

# **Wind Energy:**

Powering Economic  
Development for Colorado

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## EXECUTIVE SUMMARY

**W**ind energy can help Colorado meet a growing demand for electricity in a clean and sustainable way while providing significant economic development for rural parts of the state.

Colorado has excellent wind resources. With these resources, Colorado could potentially generate more than 200 gigawatt-hours (GWh) of wind power per year, nearly five times more than the state's current needs. But out of all that potential, wind currently produces less than one percent of Colorado's electricity.

**Developing just 10% of the state's reasonably accessible wind resources could meet all anticipated growth in electricity demand from now until 2020.**

Utility companies have chosen natural gas for nearly all recent capacity additions, shying away from coal-fired plants because of their high capital costs, stringent environmental requirements, poor public image, and 5-year construction times. However, wind energy can now compete with natural gas on equal economic footing. On March 18, 2001, the Colorado Public Utilities Commission determined that wind power can reduce electricity costs for utility customers in the state compared to an all-natural gas portfolio.

**Meeting new electricity demand with wind power instead of natural gas would result in roughly twice the total economic benefit to Colorado over the next two decades.**

Even with conservative assumptions for in-state manufacturing for wind farm components, wind power could provide 70% more one-year jobs and more than three times as many permanent jobs as natural gas. Wind power could also provide property tax payments to local governments distributed across a wider area of the state, conserve water that natural gas plants would otherwise consume, and pay royalties to farmers, ranchers, and other rural landowners.

Colorado could reasonably develop enough wind power to meet half of new demand through the next decade and three quarters of new demand in the following decade. Through 2020, the benefits of this scenario include:

- 6,300 one-year jobs in wind farm manufacturing, installation, and supporting areas, with a payroll value of \$210 million.
- 1,300 long-term, highly local jobs in wind farm operation, maintenance, and supporting areas with an annual payroll value of \$51 million.
- \$230 million in additional property tax revenue for rural counties.
- Conservation of more than 25 billion gallons of water, with water rights worth more than \$120 million at current Front Range prices.
- \$76 million in royalties paid to landowners.

Additionally, wind energy will diversify Colorado's generating portfolio, insulating consumers from the increased electricity costs that will stem from gradually increasing natural gas prices and unpredictable price spikes. Wind energy's ability to reduce electricity costs will leave consumers with more money in their pockets, potentially creating large benefits across the entire state economy.

**State policy can effectively promote the development of economical wind energy.**

State policy is crucial to realizing the benefits of wind energy. Texas, Minnesota, and Iowa are driving the development of wind energy through purchasing requirements and financial incentives. These policies help to provide market guarantees for renewable power, reduce costs, and attract investment. For example, strong wind resources and a renewable energy purchasing standard in Texas allow new wind farms there to produce power at less than three cents per kWh,

competitive with fossil technology even at low gas prices.

With effective policy, Colorado can encourage the use of wind energy to meet future energy needs and ensure stable prices while minimizing environmental impact and revitalizing plains communities. Effective policies include:

*Renewable energy purchase requirements ensuring that more than half of new demand for electricity generation will be met with renewable sources of power during the next two decades.*

Creating a guaranteed market for renewable energy with a purchasing requirement will ensure that wind developers do not overlook Colorado. The biggest barrier to developing renewable energy resources is that most of the total cost is up-front, with high capital costs followed by very low operating costs, since the “fuel” is free and inexhaustible. Renewable energy producers are in ef-

fect financing thirty years of power all at once. Guaranteed markets created by renewable energy purchasing requirements can ease this hurdle significantly and lower overall costs.

*Tax incentives for wind farm construction or manufacturing.*

Tax incentives for the sale of equipment and materials used to build wind farms reduce the high initial capital costs renewable energy producers must overcome.

*Service Charges to Fund Renewable Energy Development*

A small charge on monthly utility bills can raise funds to support renewable energy research, development, promotion, and other energy-related environmental improvements. These activities can help Colorado deepen its renewable energy industry and retain more energy dollars in-state.

## INTRODUCTION

Colorado is a windy state, as anyone who has walked along a ridge or across the open plains can testify. Colorado's wind can do more than move the clouds. It can also generate the electricity we need. It can light our homes and businesses, provide power to industry, and drive the economy.

Colorado's wind resources offer an opportunity to steer the state down a new energy path, fueled by an inexhaustible and clean energy source. Wind energy technology works better every year and costs continue to decline. Already, wind projects in Colorado are cost effective compared to traditional plants, based on bids reviewed last year by the Colorado Public Utilities Commission. The best wind energy projects now produce electricity for less than three cents per kilowatt hour (kWh), on par with new gas-fired or coal-fired power plants.<sup>1</sup>

Additionally, wind power presents an opportunity to develop Colorado's rural economy, which has not benefited from the last decade of growth and prosperity like the rest of the state. With waning opportunities in mining, farming, and ranching – traditional staples of the rural economy – rural communities have sought out new opportunities while attempting to preserve their traditions. More than a third of net farm income across the country last year came from direct government payments and emergency assistance.<sup>2</sup> Wind power is a new kind of crop these communities can look to for income.

This new income source could be a boon for Colorado's Eastern plains farmers and ranchers, many of whom are struggling to keep their family businesses afloat in the face of declining commodity prices. A few thousand dollars a year for every wind turbine taking up a small fraction of crop or range land could mean the difference between abandoning agriculture and maintaining a way of life. With extra money flowing into the school system and government services as well, wind farms could make a big differ-

ence in rural areas of the state. With enough wind energy to meet state demand many times over, Colorado could soon be harvesting a powerful bounty.

Some small Midwest towns are already discovering the benefits of wind power firsthand. For example, take the town of Montezuma in Kansas, a small farming community southeast of Lamar. FPL Energy recently installed a 110 MW wind farm in this area. Around the same time, Debbie Wehkamp's farm equipment supply business was closing its doors for good. The wind farm could not have come at a better time for her. Now she works as the administrative assistant for Gray County Wind Energy, alongside a newly employed operation and maintenance staff. With all the new activity in town, she said, "I don't think there is anyone in town who is not completely thrilled to have the wind farm here."<sup>3</sup>

Even with access to Colorado's rich renewable energy resources, the state's electric power industry currently relies almost completely on the unsustainable extraction and combustion of fossil fuels. This system harms public health, contaminates water with mercury, pollutes air with soot and smog, damages crops, and changes the climate. The risks of continuing down this path include continued pollution, unpredictable temperature changes, increased fire danger, the disruption of snow-fed water supplies, and other unforeseen changes that could damage both the economy and Colorado's quality of life.<sup>4</sup>

Despite these risks, Colorado's utilities continue to do business as usual. Xcel Energy, the state's largest utility, has been building natural gas power plants due to low up-front costs and established technology.<sup>5</sup> Tri-State Generation and Transmission, the second largest electric generating company in the state, recently proposed the first new coal-fired power plant in Colorado in 20 years, arguing that natural gas price fluctuations make coal the answer to the state's electricity needs.<sup>6</sup>

However, the state has an important responsibility to encourage the development of electricity sources that can ensure an adequate supply of energy at stable prices with positive impacts on the state's economy and environment. Colorado's utilities will definitely meet new demand for power. The question is, how will they meet it?

One path leads deeper into fossil fuel dependence, with associated environmental and

fuel costs, and the reality of limited fuel supplies. The other path leads toward renewable energy sources, cleaner air and water, reduced impacts from climate change, and a new source of revenues for rural economies searching for support. The renewable course offers a unique opportunity to unite economic development, environmental, and industrial interests around a common vision for the future of Colorado.

# COLORADO'S WIND ENERGY POTENTIAL

Colorado has a wealth of natural resources which could easily meet the state's need for electric power. These resources are not limited to coal and natural gas. As anyone who has hiked to the top of a ridge or driven across the plains knows, parts of the state are very windy. Wind contains energy in the motion of air. Unlike fossil fuels, however, wind requires no extraction and will literally never run out.

Enough wind blows across the state to meet our energy needs many times over. The Pacific Northwest Laboratory estimates that Colorado has enough wind resources to generate 481,000 gigawatt hours (GWh) of electricity per year, enough energy to meet state demand 11 times over.<sup>7</sup> Limiting consideration to the windiest locations within ten miles of existing transmission lines, the National Renewable Energy Lab in Golden estimates that wind could still generate 204,000 GWh per year, or nearly five times as much electricity as was used in 2000.<sup>8</sup>

## Note on Units

The size of a power plant is expressed in terms of megawatts (MW). This unit indicates how much electricity a plant can generate. Utilities also measure their ability to supply demand on the grid at any one time in terms of MW. Megawatts are like the horsepower of a car engine.

Power plant output and electricity consumption are measured in terms of megawatt-hours (MWh). This unit indicates the total amount of electricity generated during a period of time. A 100 MW power plant operating at full capacity for 10 hours would produce 1000 MWh, or 1 gigawatt-hour (GWh) of electricity. Megawatt-hours are like the number of miles a car travels.

Wind turbines do not always produce their maximum output due to natural variability in wind speed. Thus, wind power is often described in terms of average capacity, as well as maximum capacity. Wind farms can operate at an average of 30% to 40% of peak capacity, depending on the strength and consistency of the wind. In this report, we determine a wind facility's ability to generate electricity using the average capacity value, but describe the size of the facility in terms of peak capacity.

Colorado's fiercest winds blow across the crests of ridges in the Rocky Mountains (see Figure 1). Strong winds also blow north of Fort Collins and near the New Mexico border around Trinidad. Much of the Eastern plains has excellent wind resources, especially on the relatively high elevation areas above the Platte and Arkansas River Valleys. In general, places with average wind speeds above 14.3 mph (class 3) are usable for utility-scale electricity generation, and areas with winds faster than 15.7 mph (class 4 and above) are especially strong candidates for wind farms. Because wind power increases at the cube of wind speed, small increases in wind speed can produce much more power.

Although mountain ridges may have strong wind capabilities, the best sites are located on easily accessible terrain outside of National Parks or other wilderness areas, have reasonable access to transmission infrastructure, are reasonably far away from cities and other urban areas, and have excellent exposure to strong winds.

Most of the more promising potential sites for wind farms are in the Eastern plains. Strong candidates include the high ground between the South Platte and Arkansas Rivers east and northeast of Colorado Springs, the Culebra Hills in Costilla County, the area north of Fort Collins and east along the Wyoming border, and on some moderate peaks and mesas near Trinidad along the southeast border of the state. Many other places across the state may have good local geography and be excellent locations for wind farms as well.

## Projected Growth in Electricity Demand and Wind Power Generation

Development of a relatively small amount of Colorado's wind resources could supply much of the state's need for new generation capacity.



**Figure 1: Predicted Wind Speeds Across Colorado<sup>9</sup>**

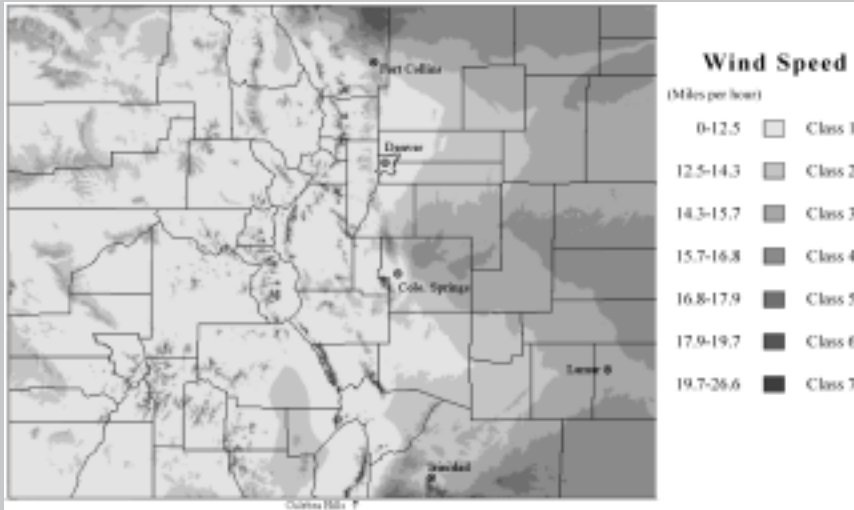


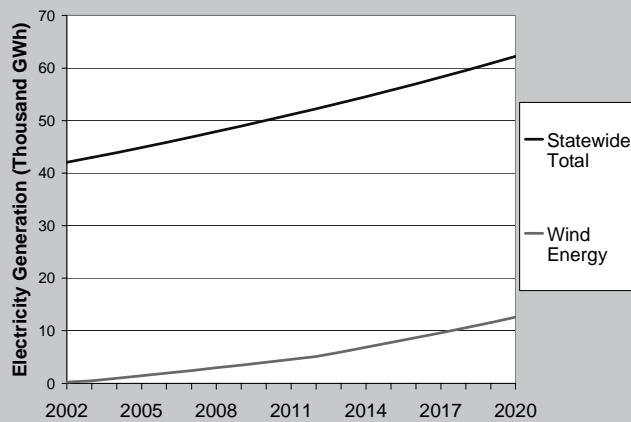
Figure 1 shows predicted wind speeds across Colorado. The best wind farm locations are generally on the Eastern plains, including the high ground above the Platte River valley stretching toward the northeast corner of the state, the land above the Arkansas River valley east of Colorado Springs and south of Lamar, north of Fort Collins along the Wyoming border, and near Trinidad along the New Mexico border.

Colorado Public Service Company estimates 2.2% annual growth in electricity use in their most recent resource plan.<sup>10</sup> At this rate, in 2020 Colorado's utilities will need 62,000 GWh, or 20,000 GWh more than current power plants can generate. Developing just 10% of the state's reasonably accessible wind resources, as identified by the National Renewable Energy Laboratory, could meet all of this demand.<sup>11</sup>

The economic analysis in this report posits a conservative scenario in which Colorado wind power meets half of new demand through the next ten years and then three-quarters of new demand in the following decade. At this rate, wind farms will generate 5,110 GWh of electricity by 2012, or 10% of Colorado's total electricity needs. By 2020, wind farms will be generating 12,600 GWh per year, or 20% of Colorado's total electricity needs (see Figure 2).

Assuming that wind turbines will be able to operate more and more efficiently with technological advances over the next 20 years, this course would require the installation of 1,800 MW of wind facilities in the next decade and 4,100 MW by 2020.<sup>12</sup> The scenario includes the addition of the 162 MW wind project near Lamar in 2003 and no ad-

**Figure 2: Projected Growth in Electricity Demand and Wind Power Generation**



ditions in 2004 due to the fact that no other projects are currently proposed. The resulting lag in generating capacity is made up for with extra installation activity in 2005.

## Coal and Natural Gas Options

Utilities in Colorado have many supply options at their disposal, including coal, natural gas, and renewables. Coal-fired plants are

the electricity generating industry's old-guard technology. Many of Colorado's coal plants were built in the 1950s, and none more recently than the early 1980s. Most recent capacity additions have been powered by natural gas, the industry's new standard-bearer. Renewable energy resources, including wind power, make up a third option. Many competing factors will affect the role each of these technologies will play in Colorado's future energy mix. Raw economics, environmental costs, and socioeconomic impacts will all play a role.

Although coal supplies more than 80% of Colorado's electricity today, the environmental and socioeconomic costs of coal-fired power plants make them an unlikely choice for meeting new capacity needs in Colorado. The health, visibility, and local air quality costs are borne by society at large, and are

external to the apparent cost included in electricity rates. Traditional accounting sets these costs at zero, which clearly underestimates the true price of coal use. While there is no universally agreed upon method for putting a price tag on these costs, accounting for them would significantly raise the price of coal-fired power. For example, a recent European Union study found that if the health and environmental costs of coal use were considered, the price of coal-fired power would double, even without considering the economic impacts of climate change or carbon sequestration.<sup>13</sup>

Coal mining is also problematic. It contaminates surface and ground waters, and damages land. The most economical coal mines, based on open pit techniques, produce coal through removing the material that covers coal seams, removing the coal, and replacing the soil, followed by reclamation of the surface. This practice can disrupt local ecosystems. Coal mining is a dangerous occupation, as well. Deaths can sometimes occur due to accidents with equipment and explosives.<sup>14</sup>

Burning coal creates unacceptable levels of air pollution. Coal combustion produces chemicals like sulfur dioxide, nitrogen oxides, soot, and mercury. Sulfur dioxide and nitrogen dioxides form smog and soot, impacting respiratory health. Mercury contaminates the food chain through fish in polluted waterways, exposing people to the threat of neurological or developmental damage. Burning coal also produces large amounts of carbon dioxide, a gas implicated in global warming scenarios. These scenarios have projected adverse impact on everything from Colorado's water supply, to the health of the ski industry, to the continued existence of Rocky Mountain meadows.<sup>15</sup>

The coal industry hopes for "clean coal" technology to solve these problems. They claim that energy can be harnessed from coal without causing extensive environmental and health risks or costs. However, the actual

**Table 1: Projected Wind Power Capacity Additions**

Year	Assumed Capacity Factor	Wind Energy Capacity Added (MW)	Total Added Capacity (MW)	Percent of Total Generation
2003	30%	162	162	1%
2004	31%	0	162	1%
2005	31%	366	528	3%
2006	32%	176	704	4%
2007	32%	180	884	5%
2008	33%	178	1,063	6%
2009	33%	182	1,245	7%
2010	34%	181	1,426	8%
2011	34%	185	1,610	9%
2012	35%	183	1,794	10%
2013	35%	281	2,075	11%
2014	36%	279	2,355	13%
2015	36%	286	2,640	14%
2016	37%	284	2,924	15%
2017	37%	290	3,215	17%
2018	38%	289	3,504	18%
2019	38%	295	3,799	19%
2020	39%	294	4,093	20%

pollution reduction from these technologies to date has been marginal and expensive. Ultimately, these technologies redirect toxins to the land and water instead of the air. The General Accounting Office recently concluded that federal spending on “clean coal” has been a waste of taxpayer money.<sup>16</sup>

On the economic side, Colorado’s baseload coal plants are able to produce cheap electricity because they are old and the initial investments have been extensively depreciated on their owners’ accounting systems. Although coal supplies and prices are more stable and less costly than natural gas, increasing environmental requirements and public scrutiny, the potential for a carbon tax or the need for carbon sequestration technology, and Clean Air Act enforcement actions all could make electricity generated from coal more expensive. The owners of a 1000 MW coal-fired power plant in Craig recently paid a half-million dollar fine and invested 160 million dollars in pollution control equipment for massive violations of federal and state air pollution laws.<sup>17</sup> The same amount of money could completely fund the construction of a 180 MW wind farm.

Finally, the construction of a new coal plant is a lengthy and costly endeavor. Citing the resulting problems with timing, Xcel Energy,

the state’s largest utility, withdrew its participation in Tri-State’s proposed new plant in August, 2002.<sup>18</sup> In its most recent resource plan, Xcel identifies high capital costs, stringent environmental requirements, poor public image, and 5-year construction times facing coal plants as challenges to the development of any new coal plant.

Although Xcel also identifies the intermittency of wind as a challenge facing wind power, they have responded to the strong public support behind renewable energy. In 1997, they launched one of the country’s first voluntary wind power purchasing programs, which attracted nearly 15,000 customers in its first two years.<sup>19</sup>

Based on these reasons, this analysis compares baseload natural gas and wind as the two most likely electricity supply options for the state. Meeting half of new demand through the next ten years and then three-quarters of new demand through 2020 with new gas-fired turbines would produce the same amount of electricity as wind power in the above development scenario. This would require 2,400 MW of additional gas-fired capacity by 2020.<sup>20</sup> These projections form the basis of the economic analysis in this report.

# COLORADO'S RENEWABLE ENERGY INDUSTRY

Colorado's renewable energy industry is ready to take up the challenge of developing the state's wind energy potential. Although the industry is relatively young, it is poised for rapid growth. We possess a highly-skilled work force trained at excellent universities and the nation's premier sustainable energy research and development center, the National Renewable Energy Laboratory (NREL).

Based on a survey conducted by the Business Research Division of the University of Colorado in 1997, Colorado's renewable energy industry was modestly sized, but pro-

vided important research and development services. Colorado's primary economic advantage is the potential for industrial development based on new technology developed by NREL, universities, and company research.<sup>21</sup>

In 1997, 347 renewable energy organizations and companies in Colorado employed about 1,125 people, in addition to 750 researchers and staff who worked at NREL. The largest employers provided services in manufacturing, design, engineering, and new technology development. These companies employed 882 workers, making up 83% of the jobs in the industry. The remaining employees worked in industry support areas such as policy, training, and planning, or in sales of renewable energy equipment.<sup>22</sup>

Most renewable energy companies were small (see Figure 3). In 1997, 81% had less than 11 employees involved in renewable energy activities. However, they were growing quickly, predicting yearly renewable energy employment growth of 10% through 2000.<sup>23</sup>

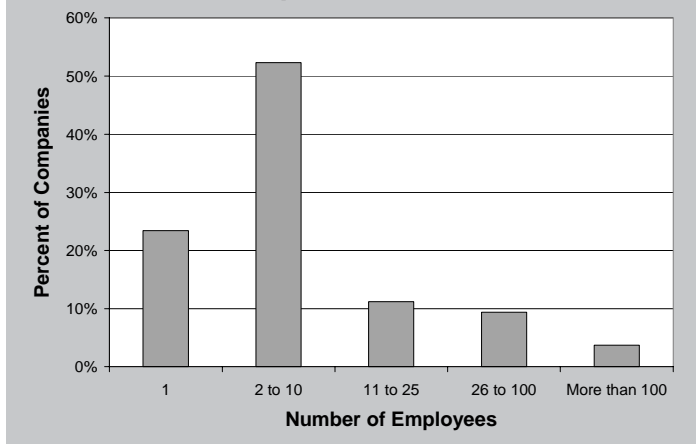
The industry in Colorado is also quite young (see Figure 4). Of the companies in existence in 1997, just under half opened their doors during the 1990s, and only 24% were active before 1980.<sup>24</sup> To put this in perspective, all of Colorado's coal-fired power plants were built before 1980, some as early as the 1950s.

Most companies work on several different generation technologies. In 1997, 9% of the companies identified wind energy as their primary activity, and 29% as their secondary activity.

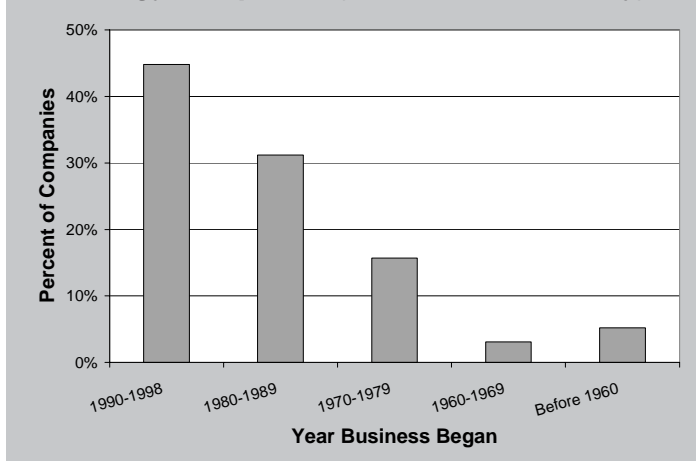
These industries had a modest impact on the Colorado economy in 1997, heavily weighted toward research and development by NREL.

- NREL awarded \$21.5 million in purchase orders, research, and subcontracts to Colorado businesses. They employed 750 Coloradans that year, with wages of approximately \$38 million.<sup>25</sup>

**Figure 3: Size of Renewable Energy Companies in 2000**



**Figure 4: Age of Colorado's Renewable Energy Companies (Based on 1997 Survey)**



- Governments, universities, and electricity generators employed 75 people in renewable energy activities, with wages of \$2.6 million.<sup>26</sup>
- 237 renewable energy related companies employed about 1,075 people with a payroll of \$31.4 million, had \$97 million in renewable energy sales (about one-third in-state), and spent \$36 million on supplies and raw materials (about one-third in-state).<sup>27</sup>

Increasing domestic use of renewable energy spurred by state renewable portfolio requirements and incentives in states like Texas, Minnesota, Iowa, Nevada, California and potentially Colorado should open new markets for Colorado renewable energy companies. Worldwide, renewable energy demand is growing quickly, driven by increased demand for electricity, legislation supporting renewables, and international agreements to reduce greenhouse gas emissions from fossil fuels. Of renewable technologies, wind power is the fastest growing, with global installations increasing at about 25% per year.<sup>28</sup>

## Representative Organizations and Companies in Colorado's Renewable Energy Industry

Colorado has a variety of organizations and companies working in the renewable energy field, both large and small. These companies provide services ranging across the board, from design to installation. A few of the Colorado-based companies that could participate in a large expansion of wind power in the state include:

### ***The National Renewable Energy Laboratory (NREL)***

NREL is the U.S. Department of Energy's premier laboratory for renewable energy re-

search and development.<sup>29</sup> The lab develops new energy technologies in almost 50 fields, ranging from photovoltaics to wind energy to advanced vehicle systems. It currently employs 1,100 researchers and support staff in the Denver metro area, the largest single group of renewable energy and energy efficiency experts in the world. The lab is home to the National Wind Technology Center, where new turbines are designed and tested in the gusty winds on the northern perimeter of Rocky Flats, north of Golden.

The more efficient turbines and other technological breakthroughs by NREL have helped drive the price of wind power down from 30 ¢/kWh in 1980 to 3 ¢/kWh today.<sup>30</sup> NREL estimates that prospective wind energy markets could generate several billion dollars in sales for the U.S. wind industry by 2005.

### ***CH2M Hill***

CH2M Hill is an environmental engineering firm headquartered in Denver that is involved in many phases of wind project development. The firm provides services including resource assessment, siting, permitting, licensing, transmission analysis, construction management, production forecasting, and operation and maintenance.

CH2M Hill has worked on some of America's largest new wind projects, including:

- The 263 MW Stateline Wind Project between Oregon and Washington.
- The planned 494 MW Maiden Wind Project in Washington's Rattlesnake Hills.
- The 250 MW Kittitas Valley Wind Project near Ellensburg, Washington.

CH2M Hill employs over 10,000 people at over 300 offices and project sites around the world.<sup>31</sup>

### ***PanAero Corporation***

Pan Aero is a wind energy consulting firm based in Lakewood, which performs feasi-



bility studies and wind resource assessments, and provides planning and implementation services for international wind energy projects. The firm employs 5 people in Colorado, and much of its business is currently overseas in areas like the South Pacific. Pan Aero specializes in making the use of large, commercial wind systems cost-effective.<sup>32</sup>

### ***The Industrial Company***

The Industrial Company (TIC) builds facilities for heavy industry. With origins in building mining equipment in the 1970s, TIC has now branched out into the installation of renewable energy equipment. The firm has experience installing geothermal, biomass, photovoltaic, and wind energy facilities. TIC headquarters are in Steamboat Springs, with satellite offices in Denver and across the country.<sup>33</sup>

### ***NextWave Energy***

NextWave Energy, based in downtown Denver, assists renewable energy companies with capital formation, market analysis, and business development.

### ***R.W. Beck***

R. W. Beck provides consulting and engineering services for a wide range of projects, including renewable energy development. Their wind energy services include environmental impact assessment, feasibility studies, and monitoring. They are based in downtown Denver, with offices spanning the country.

### ***Tim Olsen Consulting***

Tim Olsen Consulting provides a wide variety of wind energy services, including wind resource assessment, feasibility studies, site evaluation, project management, research and development, wind turbine design, and hybrid system design. On the Peetz Table wind power project in Logan County, this company provided resource assessment, turbine siting, budgeting, and planning with the utility, community, the FAA, and local governments.

### ***Architectural Energy Corporation***

Architectural Energy Corporation provides consulting services, hardware, and software products for sustainable design. The firm's clients include architectural design teams, building owners, utilities, energy service companies, and government agencies on a wide variety of projects. In addition to consulting on energy use, they provide wind energy design and data collection services. They employ a broad staff of mechanical, electrical, and architectural engineers; architects; computer scientists; technicians and research support staff, based in Boulder.<sup>34</sup>

### ***Verde Power***

Verde Power finances renewable energy projects, invests in individual companies, and owns equity in operating renewable energy projects. The company employs five people in Telluride, and does most of its business in the Midwest and Intermountain region.<sup>35</sup>

## **Current Wind Energy Generation**

Despite our technical expertise, world-class companies, and ample wind resources, Colorado currently generates only a small amount of electricity from wind. At the end of 2001, Colorado had 61 MW of wind energy facilities up and running, supplying less than 1% of the state's energy needs. The Ponnequin facility in Weld County and the Peetz facility in Logan County currently supply all of the wind-generated electricity for the state. Public Service Company of Colorado, owned by Xcel Energy, uses most of the energy produced by these farms for Windsource, a voluntary program in which consumers pay a premium to support wind energy.<sup>36</sup>

However, wind power will play a much greater role in Colorado's future. An additional 162 MW wind farm under construction near Lamar should come online in 2003. This facility, built by GE Wind Energy, will be a standard part of Xcel Energy's genera-

tion portfolio. It will provide wind power for all Xcel Colorado customers, or 70% of the state electricity market, through their base electric rates. When this facility begins operating, Colorado will be generating about 1.4% of its energy from wind.

## **Windsource**

Subscribers to Xcel Energy's Windsource program subsidize the production of energy from the Ponnequin and Peetz wind farms by purchasing blocks of wind power at 2.5 ¢/kWh above normal rates. Grassroots marketing efforts and strong public support have made this program the most successful at attracting participants in the nation. Windsource is supported by over 16,000 residential customers, as well as commercial and institutional subscribers, including the U.S. Department of Energy and the University of Colorado.<sup>37</sup> The 61 MW demand for Windsource has exceeded all expectations for a demonstration project with a 25% surcharge. Windsource has helped to pave the way for making wind energy a mainstream part of Colorado's energy future.

The Ponnequin wind farm is Colorado's first utility-scale wind power facility. The first turbine began operating in April 1998, taking advantage of average wind speeds in the range of 17-18 miles per hour.<sup>38</sup> The turbines are located East of highway I-25 near the Wyoming border, in Weld County. Keith and Myrna Romans own most of the land originally used by the wind farm.<sup>39</sup> The Romans are retired small-scale ranchers from Wyoming who raise beef cattle. When asked about the royalties he earns from the wind turbines, Keith says: "I can tell you we're making much more off this than we did off cows. And, you don't have to feed them, you don't have to break ice, and you don't have to calve them out."<sup>40</sup> Overwhelming customer demand required expansion of the site onto land owned by the State Land Board, which now collects royalty payments to support state schools.

The Peetz Table wind farm was added to the Windsource program in 2001. The turbines are located just across from the high school football field in the small town of Peetz, near the Nebraska border in northeast Colorado.<sup>41</sup> Peetz was the "queen city of the northern plains" in the early part of last century, with a healthy farming and ranching economy.<sup>42</sup> The town even had its own power company. Although a lot of the old businesses have been closed for years, some of that history is returning to life with the addition of the wind farm.

## **The Lamar Wind Project**

Colorado's newest wind energy development project is located 23 miles south of Lamar, in southeastern Colorado. The facility is scheduled to come online in 2003. It will operate independently of the Windsource program, supported by rates paid by all Xcel customers. At 162 MW, it is five times larger than any other wind plant in the state. The story behind this facility and the economic motivations behind its development signal the arrival of the next generation of Colorado wind power.

In 1999, Xcel submitted to the Colorado Public Utilities Commission (PUC) its plan for acquiring new capacity to meet demand in the years 2003 through 2005. The company planned 124 MW worth of conservation measures, 25 MW of wind power for the Windsource program (which later became the 30 MW Peetz project), and a portfolio of new generation all fueled by natural gas. Although GE Wind (formerly Enron Wind) submitted a bid to build a wind plant near Lamar, Xcel deemed the bid uneconomical and did not include it in its proposed capacity additions.

The Public Utilities Commission is charged with granting approval for all utilities' plans to increase capacity. The Commission's own staff and renewable energy advocates questioned whether it was truly appropriate to exclude the GE wind bid

from Xcel's generating portfolio. In ruling on these issues, the PUC faced the challenge of comparing the economics of natural gas and wind-powered energy. Uncertainty in the price forecasts for natural gas and the extent of "ancillary" or back up power costs to operate the wind plant were the central issues.

Xcel predicted that natural gas prices would be low and decline over time, forecasting a 7% price decline from 1999 to 2000. With several revisions of its gas price forecast, the utility eventually settled on a forecast that predicted a gentle increase in gas prices at the rate of inflation over 20 years. However, while bids were being evaluated in 2000 and while the PUC was hearing the case raised by intervening parties and its staff, natural gas prices skyrocketed to \$10 per thousand cubic feet, more than three times Xcel's highest fuel price forecast. Nevertheless, Xcel continued to forecast prices for future years that were several dollars less per thousand cubic feet of gas than the actual values at the time.<sup>43</sup>

The PUC disagreed with Xcel's prediction of gas prices. The commission determined that future prices were likely to rise due to the astonishing number of new gas-fired power plants being installed around the country. They decided to "lean toward the higher range of the gas forecast to protect Colorado's ratepayers against the substantial possibility that natural gas prices will rise."<sup>44</sup> This made the wind facility all the more attractive.

Xcel also claimed that because wind energy cannot be relied upon to generate electricity at all times, they would incur tens of millions of dollars in ancillary service costs covering for times of low wind. Again, the PUC disagreed, finding that Xcel's estimates were as much as 10 times too high based on

the experience of other utilities with large amounts of wind power. In fact, using PUC approved estimates of ancillary costs, Xcel's own modeling found that including the Lamar project would result in a net present value savings of \$6.9 million over the 15-year contract period, compared to an all natural gas generation portfolio.<sup>45</sup>

In March 2001, the commission ordered Xcel Energy to add the Lamar project to its resource plan. The commission based its decision solely on the fact that "the acquisition of the Lamar facility will likely lower the cost of electricity for Colorado's ratepayers, ... [and] is justified on purely economic grounds, without weighing other benefits of wind generation."<sup>46</sup> One PUC analyst found that, "in terms of levelized cost... the wind project was the lowest cost resource in the entire portfolio."<sup>47</sup>

After all was said and done, the PUC determined that when gas costs are higher than about \$3.50 per thousand cubic feet, wind is the most competitive energy source. In 2002, electric utilities have so far paid prices in the range of \$3.10 to \$3.85 per thousand cubic feet.<sup>48</sup>

In late September 2002, Xcel and GE wind agreed on a contract for the purchase of wind power from the Lamar facility. The price was set at 3.261 ¢/kWh escalating with inflation, a very cheap price compared to the 2.5 ¢/kWh premium Xcel charges on top of normal rates for its Windsource program.<sup>49</sup>

The Lamar project heralds a new age for wind power in Colorado. As the wind industry continues to realize economies of scale and deploys larger, more efficient turbines that can generate power at lower wind speeds, the economics of wind power will only improve. Wind energy is now a mainstream generation technology.



# ECONOMIC BENEFITS OF MEETING NEW DEMAND WITH WIND POWER

Investing in wind power will do more than supply electricity to Colorado citizens. It will benefit the economy as well, providing roughly double the benefits of new natural gas generation (see Table 2).

The analysis in this report posits a conservative scenario in which Colorado wind power meets half of new demand through the next ten years and then three-quarters of new demand in the following decade. At this pace, the state's wind energy capacity would reach 4,100 MW by 2020.<sup>50</sup> According to the Electric Power Research Institute, wind farms cost \$900,000 per MW to build.<sup>51</sup> At this price, this wind power development scenario would bring a \$4.3 billion dollar capital investment to the state.

An investment in wind power of this scale will create significant economic benefits through the year 2020, including:

- 6,300 one year jobs in wind farm manufacturing, installation, and supporting areas, with a payroll value of \$210 million.
- 1,300 long-term, highly local jobs in wind farm operation, maintenance, and support-

ing areas with an annual payroll value of \$51 million.

- \$230 million in additional property tax payments to rural counties over the next 18 years.
- Conservation of more than 25 billion gallons of water, with water rights worth more than \$120 million at current Front Range prices.
- \$76 million in royalties paid to farmers, ranchers, and other landowners.

## Employment Impact

Developing Colorado's wind energy potential will create jobs in component manufacturing, turbine installation, facility operation and maintenance, and in a variety of areas which indirectly support these activities.

Manufacturing requires skilled laborers who design and build the enormous towers, rotor blades, generators, hubs, and assorted electronic controls which make up a wind turbine. Installation typically involves local

**Table 2: Summary of Projected Economic Impacts of Electricity Generation Options**

	Total through 2012		Total through 2020	
	Wind	Natural Gas	Wind	Natural Gas
Electricity Generation	5,110 GWh	5,100 GWh	12,600 GWh	12,600 GWh
Capacity	1,800 MW	990 MW	4,100 MW	2,400 MW
One-Year Jobs				
Manufacturing	370	340	840	830
Installation	920	480	2,100	1,200
Supporting Areas	1,500	950	3,400	2,300
Long-Term Jobs				
Operation and Maintenance	260	40	590	100
Supporting Areas	300	120	680	290
Taxes Paid to Local Governments	\$74 million	\$46 million	\$230 million	\$150 million
Royalties Paid to Landowners	\$20 million	0	\$76 million	0
Conserved Water (Gallons)	6.8 billion	0	25 billion	0
Value of Rights to that Water	\$47 million	0	\$120 million	0

construction firms, boosting local economies. The operation and maintenance needs of a wind plant create permanent, high-quality local jobs ranging from servicing the turbines to accounting.

## Manufacturing

Much of the work involved in creating a wind farm goes into manufacturing the components, which include rotor blades, structural towers, hubs, gearboxes, generators and electronic controls. The Electric Power Research Institute, a utility-funded energy research consortium, estimates that every megawatt of wind energy capacity installed creates 2.06 year-long manufacturing jobs.<sup>52</sup>

Most manufacturing of specialized components will happen out-of-state, at least in the near term. Many of the world's major turbine manufacturers are based in Europe, and the U.S.-based industry is mostly in California.

However, Colorado already has some capacity to manufacture renewable energy components. Based on a 1997 survey of the Colorado renewable energy industry, over half of renewable energy companies were able to obtain the manufacturing equipment they required from in-state sources, with 31%

able to find a Colorado manufacturer of product components (see Figure 5).<sup>53</sup>

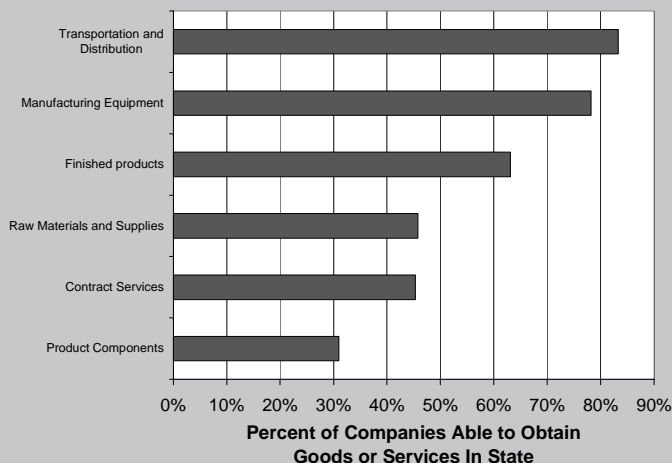
Growth in the wind energy market could bring additional manufacturing capability to the state. In Montana, for example, some current contracts for wind energy include offers to open in-state wind-turbine manufacturing facilities.<sup>54</sup>

Colorado was almost home to the American headquarters of Vestas, Inc., the world's leading wind turbine manufacturer. In June 2000, Vestas announced plans to open their U.S. headquarters and build their first American turbine manufacturing plant in Pueblo. The facility would have employed 600 workers. Vestas cited Colorado's central location to the Midwest renewable energy market as the prime reason for the decision, and urged the state to help promote renewable energy.<sup>55</sup> However, Vestas eventually decided to locate its facility in Portland, Oregon instead, where it will bring up to 1,200 jobs by 2003.<sup>56</sup> Vestas officials have refused to comment on the reason for the decision. Possibilities include access to port facilities, strong incentives offered by the city of Portland, support by state and local officials for the federal wind energy production tax credit, interest in and support for wind development by local utilities, or proximity to the large wind energy projects that are currently being planned and built along the border between Washington and Oregon.

In-state companies already producing components ranging from ball bearings to aircraft warning lights could become involved in developing the wind energy capacity of the state. For example, Colorado's steel mills make steel rails for railroads. Along the lines of Trinity Structural Towers and Bergen Southwest Steel in Texas, they could supply a growing demand for steel towers.<sup>58</sup>

Based on these facts, this analysis assumes 10% of manufacturing for Colorado wind farms will happen in-state. Following capacity growth projections, in-state manufacturing of wind energy components could create

**Figure 5. Availability of Goods and Services for Renewable Energy Companies<sup>57</sup>**



840 person-years of manufacturing employment through 2020. According to the Colorado Department of Labor, the average wage in electronics and fabricated metal product manufacturing is \$39,848 per year.<sup>59</sup> At this rate, the payroll value of these jobs would be \$33 million.

## Installation

A wind farm needs up to 300 workers on site during construction. These workers assemble turbines, erect towers, build roads, and lay cable. Unlike traditional power plants, wind farms are built quickly, usually in a year or less.<sup>60</sup>

The Electric Power Research Institute estimates that every megawatt of wind energy capacity installed creates 0.5 year-long local installation jobs.<sup>61</sup> Using this estimate, installing 4,100 MW of capacity would create 2,100 year-long jobs. At the average Colorado construction worker salary of \$35,464 per year, these jobs would have a payroll value of \$75 million.<sup>62</sup>

## Operation and Maintenance

Wind farms need staff to operate and regularly service the turbines throughout their roughly 30-year lifetimes. These needs create long-term, full-time employment close to the wind farm. The Electric Power Research Institute estimates that every 6.9 MW of capacity requires one full-time employee to operate, monitor, and service it.<sup>63</sup>

According to growth projections, in 2020 the operation and maintenance needs of Colorado's wind farms could employ 590

people. At the average Colorado salary for industrial and electrical equipment repairers of \$39,940, these workers would earn \$24 million per year.<sup>64</sup>

Table 3 summarizes the employment benefits wind power could create in wind farm installation, manufacturing, and operation and maintenance through 2012 and through 2020.

## Comparison with Natural Gas

If Colorado were to meet its electricity demand growth with natural gas power plants instead of wind energy, fewer jobs would be created.

To produce the same amount of energy as wind under the development scenario used in this analysis, Colorado would have to install 2,400 MW of gas-fired power plants. The installation of these plants would create just over half the jobs that wind power would. Although Colorado utilities do not make employment figures public, power plant developers in California are required to estimate the number of jobs to be created by proposed power plants as part of the permit application process. A review of the applications for the 19 plants that have been built or approved since July 2001 reveals that these plants were projected to create a total of 6,337 person-years of work directly within the construction projects, including new gas transmission lines, for 12,853 MW of capacity.<sup>65</sup> The construction of these plants created an average of 0.49 person years of work per MW. Assuming the same value for power plants in Colorado, building new natural gas

**Table 3. Projected Direct Employment Benefits of Wind Power through 2012 and 2020**

Year	Wind Energy Installed	Manufacturing		Installation		Operation and Maintenance	
		1-Year Jobs	Payroll Value	1-Year Jobs	Payroll Value	Permanent Jobs	Annual Payroll Value
2012	1,800 MW	370	\$15 million	920	\$33 million	260	\$10 million
2020	4,100 MW	840	\$33 million	2,100	\$75 million	590	\$24 million

plants would create 1,200 year-long jobs in plant construction.

Although wind energy creates more manufacturing jobs than natural gas per MW, the established market for gas-fired power plant components could result in a greater proportion of in-state manufacturing for gas compared to wind. Assuming that Colorado’s capability to make natural gas components is three times larger than for wind, gas plants could create about the same number of manufacturing jobs. About 30% of the costs of a natural gas plant go toward construction, while 70% go toward manufacturing of turbines, electrical systems, boiler islands, instrumentation, and controls.<sup>66</sup> Assuming that 70% of the jobs created by gas plants go toward manufacturing of these components, manufacturing needs would create about 1.14 jobs per MW, compared to 2 jobs per MW for wind. The high energy concentration in fossil fuels require much smaller power conversion systems per MW rating, yielding a lower employment intensity for fossil fuels. Colorado has no manufacturing capability for gas turbines, which are the most expensive part of the power plant. Assuming that 30% of natural gas plant manufacturing activity will happen in Colorado yields enough activity to support 830 one-year jobs through 2020. This assumption is conservative compared to the assumption of 10% in-state manufacturing for wind power.

Building more natural gas power plants would result in many fewer permanent jobs than wind energy. New natural gas plants are

highly automated and relatively easy to maintain, even more so than wind farms. The plans for 19 new plants in California include an average of only 25 jobs per plant, yielding a rate of only 0.04 direct jobs per MW of capacity. At this rate, the natural gas route would create only 100 permanent jobs by 2020.<sup>67</sup>

In terms of overall direct employment, the natural gas option would produce 920 fewer one-year jobs and 500 fewer permanent jobs than wind power.

### Indirect Employment

The economic impact of building power plants extends beyond the direct jobs created in building and installing the equipment. Each dollar invested creates impacts that ripple outwards throughout the local economy.

For example, workers at a manufacturing plant need raw materials and equipment. Their work in assembling turbines supports jobs in equipment manufacturing and component supply. Contractors at a construction site need concrete and heavy equipment, and their work supports additional jobs supplying these needs. Natural gas power plants need a steady supply of gas, supporting jobs in resource extraction and delivery.

*The Texas Comptroller’s office estimates that 1.15 indirect jobs are created for every direct wind energy job, based on the new wind farms that have gone up over the last few years.<sup>68</sup> Using this estimate, wind farm manufacturing and construction in Colorado will create 3,400 year-long jobs in supporting areas, and operating and maintenance needs will support 680 ongoing indirect jobs by the year 2020.*

Since natural gas plants create fewer overall jobs, the indirect employment they support is also less. Estimates of indirect employment from several California natural gas plant developers yield a similar multiplier effect as wind, in the range of 1.1 indirect jobs for every direct job.<sup>69</sup> Assuming that

**Table 4. Direct Employment Summary for Wind and Natural Gas**

Type of Job	Wind	Natural Gas
Installation Jobs	2,100	1,200
Manufacturing Jobs	840	830
Total One-Year Jobs	2,900	2,000
Long-term Operation and Maintenance Jobs	590	100

the employment multiplier effect is the same as wind energy, natural gas plants would support 2,300 indirect one-year jobs and 110 indirect permanent jobs.

Natural gas plants also support ongoing jobs in the extraction and delivery of natural gas. Even if Colorado's established natural gas production industry creates new jobs to meet a small increase in demand, added employment from natural gas extraction would still not create as many permanent jobs as wind farm operation and maintenance.

Electric utilities in Colorado currently use a small fraction of total Colorado natural gas output. Public Service Company's gas power plants accounted for less than one percent of state production in 1999.<sup>70</sup> Utilities overall that year used about 19 billion cubic feet of gas to produce about two thousand GWh of electricity, or 9 million cubic feet per GWh. Because Colorado is connected to a regional market by pipelines, Public Service Company estimates that 42% of the natural gas it uses comes from Colorado sources.<sup>71</sup> At this efficiency rate and considering the regional nature of supply, using natural gas instead of wind would increase demand for Colorado natural gas by less than 7%.

In 2001, Colorado employed 4,478 people in oil and gas extraction and transportation activities.<sup>72</sup> Since many of these jobs involve both crude oil and natural gas, government and industry analysts measure employment for both resources combined. Allocating these jobs according to the economic value of oil and gas produced by the U.S., an estimated 59% of these jobs stem from natural gas extraction – 2,642 jobs in 2001.<sup>73</sup> These workers produced 736,299 million cubic feet of natural gas, yielding a job intensity of 0.0036 jobs per million cubic feet.<sup>74</sup> Using the 9 million cubic feet per GWh figure and Colorado's 42% share of the regional market outlined above, increased demand for natural gas from building natural gas power plants would support only 180 permanent jobs in gas extraction.

Overall, natural gas plants would create 1,060 fewer one-year indirect jobs and 390 fewer permanent indirect jobs than wind power. Combining the figures for direct and indirect employment, wind power will support 70% more temporary workers and over three times as many permanent jobs as natural gas.

**Table 5. Indirect Employment Supported by Wind and Natural Gas through 2020**

Type of Job	Wind	Natural Gas
Short-Term Indirect Jobs	3,400	2,300
Long-term Indirect Jobs	680	290

## Landowner Revenue

Farmers, ranchers, and other rural landowners can take advantage of the income resulting from leasing a portion of their land to a wind farm developer. Unlike wheat or corn, payments from wind energy are steady and year-round. If the land is owned by a government entity, the income can be funneled into local government, schools, and services.

Although wind farms occupy large areas, the actual physical footprint of each wind turbine is small. A landowner could lease up to 10% of their land area for the construction of wind turbines, while continuing to grow crops or graze their animals. Lease terms vary, but they typically represent 2.5% of gross revenue from electricity sales.<sup>75</sup> The Union of Concerned Scientists estimates a typical farmer or rancher with good wind resources could increase the economic yield of their land by 30% - 100%.<sup>76</sup>

Assuming a contract price for electricity generated from wind power of 3 ¢/kWh, the projected electricity generated by wind power through 2020 would sell for \$3 billion.<sup>77</sup> At lease terms of 2.5% of gross rev-



enue, the lease payments associated with generating this electricity would supplement the income of farmers, ranchers, and other landowners by a total of \$76 million between now and 2020. In the year 2020, 4100 MW of wind farms would produce nearly \$380 million worth of electricity, and landowners would earn an additional \$9.4 million per year on top of their normal crop yield.

Natural gas plants would not be located on land actively used for growing crops or grazing animals. Generating capability at natural gas plants is much more concentrated, and occupies much less land than a comparable wind farm. The land for these plants would most likely be purchased outright at the cheapest price available, in areas relatively close to the Denver Metropolitan Area.<sup>78</sup> Accordingly, they would not provide lease payments to rural landowners.

**Table 6. Landowner Income and Property Taxes From Wind and Natural Gas**

	Wind	Natural Gas
Landowner Income	\$76 million	\$0
Property Taxes	\$230 million	\$150 million

## Local Tax Income

Wind turbines will raise the property tax base of a county, creating a new revenue source for education and other local government services. According to the Electric Power Research Institute, wind energy plants cost about \$900,000 per installed MW, a total of \$4.3 billion for all projected capacity additions.<sup>79</sup> A typical plant will operate for a 25-year lifetime, and the assessed value of the facility will depreciate slowly over this period. Because fossil fuels are a more concentrated form of energy than wind, natural gas and coal-fired plants need less equipment at less capital cost to generate an equivalent

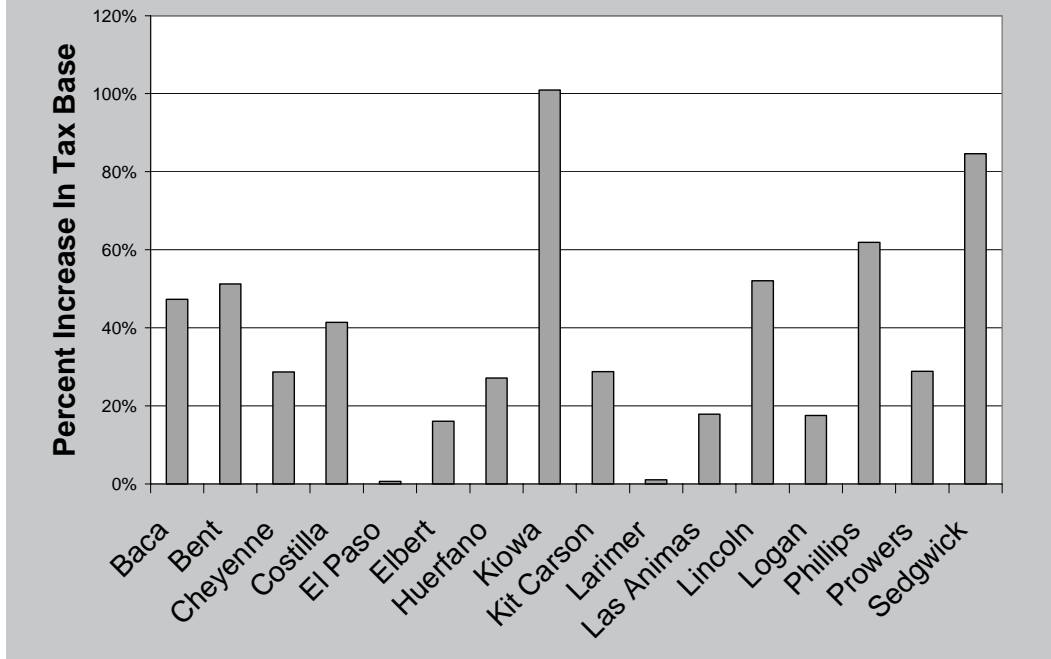
amount of electricity. As a result, wind farms often shoulder a higher property tax burden than conventional power plants.

In 2001, Colorado passed legislation that attempted to equalize the property tax burden of renewable energy plants with comparable nonrenewable facilities.<sup>80</sup> The law has not yet been implemented and there is some uncertainty in how it will be applied. The law does not specify average capacity or rated capacity. It also does not define comparable nonrenewable technology. If coal is the comparable technology, the law will have little effect. Coal-fired power plants are more expensive than wind per kW of rated capacity. If natural gas is the comparable technology, assessed values for wind turbines will decline by about 40%. The average new natural gas plant costs about \$540,000 for every installed MW based on California data, which is about 40% less than a comparable wind turbine.<sup>81</sup>

Depending on how the law is implemented, renewable energy facilities will provide differing amounts of property tax revenues for local governments. This analysis assumes that wind facilities will be valued using the capital cost of a natural gas plant based on rated capacity. Using wind development projections, the depreciating values of wind facilities, and the average Colorado property tax rate of 1.6%, wind power would funnel \$230 million into local government coffers through 2020.<sup>82</sup> Approximately 54% of these tax payments would go to fund needy school districts.<sup>83</sup>

Increases in the tax base from installing new wind farms will be largest in rural counties where the wind resources are greatest. Although the direct impact to the statewide tax base will be relatively modest, just as with new fossil-fueled plants, new wind farms can make a big difference to small communities, especially on the Eastern plains. For example, the installation of the 162 MW wind farm in Lamar will add about 29% to the tax base in Prowers County. Tax base increases

**Figure 6. Increase in Tax Base in Colorado's Windiest Counties After Installation of a 162 MW Wind Farm**



in other windy counties from an equivalent wind farm are shown in Figure 6.

New natural gas plants installed on the same schedule would increase the property tax base less than wind plants. The average new natural gas plant costs about \$540,000 for every installed MW.<sup>84</sup> With an assumed lifetime of 30 years, new natural gas plants would provide \$150 million in property taxes through 2020, about 35% less than wind farms.

## Avoided Water Use from Displaced Conventional Energy Generation

Wind energy could conserve billions of gallons of water that would otherwise be used for electricity generation by conventional power plants. Especially in times of drought, water is a valuable commodity in the state of Colorado. Utilities, municipalities, and farmers spend millions of dollars to secure water rights.

Thermoelectric energy generation requires large amounts of water for steam and cooling. Tri-State Generation's coal-fired power plants at Laramie, Wyoming and Craig, Colorado use 10 billion gallons of water every year from the Laramie and Yampa rivers. The plants dispose of the water in evaporation ponds on site, with no discharge back into the river.<sup>85</sup>

For every MWh generated, natural gas power plants use about 250 gallons of water.<sup>86</sup> Some power plants have already experienced some close calls with water shortages during this year's drought. Tri-State had to open the release gates at their backup reservoirs for the first time in nearly a decade to keep the Craig power plant operating.<sup>87</sup> Growing water demand will make even less water available for use at new thermoelectric power plants.

In contrast, generating electricity through wind uses very little water, no more than that required for an occasional washing of the turbine blades and for the mixing of concrete.

**Table 7. Projected Water Use and Value of Water Rights for Wind and Natural Gas**

	Wind	Natural Gas
Water Use in 2020	negligible	3 billion gallons
Total Water Use, 2003-2020	negligible	25 billion gallons
Value of Water Rights	\$0	\$120 million

At projected development rates, wind power could save 25 billion gallons of water compared to the use of natural gas through 2020. In the year 2020, wind power could reduce water use from Colorado’s scarce supply by 3 billion gallons per year, or 9600 acre-feet per year. Wind power could make more water available for residential use, crop irrigation, recreation, and other important needs.

Water rights from the Big Thompson River are representative of the resources on the

Front Range. Recently, rights to one unit of water per year from this river have been selling for about \$12,000. In a wet year, one unit is about an acre-foot of water, or 326,000 gallons. During a drought like the one Colorado is currently experiencing, a unit can be one-third that amount.<sup>88</sup> With the continuing drought in Colorado coupled with a growing population, demand for water will grow much faster than supply.

At current prices, the right to withdraw 3 billion gallons of water, the amount wind energy would save in 2020, would be worth \$120 million.<sup>89</sup>

## Electricity Pricing Impacts

Wind energy could also have potentially large macroeconomic benefits for the state due to impacts on the cost of electricity. First,

### Impact on Prowers County

The installation of the Lamar Wind Project will have a large impact on the economy in Prowers County.

Prowers county is a relatively small community on the Eastern plains whose largest city is Lamar. In 2000, approximately 14,240 people lived there.<sup>90</sup> The local economy is oriented toward agriculture, including farming and ranching. Crops include wheat, milo, millet, alfalfa, and corn. The main institutional employers in the county are NeoPlan USA, Lamar Community College, Lamar School District, and local government.<sup>91</sup> In 2000, the county had \$88 million in taxable assets and retail sales of \$399 million per year.<sup>92</sup>

On top of this, the Lamar wind project will add:

- 83 installation jobs lasting for one year, indirectly supporting 95 additional jobs which could be located in other parts of the state.
- 23 full-time operation and maintenance jobs for workers who will be employed locally for at least 25 years, supporting another 26 indirect jobs.
- Increased landowner income of \$350 thousand per year from lease payments.<sup>93</sup>
- Increased sales of local goods and services of \$810,000 per year for the operation and maintenance needs of the wind farm.<sup>94</sup>

Compared to 2000, this project will increase the number of jobs in Prowers county by 1.3% during the construction process, and by 0.36% permanently. The wind farm will have an assessed value of around \$25 million, raising the tax base in Prowers County by 29% and providing approximately \$1.4 million per year in increased property tax revenue, about half of which will go to local schools.



wind energy can insulate consumers from secondary price spikes due to unpredictable fluctuations in natural gas costs by diversifying the state's energy generation portfolio. Second, natural gas prices overall will continue to rise while wind energy prices continue to fall. As a result, consumers will save money that they can then apply to other sectors of the economy.

Natural gas prices are projected to increase, sometimes unpredictably. Xcel Energy has overwhelmingly chosen natural gas plants to meet Colorado's new generating needs, in line with most other utilities across the country. With their low up-front capital costs, natural gas power plants make attractive investments. However, the unpredictable price of natural gas leaves ratepayers vulnerable to dramatically increased prices. Over-reliance on natural gas also exposes customers who use natural gas for heating to price spikes caused by increased demand and decreased supply.

Since natural gas power plants are dependent on unstable supplies of natural gas and fluctuating prices, electricity generating costs from gas plants can rise dramatically during gas price spikes. In late 2000, natural gas costs more than tripled to \$10 per thousand cubic feet.<sup>95</sup> One of the biggest reasons for this price spike was natural market fluctuation. Fifteen years of low gas prices and the resulting disincentive for resource development followed by a cold winter led to depleted stocks and unprecedented wholesale prices.

With rapidly increasing natural gas demand in the Western market and far from guaranteed supply, such price spikes are almost certain to be a periodic occurrence in the future. One recent study documents a risk in California of volatile and rising gas prices and recurring supply problems, because there is a good chance that existing and currently anticipated infrastructure will not be able to meet rising demands.<sup>96</sup> As the state found out in late 2000, Colorado natural gas prices

are tied to the rest of the Western market. Supply problems in other Western states can drive up natural gas prices across the board.

Over the past two years, natural gas consumers have had to pay a premium of roughly 0.5 ¢/kWh over expected spot prices to lock in natural gas prices for the next ten years.<sup>97</sup> Because wind power has no fuel costs, it can serve as a hedge against volatile natural gas prices, reducing the need to speculate on future fuel expenditures. Diversifying Colorado's generation portfolio, just like diversifying investments in the stock market, can insulate consumers from unpredictable price fluctuations.

Limited domestic reserves of natural gas and uncertain foreign supplies make it nearly certain that gas costs overall will gradually rise over time. Proven domestic reserves will be spent by 2008, according to demand projections by the U.S. Department of Energy. The U.S. Geological Survey estimates that future domestic finds will total 1,049 trillion cubic feet of gas, which Department of Energy growth predictions suggest will only get us to 2040.<sup>98</sup> As we begin to import more of our natural gas supply, prices will rise due to increased delivery costs.<sup>99</sup>

Wind energy prices, in contrast, are projected to decline as the industry matures, takes advantage of economies of scale, and deploys more advanced technologies. Over the past several decades, the cost of wind power has dropped over 80%.<sup>100</sup> As the industry grows and takes advantage of improved technology and increased economies of scale, the cost of wind energy will continue to decline. In 2010, wind energy is predicted to be one of the cheapest electricity generating technologies available at electricity costs of 2.1 to 2.7 ¢/kWh.<sup>101</sup>

Wind power is already competitive with natural gas, and its advantages will grow stronger in the future. In 2001, the Colorado Public Utilities Commission determined that when gas costs are higher than about \$3.50 per thousand cubic feet, well-designed wind

projects can be the most competitive energy source. In 2002, electric utilities have so far paid prices in the range of \$3.10 to \$3.85 per thousand cubic feet.<sup>102</sup> In a similar hearing regarding wind power in Minnesota, the Minnesota Public Utilities Commission found that “the only reason given by any party for finding the additional wind generation not in the public interest is that it will allegedly cost more than natural gas generation, currently the lowest-priced competitor. The Commission finds that this price differential, if it exists, is not large enough to overcome the strong public policies favoring the development of this wind resource.”<sup>103</sup>

One study found that installing 1,200 MW of new wind generation over 15 years in Iowa would yield a net savings of \$300 million dollars over the next 30 years, reducing the

average homeowner’s monthly electricity bill by 0.7%.<sup>104</sup> The Lamar wind project scheduled to be built in Eastern Colorado next year will sell electricity for 3.261 ¢/kWh, a very cheap price compared to the 2.5 ¢/kWh premium Xcel charges on top of normal rates for its Windsource program.<sup>105</sup> In fact, using estimates of backup costs approved by the Colorado Public Utilities Commission, Xcel’s own modeling shows that including this project in their portfolio reduces overall costs by a net present value of \$6.9 million.

Consumers will experience these savings directly in their wallets, increasing the amount of money they have available to spend in other sectors of the economy. The effects will be felt throughout the state.

## STATE POLICIES SUPPORTING WIND ENERGY

State policy is crucial to realizing the benefits of renewable energy. Historically, there has never been a new energy technology commercialized without help from the government. Existing fossil fuel technologies benefit from large tax and public expenditure subsidies and from free use of the air, land, and water for waste disposal. Mature technologies have the advantage of occupying large and proven markets. Policy makes it possible for new energy technologies to compete with conventional energy sources. These policies act like a ladder, easing passage over an initial hurdle and helping technologies compete based on their inherent strengths and weaknesses, rather than on market share alone.

Other states prove how crucial policy is. From state contracts for renewable power to renewable purchase obligations to tax incentives, many states are finding ways to balance the playing field for renewable energy with well-established fossil fuel technologies like coal and natural gas. The lasting market for renewable power thus created is helping states to realize the long-term advantages of renewable energy and promote outcomes they find beneficial for society. For example, these types of policies are helping Texas, Minnesota, and Iowa to develop more wind energy than other states in the Midwest, protecting consumers from price spikes, reducing air pollution, and strengthening the rural economy.

### Texas

A renewables portfolio standard, requiring that utilities purchase a small amount of their electricity from renewable energy providers, is driving rapid growth in the Texas wind energy market, helping to reduce air pollution, ease demand for natural gas, revitalize struggling rural areas, and provide inexpensive electricity.

The renewables standard was signed into law by then-Governor George W. Bush in

1999. The standard requires 2,800 MW of renewable energy to be in place by 2009, or approximately 3% of the state's generating needs. An enforcement surcharge for missing renewable energy credits backs up the requirement.<sup>106</sup> The market created by this standard supported the construction of 912 MW of wind energy capacity in 2001 alone, putting Texas firmly into the leading ranks of sustainable electricity generation.

Most of this requirement will be met with wind energy, currently the least expensive renewable resource available. Wind speeds in the range of 18 mph and turbines producing an average of 40% of their peak capacity allow wind energy facilities in West Texas to produce cheap electricity. With the recently renewed federal Production Tax Credit of 1.7 ¢/kWh, these facilities produce energy for less than 3 ¢/kWh, competitive with Texas' natural gas plants even at low natural gas prices.<sup>107</sup> Some of the largest wind energy facilities in the world are being built in West Texas. Most recently, FPL Wind Energy built a 278 MW project there, north of McCamey.

In response to Texas' renewable energy requirement and uncertainty about the duration of the Federal Production Tax Credit, utilities and wind companies invested \$1 billion in 2001 to build new wind energy projects.<sup>108</sup> These projects created 2,500 direct jobs with a payroll of \$75 million, and will create \$13.3 million in tax revenue and \$2.5 million for landowners in 2002 alone.<sup>109</sup>

The renewables standard is driving utilities to gain experience with new technologies. As written, the renewables standard applies only to investor owned utilities. Although all utilities in Texas have access to federal incentives for wind power and to a renewable energy credit trading program in Texas, only investor owned utilities made significant acquisitions of wind power. Three of these companies bought 610 MW of wind energy in 2001, while six other utilities without a purchasing requirement bought only 1

MW. These three investor owned utilities alone exceeded the entire state requirement for 2001 by more than 200 MW. They seem to have found renewables to be less expensive and more reliable than predicted, and they bought more than strictly necessary.<sup>110</sup>

This policy provided dramatic benefits to the people of Pecos County, Texas. This county is one of the top ten oil producing counties in the state, but now it is attracting new types of prospectors – ones that search for landowners with excellent wind resources.<sup>111</sup> With over 400 MW of installed wind farms, the county added 14% to its total tax base in just one year.<sup>112</sup> The County will receive \$4.6 million in additional property tax revenue in 2002.

## Iowa

Motivated by a desire to “conserve ... finite and expensive energy resources and to provide for their most efficient use,” Iowa policy encourages the development of renewable energy facilities.<sup>113</sup> The 1983 Alternative Energy Production Law and its 1991 amendments require electric utilities to enter into long-term contracts for renewable energy.

This law required that investor-owned utilities in the state acquire 105 average megawatts of renewable energy.<sup>114</sup> For over 10 years, the utilities resisted the requirement, balking at any type of forced terms coming from the state utility board.

Windustries, Inc. and Midwest Wind Developers filed petitions with the Iowa Utilities Board in 1995, urging the Iowa Utilities Board to enforce the law. The board found that the utilities were not meeting their purchase requirements, and that willing renewable energy providers were ready to supply power.

In 1996, the Board set the standard contract price at 6 ¢/kWh over 33 years, guaranteeing a long-term market for some of the first renewable energy facilities in the Midwest.<sup>115</sup> The price was set to reflect the eco-

### ***A Few Wind Farms Created by Iowa Policy***

Iowa's wind farms at Storm Lake (196 MW) and Clear Lake (42 MW) directly result from state policy. These wind farms pay royalties to 115 different landowners, totaling roughly \$640,000 per year. They pay \$2 million in property taxes to counties. They employed 200 people for 6 months in construction, and support 40 permanent operations and maintenance workers.<sup>121</sup>

nomical and environmental benefits of renewable power, which the state wanted to encourage.<sup>116</sup> The Board felt that this price balanced the need to encourage renewable energy development with reasonable rates for consumers.

They noted, “While the immediate impact of the 6-cent rate may be negative ... if viewed from a rate impact standpoint only, ratepayers gain from diversity of fuel supply, lock-in of a 6-cent rate for the long-term, and environmental and economic benefits” resulting from the development of renewables.<sup>117</sup>

Two economic incentives back up this requirement. The Federal Production Tax Credit reduces the price of wind-generated electricity by 1.7 ¢/kWh over the first 10 years of electricity production. This credit is available to facilities commissioned in any state through 2003. Iowa also has a sales tax exemption for manufacturing or purchasing wind energy equipment. This statute exempts from the state sales tax the total cost of wind energy equipment and all materials used to manufacture, install, or construct wind energy systems.<sup>118</sup>

The collective impact of these policies has made Iowa one of the leading wind energy markets in the Midwest. At the end of 2001, Iowa had 324 MW of wind power capacity installed. Another 200 MW is in various stages of planning.

The utilities have already met their requirement, but are installing additional facilities because they make economic sense, and utilities are willing to enter into power purchase agreements.

Renewable energy development in Iowa has not begun to approach its potential, however. Iowa is ranked 10<sup>th</sup> in the country in wind energy potential, just ahead of Colorado. A recent study by the Iowa Policy Project, looking at several scenarios the state was considering to increase renewable energy generation, found that alternative energy provides an excellent opportunity to generate and retain dollars in Iowa and reduce the demand for coal.<sup>119</sup> Another study projects that increasing renewable electricity generation could save the state's ratepayers over \$300 million over the next 30 years.<sup>120</sup>

## Minnesota

Faced with growing pollution problems, especially the lack of safe storage space for nuclear waste, the Minnesota legislature established a preference for renewable energy. The legislature determined that renewable power was the best way to reduce the harmful impact of conventional electricity generation. They put several policies in place to shift electricity production in a more sustainable direction.

First, the legislature established a clear preference for renewable energy and conservation in their resource planning process. In

1994, they ordered Xcel Energy to purchase wind energy in exchange for allowing them to store nuclear waste at one of their plants. In 1999, the Minnesota Public Utilities Commission identified wind as a least-cost resource, competitive with traditional technologies. Finally, in 2002, the legislature helped to level the playing field between wind power and traditional technologies by linking property tax payments to output instead of assets for wind facilities.

Minnesota's electrical resource planning process has a clear preference for renewables and conservation. The rules are designed to ensure that utilities give adequate consideration to socioeconomic and environmental impacts of different resource mixes. Every two years, a utility must prepare and submit least-cost estimates for meeting 50% and 75% of their new energy needs through conservation and renewable energy. They also must evaluate the environmental costs of the generation technologies they select.<sup>122</sup> The Public Utility Commission also approves nonrenewable energy facilities only if their renewable equivalents can be shown to be against the public interest.<sup>123</sup>

The legislature ordered Xcel Energy to buy renewable power as part of a nuclear waste storage deal eight years ago. Xcel operates a nuclear power plant at Prairie Island, Minnesota. In 1994, they ran out of viable places to store the extremely radioactive waste, and asked the legislature for permission to store it in dry casks on site. As a part of this deal, the legislature prodded Xcel to get out of the

### ***Landowners Take Advantage of Wind Energy***

Roger and Richard Kas of Woodstock were part of the first group of landowners to lease land to wind developers in response to the XCEL order. They have 17 turbines taking up two percent of their 320 acres of crop-producing land. Their turbines began generating electricity in 1999. The project has been so successful that the brothers have purchased and put up their own turbines, financed by a local bank. The brothers see it as an opportunity to grow one more crop. In a recent newsletter for farmers looking to take advantage of the wind on their land, Roger said, "we're here everyday feeding the cattle and taking care of the farm, and we see the wind turbines as just a few more machines for us to take care of."<sup>129</sup>



nuclear business by ordering Xcel to purchase 425 MW of wind and 125 MW of biomass facilities by 2002.<sup>124</sup> This law spurred the construction of the Lake Benton wind farms (211 MW), creating 240 year-long construction jobs, \$1.5 million in contracts to Minneapolis engineering firms, and 61 ongoing jobs in operation, maintenance, administration, and sales in rural Minnesota.

A second part of this deal stipulated that an additional 400 MW of wind must be added if the Public Utilities Commission found that wind was competitive as a part of its least-cost resource planning process. In 1999, the commission ordered Xcel to bring the additional capacity online by 2012, finding that wind was at least as attractive as natural gas.<sup>125</sup>

In 2002, the Minnesota legislature enacted a change in the way that wind farms are taxed, helping to level the playing field between wind energy and traditional technologies.<sup>126</sup> Since the assets of renewable energy producers are worth more in terms of replacement value, they paid higher taxes. The bill exempted wind energy projects from tradi-

tional property taxes, and created a direct payment program based on the actual electricity generation of the project. Basing tax payments on output rather than assets brings Minnesota one step closer to establishing tax equity between wind and conventional technologies.

Minnesota also has a renewable energy goal of generating 10% of its electricity from renewables by 2015, excluding the 825 MW Xcel was ordered to purchase. This goal requires “good-faith” efforts from utilities, and does not include any enforcement mechanism other than the resource planning process.<sup>127</sup> As a result, this goal is unlikely to drive the renewable energy market significantly.

At the end of 2001, Minnesota had 319 megawatts of wind energy capacity. Within the next decade, Minnesota will have at least 825 MW of wind energy capacity.<sup>128</sup> Minnesota ranks 9<sup>th</sup> in terms of wind energy potential, just ahead of Iowa and Colorado. Given this potential, much more renewable energy development should happen in the state.

## POLICY FINDINGS

**T**he single biggest impediment to developing renewable energy projects is that nearly all of the costs are incurred up-front, in the form of initial construction costs. In effect, renewable energy producers are financing 30 years worth of power all at once. In the absence of long term contracts, building renewable energy plants involves more risk to investors due to uncertain future markets. Traditional power plants can be more attractive to investors because the technologies have been around longer, require less initial investment, and attract long-term purchase contracts from utilities; fuel costs are then incurred over time, and increases due to fuel cost changes can be passed on to consumers.

Due to the real and perceived risks associated with wind power, lenders have offered less favorable financing terms and demanded a higher return on investment than for traditional energy sources.<sup>130</sup> For capital-intensive technologies like wind, the price of electricity depends greatly on the interest rate at which the owners pay off debt. A 1996 study by the Lawrence Berkeley National Laboratory found that contract prices for wind-generated electricity could decrease by 25% with financial terms typical of natural gas projects.<sup>131</sup>

High plant construction costs followed by almost free production makes renewable energy unique in the world of electricity generation. But, electricity is also somewhat unique in that it is a commodity we all use which has a long history of regulation to ensure stable supplies at fair prices. To promote renewables, the state can provide a guaranteed market for renewable energy, without vast subsidies or regulation of specific investments. If renewable energy producers had a guaranteed price for much of the lifetime of their plants, the high construction costs would present less of a barrier and attract better financing terms. Given a foothold in the market, renewable energy tech-

### **Transmission Planning**

Other potential obstacles to renewable energy development can happen when transmission capacities are inadequate. Because adding or upgrading transmission lines often takes longer than building a new wind plant, problems can occur in getting the wind-generated electricity to market. For example, there is a small bottleneck between the Lamar wind facility and the rest of Xcel's grid which is not scheduled to be fixed until 2005.<sup>132</sup> Some of the wind farms in West Texas are experiencing similar problems.<sup>133</sup>

In order to accommodate sustained new wind power development, Colorado will need to make sure that necessary transmission upgrades are timely. By keeping a close eye on transmission planning with wind power in mind, the PUC can play an important role in helping the state realize the benefits of wind energy.

nologies will then be able to gain a larger market share with less assistance.

Colorado can choose from a variety of policy options to enable the state to successfully develop its wind energy resources, meet more than half of new demand for electricity with clean and sustainable energy over the next two decades, and realize the economic benefits that renewable energy can provide. Based on the experience of other states, the most effective policies ensure a lasting, stable market for renewables upon which developers and investors can depend. These policies include renewable purchase obligations and several types of tax incentives.

### **Renewable Purchase Obligations**

Creating a guaranteed market for renewable energy with a purchasing requirement will ensure that wind developers do not overlook Colorado. To ease the hurdle of high up-front costs and uncertain markets, the state can require utilities to enter into long-term contracts with renewable energy producers. Such agreements guarantee a set price for much

of the lifetime of the plant, reduce the risk of investment, and make it possible to produce cheaper electricity. Along with several other states, Texas has chosen this type of policy to encourage renewable energy generation.

Effective purchase requirements include a clear way to track utility compliance and a system of incentives and penalties to encourage utilities to follow through with procuring renewable energy.

### **Tax Incentives for Renewable Energy Equipment**

Tax incentives such as Iowa's sales tax exemption for equipment used in wind farm construction or manufacturing can help make wind energy more economical. These incentives reduce the initial capital investment required to develop a wind farm and produce a lower levelized cost for wind-generated electricity.

### **Service Charges to Fund Renewable Energy Development**

A small charge added to monthly utility bills can raise funds to support renewable energy development. Colorado has a similar service charge on telephone bills known as the Universal Service Charge. This charge ensures that rural Colorado has access to affordable telephone service. A service charge for renewable energy can support a variety of activities to support renewable energy generation, including research, development, transmission upgrades, promotion of Colorado's renewable energy resources and capabilities, and other energy-related environmental improvements. The funds could help Colorado attract and retain more renewable energy activity and dollars within the state.



## METHODOLOGY

This study provides a sketch of the economic impacts of supplying a significant amount of Colorado's electricity needs with wind energy. The intent is to give a relatively simple estimate of the economic value of various activities supported by the wind industry, as if all of the wind installation happened in the present. Accordingly, future dollar values do not include inflation or discount estimates. Key assumptions and calculations are summarized below.

### ***Demand Prediction and Wind Power Growth***

Public Service Company of Colorado (PSCo) assumes 2.2% yearly growth in Colorado's electricity generating needs in their 1999 demand forecast.<sup>134</sup> Baseline utility generation from 1988-2000 in Colorado is reported by the Energy Information Administration (EIA).<sup>135</sup> The economic analysis is based on assuming that wind energy will meet one half of new demand from 2003 through 2012 and three quarters of new demand from 2013 through 2020. The amount of wind energy facilities necessary derives from assuming the turbines will operate at 30% capacity in 2002, and that technological advances will result in an increase in capacity factor of 1% every two years. The analysis of the impacts of natural gas stem from the amount of new natural gas plants required to supply the same amount of electricity, based on a 59% capacity factor as projected by PSCo for their newest plants.<sup>136</sup>

### ***Employment***

Wind energy employment impacts derive from applying employment estimates from the Electric Power Research Institute (EPRI) to the projected development of 4,800 MW of wind power as described above, assuming only 10% of manufacturing activity will happen in-state. EPRI predicts that the manufacturing and installation of 1 MW of wind power requires 2.57 people working for one year. They estimate that 20% of that will go

towards local labor for installation, and 80% will go towards manufacturing. They further estimate that operating and maintaining 1 MW of wind energy requires 0.29 people, half of which will be local workers.

Natural gas employment estimates derive from employment intensities at 19 proposed natural gas plants in California and Colorado demand projections.<sup>137</sup> These plants require an average of 0.49 installation jobs and 0.04 operation and maintenance jobs per MW. The manufacturing estimate in this report projects employment of 0.34 jobs per MW, assuming a representative cost breakdown for a natural gas plant of 30% installation and 70% components, 2.3 times as many jobs for manufacturing than installation, and 30% in-state manufacturing.<sup>138</sup>

Indirect employment figures derive from an estimate of 1.15 indirect jobs for every direct job by the Texas Comptroller's office.<sup>139</sup> Natural gas extraction employment estimates employ the following sources: the natural gas capacity projection of 2,400 MW, PSCo's estimate of 42% Colorado natural gas supply for its power plants, figures on electricity generated by natural gas in 1999 (2,049,492 MWh) and amount of gas used for electricity generation in 1999 (19,149 mcf) from the Energy Information Administration, the 2001 Colorado employment figures for oil and gas extraction and pipeline work (4,478 people), the economic value of domestic natural gas production vs. oil production (59% natural gas), and total Colorado natural gas production in 2001 (736,299 mcf).<sup>140</sup>

The total employment figures reported in the summary sections derive from adding all of the direct and indirect jobs, split between temporary installation and manufacturing jobs and permanent operations and maintenance jobs.

### ***Landowner Income***

Royalties from land leases to wind farm owners are estimated at 2.5% of the yearly

sale of electricity at 3 ¢/kWh, escalating with projected growth in wind power use.

### **Local Taxes**

Wind farm property taxes are estimated using projected yearly growth in wind power use, the average Colorado county property tax rate of 1.59%, and a natural gas equivalent \$540,000/MW capital cost depreciating over a 25-year lifetime. Natural gas property taxes derive from growth projections and

a \$540,000 / MW estimate of capital cost depreciating over a 30 year lifetime.<sup>141</sup>

### **Displaced Water Use**

According to the American Wind Energy association, natural gas plants use 250 gallons of water per MWh generated.<sup>142</sup> Water use for natural gas plants was calculated according to this rate applied to growth projections.

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