Renewable Energy Generation within Coconino County

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Introduction

Purpose: To complete a quantitative and qualitative cost benefit analysis of siting renewable energy generation within Coconino County, AZ.

Coconino County has vast renewable energy resources such as sunlight, wind, and biomass. There is great potential and many benefits for Arizona to harness these resources and generate clean power. The renewable energy capstone is a cost benefit analysis of siting renewable energy power generation within the county. The goal is to take into consideration both the base dollar economics of this type of development as well as the net dollar impact from increased social and environmental benefits that could potentially offset the base costs.

This project is important because it addresses the offset costs and indirect benefits that renewable energy could bring to Northern Arizona. Additionally, it helps Arizona achieve the goal of providing 20% of its power from renewable sources by 2020. Some engineering related areas of study were power capacity, water consumption, new technologies, and costs of systems. The team also quantized the economic benefits that a renewable plant would bring to the county. Economic areas that were studied were jobs created, new and increased revenues, reduced air pollution, and preservation of ranch life.

Requirements

The team grouped the requirements for our project into four different groups. This organization helped us to focus on specific areas of our project coherently.

- Renewable Energy Technologies
  - Mechanical Requirements
    - Size of units
    - Efficiency of units
  - Economic Impacts
    - Jobs
    - Taxes
    - Revenues
  - Environmental Effects
    - Emissions
    - Water Use
  - Social Impacts
    - Improved Health
    - Ranchland and Farmland Preservation

Acknowledgements

We say a big thank you to our sponsors; Steve Catanach from APS, CCSEDI, and our faculty advisor, Dr. Elizabeth Brauer, our professor, Dr. David Scott, Dr. Susan Williams from FBC, APS Renewable Energy Team, and the Electrical Engineering Department at NAU.

Analysis

In beginning this analysis, the team started out by researching various renewable energy technologies. In the end, only wind and solar were considered for implementation. Hydroelectric, geothermal, and biomass technologies were eliminated from the study due to their lessened potential for getting developed here. Hydroelectricity and geothermal were eliminated because they are not feasible and biomass was eliminated due to the fact that forest permits are not guaranteed for a long period of time.

Based on the requirements of the project, wind and solar generation offset costs were calculated to bring down the net cost of renewable generation. These net costs for wind and solar were then compared to the net cost of electricity generation from clean coal plants. The net cost for coal was obtained by taking the cost per KWh from Cholla Generating Station and adding in the estimated costs of clean coal technologies.

The offset costs of solar and wind generation were calculated using quantized values from the beneficial externalities in the following areas:

- Water Usage
- CO_2 Emissions
- Other Wastes and Emissions
- Fuel Use
- Jobs Induced

Methods

Three different sizes of plants were studied and a base cost per kilowatt hour was determined for renewable energy generation. The potential sized plants considered were 60MW, 100MW, and 500MW. The analysis of wind and solar was done by comparing their capacities of power production and their socio-environmental, and economic benefits to those from clean coal power plants. Clean coal was chosen as the base case for the study because 91% of Arizona's power and nearly 100% of Coconino County's power comes from coal.

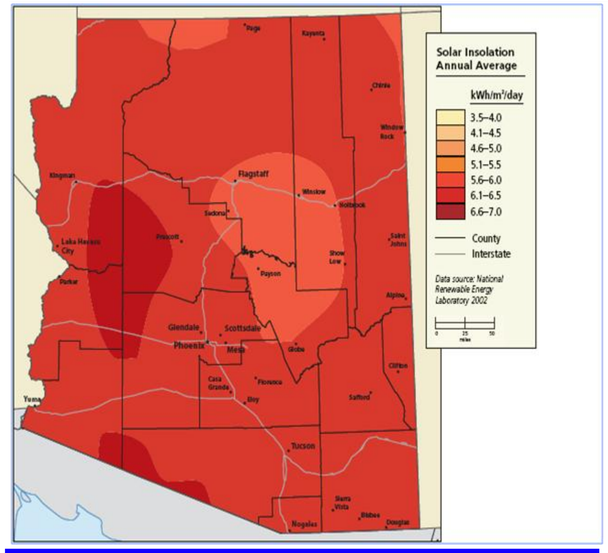
Additionally, as carbon emissions and greenhouse gasses in general become more of a pressing concern, it is likely that clean coal technologies will be implemented on existing coal plants in Arizona such as Cholla and Navajo Generating Stations. Currently renewable energy generation is more expensive than fossil fuel generation. However, with the costs of renewable technologies projected to drop significantly over the next decade, along with the major benefits of reduced water consumption and air pollution, the team will show that Coconino County will benefit greatly by harnessing renewables for power generation.

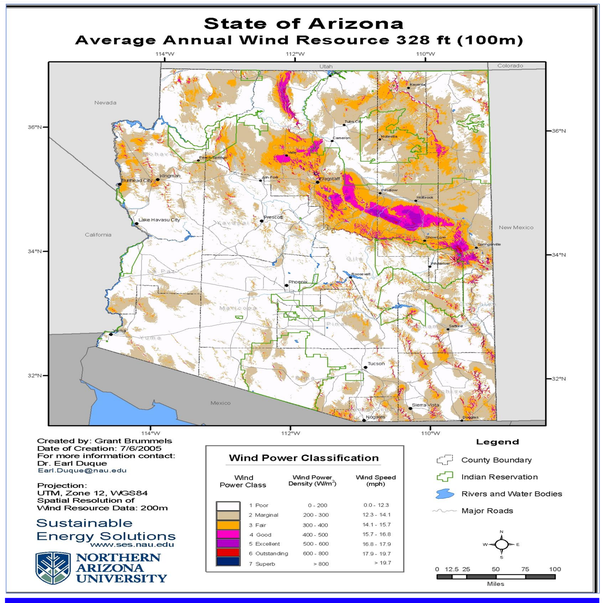
Results

Clean Coal/Wind/Solar Cost Analysis

Clean Coal Reducing Ash and Particulates and Capturing CO_2	Generation MW	Generation Cost $/MWYr	Cost for Generation with Dirty Coal $/Yr	Fuel Usage Tons/Yr	Water Usage Gal/Yr	Coal Cleaning $/Ton	Pressurized Fluidized Bed Combustion Cost $/Yr	CO2 Emissions Tons/Yr	Carbon Capture and Storage $/Yr	Jobs Created Construction and O&M	Jobs Value to County $/yr	Net Adjusted Generation Costs $/Yr	Initial Assumed Cost Cents/kWh	Adjusted Assumed Cost Cents/kWh
	500	$332,880	$166,440,000	1,051,200	6,014,178,000	$21,497,916	$300,000,000	4,432,560	$265,953,600	669	$2,792,830	$751,098,686	3.8	17.1
		Based on $38/MWh[1]		Based on 120 Tons/Hr[5]	Based on 690 Gal/MWh[6]	Based on $4.85/Ton[3]	Based On $600/kW[4]	Based on 920Kg CO2/MWh[2]	Based on $60/Ton Combusted Coal[7]					
Wind	Generation MW	Generation Cost $/MWYr	Total Production Cost $/Yr	Fuel Savings $/Yr	Water Savings $/Yr	Ash and Particulate Reduction Tons/Yr	Avoided Sox Emissions Tons/Yr	Avoided NOx Emissions Tons/Yr	Avoided CO2 Emissions Tons/Yr	Jobs Created Construction and O&M	Jobs Value to County $/yr	Net Adjusted Generation Costs $/Yr	Initial Assumed Cost Cents/kWh	Adjusted Assumed Cost Cents/kWh
	500	$946,080	$473,040,000	$36,014,112	$60,141,780	125,000	34,605	57,294	4,432,560	1,569	$6,550,000	$370,334,108	10.8	8.5
		Based on $108/MWh[8]		Based on $34.26/Ton Coal[9]	Based on $1/100Gal[10]					Based on JEDI[11]	Based on JEDI[11]			
Solar Thermal	Generation MW	Generation Cost $/MWYr	Total Production Cost $/Yr	Fuel Savings $/Yr	Water Savings $/Yr	Ash Reduction Tons/Yr	Avoided Sox Emissions Tons/Yr	Avoided NOx Emissions Tons/Yr	Avoided CO2 Emissions Tons/Yr	Jobs Created Construction and O&M	Jobs Value to County $/yr	Net Adjusted Production Costs $/Yr	Initial Assumed Cost Cents/kWh	Adjusted Assumed Cost Cents/kWh
	500	$1,471,680	$735,840,000	$36,014,112	$0	125,000	34,605	57,294	4,432,560	20,145	$84,097,992	$615,727,896	16.8	14.1
		Based on $168/MWh[8]								Based on SAM[12]	Based on SAM[12]			

1. Cholla Power Plant Average Total Cost of Generation; 2. Controlling Power Plant CO2 Emissions: netl.doe.gov; 3. Energy Citations: osti.gov; 4. PFRC: worldbank.org; 5. Responsibility Report: Pinnacle Corporation; 6. Renewing Arizona's Economy: PIRG Education Fund; 7. CCS: fossil.energy.gov; 8. AZ Renewable Energy Assessment: Black and Veatch; 9. World Price Index, 2007; 10. Residential Water Bill: April, 2008; 11. Jobs and Economic Impact Model: National Renewable Energy Laboratory; 12. Solar Aptitude Model: National Renewable Energy Laboratory





Conclusions

We concluded that renewable energy in Coconino County is a very viable option and integral part of the county's sustainable future. Implementing either type of renewable energy, wind or solar, will have important improvements over coal. Public health will be improved through emissions reduction, there will be minimal contribution to global climate change, ranchland can be preserved, and the county will be able to export excess energy. Wind energy, although cheaper to build, creates less jobs than a solar plant of same power output. Solar is more expensive, but will pay off better in the long-run since Arizona has abundant solar resources.

We also found that further research is needed in areas that are outside the scope of our project. We need to explore the potential of biomass energy generation since this resource is abundant in Northern Arizona. We also need to consider other solar technologies like photovoltaic and dish engine systems. We also recommend that further research into the monetary cost of harmful emissions into the environment be conducted. Potential economic impact of ecotourism from renewable energy also needs to be researched.

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