Michael Ortiz

Professor Davenport

Environmental Ethics

12 May 2016

The Future is Solar

As the Paris agreement has shown, the world has come to a consensus about the harmful and dangerous repercussions of burning fossil fuels. While some optimists insist that new oil and natural gas sources will be found in the coming years, one day we must come to terms with the finite nature of fossil fuel deposits. In order to ensure a less volatile, and cleaner energy market, the world needs to transition into more renewable sources of fuel. In his book *The Great Transition* Lester Brown dismisses the possibility several alternative schemes will be able to assume the bulk of our energy needs when transitioning away from fossil fuels. New hydroelectric projects have, for the most part, halted, and they can be incredibly ecologically damaging when they are built. Nuclear is too expensive and poses too great a liability for governments, so Brown doubts it will ever be accepted as our primary source of energy. Solar, on the other hand, presents a realistic and currently viable alternative. New solar technology is constantly being developed, and the field has begun to receive enormous amounts of investment from both the private and public sectors. According to Brown, "solar costs are falling so rapidly that they are starting to squeeze out coal" (Brown, xiii). There are obstacles to a complete solar transition, but many of these are either within reach, or are already being addressed.

Obstacle number one: the electric grid in the United States needs to be updated. Solar energy can generate as much power as is invested in it, but if we are feeding it into an inefficient

grid, we face billion dollar losses and are wasting good energy every year. Harry R. Weber and Mark Chediak predict that the United States would need a $2 trillion push to blend renewable energy into the power supply and fortify transmission lines against extreme weather. Even with such an investment, Americans would need to increase the efficiency of their homes to the level of their European counterparts. Chediak and Weber point out that French, Italian, and German consumers enjoy lower monthly bills even with electricity rates "as much as three times higher" than those in America (Chediak and Weber). This is due largely in part to smarter technologies, smaller homes, denser populations, and more efficient appliances. Furthermore, U.S. power grid investments have lagged nearly $50 billion behind European investments since 2000 (Chediak and Weber). Many U.S. power companies have taken up energy efficiency campaigns, including Houston based Direct Energy, the largest competitive retail power supplier in North America. It is encouraging customers to install smart water heaters and energy efficient air conditioning systems to help cut demand. Also, they offer Google Nest, a smart-home product that offers a potential 10-12% reduction in heating bills and a 15% reduction cooling bills (directenergy.com).

Adding more wattage to the grid will also require new power lines. It is suggested the 22,700 miles of new electrical "highways" will be needed to send excess power generated from solar plants to clients across the country and into batteries (Wald, 58). In order to send this energy more efficiently for longer distances, larger 765kV lines will need to be installed as opposed to the normal 345kV wires (Wald 58). Along with being physically taller and more obstructive, these lines will require large, expensive conversion stations to bring the power from DC to AC. Matthew Wald estimates that the power lines alone could cost up to $60 billion, not to mention the cost of the power conversion stations -- one of which in New Mexico cost $1 billion.

Another stumbling block comes from the difficulties associated with any interstate project. Power lines would cut through tremendous swathes of property and require a long complicated bureaucratic process to get approved. While the task is large, and would require a "strong national mandate for renewable energy," it is becoming increasingly necessary (Wald, 61). In Texas, millions of dollars have been invested in wind energy, but companies are finding that they do not have "enough local customers to buy it" (Wald, 61). In many cases like this, the supply and the demand for renewable energy exist, but the long range power grid to connect them does not.

The second obstacle is reaching grid parity on a large scale. Once solar energy becomes cheaper than, or the same price as, all other sources of power, it should take hold due to market economics alone. Luckily, grid parity has already been reached in many places do to government incentives. In the history of solar power's development, government subsidies and "forward thinking energy policies" have allowed solar to move to the next level (Brown, 68). China has recently gotten into the solar power game and currently has the second most generating capacity in the world behind Germany. Their foray into solar has been one of modest predictions and tremendous growth. For example, the Chinese government originally aimed to have 20,000 megawatts of capacity in operation by 2020, but now that number has been revised to 70,000 megawatts by 2017 (Brown 70). China's neighbor, Japan, has also begun to ramp up solar adoption. After the Fukushima incident, Japan doubled its solar capacity to 14,000 megawatts due to "generous… incentives" from the government (Brown 72). Similarly, India's government plans to boost its target to an ambitious 100,000 megawatts by 2022 (Brown 72). In order to fund the "ultra-mega solar parks" that will make up such an enormous capacity, India has recently

doubled its tax on coal, a move that will encourage solar use and discourage coal at the same time (Brown 72). To the west, even the great oil nation of Saudi Arabia plans to develop 41,000 megawatts by 2032 using a combination of photovoltaic and concentrated solar thermal projects. This ambitious goal could supply two thirds of Saudi Arabia's energy needs (Brown 73).

In many cases, governments do not need to be, and indeed are not the main driving force behind solar adoption. Market forces themselves are bringing solar to the forefront of energy investment schemes. For example, Australia has 8,000 rooftop photovoltaic systems in 2007 and in 2015 there were more than "a million" (Brown 71). Lester Brown suggests that the uptake in adoption was caused by rising energy costs from traditional utilities companies after they undertook a $45 billion upgrade to Australia's electrical grid. Pointing to the high distribution costs, Brown emphatically states that "in a growing number of places in Australia, coal-fired power would not be able to compete with solar even if the coal itself were free" (Brown 71). Compared to the 15 cents per kWh "distribution charges" from the traditional grid, solar's 10 cents per kWh is a bargain.

Unlike some of the countries previously discussed, the United States does not have any official national government targets, but solar is growing anyway. Due to the lack of a unified approach, the success of solar is distributed unevenly among the states. For example, California, Arizona, New Jersey, North Carolina, Massachusetts and Nevada all lead the U.S. in solar capacity largely due to their solar friendly "policies" like "rebates for panel owners, renewable electricity mandates for utilities" (Brown 73). When looked at from a nationwide perspective, however, solar is being adopted in the United States largely due to positive market conditions and hefty private investments. Prices of PV are falling steadily. A 9% drop in price occurred

between 2012 and 2013 for residential systems and a 16% drop for nonresidential (Brown, 73). Brown is hopeful that solar adoption will be contagious among neighbors, and predicts the number of individual PV systems to rise to 1 million by 2016, up from 600,000 in 2012 (Brown, 74).

While complete market saturation can be difficult, some companies are taking on creative solutions to make solar viable for a greater consumer base. For example, construction companies have begun offering built in solar options in their residential divisions. Some homebuilders, such as Lennar in the United States, have already made solar installations standard procedure in select neighborhoods. Solar can also help companies stand out in the market. Ichijo Co., a Japanese firm, installed solar technology on 90% of its new homes in 2012 in order to gain a "competitive sales edge over other home builders" (Brown 72). Now that firms have begun using solar as a selling point, more will be pressured to adopt the practice to stay in business. Brown goes further to predict that more than half of home builders will offer solar panels as an option by 2016 (Brown 74).

On the other hand, tapping into the residential market poses an understandable challenge, for most people are already living somewhere and are not affected by new homes. David Whitford at Inc.com estimates that 80% of U.S. residents could not directly install solar solutions even if they wanted to (Whitford). Whether living in a house with no direct sunlight hitting the roof, or living in an apartment complex, location poses a significant barrier to adoption. Fortunately, the company Yeloha has launched in hopes of fixing that problem by becoming the "Airbnb" of solar. (Whitford). Yeloha targets homeowners with sufficiently sunny roofs for an installation, but without the capital needed to invest in one. Yeloha funds all aspects of the

installment, and once the unit is operational, other residents can buy into the productive output (Whitford).

Solar adoption will bring massive changes to the utilities game which can be both an obstacle and a blessing. Increased usage of solar power is cutting into many traditional utilities company's profits, causing them to raise their rates. As we have already seen in Australia, higher energy costs from the grid can ramp up solar adoption due to homeowners looking for a cheaper alternative. While this can be good for consumers, utilities are having a harder time coping. In Germany, massive solar expansion due to a government mandate caused a drop in market value of more than half between 2009 and 2013 for the leading utilities companies (Brown 76). Both solar and wind power expansions, as well as increased efficiency in use (leading to lower demand) have made many of Germany's centralized power plants "uneconomic to run" (Brown, 76). Notwithstanding the damage to their corporate profits, the shutdown of these plants means taking "19,000 megawatts of coal and natural gas plants" offline, which is very good for the environment (Brown 76). We already have examples of solar edging out fossil fuels! Massive losses are forcing traditional utilities to adapt their business strategies. For example, one of Germany's largest power suppliers, RWE, will become "more of an energy services company" which will be "managing and integrating solar and other renewables on the grid" (Brown, 76). Like Houston based Direct Energy, RWE will begin "consulting on energy efficiency" by "selling energy-saving tools such as smart thermostats" (Brown, 76).

On the other hand, in the U.S., utilities companies will not go down quietly. Many are combining their efforts with fossil fuel giants to fight the market takeover by renewable energy. Proposed legislation would attack "net metering policies' which allow homeowners to sell the

excess energy generated by their solar installments back to the grid (Brown, 77). Even with this potential threat, Brown remains optimistic. Recently Barclays downgraded the "entire U.S. electricity sector" in view of its unpreparedness for solar power. Even financial analysts believe that solar is the future of the market, and the "roadblocks" utilities companies are trying to set up to halt its adoption are futile (Brown 77).

Still, there are some smart American companies and investors catching on to the trend. Austin Energy plans to get "55% of its electricity from renewable sources by 2025" (Brown, 78). They are driven largely by economic incentives. The photovoltaic installations they are investing in will provide power at 5 cents per kilowatt hour, thus undercutting the price of natural gas generated electricity by 2 cents per kilowatt hour, coal-fired electricity by 5 cents per kilowatt hour, and nuclear by a further 8 cents per kilowatt hour (Brown 78). Furthermore, two of the country's richest investors, Ted Turner and Warren Buffett are "plowing billions of dollars into solar power plants" (Brown 78). For example, Buffett invested $2.5 billion into several California plants with a combined capacity of 1420 megawatts (Brown 78). Additionally, new investment schemes called yieldcos are making it easier for renewable energy companies to finance their projects. Marley Urdanick summarizes the concept perfectly:

> "Renewable energy projects face some uncertainty during the development stage but tend to produce low-risk cash flows once they are operating. Yieldcos have the potential to unlock the value of these renewable assets. Yieldcos may attract new investors who may otherwise perceive unacceptable risk or lack the appropriate channels to invest capital in renewables. In exchange for the opportunity to invest in relatively low-risk assets, yieldco investors typically receive 3%–5% returns and long-term dividend growth targets of 8%–15%. (Urdanick)

Yieldcos allow solar companies to finance several projects using one portfolio that offers steady returns. In this model, the investors do not need to be interested in solar power's environmental

benefits, they are drawn in by the promise of profit. For example, Atlantica Yield, formerly known as Abengoa Yield, finances two 280 megawatt solar installations in the United States using the yieldco model (Altanticayield.com). Yieldcos are changing the game; since 2013 they have acquired "over 8 gigawatts of assets in their portfolios (renewables account for 78%) and have raised a total of $3.8 billion" (Urdanick). Massive investments allow companies to finance more expensive projects and research. One subset of the solar industry, concentrating solar power (CSP), which "uses mirrors to concentrate sunlight to drive conventional steam turbines" requires large upfront costs (Brown, 79). In 2014, the total worldwide capacity of Concentrating solar power plants was at 4,100 megawatts with Spain and the United States being the largest contributors to that number. While CSP may not make up a large portion of the total worldwide solar capacity, it offers a solution to the problem of productivity dropping off at night. By heating up molten salts which can store heat for up to 18 hours (specifically in the case of the Abengoa plant in the Atacama desert) CSP plants are able to generate power around the clock (Brown 80).

Unfortunately the added investment to the solar sector is not always peaches and cream. Increased production of photovoltaic cells, largely due to expansions in efficiency outside of China, has lead to a concerning manufacturing oversupply. Analysts from Credit Suisse warn that manufacturers face "an exacerbated oversupplied environment in 2016" (Jobin, Ky, and Mandloi). They predict that manufacturing firms are "planning on adding" close to 10 gigawatts of cell capacity" to a market where demand is only predicted to increase to about 6.1 gigawatts. (Jobin, Ky, and Mandloi). This unfortunate miscue could leave several solar cell manufacturers vulnerable to stock calls. Credit Suisse predicts a dollar dip in stock price for two major solar firms, JA Solar Holdings and Trina Solar Limited (Jobin, Ky and Mandloi). While increased

capacity means cheaper consumer prices and therefore faster solar adoption, the volatility of the markets will always play a role in the future of solar.

Perhaps an equal amount of volatility for solar's future originates in the global supply chain of rare earth metals needed to create the cells. Critics often argue that the raw materials limitations due to the amount of precious metals used in photovoltaic cells will prevent solar from building up enough capacity to displace fossil fuels in the future. Supply chains of "copper, silver, silicon, [and] indium" must be watched closely in order to make a proper prediction (Berry). Luckily, even as metal prices rise, lower cost substitutions are being found. For example, when silver "spiked to US$49 per ounce" some manufacturers were able to replace it with a cheaper metal, copper (Berry). To complicate the mix, manufacturers must play a delicate balancing game between keeping cost down by using replacement metals and keeping their cells at competitive efficiency. Beyond just silver, cheap solar panels require tellurium, which is "three times rarer than gold" making up only $1x10^{-7}$% of earth's crust (Jones). Even with such incredible scarcity of these metals, which are used in nearly every tech product on the market, recycling rates are incredibly low. For example, 49 millions tons of "e-waste" are thrown away each year from products ranging from cellphones to refrigerators, but only 10% of that is recycled (Jones).

There is hope for improvement however. Like in the solar market, brilliant startup companies are trying to make a big difference while making a big profit. Umicore, a Brussels-based company, recycles about "350,000 tons of e-waste, including photovoltaic cells" (Jones). If solar is to become a truly renewable resource, more companies will need to step into the market, but first it will need to stop expanding. Once solar takes over for the world's energy

needs, Nicola Jones suggests the “recycling is the best route forward for elements where demand is predicted to level off in the long run” (Jones). Even so, current exploration has located “450 potential rare earth mines” from which the world could extract the next generation of solar cell components (Jones).

In conclusion, there are still several barriers to the full scale adoption of solar energy, but in the long run the only thing standing in our way is a lack of willpower. Recent history has provided numerous example of government incentives working well to hasten the transition, but more promisingly, market forces also favor solar. With enough demand from consumers, energy companies and utilities will begin making the switch in order to stay afloat. One of the most important objective moving forward is a firm resolution to make the transition. There will be many detractors along the way, especially big fossil fuel company interests in the United States, but the benefits of conversion far outweigh the costs. Unlike energy sources like coal, natural gas, and oil which are controlled by bureaucracies around the world, solar power is ubiquitous. No one can buy the rights to the sun and lord it over the rest of the world. As Brown says in the preface of *The Great Transition*, renewable resources like solar are the most “democratic” option we have (Brown, xiv). And who doesn’t want a little more democracy in the world?

Works Cited

Atlantica Yield. N.p., 2016. Web. 6 May 2016.

Berry, Chris. "Enough to Go Around? Raw Materials and Limits to Growth in Solar Energy." *PV-Tech*. PV-Tech, 16 Dec. 2014. Web. 06 May 2016.

Brown, Lester R., Janet Larsen, J. Matthew. Roney, and Emily E. Adams. *The Great Transition: Shifting from Fossil Fuels to Solar and Wind Energy*. New York: W.W. Norton, 2015. Print.

Brown, Lester R., Janet Larsen, J. Matthew. Roney, and Emily E. Adams. *The Great Transition: Shifting from Fossil Fuels to Solar and Wind Energy*. New York: W.W. Norton, 2015. Print.

Brown, Lester R., Janet Larsen, J. Matthew. Roney, and Emily E. Adams. *The Great Transition: Shifting from Fossil Fuels to Solar and Wind Energy*. N.p.: n.p., n.d. Print.

Jobin, Patrick, Maheep Mandloi, and Jennifer Ky. "Solar Manufacturing Oversupply: Likely Exacerbating Before Correcting." Credit Suisse, 21 Mar. 2016. Web.

Jones, Nicola. "A Scarcity of Rare Metals Is Hindering Green Technologies." *By Nicola Jones: Yale Environment 360*. N.p., 18 Nov. 2013. Web. 06 May 2016.

Urdanick, Marley. "A Deeper Look into Yieldco Structuring." *Welcome*. Alliance for Sustainable Energy, 9 Mar. 2014. Web. 06 May 2016.

Wald, Matthew L. "How to Build the Supergrid." *Scientific American* (2010): 57-61. *Scientific American*. Nov. 2010. Web.

Weber, Harry R., and Mark Chediak. "US Power Grid's $2 Trillion Upgrade Needs European Efficiency." *US Power Grid's $2 Trillion Upgrade Needs European Efficiency*. Bloomberg, 24 Apr. 2015. Web. 06 May 2016.

Whitford, David. "Here Comes the Airbnb of the Solar Industry." *Inc.com*. Inc., 7 Apr. 2015. Web. 06 May 2016.