Should Colorado Go Green?

Analyzing and Debunking the Myths of Colorado's Renewable Energy Policy

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Issue Paper
Number 5-2003
March 2003

Executive Summary

Some Colorado politicians are attempting to develop policies to promote renewable energies (so-called green energies)* because of the perceived health and environmental risks of coal and natural gas power. Pro-green advocates often claim that renewable energies are more efficient than traditional energy generation technologies.

These claims ignore the increasing cleanliness of the traditional technologies. These claims also ignore the technological and economic inefficiencies of renewable energy, especially solar and wind power. Lastly, these claims overestimate the environmental benefits of renewable energy.

Colorado officials have developed several policies to try to promote renewable energy:

- Mandate the use of renewable energies
- Government purchasing of renewable energy electricity power for consumers
- Market strategies that allow customers to choose whether or not they would like to pay more for renewable energies

Mandating renewable energies will increase the price of electricity, but will not significantly reduce pollution. The government purchasing of renewable energy electricity power stunts the innovation of renewable energies and will increase the amount of inefficient energies providing electricity to all consumers. Market-based solution have the most potential for increasing the efficiency of the renewable energies by encouraging innovation.

* In this paper the term renewable energies is only meant to include the three renewable sources discussed herein: solar, wind, and biomass. It does not include hydropower or nuclear power, as some definitions of the term do.

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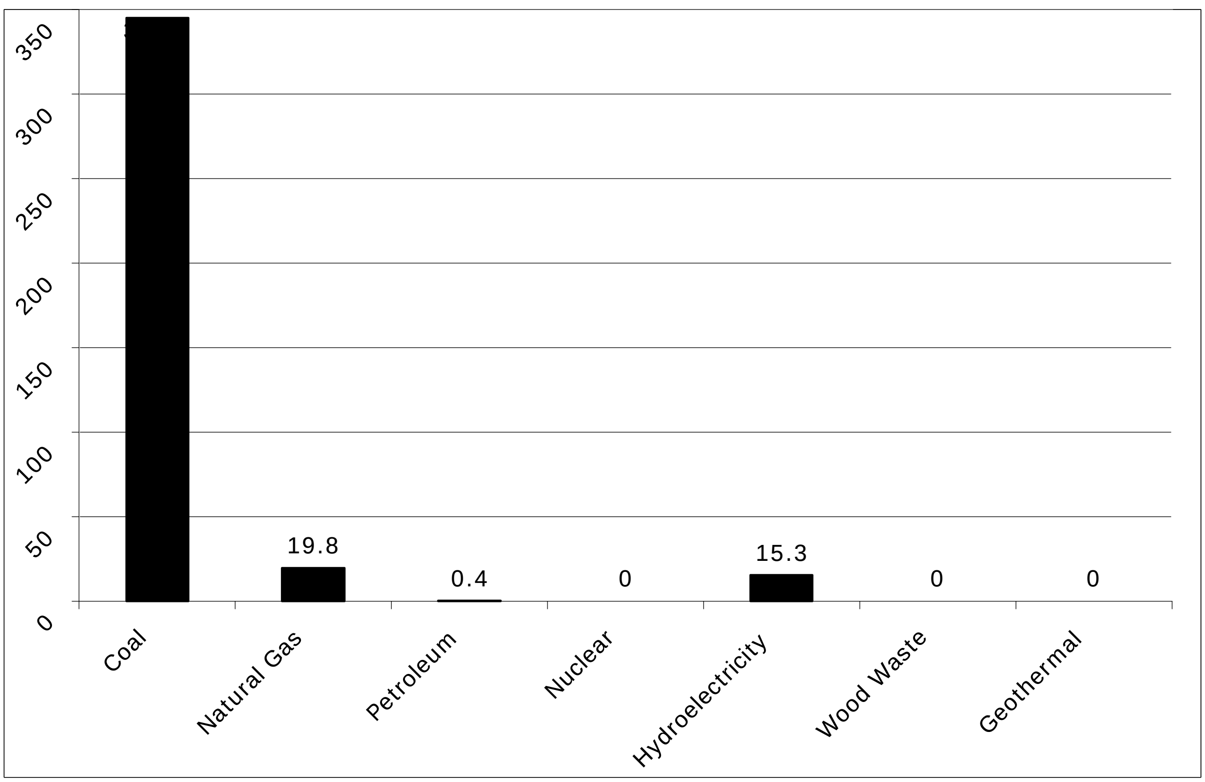
I. Just How Green is Colorado?

The primary electricity fuel for Colorado is coal, responsible for 90 percent of all electricity used in Colorado. This is followed distantly by natural gas at five percent. Renewable energies, including the quasi-renewable energy hydroelectricity, and the wood/waste burning (bioenergy) produce another 5 percent.[1]



Graph 1: Electric Utility Use of Energy in Colorado, 1999, Energy Information Agency

II. What the Pro-Greens Say

According to Colorado's leading pro-renewable-energy organization, the Colorado Public Interest Research Group (CoPIRG), Colorado needs to get off the path that "leads us back into the past, to the technology of the 19th century. This is the path of dirty coal and limited reserves of fossil fuels such as oil and gas."[2]

In a 2002 study, CoPIRG stated that there was "severe environmental and public health damage" from the carbon dioxide, sulfur dioxide, and nitrogen oxide emitted by current power alternatives, specifically the fossil fuels, at current levels. In fact, COPIRG claims that if current technologies continue to be used, with no technological improvements, the toxic emissions will double in 20 years.[3]

CoPIRG and similar organizations also suggest that fossil fuel resources are drastically scarce. Because of this, Colorado, and the entire world, according to some renewable energy advocates, will run out of current resources before an efficient and environmentally friendly replacement is found.

CoPIRG argues that coal and natural gas, the two main fuel sources used in Colorado currently, are not as efficient as renewable energies, for "today's best renewable energy projects produce power that costs less than fossil fuel-generated electricity."[4]

But is any of this true? First we examine whether coal and natural gas are as dirty as these organizations suggest. Then the bulk of this paper will address the questionable efficiency of renewable energy, both in economic and non-economic terms.

III. Scarcity Problems with Traditional Fuels

Traditional resources of coal and natural gas are not nearly as scarce as renewable advocates suggest. The truth however is quite the opposite. According to the United Stated government's Energy Information Administration, a non-political division of the Department of Energy, in the recently released Annual Energy Outlook 2002 (which includes projections to 2020), demand for electricity is expected to increase, but it is also expected that generation of coal and natural gas will keep pace.[5]

A. Coal

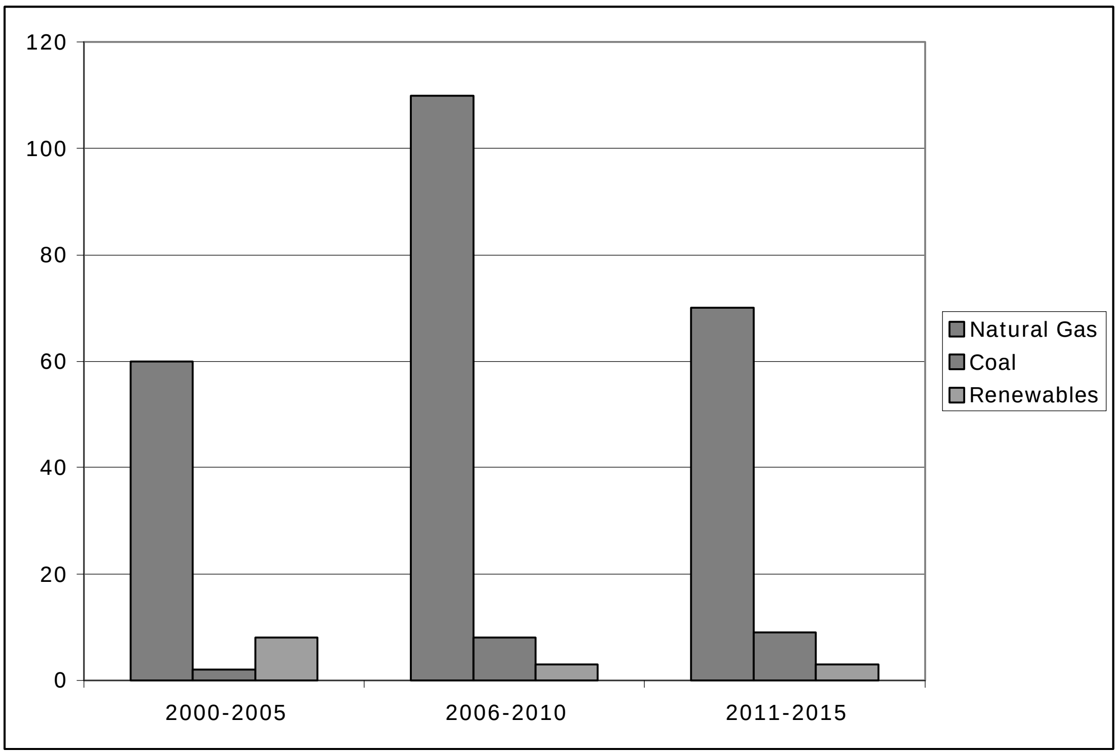
The use of coal is decreasing as natural gas consumption is increasing.[6] Internationally coal in 1999 supplied 22 percent of electricity and this is expected to fall to 20 percent of total electricity consumption in 2020.[7]

Even if demand and use do not decline there is enough coal to last for approximately 230 year.[8] As of 1999, there were about 1,089 billion tons of recoverable reserves.[9] By the end of 230 years it is very likely that another technology, possibly renewable energy, will be able to efficiently replace coal. This forces the question, what is the urgency?

B. Natural Gas

The scarcity arguments about natural gas are just as unfounded as the scarcity arguments for coal. This is obviously so as natural gas is becoming the replacement of coal; it would not be the replacement if it did not have good future potential. By 2020, natural gas is expected to generate 24% of the energy in industrialized countries.[10] In the United States, 80% of new capacity is projected to be natural gas.[11]

The chart below clearly shows the low use of coal and the larger use of natural gas for generating new electric capacity over the next 15 years.



Graph 2: Projected Electricity Generation Capacity Additions By Fuel Type, Annual Energy Outlook 2002, Energy Information Administration, Department of Energy, DOE/EIA 0383(2002), page 73.

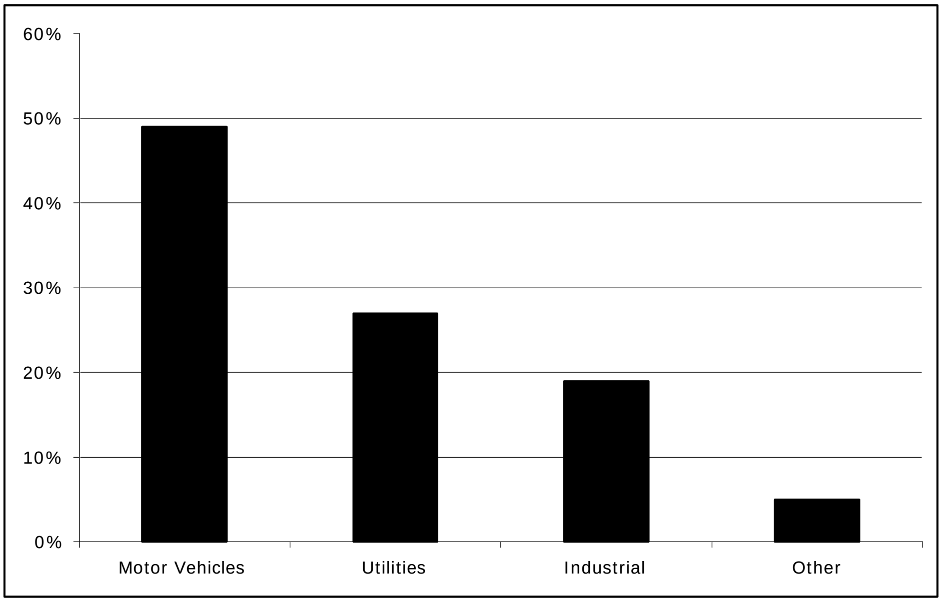
IV. Dirty Fuel? Coal and Natural Gas Air Emission Trends

A. What Does Coal Pollute?

Coal and natural gas plants are not the primary sources of some types of air pollution. In many cases, the major pollutants come primarily from motor vehicles, not coal and natural gas plants.[12] Take for example particulate matter, one of many types of pollution emitted from coal and natural gas plants. The main sources of particulate matter pollution are displayed in Graph 3. As can be clearly seen in this graph, barbeque grills create more particulate matter than coal power plants.

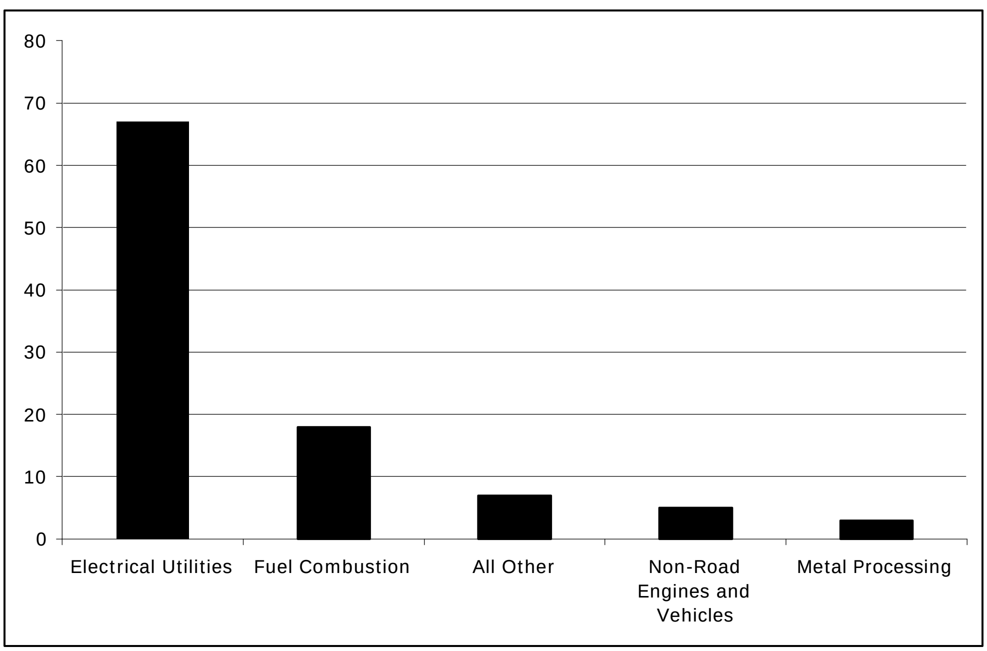
Graph 3: Colorado Air Quality Control Commission, Colorado Department of Public Health and Environment, p. 2.

The same trend is seen with nitrogen oxides. Throughout the United States, utilities, primarily electrical, are responsible for 27% of all nitrogen oxides emission.[13] As seen in Graph 4, the primary polluter is motor vehicles.



Graph 4: "NO_x: What is it? Where does it come from?", U.S. Environmental Protection Agency, http://www.epa.gov/air/urbanair/nox/what.html.

In other cases electrical plants, especially coal, are the primary source of pollution. For example, coal plants cause 65% of sulfur dioxide emissions throughout the United States.[14]

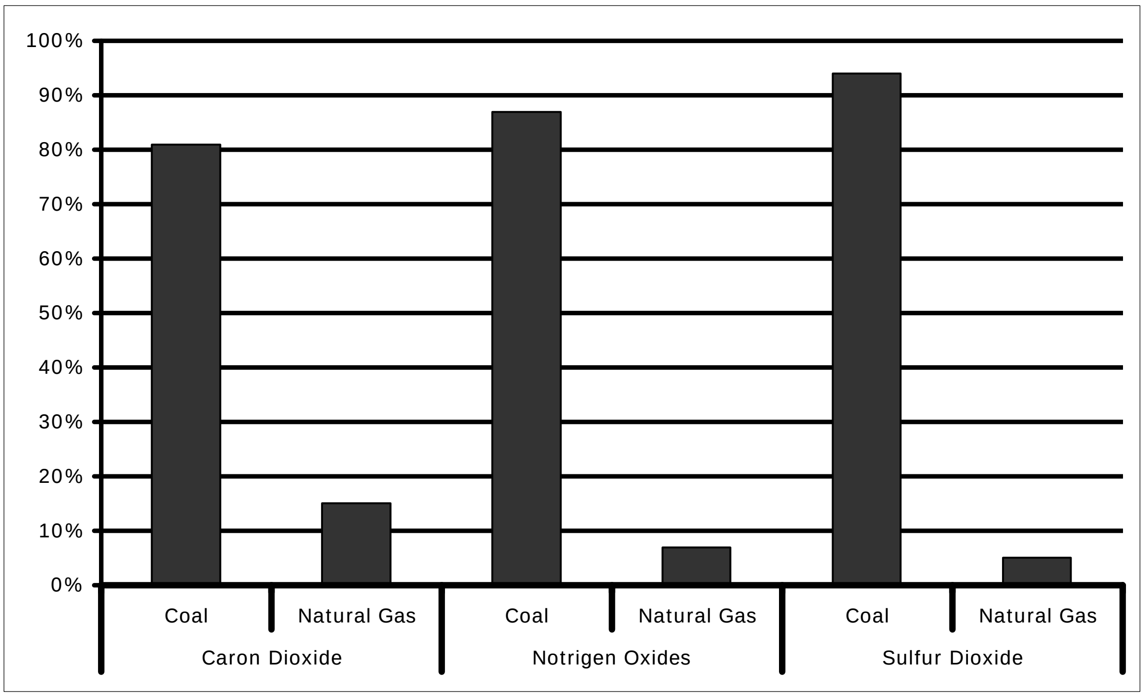


Graph 5: "SO_2: What is it? Where does it come from?", U.S. Environmental Protection Agency, http://www.epa.gov/air/urbanair/so2/what1.html.

B. Natural Gas

As discussed earlier, natural gas is replacing coal power. Coal by 2020 will likely generate 49 percent of electricity, but will be responsible for 80 percent of electricity-related Carbon Dioxide (CO) emission. Natural gas by 2020 will be for generate approximately 28 percent of electricity generation in 2020 and will be responsible for only 19 percent of electricity CO emissions.[15]

This is very good for the environment, as natural gas is a cleaner fuel source. According to the Environmental Protection Agency, natural gas emits half the amount of carbon dioxide, one-third the amount of nitrogen oxides, and one percent the amount of sulfur dioxide.[16] This is summarized in graph 6.



Graph 6: How does energy use affect the environment?, U.S. Environmental Protection Agency, http://www.epa.gov/cleanenergy/impacts/impacts.htm#chart.

C. Air Trends: Getting Cleaner All the Time

Pollution from particulate matter, and sulfur dioxide (SO_2) is decreasing in Colorado according to the Colorado Department of Public Health and Environment, and the federal Environmental Protection Agency:

- Particulate matter has fallen from 250 micrograms per cubic meter in 1995 to just under 150 micrograms per cubic meter in 2000.[17]
- SO_2 has decreased 50% since 1981[18]

The decreases are partly a result of an increase in the use of cleaner technology, such as better techniques at scrubbing coal and the decrease in the sulfur content of coal.[19]

D. Renewable Energy Emissions

Unlike natural gas and coal, renewable energy has zero pollution emission. Even so if renewable laws renewable energy mandates do not have a substantial impact on sulfur dioxide and nitrogen oxide. For example, with a mandate requiring 20% renewable energies by 2020, and making an overly utopian assumption that by 2020 there would actually be 20% generation committed to renewable energies, sulfur dioxide would account for 8.9 million tons of emissions as opposed to 8.9 million tons of emissions without the 20% mandate.[20] Nitrogen oxide would emit at 4.2 million tons with no quota in 2020, and with the 20% mandate would be 4.1 million tons.[21]

V. Technological Tribulations of Renewable Energies

How well do renewable energies work? We will examine the three main proposed renewable energies proposed for Colorado are: wind power, solar power, and biotechnology.

A. Wind Power

1. Technology Overview

A turbine is used to collect wind and then convert the collected wind into electricity. There are two common types of wind turbines: horizontal and vertical. The most common type is the horizontal axis wind turbine (HAWT).[22] HAWTs collect wind from the richer wind sources above ground level.[23] The original wind turbines of the early 1900s had a very similar design to the modern HAWT.[24] Vertical axis wind turbines (VAWTs) are designed much like a water wheel and operate on a similar technology.[25] Because VAWTs operate very close to the ground, they are not as efficient as the HAWTs and are therefore rarely used.[26]

Wind turbines convert the force of the wind and the resulting rotation of the blades into a torque which is then turned into energy.[27] Numerous factors are involved in determining how much of that wind becomes energy, of which the primary factors are the air density, the wind speed, and the rotor area.[28] Additionally, the wind turbines must be tall enough to avoid irregularity and roughness of terrain problems with low level (surface) winds.[29]

2. Technological Problems

The first step with wind technology is finding the right location with the right conditions. Rotor area and height of the machine can be more easily adjusted but mountains or buildings obstructing the access to the wind current.

If a plot of land does not have sufficient amounts of wind, then the wind turbines will not work. The amount of wind available in various areas is measured by the Geographical Information Systems (GIS) based out of the National Renewable Energy Laboratory (NREL) located in Golden, Colorado. The GIS gives a ranking of 1 for inefficient wind energy conditions to 7 for efficient wind energy conditions.[30]

Yet there cannot be too much wind, as too much wind leads to turbulence (wind speed variability) and turbulence leads to increased wear and tear on the turbine, which decreases the effectiveness of the wind turbine. Turbines therefore need to placed in locations distant from major areas of turbulence or at a high enough altitude to avoid surface turbulence.[31]

Second, the ideal location must be a flat land free of rough terrain, because the rough terrain decreases the amount of available wind.[32] The roughness class is determined by the amount of items obstructing the location: a roughness class of zero (0), the ideal location, would be given to a completely open terrain with a completely smooth surface while a roughness class of four (4) would be assigned to a very large city with numerous skyscrapers and other tall buildings. An airport runway receives a roughness class of 0.5 and New York City would receive a roughness class of 4.[33]

The best locations with sufficient wind, but not too much, and a low roughness factor, are often far away from the major areas of electrical consumers, such as cities. There needs to be a massive transmission system to get the generated power from the distant and ideal generation location to the power users. Access to transmission capacity is the most difficult part of sitting a wind farm. Because of the high transmission costs, wind power has often been used on farms where the source of power generation and the location of use of that power are closer.

Finally, all of these demands for finding the right amount of wind and finding the right roughness factors means that the most efficient windmill, in terms of how much wind can be converted into usable electricity, is only 50%, with a theoretical upper limit of efficiency of 59%.[34] In other words, only half the wind that hits the windmill can be converted to usable electricity. The larger three-blade wind turbine only has a maximum efficiency of 45%.[35] Some work is underway to readjust blade sizes to attempt to increase efficiency.

3. Will it work in Colorado?

At present, Xcel Energy has one wind farm in Ponnequin, Colorado, near the Colorado-Wyoming border, and has another farm planned for Peetz, Colorado, also near the Colorado-Wyoming border.[36]

Considering all legal factors and wind requirement factors, about 17% of Colorado is viable for wind energy development.[37] If this land was used to full potential, it could produce 461 million megawatt hours of electricity per year.[38]

Because of the long-term variability of the weather and wind speeds, it can never be known if adequate wind will occur throughout the lifetime of the wind turbine to allow for full potential. Projections for something as variable as the weather can never be certain. The Traverse City Light and Power installed a large wind generation farm in 1996 but wind speeds have fallen below projections and the plant has only been able to produce 67 percent of the electricity that had been projected.[39]

Moreover, due to technological flaws in the blade structure wind towers cannot often be used during peak energy demands when the weather is severe in the summer or winter.[40] Thus, wind power cannot currently be relied on for baseload electricity generation (continuous electricity generation).

4. Environmental Problems

An environmental problem of wind power is the massive amount of land it requires. Approximately 4 watts of electricity can be generated from 10.764 square feet of land area.[41] This is 30 to 200 times more space required than for natural gas plants to generate the same amount of power.[42] Wind turbines obstruct the visual landscape at the wind farm site. In addition, the wires to transport the power and the turbines involve the digging of otherwise undeveloped land.

B. Solar Power

1. Technology Overview

Solar power collects the sunrays and converts them into electrical power. The most common type of solar power is the photovoltaic (PV) solar cell.

PVs convert the light they collect from the sun directly into electricity, creating an electric current that can either be immediately consumed or stored in a battery.[43] The single PV cell is about 10 centimeters in size and generates about 1 watt of power, which is "enough to power a watch, but not enough to run a radio."[44] The PVs are not often found in single units but are more typically found in modules, a grouping of 40 of the 10 centimeter PV cells. A PV module can produce electricity to power a small light bulb.[45] The modules can be combined into groups of ten to form solar arrays. Ten to twenty PV arrays can power a single household, but for larger electrical needs, such as industrial factories, hundreds of arrays need to be connected to generate enough power.[46] Ten acres of arrays are needed per megawatt of installed capacity.[47]

PVs have two ways that they can collect the solar power. The flat-plate PVs are tilted in various directions to collect the most sun possible. The amount collected is measured in "global solar radiation". The second type of PVs is a type designed to direct beams via lenses into the solar panel, the so-called concentrated solar panel. Estimates show the two types generate the same amount of electricity. However, the concentrated PVs produce more electricity per square meter because they are able to direct the sun more efficiently into the panel.[48]

2. Technological Problems

The largest drawback of solar technology is the need to have a large amount of solar cells to generate ample power, it takes 10 to 20 arrays of solar panels, consuming approximately a quarter to half a mile of land, to electrify just one home. Solar power however does work well on a small scale, such as operating small water pumps on rural farms or powering calculators.[49]

As with wind power, another concern with solar power is availability of the natural resource. The sun does not shine strongly enough in some areas long enough to allow sufficient amounts of power to be collected.

During the periods of no or little available sun, and low reserves of power, backup power plants – often natural gas plants – have to be used. Alternatively, solar (and wind) plants can be built as supplemental plants to coal or natural gas. That is, the solar or wind plants can be used on sunny (or windy) days instead of coal or natural gas plants. Either way, the utility must build two power plants (a solar and a coal, for example) instead of one (for example, just a coal plant).

If a back up plant is built (for example, a natural gas or coal power plant), it can only be used as a backup; it cannot be used at the same time as the main power plant (in this case, a solar power plant). If it were used at the same time, then it would quite likely not be available when the solar power plant failed or was unable to work.

3. Will it work in Colorado?

The concentrated solar panel has good potential in the southern portion of Colorado[50]. However, a goodly amount of land would be required by solar farms: about 150 acres of Colorado would be required to help generate part of the power needs for about 6,180 homes.[51] Placing solar panels on every home is simply not an option for many homes that are not located in ideal solar collection locations. Without being in an ideal solar collection location, barely enough power could be collected to electrify a light bulb.

4. Environmental Problems

Most of the environmental problems with solar closely mimic those of wind power. Like wind, solar requires vast amounts of land. Solar panels require five to ten acres per megawatt of installed capacity[52] which is approximately half a mile (linear) of solar panels per home fully electrified by solar. This land destruction is far greater than the land destruction caused by traditional technologies for the same amount of electricity produced.

C. Bioenergy/Biomass Technology

1. Technology Overview

Bioenergy is the burning of natural waste to create energy in a process very similar to the process for coal and natural gas.[53] This natural waste, or biomass, can include everything from trees, grasses, agricultural crop residues, forestry residues, to plant waste.[54]

2. Technological Problems

There are few technological problems with biomass, because it is similar to current, and well-developed, technologies.

Of concern however, is the cost of collecting this waste. The reason is that waste is spread out through many locations, instead of being concentrated in one location, such as a coal mine. This makes finding the waste difficult. Agriculture waste, which is the unusable parts of wheat and corn crops, has an enormous collection cost, because the waste tends to blow away easily. Thus agriculture waste is not the choice waste for biomass generation. Other biomass, such as wood waste, has become more popular as it has less technological collection costs, because it tends to be collected in more central locations than agricultural waste.[55]

One solution to the waste being spread about is converting farms currently used to produce food in to waste generators. Another alternative would be to convert remote deserts into waste producers, by planting desert friendly plants to grow for waste.

3. Will it work in Colorado?

Estimates show that biomass in Colorado could fully generate enough power for 43 percent of Colorado homes, approximately 521,000 homes.[56] Because of the similarity to other technologies, implementation may be a bit easier, and the ability of land might be easier as well, as a factory requires less room than a massive solar or wind farm.

4. Environmental Problems of Biomass

The major environmental concern is not what is emitted but rather the impact on the environment. In order to use biomass, trees and other natural resources must be cut down or converted to generate sufficient fuel. This would require changing the ecosystems of the land.[57]

VII. The Economic (In)efficiency of Renewable Energies

A. The Impact of Subsidies

The main problem with judging economic efficiency is that the true costs of renewable energy are hidden by energy subsidies.[58] On the federal level, these include tax credits for various stages of wind and solar farm development. The most important federal subsidies are[59]:

- A 1.7 cent per kilowatt hour federal tax credit for operation of a pre-2001 wind power plant during the first 10 years of operation
- A 10 percent federal tax credit for electricity-generating solar technologies
- A five-year accelerated depreciation for some types of renewable energies

On the state level, there are also policies that hide the cost of renewable energies. These include:

- Price caps enforced by the Public Utilities Commission
- Subsidies from various local governments (which will be discussed in more depth in Section VIII.B.)

Because the cost is hidden, renewable energies appear to be more competitive with traditional technologies. As noted by Christine Real de Azua of the Wind Energy Association, renewable energy "was still not competitive enough [as of 1998] to win all-source bids from utilities in the absence of policies that either created a steady assured market for renewable energy, ensured that is environmental attributes were adequately captured and valued in the marketplace."[60]

B. What low cost alternative?

Despite these subsidies, staggering cost differences occur between renewable and non-renewable energies. Estimates from the Department of Energy show that wind, solar PVs, and bioenergy do increase the cost of energy. These costs are to some extent shown in Table 1. The table shows levelized costs (costs adjusted for subsidies) and thus do not reflect the real price of these technologies. Furthermore, these prices in the table are not adjusted for transmission costs, which can be massive for wind and solar power, as noted above. Therefore, this table only begins to suggest the real costs associated with renewable energy.

In addition, the numbers in Table 1 should be compared to the **non-levelized** cost of the most popular new electricity source, natural gas, which is 3 cents per kilowatt-hour.[61]

Levelized Cost of Energy, Measured in Cents/KwH		
Technology	**Cost in 2000**	**Cost in 2010**
Wind Power	3.4-4.3	2.5-3.1
Solar Pvs	24.4-29.7	8.1-17.0
Bioenergy/Biomass	6.7-7.5	6.1-7.0
Natural Gas, Non-Levelized Cost in Cents/KwH		
Natural Gas	3	

Table 1: Office of Utility Technologies, Energy Efficiency and Renewable Energy Network, Department of Energy, "Renewable Energy Technology Characterizations", TR-109496, December 1997, page 7-3.

C. Prices Will NOT Fall Over Time

Many like to think that as more areas become developed into wind farms, the price of wind energy or solar energy will start to decrease. Because of the levelization of costs in the table above prices seem to be decreasing in the long term.

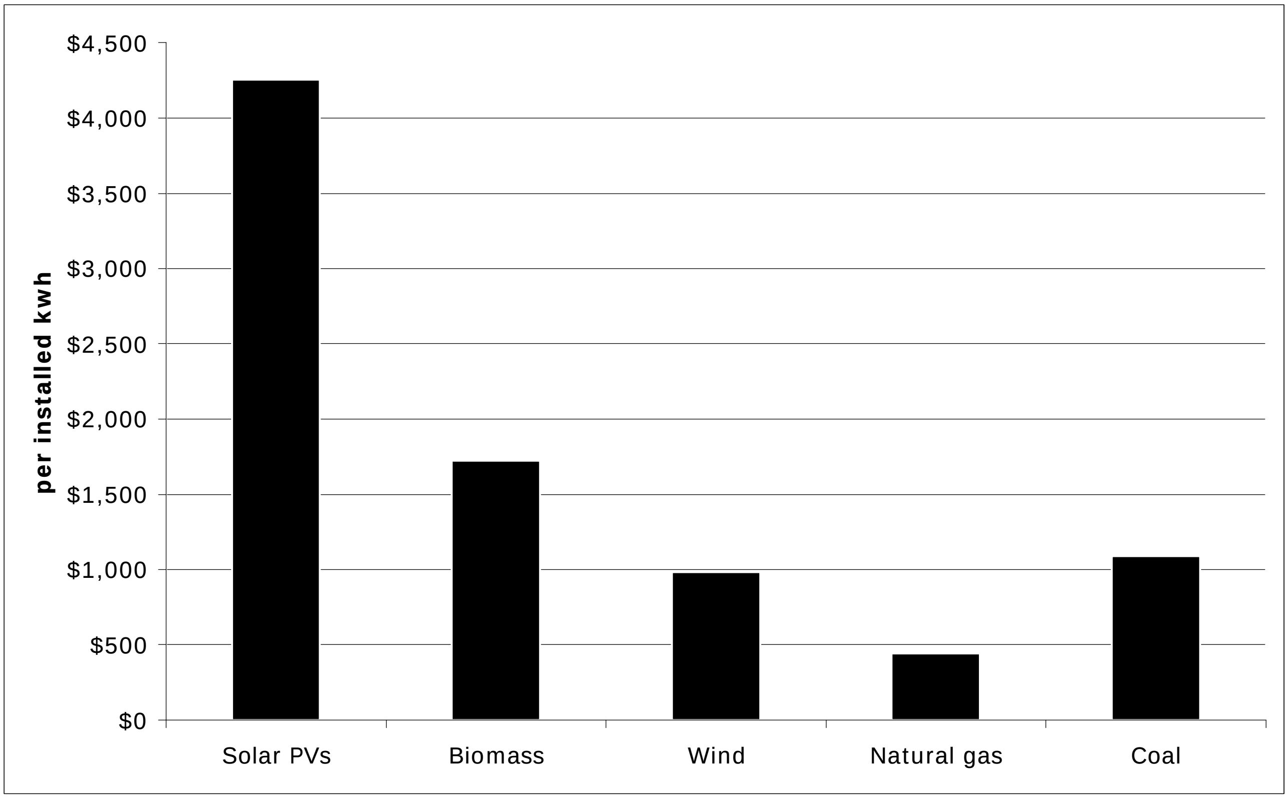
Prices will not fall over time due to the fact that the largest contributor to production costs, location problems, face several problems. The first locations to be developed will be those ideal locations where land conditions and nearby transmission capacity maximize the efficiency of the technology. These super ideal locations will allow the renewable technology to work at maximum efficiency, producing energy at prices similar to those in Table 1.

As those locations are used, less efficient locations will have to be used. The less ideal a location the more production costs will arise so that the location can be properly altered to reach the same efficiency as the first highly efficacy locations.[62]

If the technology improved this could potentially reduce production costs for the less ideal locations. However current policies, as will be discussed in Section VIII, restrict such innovation.

D. Capital Costs: Keep Going Up and Up and Up

By far the worst economic problem with renewable energies is their tremendous capital costs, as items with high capital costs are a considerably riskier investment. The PVs have the highest capital cost of approximately $4,252 per installed kilowatt hour, biomass/bioenergy has the second highest at $1,723 per installed kilowatt hour, wind ranks in at $983 per kilowatt hour, natural gas has a capital cost of $445 to $467 and coal has a capital cost of $1,092.[63]



Graph 7: Capital Costs per installed kilowatt hour, Source: "Assumptions to the Annual Energy Outlook 2001," Energy Information Administration, DEA/EIA-0554 (2001), 69.

Some people argue that the enormous capital costs for renewable energies will be reduced when there is increased capacity, as the increased capacity would increase the amount of purchasers. However this is not the case for renewable energy: the capital costs increase linearly as capacity increases.[64] In other words, the price of renewable energies will actually continue to increase as the number of renewable energy plants increase. This is because while renewable energy (like coal) has high capital costs suitable for baseload production, they are not capable of baseload generation, because they are intermittent technologies (only usable when the weather is right).[65] If capital costs were reflective of wind (or biomasses) ability to be used for baseload generation, the capital costs for the renewable technologies would decrease.

E. Is Wind the Most Price Competitive?

Most policy efforts in Colorado have been directed toward the promotion of wind energy. Many proponents of renewable energy claim that wind is the renewable energy most likely to compete with traditional energy sources.[66] This forces the question: is it the most competitive in terms of price?

1. Transmission Costs: 1.5¢ per KwH

There are a tremendous amount of transmission costs involved with wind power: the transporting of the energy from the remote generation source to the electricity consuming population. In Colorado, the wind power has to get from the Peetz wind farm, near the Wyoming-Border, to primarily the Denver area.[67] While no studies have been done to measure the exact transmission costs of the Peetz wind farm, broad scoped studies focusing on generic wind farms in the United States suggest that these transmission costs add approximately 1.5 cents per kilowatt hour.[68]

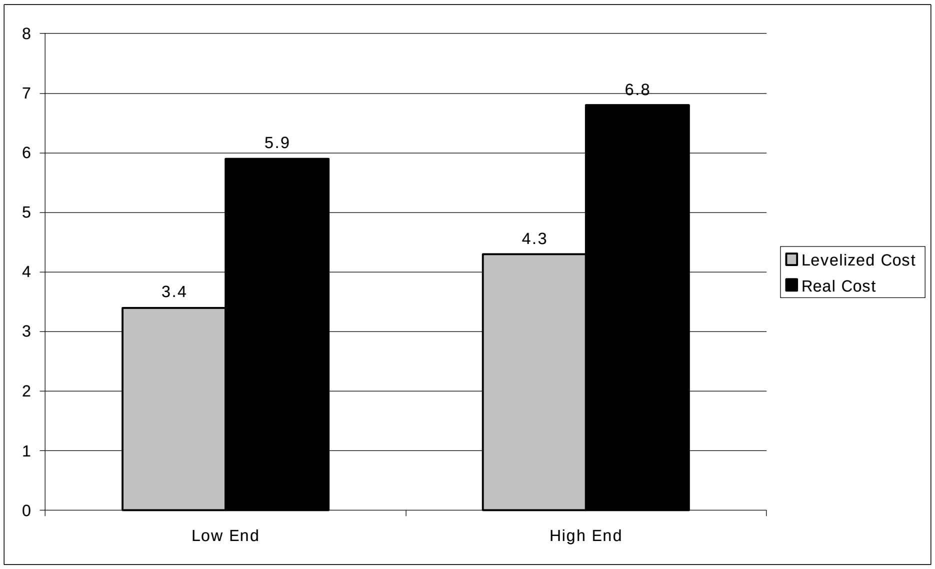
2. Ancillary Costs: 1¢ per KwH

In a culture highly dependent on electricity, the idea of electricity that fluctuates between working and not working seems absurd. However, this fluctuation is what wind energy provides; when the wind stops blowing, the wind turbines stop collecting that wind and converting it to energy. Because of the instability of electricity provided by wind and solar, these energies are not suitable for baseload generation of electricity.[69]

This is also the reason that wind farms (and solar panel farms) have ancillary energy sources, often in the form of a natural gas plant. When the solar or wind plant is not in operation, the backup natural gas plant generates an equal amount of power. The plant cannot be operated at other times because then it would not be available when the wind power stopped generating power. The cost of maintaining the backup plant per each kilowatt-hour of electricity is estimated to be roughly 1 cent per kWh in addition to the base production cost.[70]

3. The Levelized Cost Plus Transmission and Ancillary Costs

In Table 1 the levelized price of wind was 3.4-4.3 cents per kilowatt-hour. It is assumed for sake of argument that the levelized cost is the cost with subsidies to remove the transmission costs and ancillary costs. To obtain the total price of wind, the price in Table 1 will be combined with the transmission and ancillary costs. When these are combined, wind power costs approximately 5.9 to 6.8 kilowatts per hour more than the fuel-based technologies. And because of the decreasing numbers of those ideal sites over time, the costs will more than likely increase in the long term.



Graph 8: Levelized Cost versus Real Cost of Wind Power, derived from above discussion and Table 1.

4. Windsource: Wind Farms in Action

Windsource is a program run by Xcel Energy that sells blocks of wind power to volunteer customers. In order to partake in this program, customers pay $2.50 per 100 KwH block, an average of $15 per customer, in addition to their current electrical bill each month.[71] This demonstrates that wind power costs more than the fuel based technologies. (Please see Section VII.C. for more on Windsource.)

5. The cost of solar and biomass?

Solar and biomass have prices so high at the levelized cost (see Table 1) that even the greenest economist does not foresee these technologies becoming competitive in the near future.

F. Conclusion

Renewable energies are not cheap. The heavily subsidized cost hides the real numbers from investors and customers. However, the real cost is far from competitive with fuel based technologies.

Despite these enormous costs, and in many ways in order to hide these enormous costs, several policies have been implemented to encourage the use of renewable energy power.

VIII. The Quest to Get Green (Strategies Promoting Renewable Energies and Analysis)

There are three categories of policies: command and control, green power purchasing, and market solutions. Command and control will increases the cost of energy, while green power purchasing promotes an inefficient energy. Market solutions promote efficiency of renewable energy.

A. Command and Control

Command and control regulation is when the government commands that something occur and controls that it occurs. These policies have become famous not just in Soviet Russia, but also in the minds of utopian renewable energy advocates.

1. Renewable Energy Quotas/Renewable Energy Portfolio Standards

The most popular command and control regulation in regards to renewable energies is the renewable energy portfolio standards – a quota that requires a specific percentage of renewable energy is a part of the total energy generated. The Sierra Club for instance has supported a twenty percent renewable portfolio standard, which they claim would not only increase the amount of renewable energies in a cost effective manner but would also have vast economic benefits.[72] The Sierra Club's arguments are incorrect.

i. Quotas in Other States

Currently 14 states, not including Colorado, have implemented renewable energy quota policies.[73] These quotas range from 1% in Arizona to 30% in Maine.[74] In Florida, where the portfolio is 7.5%, the electric utility is having trouble increasing the use of renewable energies to that amount.[75]

ii Problems With Quotas

Quotas would add too much cost, especially if high percentages are mandated. A twenty percent renewable energy quota would, according to the Energy Information Agency (EIA), increase the price of electricity by 3 percent in 2010 and 4 percent by 2020.[76]

Second, the EIA has shown that pushing energy companies to reach these high levels of renewable energies will require the companies to endure higher costs. To recover higher costs of going to 10 percent quota by 2012 would require eight years of recovery through credit sales.[77] In other words, energy companies would have to charge customers more for electricity with a renewable energy quota; the companies may charge a lot more than that 3 to 4 percent.

Third, the EIA has projected that a 20% renewable energy requirement could not be met by 2020. Without a mandate, by 2020 there will be 12% worth of renewable energies in the portfolio.[78] This 12% will occur naturally from market demand. The full 20% cannot be achieved naturally because there is not enough time for developers to regain their investment of capital costs.[79] It takes a longer period of time to regain capital costs with the renewable energies simply because of the newness of the technology; the more a technology is developed, the lower the initial capital cost, as is the case with natural gas. Because of the price cap in Colorado, this is not much of an issue because if the energy companies pass the capital cost on to the customer; energy bills will increase.

Fourth, a mandate this would do little to reduce emissions of nitrogen oxides and sulfur dioxide. As seen in the table below, without the quota, by 2010 Nitrogen Oxides and Sulfur Dioxides will be the same regardless of quota, and by 2020 only a small difference in pollution.

	2010			2020		
Polluter	No Quota	10% Quota	20% Quota	No Quota	10% Quota	20% Quota
Nitrogen Oxides	4.0	4.0	4.0	4.2	4.1	4.1
Sulfur Dioxides	9.7	9.7	9.7	8.9	9.0	8.9

Table 2: "Impacts of a 10-Percent Renewable Portfolio Standard", Energy Information Agency, Department of Energy, SR/OIAF/2002-03, February 2002, 30.

The EIA's report was in reference to a national renewable energy portfolio. There is no reason to believe that its conclusions are not applicable to Colorado.

2. IRP

Under Associated Rule 723-21 Integrated Resource Plan (IRP), of the Colorado Public Utilities Commission, the Colorado's government is a quick step away from implementing renewable energy quotas. The IRP was enacted to allow the PUC to plan and structure the energy sale and generation over a five-year period, specifically giving the PUC the power to provide an "assessment of [the] need for additional supply-side resources", such as power plants.[80] Decisions are made through a bidding process whereby various plans offered by energy producers are assessed by the PUC, resulting in electricity plan for the next five years.

Because of the provision within the IRP requiring the PUC to decide on the final electricity generation for Colorado, the IRP statute could easily be changed by the legislature to require that the PUC require that a certain percentage of the energy generation plan be renewable energies. This plan is almost identical to the quota, the only difference being that this quota is implemented by altering existing electricity planning law.

Because of the similarity of this use of IRP to the quota proposal, the arguments against using the IRP to mandate renewable energies are the same. First, it will increase the cost of the electricity. Second, the quota requirement will not decrease pollution. Finally, the cost incurred by the energy company, and the customers, will be large.

B. Green Power Purchasing/Green Pricing

1. What is it?

Green power purchasing is when the governments purchases power for the citizens and businesses within their jurisdiction. Green power purchasing has been tried in a handful of locations across Colorado. One of the largest green power purchasing programs is the Community Office for Resource Efficiency (CORE) in Aspen, Colorado. The Aspen CORE program has installed PVs (photovoltaic solar panels) at some of the local public high schools and middle schools. The power collected by these PVs is directed into the electricity grid of the community.[81]

In addition to the grid programs, CORE has started a Wind Power Pioneers Program, to encourage businesses and local governments, via subsidies in the Aspen area, to purchase power partially from wind.[82] CORE also encourages the purchasing of grid-connected solar power via "solar production incentives." This solar power then is installed on the customers' homes and then produces power for the community. Those in the program receive 25 cents per kilowatt-hour they produce, and can receive no more than $1,000 per year in this program.[83]

2. Does it Work?

This program is a subsidy: it gives money to customers to promote renewable energies. Yet it is more than a subsidy because it requires the government purchase power for citizens and connect that power to the grid.

The extra money offered to the purchasers, by the subsidy, becomes the selling feature instead of the efficiency of the technology. That is to say, if a customer is offered the chance at money, he will readily take that money instead of trying to find highly efficient or cost effective products that consumers would seek if not for the subsidy.

Placing of solar panels on public buildings will also add cost to the electricity from the grid. In Florida where there is a similar program, the electric utility is facing costs of renewable energies ten times higher than traditional energies because of green power purchasing; this cost is passed on to customers.[84]

C. Market Based Solutions/Windsource

1. What is it?

Market based policies require considerably less government involvement than the power purchasing and command and control regulations.

One such market program is Windsource, operated by Xcel Energy. Windsource sells blocks of wind energy to customers. The blocks are 100 kilowatt-hours of electricity and cost $2.50 a month in addition to other electricity bill costs.[85] Given an average use of electricity of 600 kilowatt-hours of electricity per customer, customers pay $15 extra a month to have wind power. Approximately 15,000 home customers and 250 businesses have asked to receive all or part of their electricity package through wind power blocks from Windsource.[86]

Windsource creates a market for renewable energy by encouraging Xcel Energy to sell renewable energies as an alternative to coal and natural gas.

2. Does it work?

As evinced by the number of customers signing up, Windsource has been somewhat successful. These numbers suggest that some people do want renewable energies.

Second, this program is innocuous, as customers choose whether to use traditional technologies or pay more to convert to the renewable technologies.

3. Limitations

Windsource is currently hindered by proposed quotas and the current IRP policies because both would require the government, and not the customers, make the choice as to which technologies are more best for them. In the case of the IRP, the PUC currently decides whether or not Xcel Energy can build the wind power plants and/or purchase wind power plants, instead of having customers decide by demanding more or less renewable energies in the market.

Obviously, Windsource does cost more; however the entire cost of wind power, shown earlier to be 6.8 cents per one kilowatt hour, is not reflected in the block price of $2.50 for 100 kilowatt-hours of wind power, as that $2.50 should be closer $6.80. If were priced at this level, Xcel Energy would not sell so many customers. If Xcel Energy did wish to reach these customers, Xcel would have to increase the efficiency of wind power in order to reduce the cost from $6.80 per block to a more sellable price.

Finally, there is the issue of capital costs. Right now, Colorado utilities have guaranteed return on investment due to the monopoly powers granted to Xcel Energy and other Colorado energy companies. If these laws were removed, no further renewable energy plants and farms would be built until they become economically efficient and see costs decreased.[87] These capital costs are not expected to decrease.

D. Summary of Policy Choices

- Quotas increase the price of renewable energy by adding production costs for the energy producer.

- Green power purchasing subsidies than encourage the addition of inefficient technologies to the grid.

- Market strategies allow customers to decide if they want to pay the extra costs for renewable energy.

Conclusion

Colorado's main energy consumed is coal. Many renewable energy lobby groups claim that this situation will lead to several health and environmental problems. In fact, most pollutants are decreasing.

The pro-renewable lobbies argue that renewable energies are more efficient than natural gas and coal. This too is an unsubstantiated claim.

Wind power and solar power are subject to the availability of wind and the sun. Attempting to get the power collected from the wind and solar farms to the consumers requires an elaborate transmission system, which leads to additional costs of electricity. Furthermore, because of the lack of availability of wind and solar, there is a need for ancillary power plants to be installed to act as an auxiliary power source in case the sun or wind fails to generate sufficient power levels.

All renewable technologies add costs to the electricity bill. Wind for example adds about 6.5 cents per kilowatt-hour extra when transmission costs and ancillary service costs are included. Renewable energies are not a low cost alternative.

Renewable energies still remain politically popular, however, and therefore there are numerous policies either enacted or proposed to increase the amount of renewable energies used. These policies range from government mandating renewable energy use, to government purchasing renewable energies, to market strategies to sell renewable energies. The market strategies are the best, as this policy will have the most chance at increasing the effectiveness of renewable energies.

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