Critical Analysis of Power Purchase Agreement Performance in the United States

Sean Martin

Environmental Management and Policy Master's Program
Lund University
Instructor: Luis Mundaca
8 December 2015

Acronyms

FERC – Federal Energy Regulatory Commission
IPP – Independent Power Producer
ITC – Investment Tax Credit
MBI – Market-Based Instrument
MW – Megawatt
PPA – Power Purchase Agreement
PTC – Production Tax Credit
PURPA - Public Utility Regulatory Policies Act
RE – Renewable Energy
REC – Renewable Energy Credit
RPS – Renewable Portfolio Standard

Introduction and Scope

Despite Power Purchase Agreements (PPA) having the supporting regulatory framework for over 30 years, their widespread use as a financial mechanism for corporations to purchase renewable energy did not become mainstream until recently. PPAs provide a guaranteed line of capital for renewable energy projects that likely would not be built without it, which propagates the technology change away from fossil fuels and decreased environmental harm from emissions. In 2009 Google paved the way for widespread adoption by completing its first PPA for a 20-year contract for the purchase and use of 114 MW of wind power in Iowa, to power their data center in that state (Google Green, 2013).

This paper will make a few key distinctions in order to constrain the scope when analyzing PPAs within the United States context:

1. Renewable Energy: PPAs have existed since 1978 when the partial deregulation of the energy market occurred during the many oil crises of the 1970s. However, this paper will only examine PPAs as relevant in their use for renewable energy (solar and wind), given the meteoric rise in their usage for this application in recent years.
2. On-Site vs. Virtual PPA – See Appendix 1.1 and 1.2 for a distinction between flows.
    - There are two significant categories for PPAs. An on-site PPA is when the purchaser of electricity sites the equipment on campus, typically solar PV, where the power is to be used.[1] This is distinguished from a "solar lease" where the purchaser pays a monthly fee for the use of the panels, rather than only purchasing the electricity produced.[2] This type of contract will *not* be evaluated by this paper, as this is typically for smaller scale consumers.
    - The second type is a *virtual* or *synthetic* PPA. In this instance, the purchaser of electricity does not host the power-producing equipment, instead contracting the purchase of power from a site farther away from where it is used in an agreement with the associated utilities. This allows larger production sites to be considered

[1] Solar Power Purchase Agreements. (n.d.). U.S. Environmental Protection Agency.

[2] Maehlum, M. (2015, April 6). *Best Solar Lease and PPA – SolarCity, SunRun, Sungevity, or SunPower?*

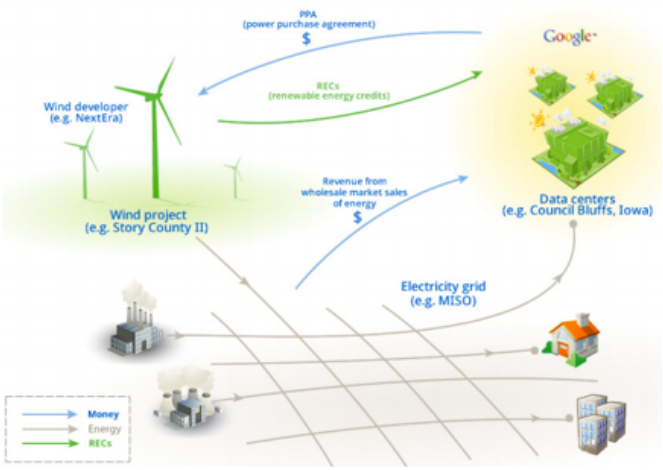
such as wind farms and larger scale solar plants, which typically will be utilized by a much larger entity like a municipality or corporation, for whom this analysis focuses on.

Purpose

The purpose of this analysis is threefold; (1) to describe and distinguish the roles of PPAs in the U.S. energy market as well as their relationship to other Market-Based Instruments, (2) analyze the relative effectiveness and success of PPAs in the energy market against selected criteria, (3) and lastly to identify barriers to implementation and adoption.

How PPAs Function

Power purchase agreements have multiple layers to their design in order for them to function within the existing energy market. This section will also aim to highlight PPAs interrelatedness with the many other types of MBIs that they interact with, to display their role within the market. To start, here is a simple representation of a virtual PPA conducted by Google for the wind project in Iowa.



PPAs as aforementioned got their start in 1978 with the Public Utility Regulatory Policies Act (PURPA).[3] PURPA established the means for Independent Power Producers (IPP) to interconnect with the grid and supply power, despite not being a FERC authorized utility. The mechanisms that allowed IPPs to sell their power were the first Power Purchase Agreements. PPAs could generally be classified as a preferential agreement, as there is no obligation to use them or compliance related measure as is typical with taxes, incentives and subsidies. This means that their direct effects and impacts on the market and environment are harder to quantify, as they themselves often rely on other MBIs to function.

It is important to distinguish that power markets operate independently from physics, as according to Kirchhof's circuit laws[4], the power produced does not directly go to the purchaser of that power, since that there is no way to direct or track electrons on the grid once they have been added. Given this fact, PPAs provide the financial mechanism to connect the producer and the purchaser, aiming to liberalize energy markets, using Google as a case study the dynamic is thus; (1) the purchaser Google agrees to buy power at a predetermined price for a given period, typically 20 years, from a renewable energy developer, (2) the power producer puts the electrons on the grid which Google owns and sells at the wholesale price on the energy market, (3) since this power was "renewable" Google receives Renewable Energy Credits (RECs) for each unit of energy produced which can then be applied to offset the generic grid electricity used on-site.

[3] Public Utility Regulatory Policies Act of 1978 (PURPA). (n.d.). Energy.gov.

[4] Oldham, Kalil T. Swain (2008). The doctrine of description: Gustav Kirchhoff, classical physics, and the "purpose of all science" in 19th-century Germany (Ph. D.). University of California, Berkeley. p. 52. Docket 3331743.

Next it is vital to discuss how PPAs interconnect and relate to other MBIs, as they do not always function in and of themselves when used for renewable energy.

Renewable Portfolio Standards (RPS) – RPS often provide (but are not necessarily required) the available marketplace needed for PPAs to thrive. The existence of an RPS in a given state provides the demand for renewable energy projects to be built, and PPAs help fulfill the ability to create those projects by connecting the purchaser or off-taker to the developer-producer.

Renewable Energy Credits (RECs) – As described in Google's case, the REC provide a pivotal role in the off-taker's ability to make legal claims about the use of green electricity in their operations. RECs are currently used in all 50 states, whereas PPAs have been contracted in 40 to date.[5]

Investment Tax Credit (ITC) – The ITC is an incentive under the Obama administration in order to spur investment in RE generation. The credit provides a direct tax rebate of a certain percentage (up to 30%) of the investment in a qualified asset or business in the form of a rebate.[6]

Production Tax Credit (PTC) – The PTC is the sister-policy to the ITC but for the supplier, which manifests in a tax credit for the amount of RE produced, most often in the form of a flat amount per kWh.[7] The combination of the ITC and PTC has been one of the main spurs for the rise in PPA usage and deployment of new RE production facilities.

Other MBIs that help to facilitate the effectiveness of PPAs in both direct and indirect ways, but will not be covered in greater detail are: The Department of Energy Loan Guarantee, accelerated depreciation, preferential use of federal lands, property-tax exemptions for RE, which all have positive effects for the use of PPAs as a tool for RE procurement (Varadarajan).

---

5 Heeter, J., O'Shaughnessy, E., Liu, C., & Nobler, E. (2015). Status and Trends in the U.S. Voluntary Green Power Market (2014 Data). National Renewable Energy Laboratory.

6 Business Energy Investment Tax Credit (ITC). Energy.gov.

7 Renewable Electricity Production Tax Credit (PTC). Energy.gov.

Critical Analysis

This section will aim to analyze the relative performance of PPAs as an MBI against a number of criteria. Since PPAs are aiming to reduce the environmental problem of fossil fuels in the energy mix, they will be evaluated on three criteria (1) Additionality, or the ability to create new renewable energy on the market, (2) The level of participation or investment by actors, in order to display growth, and (3) Economic-efficiency, in order to determine the effectiveness and sense behind PPA utilization.

Additionality

The foremost criterion for evaluating the performance of PPAs is "additionality", which can be defined as the ability to create more renewable power on the market. While not necessarily an empirical criterion, it is likely the most important, as the ultimate goal is to grow the size of the renewable energy market. A company or municipality typically has three options when looking to invest in renewable energy, (1) to purchase and build infrastructure to directly power operations, (2) purchase RECs to offset grid electricity usage, (3) or perform a power purchase agreement. Purchasing RE infrastructure outright has a high upfront capital cost, which is often unfeasible for some entities, or is not possible due to geographical constraints.

PPAs aim to solve several key market failures in the energy sector. The first revolves around the common argument of intermittency, given that wind and solar sources of supply are not constant, while the energy demand of many industries are, the direct installation of RE is not always feasible nor sensible. The second is that the most efficient location for the generation of wind or solar power, is often not at the same location where the demand for that power is (Google Green, 2013). In the case of Google's data center in Iowa, the wind farm was most productive and practically sited in a rural area, whereas the data center needed to have close connectivity to mainline internet infrastructure. PPAs help to alleviate both of these obstacles in energy markets by providing a financial mechanism to bridge the disconnect between the production and use of renewable energy.

The final and most pivotal market failure that PPAs are able to correct is the inability for new renewable energy products to acquire adequate funding to meet high upfront construction and investment costs. The PPA is essentially a revenue guarantee that a RE developer can bring to the bank in order for a RE production site to begin construction, that otherwise would have never been built without the PPA, which is the cornerstone of additionality.

When direct infrastructure is not possible, the additionality argument boils down to the distinction between RECs and PPAs. When a company purchases an unbundled REC, they are buying the legal right to claim the use of renewable energy. This means that solar or wind power is being produced somewhere non-specific on the market and the entity buys the credit, but not the electricity itself. PPAs on the other hand help to directly fund a specific project or plant, with a direct purchase of their produced electricity. As described before this often allows new generation to be built, whereas RECs only facilitate trade of already existing projects. So it could be said the

PPAs can be *just as* additional as direct investment, and *more* additional than RECs, which is the core argument behind Google Green's strategy towards renewable energy investment.[8]

Level of Participation & Investment

A clear indicator of PPAs performance would be the simple participation level of entities undertaking these agreements, which can be measured by either the number of organizations or the level of investment in dollars or MWh capacity. The graphic below taken from NREL's study on *Status and Trends in the U.S. Voluntary Green Power Market* shows a growth in both actor participation and sales of renewable electricity from 2013 to 2014.

Figure 1. NREL: PPA growth from 2013 to 2014

Table 12. Status of Voluntary PPAs in 2014

	Participation	Sales
2014	295 customers	6,700,000 MWh
Change from 2013	+15%	+14%

PPAs are becoming a dominant trend in the right direction as "over 75 percent of corporate renewable energy transactions are power purchase agreements," (Abbot, 2015) and according to "American Wind Energy Association's recently released U.S. Wind Industry Annual Market Report 2014, last year corporations and other institutional buyers—including IKEA, Facebook, Microsoft, Walmart, and Yahoo—signed PPAs accounting for over 23 percent of the wind power contracts."[9] The bar graph on the left shows the size of the market from large actors since 2008, while the table on the right shows greater granularity into 2014. 2014 was the first year that NREL included PPAs as part of their analysis on the voluntary green power market, which is a testament to their growth and usage, as displayed by the doubling in total project size from the left graphic.

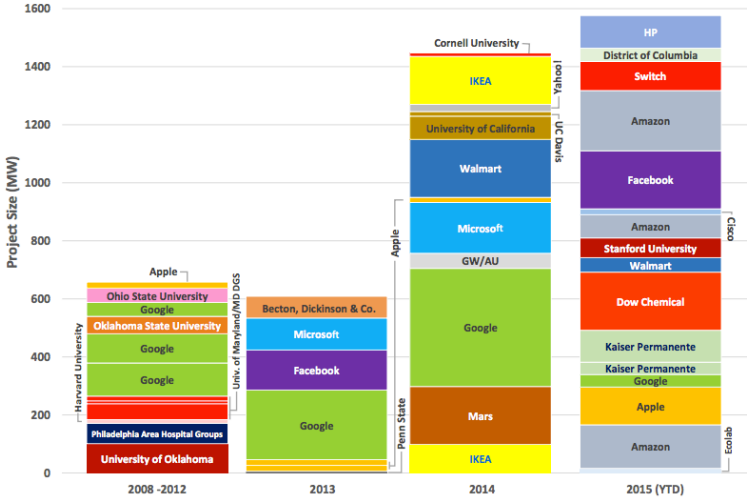


Figure 2. Renewable energy investments from PPAs[10]

Table 1. Voluntary Green Power Participation and Sales in 2014

Green power option	Participation	Sales (MWh)
Utility green pricing	743,000	7,040,000
Competitive suppliers	1,584,000	16,250,000
Unbundled RECs	89,000	36,000,000
Community solar	42,000	150,000
CCAs	2,500,000	7,700,000
Voluntary PPAs	295	6,700,000
Total[6]	4,916,000	73,690,000

Figure 3. NREL: Participation across purchase options

8 Google's Green PPAs: What, How, and Why. (2013, September 17).

9 Guevera-Stone, L. (2015, May 11). *Opening the Corporate Renewable Energy Floodgates.* Rocky Mountain Institute.

10 Staple, G., & Bromaghim, G. (2015, August 4). *Google is just a small slice in the new corporate PPA boom.* GreenBiz.

While RECs still dominate the market in terms of overall MWh sales, however this is primarily due to an oversaturation in the market and associated low prices per credit, currently at less than $1/MWh (Heeter, 2015). PPAs on the other hand, according to RMI's Business Renewable Center saw a 10 percent increase of all utility-scale solar PPAs in 2014 by corporate off-takers, and approximately 25 percent of such PPAs have been signed by corporate buyers so far in 2015.

As represented by the final graphic from NREL's study on the right, this resulted in about 15% increase in both participation and sales from 2013, and apart from community solar this is the most rapidly increasing mechanism used in voluntary green power markets (Hill, 2015).

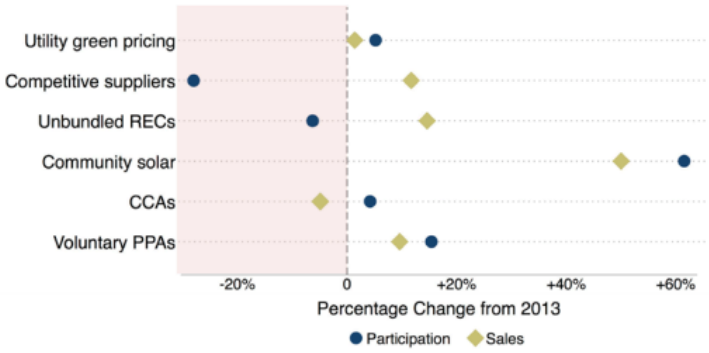


Figure E1. Percentage changes (2013-2014) in green power market participation and sales.

Figure 4. NREL: Percent change in participation & sales

Economic-Efficiency

MBIs are also meant to increase economic efficiency. PPAs enable the marginal cost of the electricity production mix to be lowered as represented by the diagram below. Renewable energies typically have the lowest variable cost when compared to the rest of the production mix (Mundaca, 2013). By enabling corporations to increase the share of renewable energy in their portfolio, the demand curve below is shifted to the left, decreasing costs.

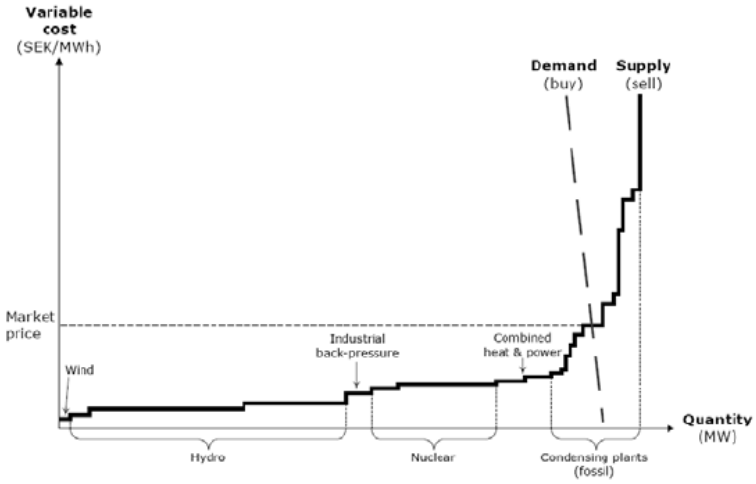


Figure 5. Variable cost across energy mix (Mundaca, 2013)

Example Savings in a Renewable Energy PPA

Prices shown for 1 MWh

	Today	Future
Situation 1: No PPA		
Utility Rate	($40)	($50)
REC Price	($2)	($5)
Total	($42)	($55)
Situation 2: With a PPA		
Utility Rate	($40)	($50)
PPA Rate	($35)	($35)
Market Rate	$40	$50
REC Price*	$0	$0
Net Total	($35)	($35)
Savings	**$7**	**$20**

* In this example, the renewable energy credits (RECs) are included as part of the PPA.

Figure 6. RMI: PPA savings scenario (Abbott, 2015)

Not only are PPAs more economically efficient, but they allow energy purchasers to hedge themselves against risk and volatility in the energy market as represented by the generic pricing scenario on the right. PPAs guarantee funding to the developer as described in the previous section, while also locking in a set price per kWh for electricity, lowering costs for the user. So when it

comes to costs to the off-taker, who may not only be investing in renewable energy, but purchasing electricity in general, PPAs provides a highly economically efficient option.

PPAs also enable the most efficient allocation of fiscal resources when it comes to developing renewable energy projects, as described briefly through the Google case. While Google *could* invest in solar or wind for a behind-the-meter direct installation, the project might be more expensive due to restraints in the location. In tandem to this, the actual production of power itself might not be as productive due to the project not being optimally sited, in order to achieve maximum solar or wind capacity, reducing energy output (Google Green, 2013). PPAs remove these geographical restraints and provide the means for the most efficient allocation of fiscal resources when it comes to renewable energy investment.

Conclusion

The power-purchase agreement as a financial mechanism for energy procurement has existed for decades, however its innovative use for renewable energy while also reducing costs is something one can only expect from the likes of Google. The design and successful implementation of PPAs have been continually proven, however the industry has expressed a demand for a standard contract, as currently each deal must be individually negotiated and managed. In Yahoo!'s recent PPA experience they illustrate that despite the benefits many barriers still exist such as, "complexity of large-scale, off-site renewable transactions, high transaction costs, and a lack of necessary information and tools" (Abbott, 2015). The transaction costs are primarily associated with legal/negotiation fees or grid fees to the utilities, and many firms have begun to specialize in PPA deals to reduce these costs to potential off-takers. Another clear trend is that given the level of complexity and high transaction costs, synthetic PPA deals are typically limited to very large institutions, as highlighted by Figure 2. Only four or five companies contributed to 63% of Q1 new wind contracts in 2015[11], and experts interviewed by the Business Renewables Center expressed that it is "unusual to find PPAs that cover loads of less than 10 megawatts."[12] There is a high demand in the market for renewable energy PPA deals, however there is an immense need for a standardization of contracts while will ameliorate complexity and costs, as well as allow entry for smaller contracts and smaller buyers.

Lastly is the concern surrounding the expiration of the ITC and PTC, which benefit the off-taker and developer respectively. With the expiry of the ITC and PTC in 2017, PPAs will face some enormous challenges as the number of new renewable projects being built will likely decline since neither investors or developers will not be able to claim the credits. Despite the levelized cost of energy continuing to fall for both solar and wind, this creates uncertainty and unpredictability in the energy market, which may deter many potential investors and developers from investing in new projects. Word Count: 2830

[11] Clancy, H. (2015, April 14). 21st century energy: What you need to know about power purchasing. GreenBiz.com. Retrieved December 4, 2015.

[12] Guevera-Stone, L. (2015, May 11). *Opening the Corporate Renewable Energy Floodgates.* Rocky Mountain Institute. Retrieved November 27, 2015.

References

Abbott, S. (2015, November 10). *Yahoo's Pursuit of Green Power: New Business Models Offer Companies High-Impact, Economic Alternatives*. Rocky Mountain Institute. Retrieved November 27, 2015.

Business Energy Investment Tax Credit (ITC). (n.d.). Energy.gov. Retrieved December 6, 2015, from http://energy.gov/savings/business-energy-investment-tax-credit-itc

Clancy, H. (2015, April 14). 21st century energy: What you need to know about power purchasing. Retrieved December 4, 2015, from http://www.greenbiz.com/article/power-purchase-agreements-renewables-IBM-Kaiser-NRG

Google's Green PPAs: What, How, and Why. (2013, September 17). Retrieved November 27, 2015, from https://static.googleusercontent.com/media/www.google.com/en//green/pdfs/renewable-energy.pdf

Guevera-Stone, L. (2015, May 11). *Opening the Corporate Renewable Energy Floodgates.* Rocky Mountain Institute. Retrieved November 27, 2015.

Heeter, J., O'Shaughnessy, E., Liu, C., & Nobler, E. (2015). Status and Trends in the U.S. Voluntary Green Power Market (2014 Data). *National Renewable Energy Laboratory*.

Hill, T., & Holmes, W. (2015). Corporate Energy Sourcing: A New Engine For Renewables. *Law360*. Retrieved December 8, 2015.

Maehlum, M. (2015, April 6). *Best Solar Lease and PPA – SolarCity, SunRun, Sungevity, or SunPower?* Retrieved December 6, 2015, from http://energyinformative.org/best-solar-lease-ppa-solarcity-sunrun-sungevity-sunpower/

Mundaca, L. T., C. Dalhammar, D. Harnesk (2013), 'The Integrated NORDIC Power Market and the Deployment of Renewable Energy Technologies: Key Lessons and Potential Implications for the Future ASEAN Integrated Power Market' in Kimura, S., H. Phoumin and B. Jacobs (eds.), Energy Market Integration in East Asia: Renewable Energy and its Deployment into the Power System, ERIA Research Project Report 2012-26, Jakarta: ERIA. pp.25-97.

Oldham, Kalil T. Swain (2008). The doctrine of description: Gustav Kirchhoff, classical physics, and the "purpose of all science" in 19th-century Germany (Ph. D.). University of California, Berkeley. p. 52. Docket 3331743.

Public Utility Regulatory Policies Act of 1978 (PURPA). (n.d.). Energy.gov. Retrieved December 5, 2015, from http://energy.gov/oe/services/electricity-policy-coordination-and-implementation/other-regulatory-efforts/public

Renewable Electricity Production Tax Credit (PTC). (n.d.). Energy.gov. Retrieved December 6, 2015, from http://energy.gov/savings/renewable-electricity-production-tax-credit-ptc

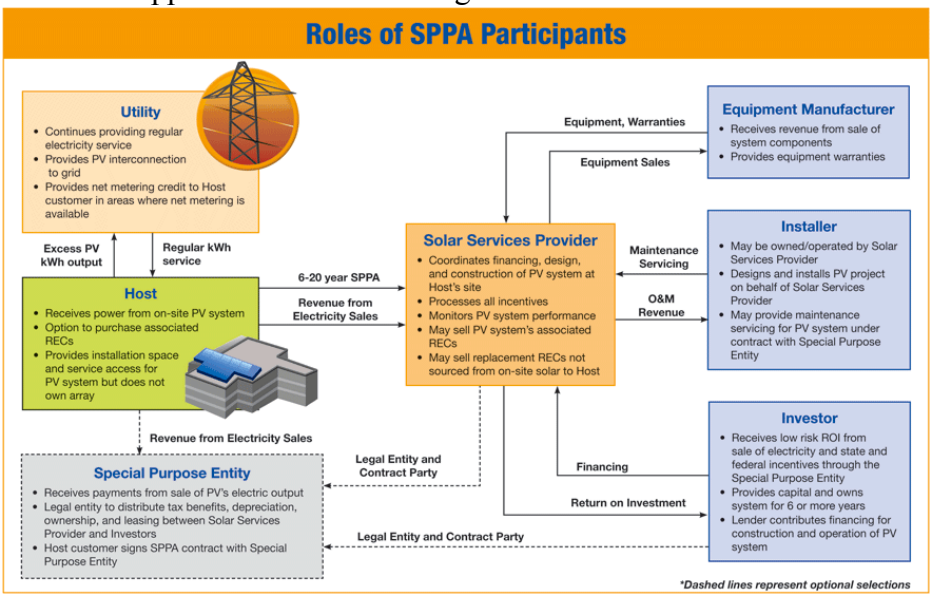
Solar Power Purchase Agreements. (n.d.). U.S. Environmental Protection Agency. Retrieved November 27, 2015, from http://www3.epa.gov/greenpower/buygp/solarpower.htm

Staple, G., & Bromaghim, G. (2015, August 4). *Google is just a small slice in the new corporate PPA boom.* GreenBiz. Retrieved November 27, 2015.

Varadarajan, U., Pierpont, B., & Nelson, D. (n.d.). A Comparative Case-Study Analysis of the Effectiveness and Efficiency of Policies that Influence the Financing of Renewable Energy Projects: U.S. and Europe. *Climate Policy Initiative*.

Appendix

Appendix 1.1 – Flow Diagram of On-Site Solar PPA



Appendix 1.2 – Flow Diagram of Virtual Wind PPA by Google