

Wind Farm Project

For this assignment I have decided to do a cost-benefit analysis on hypothetically building a wind farm in Douglas County in East Central Illinois, which is just south of where I live in Urbana, Illinois. Recently, there have been many wind farms constructed in the area, including the Pioneer Trails Wind Farm consisting of ninety-four wind turbines in nearby Ford and Iroquois Counties as well as the Twin Groves Wind Farm consisting of 240 wind turbines located in McLean County, Illinois. I thought that it would be relatively easy to compare the costs and benefits of wind farms such as these to my hypothetical wind farm, especially since the areas are likely to be very similar geographically and population-wise, so few adjustments would have to be made to the data. While these wind farms are typically large having near or over one hundred turbines, my farm will be a bit more modest in nature and consist of only fifty turbines. They will be of the same type used in the Pioneer Trails Wind Farm, which are expected to have a twenty-five year life span, so I will be looking at a twenty-five year time horizon. Based on completion times for other projects in the area, construction of these turbines should only last about one year so we will estimate that construction of the wind farm will be completed by the end of 2012 so that it can begin producing electricity starting in 2013. We will begin construction of the turbines in early 2012 and so will have that be year one of the project. We will then go out twenty-five years to 2037 to represent the lifespan of our turbines.

The most obvious benefit of this new wind farm would be the electricity it generates in a clean and renewable way. It would also generate benefits for the local economies from all the increased tax revenue it would bring in from the firms operating the wind farm. Constructing the wind farm will also create construction jobs for building the turbines as well as money being given to the owners of the land on which the turbines are built. Costs of the wind farm we will

have to consider include construction and maintenance costs of the wind mills, lost revenue from the farmland which is built over to construct the turbines, and possibly a decrease in value of residential property due to disturbances turbines might cause such as noise and being an eyesore. We will have to see how big these costs are, if they are significant at all. I will try discounting these benefits and costs using two different discount factors, 1 percent and 3 percent, to see if there is any difference.

Benefits

Electricity Production Benefits

Each of our wind turbines will have a nameplate capacity of 1.6 megawatts, which when multiplied by fifty means that our wind farm has an 80 megawatt capacity. Each megawatt has a “fair cash value” of \$360,000, which is based on 2007 figures. A trending figure is then multiplied to this value to account for inflation. In 2011 this factor was 1.09. This factor is based on the CPI, so if we assume that that grows by about 2 percent on average each year, we can then estimate each trending factor as being 0.02 higher than the year before. Once we have then calculated the “trended real property cost basis” for a megawatt, we can then multiply by eighty for the whole farm.

Source: Brumleve, Will. “Assessment Delayed till Start of ’12.” The News Gazette. 26

November 2011

Benefits from Salaries Paid to Workers

The Pioneer Trails Wind Farm with its ninety-four wind turbines were expected to bring in two hundred jobs in constructing the turbines while creating around ten permanent positions for maintenance of these turbines. Here, we will roughly half both of these so that our wind farm will create one hundred jobs during the year it is being built with five permanent jobs in maintaining these wind farms afterward during the twenty-five years in which they are operational. The average construction laborer makes about \$35,000/year so about \$3.5 million will be paid out in salaries to our construction laborers during the year of construction.

Assuming that they will spend their salaries at local businesses, we can apply a multiplier of

about 4 to this, so total benefits from the first year will be about \$14 million from the salaries of the construction laborers. The technicians who maintain the wind farm average a salary of about \$75,000/year so when multiplied by the five technicians and the multiplier of 4, the average annual benefit from their salaries will be \$1.5 million/year, though since this is in the future we will have to discount this.

Sources:

<http://mcec.org/Documents/Wind%20Farm%20Fact%20Sheet.pdf>

<http://windenergy.hubpages.com/hub/wind-farm-jobs>

Benefits Paid to Local Land Owners

For allowing the use of their land for the turbines, local land owners will receive a lease of \$15,000/year/turbine, which seems to be about what other land owners in the area are receiving. Thus, when multiplied by the fifty turbines, local land owners would receive \$750,000/year, or \$3 million/year when the multiplier of 4 is applied.

Source:

<http://www.news-gazette.com/news/agriculture-and-environment/2009-01-27/farmers-get-facts-about-leasing-land-wind-energy-firms.h>

Benefits from Local Taxes

The last major benefit to consider is the benefit which comes from the new local property taxes which will be paid to local governments from the wind farms. The Pioneer Trials Wind Farm is expected to pay \$1.66 million/year in property taxes to local governments using 2009 tax rates. If we half this, then our farm will generate \$830,000/year in local property taxes assuming a 2009 tax rate and that local tax rates in the two areas are roughly the same. (I would not know what to do if we did not assume this.) Local governments will spend this money so we will again have a multiplier of 4. So the average benefits per year from the increases taxes should be about \$3.32 million. Again, this will need to be discounted appropriately.

Source: Source: Brumleve, Will. "Windfall on Way." The News Gazette. 26 November 2011

Costs

Construction Costs

In 2007 the cost for constructing a wind turbine ranged in between \$1.2 million and \$2.6 million per MW of nameplate capacity. Because of inflation, we will go ahead and say that the cost of constructing a turbine for us is going to be on the higher end of that range, say \$2.5 million/MW. Our turbines are rated at 1.6 MW meaning that the construction cost of building a turbine will be \$4 million per turbine. Multiply by 50 means that the whole wind farm will cost \$200 million to construct. Since this will all take place during the first year, we do not have to discount this cost.

Source: <http://www.windustry.org/how-much-do-wind-turbines-cost>

Operations and Maintenance Costs

Operation and maintenance costs include a variety of different costs in making sure that our turbines are in working order, including insurance, regular maintenance and repair, spare parts, and administration. Annual O & M costs are estimated to be between 3 percent and 5 percent of the construction costs of the turbine, though they typically increase with the age of the turbine. So what we will do for our estimates is say that O & M costs for our turbines are 3 percent of construction costs for the first ten years of their lifespan, 4 percent for the next ten years, and 5 percent for the last five. Thus, O & M costs will be \$6 million in each of the first ten years, \$8 million in each of the next ten years, and \$10 million in the last five years, with proper discounting applied as well.

Source: http://ecmweb.com/market_trends/wind-turbine-operation-maintenance-20111101/

Loss of Agriculture

Each of our wind turbines takes up about two acres of land so our wind farm will prevent one hundred acres of land from being used to grow crops each year. In Douglas County, the average value of crops sold per acre harvested is \$261.48. Thus, each year we are losing \$26,148 worth of crops which could be grown on the land which is used to construct our turbines. We will apply 2 percent inflation to each year to account for rising costs and then discount the costs appropriately.

Sources: <http://mcec.org/Documents/Wind%20Farm%20Fact%20Sheet.pdf>

http://www.city-data.com/county/Douglas_County-IL.html

Losses in Housing Value and Aesthetic Value

There have been studies done which show that having a wind farm located nearby does not significantly decrease house prices in the vicinity. However, some residents still might find the wind farm to be an annoyance and may wish to be compensated for not being able to live in an area without turbines. If local residents wish to be compensated for the loss of aesthetic value the wind farm produces, each household should not demand more than about \$20 in compensation annually. Douglas County has 7,596 households in it so that comes to \$151,920 paid out each year.

Sources: <http://www.realtor.org/library/library/fg509>

<http://quickfacts.census.gov/qfd/states/17/17041.html>

Conclusion

From my analysis the benefits of constructing this wind farm would be quite huge as a result of all the clean electricity the wind farm would generate as well the salaries paid in constructing and maintaining it, the leases paid to local farmers, and the taxes generated for local governments. These later 3 are all further increased by the multiplier effect. There are some large costs associated with the wind farm as well, such as the large construction and maintenance costs. There are also some smaller costs as well, such as the loss of agriculture from the land that was used to build this wind farm as well as people being annoyed by the presence of the wind farm, but these costs prove not to be very large in comparison. When total benefits are compared to total costs, we see that the benefits way outweigh the costs at both discount rates, though it is interesting to note that at the higher discount rate the net benefits are smaller though still quite huge. Thus, it seems from my analysis that unambiguously we should proceed with building this wind farm; we will get way more out of it than we will lose.

Benefits from Electricity

Year	Trending Factor	value of MW * trending factor*80	Discount by 1%	Discount by 3%
2012	1.11	no electricity in 2012		
2013	1.13	32544000	32221782.18	31596116.5
2014	1.15	33120000	32467405.16	31218776.51
2015	1.17	33696000	32705005.62	30836613.35
2016	1.19	34272000	32934718.37	30450228.11
2017	1.21	34848000	33156676.28	30060190.92
2018	1.23	35424000	33371010.41	29667042.31
2019	1.25	36000000	33577849.97	29271294.41
2020	1.27	36576000	33777322.35	28873432.15
2021	1.29	37152000	33969553.15	28473914.44
2022	1.31	37728000	34154666.23	28073175.22
2023	1.33	38304000	34332783.68	27671624.58
2024	1.35	38880000	34504025.88	27269649.74
2025	1.37	39456000	34668511.52	26867616.07
2026	1.39	40032000	34826357.6	26465868
2027	1.41	40608000	34977679.47	26064729.96
2028	1.43	41184000	35122590.86	25664507.22
2029	1.45	41760000	35261203.87	25265486.78
2030	1.47	42336000	35393629.01	24867938.11
2031	1.49	42912000	35519975.23	24472113.98
2032	1.51	43488000	35640349.93	24078251.2
2033	1.53	44064000	35754858.95	23686571.29
2034	1.55	44640000	35863606.66	23297281.24
2035	1.57	45216000	35966695.92	22910574.1
2036	1.59	45792000	36064228.11	22526629.65
2037	1.61	46368000	36156303.16	22145615.04
Total Benefits from Electircity			862388789.6	671775240.9

Benefits from Salaries

1st year construction salaries	14000000	14000000
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Permanent Technician Salaries: 1.5 mil/year	Discount by 1%	Discount by 3%
2012		
2013	1485148.515	1456310.68
2014	1470444.074	1413893.864
2015	1455885.222	1372712.489
2016	1441470.517	1332730.572
2017	1427198.531	1293913.177
2018	1413067.853	1256226.385
2019	1399077.082	1219637.267
2020	1385224.834	1184113.851
2021	1371509.736	1149625.099
2022	1357930.432	1116140.872
2023	1344485.576	1083631.915

2024	1331173.838	1052069.82
2025	1317993.899	1021427.01
2026	1304944.454	991676.7087
2027	1292024.212	962792.9211
2028	1279231.893	934750.4088
2029	1266566.231	907524.6688
2030	1254025.971	881091.9114
2031	1241609.873	855429.0402
2032	1229316.706	830513.6313
2033	1217145.253	806323.9139
2034	1205094.31	782838.7513
2035	1193162.683	760037.6226
2036	1181349.191	737900.6045
2037	1169652.664	716408.3539
Total	33034733.55	26119721.54

Benefits to Local Land Owners for Leasing the Land for the Turbines

\$3 million/year	Discount by 1%	Discount by 3%
2012	3000000	3000000
2013	2970297.03	2912621.359
2014	2940888.148	2827787.727
2015	2911770.444	2745424.978
2016	2882941.033	2665461.144
2017	2854397.063	2587826.353
2018	2826135.706	2512452.77
2019	2798154.164	2439274.534
2020	2770449.667	2368227.703
2021	2743019.473	2299250.197
2022	2715860.864	2232281.745
2023	2688971.153	2167263.83
2024	2662347.676	2104139.641
2025	2635987.798	2042854.02
2026	2609888.909	1983353.417
2027	2584048.424	1925585.842
2028	2558463.787	1869500.818
2029	2533132.462	1815049.338
2030	2508051.943	1762183.823
2031	2483219.745	1710858.08
2032	2458633.411	1661027.263
2033	2434290.506	1612647.828
2034	2410188.62	1565677.503
2035	2386325.366	1520075.245
2036	2362698.382	1475801.209
2037	2339305.329	1432816.708
Total	69069467.1	55239443.07

Benefits from Increased Taxes to Local Governments

\$3.32 million/year	Discount by 1%	Discount by 3%
2012	3320000	3320000
2013	3287128.713	3223300.971
2014	3254582.884	3129418.418
2015	3222359.291	3038270.309
2016	3190454.744	2949776.999
2017	3158866.083	2863861.164
2018	3127590.181	2780447.732
2019	3096623.942	2699463.818
2020	3065964.299	2620838.658
2021	3035608.216	2544503.551
2022	3005552.69	2470391.797
2023	2975794.742	2398438.638
2024	2946331.428	2328581.202
2025	2917159.83	2260758.449
2026	2888277.059	2194911.115
2027	2859680.256	2130981.665
2028	2831366.591	2068914.238
2029	2803333.258	2008654.6
2030	2775577.483	1950150.097
2031	2748096.518	1893349.609
2032	2720887.642	1838203.504
2033	2693948.16	1784663.596
2034	2667275.406	1732683.103
2035	2640866.738	1682216.605
2036	2614719.543	1633220.005
2037	2588831.231	1585650.49
Total	76436876.93	61131650.34
Total Benefits	1054929867	828266055.8

Construction Costs

\$200 million in 1st year only

Discount by 1%

200000000

Discount by 3%

200000000

Operations and Maintenance Costs

Year	Cost	Discount by 1%	Discount by 3%
2012	Construction Year - No O & M Costs		
2013	6000000	5940594.059	5825242.718
2014	6000000	5881776.296	5655575.455
2015	6000000	5823540.888	5490849.956
2016	6000000	5765882.067	5330922.287
2017	6000000	5708794.126	5175652.706
2018	6000000	5652271.412	5024905.54
2019	6000000	5596308.328	4878549.068
2020	6000000	5540899.335	4736455.406
2021	6000000	5486038.945	4598500.394
2022	6000000	5431721.728	4464563.489
2023	8000000	7170589.74	5779370.213
2024	8000000	7099593.802	5611039.042
2025	8000000	7029300.794	5447610.72
2026	8000000	6959703.757	5288942.447
2027	8000000	6890795.799	5134895.579
2028	8000000	6822570.098	4985335.514
2029	8000000	6755019.899	4840131.567
2030	8000000	6688138.514	4699156.861
2031	8000000	6621919.32	4562288.214
2032	8000000	6556355.763	4429406.033
2033	10000000	8114301.687	5375492.759
2034	10000000	8033962.066	5218925.009
2035	10000000	7954417.887	5066917.484
2036	10000000	7875661.274	4919337.363
2037	10000000	7797684.43	4776055.693
Total		165197842	127316121.5

Losses to Agriculture

Year	Inflated Cost	Discount by 1%	Discount by 3%
2012	26148	26148	26148
2013	26670.96	26406.89109	25894.13592
2014	27204.38	26668.34546	25642.73654
2015	27748.47	26932.38848	25393.77794
2016	28303.44	27199.04579	25147.2364
2017	28869.5	27468.34328	24903.08848
2018	29446.89	27740.30707	24661.31092
2019	30035.83	28014.96358	24421.88072
2020	30636.55	28292.33945	24184.77508
2021	31249.28	28572.46163	23949.97144
2022	31874.27	28855.35729	23717.44744
2023	32511.75	29141.05389	23487.18096

2024	33161.99	29429.57918	23259.15008
2025	33825.23	29720.96115	23033.33309
2026	34501.73	30015.22809	22809.7085
2027	35191.77	30312.40857	22588.25501
2028	35895.6	30612.53143	22368.95157
2029	36613.51	30915.6258	22151.77728
2030	37345.78	31221.7211	21936.71148
2031	38092.7	31530.84705	21723.7337
2032	38854.55	31843.03366	21512.82366
2033	39631.64	32158.31122	21303.9613
2034	40424.28	32476.71034	21097.12672
2035	41232.76	32798.26193	20892.30025
2036	42057.42	33122.99719	20689.46238
2037	42898.57	33450.94766	20488.59382
Total		771048.6614	603407.4307

Aesthetic Losses

\$151920/year	Discount at 1%	Discount at 3%
2012	151920	151920
2013	150415.8416	147495.1456
2014	148926.5758	143199.1705
2015	147452.0553	139028.3209
2016	145992.1339	134978.9523
2017	144546.6673	131047.5265
2018	143115.5121	127230.6083
2019	141698.5269	123524.8624
2020	140295.5712	119927.0509
2021	138906.5061	116434.03
2022	137531.1942	113042.7476
2023	136169.4992	109750.2403
2024	134821.2863	106553.6314
2025	133486.4221	103450.1276
2026	132164.7743	100437.0171
2027	130856.2122	97511.66705
2028	129560.6062	94671.52141
2029	128277.8279	91914.09845
2030	127007.7504	89236.98879
2031	125750.2479	86637.85319
2032	124505.1959	84114.42058
2033	123272.4712	81664.486
2034	122051.9517	79285.90873
2035	120843.5165	76976.61042
2036	119647.0461	74734.57322
2037	118462.4219	72557.83808
Total	3497677.814	2797325.397
Total Costs	369466568.5	330716854.3

	Discount at 1%	Discount at 3%
Total Benefits	1054929867	828266055.8
Total Costs	369466568.5	330716854.3
Net Benefits	685463298.7	497549201.5
Should we do it?	Yes	Yes