

Amazon's Climate Moves

By John Benson

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1. Introduction

Effectively combating climate change will involve many small, imperfect steps where no other progress is immediately available. On the other hand, when opportunity presents them giant leaps can and should be made. This post is about a major firm that is combining both of these to move as fast as they can to fight climate change.

From the title of this post you can probably guess what the “major firm” is, but you probably cannot guess how fast they are moving.

Although your author is old-fashioned in many respects (for instance, neither my wife nor I have a smart phone), when it comes to e-commerce, we are probably ahead of the crowd. This because until roughly ten years ago, my wife ran an Internet antiques and collectable business that used eBay, and I was her IT Manager (in addition to my day job as an engineering manager). My wife also tended to buy most medium-sized merchandise on eBay until recently, but I've always preferred Amazon.

This post is about Amazon's moves to fight climate change.

2. Big Steps

When Richard and Carson Harkrader first heard that 696 acres of North Carolina farmland had come up for sale, in 2016, one feature of the rolling landscape particularly caught their attention: the power lines that sliced across it. For the Harkraders, father-and-daughter operators of Carolina Solar Energy, an independent developer of solar-energy projects, the prettiest thing of all were those heavy-duty transmission lines that arced to the northwest, lacing into the PJM Interconnection, the giant electric grid that dominates the mid-Atlantic.¹

"It was kind of a gold rush," the elder Harkrader says one morning this summer, standing amid the hundreds of thousands of glistening black panels, now known as Hawtree Creek Solar Farm, that follow the curve of the hills and tower over our heads. By midmorning the panels are sending 34 megawatts out to the grid. By noon, it's 65 megawatts-the maximum the grid will take.

About 200 miles north, in Virginia, are the eager buyers of that electric gold: the mega-technology companies, like Amazon, Microsoft, and Google that operate giant data centers essential to our daily lives, whether we're ordering on Prime or backing up family photos. Under pressure from customers, employees, and shareholders-and, arguably, out of their own eagerness to reduce emissions they have been increasingly determined to run these data centers on renewable energy. Once the Harkraders had secured the new solar farm's preliminary permits and permissions-making a plan to accommodate local deer and joining the crowded "interconnection queue" to plug into the grid-they leased the land to Engie, a French energy giant that builds and operates more than

¹ Andrew Blum, Time, “Amazon's Power Play,” Sep 26, 2022 issues (hardcopy). To order a copy of a Time issue, call 800-843-8463.

4,500 megawatts of solar power around the world. And then, before the panels had even arrived on site for installation, Engie in turn struck a deal to sell all the site's power to a single company: Amazon.

That financial and legal arrangement, known as a PPA (power purchase agreement), has been a crucial force in the U.S.'s transition to clean energy. Of the approximately 235 gigawatts of wind and solar capacity now installed on the nation's grid, nearly one-quarter (more than 52 gigawatts) has been contracted by corporations, mostly over the past decade. That vigorous-and notably voluntary-corporate action has boosted a web of wind and solar manufacturers, developers, and operators. It has made renewables cost-competitive and helped grid operators learn to manage systems with more variability...

Solar panels and wind turbines are expensive to build but cheap to operate, given that their fuel, sunlight and fresh air, are free. By guaranteeing the electricity will be sold long before it's been generated, a PPA gives banks confidence to front the money for construction-especially when there's a giant corporation guaranteeing the deal. In the way that power grids work, all that electricity isn't wired directly to these companies' facilities, but adds more juice to each region as a whole. But the way that PPAs work means the companies can legitimately argue that these giant renewable projects wouldn't have happened without them. PPAs stitch together developers like the Harkraders, energy operators like Engie, electric grids like PJM, and above all, the large companies hungry for power from renewable sources.

Author's comment: PJM is a regional transmission system operator (RTO). The way that these and independent system operators (ISOs) work is quite complex because they must run models of their system daily to make sure that all generators that use the transmission system can get that power from where it's generated to where it is used as efficiently and safely as possible. They also need to model future years with future loads and future generation (especially intermittent renewables) periodically to make sure that they can continue to do this for several years into the future.

I have written multiple posts on this, but I will not reference them. If anyone is REALLY interested in this, respond to this post, and I will answer with links to these papers. However, be prepared to read about 80 pages of technical papers, and, oh yes, learn a completely new language.

THEY ALSO SET UP the biggest corporate power purchase of all: Amazon has leveraged that ecosystem to go on the largest ever solar and wind shopping spree, buying 15.7 gigawatts globally over the past three years, nearly equal to the prodigious energy demands of the \$1.4 trillion company. Amazon's fervor has been felt across the industry while also giving a glimpse of the incredible growth still to come, with the arrival of \$369 billion in federal funds provided by the Inflation Reduction Act (IRA). Understanding this key driver of the past decade of solar and wind development helps us see what is likely to happen next: an unprecedented boom in renewable energy that could form expand the effort to reduce carbon emissions and limit the warming of the atmosphere.

"If it was a market that only waited till something was built-and then you went out and tried to sell the electricity these projects wouldn't get done:" says Harkrader. "People like Amazon, or Microsoft, Walmart, Target-on and others are standing up and making this market possible. And it's exploding."

These days, Amazon is the hungriest of all. The behemoth was not the first to buy renewable power for its operations, but it is now buying the most. The plans it has announced, globally, amount to the equivalent of around 250 more Hawtree Creeks, and more or less equal to all the solar generation built in the U.S. last year. The buying spree is part of Amazon's broader effort to reach "net-zero carbon" by 2040, meaning it will eliminate or offset the carbon emissions from all its operations, including trucks, planes, and manufacturing. That won't be easy. An estimated two-thirds of American households are Amazon Prime members; it is almost impossible to use the internet without accessing an Amazon data center. Since it announced its climate goal in 2019, Amazon's emissions have grown 40%-as its sales have grown more than 50%. "The path to achieving some of our goals will be long and complex:" acknowledges Kara Hurst, who leads Amazon's sustainability efforts. But clean electricity is Amazon's climate bright spot. With today's technology-and a fat checkbook-the company has nearly eliminated its use of dirty energy, prioritizing the hard realities of glass and steel over tree planting or tricky accounting, building at a scale that rivals that of many countries. Amazon has catapulted itself to the front ranks of corporate buyers, contracting last year for more than double its nearest competitor, Microsoft.

For the past decade, in the absence of major climate legislation and in the face of a complex patchwork of regulations that limited the ability of utility companies to build renewable power, PPAs have done the job. But the IRA the most substantial piece of climate focused legislation the U.S. has seen takes that progress and adds billions of dollars in federal incentives. "It supercharges both the role and the potential for customers to drive even more of this:" says Brynn Baker, senior director at the Clean Energy Buyers Association. The latest predictions are gargantuan. Solar developers expect to install more than 215 gigawatts of capacity over the next five years-40% more than was expected before the IRA, according to a report from the Solar Energy Industries Association and Wood Mackenzie.

Also note that Amazon has contracted with Rivian to purchase 100,000 delivery trucks like the one seen below. These will mostly eliminate the ongoing emissions for the last miles of Amazon's deliveries.



There will eventually be three variants, all known by how many cubic feet of cargo space they provide. The first two to start spreading Amazon smiles will be the EDV 500 and EDV 700, followed at some point by an EDV 900. Drivetrains will come in three flavors,

either single-motor front-wheel drive, dual-motor front-wheel drive, and dual-motor all-wheel drive...²

...By the end of 2022, Rivian said it expects to have 10,000 vans in Amazon service in 500 and 700 capacities, reaching a total of 100,000 vans covering all three trims by 2025. The EDV 500 will make the trip overseas, being produced in right- and left-hand drive...

In addition to “last mile” delivery vans, Amazon also uses a huge number of large trucks, including Class-8 Semis to deliver merchandise to and from warehouses, suppliers’ facilities and fulfillment centers. How does it plan to clean those up? Read on.

3. Small Steps for Big Trucks

Large trucks have very long lifetimes. This is one reason that the State of California is considering rules that would have the largest trucks with diesel engines outlawed in our state in 2040, per a proposal being considered by the California Air Resources Board (CARB).³ This is in spite of the recently adapted CARB Rule that lighter vehicles would (mostly) need to stop burning gasoline by 2035.⁴

Medium- and heavy-duty vehicles contribute a quarter of the transportation sector’s GHG emissions and a third of the transportation sector’s NOx emissions, a disproportionately high share considering these vehicles represent only about 1.8 million trucks among the 30 million registered vehicles in the state. The proposed Advanced Clean Fleets (ACF) regulation, or “proposed ACF regulation,” would contribute to achieving the State’s criteria pollutant and GHG reduction goals as well as cleaner technology targets needed to protect communities. Implementing this proposed ACF regulation is expected to save over 5,000 Californian lives between 2024 and 2050. These avoided premature mortalities and other avoided adverse health benefits have an estimated value of over \$57 billion dollars.

The proposed ACF regulation is part of a comprehensive strategy that would, consistent with public health needs, accelerate the widespread adoption of zero-emission vehicles (ZEV) in the medium- and heavy-duty truck sector and in light-duty package delivery vehicles. The proposed ACF regulation would require certain fleets to deploy ZEVs starting in 2024 and would establish a clear end-date of new medium- and heavy-duty internal combustion engine (ICE) vehicle sales in 2040...

The ICE-Powered trucks have several problems: They emit greenhouse gases (GHG) and particulates. They cause air pollution with health issues as described in the above text.

What if there was a short-term (and perhaps partial) fix for one of these problems? Furthermore, what if this fix were very easily implemented. Should we buy into this?

² Jonathon Ramsey, Autoblog, “Rivian Amazon Prime delivery van details found in NHTSA VIN document,” Oct 26, 2021, <https://www.autoblog.com/2021/10/26/rivian-amazon-delivery-van-details/>

³ CARB, Public Hearing to Consider the Proposed Advanced Clean Fleets Regulation, Staff Report: Initial Statement of Reasons, Released: Aug 30, 2022, Scheduled for Consideration: Oct 27, 2022, <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/isor2.pdf>

⁴ See section 7 of “EVs Early Fall 2022,” Sep 2022, <https://energycentral.com/c/ec/evs-early-fall-2022>

Twenty years ago my state passed regulations requiring most vehicular diesel engines to have state-of the art diesel emission reduction. This was definitely a partial fix. See the text below.

A comprehensive plan to reduce harmful particulate matter (PM) emissions from diesel equipment was approved Thursday by the California Environmental Protection Agency's Air Resources Board (ARB).⁵

The Diesel Risk Reduction Plan (Diesel RRP) proposes a three-pronged approach that would require use of low-sulfur diesel fuel; retrofitting existing engines with PM filters; and nearly a 90 percent reduction of PM emissions from all new diesel engines and vehicles.

"Full implementation of this plan means a reduction in health-damaging diesel PM emissions of 75 percent by 2010 and 85 percent by 2020," said ARB Chairman Dr. Alan Lloyd. "This plan will benefit the health of every California resident and every person who visits California," he added.

To aid in implementation of the Plan, ARB has formed a committee of more than 40 international experts to assess the best technology for reducing diesel PM. The Diesel Retrofit Advisory Committee will hold its first meeting in Los Angeles in early November.

As pointed out above, there are still many issues with diesel emissions in spite of the above regulations, which is why my state strongly supports the transition to electric medium / heavy vehicles.⁶ However, what if we had a quick fix for the greenhouse gas issues, should we use this?

The section below is about this quick fix and one firm that is planning to use it (you guessed it).

4. **Electrofuels**

I had not heard of this product before I came across the Forbes article referenced below.

Amazon, with a massive fleet of tens of thousands of delivery vehicles, will begin using a new, renewable form of diesel fuel for trucks in Southern California. The retail giant says this "Electrofuels" diesel results in significantly less carbon pollution than the petroleum-based version.⁷

Starting in 2023, it will use this diesel Electrofuels for trucks making so-called middle-mile deliveries, such as between vendors and its distribution centers, said Daniel Gross, director of Amazon's Climate Pledge Fund. Though this type of fuel has the same exhaust emissions of conventional diesel when used in an engine, the carbon savings come from how it's produced: blending clean hydrogen made from renewable energy with waste carbon dioxide that's been captured from industrial sources. Amazon is

⁵ CARB Press Release 00-24, "ARB Adopts Diesel Emissions Reduction Plan," Sep 28, 2000, <https://ww2.arb.ca.gov/news/arb-adopts-diesel-emissions-reduction-plan>

⁶ See "Electric Trucks and Buses in California," March 2022, <https://energycentral.com/c/ec/electric-trucks-and-buses-california>

⁷ Alan Ohnsman, Forbes, "Amazon Will Power Trucks With 'Electrofuel' Diesel To Curb Carbon Emissions," Sep 20, 2022, <https://www.forbes.com/sites/alanohnsman/2022/09/20/amazon-will-power-trucks-with-electrofuel-diesel-to-curb-carbon-emissions/>

sourcing the fuel from Infinium, a Sacramento, California-based startup that the Climate Fund invested in last year.

Including carbon pollution from oil drilling and the diesel fuel refining process, “we believe it’s about a 95% reduction in CO₂ emissions,” Gross tells Forbes. It also appears to be less polluting than bio-diesel. “The overall profile in terms of carbon emissions is better than what you would see from renewable diesel that’s based on some food crop.”

Amazon and Infinium say the initial phase of the fuel supply deal is to get enough synthetic diesel fuel to power trucks for 5 million miles of operation per year, declining to specify how many gallons that would be. Given that the average semi-truck gets about 5 miles per gallon of diesel, Infinium will likely produce several hundred thousand gallons for Amazon initially...

The fuel deal comes as Amazon, which says it wants to have “net zero” carbon emissions by 2040 across its operations, expands the use of renewable energy from a range of sources to offset pollution created by its delivery fleet and data centers. It also previously announced big purchases of “green” hydrogen from fuel-cell maker PlugPower and is adding up to 100,000 battery-powered delivery trucks from EV maker Rivian. Nevertheless, the company disclosed last month in its annual sustainability report that total carbon emissions across its operations were the equivalent of 71.5 million metric tons in 2021, up 18% from a year earlier.



When I went to the Infinium web site, I found some confusion regarding the name of these new fuels. I edited the above text to be consistent with names on the site, but then I found a second set of product names:

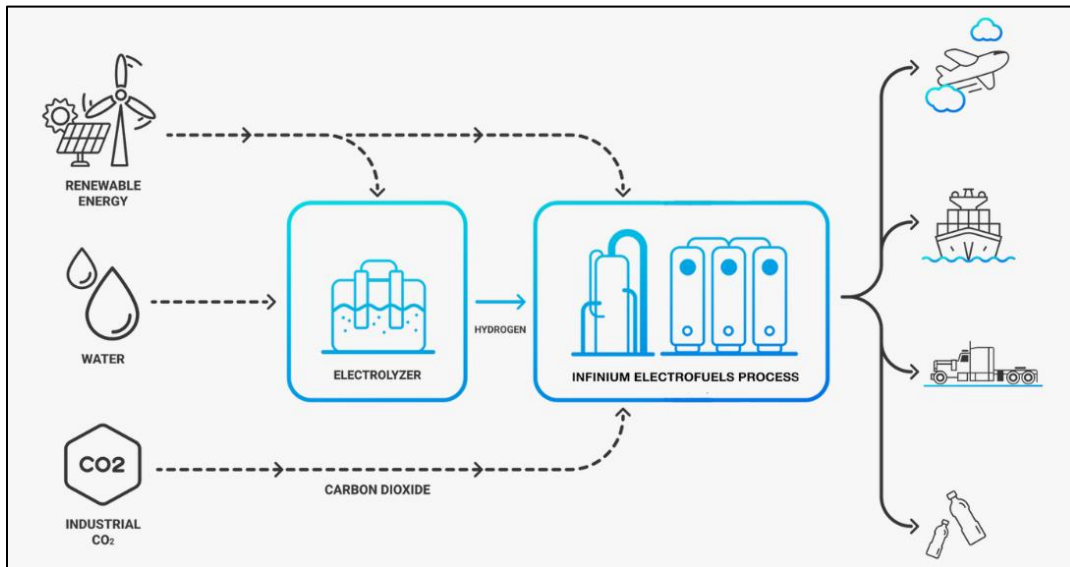
Electrofuels are a new class of ultra-low carbon synthetic fuels developed by Infinium. Our technology produces Infinium Jet, Infinium Diesel and Infinium Naphtha which are

drop-in replacements to traditional fossil-based fuels and feedstocks used in transportation and manufacturing.⁸

Our SAF and diesel Electrofuels can be used in today's planes, ships and trucks as an immediate replacement to carbon intensive petroleum fuels with no costly engine modifications required. Our naphtha Electrofuels can be used in chemical manufacturing processes for goods like plastics and solvents.

"SAF" in the above is sustainable aviation fuel. See the earlier post referenced at the end of this paragraph for more information on this fuel.⁹

I also found a nice graphic that demonstrated how Electrofuels are made (below).



5. Final Words

Who would have thought that the humble power purchase agreement would be one of the most powerful tools to mitigate climate change? Or a quick fix like Electrofuels could drive some really rapid reductions in greenhouse gas emissions across multiple sectors (see the above graphic).

Most of Amazon's competitors have already completed the deals that lock them into a decade or more of renewable power. Facebook, now known as Meta, long ago "unfriended coal" and has 7.5 gigawatts of renewables under contract. Google reached 100% renewable electricity in 2017, with over 7 gigawatts procured; its next effort is ensuring its data centers run "24/7" carbon-free, meaning all of its energy all the time comes from renewable sources, rather than, for example, buying excess solar during the day to make up for coal power it needs at night. Apple announced that it had sourced 100% renewable energy for its operations in 2018, with 87% of that in the form of PPAs; the next, far more challenging step is helping its suppliers and manufacturers do the

⁸ Infinium, Products, Electrofuels, "What Are Electrofuels?" <https://www.infiniumco.com/electrofuels>

⁹ "A Circular Jet Fuel," June 2022, <https://energycentral.com/c/ec/circular-jet-fuel>

same-a goal it has set for 2030. And Microsoft has nearly 8 gigawatts, 5.8 of which it bought in 2021.¹

Even on a global scale Amazon's efforts stand out. The company's initial Climate Pledge called for 100% renewable energy by 2030. But early in the pandemic, that pace shifted, when Daitch and his colleagues realized they could move much faster than they already were. Yet other aspects of Amazon's business-like all those trucks and planes-were not going to decarbonize anytime soon.

Generally, Hawtree Creek is emblematic of how the process often works: a local developer who really knows the geography of the state, its electric-transmission network, and the local politics of its counties might respond to Amazon's solicitation. But once things are under way, they hand the project off to a large energy operator, like Engie.

At the end of 2021, Amazon announced a blockbuster purchase: 18 new projects around the world, bringing its total to 12 gigawatts and making Amazon the largest corporate buyer of renewable energy in the world. In April, it added 3.5 more gigawatts.