Wind Resource Evaluation
at Colorado Agricultural Operations

July, 2010

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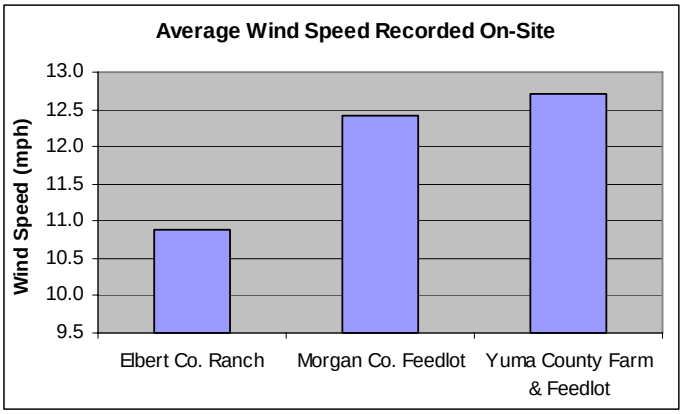
EXECUTIVE SUMMARY

This report evaluates the wind resource at three livestock operations in Colorado and identifies the most cost-effective wind turbine for each site. The value of each site's wind resource was most influenced by its average wind speed, electricity usage and electricity cost.

The study sites include a ranch in Elbert County, a feedlot in Morgan County, and a diversified farming, cow-calf and feedlot operation in Yuma County. Wind speed monitoring and recording equipment was installed and operated at each site for approximately one year. Wind speed data were used in conjunction with wind turbine output and cost information and site specific electric usage and cost to determine the most economical, or "best fit" wind turbine for each site. Projected electricity rate inflation, loan interest, tax credits and grants were also examined and factored into turbine payback time frames. Policies of the cooperative electric association serving each site were examined regarding net-metering and renewable energy credits (REC) purchase.

The most cost-effective turbine for each site was identified, and Net Present Value (NPV) and Return on Investment (ROI) were calculated. Turbine payback time frames were calculated based on a variety of scenarios, including whether or not loan interest was paid, and whether or not a USDA-cost share grant was obtained.

Figure 1.



Key Findings

- Cost-share funding combined with the federal tax credit make wind turbines cost-effective in areas with even marginal wind speeds.
- The average wind speed measured on-site was not always similar to the wind speed expected based on the U.S. DOE, NREL 50 meter wind speed map when adjusted for tower height differences.
- The federal (ARRA) 30 percent tax credit can largely offset loan interest cost.
- Turbine payback times ranged from 4 to 23 years.
- Limits on cost-share funding and tax credit eligibility tend to make smaller turbines more economically feasible than larger, more efficient turbines.
- All wind turbines are not equally efficient at producing electricity. Buyers should examine the ratio of turbine cost versus electricity output to determine the best-fit turbine.
- The evaluative methods used in this study may be utilized to determine the wind resource value for any type of agricultural operation.

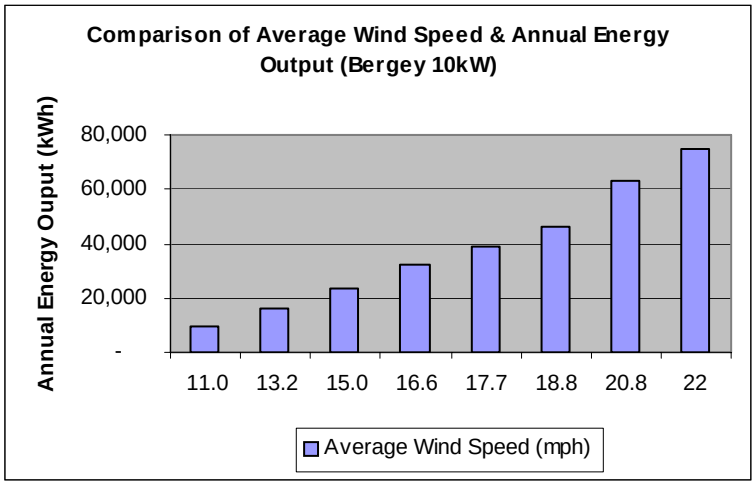
- A wind turbine with a 15-year payback time frame will produce a return on investment of about three percent annually assuming a turbine life span of thirty years.

WIND ENERGY

Wind possesses kinetic energy. The terms "wind energy" or "wind power" describe the process by which the wind's kinetic energy is converted by wind turbines into mechanical or electrical power. The energy contained within a moving air mass (wind) is a function of its speed and density. Wind density declines with increasing altitude and increasing temperature.

The energy available in wind is proportional to the cube of its speed. The importance of wind speed in determining energy output is displayed in Figure 2 (below), which compares the annual energy output of the same 10 kW turbine under different average wind speeds.

Figure 2.



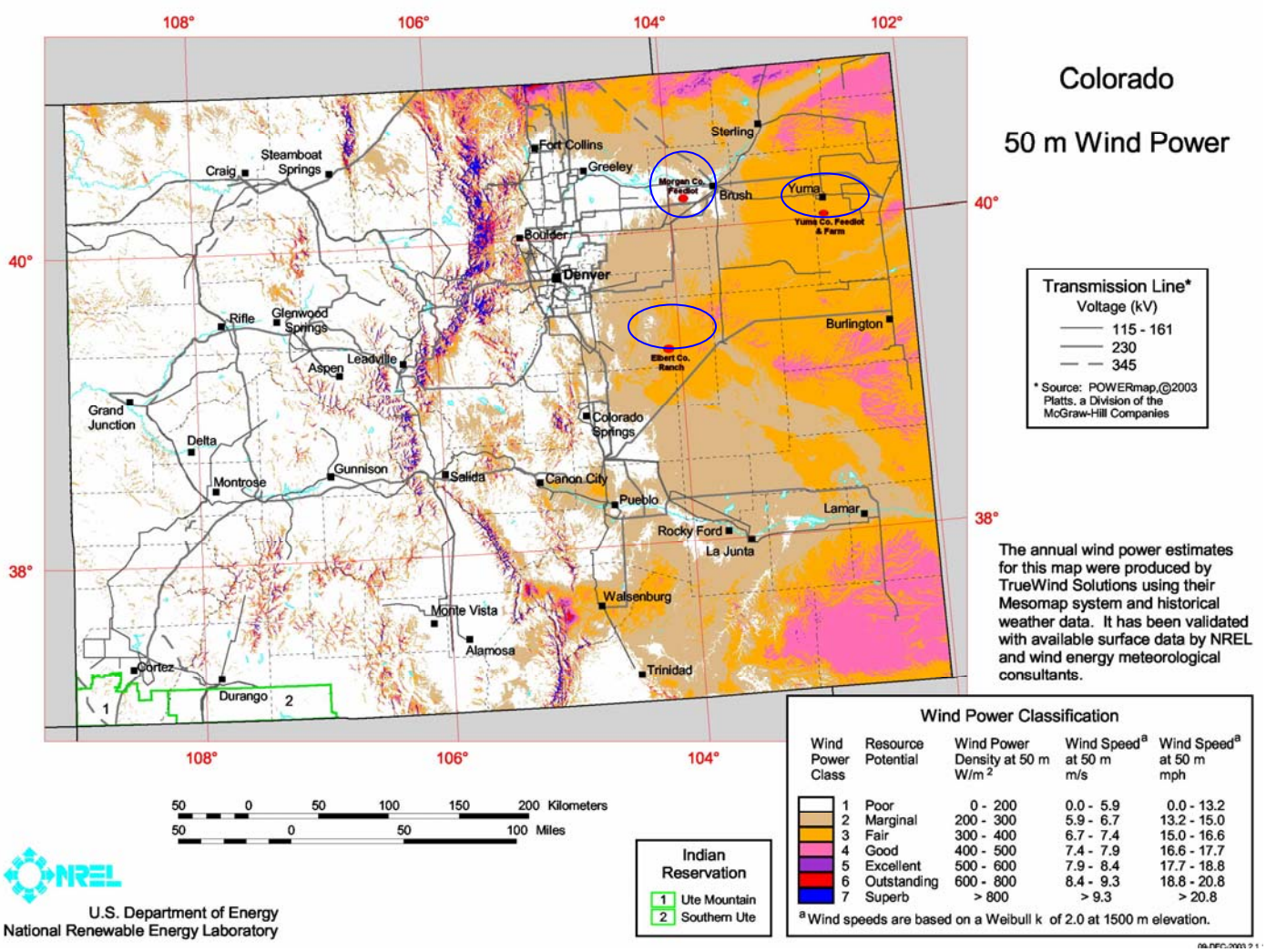
As the chart indicates, a 22 mph average wind speed can produce almost eight times more electricity in a year than an 11 mph average wind speed (Source: 2008 Wind Energy Feasibility report). A site's average wind speed is the most important variable in determining whether a wind turbine will be economically viable.

PROJECT BACKGROUND

This project follows a 2008 wind energy feasibility study which determined that Colorado livestock production facilities can utilize wind energy cost-effectively under the right conditions. As livestock producers face rising fixed costs (inputs, energy, equipment, etc.), they have a compelling financial need to reduce costs wherever possible, and develop new sources of income. Revenue streams that enable livestock producers to diversify beyond conventional agricultural-based income sources help operators to maintain a more stable financial condition, which in turns benefits rural city and county economies through job creation and tax revenue.

The 2008 ***Wind Feasibility Report for Colorado Livestock Operations*** found that the three participating livestock facilities had the potential to generate wind energy economically. However, all energy output estimates pertaining to the wind turbines examined were based on average wind speeds derived from the U.S. Department of Energy (DOE), National Renewable Energy Lab (NREL) *Colorado 50 Meter Wind Power Map.* The color-coded NREL map displays estimated wind speeds in Colorado at a height of 50 meters (163 feet) above the ground. The map is intended to be used to get a general idea of the wind resource in a given area of the state. Site specific wind speed data must be collected to get a clear understanding of a site's wind resource. This study included the installation of wind monitoring equipment at three Colorado livestock production facilities. The three study sites are superimposed on the NREL map below (Figure 3).

Figure 3.



WIND DATA ANALYSIS

Wind speed was measured at each site for slightly more than one year to better assess each site's actual wind resource value. The U.S. Department of Energy, Western Area Power Administration (WAPA) provided 20 meter (65 feet) tilt-up towers and related wind monitoring equipment for the study. The equipment was returned to WAPA when the monitoring component of the study was completed.

At each site, an anemometer (wind measuring device) was mounted on a tower and connected via cable to a data logger mounted at the base of the tower. The data logger was powered by a 9-volt battery. The tower and wind monitoring equipment are manufactured by NRG Systems. Wind speed was recorded every ten minutes and stored on a data plug, which was inserted in the data logger. Each site was provided with two data plugs for use on a rotational basis. When a data plug was removed and sent in for analysis, the other data plug was inserted in the data logger. Full data plugs were typically removed by the participating facility owners and mailed to BRINK, Inc. for download on an approximately monthly basis. There were some instances in which data plugs were not removed and mailed in as regularly and up to several days worth of wind data were not recorded. All sites had at least 7,500 recorded wind speed observations, thus, the impact of the aforementioned data gaps is not believed to have significantly skewed the computed wind speed averages.

Wind monitoring equipment mounted on tower

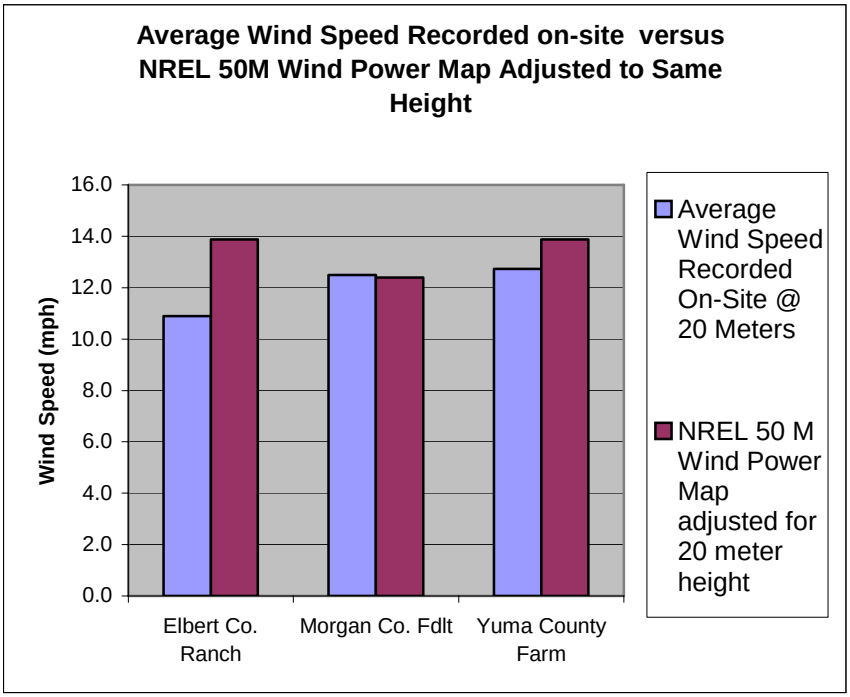
The anemometers were mounted on tilt-up towers approximately 20 meters (65 feet) above the ground at Morgan County Feedlot and Elbert County Ranch. At Yuma County Farm & Feedlot, the anemometer was secured to an existing 100 feet tall antennae located at the facility. All obstacles (trees, etc.) within a 300 feet radius of the towers were at least thirty feet below the instrument heights. Wind data were collected at the sites for approximately one year. The equipment was not installed at the same time at the three sites, thus, the beginning and end dates of the wind data sets differ.

Wind speed increases with height above the ground. Thus, the NREL 50 meter average wind speed estimate for a given site must be mathematically adjusted to a 20 meter height to compare the NREL map's wind speed estimate with the actual, measured wind speed at each site.

The "1/7 Power law" is commonly used to accomplish this adjustment. Using the air speed (V1) at a known height (h1), the airspeed (V2) at a different height (h2) can be estimated as: $V2 = V1 \times (h2/h1)^{1/7}$ (*source: USDOE, NREL*).

Figure 4 (below) compares the average measured wind speed at each site with the wind speed extrapolated from the *NREL 50 Meter Wind Power Map* and then adjusted for a 20 meter (65 feet) height above ground.

Figure 4.



At Elbert County Ranch and Yuma County Farm and Feedlot, the NREL map depicts a higher average wind speed than the wind speed measured at the sites. As noted previously, the NREL map was designed to provide a general idea of wind resource potential in a given area of the state rather than a site-specific wind speed.

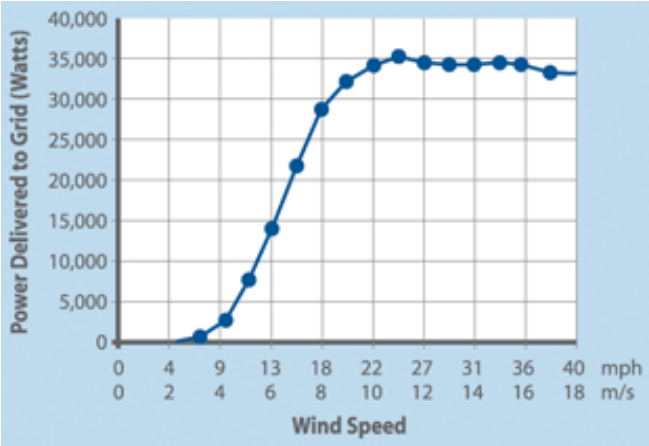
The differences in wind speeds (shown in the graph above) between the *NREL 50 Meter Wind Power Map* and the actual wind speeds recorded at the site highlight the importance of obtaining site specific wind measurements. However, it is also important to note the accuracy of the NREL map in predicting wind speed at the Morgan County Feedlot site.

WIND RESOURCE EVALUATION

Just as average wind speed varies from one site to another, so does the value of the wind resource. The **value** of wind energy at a given facility is primarily driven by the following four variables:

1. Average Wind Speed
2. Facility Electricity usage
3. Cost of electricity
4. Availability of tax credits, grants, and net metering

Figure 5.



The more efficiently a wind turbine can extract and convert wind energy into electricity, the more cost-effective it is. To identify the best fit wind turbine for each site (ie. the most cost-effective), the installed costs of several wind turbines were obtained using best available information from manufacturers, dealers and wind turbine customers. The estimated electricity output of each turbine was derived from each manufacturer's published power curve, using the wind speed average measured at the relevant study site. Figure 5 is an example of a typical wind turbine manufacturer's power curve (*source: Endurance Wind Power 35 kW turbine power curve chart, 2010)*. Additionally, some manufacturers also publish annual energy production charts for their turbines. These were also utilized when available.

Wind Turbine Life Span & Maintenance:

A 30-year turbine life span was used in all of the turbine cost and payback estimates. Thirty years represents the expected life of today's turbines for established, reputable wind turbine manufacturers. The cost per kilowatt hour and payback time periods will both decline for any of the turbines included in this study if they continue to function longer than thirty years.

A $0.01 (one-cent) per kilowatt-hour operation and maintenance (O & M) cost is built in to the calculated cost of wind-generated electricity for all turbines included in this study.

Renewable Energy Credits

One method of reducing initial capital costs associated with the purchase and installation of the wind turbine(s) is through the up-front sale of renewable energy credits (RECs) that the wind turbine(s) will be producing. Renewable Energy Credits (RECs), also known as "green tags, are greenhouse gas emission offset products. For every unit of electricity generated from renewable sources, an equivalent amount of renewable certificates, or Green Tags, is produced. A purchase of green tags is intended to offset the environmental effects of burning coal, gas and other fossil fuels across North America (s*ource: Bonneville Environmental Foundation website, 2008)*. Renewable energy credits are considered separate from the actual energy produced by a wind turbine.

Renewable energy credits are currently being marketed by various non-profit entities, for prices ranging from less than $10 to more than $40 per 1,000

kWh. If the turbine owner is paid, for example, $5 per 1,000 kWh, and his wind turbine produces 30,000 kilowatt-hours per year, the resulting income would be $150 per year.

Some cooperative electric associations (CEAs) do not allow landowners to sell their RECs if the landowner's wind turbine is tied into their grid (net-metering). Y-W Electric, which serves the Yuma County Farm and Feedlot, reserves for itself all RECs that are produced by the customer's wind turbine (*Source: Y-W Electric email communication, May 25, 2010*).

Mountain View Electric Association, which serves the Elbert County Ranch, will negotiate a purchase of a customer's RECs. The purchase price for the RECs usually equals the CEA's $200 net metering fee. Mountain View Electric Association (MVEA) is the only electric cooperative among the three sites that participates in the Governor's Energy Office renewable energy rebate program. If a customer-generator receives any type of rebate from MVEA, the rebate purchases all of the customer's renewable energy credits (*source: MVEA, May, 2010*).

Morgan County Rural Electric Association (MCREA) deals with RECs on a case-by-case basis and requires project-specific information before it will provide a compensation number.

The value of renewable energy credits (RECs) was also projected, along with the cost of borrowed money (loan interest), where applicable. Loan terms were assumed to be 15 years at a six (6) percent interest rate. An annual inflation rate of three (3) percent was figured into the cost of future utility-supplied power.

Tax credits and/or cost-share grants can significantly improve the economic feasibility of wind systems. The American Recovery and Reinvestment Act (ARRA) of 2009 included a thirty (30) percent federal tax credit for wind turbines with nameplate power ratings up to 100 kilowatts. The USDA-NRCS Environmental Quality Incentive Program (EQIP) can provide cost-share grants for wind turbines on eligible agricultural operations as a component of an operation's conservation plan. These two types of government incentives were included in the analysis. The USDA -EQIP cost-share grant amount is based on a rate of $3,800 per installed kilowatt, up to a maximum payment amount of $35,000 per turbine.

The USDA Rural Development offers grants and guaranteed loans to agricultural producers on renewable energy and energy efficiency projects. The grants and loans are offered through USDA Rural Development's Rural Energy for America Program (REAP).

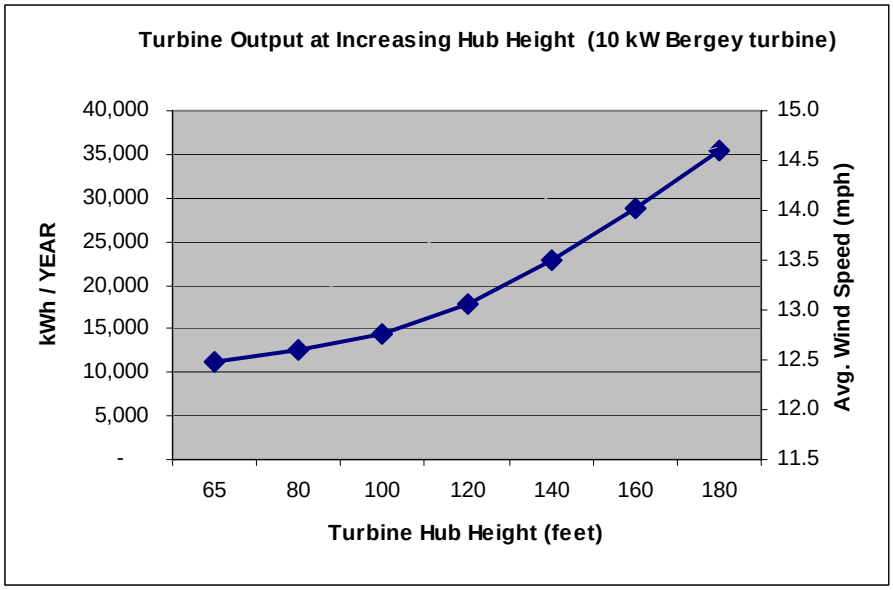
Turbine & Tower Height

Wind turbines can be mounted at differing heights above the ground. The appropriate tower height for a typical site is influenced by the size of the turbine, cost of the tower, surrounding landscape features and zoning restrictions.

As noted previously, wind speed increases with height. Although the average wind speeds at the three study sites were collected at 20 meters (65 feet) above ground, by mathematically adjusting each site's average wind speeds upward to match normal tower heights (ex: 80 feet, 100 feet, etc), it is possible to predict how much electricity the same turbine would produce at different tower or "hub" heights. "Hub" height refers to the distance from the ground up to the center of a turbine's hub.

Figure 6.

Figure 6 illustrates how tower height influences turbine electrical output. It displays the output of the same 10 kW turbine based on different turbine hub heights. The right side of the graph shows the average wind speed that corresponds to each hub height.



Net Metering

The 2008 *Wind Feasibility Report* found that wind-generated electricity is most valuable to a customer-generator when it is used on the customer side of the meter. Since the output from a wind turbine rarely matches precisely with a customer-generator's electrical usage, excess electricity from the wind turbine is delivered to the power grid. In the absence of net metering, this electricity would be valued at the wholesale rate. Net metering addresses this challenge by allowing excess customer-generated electricity (that amount delivered to the utility grid) to be carried forward and credited against the customer's future electricity purchases. Once a year, the cooperative electric association (CEA) pays the customer-generator for any remaining unused balance of energy credits at a rate equal to the average wholesale rate paid by the CEA over the previous year.

The current net-metering policies of each cooperative electric association were reviewed to determine the value of projected turbine-generated electricity. Cooperative electric associations are required by Colorado law to provide net metering to residential customers who generate up to 10 kilowatts and industrial customers who generate up to 25 kilowatts from wind power. Some cooperative electric associations restrict the size of wind turbines that can be tied into their grids to these nameplate rating thresholds. Larger turbines may be considered through a board review and approval process.

The three sites included in this study are each served by a different cooperative electric associations. Elbert County Ranch is served by Mountain View Electric Association; Morgan County Rural Electric Association serves Morgan County Feedlot, and Yuma County Farm and Feedlot is served by Y-W Electric Cooperative. Their respective net metering policies are as follows:

1. **Elbert County:** Mountain View Electric Association (MVEA): Net metering up to 10 kilowatts for residential customers and 25 kilowatts for commercial customers. Installation of a larger turbine in either customer-class requires MVEA board approval if it will be connected to the utility's grid.

2. **Morgan County:** Net Metering Policy: Anything exceeding 25 kW capacity must be approved by MCREA. Net metering will be available to members on a first-come, first-served basis until the rated generating capacity owned and operated by eligible member-generators reaches 1,000 kilowatts, at which time MCREA may elect not to offer this schedule to additional member-generators.

3. **Yuma County:** Net metering up to 10 kilowatts for residential customers and 25 kilowatts for commercial customers.

The current wholesale rate is slightly less than 3 cents per kWh. Since the wholesale rate is often less than one-third of the retail rate, a wind turbine that is properly matched with its site will generate little or no surplus electricity that must be sold at the wholesale rate. In other words, the output of a properly-sized wind turbine will either be used directly by the customer (behind the meter) or will be credited to the customer through net metering.

FINDINGS by SITE

An evaluation of the each participating facility's wind resource is displayed on the following pages.

Elbert County Ranch:

Type of Operation:	Cow-calf producer
Location:	North of Simla
Electricity Supplier:	Mountain View Electric Association (MVEA).
MVEA REC Purchase Policy:	Trade all for net-metering fee or purchase if rebated
Meter Analyzed:	Barn and associated pens
Average Electricity usage:	3,200 kWh per year
Average wind speed:	**10.9 mph** (4.9 m/s) at 20 meters (65 feet)
Turbines Analyzed:	(1) Raum 1.5 kW
	(2) Southwest Windpower 2.4 kW Skystream

Figure 7.

Figure 7 shows the average monthly wind speed at this site. Figure 8 (below) shows the estimated payback time of two wind turbines based on two different scenarios: The first scenario is based on an all cash purchase with a 30% federal tax credit. The second scenario is also based on an all-cash purchase with the 30% federal tax credit combined with a USDA cost-share grant. An all-cash purchase was assumed for both turbines since the best-fit turbine for Elbert County Ranch's usage is relatively modest in size and price.

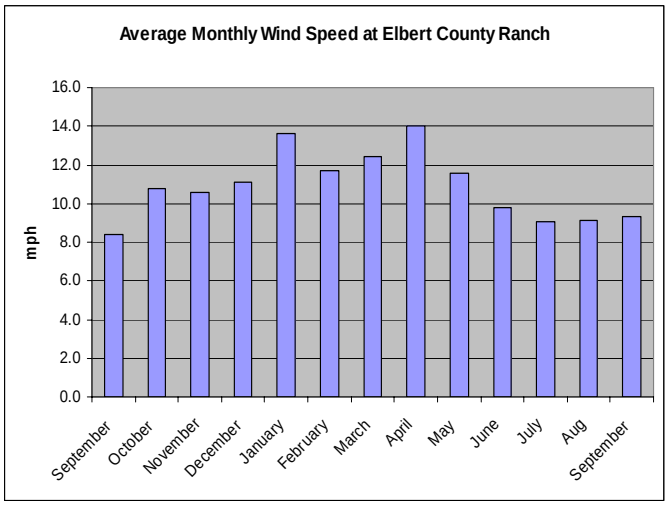
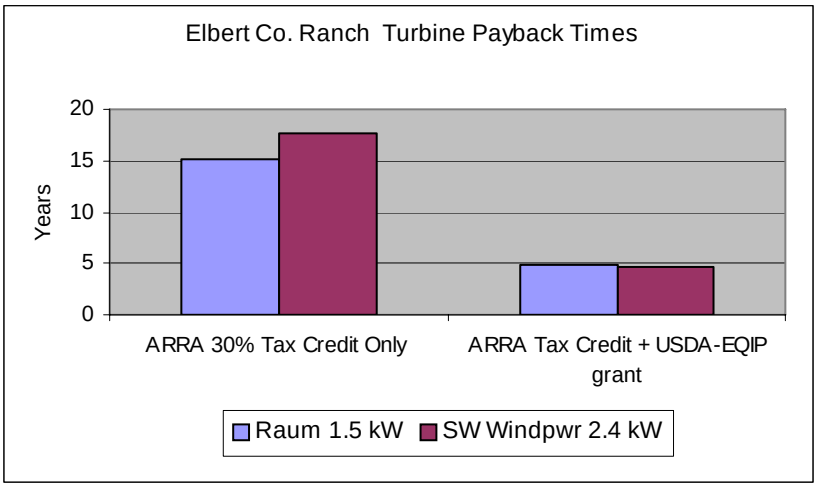


Figure 8



Best Fit Turbine:
Raum 1.5 kW or SW Windpower 2.4 Skystream.

Payback period:
1) Tax credit only: Raum; 15 yrs

2) Tax Credit + USDA-EQIP grant, either turbine; ~ 5 years.

Figure 9.

Wind Resource Analysis: ELBERT COUNTY RANCH

Meter: Barn

Annual electricity usage (kWh):	**3,200**	
Average Annual Electricity Cost:	$ 454	
Average wind speed @ 20 m (65') height:	**10.9**	**mph**
Average wind speed @ 20 m (65') height:	4.9	m/s

TOWER HEIGHT Recommendation

Recommended Minimum Hub (tower) Height above ground (feet)	**48**	**40**
Estimated average wind speed at hub height* (mph)	**10.7**	**10.5**
Estimated average wind speed at hub height* (m/s)	4.8	4.7

** Readings above 20m (65') height are calculated from 1/7 Power formula*

TURBINE Recommendation

Line #		Manufacturer:	**RAUM**	Southwest Wind power
		Turbine:	**1.5 kW**	Skystream 3.8
1	**Rated Capacity of Turbine (kW)**		**1.5**	2.4
2	Approximate total installed cost[2]		$ 12,000	$ 17,600
3	**Installed Cost less 30% Federal ARRA Tax Credit**		**$ 8,400**	**$ 12,320**
4	**Installed Cost minus ARRA Tax Credit + USDA-EQIP cost share[3]**		**$ 2,700**	**$ 3,200**
5	Total Loan Interest (70% financed, 6% rate, 15yrs*)		$ -	$ -
6	**Estimated Annual Energy Output (AEO) in kWh[4]**		**2,460**	**3,100**
7	Wind energy cost per kWh [4] NO LOAN; 30 yr turbine lifespan[5]		$ 0.17	$ 0.20
8	Wind energy cost per kWh [4] 15 YR LOAN		$ -	$ -
9	Average electricity cost charged by CEA; this meter (kWh):		$ 0.14	$ 0.14
10	Utility wholesale rate (kWh)[6]		$0.027	$0.027
11	**Annual Facility Electricity Usage (kWh):**		3,200	3,200
12	Turbine Output as a Percentage of facility annual usage		77%	97%
13	Avoided Cost (Annual Turbine Output x Retail Rate)		$ 349	$ 440
14	Annual Surplus Electricity Value (Prod - usage x wholesale rate)		$ -	$ -
15	**Turbine Output Value (annual)**		$ 349	$ 440
16	Avoided REA elec. inflation (3% annual); AVG next 30 YRS		$ 204	$ 258
17	Additional Value from Selling REC (use $10 per 1,000 kWh)		$ -	$ -
18	**Total Annual Wind Turbine Value**		$ 553	$ 697
19	**Turbine Payback (years); ARRA 30% Tax Credit Only**		**15**	18
20	**Turbine Payback (yrs): ARRA Tax Credit +USDA-EQIP grant**		**5**	**5**
	BEST TURBINE for FACILTY		**X**	**X**
	Net Present Value[7] (including 30% Tax Credit)		$ 8,204	$ 8,604
	Annual Return on Investment[8] (30% Tax Credit only)		**3%**	**2%**
	Annual Return on Investment[8] (30% Tax Credit + NRCS cost share)		**17%**	**18%**

(1) Shipping, sales tax, permit costs, foundation, wire run, turbine/ tower erection, electrical interconnection, insurance, etc.

(2) Based on component prices indicated by manufacturers and/or distributors, and in some cases includes customer refs.

(3) USDA EQIP Pgm; application required, must meet eligibility requirements, grant is not guaranteed, est. $3800/installed kw nameplate rating up to $35K max.

(4) Based on manufacturer power curves

(6) Based on approximate average price of electricity charged by Tri-State to the REA

(7) Net Present Value (NPV) = Sum of the present value of future positive cash flows - initial investment

(8) Annual ROI = ((Gain from Investment - Cost of Investment) / Cost of Investment) divided by expected turbine life in years

Morgan County site:

Type of Operation:	Commercial Feedlot
Location:	Fort Morgan vicinity
Electricity Supplier:	Morgan County Rural Electric Association (MCREA)
REA REC Purchase Policy:	Case-by-case basis
Meter Analyzed:	Main service for feedlot
Average Electricity usage:	500,000 kWh per year
Average Electricity cost:	$44,000
Average wind speed:	**12.4 mph** (5.5 m/s) at 20 meters (65 feet)
Turbines Analyzed:	(1) Endurance 50 kW
	(2) WES 80 kW
	(3) WES 250 kW

Figure 10.

Figure 10 shows the average monthly wind speed at this site.

Figure 11 shows the estimated payback time of three (3) wind turbines based on two different scenarios: The first scenario assumes the turbines will be financed in combination with a 30% federal tax credit. The second scenario also assumes financing will be used, but that both a 30% federal tax credit and a USDA cost-share grant will be utilized to reduce the costs. Note: the 250 kilowatt turbine is not eligible for the federal tax credit.

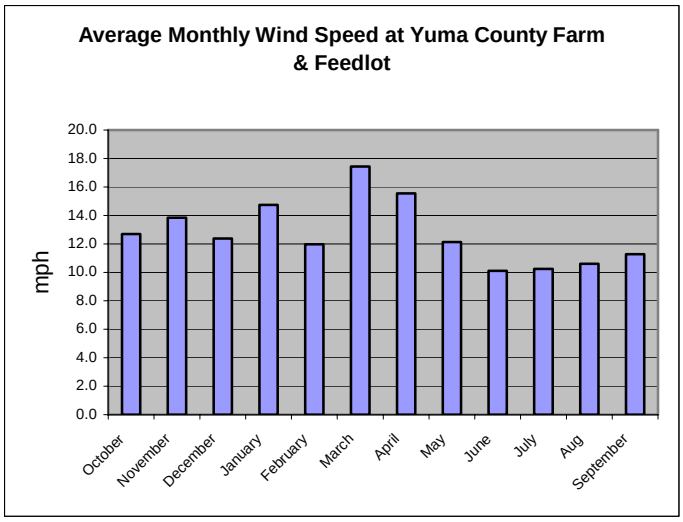
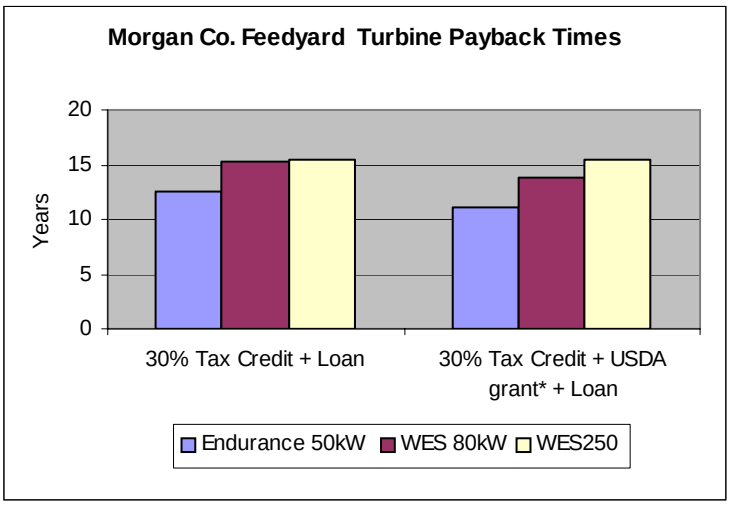


Figure 11.



Best Fit Turbine:
Endurance 50 KW

Payback period:
1) Tax credit + Loan = 13 years

2) Tax Credit + USDA-EQIP grant, either turbine + Loan ~ 5 years.

Figure 12.

Wind Resource Analysis: MORGAN COUNTY FEEDLOT

Meter: Feedlot (including mill, office, etc.)

Annual electricity usage (kWh):	**500,000**	
Average Annual Electricity Cost:	$ 44,000	
Average wind speed @ 20 m (65') height:	**12.4**	**mph**
Average wind speed @ 20 m (65') height:	5.5	m/s

TOWER HEIGHT Recommendation

Recommended Minimum Hub (tower) Height above ground (feet)	**140**	**140**	**140**
Estimated average wind speed at hub height* (mph)	**14.2**	**14.2**	**14.2**
Estimated average wind speed at hub height* (m/s)	6.3	6.3	6.3

** Readings above 20m (65') height are calculated from 1/7 Power formula*

TURBINE Recommendation

Line #		Manufacturer:	**Endurance**	WES	WES 250
		Turbine	**E-3120**	**WES 80***	WES 250*
1	**Rated Capacity of Turbine (kW)**		**50**	**80**	250
2	Approximate total installed cost[2]		$ 300,000	$ 375,000	$ 800,000
3	**Installed Cost less 30% Federal ARRA Tax Credit***		**$ 210,000**	**$ 262,500**	$ 800,000
4	**Installed Cost minus ARRA Tax Credit + USDA-EQIP cost share[3]**		**$ 172,000**	**$ 224,500**	$ 762,000
5	Total Loan Interest (70% financed, 6% rate, 15yrs*)		$ 108,978	$ 136,222	$ 290,608
6	**Estimated Annual Energy Output (AEO) in kWh[4]**		**175,000**	**180,000**	**490,000**
7	Wind energy cost per kWh[4] ARRA tax credit, NO LOAN; 30yr turbine life[5]		$ 0.05	$ 0.06	$ 0.06
8	Wind energy cost per kWh[4] ARRA tax credit*,15 YR LOAN		$ 0.07	$ 0.08	$ 0.08
9	Average electricity cost charged by CEA; this meter (kWh):		$ 0.088	$ 0.088	$ 0.088
10	Utility wholesale rate (kWh)[6]		$0.027	$0.027	$0.027
11	**Annual Facility Electricity Usage (kWh):**		500,000	500,000	500,000
12	Turbine Output as a Percentage of facility annual usage		35%	36%	98%
13	Avoided Cost (Annual Turbine Output x Retail Rate)		$ 15,400	$ 15,840	$ 43,120
14	Annual Surplus Electricity Value (Prod - usage x wholesale rate)		$ -	$ -	$ -
15	**Turbine Output Value (annual)**		$ 15,400	$ 15,840	$ 43,120
16	Avoided REA elec. inflation (3% annual); AVG next 30 YRS		$ 9,022	$ 9,280	$ 25,262
17	Additional Value from Selling REC (use $5 per 1,000 kWh)		$ 875	$ 900	$ 2,450
18	**Total Annual Wind Turbine Value**		$ 25,297	$ 26,020	$ 70,832
19	**Turbine Payback (years); ARRA 30% Tax Credit + Loan**		**13**	**15**	**15**
20	**Turbine Payback (yrs): ARRA 30%Tax Credit* + USDA grant* + Loan**		**11**	**14**	**15**
	BEST TURBINE for FACILTY		**X**		
	Net Present Value[7] (including LOAN interest and 30% Tax Credit)		$ 439,934	$ 381,872	$ 1,034,344
	Annual Return on Investment[8] (LOAN & 30% Tax Credit, except WES250)		**5%**	**3%**	**3%**

(1) Shipping, sales tax, permit costs, foundation, wire run, turbine/ tower erection, electrical interconnection, insurance, etc.

(2) Based on component prices indicated by manufacturers and/or distributors, and in some cases includes customer refs.

(3) USDA EQIP Pgm; application required, must meet eligibility requirements, grant is not guaranteed, est. $3800/installed kw nameplate rating up to $35K max.

(4) Based on manufacturer power curves (5) Based on 30 year turbine life; includes $0.01/kWh for annual O&M cost

(6) Based on approximate average price of electricity charged by Tri-State to the REA

(7) Net Present Value (NPV) = Sum of the present value of future positive cash flows - initial investment

(8) Annual ROI = ((Gain from Investment - Cost of Investment) / Cost of Investment) divided by expected turbine life in years

* WES 250 not elible for ARRA Tax Credit

Yuma County Feedlot and Farm site:

Type of Operation:	Irrigated farming and small cattle feeding
Location:	Yuma County vicinity
Electricity Supplier:	Y-W Electric Association
REA REC Purchase Policy:	Y-W assumes ownership of all customer RECs
Meter Analyzed:	Main service for headquarters, including feedlot
Average Electricity usage:	59,000 kWh per year
Average Electricity cost:	$4,700
Average wind speed:	**12.7 mph** (5.7 m/s) at 20 meters (65 feet)
Turbines Analyzed:	(1) Bergey Excel 10 kW
	(2) Proven 15 kW
	(3) Jacobs 20 kW

Figure 13.

Figure 13 shows the average monthly wind speed at this site.

Figure 14 shows the estimated payback time of three (3) wind turbines based on three different scenarios: The first scenario assumes only a 30% federal tax credit. The second scenario assumes that both a 30% federal tax credit and a USDA cost-share grant will be utilized. The third scenario assumes a tax credit only combined with a loan.

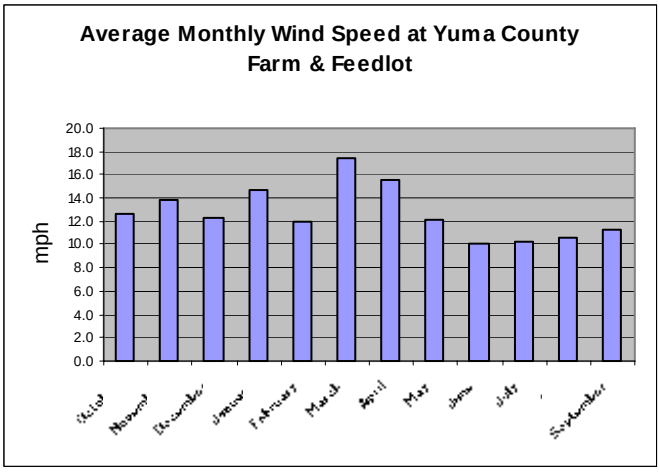
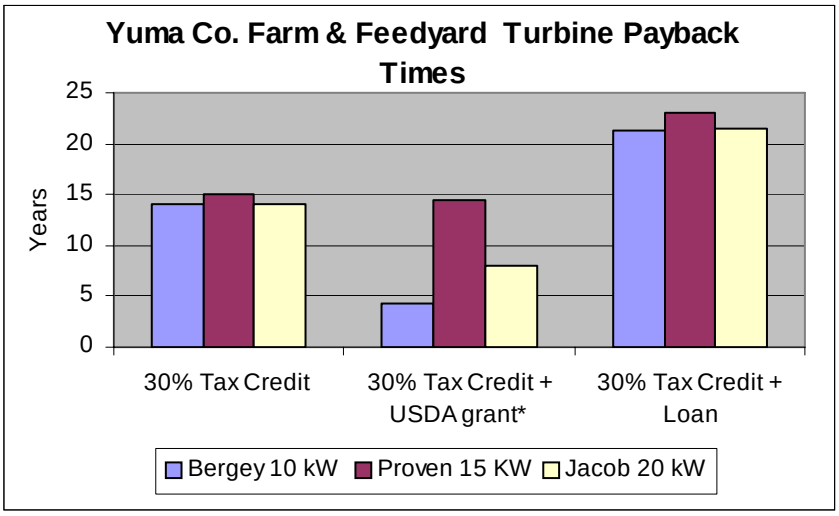


Figure 14.



Best Fit Turbine:
Bergey 10 kW

Payback period:
1) Tax credit + Loan = 14 years

2) Tax Credit + USDA-EQIP grant = 4 years

3) Tax Credit + Loan = 21 years.

Figure 15.

Wind Resource Analysis: YUMA COUNTY FARM & FEEDLOT

Meter: Headquarters (Feedlot, Shop, etc.)

Annual electricity usage (kWh):	**59,000**	
Average Annual Electricity Cost:	$ 4,700	
Average wind speed @ 20 m (65') height:	**12.7**	**mph**
Average wind speed @ 20 m (65') height:	5.7	m/s

TOWER HEIGHT Recommendation

Recommended Minimum Hub (tower) Height above ground (feet)	**140**	**140**	**140**
Estimated average wind speed at hub height* (mph)	**14.2**	**14.2**	**14.2**
Estimated average wind speed at hub height* (m/s)	6.3	6.3	6.3

** Readings above 20m (65') height are calculated from 1/7 Power formula*

TURBINE Recommendation

Line #		Manufacturer:	**Bergey**	Proven	WTIC (Jacobs)
		Turbine	**Excel-S**	WT15000	WT15001
1	**Rated Capacity of Turbine (kW)**		**10**	15	20
2	Approximate total installed cost[2]		$ 78,000	$ 110,000	$ 127,000
3	**Installed Cost less 30% Federal ARRA Tax Credit**		**$ 54,600**	**$ 77,000**	**$ 88,900**
4	**Installed Cost minus ARRA Tax Credit + USDA-EQIP cost share[3]**		**$ 16,600**	**$ 73,200**	**$ 50,900**
5	Total Loan Interest (70% financed, 6% rate, 15yrs*)		$ 28,334	$ 39,959	$ 46,134
6	**Estimated Annual Energy Output (AEO) in kWh[4]**		**29,640**	**38,800**	**48,000**
7	Wind energy cost per kWh [4] NO LOAN; 30 yr turbine lifespan[5]		$ 0.10	$ 0.10	$ 0.10
8	Wind energy cost per kWh [4] 15 YR LOAN		$ 0.13	$ 0.14	$ 0.13
9	Average electricity cost charged by CEA; this meter (kWh):		$ 0.080	$ 0.080	$ 0.080
10	Utility wholesale rate (kWh)[6]		$0.027	$0.027	$0.027
11	**Annual Facility Electricity Usage (kWh):**		59,000	59,000	59,000
12	Turbine Output as a Percentage of facility annual usage		50%	66%	81%
13	Avoided Cost (Annual Turbine Output x Retail Rate)		$ 2,361	$ 3,091	$ 3,824
14	Annual Surplus Electricity Value (Prod - usage x wholesale rate)		$ -	$ -	$ -
15	**Turbine Output Value (annual)**		$ 2,361	$ 3,091	$ 3,824
16	Avoided REA elec. inflation (3% annual); AVG next 30 YRS		$ 1,383	$ 1,811	$ 2,240
17	Additional Value from Selling REC (use $10 per 1,000 kWh)		$ 148	$ 194	$ 240
18	**Total Annual Wind Turbine Value**		$ 3,893	$ 5,096	$ 6,304
19	**Turbine Payback (years); ARRA 30% Tax Credit Only**		**14**	15	14
20	**Turbine Payback (yrs): ARRA Tax Credit + USDA-EQIP grant**		**4**	**14**	**8**
21	**Turbine Payback time; 15 YR LOAN (years) with 30% Tax Credit**		**21**	**23**	**21**
	BEST TURBINE for FACILTY		**X**		
	Net Present Value[7] (including LOAN interest and 30% Tax Credit)		$ 33,845	$ 35,910	$ 54,082
	Annual Return on Investment[8] (LOAN interest and 30% Tax Credit)		**1%**	**1%**	**1%**
	Annual ROI [8] (NO LOAN, 30% Tax Credit + NRCS cost share)		**20%**	**4%**	**9%**

(1) Shipping, sales tax, permit costs, foundation, wire run, turbine/ tower erection, electrical interconnection, insurance, etc.

(2) Based on component prices indicated by manufacturers and/or distributors, and in some cases includes customer refs.

(3) USDA EQIP Pgm; application required, must meet eligibility requirements, grant is not guaranteed, est. $3800/installed kw nameplate rating up to $35K max.

(4) Based on manufacturer power curves (5) Based on 30 year turbine life; includes $0.01/kWh for annual O&M cost

(6) Based on approximate average price of electricity charged by Tri-State to the REA

(7) Net Present Value (NPV) = Sum of the present value of future positive cash flows - initial investment

(8) Annual ROI = ((Gain from Investment - Cost of Investment) / Cost of Investment) divided by expected turbine life in years

ZONING:

Elbert County: One wind turbine is allowed on Ag-zoned land under use by right with a minimum 60 acre parcel size. More than one turbine per 60 acres is considered commercial and requires a county special use permit.

Morgan County: "Small wind energy conversion systems" are allowed with a Conditional Use Permit within Ag / Agri-business zoned areas. The conditional use permit requires approval of a site plan by the county administrator, or by the county commission at the discretion of the county administrator.

Yuma County: Zoning requirements have been added to the land use code regarding commercial wind farms, however, there are no land use regulations covering small wind turbines as of the date of this report. Yuma County may add zoning language in the future for residential and farm wind systems. The county does have a process for individuals to install improvements on their own property called an *activity notice*. The activity notice is similar to a building permit. An activity notice would be required to install a 10 kW turbine in the county.

In all three counties, a building permit or equivalent is required.

FINANCIAL INCENTIVES: Tax credits, grants, and guaranteed loan programs.

Federal 30% Tax Credit

On October 3, 2008, the Emergency Economic Stabilization Act of 2008, H.R. 1424, was enacted into law and included a new federal-level investment tax credit to help consumers purchase small wind turbines for home, farm, or business use. Owners of small wind systems with 100 kilowatts (kW) of capacity and less can receive a tax credit for 30% of the total installed cost of the system. The credit is available for equipment installed through December 31, 2016. The incentive was further expanded through the *American Recovery and Reinvestment Tax Act of 2009*, which removed the financial cap that had been present in the 2008 legislation. Sources: h*ttp://energytaxincentives.org/ business /renewables.php*

If a qualifying wind turbine is placed in service or at least started in 2010, business taxpayers can apply for a grant instead of claiming the energy investment tax credit. The grant is 30 percent of the investment in the facility and the property must be placed in service (i.e. completed) before 2013 (for wind facilities)." *Source: IRS website www.irs.gov/newsroom/article/0,,id=209564,00 and US Dept. of Treasury website www.treas.gov/recovery/docs/guidance.pdf.*

USDA-NRCS Environmental Quality Incentives Program (EQIP)

The USDA - Natural Resources Conservation Service offers cost-share grants through its EQIP program. Wind energy projects may be eligible for cost-share funding as part of an overall farm conservation plan.

USDA Rural Development REAP Program

The USDA Rural Energy for America Program (REAP) offers grants and loan guarantees for the purchase and installation of renewable energy generating systems and for energy efficiency improvements. Assistance is limited to small businesses and farmers & ranchers. Projects must be located in a rural area. REAP grants and loan guarantees may be used individually or in combination. Together they may finance up to 75% of a project's cost. Grants can finance up to 25% of project cost, not to exceed $500,000 for renewables, $250,000 for efficiency. There are also REAP grants to help pay for technical assistance on energy projects. *Source: http://www.rurdev.usda.gov/or/reap.htm.*

USDA's Rural Development also operates a Guaranteed Loan Program which offers loan guarantees on agricultural and rural renewable energy projects for up to 75 percent of the project cost.

Governor's Energy Office Small Wind Incentive Program

The Governor's Energy Office (GEO) offers a Small Wind Incentive Program to interested partners from utilities, counties and municipalities as an incentive to increase installed renewable energy. The Small Wind Incentive Program offers matching grants to partners who will administer the rebates to residents and business owners who install small wind turbines. Partners/recipients are responsible for matching the grant dollar for dollar, and providing the staff support required to administer the rebate program in accordance with GEO's guidelines.

Colorado Department of Agriculture ACRE Program

Colorado Department of Agriculture (CDA), which provided partial funding for this study, offers funding to promote energy-related projects beneficial to Colorado's agriculture industry. Funding is offered through the ***Advancing Colorado's Renewable Energy (ACRE) Program,*** which is administered by the Colorado Agricultural Value-Added Development Board. Eligible projects must, in some way, benefit Colorado's agriculture industry and may include biofuels development, biomass conversion, and wind and solar energy. Information about the ACRE Program can be accessed at: http://www.colorado.gov/cs/Satellite/Agriculture-Main/CDAG/1184661927876.

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- Bergey Windpower Co., turbine manufacturer
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- Proven Wind Turbines, turbine manufacturer
- Wind Energy Solutions (WES), turbine manufacturer
- US Department of Treasury
- Database of State Incentives for Renewables and Efficiency (DSIRE)
- The owners and/or managers of the three livestock facilities that participated in this study.

REFERENCES:

- Elbert County Land Use Code
- Yuma County Land Use Code
- Morgan County Land Use Code
- HB 1160
- Colorado Amendment 37
- US Dept. of Treasury
- Y-W REA ($0.02735 / kWh paid for excess energy delivered to grid)
- Bergey Wind Power
- Endurance Wind Power

We also wish to thank the U.S. Department of Energy, Western Area Power Administration (WAPA) Wind Monitoring Equipment Loan Program for providing the wind monitoring equipment used in this study.

sources:
USDA Rural Development Program: http://www.rurdev.usda.gov/or/reap.htm