The Impact and Cost-Effectiveness of the Missouri Solar Rebate

by Erin Noble

April 27, 2012

Masters project proposal submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University

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ABSTRACT

Missouri receives more than 80% of its electricity from coal – more than two times the national average. Nearly all coal burned in Missouri power plants is imported from states such as Wyoming causing a $1.1 billion drain on Missouri's economy.

Historically, Missouri has been slow to expand the use of renewable energy. In 2005, Missouri received less than .01% of its electricity from renewables and ranked 49th in the country on renewable energy usage.

In an attempt to increase the in-state development of renewable energy, Missouri advocates worked to pass a renewable electricity standard and solar rebate through a voter enacted initiative in 2008. In its first two years, the Missouri solar rebate created a 3400% increase in the amount of solar photovoltaic (PV) installed in Ameren and Kansas City Power and Light's service territory. In those utility territories, PV capacity grew from 38 installations totaling 100 kilowatts in 2009 to 474 installs totaling 3500 kilowatts (3.5 megawatts) in 2011.

The purpose of this report is to analyze the impact and cost-effectiveness of the Missouri solar rebate. The report also quantifies the clean air and economic benefits of the Missouri solar rebate with the goal of helping citizens and policymakers make informed decisions about the future of solar energy in Missouri.

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INTRODUCTION

A large amount of Missouri dollars are spent importing energy resources from other states. For example, over 90% of the coal used in Missouri is transported via railcar from Wyoming (U.S. EIA 2011). Missouri receives more than 80% of its electricity from coal and is nearly two times more reliant on coal for electricity than the national average. Historically, Missouri has been slow to expand the use of renewable energy. In 2005, Missouri received less than .01% of its electricity from renewable energy and ranked 49th in the country on renewable energy usage (U.S. EIA 2005).

To help Missouri play catch up in its deployment of in-state renewable energy, Missouri renewable energy advocates in 2007 encouraged state lawmakers to pass a statewide law requiring all Missouri utilities to offer simple interconnection and true net metering for customer-sited renewable energy systems (Missouri Revised Statutes - Section 286.890). This law known as the “Easy Connection Act” makes it easier and more cost effective for Missourians to install distributed wind and solar generation systems.

In 2008, advocates next worked to pass a renewable electricity standard and solar rebate through a voter enacted initiative called Proposition C – The Missouri Clean Energy Initiative. One goal of the law was to encourage the usage of renewable energy in Missouri to help alleviate the reliance on out-of-state resources for electricity and create economic development in Missouri.

Prop C passed in November 2008 with two-thirds of the statewide vote. The law is a 15% by 2021 renewable electricity standard (RES) and a $2 per watt solar rebate. Since its passage, the Initiative has been subjected to a 19-month marathon rulemaking in the Public Service Commission, legal challenges, and rollbacks by the Missouri General Assembly (DSIRE - Missouri Renewable Electricity Standard).

Amidst Prop C’s continued political struggles, the solar rebate has remained the success story of the Initiative. In its first two years (2009-2011), the solar rebate created a 3400% increase in the amount of solar photovoltaic (PV) capacity installed in Ameren and Kansas City Power and Light’s service territory. The amount of PV installed grew from 100 kilowatts (kW) in 2009 to 474 installs totaling 3500 kW in 2011.

The purpose of this report is to analyze the impact and cost-effectiveness of the Missouri solar rebate with the goal of helping citizens and policymakers make informed decisions about the future of solar energy in Missouri.

OBJECTIVES

To determine the impact and cost-effectiveness of the Missouri solar rebate, I will:

1) examine how the solar rebate has impacted the expansion of solar in Missouri, both in the number of Missouri solar installations and the overall amount of installed solar capacity. I will compare Missouri solar deployment to Nebraska and Kentucky, which have similar electricity portfolios, but do not have a solar incentive program.

2) explore the cost-effectiveness of the solar rebate in comparison to utility expenditures on other forms of new energy generation such as natural gas, coal, wind, and nuclear power.

3) determine the impact the Missouri solar rebate has had and will have on emissions, public health, and the local economy.

OVERVIEW OF THE U.S. & MISSOURI ELECTRICITY PORTFOLIO

In 2010 the United States received 45% of its electricity from coal, 24% from natural gas, 20% from nuclear, and 4% from renewable sources like wind, solar, and biomass (U.S. EIA Electric Power Monthly 2012). Solar PV represents less than 1% of the total U.S. electricity generation and powers nearly one million U.S. homes.

The United States ranks fifth in the world of total installed capacity. The U.S. has only 6% of the total PV capacity trailing Germany (44%), Spain (10%), Japan (9%), and Italy (9%) (Ren 21).

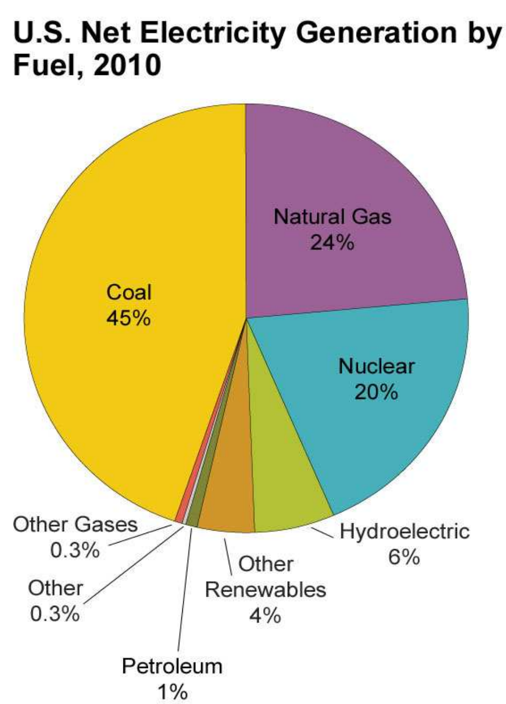

Figure 1. U.S Net Electricity Generation by Fuel, 2010
Source: U.S EIA Electric Power Monthly 2012

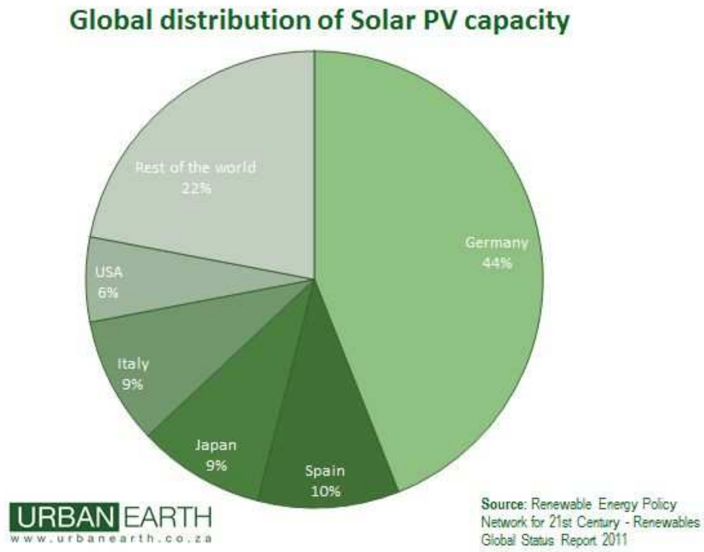

Figure 2. Global Distribution of Solar PV Capacity
Source: Renewables 2011 – Renewables Global Status Report 2011

The amount of solar is growing quickly. Solar PV capacity more than doubled in 2010 and again in 2011, and the solar industry is the fastest growing industry in America for those same years (SEIA/GTM Research- U.S. Solar Market Insight: Year-in-Review 2011).

Though solar is still a small percentage of the U.S portfolio, efforts are underway to reach widespread deployment of solar. The Department of Energy SunShot Initiative is supporting efforts by private companies, academia, and national laboratories to drive down the cost of solar electricity to $0.06 per kilowatt-hour. The goal of the SunShot is for solar-generated power to account for 14% of America's electricity generation by 2030 and 27% by 2050, and the initiative is on track to reach that goal (DOE SunShot Initiative).

The use of natural gas for electricity is increasing in the United States as well. Since the early 2000s, advancements in natural gas hydraulic fracturing or “fracking”, has resulted in a surge in domestic availability of natural gas, and the expansion has resulted in a dramatic drop in its price. The use of natural gas in the U.S. expanded from 18% of the overall production in 2005 to 24% in 2010 (U.S. EIA Annual Fuel Outlook 2005 & 2010).

As the use of natural gas and renewables are expanding, the nation’s usage of coal is shrinking. Coal-fired electricity generation has shifted from 50% of the U.S. portfolio in 2005 to 45% in 2010 (US EIA Annual Energy Outlook 2005, US EIA Annual Energy Outlook 2010). The closure of old and inefficient coal-fired plants in response to implementation of new EPA anti-pollution rules is likely to accelerate this trend in coming years.

The natural gas industry expected to drill more than 10,000 new wells in the U.S in the next few years. The expansion has caused residents concern about the possibility of explosions, microseismic activity, and possible methane and fracking fluid contamination in drinking water (Osborn, Vengosh, Warner, and Jackson 2011).

A Duke University study, the first peer-reviewed study on the negative externalities of fracking, found levels of methane 17 times higher in groundwater near drilling wells (Osborn, Vengosh, Warner, and Jackson 2011). Levels were often so high that homeowners can light their tap water on fire. The same study, however, did not find evidence that ground water was contaminated by the chemical-laden fracking fluid or the high-saline wastewater. The authors of the study call for additional research to fully understand the health and environmental effects of the technology (Osborn, Vengosh, Warner, and Jackson 2011).

Over the long term, electricity demand growth has slowed progressively in each decade since the 1950s. Annual demand grew by 10% in the 1950s, 2.4% per year in the 1990s, and 0.9% per year from 2000 to 2008. Efficiency gains are a result of new appliance efficiency standards and investment in energy-efficient equipment, but now these gains are being threatened by a growing demand for personal electrical devices. Total electricity demand is expected to increase by 1% annually through 2035 (U.S. EIA 2010 Annual Energy Outlook 2010).

POLICY DEFINITIONS

RENEWABLE ELECTRICITY STANDARD

The renewable electricity standard (RES) has emerged as one of the most popular tools to foster the development of renewable energy and move away from heavily polluting fossil fuels. An RES requires a utility to obtain a certain percentage of its electricity from renewable energy by a certain year letting the market determine how the utility will meet its renewable targets. Today more than 29 U.S. states and 10 countries such as China, India, and the United Kingdom have an RES (Wiser 2010).

No two RES policies are the same. The variability in design has allowed each state to set its own targets, incentives, cost-caps, and compliance mechanisms according to its particular energy portfolio, supply of renewable resources, and market structure (Wiser 2010).

A major goal of an RES is to diversify a state's electricity portfolio. Wind energy has accounted for 94% of all RES-driven renewable energy capacity additions in the US from 1998-2009 (Wiser 2010). To ensure diversity, RES policies often include specific targets for solar. Missouri's RES requires .3% of the overall power mix to be from solar PV by 2021 (DSIRE – Missouri Renewable Electricity Standard).

Solar set-asides within the RES framework have played a significant role in the recent growth of the national solar market. Excluding California, in each year from 2005-2009, approximately 78% of the annual grid-connected photovoltaic PV capacity additions in the U.S. occurred in states with solar set-asides (Wiser 2010). By 2025, approximately 9,500 megawatts (MW) of solar generation capacity will be needed to meet existing state set-aside requirements. By comparison, the U.S. had approximately 2,100 MW of installed solar electric capacity by the end of 2010 (SEIA 2010).

One major concern with a solar set-aside within an RES is that it could result in higher electricity rates. However, the rate impacts of solar set-asides have been relatively low, ranging from .01% - 1% of retail sales in the seven states where the set-aside exists and rate data is available (Wiser 2010).

Renewable electricity standards in general have not shown to have any significant impact on rates, either. "…the cost impacts of state RPS policies have varied by state but, at the same time, there is little evidence of a sizable impact on average retail electricity rates so far...in most cases, rate increases are estimated at 1% or less…"(Wiser 2007).

SOLAR REBATE AND OTHER DIRECT CASH INCENTIVES

Direct cash incentives such as solar renewable energy credits (SRECs,) rebates, and grants are other policy tools used to spark residential solar development in the United States. They are typically issued by a state or local government or by a utility after the system is installed. Around 30 states and 150 utilities offer direct incentives for PV and solar thermal, and incentives usually cover between 20% and 50% of the costs of the solar project (DSIRE 2011).

Direct cash incentives are often preferred to tax credits because they are available to all people whether or not they pay tax. (For example, a retired person or a non-profit entity would be able to receive a direct cash incentive but not a tax credit; similarly, a tax credit would not have value to a small business without taxable profits). Direct cash incentives are a critical first step to deploying solar as they support early adopters, demonstrate the feasibility of solar, and increase market penetration. Also, these incentives often help reveal potential market barriers to widespread adoption of solar (NREL 2009).

PROPOSITION C: THE 2008 MISSOURI CLEAN ENERGY INITIATVE

For nine years, the Missouri General Assembly considered, but failed to pass a renewable electricity standard. In 2007, the General Assembly passed S.B. 54 which included non-binding renewable energy targets (DSIRE – Missouri Renewable Electricity Standard). Missouri renewable energy advocates were not satisfied as it is widely accepted that utilities do little to increase the usage of renewable energy unless there face strict renewable energy requirements that includes repercussions if targets are not met.

Polling demonstrated that Missourians were supportive of a RES that held utilities accountable to an expansion of renewables. A grassroots coalition formed called Missourians for Cleaner Cheaper Energy (MCCE). This was supported by the American Wind Energy Association (AWEA), Missouri Coalition for the Environment, Missouri Votes Conservation, Renew Missouri, and Sierra Club. MCCE gathered the 176,000 signatures needed to put the Missouri Clean Energy Initiative (a 15% by 2021 RES with utility solar rebate) on the November 2008 statewide ballot (Ballotpedia.org).

Two-thirds of Missourians voted in favor of the initiative making Missouri the 27th state in the United States to have a RES, but only the third to do so by statewide ballot initiative (DSIRE.org). The Missouri RES applies to the state's three investor-owned utilities (IOUs), which make up approximately 75% of the state's electricity usage (U.S. EIA 2011). To fulfill the RES, KCPL will have to obtain approximately 2,400 MW of renewables by 2021, 43 MW of solar. Ameren will have to obtain 4,900 MW of renewables, 98 MW of solar. Empire Electric – 550 MW renewable, 11 MW of solar.

The ballot initiative also requires Missouri Investor-Owned Utilities (IOUs) to offer customers a $2 per watt rebate for customer-sited solar PV up to 25 kW. In 2011, this provided approximately 36% of the system's overall cost[1]. Two IOUs, Ameren Missouri and Kansas City Power and Light (KCPL) are offering the solar rebate.

To protect ratepayers from spikes in electric rates due to the RES and the solar rebate, the law contains a 1% rate cap. This means that utilities cannot raise rates more than 1% over what the rate increases would have been if the renewable standard was not in place. Once they hit 1%, the utilities

[1] Assumes solar PV installed cost to be $5.50/watt.

are not required to bring more renewables online. The rate impact of nearly all other state RES have remained under 1% thus far (Wiser 2007).

DETERMING THE IMPACT OF THE MISSOURI SOLAR REBATE

METHOD

To determine the impact the Missouri solar rebate has had on the in-state solar market, I first quantify the growth of U.S. solar capacity and examine the reasons for its rapid expansion. Then, I perform two comparisons to isolate the expansion of solar in Missouri that resulted from the solar rebate from the growth that would have occurred normally if the rebate was not in effect.

First, I compare solar installations in Ameren and Kansas City Power and Light's service territory to that of the third Missouri IOU, Empire Electric, which is not offering the solar rebate. Second, I compare solar installations in Ameren and KCPL to utilities in two similar Midwestern states (Nebraska and Kentucky) that are not offering a solar incentive. Together, these comparisons make it clear that the substantial growth of PV installations in Ameren and KCPL service territory was a result of the solar rebate program.

ANALYSIS

US SOLAR EXPANDING RAPIDLY DUE TO FALLING PRICES AND RISING ELECTRIC RATES

Since 2001, the number of grid-connected solar PV installations in the United States has grown exponentially. In 2010 alone, grid-connected PV increased approximately 102% from the previous year to a cumulative installed capacity of approximately 2.1 GW (SEIA 2010).

The US solar industry was the fastest growing sector in the economy in 2010. The number of jobs in the U.S. solar industry grew 6% compared to less than 1% job growth in the rest of the economy.

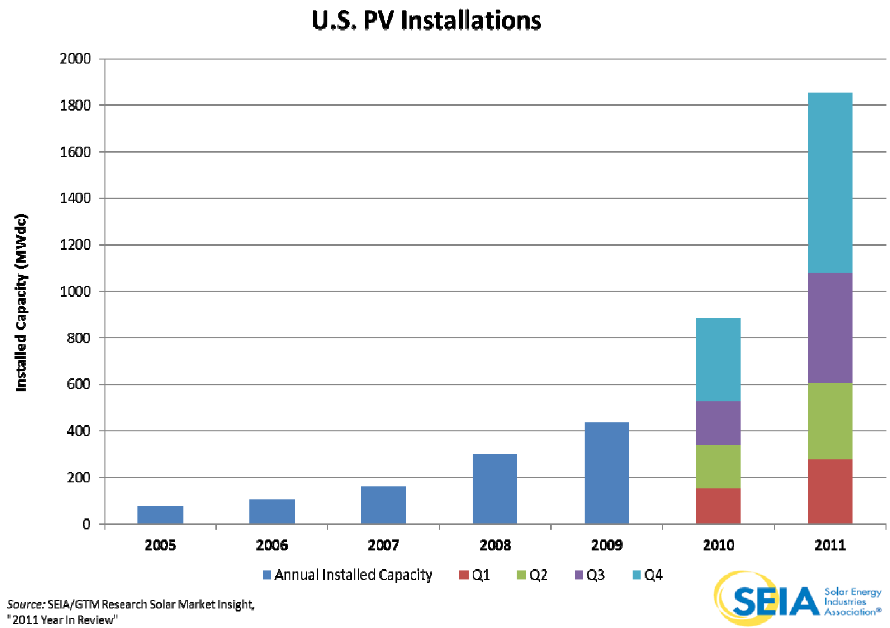

Figure 3. U.S. Solar Electric Installations: 2005 - 2011
Source: SEIA/GTM Research Solar Market Insights "2011 Year in Review"

The rapid growth of solar installations over the last several years is largely attributed to the substantial decrease in the price of solar components. There was a clear downward trend in prices of solar PV from 1980-2009 as demonstrated in Figure 4 below (DOE NREL Solar Technologies Market Report 2010). Between 2009 and 2011, the decrease continued -- the wholesale cost of solar modules dropped another 70% (Brankera, Pathaka, Pearce 2011).

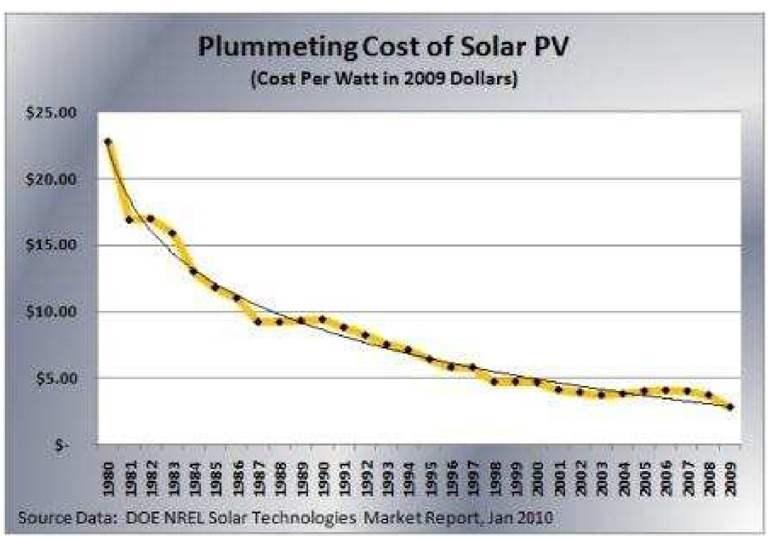

Figure 4. Average cost of solar PV in 2009 dollars
Source: NREL Solar Technologies Market Report 2010

Non-module costs also declined 18% between 2009 and 2010 because of increased installer competition and market maturity. According to the Lawrence Berkeley National Laboratory, the cost of a solar PV installation fell 37% from 2008 to 2010 (Lawrence Berkeley National Laboratory 2010).

Lastly, electric rates continue to increase. In December 2011, USA Today reported that electric bills have increase significantly in the last five years, which is a substantial shift from the previous twenty-five years of stable electricity rates (Cauchon 2011).

A USA Today analysis of government data found that 2010 to be the fifth consecutive year of electric bill increases above the inflation rate. The jump has added about $300 a year to what households pay for electricity which is the largest sustained increase since a run-up in electricity prices during the 1970s (Cauchon 2011).

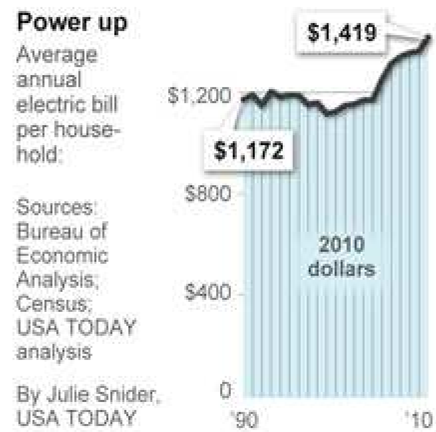

Figure 5. Average Annual Electric Bill per Household
Source: USA Today

Missouri was no different. Ameren Missouri has increased electric rates four times in five years. The increases totaled $604 million and were a 28% increase in five years (Tomich 2011).

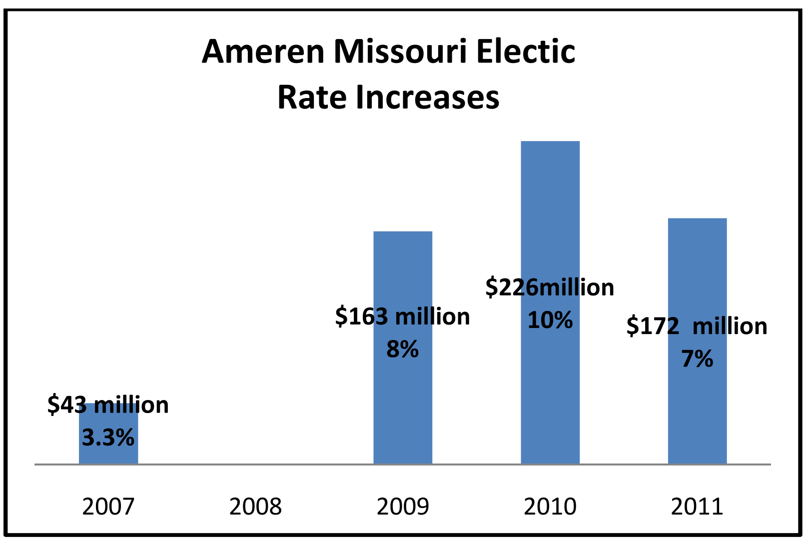

Figure 6. Ameren Rate Increases 2007 - 2011
Source: St. Louis Post-Dispatch 2011

In February 2012, Ameren Missouri announced it was seeking another 15%, $376 million rate hike. If approved by the Missouri Public Service Commission, the averaged Ameren residential bill of 1,100 kilowatt-hours (kWh) would increase about $14 a month (Tomich 2012).

The rapid expansion of solar is largely attributed to the drop in solar prices and higher electric bills, shrinking the "payback period" for solar investments. As the solar market continues to expand, the cost to install is also decreasing. Parts of the world with higher electric rates have already reached solar grid parity, where the cost of unsubsidized solar is equal to traditional form of electricity generation (Farrell 2011).

According to Suntech Power CEO Shi Zhengrong[2], unsubsidized solar power is already cost competitive with fossil fuels in India, Italy, Spain, and Hawaii (Clifford 2012). In February 2012, Zhengrong predicted that solar power will be able to compete without subsidies against conventional power sources in half the world by 2015 (Morales and Simmons, 2012).

Recently subsidies and federal loan guarantees for renewable energy have fallen under harsh scrutiny. The backlash heightened when Solyndra, a California-based PV manufacturing receiving a federally-backed loan, went bankrupt in 2011.[3] As demonstrated in figure 7, fossil fuels, like oil and gas, have received substantial subsidies for the last 100 years -- higher subsidies than the subsidies received by renewable energy in the last 15 years (Pfund and Healy 2011).

[2] In 2011, Suntech power was one of the world's largest producers of silicon solar modules.

[3] Solyndra went bankrupt because they were implementing solar PV technology that was more expensive than solar panel manufacturers, but uses less silicon. When the price of silicon plummeted instead of increased in the late 2010s as they had anticipated, the prices of traditional panels plummeted and Solyndra's technology could no longer stay competitive.

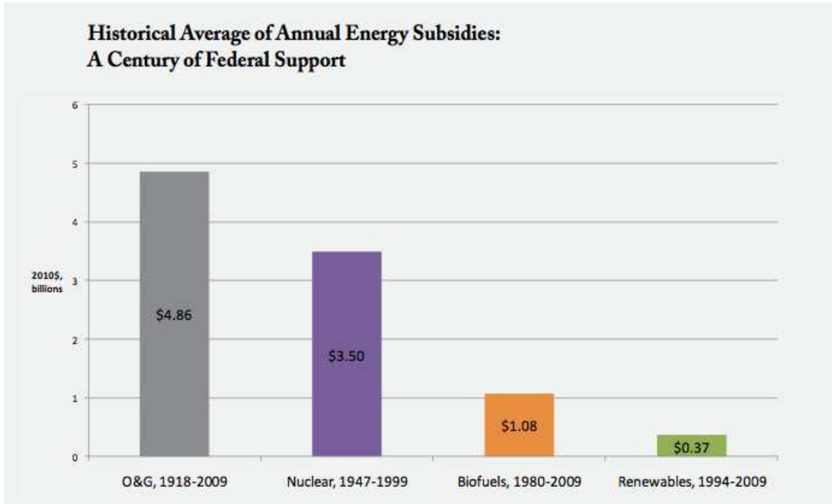

Figure 7. Historic Average of Annual Energy Subsidies
Source: Pfund and Healy 2011

The other major difference is the subsides for renewables are in place to help renewable technologies become cost competitive with fossil fuels. When they do, the need for the subsidies will dissolve, providing widespread access to affordable clean, renewable energy. In contrast, ongoing subsidies to oil and gas continue to result in expensive and detrimental impacts to public health and the environment such as oil spills, premature deaths, polluted air and water, and climate change.

GROWTH OF MISSOURI SOLAR VS BASELINE

In order to identify the growth of solar capacity that would have normally occurred due to lower equipment and installation costs and higher electricity prices, I compare the Missouri solar market to a baseline. I collected solar data from each utility and compared the amount of grid-tied[4], solar PV installed KCPL and Ameren to Empire Electric, an IOU which claims they are not required by law to offer customers the solar rebate. The results of this comparison are displayed in figure 8.

In the two years since the rebate took effect, the amount of solar installed in KCPL and Ameren grew 3400% from 101 kW to 3.5 MW. The number of installations expanded from 38 to 474.

[4] Off grid tied or battery solar systems are not included in the study as these types of systems are rarely installed , are not eligible for the solar PV rebate, and the utility is not typically informed of their installation. The batteries for these types of systems are still quite expensive and are therefore rarely installed.

Ameren Missouri saw the greatest increase in the amount of solar installed. The number of solar systems increased from 19 in 2009 to 334 in 2011. The amount of solar generating capacity increased from 56 kW in 2009 to 2196 kW in 2011.

Solar installations in KCPL service territory increased rapidly as well. KCPL went from 19 installations totaling 57 kW in 2009 to 140 systems for 1307 kW in 2011.

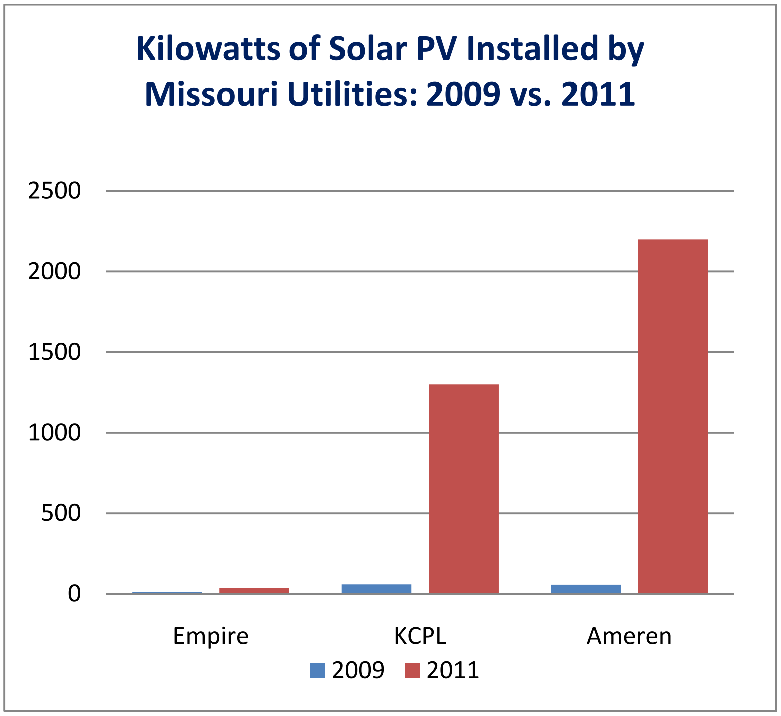

Figure 8. Kilowatts of grid-tied solar PV installed in Missouri Investor-Owned Utilities. 2009 & 2011 Source: Utility Data

Empire Electric, located in Joplin, did not offer the solar rebate and therefore saw little or no increase in solar deployment in its service area. At the end of 2011, Empire has only 10 grid-tied solar PV systems installed in its service territory with a total installed PV capacity of 37 kW.[5]

[5] In the middle of the two years of rapid solar expansion within Ameren and KCPL, a tornado struck the center of Empire Electric service territory (Joplin, Mo). The tornado was the most deadly tornado in the U.S. since 1947. The tornado likely had a negative effect on the amount of people interested in and able to install solar. However, there was no increase in the usage of solar in 2010 before the tornado hit which suggests that solar installations in Empire would not have increased even without the disaster.

In 2009, solar installations in each of the three utilities were near zero. The comparison of solar usage in Empire, KCPL, and Ameren in 2011 clearly displays the uptick in solar installations that occurred because KCPL and Ameren began to offer the solar rebate.

Second, I compare the amount of solar PV installed in KCPL and Ameren Missouri areas versus the amount of solar PV installed in Nebraska and Kentucky. These other Midwestern states provide a useful comparison, as they each have similar electricity costs and electricity portfolio to Missouri, as seen in table 1 below.

	Missouri	Kentucky	Nebraska	National
Average 2011 Residential Electricity Rates (residential)	9.25 cents/kWh	9.53 cents / kWh	10.97 cents/kWh	Average: 11.82 cents/kWh
Coal reliance in electricity portfolio	85% coal	93% coal	56% coal	Total: 45% coal
2009 state rank for renewable generation	36st in US.	28th in US	47th in U.S.	
2009 renewable generation as % of state's overall electric portfolio	2.7% renewable. (2.1% hydro, .6% wind)	4.1% renewable (3.7% hydro, .3% wood waste, .1% landfill gas)	2.6% renewable (1.3% hydro, 1.1% wind)	Total: 10.6% renewable (7.7% hydro, 3.3% wind, .7% wood waste)
Total electric net generation (Thousand megawatt hours)	88,354	90,630	34,002	
Population (2010 Census)	5,988,927	4,339,367	1,826,341	
2009 Per capita energy related CO2 emissions metric tons/ person	22.1	33.7	26.1	Average: 17.6
Solar incentives	$2/watt, 25 kW cap	Only in TVA service territory (more info below)	None	
Electric Utility Market Structure	Regulated	Regulated	De regulated:	

Table 1. Missouri, Kentucky, and Nebraska Electrical Energy Portfolio Comparison
Sources: U.S. EIA - 2009 State energy profiles: KY, MO, and NE
U.S. EIA - State-level energy-related carbon dioxide emissions 2000-2009

Missouri residents living in KCPL and Ameren Missouri territory were offered a $2/watt solar rebate beginning in 2010. KCPL and Ameren are the two largest utilities in Missouri and are located in the portions of the state with the highest population densities (Kansas City and St. Louis, respectively).

Nebraska residents do not have access to utility or state solar incentives. The utilities with the most similar demographics and therefore those included in the study are Nebraska Public Power District (Nebraska's largest utility with customers throughout the state), Omaha Public Power District (Omaha), and Lincoln Electric System (Lincoln).

A majority of Kentucky did not have access to utility or state solar incentives, either. Only a small fraction of the state – those living in the Tennessee Valley Authority service territory -- were offered a small solar incentive and thus were not included in the comparison. After gathering data on the population density and utility size data from each of the utilities, I found Duke Energy (Cincinnati suburbs), Louisville Gas and Electric (Louisville), and Kentucky Utilities (Lexington) to be most similar to Ameren Missouri and KCPL.

I contacted each utility in early 2012 and their employees provided the number of solar PV installations and total kW generating capacity of the systems in each of the utility service territories through 2011. To normalize the data, I divided the number of solar systems by the number of customers served by the utility. Next, I multiplied it by 1,000,000 to indicate the number of systems and the number of kW installed per million customers. The results are shown in Table 2 below.

Utility / Solar Incentive	# of customers	2011		Systems/million customers	kw installed per million customers
Kentucky - No incentive		**# of systems**	**total kW**		
Duke Energy (Cincinnati suburbs)	135,000	17	451	126	3341
Louisville Gas and Electric (Louisville)	394,000	92	260	234	660
Kentucky Utilities (Lexington)	512,000	36	173	70	338
Kentucky - No Incentive total	**1,041,000**	**145**	**884**	**139**	**849**
Missouri - No Incentive					
Empire Electric	215,000	10	37	47	174
Missouri - No incentive total	215,000	**10**	**37**	**47**	**174**
Missouri - With Incentive					
Ameren	1,200,000	334	2200	278	1833
KCP&L Missouri	581,000	140	1291	241	2222
Missouri - With incentive total	**1,781,000**	**474**	**3491**	**266**	**1960**
Nebraska - No Incentive					
Lincoln Electric System	275,000	8	33	29	118
Nebraska PPD	1,000,000	5	84	5	84
Omaha PPD	346000	13	228	38	660
Nebraska - No Incentive Total	**1621000**	**26**	**345**	**16**	**213**

Table 2. Solar installs and kW installed per million customers through 2011
Source: Utility Data

Figure 9, below, shows the same data in a bar graph. The graphs illustrates that the $2/watt rebate available in Ameren and KCPL in Missouri has resulted in over 2 times more solar than in similar utility service territories in Kentucky that do not have access to a solar incentive. Compared to Nebraska, the Missouri solar rebate has also resulted in more than 9 times the amount of solar installed.

Further evidence that a solar incentive produces sizable growth is evidenced by the growth of solar in Ameren and KCPL compared to Empire Electric, which has not yet offered the solar rebate required by the 2008 Proposition C.

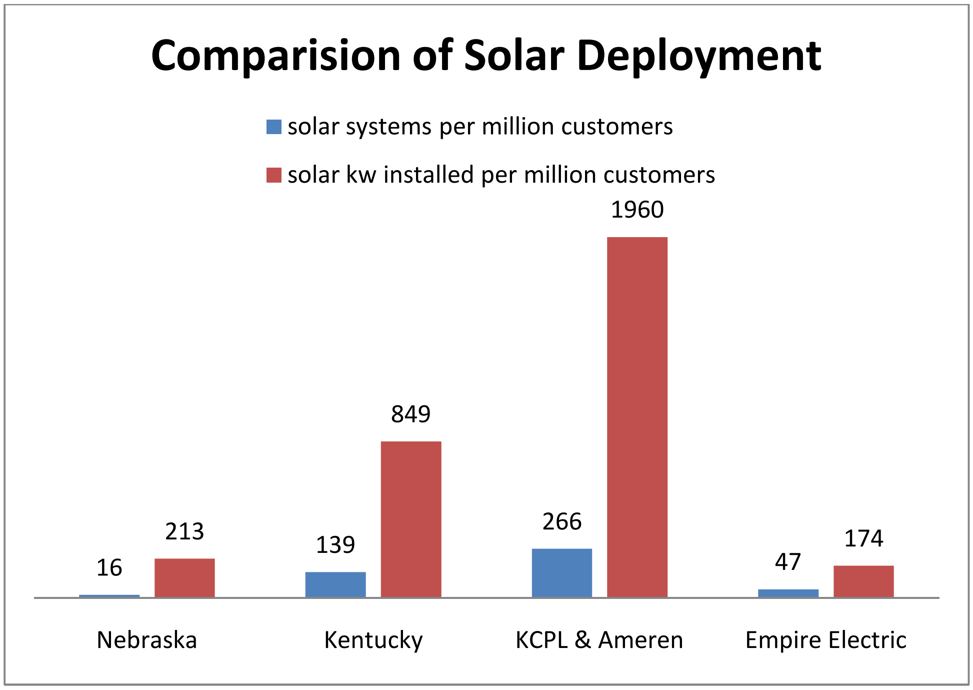

Figure 9. Comparison of solar per million customers. Kentucky: Duke Energy, Louisville Gas and Electric, and Kentucky Utilities. Nebraska: Nebraska Public Power District, Omaha Public Power District, Lincoln Electric System
Source: Utility Data

DETERMING THE COST EFFECTIVENESS OF THE MISSOURI SOLAR REBATE

Method

Prop C requires investor-owned Missouri utilities to pay customers a $2 per watt solar rebate up to 25 kW. The customer is responsible for the remaining costs of the system and its maintenance. However, the solar electricity produced by rebate-financed solar PV systems helps to ease electricity demand and therefore helps mitigate future utility investment in new power plants. In this section, I find that Ameren and KCPL can meet new demand through the $2/watt solar rebate program more cheaply than through any other new generation source.

To determine the cost effectives of the Missouri solar rebate I compare the utility's cost of paying the solar rebate to generate new electricity versus their cost to develop other new sources of generation. I also discuss how 1) electricity becomes increasingly expensive for utilities to provide as demand increases, 2) that demand for this expensive power (called peak power) is on the rise, 3) that solar PV, which produces power during these peak demand times, is an excellent resource to help curtail peak power demand, and 4) that it is cheaper for utilities to provide the solar rebate to meet peak power demands than to provide it through electricity generated from “peaker” power plants.

ANALYSIS

When determining how to meet growing demand, a utility has many electricity generation sources to consider: coal, nuclear, oil, natural gas, wind, solar, and other renewables. Regulated utilities, like Ameren and KCPL, are required to place primary consideration on the least-cost option when determining which source to pursue. The utilities inform their regulating body, the Missouri Public Service Commission (PSC) of their generation planning through an Integrated Resource Plan, a document which covers a 20 year time horizon.

To determine the cost effectives of the Missouri solar rebate, I compare the utility’s cost of paying the solar rebate to generate new electricity versus its cost to develop other new sources of generation. I use the U.S. Energy Information Administration’s 2011 Energy Fuel Outlook report titled “Total Levelized Cost of New Generation, 2016”. Table 3 shows the EIA levelized cost of per megawatt hour for coal, advanced coal with carbon capture and storage, nuclear, natural gas, and wind for a 30-year life span (U.S. EIA 2010).

Column 1 “utility cost for solar rebate” is data I develop based on the utility’s cost per MWH of solar of $2 per watt. Therefore, the utility cost for solar is $2 million per MW. According to NREL, one MW of solar in Missouri produces approximately 1,300 MWHs of electricity, and a solar system is under warranty for 25 years, though often they will produce for 30 plus years. (Expanding its life cycle from 25 years as I did in the below comparison to 30 years would only further increase its cost-effectiveness). This brings the total utility cost per MW of solar to $60, compared to the EIA data which determine $66 per MW for natural gas, $97 for wind, $113 for nuclear, and $136 for advanced coal with carbon capture and storage.

Total Levelized Cost of New Generation Resources, 2016.

U.S. Average Levelized Costs (2009 $ per MWH) for plants entering service in 2016

	Utility cost for solar rebate	Conventional Coal	Advanced Coal w ccs	Natural Gas: Conventional Combined	Natural Gas: Advanced Combustion Turbine	Advanced Nuclear	Wind
Capital cost per MW	$2,000,000						
Capital cost per MWH		$65.3	$92.7	$17.5	$31.6	$90.1	$83.9
Operation & Maintenance	$0	$3.9	$9.2	$1.9	$5.5	$11.1	$9.6
Variable O&M incl. fuel	$0	$24.3	$33.1	$45.6	$62.9	$11.7	$0
Transmission	$0	$1.2	$1.2	$1.2	$3.5	$1	$3.5
Capacity factor	15%	85%	85%	87%	30%	90%	34%
MWHs produced per year	1,300						
Total life cycle average	25 years						
lifetime production (MWh)	32,850						
Utility Cost per MWh	$60.88	$94.70	$136.20	$66.20	$103.50	$113.90	$97.00

Table 3. Total Levelized Cost of New Generation Resources, 2016
Source: U.S. Energy Information Administration Annual Fuel Outlook 2011

As shown below in table 3, meeting new demand by offering customers a $2/watt solar rebate is the least-cost option. This is largely because utility because the rebate offsets a portion of the system's costs and the customer provides the rest. The customer is responsible for any operations and maintenance costs (which are minimal for solar PV) and fuel costs (which are zero).

Lastly, when the utility invests in new generation though customer-owned solar systems they do not incur decommissioning or disposal costs at the end of the system's life – the customer is responsible for this. The chart above does not include data for decommissioning and disposal costs associated with each type of fuel source. If it did, the cost-effectiveness of the solar rebate would be even greater if decommissioning and disposal – hugely expensive expenditures at the end of the life of a coal, nuclear, and natural gas plants – were included in the analysis.

Another strength of distributed solar is that it can be installed much more rapidly than large fossil fuel generation plants. Within the first two years of the solar rebate program, the amount of solar installed in Ameren and KCPL grew from 100kW to 3.5 MW and as the market continues to mature the growth will even more rapidly accelerate.

Heidi Shoen, Executive Director of the Missouri Solar Energy Industries Association, predicts the amount of solar PV installed in Missouri will double in 2012 alone (H Shoen, personal communication, Feb 2012). States like New Jersey and Colorado experienced rapid solar deployment. New Jersey went from 6 installations in 2001 to 14,000 and 650 MW of solar installed only 10 years later (New Jersey Clean Energy Program). Colorado expanded from 23 MW of PV installed in 2009 to 62 MV in 2010 -- a 165% increase in one year (IREC 2011). Solar PV is a distributed generation model which is installed quickly. By comparison, a nuclear plant often takes 15-20 years to permit and build.

Solar is a more flexible and less risky to meet new demand for power. For example, if a utility chooses to proceed with a large coal or nuclear plant, but later it is found they picked the wrong type of plant, the wrong size compared to the eventual need, or misestimating the plants costs and construction timetable, the economic consequences can be financially devastating to the utility company and its ratepayers. In addition, solar diversifies Missouri's power supply and therefore helps to provide stability to long-term electricity rates and protection against higher fossil fuel prices.

Next, meeting "peak load" power demand is a constant challenge for utility generation planning. The need for peak power occurs on the hottest days of the year when demand for electricity is extremely high because of the widespread use of electric air conditioners. Less than half of the generation capacity in the U.S. comes from base load power plants which are designed to run all the time. The rest of the generation capacity is on reserve for use during "shoulder" periods and peak demand days. Reserve power plants are much more expensive to operate, resulting in large disparities in the electric generation costs throughout the day and year. According to a 2004 report by the U.S. Government Accountability Office, it can cost up to 10 times more to generate electricity during a summer afternoon compared to a summer night (Orcutt 2010). The high cost of peak power is also driven by the need to cover the fixed costs of peaker plants during the course of relatively few hours of operation.

For Missouri, figure 10 displays the dramatic jump in the cost to a utility to produce of electricity at peak demand periods. The data is from an SNL Financial power plant database and the analysis was performed by ESource.

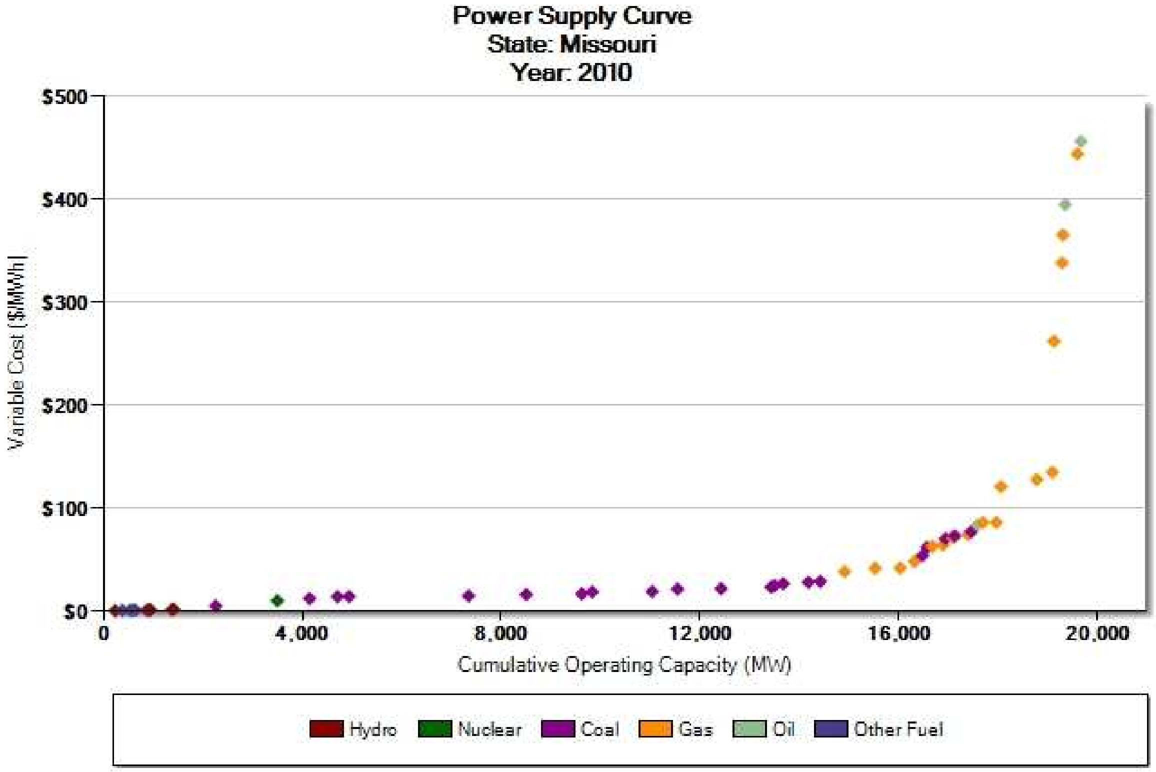

Figure 10: 2010 Missouri Power Supply Curve
Source: SNL Financial and ESource.

Plant Name	Capacity (MW)	Cumulative Capacity (MW)	Variable Operating Cost ($/MWH)	Fuel Type	Capacity Factor (%)
Table Rock	230.00	230.00	1.03	Water	27.70
Farmers City Wind	146.00	376.00	1.40	Wind	26.10
Lost Creek Ridge Wind	150.00	526.00	1.46	Wind	19.64
Bluegrass Ridge	56.70	582.70	1.63	Wind	24.08
Conception Wind Farm	50.40	633.10	1.66	Wind	24.65
Osage	237.40	870.50	1.69	Water	39.13
Cow Branch	50.40	920.90	1.71	Wind	21.93
Ozark Beach	16.00	936.90	1.89	Water	62.86
Taum Sauk	440.00	1,376.90	2.05	Water	25.43
Clarence Cannon Hydro	27.00	1,403.90	2.63	Water	26.70
Iatan 2	850.00	2,253.90	5.60	Coal	19.49
Callaway	1,240.00	3,493.90	10.65	Nuclear	82.82
Iatan	651.00	4,144.90	12.82	Coal	90.77
Hawthorn	563.00	4,707.90	14.64	Coal	78.01
Sikeston	233.00	4,940.90	14.87	Coal	87.82
Labadie	2,405.00	7,345.90	15.35	Coal	87.24
New Madrid	1,160.00	8,505.90	16.73	Coal	73.77

Thomas Hill	1,120.00	9,625.90	17.31	Coal	75.60
Asbury	210.00	9,835.90	19.33	Coal	68.80
Rush Island	1,205.00	11,040.90	19.60	Coal	70.77
Montrose	510.00	11,550.90	21.95	Coal	70.54
Meramec	879.00	12,429.90	22.43	Coal	69.03
Sioux	1,006.00	13,435.90	23.91	Coal	65.06
Chamois	68.00	13,503.90	25.43	Coal	70.04
Southwest Power Station	178.00	13,681.90	27.25	Coal	86.79
Sibley	508.30	14,190.20	28.65	Coal	62.62
James River Power Station	236.00	14,426.20	29.41	Coal	69.98
St. Francis	492.00	14,918.20	39.01	Gas	17.50
Dogwood	614.30	15,532.50	42.20	Gas	16.57
State Line CC	500.00	16,032.50	42.48	Gas	41.38
Hawthorn CC	292.00	16,324.50	48.76	Gas	8.89
Lake Road	157.60	16,482.10	54.46	Coal	33.71
Blue Valley	93.00	16,575.10	62.47	Coal	12.52
McCartney	108.00	16,683.10	63.42	Gas	7.31
Peno Creek	212.00	16,895.10	64.86	Gas	6.20
University of Missouri - Columbia	51.20	16,946.30	70.85	Coal	25.63
James River Power Station CT	155.00	17,101.30	71.57	Gas	2.49
Marshall, MO	26.00	17,127.30	73.71	Coal	11.86
Holden	268.50	17,395.80	75.08	Gas	2.26
Columbia, MO	73.50	17,469.30	77.71	Coal	10.27
Meramec CT	117.00	17,586.30	84.27	Oil	0.09
Southwest Gas Turbine	112.00	17,698.30	86.67	Gas	1.15
Empire Energy Center	269.00	17,967.30	86.74	Gas	4.14
State Line CT	96.00	18,063.30	121.38	Gas	2.27
Audrain Generating Station	720.00	18,783.30	128.26	Gas	0.84
South Harper	315.00	19,098.30	135.48	Gas	2.10
Viaduct	34.00	19,132.30	262.65	Gas	0.02
Columbia Energy Center (MO)	160.00	19,292.30	338.85	Gas	0.23
Kirksville	16.00	19,308.30	365.88	Gas	0.05
Howard Bend	50.00	19,358.30	395.13	Oil	0.02
Greenwood	244.60	19,602.90	444.47	Gas	1.03
Moberly	68.00	19,670.90	456.60	Oil	0.06
Ralph Green	71.00	19,741.90	978.82	Gas	0.02
Lake Road CT	111.20	19,853.10	1,168.94	Gas	0.06
Hawthorn CT	180.00	20,033.10	1,888.32	Gas	0.02

Table 4: Missouri power plants: Capacity and Variable Operating Cost ($ per MWH)
Source SNL Financial

The line graph in figure 10 and the data set in table 4 demonstrate the varying prices of electricity per megawatt hour in Missouri. Prices range from $1-$2 per MWH for hydro and wind, to $5-$30 for coal, $10 for nuclear, and $40- $18888 for natural gas as summarized below in table 5.

	Average of Variable Operating Cost ($/MWH)
Wind	$1.57
Water	$1.86
Nuclear	$10.65
Coal	$31.17
Oil	$312.00
Natural Gas	$322.69
Average	**$146.77**

Table 5. Missouri Power Plants: Average of Variable Operating Cost ($/MWH)
Source: SNL Financial

The expensive "peakers" natural gas plants cost $40 - $1,888 per MWH. The great disparity between base load and peaker plants demonstrate why it is disproportionately expensive for utilities to meet peak demand.

Peak electricity demand is on the rise. A 2009 report by the North American Electric Reliability Corporation (NERC) predicts that, on average, peak demand will increase by almost 15 percent by 2018 (Orcutt 2010). The increasing demand is a result of population growth, the proliferation of consumer electronics, and the potential of electric cars.

Yet another benefit of the Missouri solar rebate is that solar PV is an excellent peak power generation resource. Solar PV typically has high output production during peak load times (summer days). Natural gas is also a good peak power fuel because natural gas generators have the ability to quickly ramp up or down, whereas coal and nuclear plants serve as base load power generators that are not as easily cycled on and off. By investing in the $2/watt rebate a utility avoids peak power production prices that are often 300 times more expensive than traditional base load power. In addition, widespread deployment of rooftop PV, a distributed electricity resource, could help defer distribution system upgrades and enhance reliability as demand grows, particularly if it is eventually combined with electricity storage systems such as advanced batteries.

EMISSIONS AVOIDED DUE TO MISSOURI SOLAR REBATE

METHOD

To determine the reduced emissions from the increased usage of PV associated with the Missouri RES and solar rebate, I take the amount of fossil fuel generation offset by PV and multiply it by the average emission rates for those fuels. For this analysis, I used data from a 2007 National Renewable Energy Laboratory report titled "Energy, Economic, and Environmental Benefits of the Solar

America Initiative" written by Dr. Stephen Grover. To determine average emission rates per natural gas and coal fired generation, Dr. Grover used the Environmental Protection Agency's eGrid 2000 database which tracks power plant data from across the United States.

ANAYLSIS

According to the U.S. Environmental Protection Agency (EPA), electricity generation is the largest industrial source of air emissions in the United States (Grover 2007). A reported titled "A toll from Coal: An updated assessment of death and disease from America's Dirtiest Energy Source" summarizes the impact coal has on public health:

> *Among all industrial sources of air pollution, none poses greater risks to human health and the environment than coal-fired power plants. Emissions from coal-fired power plants contribute to global warming, ozone smog, acid rain, regional haze, and–perhaps most consequential of all from a public health standpoint – fine particle pollution. …Emissions from the U.S. power sector cause tens of thousands of premature deaths each year and hundreds of thousands of heart attacks, asthma attacks, emergency room visits, hospital admissions, and lost workdays (Schneider and Banks, 2010, p. 4).*

Fossil fuel-fired power plants are responsible for 40% of man-made carbon dioxide (CO2) emissions, 23% of the nation's nitrogen oxide (NOX) emissions, and 67% of sulfur dioxide (SO2) emissions (U.S. EPA). These emissions contribute to the formation of smog and haze, and coal-power plants are the number one contributor to climate change (Grover 2007).

Coal power plants are also the largest source of emissions of mercury, a highly toxic metal. Mercury from coal plants builds up in fish, and people are exposed to it when they eat the contaminated fish. Mercury exposure is a particular concern for women of childbearing age, unborn babies, and young children. The toxin effects neurological development and can impair a child's ability to think and learn (U.S EPA 2011).

Solar power reduces the demand for coal and natural gas fired electricity. Table 6 displays the emissions avoided, by fuel type, for PV installations in 2007 and 2011. The table also displays emissions avoided through PV capacity in 2015 and 2020 if the solar targets set by the 2008 Proposition C Initiative are met. The final rows on table 6 display the emissions avoided if the newest 2012 Renewable Energy Initiative is passed and the PV targets set for utilities increase, especially in later years.

The chart assumes that PV generation would replace fossil fuel generation on a one-to-one basis, and that 75% of the fuel displaced would be natural gas and 25% would be coal. PV systems only generate power during daylight hours and they often reduce emission from natural gas peaking units that are used to meet daytime peaking electricity demand (Grover2007).

Table 6. Annual emission offset of Solar PV
Source EPA eGrid 2008

U.S. Average Emission Rates (lbs/MWH)					
Natural Gas Electric Generators			Coal Electric Generators		
CO2	NOX	SO2	CO2	NOX	SO2
1,135	1.7	0.1	2,249	6	13

Emissions Avoided Due to Solar Rebate (annual pounds)

2008 Prop C	PV installed (MW) KCPL & Ameren	MWH per year	Natural Gas (75%)			Coal (25%)			Total		
			CO2	NOX	SO2	CO2	NOX	SO2	CO2	NOX	SO2
2007	0.044	57.2	48,692	73	4	32,161	86	186	80,852	159	190
2011	3.5	4550	3,873,188	5,801	341	2,558,238	6,825	14,788	6,431,425	12,626	15,129
2015	45	58500	49,798,125	74,588	4,388	32,891,625	87,750	190,125	82,689,750	162,338	194,513
2020	100	130000	110,662,500	165,750	9,750	73,092,500	195,000	422,500	183,755,000	360,750	432,250

ECONOMIC DEVELOPMENT AND JOB CREATION BENEFITS OF SOLAR

METHOD

Nearly all of the coal and natural gas burned in Missouri is imported from out of state resulting in a substantial dollar drain on Missouri's economy. This makes Missouri the most dependent on net imports as a share of total power use (Union of Concerned Scientists 2010). In 2008, Missouri sent $1.13 billion dollars out-of-state to import coal. Investing, instead, in the development of Missouri's renewable energy sources redirects funds back into the local economy and creates in-state jobs. This final section of the report investigates the economic opportunities of increasing the amount of solar PV in Missouri. The information was gathered through a literature review.

ANALYSIS

As compared to traditional fossil fuels, the renewable energy sector is more labor-intensive and requires a larger number and wider variety of jobs such as manufacturing, construction, installation, and ongoing operation and maintenance (Kammen, Kapadia, and Fripp 2004).

UC Berkeley's Renewable and Appropriate Energy Laboratory (RAEL) completed an analysis of 13 different reports on the job creating potential of the clean energy and found that renewable energy technologies create more jobs per average megawatt (MW) of power generated, and per dollar invested than coal or natural gas. Over ten years, the solar industry creates 5.65 jobs per million dollars in investment, the wind energy industry 5.7 jobs, and the coal industry only 3.96 (Kammen, Kapadia, and Fripp 2004). In the case of coal mining, wind and solar energy generate 40 percent more jobs per dollar invested (Kammen, Kapadia, and Fripp 2004).

A Union of Concerned Scientists analysis conducted for the state of Wisconsin found that an 800 MW mix of new renewables would create about 22,000 more job-years than would new natural gas and coal plants over a 30-year period (Brower, Tennis, and Denzler 1993).

Already, the solar industry has been a bright spot in the struggling U.S. economy. In 2010, solar grew at 6.8% while the rest of the economy only grew .7%. At the end of 2011, more than 100,000 Americans work in solar, twice as many than 2009. Figure 10 displays the U.S. solar industry employees more 20,000 more people than the U.S. coal mining industry. In fact, solar PV creates 7 times more jobs per MW than coal, natural gas, and nuclear (Kammen, Kapadia, and Fripp).

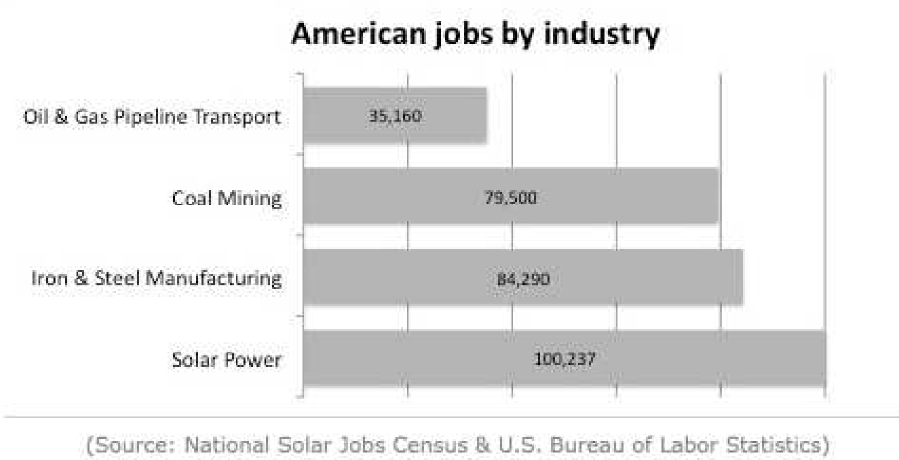

Figure 10. American Jobs by Industry, 2011
Source: National Solar Jobs Census & U.S. Bureau of Labor Statistics.

According to Heidi Schoen, the president of the Missouri Energy Industries Association (MOSEIA), the Missouri solar industry has seen rapid growth in recent years. Between 2009 when MOSEIA formed through 2011, the industry grew from fewer than eight small "mom and pop" installation companies to 26 installation companies that are members of MOSEIA and several more that are not (H Shoen, personal communication, Feb 2012). Missouri is also home to 171 solar-related manufacturing establishments (Missouri Partnership) and in 2011 the solar industry employed more than 1,205 Missourians (Brookings 2011). The Missouri Partnership created the chart below to demonstrate the growth of solar industry in Missouri and to recruit additional firms to the state.

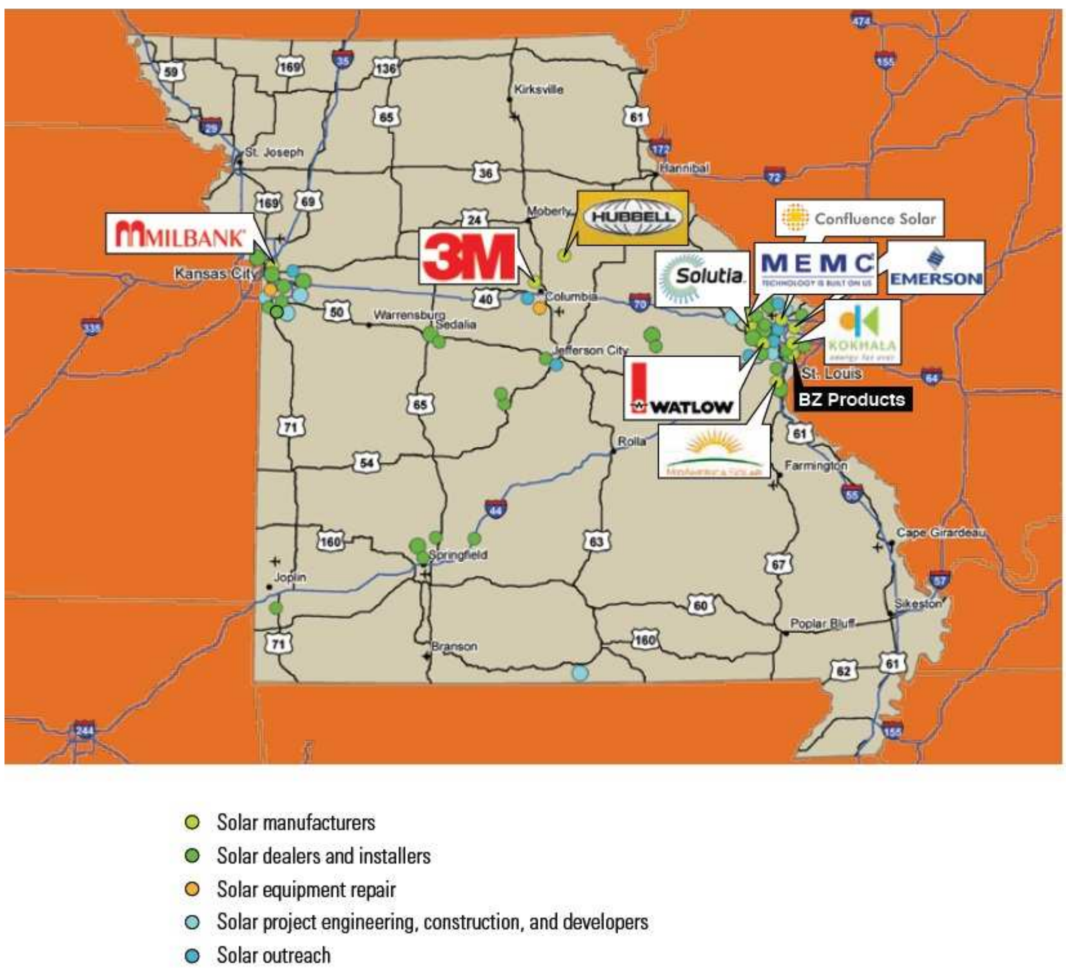

Figure 11. Solar Industry in Missouri
Source: Missouri Partnership 2011

CONCLUSION

According to Ameren's 2011 Integrated Resource Plan, "Rising customer demand, when coupled with the shutdown of Meramec (coal) Plant, will result in a meaningful shortfall of generation available to meet our customers' needs – about 1000 megawatts by 2020."

The 2011 Ameren IRP next discusses several different ways the utility can meet that demand: investment in energy efficiency, building a second nuclear reactor at the existing Callaway Nuclear plant (1600 mw), and 600 MW combined cycle natural gas plants.

The IRP says, "If Ameren Missouri were to pursue the RAP Demand Side Management portfolio (i.e. energy efficiency) no supply-side resources would be needed in the planning horizon, even with the retirement of Meramec, assuming customer response to program incentives is consistent with our estimates."

Energy efficiency consistently proves to be the "least-cost" option and should be fully pursued.[6] Investment in the solar rebate is the second cheapest option (mainly because the utility only has to pay a portion of its total cost) and also because is a great resource to meet expensive "peak power" demand.

The 2008 Prop C Initiative calls for Ameren to have 98 MW of solar PV, KCPL 43 MW, and Empire 11 MW and includes the rebate to help meet these targets The solar rebate program is the second most cost-effective way to meet Missouri's future energy demands and should continue to be required of the utilities. Coupling it with investing in energy efficiency would prevent the need for Missouri investor-owned utilities to invest in large electricity generating plants over the next 20 years.

Beyond being a cost-effective option, the solar rebate will result in cleaner air and water, local job creation, and a reduction in Missouri's billion dollar expenditures on imported fossil fuels. In only its first two years in action, the Prop C Missouri Solar rebate has been extremely successful, resulting in a 14-fold increase in solar installations at far less cost to utilities than investment in other new generating sources. It is a program that should be celebrated, continued, and modeled by other states.

[6] Although not the focus on this report, energy efficiency is often the least-cost resource option for utilities. Missouri ranks 44th in the country on energy efficiency (ACEEE 2011) and has many untapped efficiency opportunities. Efficiency has the potential to meet 17% of the state's electricity needs and about 10% of natural gas use by 2025. These efficiency gains would save consumers $6.1 billion in net energy bills (ACEEE 2011).

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