BI-PARTISAN SUPPORT DRIVING SOLAR ENERGY DEVELOPMENT

PRINCIPAL SOLAR INSTITUTE

Illuminating and Rectifying the Politics Behind Utility-Scale Solar

Michael Gorton, *CEO and Chairman*, **Principal Solar, Inc.**

Mark Victor Hansen, *Founder and Co-Creator*, **Chicken Soup for the Soul,** *and Advisor*, **Principal Solar, Inc.**

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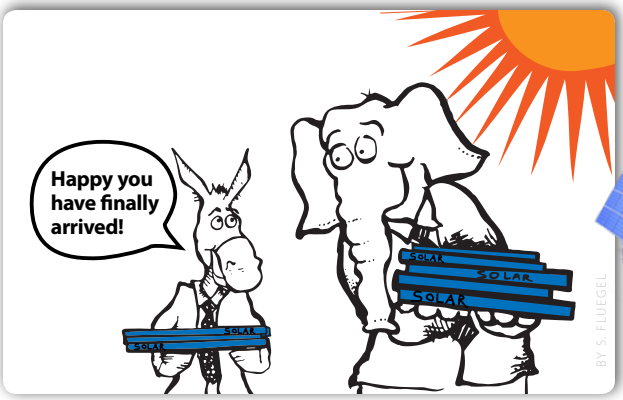

AUTHORS

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INTRODUCTION

This paper is dedicated to making the case that the development of solar is consistent and in line with conservative values.

The end result of our national support for this segment of the energy sector will be a stronger economy, job creation, reliable energy that supports existing infrastructure and extends the lifetime of the nation's natural gas supply, and a new resource for clean, affordable electricity as our demand continues to grow.

OVER THE LAST TWO DECADES

WITHIN 20 YEARS

solar energy has experienced one of the **most remarkable growth curves** in the U.S. technology sector, and worldwide.

This is the result of two important trends:

- The cost of solar has **dropped significantly** year-after-year.

- The amount of solar installed worldwide has **grown exponentially** over the last few years.

Many have tied solar's growth to subsidies and politics. The naysayers believe that once subsidies end, the demise of the industry will be imminent. The trends do not support this belief. In the U.S., Democrats have supported development and growth while Republicans, at best, either ignored, or worse, opposed the entrée of photovoltaic (PV) power generation as it worked its way into the mainstream.

This white paper is focused on paving a road to change this dynamic, and unite parties in driving utility-scale solar development.

Like many energy-savvy analysts, these authors held the opinion just five years ago that solar could never be cost-competitive with traditional utility-scale generation.

It was an easy perspective to take. Two decades ago, solar installations ran nearly 60 times the cost of traditional generation. By 2016, after years of struggling against cheap, natural gas prices and variable subsidies, **solar electricity is poised to produce electricity as cheap, or cheaper, than average electricity-bill prices in 47 U.S. states**, according to a Deutsche Bank report.[1]

—IN ADDITION—

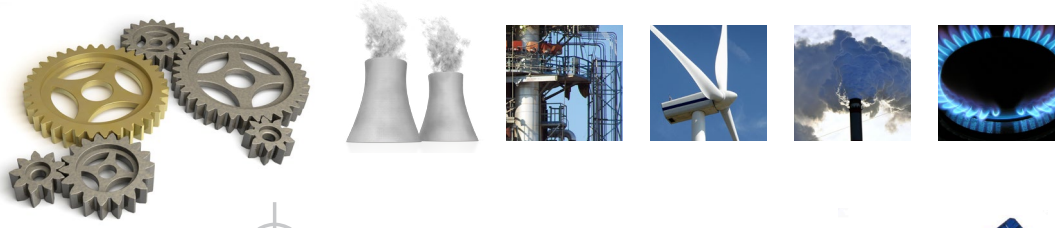
Over the past decade, the amount of solar power produced in the U.S. has jumped

139,000 PERCENT.[2]

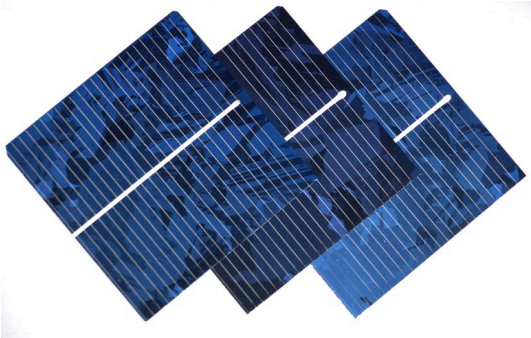
Our goal is to educate and inform decision-makers about how utility-scale solar, as a primary generating resource, will create a new avenue for cost-effective diversity in the existing power-generation infrastructure.

A BRIEF HISTORY **OF SOLAR**

Solar electricity production using PV cells is unique in the world of power generation. Every other mainstream source of electricity generation requires significant numbers of moving mechanical parts.



Solar has no moving parts.



While some people confuse this technology with other renewable resources, such as wind, wave power, hydroelectric and solar thermal, all utilize significant mechanical moving parts to produce electricity.

Simply put: PV solar is a rock that converts sunlight into electricity.

$$\text{Solar Efficiency} = \frac{P_m}{G \times A_c}$$

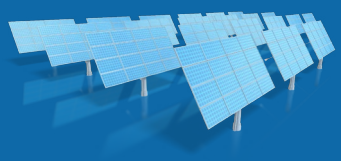
Cell's Power Output—in watts—at its maximum power point (P_m)

Input light in watts/square meter multiplied by the surface area of the solar cell, (A_c)

P_m is the maximum power output

G is the *solar insolation (light input)* in watts per square meter

A_c is the surface area of the cell



Typical efficiencies for solar cells run between 17 percent up to 20 percent. The theoretical max efficiency is 33 percent for single junction cells.

The era of PV energy production was ushered in with Albert Einstein's 1905 paper entitled: *"On a Heuristic Viewpoint Concerning the Production and Transformation of Light."*

In his paper, Einstein showed how light packets, which he called photons, could free electrons from a material. Free or flowing electrons are known as current or, to be more precise, electric current. Einstein would go on to win the Nobel Prize for this work in 1921.

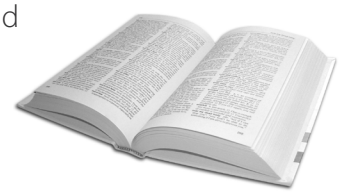
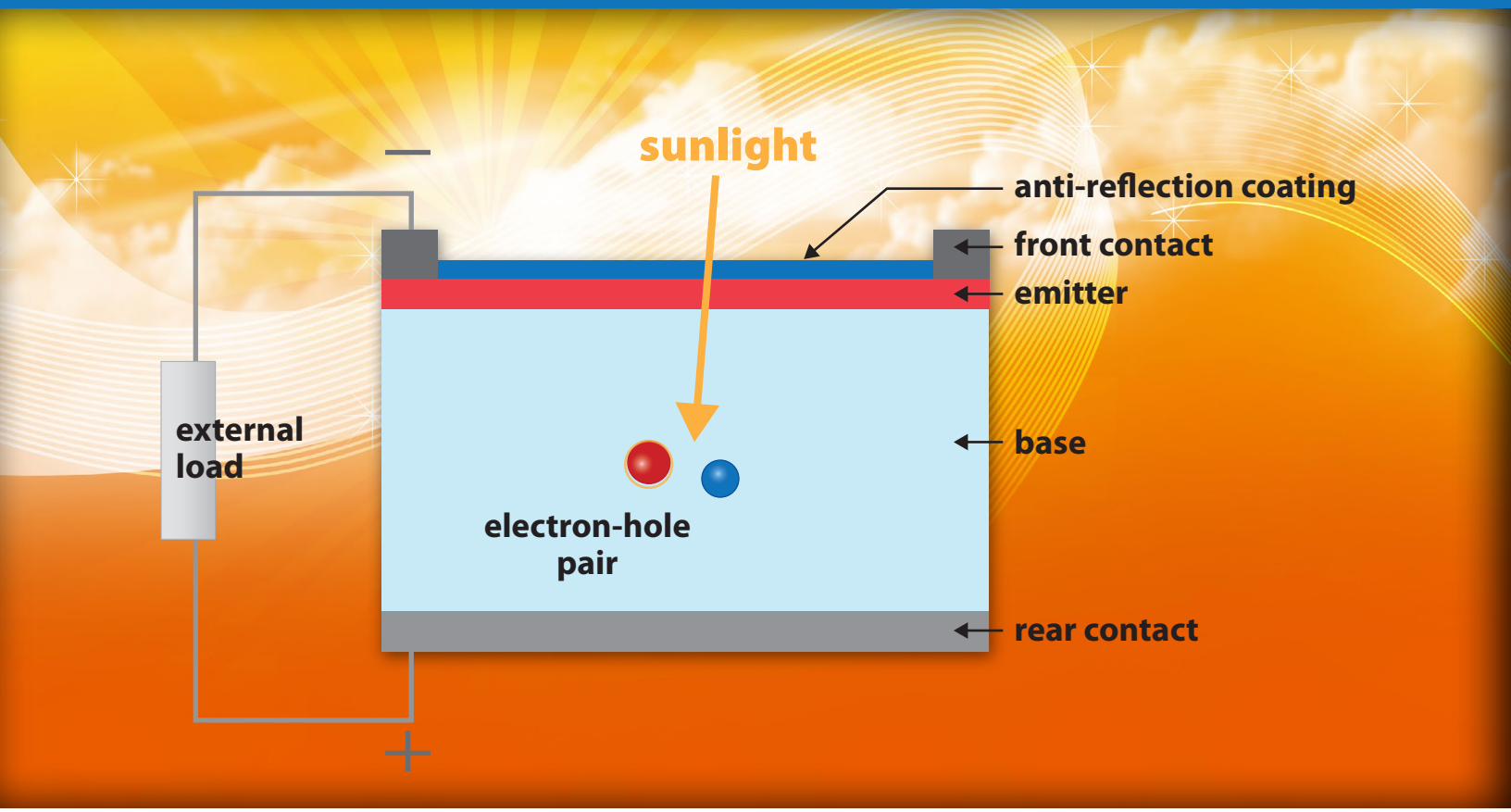


PHOTO CELL STRUCTURE

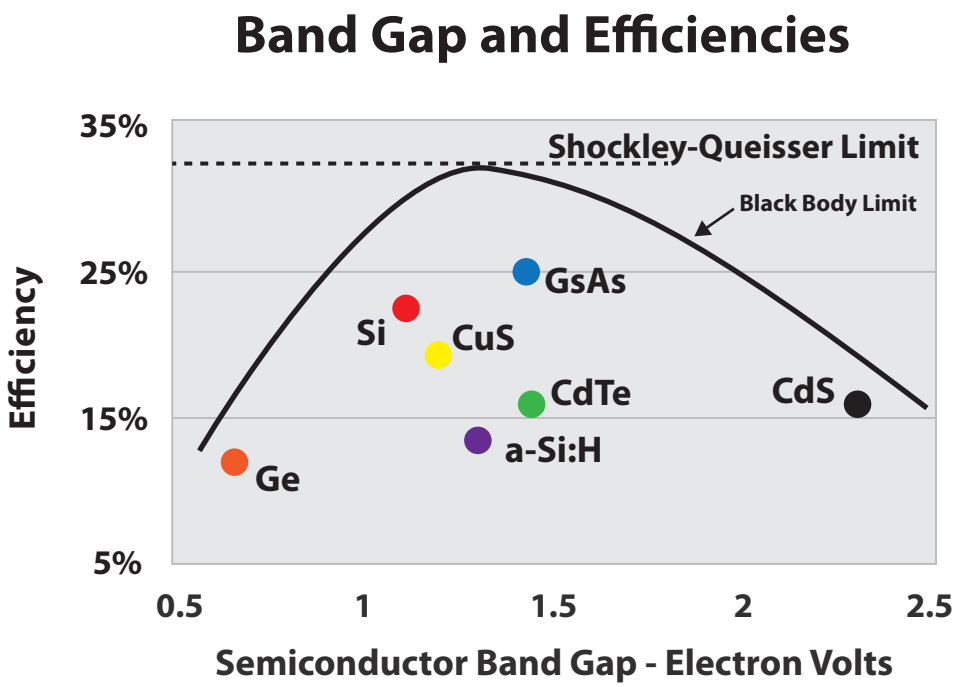


Source: http://www.pveducation.org/pvcdrom/solar-cell-operation/solar-cell-structure

IN THE LAST 110 YEARS, *since Einstein's paper,*

solar has grown into a clean, affordable source of energy that could easily support natural gas as a primary generating resource for the U.S. and the world. It should be noted that PV solar is approaching its theoretical limits in terms of efficiency, but that is not the driving force behind solar entering the mainstream.

In a calculation known as the **Shockley Queisser Efficiency Limit (SQ Limit)** the theoretical limit is set at around 33 percent.



Source: DOE, Lewish Group at Caltech; http://solarcellcentral.com/limits_page.html

Modern cells are running about 24 percent on the high side, with 17–20 percent average. So, if it is not cell efficiency that's the driving force, what is it?

The straightforward answer is that manufacturing processes are improving, making modules more affordable.

Additionally, as we build increasingly larger facilities, all of the peripheral or balance-of-system costs are also dropping.

COST **THEN**	COST **NOW**	**EXPECTED**
> $6.00 / watt	**< $2.00 / watt**	**< $1.00 / watt**

Just a few years ago, the cost to build a solar facility was more than $6.00 per watt. Now, that cost is under $2.00 per watt. Over the next five years, expectations are that the installed cost of a solar facility will be under $1.00 per watt.

SOLAR GROWTH *& Politics*

Solar power generation is essential physics and engineering, so it seems strange that historically it has maintained a political side.

What we are now demonstrating is that solar has achieved economic equality (often termed "grid parity"), and deserves a place in the mainstream of utility-scale generation. Clearly, achieving grid parity required fairly significant subsidies and governmental support. The bottom-line is that smart money invests in the future, and while some investments do not pan out, others do. Solar is clearly shining as one of the good ones that will more than pay for itself.

Leveling the political landscape for solar is now more about education than required subsidies.

That being said, many believe another two years of subsidies would accelerate the industry and dramatically improve timelines for solar as a primary utility-scale electricity resource. These authors are not in favor of subsidies, but we also recognize that all forms of energy and power generation currently have various levels of government support.

To remove the subsidies from one resource, but not the others, would provide an unfair advantage, and not reflect well on the free market.

It is very important that we differentiate from government support, designed to spawn a new technology and accelerate the market.

Clearly, the Internet, once funded 100 percent by government dollars, is a shining example.

Most importantly, in the coming years, it is expected that solar energy costs will continue to drop, allowing the technology to move through grid parity and support natural gas as an integral part of a diverse energy portfolio. In doing so, solar, a resource without variable operating costs and zero fuel costs, will help to stabilize pricing in the electric utility space.

57%

of new electric generation capacity INSTALLED IN THE FIRST SEVEN MONTHS OF 2015 **came from wind and solar.**

Source: http://www.ferc.gov/legal/staff-reports/2015/july-infrastructure.pdf

As solar achieves grid parity, a landscape will unfold where the demand for electricity continues to rise while aging power plants will close.

Engineers will search for new resources for an energy-hungry society.

—MEANWHILE—

Total global energy demand will rise by 33 percent by 2040.[3]

The country is entering a time period where a large percentage of aging power plants will need to be replaced.

51%
BUILT **BEFORE** 1980

According to the National Association of Regulatory Commissioners (NARC), 51 percent of the generating facilities in the U.S. were built before 1980, and many of those plants were originally constructed to last 35-40 years. Many of those facilities are now being rebuilt to extend their lifetimes, but many more will need to be replaced.

THE POWER INDUSTRY: A COMPARISON

COAL: *A Significant Pollutant*

While abundant, coal as a primary generating source produces significant pollution and is one of the world's biggest sources of carbon dioxide emissions.

Right or wrong, the Environmental Protection Agency (EPA) and much of the American public are opposed to new coal generation. In fact, there are currently no new coal plants under construction in the U.S. Unless a new technology emerges to reduce coal plant pollution in a cost-effective way, coal will gradually recede to a position where it is not financially or environmentally sustainable. This appears to be happening already. Virtually no new coal fired facilities are under development in this country.

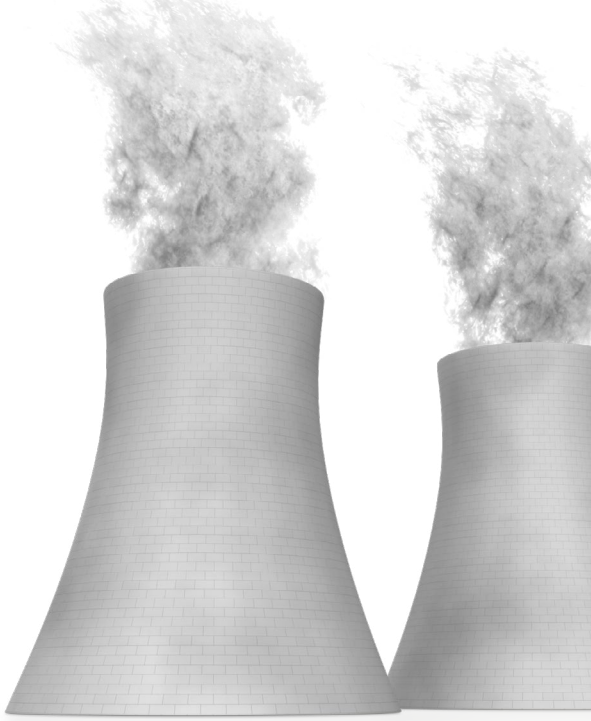
Nuclear Power Plants: *Far and Few Between*

There are a few nuclear power plants in various stages of construction and/or licensing around the U.S.

Like with coal, the general public remains skeptical about the future of nuclear. Several years ago, there was talk of a "nuclear revival," but the incident at Fukushima seems to have quelled that dream.

The last wave of nuclear power plants to be licensed in the country occurred in the early 1990s, which leaves a fairly significant gap in the number of experts to design, build and maintain nuclear facilities.

It is understandable that power companies are reticent to begin design and construction of new nuclear facilities in the current environment.



Natural Gas: *A Partner that Fits*

The good news is that the U.S. has significant resources of natural gas.

Still, over-reliance on abundant natural gas is also an issue. Most experts believe it would not be prudent to rely upon a single primary fuel for electric power generation.

Turning solar into a power partner with natural gas is an obvious fit that lends much-needed diversity to the power grid.

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RENEWABLE ENERGY SOURCES **REPRESENT THE FUTURE.**

In its forecast of the use and consumption of energy worldwide, the International Energy Agency concluded:[4]

- **DEMAND** for efficiency and regulations promoting efficiency is growing.
- **THE SHARE** of non-fossil fuels in the overall energy mix will rise from 19 percent in 2015 to 25 percent by 2040.
- **$0.60 CENTS** of every dollar invested in energy infrastructure in 2040 will be invested in renewables.
- **RENEWABLE** prices will go down, and fossil prices will rise.
- **NATURAL GAS**, the cleanest fossil fuel, is the only one on the rise globally with consumption rising by nearly 50 percent by 2014.
- **OIL WILL** return to $80.00 a barrel by 2020, and oil demand will rise to 103.5 million barrels per day by 2040.
- **COAL'S OVERALL** contribution to the world's energy demand will drop from 41 to 30 percent.

A REPORT FROM CITI RESEARCH STATES,

"Solar is here to stay."

New data from market analysis firm GTM Research finds that 2014 was solar's biggest year ever, with 30 percent more photovoltaic (PV) installations installed than in 2013. Every indicator suggests that 2015 will eclipse the 2014 records.

SOLAR CROSSES PARTY LINES

Over the past few decades, solar has been supported primarily by the Democratic Party, and ignored or opposed by Republicans.

But this scenario is changing.

Political opponents of solar energy who remain entrenched, and working behind the scenes to thwart government support on behalf of energy monopolies, ***are working against the best interests of the American public***.

In defense of the Republican position, *as recently as 2009,* natural gas power plants were constructed for well under **$1.00 per watt**, while **solar was running 25–30 times** that number.

TODAY, THE STORY IS VERY DIFFERENT **AND QUITE COMPELLING.**

PV solar cell prices have dropped by a factor of 100 over the last 35 years—and by a factor of 10 over the last 15 years.

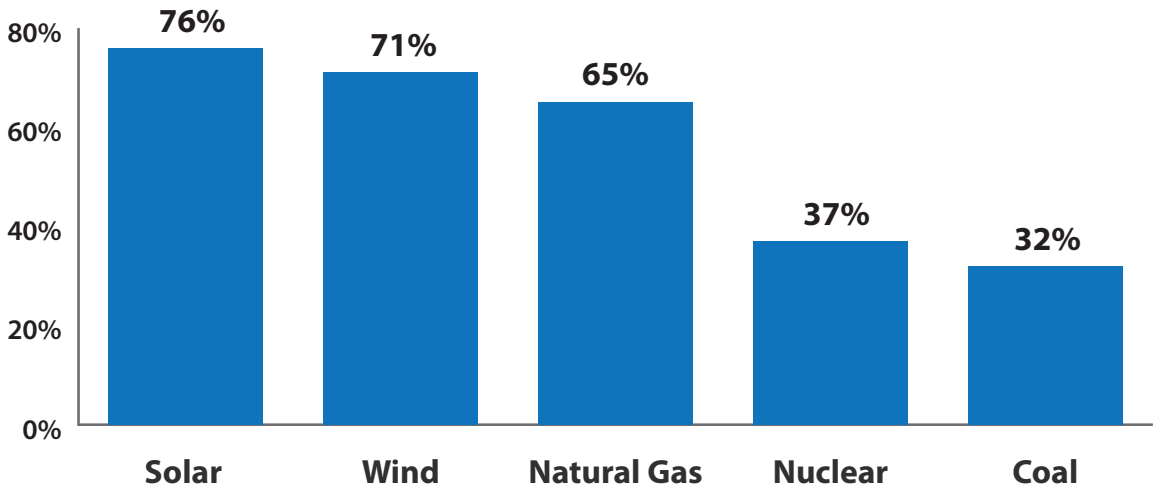
The 2015 Q1 average solar cell price was $0.31 per watt and the average solar module price was $0.72 per watt.[5]

NO CREDIBLE ANALYST COULD HAVE PREDICTED THIS TREND.

The goal of this paper is to illuminate this remarkable trend to those who have not been monitoring the industry.

What's more, a majority of Americans want the U.S. to put more emphasis on **producing domestic energy** using solar power (76 percent), wind (71 percent), and natural gas (65 percent).[6]

Americans' Emphasis On Domestic Energy Production



Source Data: GALLUP—http://www.gallup.com/poll/161519/americans-emphasis-solar-wind-natural-gas.aspx
Chart by © Prinicipal Solar Institute

Far fewer want to emphasize the production of oil (46 percent) and the use of nuclear power (37 percent). Least favored is coal, with about one in three Americans wanting to prioritize its domestic production.[6]

Despite this prevailing sentiment, **solar continues to play a perplexingly minimal role in the U.S. infrastructure**, providing less than half of one percent of the energy produced in the U.S.—*even with its potential to power the entire country 100 times over.*[7]

THE BOTTOM-LINE, with regard to free enterprise—**the Republican Party and solar should be aligned**.

This country has invested in the technology, and that investment is beginning to pay off. As the rewards accrue, and as solar becomes an integral and important part of our energy infrastructure, this renewable energy source will support natural gas by lowering the amount we burn each year—thereby increasing the lifetime of that non-renewable resource.

Looking forward, one can rely on fundamental Republican principles to guide the pathway.

Republicans support the right of the individual to decide on important issues like healthcare and schools, so why not add affordable solar energy to that list?

SUBSIDIES VERSUS INVESTMENT

According to the Cato Institute, the federal government spent $92 billion on corporate welfare in 2006, and those dollars continue to increase at a rate greater than the inflation rate.[8]

We think we can all stipulate that the federal government spends too much on corporate welfare programs. The real question is whether a case can be made for government spending dollars that help create new industries.

Many people are surprised to learn that, like the renewable space, fossil fuels are also the beneficiary of subsidies.[9] Several years ago, the government began providing financial support for solar. At the time, solar was a developing technology that was a long way from becoming part of the mainstream energy infrastructure. Still, one could make a good case for the fact that solar would not have reached its current level of success without those dollars. Historically, government spending appropriations on the Internet and space systems, such as GPS and satellite communications, have helped to create some of the most important and vibrant industries in our capitalist society.

BASED ON THE CURRENT TREND LINES, one can see that government **appropriations in solar energy have begun to spark** the beginning of an industry that is now (early 2016) just a few years from supporting existing electric utility infrastructure, and having the potential to **generate significant returns for investors**, as well as clean and affordable energy for the consumer.

AMERICA IS A COUNTRY THAT PRIDES ITSELF ON ITS PIONEERING **SPIRIT & INNOVATION.**

The most prevalent modern example of the pioneers who built this country are the entrepreneurs.

Entreprenuers tend to do things that the mainstream believes is impossible.

Many of the greatest success points in government-appropriated tax dollars come from those that spawned entrepreneurs to step in and take radical steps that rapidly created new industries. Obviously, the modern examples of this are microcomputers, cell phones, the Internet and even the new and exciting space program.

TODAY, SAVVY ENTREPRENUERS PERMEATE THE SOLAR INDUSTRY.

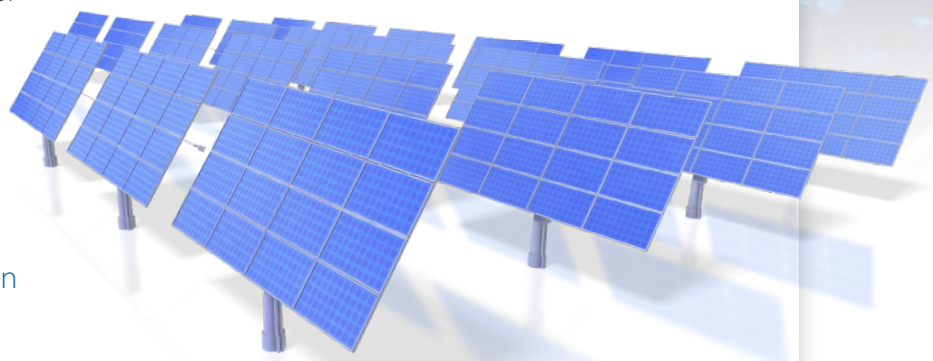
While Solyndra is the modern poster child for government waste, mistakes will be made in any investment cycle. Nevertheless, the solar industry is on the precipice of changing the world, and that change would not be possible without the research and development dollars from corporations and governments worldwide. The key in differentiating between corporate welfare and support for American innovation—and the entrepreneurial pioneering spirit—is to look for the entrepreneurs and pioneers. When the entrepreneurs and pioneers leave the industry, that's the time to look elsewhere.

RENEWABLE + CLEAN - CLIMATE CHANGE = SOLAR IMPACT

It is no secret that, for many conservatives worldwide, the jury is still out on climate change. The purpose of this paper is not to discuss or debate that issue. The stated theme of this white paper is to clarify the facts on why Republicans should support utility-scale solar power.

With regard to solar power, the question of climate change can be completely eliminated because solar has reached an efficiency and price point where it does not need the potential of climate change to bolster support. Stated differently, Republican support of PV solar should not depend on the credibility or verisimilitude of anthropogenic climate change.

Solar is a renewable, clean resource for electricity production. It is renewable simply because it does not require a fuel supply that is depleted as we use it. Every ton of coal we burn is a ton less on the planet. Every cubic foot of natural gas we burn is a cubic foot no longer on the planet.



The fuel for solar is sunlight, which is free and un-taxed. It renews every morning when the sun rises in the east.

Many Americans correctly believe that natural gas is one of our most important natural resources.

The best news about solar is that every megawatt hour of electricity produced by solar extends the lifetime of our natural gas supply.

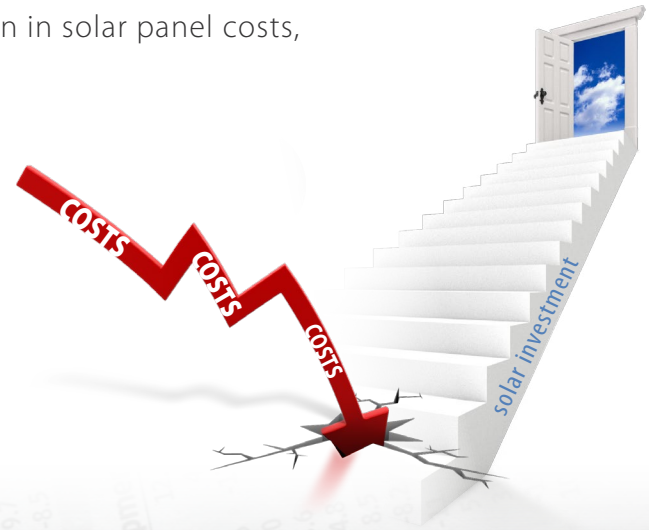
It has been said that Republicans like pollution and dirty air. *This is simply not true*. No political party has a monopoly on a love of clean fresh air. It is a common value that spans politics, religion and nationality. Solar PV electricity generation is essentially a manufactured rock that converts sunlight into electricity. There are no moving parts, and no pollution is created in the generation of that electricity. Solar is clean, and clean is and should stay a Republican value.

SOLAR AS A SMART INVESTMENT

Deutsche Bank investment analysts state that the economics of solar have improved significantly as a result of the reduction in solar panel costs, financing costs and balance-of-system costs.

OVERALL SOLAR SYSTEM COSTS **HAVE DECLINED**

at approximately 15 percent compound annual growth rate (CAGR) over the past eight years, and the marketplace **can expect another 40 percent cost reduction** over the next four to five years.[10]



The solar sector has been generally under-owned by institutional investors, *according to Deutsche Bank,* but greater institutional ownership will drive positive momentum for the sector over the next 12-18 months.

Furthermore, a number of new business models focused on the downstream part of the value chain will emerge, as will innovative private companies to drive cost improvement/solar adoption. Companies involved in the financing/downstream part of the value chain can anticipate the most significant shareholder value in the near term.[11]

THE INVESTMENT BANK ALSO PREDICTS

SOLAR SYSTEMS WILL BE AT GRID PARITY IN UP TO 80% OF THE GLOBAL MARKET

within two years

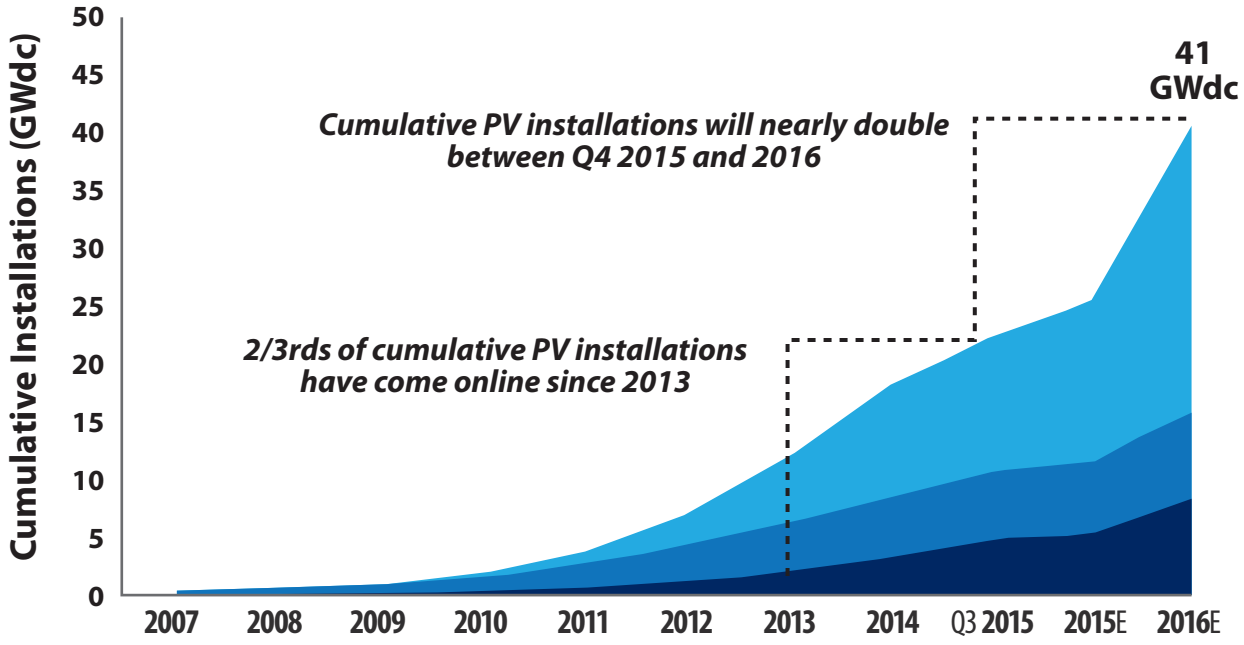
—and says that the collapse in the oil price will not impede the solar juggernaut.[12]

For the fourth consecutive quarter, solar was the top sector driving Q3 2015 job growth.

At more than 20 solar projects located across the country, about 7,300 jobs were announced either in the solar power generation or solar manufacturing industries. Declining materials costs and favorable policies have spurred recent growth.

Source: https://www.e2.org/ext/doc/2015_Q3_Report_Final_HR.pdf

Cumulative U.S. PV Installed—2007-2016E



Source: GTM Research U.S. Solar Market Insight Q3 2013

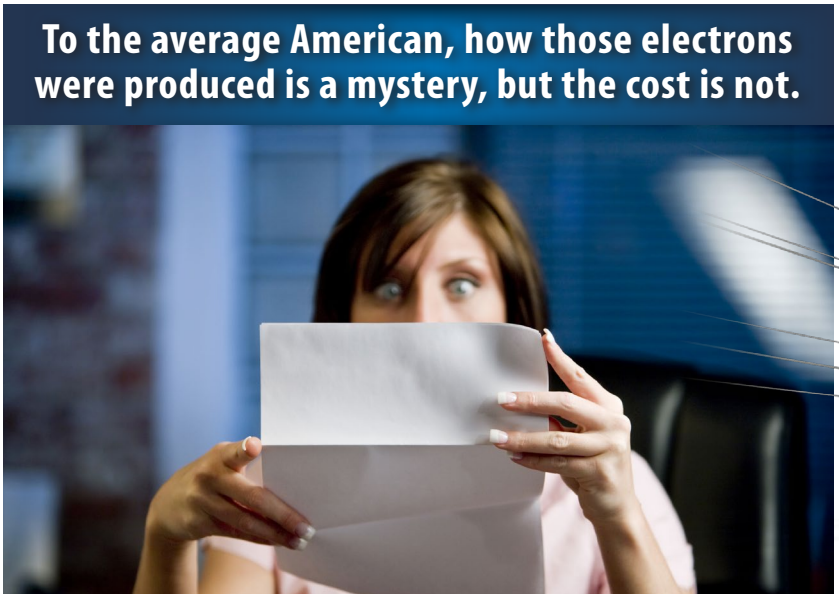
As the downward trend in cost of solar has progressed, the electric energy industry around it has grown.

The chart above shows dramatic growth in the utility sector of the solar industry. Clearly, this growth is a function of cost, reliability, demand and availability. Once again, this information reflects decision points that will influence Republican and mainstream capitalist support.

The rise of solar, mirrors growth seen in silicon revolution that has driven the development of the computer over the past 50 years. Consider the progression from computers that once filled a room to the smart phone fitting inside a pocket. The same silicon drivers accelerating the downward cost of computer technologies are propelling cost improvements in solar.

Ultimately, the free market should be the primary determining factor, although not the sole determinant. Many of the failures and bankruptcies in the solar industry serve as a warning for companies that build more efficient panels featuring "cool" technologies and a high per watt price tag. The message should be clear: the consumer is buying electrons, which conveniently flow into a wall plug as opposed to cool panels or panel manufacturing.

The origin of that electricity, whether it emanates from nuclear, coal, natural gas or solar, is indistinguishable even to the best electrical engineer.



Again, the lesson for those who persist in opposing solar investment: price is everything.

SOLAR AS THE **IDEAL POWER PARTNER**

Many people advocate that the U.S. should regain its position as an energy-independent nation.

According to the Energy Information Administration (EIA), there are approximately 2,276 trillion cubic feet (Tcf) of recoverable natural gas in the U.S. In 2013, the rate of consumption was 27 Tcf per year, which means we have just over 84 years of supply. If coal plants begin closing and are replaced with natural gas, that 27 Tcf per year will increase, and the 84-year calculation will drop.[13]

Once again, solar is a good partner for natural gas. One could drill down on this a bit more, understanding that solar only produces when the sun is shining.

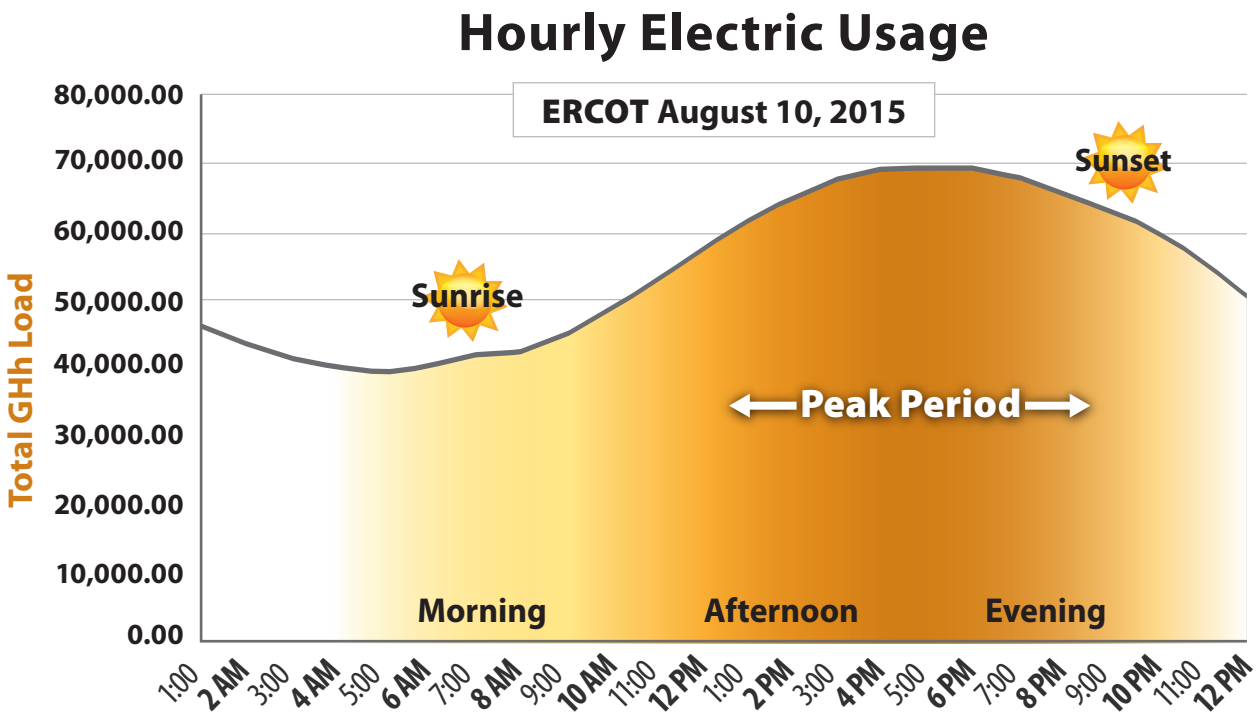
The good news is that power consumption is highest when the sun is producing the highest insolation.

1, 2, 3

1. **Solar generates during the day** when electricity demand is highest.
2. **Solar extends the lifetime supply** of natural gas while producing electricity at about the same cost.
3. **Solar adds much needed diversity** to the grid as aging nuclear and coal plants are closed.

SOLAR CAN READILY BECOME WHAT IS KNOWN AS A PEAK-LOAD GENERATING FACILITY.

Peak power generation is currently being handled by power plants that have the ability to turn on quickly, and run for short demand periods (known as peakers or gas peakers). As a rule, they are significantly less efficient than combined cycle plants and much more expensive to operate.



Source Data: http://www.ercot.com/gridinfo/load/load_hist/index.html | Chart by © Prinicipal Solar Institute

With solar costs on the decline, this clean, renewable energy has emerged as a viable "power partner" for generating cost-effective peak generation energy.

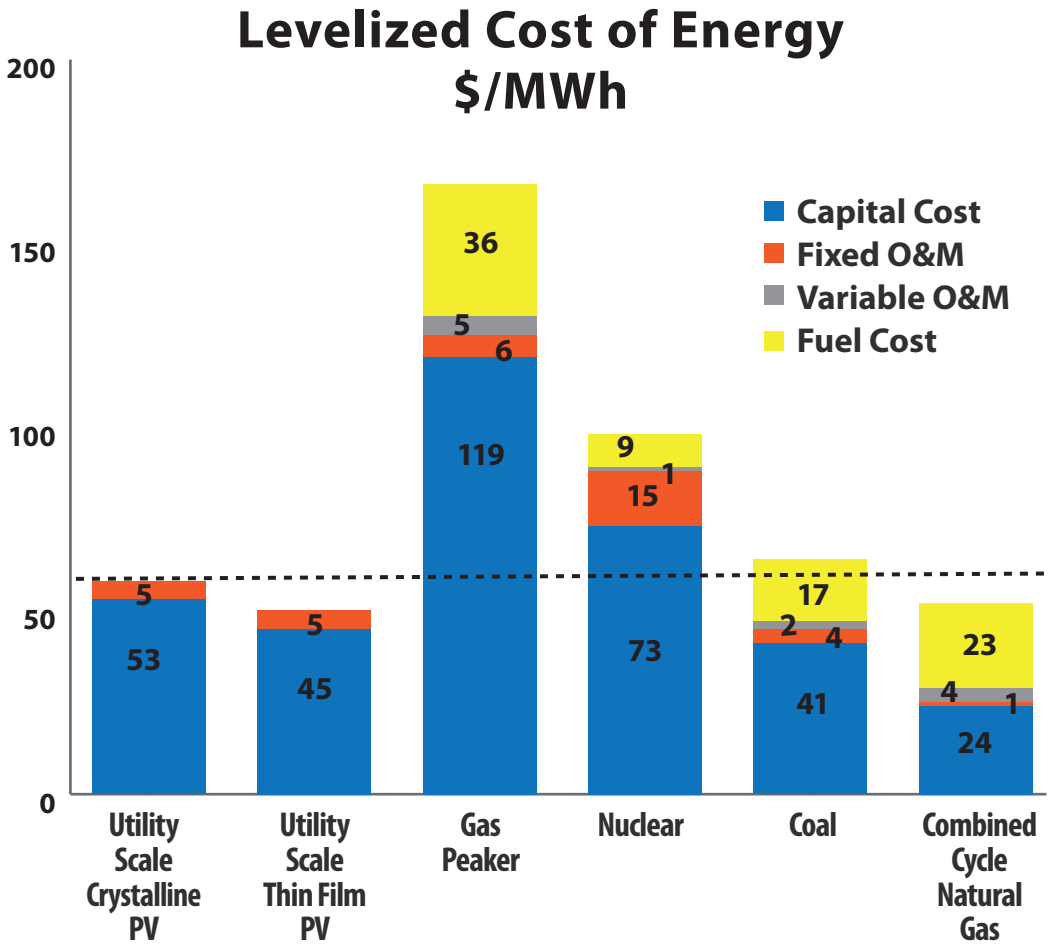
This is important given that in 2010 the U.S. electricity generation was 4,361 billion kWh gross, with annual electricity demand projected to increase to 5,000 billion kWh by 2030.[14]

THE REAL QUESTION TODAY MIGHT REMAIN:

HOW DOES SOLAR STACK UP WHEN COMPARED TO TRADITIONAL UTILITY-SCALE GENERATION?

The best place to turn for the answer is the annual Lazard study.

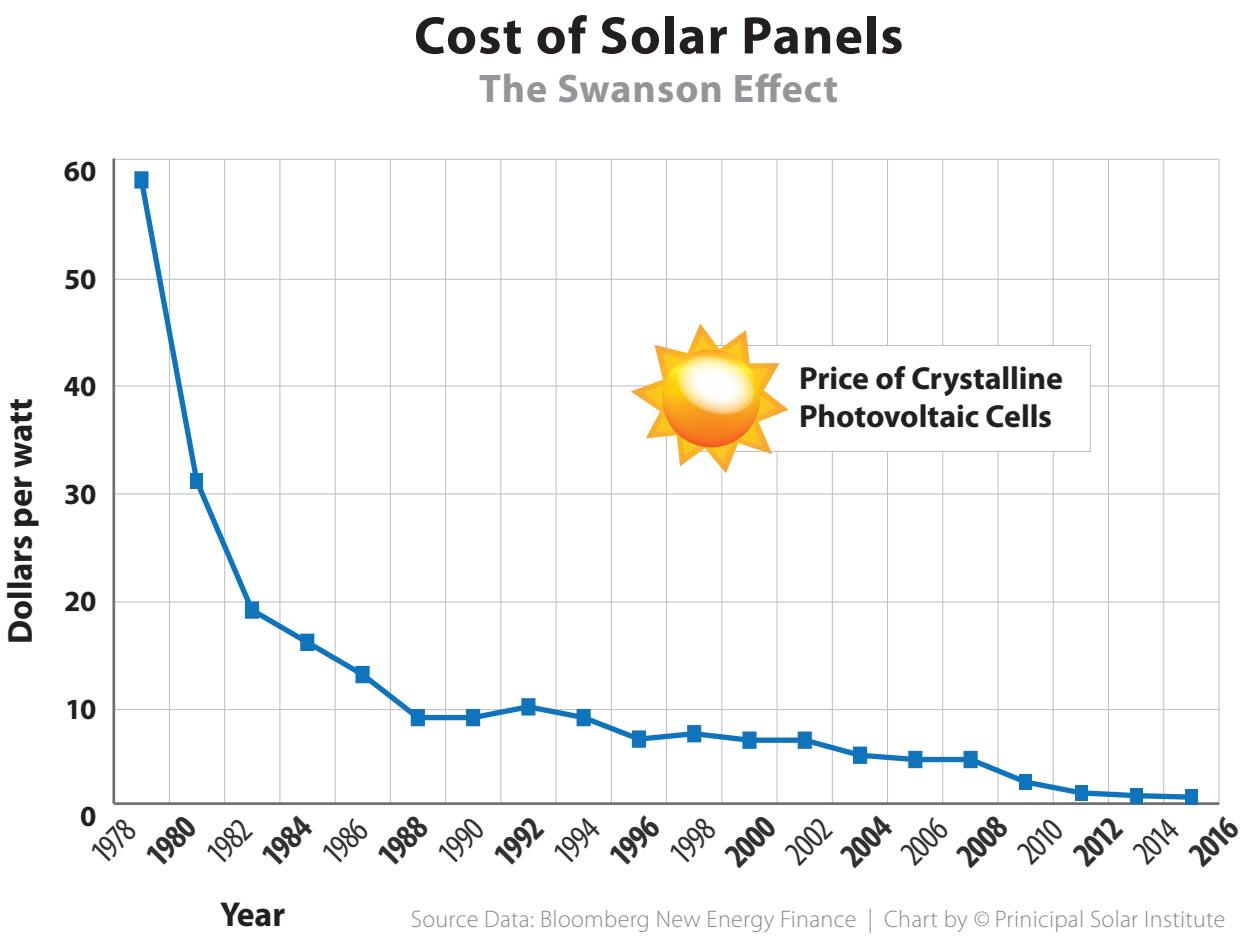
The chart below was developed from the November 2015 version of Lazard's annual Levelized Cost of Energy analysis. In the report, Lazard notes that this version of the data is on an unsubsidized basis. For clarity, subsidies have been removed from the solar analysis, as well as from the traditional generation. It clearly shows that solar has nearly reached a point where it can support existing infrastructure as a primary generating resource.



Source Data: Lizard Levelized Cost of Energy—Version 9, November 2015 | Chart by © Prinicipal Solar Institute

With a closer look at the chart, one should be able to see that the two solar data points do not have fuel costs or variable operating expenses. Gas peakers are the generators that kick on during peak demand periods and, as such, are the power plants that directly compete with solar.

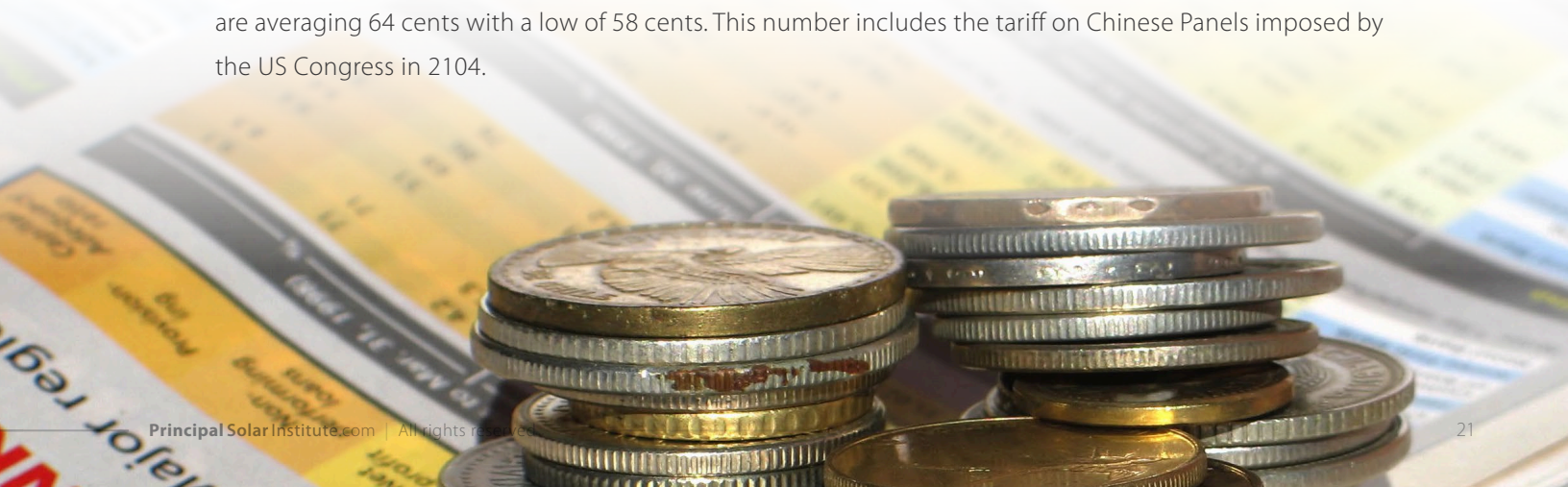
Perhaps the most compelling chart is the trend line in the cost of solar panels since 1978.



The data set has become known as Swanson's Law, similar to Moore's Law in the semiconductor industry.

Richard Swanson has observed that photovoltaic modules tend to drop in price 20% for every doubling of shipped volume.

Based on this trend, costs should be reduced by half every ten years. As of January 2016, tier 1 modules are averaging 64 cents with a low of 58 cents. This number includes the tariff on Chinese Panels imposed by the US Congress in 2104.



CONCLUSION

In this paper we have shown how over the last two decades, solar energy has experienced one of the most remarkable growth curves and cost-reduction trends in the U.S. technology sector.

Specifically, three factors have surfaced as driving forces in the future of electricity as it applies to the utility segment of the market:

- **The cost of solar has dropped significantly year-after-year**, and is now approaching a point where solar is cost competitive with traditional generation.
- **Because of improved manufacturing and reduced costs**, the amount of solar installed worldwide has grown exponentially over the last few years.
- **The demand for new electricity will continue to grow** as existing, aging power plants are closed.

It was America's post-World War II commitment to infrastructure and science that contributed to the nation's current prosperity. Innovation demands forward-thinking leadership across the board—and across the aisle. The reality is that the U.S. can only win the future if we invest in it.[15] As a nation, we have made both good and bad decisions with regard to technology investments. Many of the bad ones are largely forgotten, though most still remember Solyndra in the scope of very bad solar investments. It is important to note that the road to success is often littered with mistakes, but again, solar in general is well on its way to being an important "success" component in our energy infrastructure.

As we write this, the solar industry is experiencing a downturn on the public market. We believe this is a temporary trend that will be followed in the coming months by a significant uptick. Still, the solar companies that have adhered to the basic tenets of the free market have done well over the past few years, and will continue to do so into the future.

Conservatives should begin to understand that solar power can be consistent with free market principles that emphasize the **ideals of individual choice and private sector economic empowerment.** In fact, national surveys show overwhelming support for solar energy and other renewables as the best solution for diversity in power generation and present security issues.

Republicans and Democrats are now aligned in their support:

A poll conducted by the Pew Research Center found that 73 percent of Americans—*including 58 percent of Republicans*—support increasing federal funding for solar, wind and hydrogen, and 58 percent believe developing renewables should be at the top of the U.S. energy agenda.[16]

Clearly the beginning of a new age for solar has arrived in this country—introduced by support from our federal government, but now driven by its own momentum. Our intent with this paper has been to demonstrate to decision-makers that utility-scale solar, as a primary generating resource, can create a new avenue for cost-effective diversity in the existing power-generation infrastructure.

ABOUT THE **AUTHORS**

Michael Gorton, *CEO and Chairman,* **Principal Solar, Inc.**, is a prolific author and serial entrepreneur who draws on his extensive business expertise, scientific education and engineering training to serve as a strong voice and proponent of the solar power industry. As founder of the Principal Solar Institute, Gorton is an advocate of solar education across all sectors worldwide.

Mark Victor Hansen, *Founder and Co-Creator,* **Chicken Soup for the Soul** franchise, *and Advisor,* **Principal Solar, Inc.,** gained international recognition for authoring a series of personal transformation guides that sold over 500 million worldwide. Hansen and his colleague turned Chicken Soup for the Soul into one of the most successful publishing franchises in history.

Retired Lt. Col. Allen West, *President and CEO,* **National Center for Policy Analysis** (www.ncpa.org), served in the U.S. Army for 22 years, and received many honors, including a Bronze Star, three Meritorious Service Medals, three Army Commendation Medals and a Valorous Unit Award. In 1993 he was named the U.S. Army ROTC Instructor of the Year.

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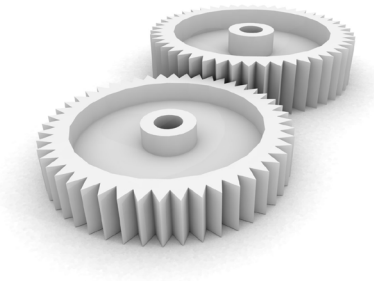
MORE **INFORMATION**



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PRINCIPAL SOLAR INSTITUTE

Illuminating and Rectifying the Politics Behind Utility-Scale Solar

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