standards to encourage renewable energy growth. Colorado was the first state to enact a Renewable Electricity Standard via a state ballot initiative in November 2004; this standard required utilities with 40,000 or more customers to supply 10% of their retail electric sales with renewable energy[65]. In March 2007, Colorado's Renewable Portfolio Standard was broadened, and a new reduction target was set to 20% by 2020[66].

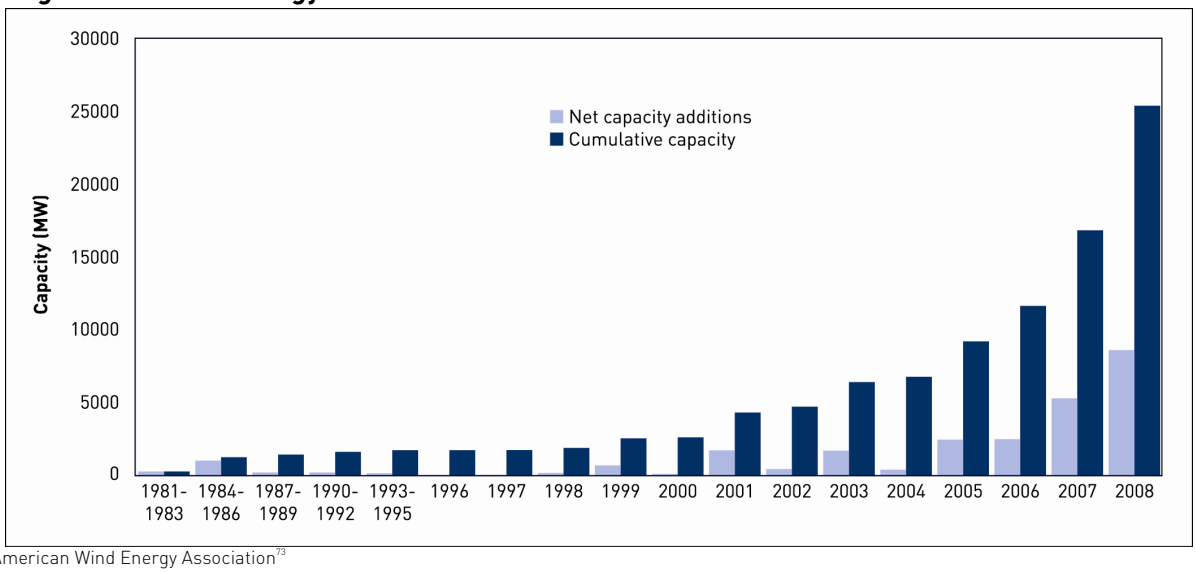
Today, Colorado is ranked 3rd in the country for the share of electricity generated by wind, contributing 6% of the state's power needs[67]. The state has an existing wind energy capacity of over 1,000 megawatts; with an estimated developable potential many times greater[68].

Growth of Wind Energy

The U.S. Department of Energy has documented that the U.S. can generate 20% of the nation's electricity from wind energy by 2030; this scenario would decrease cumulative greenhouse gas emissions by 7,600 million metric tons of CO_2 [69]. If current trends continue, the country would be on track to achieve this goal, and many experts believe that even greater progress is possible. National cumulative wind energy capacity has grown from 1,900 megawatts (in 1998), to over 25,000 megawatts (in 2008)[70] over the last decade (see Figure 3).

In 2008 alone, over 8,500 megawatts of new wind energy capacity was added, and these new projects are estimated to avoid almost 44 million metric tons of carbon emissions. As a result of this tremendous growth, the U.S. has become a world leader in wind power capacity, overtaking the previous leader, Germany. In 2009, more than 5,000 megawatts of new capacity is expected.[71] Additionally, the U.S. market for small wind turbines grew 78% in 2008, with 17 megawatts installed; the new 30% federal investment tax credit is expected to push growth to a total of 1,700 megawatts in the next 5 years[72].

FIGURE 3
National growth in wind energy.



Source: American Wind Energy Association[73]

BENEFITS OF WIND DEVELOPMENT FOR RURAL COLORADO

In recent years, rural economic development has been revitalized by wind energy development projects in Colorado. These projects provide a suite of benefits to rural communities, including jobs, landowner revenues from lease agreements, and an increased local tax base.

A 2008 study by the National Renewable Energy Laboratory (NREL), based in Golden, Colorado, evaluated the impacts of "Colorado's First 1,000 Megawatts of Wind Energy"[74]. NREL estimated that each 1,000 megawatts of wind power in Colorado:

- Generates enough electricity for 248,000 homes (11.8% of Colorado homes in 2006),
- Created approximately 1,700 full-time construction-related jobs (with a total $71.3 million in payroll), and about 300 permanent jobs in rural areas (with a total $14.7 million in payroll), and
- Produced economic revenue for communities with wind projects in a number of areas: increased local economic activities during construction, leading to higher sales tax revenues; higher annual property tax income, and extra income for property owners (primarily farmers and ranchers) that have lease agreements with wind developers.

Currently, Colorado has over 1,200 megawatts of wind energy (see Table 1).

EXAMPLES OF WIND PROJECTS IN EASTERN COLORADO

Colorado's first wind project, the 30-megawatt Ponnequin facility in Weld County, began operation in 1999[75,76]. In 2003, the 162 megawatt Colorado Green Wind Power Project was constructed in Prowers County, near Lamar. Colorado Green was the largest capital investment in Prowers County history and increased the county's tax base by 29%[77]; the project now plays a key role in the county's economy, employing 15 to 20 people[78] and providing $1.3 million in tax revenue in 2007.[79]

Several large projects came on-line in Colorado in 2007, creating significant benefits for neighboring communities. The Peetz Table Wind Energy Center is a 400 megawatt wind plant that is made up of 267 1.5 megawatt turbines in Logan County, in northeastern Colorado[80]. A 78-mile power line was built in order to connect the project to the power grid. At the time of the project, it was the 2nd largest wind facility in the country[81]. This project has provided a boost to the local community in the

form of $2.6 million in annual property taxes and $1.5 million in annual landowner lease payments[82]. The facility also employs 22 staff and spends about $3 million in local operating costs[83]. Important aspects of this project for this agricultural region are that the project uses no water in the generation of electricity[84] and that the project's land remains in agriculture[85].

"There has not been a group of projects of this magnitude in our community over its entire history." – *Jim Neblett, Logan County Director of Planning and Zoning, speaking about the Peetz Table development*[88]

In nearby Weld County, the Cedar Creek Wind Energy Project also came on-line in 2007, with a 300 megawatt capacity project; enough power for 90,000 homes. This project created 400 construction jobs, and 20 full time staff[86]. A new project, the Northern Colorado Wind Facility, is planned to go on-line by the end of 2009, and will generate an additional 152 megawatts of wind power[87].

A summary of recent wind energy projects in Colorado is given in Table 1. Each of these projects has enhanced local economic development by creating jobs, boosting tax receipts, and providing royalties for landowners with towers on their property. A national level climate policy would encourage further development of similar wind projects.

TABLE 1
Summary of wind energy projects in Colorado (adapted from Interwest Energy Alliance)[89]

Wind project	Capacity (megawatts)	Year online	Owner/developer
Springfield, Baca County	1.5	2004	Arkansas River Power Authority
Cedar Creek	300	2007	Co-owned by Babcock & Brown and Greenlight/BP Alternative Energy
Colorado Green	162	2003	Iberdrola Renewables and Shell WindEnergy
Colorado Pork Demonstration Turbine	0.07	2005	Governor's Office of Energy Management & Conservation and US Department of Energy
Northern Colorado Wind Energy Center	152	*2009	NextEra Energy Resources (formerly FPL Energy)[90]
Peetz Table Wind Energy Center	400	2007	FPL Energy
Ponnequin	31.5	1999–2001	Xcel Energy
Lamar, Prowers County	6	2004	Arkansas River Power Authority
Ridgecrest-Peetz	30	2001	Developed by enXco; owned by Caithness
Spring Canyon	60	2006	Invenergy
Twin Buttes	75	2007	Iberdrola Renewables
Wray School District Wind Turbine	0.9	2008	Wray School District
TOTAL	1,219		

* Expected to go online in late 2009.

WIND MANUFACTURING IN COLORADO

In addition to wind farms, Colorado is becoming home to a number of major manufacturing facilities in the wind energy business. In 2008, Vestas Wind Systems opened a wind blade manufacturing facility in Windsor, Colorado[91]. Vestas is currently constructing three additional factories in Colorado. The Vestas Wind Turbine Tower Manufacturing Campus in Pueblo is expected to be completed in mid-2009, and will be the largest such facility in the world. There are also two more Vestas facilities planned for Brighton, one for wind blade production and one for nacelle assembly. In total, these facilities will add about 2,500 new jobs to Colorado[92].

Other companies have also decided to add wind manufacturing facilities in Colorado. For example, Hexcel, a parts supplier to Vestas, will "tag along" in establishing a facility in Windsor in order to be near Vestas's facility[93]. Siemens Energy is locating its U.S. wind turbine research center in Boulder, creating 50 new jobs; this center will focus on testing wind turbines and will partner with nearby NREL on a pilot wind project[94]. Spurred by the support that the wind industry has received under the Ritter administration, these companies have created significant economic growth in Colorado that would likely expand under a national climate policy supportive of renewable energy projects[95].

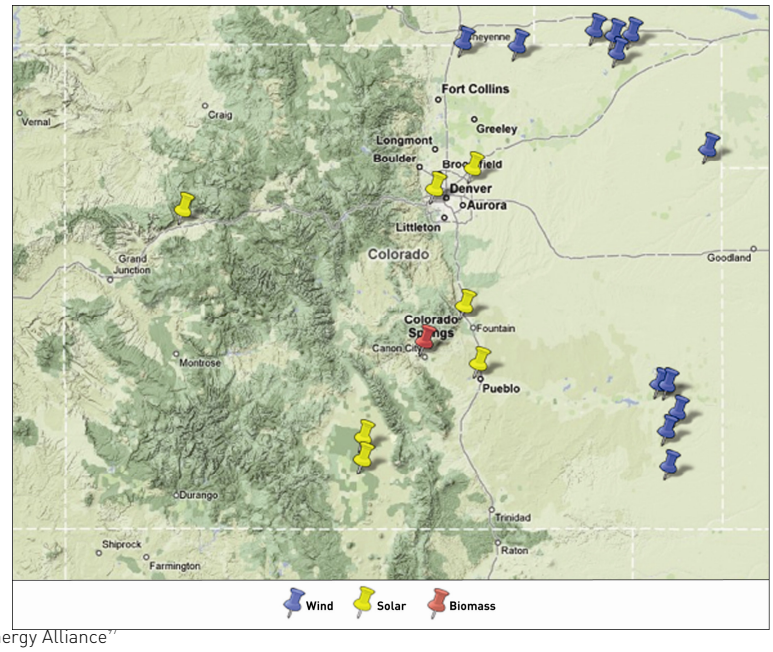
OPPORTUNITIES FOR RENEWABLE ENERGY IN COLORADO

Renewable energy industries have grown significantly in recent years in Colorado. Figure 4 shows a map of current renewable energy projects in Colorado.

One issue that Colorado faces is the availability of transmission capacity; this issue needs to be addressed in order to allow the large development of future renewable energy projects. A recent study showed that Colorado's summer "electric peak" of 11 gigawatts is much less than Colorado's estimated total potential to develop over 96 gigawatts of wind, and 1,300 gigawatts of solar energy. Assuming appropriate transmission lines could be developed, if only a small percentage of this capacity were deployed, there could be enough capacity that Colorado could export some of its renewable energy[96].

FIGURE 4

Map of existing renewable energy projects in Colorado.



Source: Adapted from Interwest Energy Alliance[97]

According to one report, Colorado is presently the fourth largest state for photovoltaic installations, and had the fastest growth in 2007[98]. Recently, Xcel and SunPower announced plans for a 17 megawatt solar photovoltaic plant in Alamosa (in south-central Colorado), which will use SunPower's Tracker technology[99]; operations are expected by the end of 2010, and construction will create an estimated 200 jobs. There is currently an 8.2 megawatt solar farm (completed in 2007 by SunEdison) adjacent to the planned 17 megawatt facility, and the new plant "will be the second-largest high-efficiency solar PV power plant in North America"[100].

Colorado's Governor's Energy Office supports a range of renewable energy programs in the state[101]. For example, state programs include the assessment of potential geothermal and small hydroelectric resources. Colorado's Geothermal Working Group is working to assess potential geothermal development in the state. Additionally, the Governor's Energy Office has established a Small Hydro Pilot Program to explore development possibilities[102]. These programs illustrate Colorado's commitment to the development of sustainable and renewable energy sources, and future projects may potentially provide economic opportunity for rural areas.

Benefits of Climate Security for Colorado Communities

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It is projected that by 2025, Colorado will warm by 2.5 degrees F (as compared to the 1950-1999 baseline) and by 2050, a warming of 4 degrees is predicted. These temperature changes are expected to affect the use and distribution of water in Colorado. For example, model projections show a potential 6 to 20% decrease in runoff by 2050 for the Upper Colorado River Basin[103]. According to a recent study, a possible 10 to 20% reduction in runoff could lead to an estimated 58 to 88% reduction in scheduled water deliveries for the Colorado River system by 2050[104].

The effects of climate change on water resources are potentially severe. Colorado faces large scale water resource challenges, such as meeting interstate water contracts and statewide drought planning[105]. Although the agriculture sector represents only a portion of total greenhouse gas emissions, it is critical that sectors directly affected by climate change are involved in mitigation efforts. Action by the agriculture sector to reduce greenhouse gas emissions has the potential to generate income from agricultural offsets and, importantly, help protect our state against the threats of a changing climate.

Conclusion

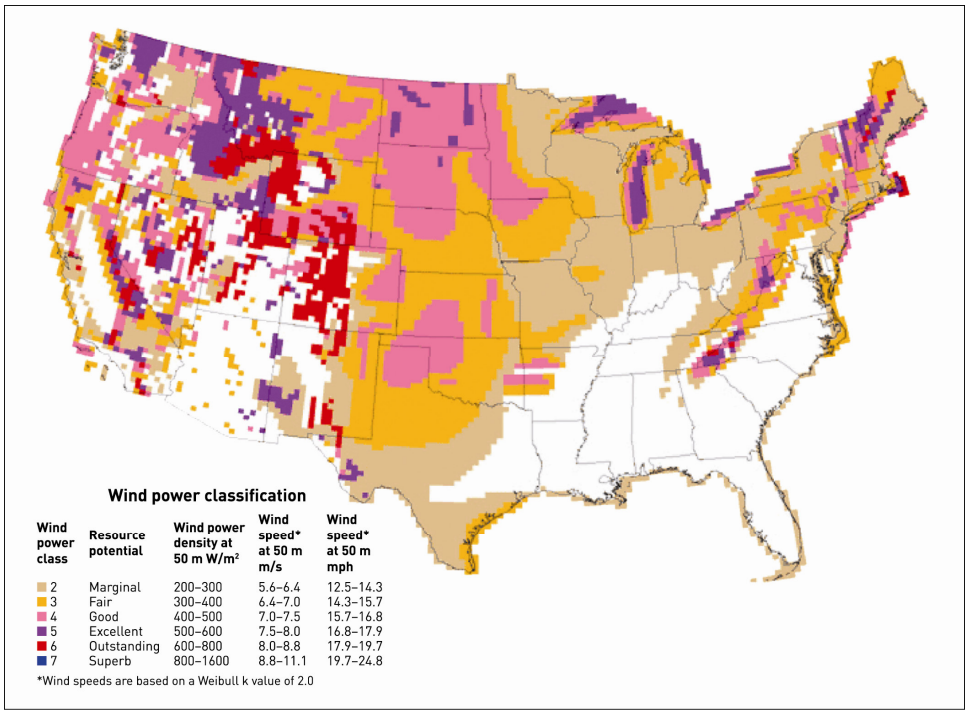
National Renewable Energy Laboratory

America is seeking climate security through clean energy solutions in order to dampen the impact of the predicted rise in global temperatures. A cap on major industrial emitters and the opportunity for agriculture to generate voluntary emissions mitigation through offsets will create a robust and successful cap and trade market. As national policy is formulated, there is great potential for those in the agriculture sector to create new opportunities by forging innovative, rigorous ways of reducing net greenhouse gas emissions, especially for nitrous oxide and methane, with their higher atmospheric warming potentials.

Government policy that supports innovation will be instrumental in creating successful programs. Well-designed policy solutions will require the joint efforts of climate scientists, stakeholders and policymakers. The current climate crisis requires actions at all scales. Colorado has already made steps to be at the forefront of taking climate-friendly actions, as evidenced by the development of its world class wind resources. Working together, Coloradans can do their part to address the climate crisis while providing new economic opportunities for rural communities.

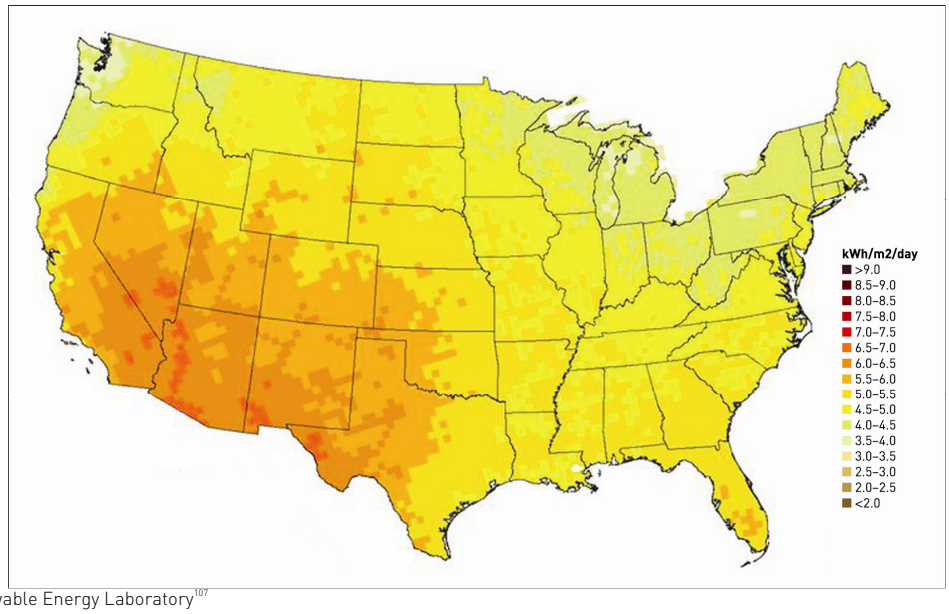
Appendix: Maps of solar and wind energy potential in the U.S.

FIGURE A-1
Wind Resources for the U.S.



Source: U.S. Department of Energy, National Renewable Energy Laboratory[106]

FIGURE A-2
Photovoltaic Solar Radiation for the U.S.



Source: National Renewable Energy Laboratory[107]

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