Feasibility Study of Constructing and Operating Wind Turbines in the State of Colorado

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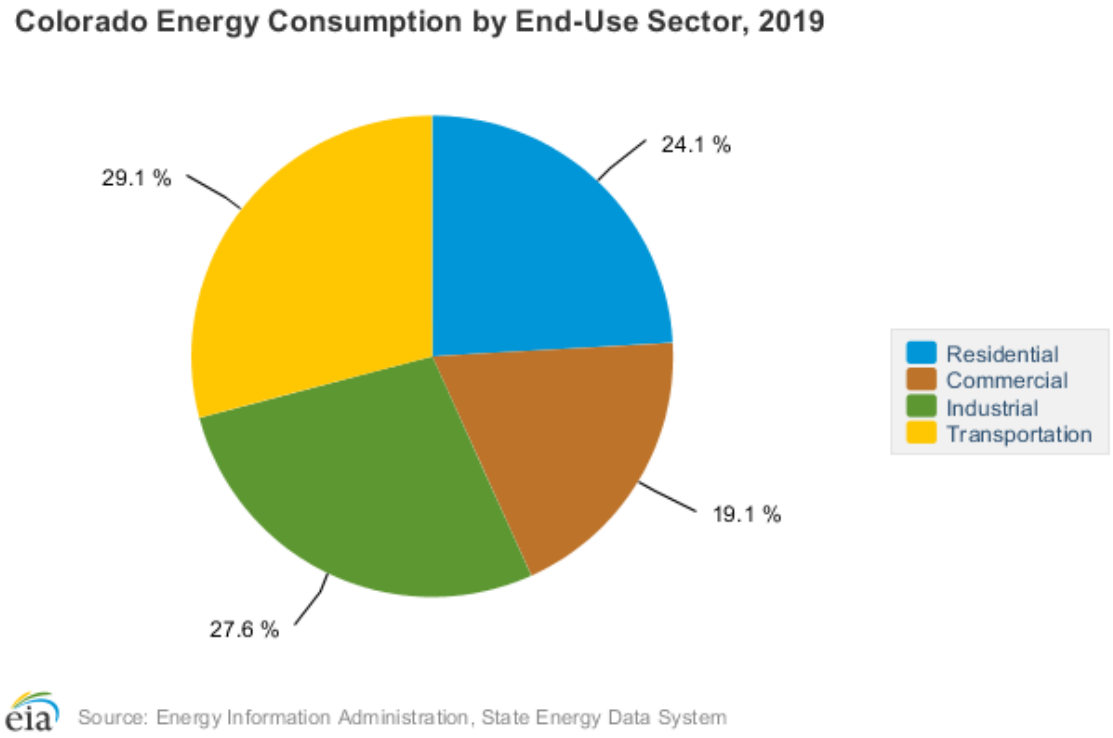
Introduction

Overall, due to the amount of wind, especially in the eastern part of the state, Colorado is a great location to choose for wind turbines. In this feasibility study we will be looking at several things to consider whether or not the state of Colorado is an appropriate location to develop wind turbines. We will be looking at the energy needs of Colorado, current energy sources being used and their associated costs, wind resources available in Colorado, an economic analysis of wind turbine systems, and public policy issues to consider.

Energy Needs of Colorado

Present

Currently, Colorado consumes about 56,000 GWh of energy per year. Below we can see a breakdown of energy consumption as a percentage of a whole for energy use by sector:



That energy consumption broken down is
Residential: 13,500 GWh
Commercial: 10,700 GWh
Industrial: 15,500 GWh

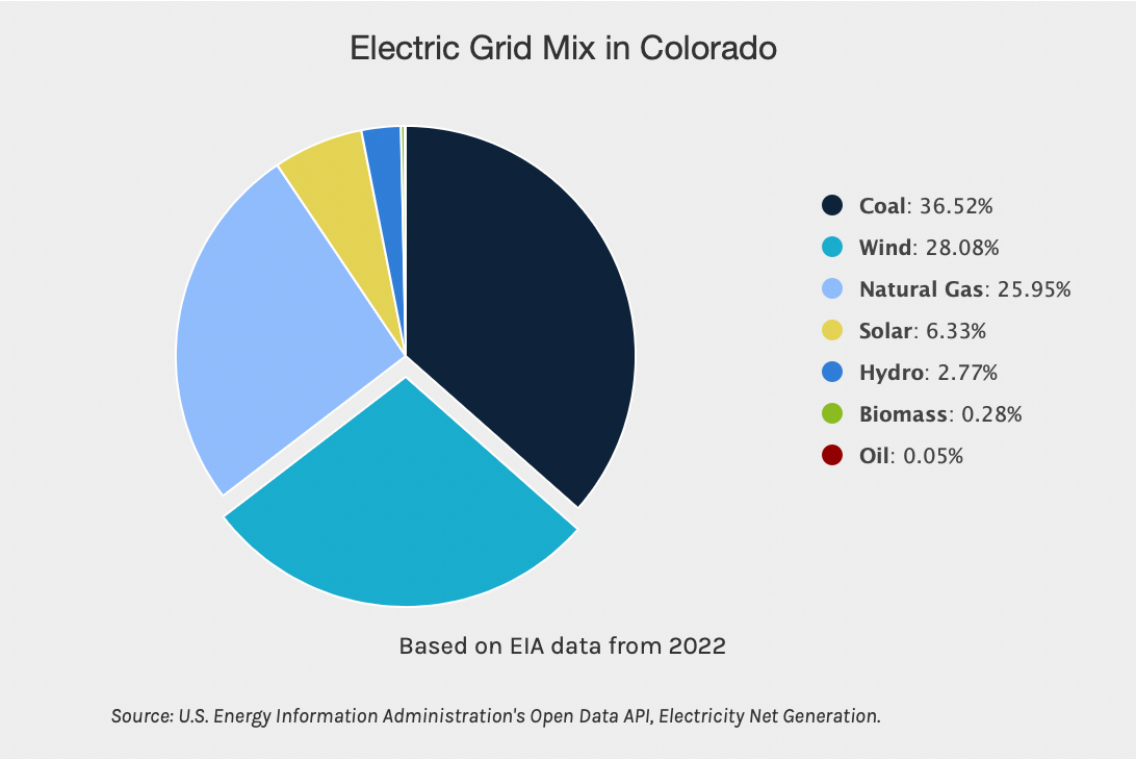
Transportation: 16,300 GWh
Projected

Within the next ten years, Colorado will see an estimated population increase of 500,000 (from 5,800,000 to 6,300,000). Thus, the total energy consumption will increase from 56,000 GWh to estimated 65,000 GWh. This is due to economic development, transportation shifting to all electric, and overall increase in energy use by the general public.

Current Energy Sources and Costs

Energy Sources

Colorado uses both fossil fuels and renewable resources for harnessing energy. The breakdown of the resources generated is shown in the chart below:



Compared to other states, Colorado is known for investing heavily in renewable resources especially wind and solar.

Costs

The following is a breakdown of the energy sources and their associated average costs:

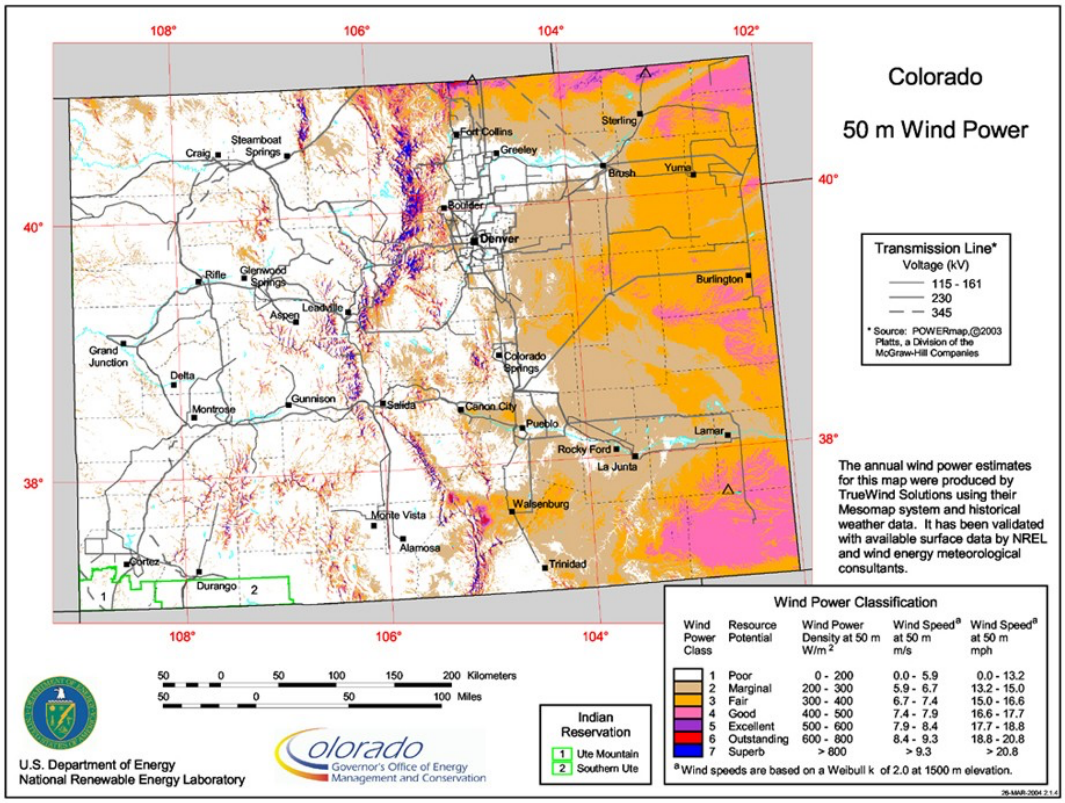
- Coal: 3-5 cents/kWh

- Natural Gas: 4-6 cents/kWh
- Wind: 2-4 cents/kWh
- Solar: 3-6 cents/kWh
- Hydropower: 3-5 cents/kWh

Clearly, in Colorado, wind is the most cost-efficient energy resource which is why Colorado relies heavily on it.

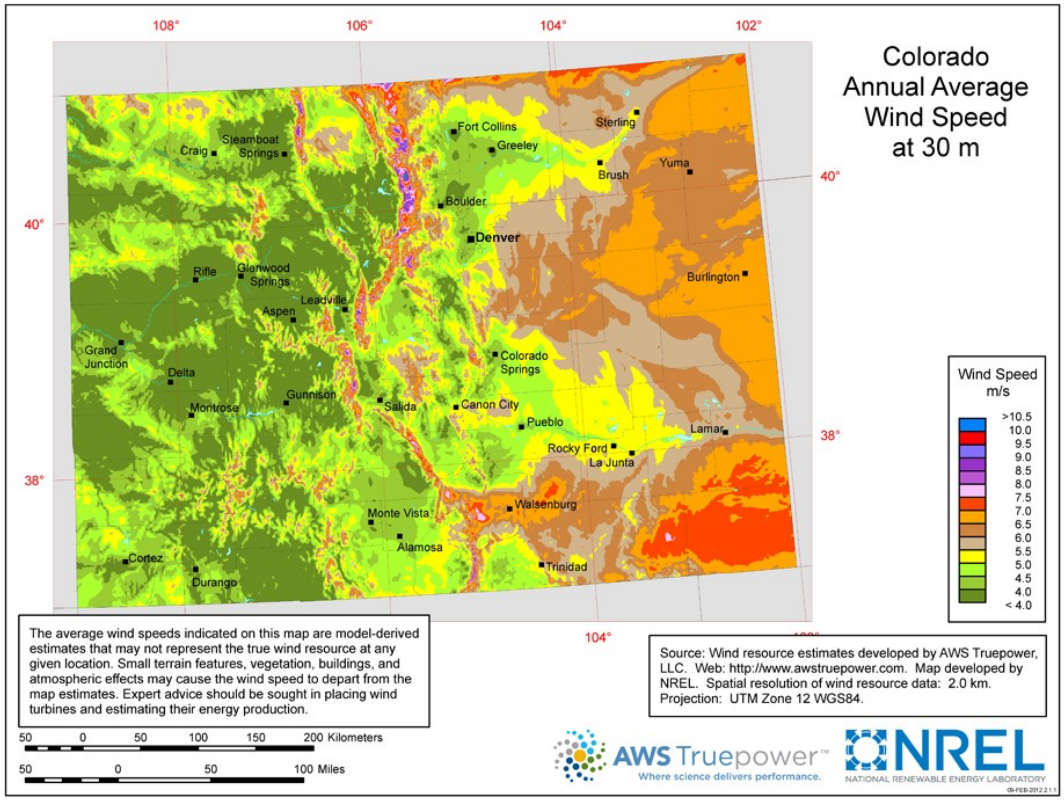
Wind Resources

Colorado has a great amount of wind resources available to it. Some of the most dense regions with these wind resources include :the eastern plains of Colorado where it borders the state of Kansas and also mount areas where there is high elevation. In the eastern plains is where you will see large scale projects and wind farms. In the more mountainous areas you will see small scale family based projects. In the graphic below you can see where this wind power resources is really concentrated. The main large scale projects are to the east and the smaller mountainous projects fall right between the middle of the state.



Capacity Factor

Capacity factor represents the energy output as a percentage of maximum possible output. The average annual capacity factor for wind projects in Colorado in 2023 was 34 percent. Some key factors that impact this capacity factor include: consistent high wind speeds, advanced turbine technology and efficiency, and topography specific to Colorado impacting weather patterns. We can see some of this shifting topography especially in eastern Colorado in the graphic below. While this graphic represents average annual wind speed you can clearly see the difference in plains on the east and mountains on the west.



Economic Analysis

We are now going to do an economic analysis of the wind resources available in the state of Colorado. To do this we are going to find the Cost in Cents/kWh. We will use the following equation:
Cost (¢/kWh) = (Capital Recovery Cost + O&M) // kWh/year

Costs

Capital Costs include investment that is required for the production of a turbine, preparing the site, transportation, and installing at the site. Since Colorado is utilizing 56,000 GWh of energy annually and 28.08% of it comes from wind, we can assume an annual utilization of 15,700 GWh of wind energy. If we assume a cost of $1,500 for a 1 MW turbine, we can see an annual cost of $23.55 Million Dollars. Calculations are shown in Appendix A. For now we will disregard the O&M costs. For now we will also assume a discount rate of 10%

Cost (Cent//kwh)

To find our kwh per year amount using our known utilization of 15,700 GWh annually and a capacity factor of 34%, we can see in Appendix A that we are utilizing 46.8 Million kWh/year.

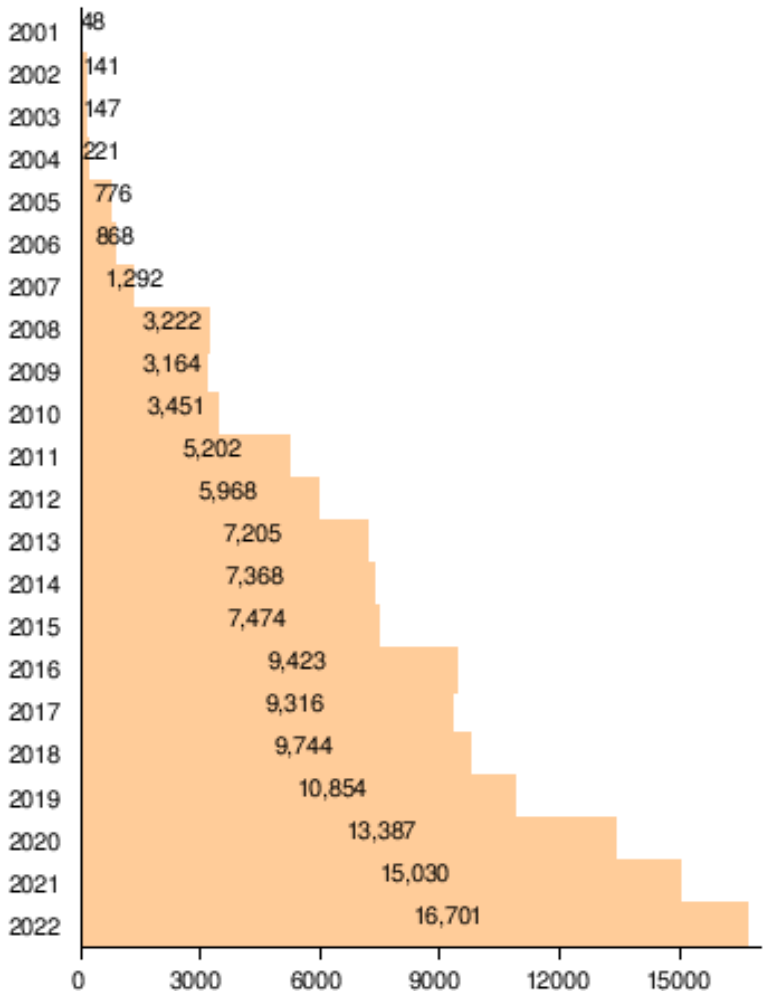
Once plugging that into the denominator of our formula we can see our cost//kwh/year equal $23.55M//46.8M kWh/year which gives us .503 cent/kWh for our cost.

Public Policy

There are several public policy issues that we have to consider in the state of Colorado when it comes to wind energy. The main issues stem from zoning laws in the various counties of Colorado. Every wind farm is subject to environmental impact assessments before and during the development of a wind project. They are required to evaluate their impact on the surrounding ecosystems and landscapes. Every wind producing site must also be assessed on their community impact. The biggest issue with this stems from noise and visual impacts, as well as land use rights

Another policy that Colorado has implemented is its Renewable Portfolio Standards which requires that utilities owned by private investors must ensure that at least 30% of their electricity sales come from renewable resources by 2020. There must be specific carve outs for distribute generation and small-scale renewables.

The state also supports wind energy development through the incentives of state and federal tax credits. Production Tax Credits provide credits per kWh produced by qualified energy resources. Investment Tax Credits offer a percentage base in the investment of renewable energy projects. There are also other state incentives such as rebates and grants provided by the Colorado energy office and local governments. All these economic incentives, especially developed in the last decade, have really boosted Colorado's wind energy sector as shown in the growth below in wind electricity production per year.



Conclusion

As we can clearly see, production and operation of wind turbines is very feasible. High availability of wind resources, a positive economic outlook, and a very supportive public policy program are all factors that play into Colorado's role as a major wind energy production state. The state has committed to increasing renewable energy resources and reducing the reliance on fossil fuels by clearly seeing the benefits of utilizing wind energy as a resource.

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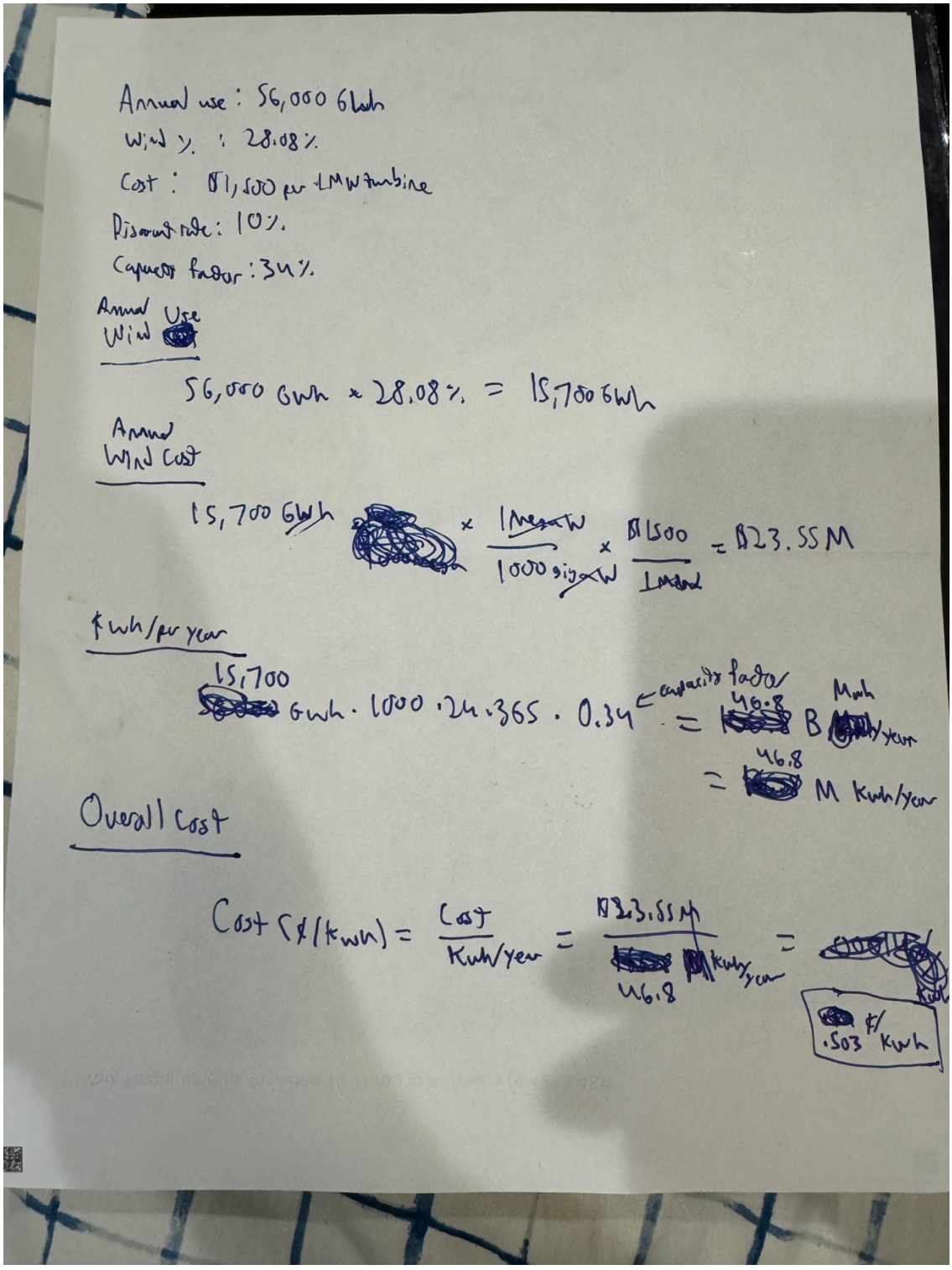
Appendix A


Annual use : 56,000 Gwh
Wind %. : 28.08%
Cost : $1,500 per 1MW turbine
Discount rate: 10%.
Capacity factor: 34%.
Annual Use Wind
56,000 Gwh * 28.08% = 15,700 Gwh
Annual Wind Cost
15,700 Gwh
$1500
= $23.55M
$ wh/per year
15,700
Gwh · 1000 · 24 · 365 · 0.34
capacity factor
46.8
Overall cost
Cost ($/kwh) = Cost / Kwh/year = $23.55M / 46.8 =
$.503 $/Kwh