Google

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Google's Green PPAs: What, How, and Why

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Introduction

Google has pledged to reduce its carbon footprint to zero. Zero is an aggressive goal, not easily achieved by any one measure, so we pursue a multi-pronged approach to get there. Efficiency is one prong of the approach and carbon offsets is another. But a very important third prong of the approach is the purchase and use of carbon-free renewable electricity to power our data centers.

When we started out on this path, we realized that we had a lot of learning to do. We had basic questions, such as:

- What types of resources are most appropriate, and from where?
- How do we get the electricity to our facility to use?
- How can we make such a purchase economical, and how can it be leveraged to protect us from higher prices in the future?
- How can we maximize the impact of our green power purchases on our carbon emissions and global emissions?

We also knew we wanted to enforce some fundamental principles that we value:

First, our activities must meet the basic criterion of "additionality." We'll describe this more a bit further down, but fundamentally, a renewable energy purchase is additional if it has an effect in the real world, be it direct or indirect. A direct effect would be causing a new renewable project to be built. An indirect effect would be increasing demand for renewable energy such that market pressures are able to encourage new investment.

Second, when possible, our projects should go beyond basic additionality and directly address problems that limit the growth of the renewable industry. For example, if we know that we are going to need renewable energy for a long time, it may be better for renewable project developers if we commit to a long-term contract rather than purchasing as we go, because it makes it easier for them to raise capital.

This paper attempts to show how we have answered these questions and met our principles in a way that makes business sense for us. We hope also that this will serve as a useful starting point for other companies that want to buy renewable power.

Electrons, markets, and the art of the possible

Electrons

First, a little background: We know from Kirchoff's circuit laws that electricity generated in one spot cannot be directed to a specific user over the electricity grid. Once you put electricity on the grid there is no actual way to know "the energy from wind farm X is going to my data center Y."

Given that you can't tell electrons where to go, how do you "use"—and show your use of—renewable energy? One solution is to not use the grid at all. After all, we could put the renewable project "behind the meter," meaning that it would be on the same premises as our data center. This is what is happening when people put solar panels on their roofs. It is also what we have done on our main campus in Mountain View, California, where our 1.6 megawatt (MW) solar panel facility helps power our offices. But this is not feasible for Google data centers (or most companies' data centers) for a number of interrelated reasons.

For one, the area necessary to harness sufficient energy to power a data center by either method is much larger than the actual area of a data center and its surrounding property. Also, neither the wind nor the sun are constantly available resources. They come and go with the weather, while Google's data centers operate 24x7.[1] No matter what, we'd need to be connected to the grid to access "conventional" power to accommodate our constant load. The plain truth is that the electric grid, with its mix of renewable and fossil generation, is an extremely useful and important tool for a data center operator, and with current technologies, renewable energy alone is not sufficiently reliable to power a data center.

In addition to these technical reasons why a behind-the-meter solution doesn't work for Google, there is a larger, and perhaps more important reason: there is no appreciable difference between putting a wind farm or solar facility behind our meter or on the grid. At best the difference is one of appearance (Google would "look greener") and at worst it reduces the impact of our investment because a project built in a less favorable location would generate less energy over its life. Fundamentally, data centers and wind farms should each be sited where they can be most effective—and this is often in different locations.

Markets

While we know from physics that on a pooled electricity grid we can't tell if energy came from a "green" or "brown" source, people do indeed claim to use electricity from a specific project at a specific location. Since this isn't generally technically possible, what do they mean? This is precisely the role of power markets, which are designed to track who should get paid for producing power and who should pay for using it. For example, in Iowa, where we signed our first wind power purchase agreement (PPA), the power transmission authority MISO runs the wholesale power market.

The power market is pretty complicated, but fundamentally if you put in (generate) or take out (use) energy from a given location and at a particular time, you earn or pay a price specific to that location and time. If you want to "move" power from one place to another, you put it in at one location and get paid a location-specific price and take it out in the other and pay a potentially different location-specific price. Prices vary for a whole host of reasons, including where power is most needed, what power losses occur in moving the power to different locations, and how much power the transmission lines are transporting relative to their capacity.

In effect, the power market works independent of physics—MISO can determine how much people pay or get paid per megawatt-hour (MWh), even if they aren't able to determine exactly which MWh they produced or used. This extends to so-called green power: you can determine who should pay or be paid for producing or consuming green power from a wind farm instead of brown power from a coal plant or natural gas plant, even though you can't possibly track flows of green power through the grid. In the U.S., this is often done through renewable electricity credits (RECs), which are a market-based means of keeping track of who produces and who uses green electricity. One REC is created when a MWh of green energy is generated and one REC is consumed when a user says they "used" a MWh of green energy.

What's possible

A final important issue is access to these power markets, which is typically limited to wholesale entities like power utilities and generation companies. At our data centers, Google is a retail customer—we have no way of taking power off the grid wholesale and applying it to our load. We have to buy power just like you do: from our local regulated utility.[2] And just like you, we have no control over where the utility gets its power—they buy and generate (and sometimes sell excess electricity) on behalf of their customers. In some regions customers can choose the utility from which they purchase power. In most markets, however, including those where we operate data centers, there is no provision for an end user like Google to buy its own power directly from a renewable generator.

Meeting our principles

Given the background above, let's recall what Google seeks to accomplish with renewable energy purchases. There are two important goals:

- Our purchases should be additional. This means they should actually help to create more renewable power.
- Our investments should have the highest possible positive impact on the industry that they can.

Additionality is a tricky concept. Perhaps it is easiest to give an example of what's not additional. Imagine a power company built a wind farm many years ago. They built it because they thought it was good business at the time, but the fact that it was a renewable resource was not important to their decision. They currently sell the power into the grid, and they're happy with their investment. Moreover, this power company has no plans to build any more wind farms. One day, they learn that Google is looking to purchase renewable electricity. The power company figures it could sell Google the output of their wind farm; for their existing customers they would just make up the difference by buying some other source of energy, perhaps from the coal plant down the street.

In our view, this is not additional. We'd be handing money over for green electricity, but in the grand scheme of things, nothing would change. The carbon output of the whole system would be the same and no new renewable generation would get built.

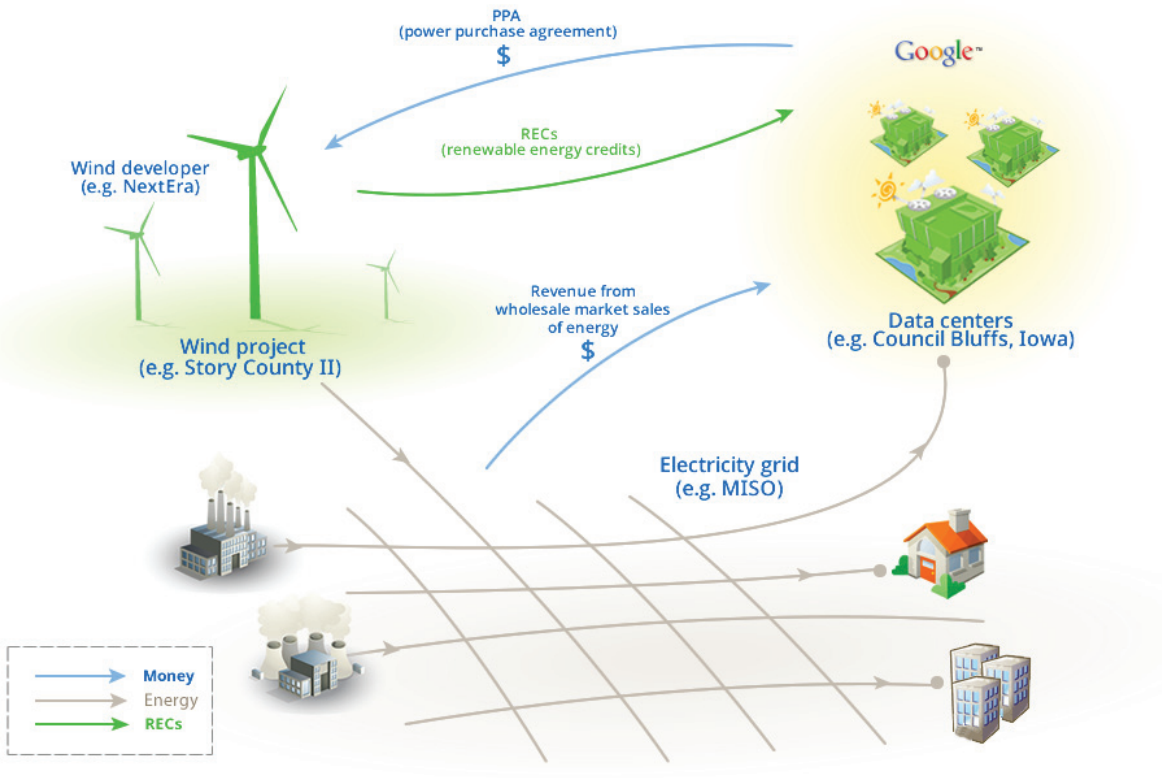
However, let's change the story such that the wind project doesn't yet exist. There is a company that wants to build one, but they need a reliable customer to help them make the project financially sound. In this scenario, signing up would spur the development of additional renewable power.

Let's change the scenario one more time. Perhaps a company does own an operating wind project, and is known to be a serial developer of renewable energy projects. They use the cash flow from one project to finance the next or to convince Wall Street that they have bankable income. As in the previous case, we would consider the power from this wind farm as additional since we have confidence that the proceeds will be used to finance additional renewable power.

What Google actually does

With all this in mind, Google settled on the following plan:

1. Google buys electricity directly from a renewable project developer in the form of a power purchase agreement, or PPA. A PPA is a contract to buy power over a period of time at a negotiated price from a particular facility. We select a project that is on the same power grid as one of our data center facilities so that the power generated by the project could conceivably be used by our data center. Even if we can't legally or physically transfer the power to our facility, being in the same power market ensures we are contributing to greening the grid where we operate. For example, under our first PPA with NextEra, we contracted to buy 114 MW of wind power for 20 years from a project in Ames, Iowa that we "use" to power our data center in Council Bluffs, Iowa. With our subsequent and latest PPA in Oklahoma, we are adding another 100.8 MW of wind power that we similarly use at our data center in Mayes County, Oklahoma.
2. We then sell that power right back into the grid at the local, wholesale price. Today, because generic "grid" power is cheap and renewable power is relatively expensive, this may result in a slight net loss for Google, but we expect the contract to eventually make money as power gradually becomes more expensive over time. In any case, in the process of selling, we strip renewable energy credits (RECs) and keep them so that no one else can claim credit for the green aspect of our purchase.
3. Finally, we apply those RECs to the energy used at our data centers. As mentioned before, our data center in Iowa gets its power from the utility, at an average carbon intensity of about 1.77 lb CO_2/kWh.[3] Since the RECs were produced on the same grid, one REC represents one MWh of renewable power "used" at our Iowa data center, displacing one MWh of local conventional power. Once we apply the REC, the electricity consumed at our Iowa data center can now be treated as carbon free.[4]



We are often asked: If RECs are a tradable commodity, why not just buy RECs from a renewable project and not mess with the energy? The answer in this case is that buying a few years' worth of RECs from a renewable project does not provide the stable and sizable cash stream that a renewable project developer needs to get financing to build new green power projects. In a PPA, Google is agreeing to buy all the power from a project for many years. Google has, in effect, totally accepted the power price risk that the project owner would otherwise face—instead of taking the risk of selling into the power market on a short-term basis, Google is providing the seller with a guaranteed revenue stream for 20 years. This is something the developer can literally take to the bank. If we were to buy only the RECs, this would represent a fraction of the value of a typical power project,[5] and would still leave the renewable developer to face the market risks of future energy prices, making it much harder for them to obtain financing for projects.

Why don't we do things in a different way?

What we've described above is how we currently pursue the majority of our renewable power purchases, but it is not the only way and we are always looking for more and better ways to green our operations and increase our impact. For example, we continue to pursue compelling opportunities for on-site generation, as we have for our Mountain View, California campus where we have installed 1.6 MW of solar panels, operate 400 kW of fuel cells and have a 970 kW generator adjacent to our campus that burns landfill gas that would otherwise have been vented to the atmosphere.[6] Nevertheless, we believe that our approach is the best possible option we have today to purchase renewable energy at scale. We are proud of both the scale of our purchases and the impact they have on the market. In particular:

- By signing long-term contracts for bundled energy and RECs, we are giving renewable power project developers the access to financing they need to build new projects that contribute to new green power on the grid.
- By making the details of our power procurement strategy and process publicly available, we are helping provide a blueprint for other companies to green their operations and the grid without having direct access to power markets.
- By focusing on the impact of our actions instead of the optics, we are making a greater contribution to reduced greenhouse gas emissions and increased green power production.

We know that others have different perspectives and knowledge, and may approach the question of sourcing renewable energy differently from us. However, there are some common objections to our approach that we believe are faulty and which we'd like to address directly.

Argument 1: Google shouldn't call its Iowa or Oklahoma data centers green since they don't use the power directly.

This argument would be justified if "consuming" the power "directly" was the only method to lower overall greenhouse gas emissions and increase the amount of renewable power on the grid. We cannot find an argument that this is the case. In fact, we believe that siting renewable power behind our meter would result in less renewable power since in almost no situation are the very best location for a data center and the very best location for a solar or wind project the same. We believe that by taking advantage of the dynamics of energy markets as well as our ability to purchase and sell power on the wholesale market, we are effectively supplying two of our major facilities with renewable energy. We are able to achieve this by allowing the wind developer to build projects in areas with the highest quality wind resource while not compromising location decisions for our data centers.

Argument 2: Buying power from a renewable power facility that is already built doesn't contribute to new renewable power on the grid.

This argument makes intuitive sense at first, but doesn't fully incorporate how markets work over time. Using this reasoning, purchasing a television doesn't contribute to new televisions being manufactured. The economic fact is that if there is demand for something, suppliers will come into the market to provide it. We know that if customers continue to purchase televisions, suppliers will continue to produce them. When customers stop purchasing televisions, and when others stop buying wind power, suppliers will stop producing it.

It is true that if we purchased wind power from a supplier that is unlikely to invest in more projects (perhaps they are no longer in healthy financial shape or they have shifted their focus away from renewables), then the direct link to greater renewables is more tenuous. For that reason, during our due diligence we make sure we are comfortable that we are purchasing power from a supplier that is likely to take our commitment "to the bank," and use it to build new renewable power facilities. In fact, in the case of our Iowa PPA from NextEra, they were able to quickly finance the project after Google signed on.

Argument 3: Google should just buy RECs rather than engaging in the PPA and its associated buying and selling of energy.

This is something we thought about for a long time. Rather than signing a PPA and essentially making our own RECs by stripping the energy from the renewable power and selling it to the system, leaving only the RECs, we could have bought the RECs directly without the power. But this would have only provided the seller with the value of RECs—which is much less than the value of the energy. (One can think of the value of a renewable kWh as being equal to the sum of a "generic" kWh plus a REC. The REC is a small fraction of the total value of the renewable kWh.) By agreeing to buy renewable energy from a project developer like NextEra, we are guaranteeing them a long-term income stream that is "bankable." That is, the developer can use it to get financing, which can be used for the next project. A promise to buy just the RECs but not the energy would be much less valuable, and hence less helpful from a finance perspective.

Argument 4: Google should build its data centers in locations with lots of clean power.

The places with the best clean power potential are generally not the same places where a data center can best serve its users. Building a renewable project in the backyard of a data center might be intuitively appealing, but doing so would simply mean that, dollar for dollar, you'll be getting less renewable energy than if you had built in an optimal location. The converse—building a data center in an optimal area for renewable development—would result in increased latency for our users and the inefficient use of land better used for renewable energy.

The flexibility of the electric grid is a powerful and useful tool. It allows load and generation to be located where they each make the most sense. That said, there is plenty of room for improvement in the US electric grid in order to make it a more efficient and effective means to bring renewable power from where the wind blows and sun shines to where the people live. We fully support such efforts and have even made an investment in such a project, the Atlantic Wind Connection, which will make it easier to bring off-shore wind power to the load centers of the Eastern Seaboard.

1. Storage technologies can be used to turn an intermittent source of energy like wind into one that can be relied on. We look forward to advances in this area, but currently such technologies are extremely expensive.
2. Google does have authority from the Federal Energy Regulatory Commission that allows us to trade power on the wholesale markets, but it does not allow us to sell to end-use customers even when that customer is ourselves.
3. This is the regional eGRID carbon intensity as calculated by the EPA, not the utility's carbon intensity.
4. This is true to a first approximation. In reality, carbon emissions are not perfectly balanced. The carbon avoided by generating a MWh of wind energy depends on what kind of power plant would have otherwise provided that energy if the wind had not been there. Similarly, on the load side, the amount of carbon emitted for a MWh used depends on what power plant generates the incremental energy. These values are likely to be similar, but not exactly the same. We are currently investigating potential methodologies to make such adjustments.
5. REC prices in voluntary markets today are on the order of $0.01/kWh.
6. Google is also a serious supporter of renewable energy development as a direct investor in projects and companies. Project investments include $168 million in BrightSource Energy's Ivanpah project, about $100 million in the Shepherds Flat Wind Farm in Oregon and nearly $39 million in another North Dakota wind project from NextEra. Companies we have invested in include eSolar, BrightSource, Makani, AltaRock and Potter Drilling.

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