Benefit Cost Analysis for the Application of PV Solar in Missouri

The Effect of Proposition C on the Economics of Power Production

James M. Holtzman

MBA Graduate Student, Marylhurst University

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Abstract

This study begins with an overview of renewable legislation in the state of Missouri over the past three years and then takes a close look at Proposition C (Appendix B), a new state law passed by referendum in November of 2008, which requires that 15% of all electrical power generated in the state of Missouri be supplied from renewable sources. Acting as a Renewable Energy Standard (RES) for the state the law also requires that 2% of the total be from solar sources. This study attempts to weigh the costs and benefits of this decision in terms of electricity production and savings accrued, emissions forestalled and assigned market values as well as total costs of systems installation required to meet the goal. The potential for payback over the warranted life of the Photovoltaic (PV) panels , twenty-five years, is used as a yardstick/timeframe in comparison to benefits and system costs.

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The ultimate renewable resource on the planet is solar energy. From it we obtain our light, warmth, and sustenance. In past cultures the sun was worshiped as a god in societies as diverse as ancient Egypt and Rome, the Aztecs, Hindus, and within Indonesian mythologies. (Wikipedia, 2010). The sun as the source of life on earth clearly deserves and holds a special place in our collective psyche. Consequently, the policies which societies formulate and the way we describe and mythologize our relationship to our closest star must be a central focus in any discussion relating to the creation of sustainable culture.

Government actions and policy relating to the advancement of renewable energy production in the state of Missouri began in 2007 with the passage of a net metering bill otherwise known as the Easy Connection Act (ECA). Scheduled to go into effect October 1, 2008 the law uses a regulatory approach requiring all *electric regulated utilities, municipal and rural electric cooperatives* (addressee's) in the state to allow for an interconnection to the main electrical grid by any/all *renewable energy* systems as well as requiring all excess power produced by these systems be purchased back by the utility at the same retail pricing structure that is currently in force for that customer. The ECA was the first step in making renewable energy cost effective in Missouri.

In November of 2008 an initiative named Proposition C was passed by a 66% margin after being defeated twice in legislative sessions previously making Missouri the 27'th state to adapt a renewable electricity Standard (RES). "Prop C requires all investor-owned utilities to get at least 15% of their total electricity from "clean" energy sources by 2021, 2% of which must come from solar." (Renew Missouri, 2010). Proposition C is therefore a *regulatory instrument* in that it requires all investor owned utilities to produce a minimum threshold of all electricity produced by defined renewable methods and if these standards are not met, "Penalties of at least twice the

average market value of renewable energy credits for the compliance period for failure to meet the targets" (Appendix B) will be assessed. The target of this instrument is electrical generation and the reduction of fossil fuel emissions. The language of Proposition C also allows for flexibility and incentive based behavior in meeting the regulations: "A utility may comply with the standard in whole or in part by purchasing renewable energy credits (RECs). Each kilowatt-hour of eligible energy generated in Missouri shall count as 1.25 kilowatt-hours for purposes of compliance." (Appendix B)

Another portion of Proposition C acts as a subsidy instrument in that is targets all investor owned utilities to offer a $2 per installed KW rebate on all new and/or existing expanded systems installed from 2010 on. Recipients of this subsidy become every new owner of a solar PV system including businesses, individuals, and any other organizational entity that uses electric power from the grid. The proposition also has a built-in flexibility that allows for the subsidies to cover either wind, biomass, solar, or small scale hydro production. In this way the economics of place, budget, and preference are given an appropriate and considered weight.

The primary motivation behind this policy is based upon emissions and pollution control for the benefit of society at large. Clean air is a necessity for the health and well being of us all and the current prevalence of the discussion on global warming only exacerbates the issue. Any movement towards the passage of a carbon cap and a federally institutionalized carbon trading policy will also add *fuel to the fire*. The subsidy instrument on PV installations targets emissions by the polluter , is addressed to the utility industry, and has a regulation area defined by the state boundaries of Missouri. Business (heavy coal and fossil fuel generation) as usual would continue without the effort that this law puts forth. Missouri is the #14th highest Carbon Dioxide polluting state in the country where coal is consumed for 82% of current total power production. (Ameren UE, 2009)

Without a program such as this an additional 1,663,199 metric tons of CO2 alone would be spewed into the air based upon the accounting from the 2% solar component alone. (See BCA spreadsheet assumptions). Economic effects as a result of the achievement of Proposition C's goals according to an Economic Impact Study performed by The Missouri Coalition for the Environment include a total estimated impact to the Missouri economy in the creation of 22,400 new jobs which would generate up to 1.76 Billion in new gross income and produce additional asset and capitol equity valued at 4.57 Billion statewide.

The fairness quotient to be considered within this policy effort is one that is most certainly broad based and egalitarian. Projects are awarded on the ability to purchase and install a PV system. This does create as a matter of course an economic bias towards folks who are able to afford to install these systems, on the other hand the policy is far from a give away to big business in that the decentralized nature of smaller PV installations tends to democratize and decentralize an energy industry that has, for far too long held an essential monopoly on the politics of energy and power in this state and country. Additionally, the energy independence gained by every successful solar installation, is indeed priceless.

Let us now consider the ramifications of such issues as moral considerations, long term risk assessment, and political acceptability. Arguing the morality of clean energy production is an easy issue to debate when we base our logic upon the welfare of all future generations, the health and well being of current populations, and on upon the health and vitality of earths' dynamic and diverse ecosystems of which we form just a tiny part. Surely a short term investment that creates a payback over twenty-five years of over 2.6 billion dollars that also entails such strong obvious public benefit is one that has to be considered worth its salt and a small price to pay for such a return.

Analyzing the long term risk assessment for PV panels with a built-in manufacturers' warrantee of 25 years, for a product with virtually no moving parts and with a life expectancy of considerably longer, is also obviously something of a *no-brainer* given a benefit-cost ratio of 6.71 over a 25 year term investment (See BCA spreadsheet). Additional, I believe the case can be made that we can depend upon the sun shining for the foreseeable future… and givens Missouri's' average *insolation* factor of almost 5 hours of sun per day over the year, we are in a perfect position to take advantage of natures abundance today. Let it also be noted that Germany, a country that ranks among the top square feet of installed PV's in the world has an *insolation* factor less than Seattle, WA.

It is hard to argue against the politics of free energy. According to a study by Researchers at the Department of Energy's Lawrence Berkeley National Laboratory if was found "that average installed costs, in terms of real 2007 dollars per installed watt, declined from $10.50 per watt in 1998 to $7.60 per watt in 2007, equivalent to an average annual reduction of 30 cents per watt or 3.5 percent per year in real dollars." (ScienceDaily, 2009) The discussion brings together such diverse voices together as Sarah Palin "As governor of Alaska in Jan. 2009, Sarah Palin announced a statewide energy plan that called for 50% of Alaska's power to be generated by renewable resources by 2025." (Conservapedia, 2010) and progressive author, Thomas Friedman "Simply put, the green revolution will be the biggest single peacetime project humankind will have ever undertaken." (Friedman, 2008). One might even go as far as to say that since Missouri is only the second state in the US to pass a RES law through referendum that the politics of the day have created a mandate with a passage of over 75% of the vote statewide on the heals of numerous failures through the legislature.

In estimating the social costs and benefits of the solar portion of the regulatory requirements of Proposition C I have made the following basic assumptions:

- Total benefits accruing from the 2% solar renewable generation mandate shall produce savings in both costs of energy not purchased from the grid and emissions not produced as a result of the electricity savings. These emission savings have been given weighted values based upon information from the Green Exchange (2009).
- Total costs accruing from the 2% solar renewable generation mandate are based upon an assumed average cost of installation of $7.60 per kW and a $6.67 per installed kW O & M annual cost over the life of the 25 year PV system panel warrantee. This number is less than what is recommended for large scale centralized solar power generation facilities but more than what is recommended for small scale O&M (less than 10kW) installations. (See Appendix A)
- A discount rate of 4% for net present value calculations on both cost and benefits over the 25 year analysis timeframe which corresponds to the manufacturer's warrantee life of the PV panels.

A final summary of the above cost and benefit comparisons can be ascertained by a close look at the total net benefits of the policy, totaling $2,642,825,808 and at a 6.71 benefit-cost ratio. Anyone realistically looking at these numbers must draw a positive conclusion as to the long term viability of such a program. In addition to creating new work for a significantly underemployed population, the long term creation of capital in the form of PV installations on the ground cannot be too highly touted. For years governments have been subsidizing the extraction and burning of fossil fuels and other sources of electrical generation. Proposition C allows for a small payback and pay down to both our existing infrastructure and job market as well as to generations to come.

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Appendix A:

Table 3.1.6-2 2005 Benchmarked Parameters, 2011 and 2020 Projections for Modeling of 4-kW Residential Reference System

System Element	Units	2005	2011	2020
System Location		Phoenix		
System Size	kW	4	4.56	5.92
Module Price	$/Wdc	4.00	2.20	1.25
Conversion efficiency	%	13.5	16	20
Module size	Wpdc	100	118.5	148
Inverter Price	$/Wac	0.90	0.69	0.30
Inverter size	kW	4	4.74	5.92
DC-AC conversion efficiency	%	90	96	97
Inverter life/replacement	Years	5	10	20
Other BOS	$/Wdc	0.61	0.40	0.33
Installation	$/Wdc	1.66	0.57	0.42
Other/Indirect*	$/Wdc	1.30	1.14	1.00
INSTALLED SYSTEM PRICE	$/Wdc	8.47	5.00	3.30
Lifetime	Years	30	35	35
Degradation	%/Yr	1	1	1
System derate	%	5	5	5
O&M Cost (not including inverter replacement)	% installed price	0.5	0.3	0.2
LEVELIZED COST OF ENERGY (LCOE)	$/kWhac	0.32	0.15	0.09

*For this and other tables presented below, the "Other/Indirect" category includes design, engineering, site-related costs, permitting, and profit.

2005 benchmark cost and performance values contained here are from detailed data on more than 200 residential PV systems installed between 2000 and 2005, with emphasis on those more recently installed; Web-based price information on more than 5000 installations in 2004 and 2005; and laboratory-based measurements and modeling. Out-year projections are based on the PV industry roadmap, earlier versions of this Multi-Year Plan, and input from engineers and scientists in the DOE Solar Program and in industry.

Proposition C - the Missouri Clean Energy Initiative

Official Ballot Language Explained

Be it enacted by the people of the state of Missouri:

Chapter 393, RSMo, is amended by repealing sections 393.1020, 393.1025, 393.1030, and 393.1035, and substituting therefor three new sections to be known as sections 393.1020, 393.1025 and 393.1030, to read as follows:

393.1020. Sections 393.1025 to 393.1030 shall be known as the Renewable Energy Standard.

393.1025. As used in sections 393.1020 to 393.1030, the following terms mean:

1. "Commission", the public service commission;
2. "Department", the department of natural resources;
3. "Electric utility", any electrical corporation as defined by section 386.020;
4. "Renewable energy resources", electric energy produced from wind, solar thermal sources, photovoltaic cells and panels, dedicated crops grown for energy production, cellulosic agricultural residues, plant residues, methane from landfills or from wastewater treatment, clean and untreated wood such as pallets, hydropower (not including pumped storage) that does not require a new diversion or impoundment of water and that has a nameplate rating of 10 megawatts or less, fuel cells using hydrogen produced by one of the above-named renewable energy sources, and other sources of energy not including nuclear that become available after the effective date of this section and are certified as renewable by rule by the department; and
5. "Renewable energy credit" or "REC", a tradable certificate of proof that one megawatt-hour of electricity has been generated from renewable energy sources.

393.1030.1. The commission shall, in consultation with the department, prescribe by rule a portfolio requirement for all electric utilities to generate or purchase electricity generated from renewable energy resources. Such portfolio requirement shall provide that electricity from renewable energy resources shall constitute the following portions of each electric utility's sales:

(a) No less than two percent for calendar years 2011 through 2013;
(b) No less than five percent for calendar years 2014 through 2017;
(c) No less than ten percent for calendar years 2018 through 2020; and
(d) No less than fifteen percent in each calendar year beginning in 2021.

At least two percent of each portfolio requirement shall be derived from solar energy. The portfolio requirements shall apply to all power sold to Missouri consumers whether such power is self-generated or purchased from another source in or outside of this state. A utility may comply with the standard in whole or in part by purchasing RECs. Each kilowatt-hour of eligible energy generated in Missouri shall count as 1.25 kilowatt-hours for purposes of compliance.

This repeals Missouri's existing "voluntary renewable energy standard" which are widely recognized as meaningless, as they have no incentives for compliance or penalties for non-compliance.

This means Investor-Owned Utilities, which control 76% of electricity generation, and include Kansas City Power & Light, Aquila, Empire, and AmerenUE.

This means only SMALL hydro-electric dams (typically sized dams are 200-300 megawatts).

This is called a "solar carve-out"; it's what is necessary to ensure the development of solar, secure a market in Missouri, and drive down the cost.

This effectively helps encourages in-state development of renewables, but allows utilities to comply developing renewables elsewhere as well.

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2. The commission, in consultation with the department and within one year of the effective date of sections 393.1020 to 393.1030, shall select a program for tracking and verifying the trading of renewable energy credits. An unused credit may exist for up to three years from the date of its creation. A credit may be used only once to comply with this act and may not also be used to satisfy any similar non-federal requirement. An electric utility may not use a credit derived from a green pricing program. Certificates from net-metered sources shall initially be owned by the customer-generator. The commission,
except where the department is specified, shall make whatever rules are necessary to enforce the Renewable Energy Standard. Such rules shall include:

(a) A maximum average retail rate increase of one percent determined by estimating and comparing the electric utility's cost of compliance with least-cost renewable generation and the cost of continuing to generate or purchase electricity from entirely non-renewable sources, taking into proper account future environmental regulatory risk including the risk of greenhouse gas regulation;

This policy will KEEP ELECTRIC RATES LOW, and keep them EVEN LOWER over time; however, if they ever make rates go up, they can't be more than 1% higher than they would have been without this policy in place.

(b) Penalties of at least twice the average market value of renewable energy credits for the compliance period for failure to meet the targets of subsection 1. An electric utility will be excused if it proves to the commission that failure was due to events beyond its reasonable control that could not have been reasonably mitigated, or that the maximum average retail rate increase has been reached. Penalties shall not be recovered from customers. Amounts forfeited under this section shall be remitted to the department to purchase renewable energy credits needed for compliance. Any excess forfeited
revenues shall be used by the department's energy center solely for renewable energy and energy efficiency projects;

Utilities must comply with the RES targets; if not, they're fined.

(c) Provisions for an annual report to be filed by each electric utility in a format sufficient to document its progress in meeting the targets.

(d) Provision for recovery outside the context of a regular rate case of prudently incurred costs and the pass-through of benefits to customers of any savings achieved by an electrical corporation in meeting the requirements of this section.

3. Each electric utility shall make available to its retail customers a standard rebate offer of at least $2.00 per installed watt for new or expanded solar electric systems sited on customers' premises, up to a maximum of 25 kilowatts per system, that become operational after 2009.

This rebate program will effectively lower the cost of solar by 20% or more.

4. The department shall, in consultation with the commission, establish by rule a certification process for electricity generated from renewable resources and used to fulfill the requirements of subsection 1 of this section. Certification criteria for renewable energy generation shall be determined by factors that include fuel type, technology, and the environmental impacts of the generating facility. Renewable energy facilities shall not cause undue adverse air, water, or land use impacts, including impacts associated with the gathering of generation feedstocks. If any amount of fossil fuel is used with renewable energy resources, only the portion of electrical output attributable to renewable energy resources shall be used to fulfill the portfolio requirements.

Assumptions, Givens, and Totals: BCA Analysis on Missouri Proposition C by James M. Holtzman:

Assumptions			**Justification/Data/Source**
Base Year	2010		
Time Horizon	2035	25 years	Average PV Panel Warranty Period
Discount Rate	0.04		Approximately 1% Higher Than the Current Average Rate of Inflation
Average Cost of Electricity Per Resident (No Increase for Inflation)	0.0688	$ Per kWh	U.S. Energy Information Administration (DOE)
Total Electrical Usage in Missouri in 2010	91,000,000	mWh	Total State Electricity Generation in 2010 (2.8% Per Year))
Percentage of Total Electrical Output by Investor Owned Utilites as Defined by Proposition C	0.75	75%	Language Taken from "Proposition C"
Estimated Electical Usage and Emissions Increase Per Year Over 25 Years	0.0225	Annually @ 2.25%	Estimate
Average Annual Total Capacity of Solar Generation in Missouri Over 25 Year	60	mW	Missouri Economic Impact Study of Proposition C ((2% of Total (3,000 mW) Over 25 Years)
Average Annual Total of Solar Generation in Missouri Over 25 Years	1,820,000	mWh	National Resources Defense Council (2% of Total Over 25 Years)
Operation and Maintenance Costs	6.67	$/kW	Interpolation from Assumptions based on Annual Energy Outlook 2009 (DOE) and Local Install Knowledge w/ CPD
Installed Costs of Total PV System	7,600	$ Per Installed kW (AC)	Clean Power Design (CPD) Proposal (Local St. Louis, MO. Design & Install Company)
Solar energy mWh	1000	kWh	Conversion Factor

Calculations:

GHG Emissions Saved in the First Year (2010) From Solar Generation:

CO_2	75,599,966(from EIA Chart) x 1.1%(increase from 2008 to 2010) x 2%(amount of solar)	1,663,199	Metric Tons (MT)	45 Per MT	$56,132,975	Interpolated from U.S. Energy Information Administration Data
NO_x	81,316(from EIA Chart) x 1.1%(increase from 2008 to 2010) x 2%(amount of solar)	1,789	Metric Tons (MT)	600 Per MT	$805,028	Interpolated from U.S. Energy Information Administration Data
SO_x	239,474(from EIA Chart) x 1.1%(increase from 2008 to 2010) x 2%(amount of solar)	5,268	Metric Tons (MT)	71.75 Per MT	$283,507	Interpolated from U.S. Energy Information Administration Data
				Total:	**$57,221,510**	

Annual Benefits

Retail Cash Value of Annual Solar Production		93,912,000
Cash Value of Annual Emissions Benefits		$57,221,510
	Total:	**$151,133,510**

Costs

Cost of Installation (Complete Installation Assumed First Year)	456,000,000
Annual O & M Costs	$400,200

Benefit-Cost Ratio: **6.71**
Net Benefits: **$2,642,825,808**

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	Benefits			Costs				
Year	GHG	Electricity Generated	**Total Benefits**	Installation Costs	O & M Costs	**Total Costs**	Discounted Benefits	Discounted Costs
2010	$57,221,510	$93,912,000	$151,133,510	$456,000,000	$400,200	$456,400,200	$151,133,510	$456,400,200
2011	$58,508,994	$96,025,020	$154,534,014		$400,200	$400,200	$148,590,398	$384,808
2012	$59,825,447	$98,185,583	$158,011,030		$400,200	$400,200	$146,090,079	$370,007
2013	$61,171,519	$100,394,759	$161,566,278		$400,200	$400,200	$143,631,833	$355,776
2014	$62,547,879	$102,653,641	$165,201,519		$400,200	$400,200	$141,214,951	$342,093
2015	$63,955,206	$104,963,348	$168,918,553		$400,200	$400,200	$138,838,738	$328,935
2016	$65,394,198	$107,325,023	$172,719,221		$400,200	$400,200	$136,502,509	$316,284
2017	$66,865,567	$109,739,836	$176,605,403		$400,200	$400,200	$134,205,592	$304,119
2018	$68,370,043	$112,208,982	$180,579,025		$400,200	$400,200	$131,947,325	$292,422
2019	$69,908,369	$114,733,684	$184,642,053		$400,200	$400,200	$129,727,057	$281,175
2020	$71,481,307	$117,315,192	$188,796,499		$400,200	$400,200	$127,544,150	$270,361
2021	$73,089,636	$119,954,784	$193,044,420		$400,200	$400,200	$125,397,974	$259,962
2022	$74,734,153	$122,653,767	$197,387,920		$400,200	$400,200	$123,287,912	$249,964
2023	$76,415,672	$125,413,476	$201,829,148		$400,200	$400,200	$121,213,356	$240,350
2024	$78,135,024	$128,235,280	$206,370,304		$400,200	$400,200	$119,173,708	$231,106
2025	$79,893,062	$131,120,573	$211,013,636		$400,200	$400,200	$117,168,381	$222,217
2026	$81,690,656	$134,070,786	$215,761,442		$400,200	$400,200	$115,196,798	$213,670
2027	$83,528,696	$137,087,379	$220,616,075		$400,200	$400,200	$113,258,390	$205,452
2028	$85,408,092	$140,171,845	$225,579,937		$400,200	$400,200	$111,352,600	$197,550
2029	$87,329,774	$143,325,712	$230,655,485		$400,200	$400,200	$109,478,879	$189,952
2030	$89,294,694	$146,550,540	$235,845,234		$400,200	$400,200	$107,636,686	$182,646
2031	$91,303,824	$149,847,927	$241,151,751		$400,200	$400,200	$105,825,492	$175,621
2032	$93,358,160	$153,219,506	$246,577,666		$400,200	$400,200	$104,044,774	$168,867
2033	$95,458,719	$156,666,944	$252,125,663		$400,200	$400,200	$102,294,021	$162,372
2034	$97,606,540	$160,191,951	$257,798,491		$400,200	$400,200	$100,572,727	$156,127
Totals:	**$1,892,496,740**	**$3,105,967,537**	**$4,998,464,277**	**$456,000,000**	**$10,005,000**	**$466,005,000**	**$3,105,327,842**	**$462,502,035**