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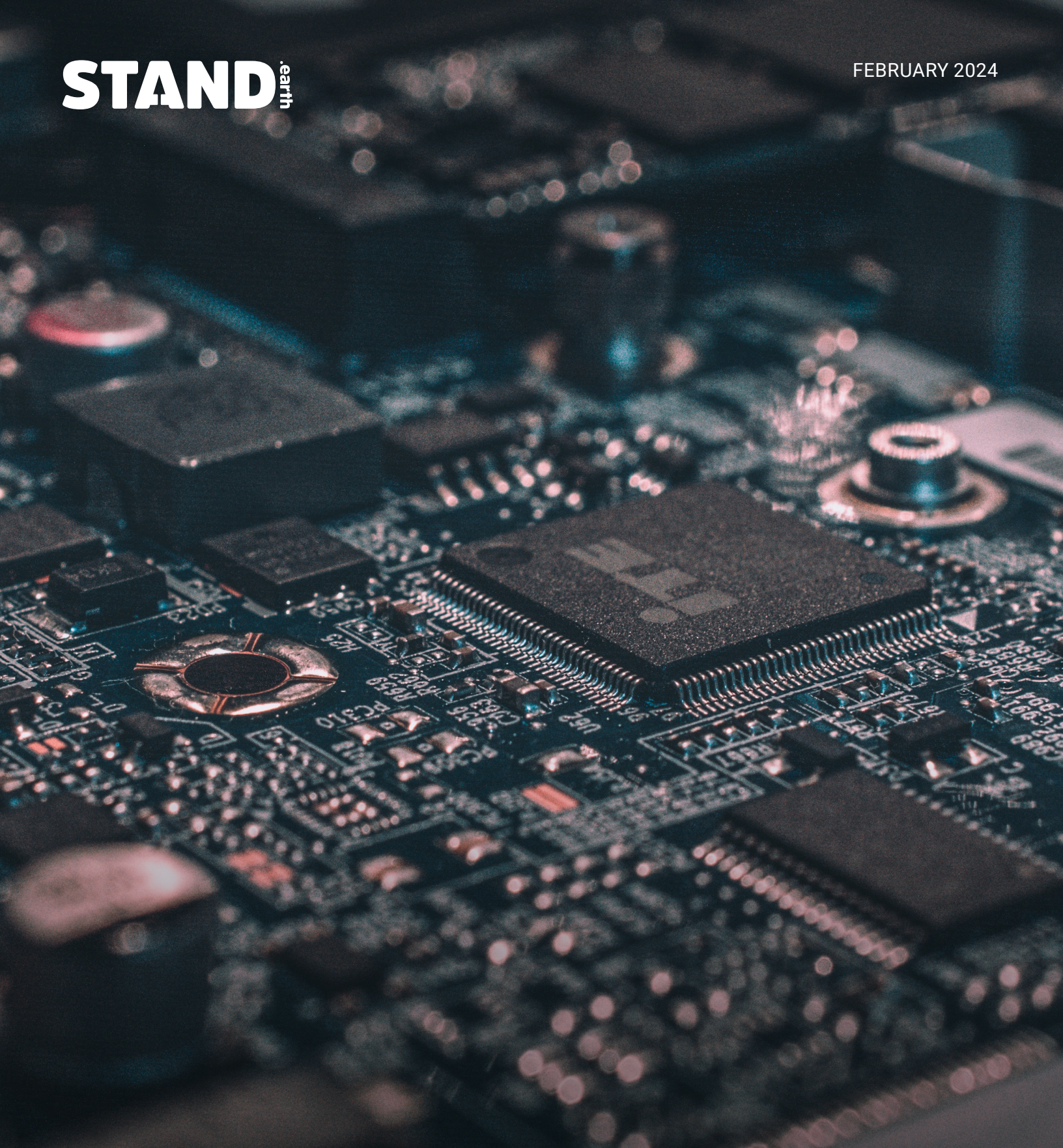


Clean Clicks or Dirty Chips?

Despite Commitments to 100% Renewable Energy,
U.S. Semiconductor Expansion Driving Demand for Dirty Energy

Contents

Executive Summary

Semiconductors have spread into seemingly every corner of daily life in the Western world today, from smartphones, appliances and automobiles, to the rapid rise of AI tools and platforms. Growing concerns over semiconductor supply chain security in combination with the passage of the $53 billion US CHIPS & Science Act has triggered a wave of major new semiconductor manufacturing investments in the US. Not surprisingly, some of the largest plans for expansion come from the largest semiconductor manufacturers, with megafactories by the top four manufacturers already under construction across in several U.S. states, including Intel (Arizona, Ohio, Oregon), Taiwan Semiconductor Manufacturing Company (Arizona) Micron (New York, Idaho) and Samsung Electronics (Texas).

Each of these megafactories will require a tremendous amount of electricity, the equivalent to a medium sized town.[1] For the states and regions where these factories are being built, how this large new electricity demand will be met is a critical question for moving the grid away from fossil fuels and toward a zero emissions electricity grid the International Energy Agency (IEA) has indicated is needed by 2035 in the U.S. and other advanced economies to preserve a 1.5 C pathway[2]. The Biden administration and some states are asking companies to include plans to mitigate greenhouse gas emissions in their application for federal government subsidies under the CHIPS Act[3] and similar programs at the state level. Growing pressure from customers like Apple, who has already begun publicly labeling a subset of its semiconductor laden products as “carbon neutral”, also draws increased scrutiny on the action of their semiconductor suppliers.

But despite their public commitments to 100% renewable energy, the rapid expansion by the top four semiconductor manufacturers in the United States has

not been met with an equivalent scaling of renewable energy projects to meet the projected 2.1 GW in new electricity demand from U.S. semiconductor factories (fabs) that are currently under development.

As already evidenced in Arizona, where the biggest concentration of manufacturing capacity is under construction, the growing gap between new electricity demand from semiconductor factories and local renewable supply is being used to justify additional investments and continued operations of coal and fracked gas power plants. If these new factories are not matched with a significant scaling of locally sourced renewable electricity generation, this rapid expansion of U.S. semiconductor manufacturing threatens to trigger a new round of investment in fossil-based electricity generation across multiple states, locking in a dramatic increase in greenhouse gas emissions and saddling local communities with higher levels of pollution from the increased burning of fossil fuels.

Major data center operators like Apple, Google, and Meta understood this danger over a decade ago as they rapidly expanded their power hungry infrastructure to power the internet and other parts of our digital universe that the global economy has now become heavily dependent on. They were among the first to make corporate commitments to 100% renewable energy, and rather than purchase cheap renewable energy credits, focused on adding large new renewable energy projects to local grids to meet rapidly rising electricity demand from their data centers. Corporate driven power purchase agreements (PPAs) for renewable energy have become one of the biggest drivers of renewable energy in the past decade.[4]

Yet despite seemingly identical commitments to 100% renewable energy and the growing access to renewable electricity, semiconductor giants like Intel and TSMC have not followed the lead of data center operators like Apple, Google, and Meta in matching their expansion with additional renewable electricity projects. Instead, they have relied heavily on the purchase of unbundled renewable energy credits (RECs) to support their claims of clean energy supply, an approach that has been broadly discredited as an effective means of increasing deployment of new renewable electricity projects.

The massive expansion of semiconductor manufacturing capacity currently underway in Arizona provides a clear window on the danger from the continued reliance on RECs by silicon giants like Intel and TSMC and the global IT brands that are their largest customers. With nearly 600 MW in electricity demand expected from fabs already under construction in Arizona, and a relatively small amount of new renewable supply being brought online by TSMC and Intel, local utilities are using new electricity demand from semiconductor factories to justify both a significant expansion in new fracked gas fired power plants and a delay in the retirement of coal fired power plants, over the strong objections of local communities.

The shift of semiconductor manufacturing to the U.S. should present a unique opportunity for the IT sector to transition a critical piece of its supply chain to renewable energy, and for semiconductor manufacturers and their host communities to secure a long term competitive advantage in a world that is racing to move beyond fossil fuels. However, without a significant reorientation by Intel, TSMC, Samsung and other major semiconductor manufacturers of their 100% renewable energy and Net Zero commitments away from the current reliance on unbundled RECs and towards high impact renewable energy procurement, the rapid expansion of semiconductor fabs in the United States will actually increase the sector's fossil fuel demand, pollution and human health impacts, and trigger further investment in fossil based electricity production, taking us away from the zero emission electricity grid that the International Energy Agency (IEA) has said is needed no later than 2035 in advanced countries in order to keep us on track for the net zero goal by 2050 called for under the Paris Climate Agreement.[5]

Intervention Opportunities

Interventions by semiconductor manufacturers, global IT brands who are their largest customers, policymakers, and standards setting bodies are all needed to prevent the ongoing rapid expansion of semiconductor fabs in the United States from locking in higher greenhouse gas emissions from the increased demand for coal or fracked fossil gas electricity generation.

Net Zero and 100% Renewable Commitments of Customers

Despite the near universal adoption of 100% renewable and Net Zero targets by the largest US consumer electronics brands, only Apple and Google have consistently prioritized high impact renewable energy procurement strategies in their own decarbonization plans, and only Apple has set this same expectation for semiconductor and other large suppliers in its supply chain. Amazon, HP, Lenovo and Dell, remain heavily reliant on the purchase of unbundled RECs for their reported renewable energy supply. While Microsoft and Amazon have significantly increased the scale of its renewable energy PPA in the past two years,[6] the dramatic increase in electricity demand by both companies has meant that both companies continue to rely on unbundled RECs for over 50% of its renewable energy claims.[7] The lack of leadership in pursuing high impact strategies for purchasing their own renewable electricity supply certainly shapes expectations among their semiconductor and key component suppliers. Suppliers will look first at what actions their largest customers have taken to advance their own environmental claims in considering what strategies to include in their own decarbonization plan.

Federal and State Incentives

To receive funding under the $54 billion US Chips Act, the Biden Administration requires semiconductor manufacturers to include their plan to mitigate climate change in their application, including the use of renewable energy. States are also offering taxpayer support to attract new manufacturing hubs, with New York State's Green Chips Act requiring new facilities to have a 100% renewable supply for factories to receive support. However, it is unclear whether these programs will require companies to pursue renewable power purchase agreements (PPAs) or other high impact strategies to bring additional local supply of renewable energy on to the grid, or will allow unbundled RECs to continue to be used to mask rising emissions from underlying fossil fuel demand.

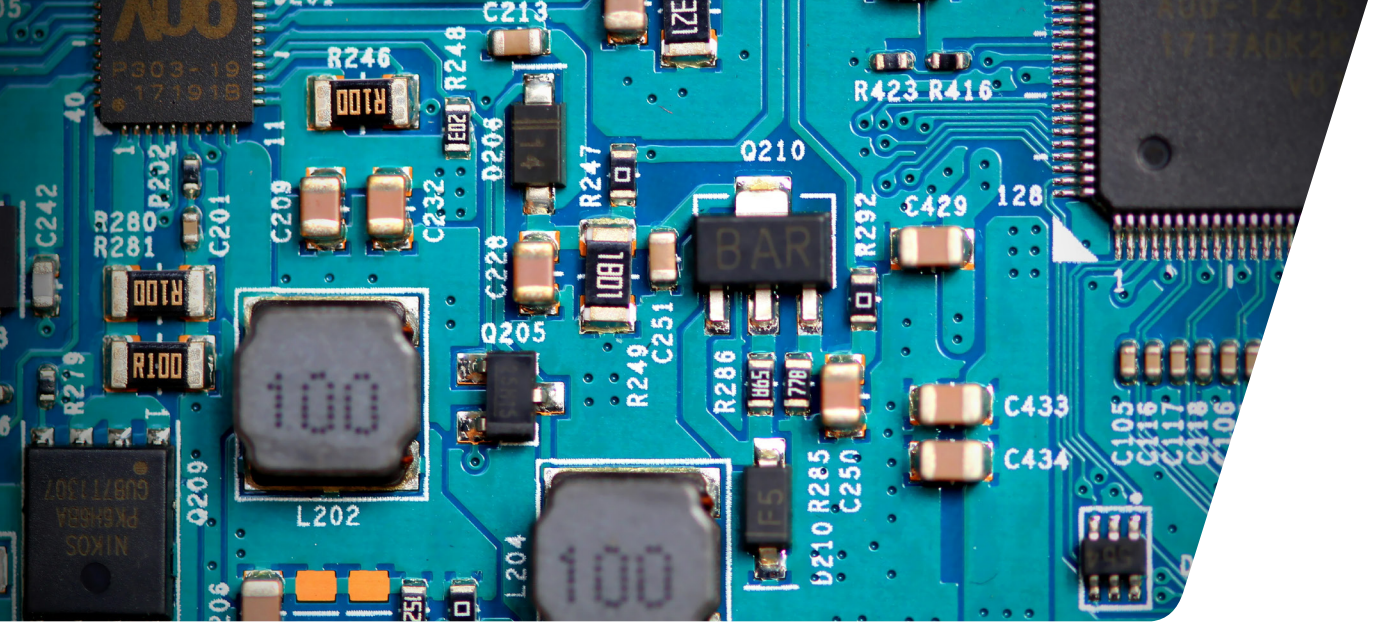
Strengthening Reporting Standards

The existing bible for the voluntary reporting of greenhouse gas emissions by corporations is the Greenhouse Gas Protocol(GHG Protocol), which is increasingly relied upon as a foundation for regulations mandating corporate reporting of annual greenhouse gas emissions. The inclusion of "market-based reporting" of emissions from electricity consumption(Scope 2) in the last GHG Protocol standard update in 2014 has been a catalyst for companies like Apple, Google and Meta to reduce their emissions by signing high impact contracts for renewable energy that added new renewable energy to the local grid powering their data centers.

Unfortunately, the GHG Protocol update also left the door open for companies to purchase low impact unbundled renewable energy credits, allowing companies like Intel to dramatically reduce their climate pollution without any change in the source of their electricity supply, leading to a significant undercounting of corporate climate pollution. The GHG Protocol standards for reporting emissions from electricity(Scope 2) are slated for a major update in the coming year[8] is a critical opportunity to close these loopholes and shift to a much more granular measurement of the impact of corporate renewable energy to reflect the actual transition off of fossil fuels to 100% renewable energy electricity.

Key Findings:

- New semiconductor factories currently under construction by the four largest semiconductor manufacturers – Intel, TSMC, Samsung, and Micron – are expected to generate approximately 2.1 gigawatts in new electricity demand, more than double the annual electricity consumption of the City of Seattle.
- Unlike Apple, Google, and Meta - all companies that have met their 100% renewable energy commitments by bringing new renewable energy projects online to match their rapidly rising electricity demand, despite having made public commitments to be 100% renewably powered, Intel, TSMC, Samsung, and Micron have thus far failed to secure additional renewable energy supply to meet their existing and future electricity demand in the U.S., relying instead on the purchase of unbundled renewable energy credits.
- Intel and TSMC are building four new semiconductor factories in Arizona that are expected to consume as much electricity as 260,000 homes[9] but have failed to sign renewable power agreements for their massive new factories in Arizona, enabling local utilities to justify both a significant expansion in new fracked gas fired power plants and a delay in the retirement of coal fired power plants, over the strong objections of local communities.
- Unless the renewable energy purchasing strategy of the semiconductor industry is shifted to focus on adding new renewable energy to the local grid, their ongoing expansion threatens to increase investment and demand for fossil fuels in multiple U.S. states, and undermine federal and state targets to transition to zero emission electricity generation.
- Due to significant weaknesses in the current reporting standards for greenhouse gas emissions, companies with 100% renewable energy or Net Zero commitments are able to use the purchase unbundled RECs to mask a significant increase in its greenhouse gas pollution and related fossil fuel consumption. Intel, who has been one of the largest corporate purchasers of unbundled RECs in the United States over a decade, has used its purchase of unbundled RECs to report a dramatic reduction in their GHG emissions from electricity, claiming that all of its facilities in the US and EU have zero emissions associated with electricity consumption.



Introduction

The rapid expansion of the digital world is increasingly shifting more and more parts of the global economy to greater dependence on computing capacity. Collectively, the IT sector is estimated to already be responsible for at least 2% or more of the world's annual greenhouse gas emissions,[10] but its rapidly expanding infrastructure can drive electricity demand and corresponding greenhouse gas emissions much higher in places where its energy intensive infrastructure is concentrated.

A renewable powered electricity grid is critical for decarbonizing other sectors of the economy, as transportation and industrial demand for fossil fuels are eliminated by electrification via electric vehicles, heat pumps, and electric arc-furnaces. The International Energy Agency identified that in order to achieve net-zero levels of emissions by 2050 that are necessary to limit global temperature to 1.5°C, fossil fuels must be eliminated from electricity production first. According to the IEA, electricity must be zero emission by 2035 for Advanced Economies, and by 2040 for the rest of the world as the electricity grid becomes the primary source of the world's energy consumption.[11]

Two of the largest and most energy intensive pieces of the IT sector's footprint are (1) data centers and (2) the large semiconductor factories (or Fabs) that serve as the virtual and physical engines respectively of our digital world, with both "hyperscale" data centers and semiconductor "megafactories" that are dozens of football fields in length capable of consuming electricity equivalent to a medium sized city.

Because of the huge amount of energy needed to produce them, semiconductors are typically the biggest part of the the carbon footprint of device manufacturers. As illustrated by Figure 1, semiconductor carbon emissions represent half of Apple's overall manufacturing footprint, which itself is 77% of the company's overall carbon footprint.

Given their energy intensity and current phase of rapid expansion, decisions on how the rising electricity

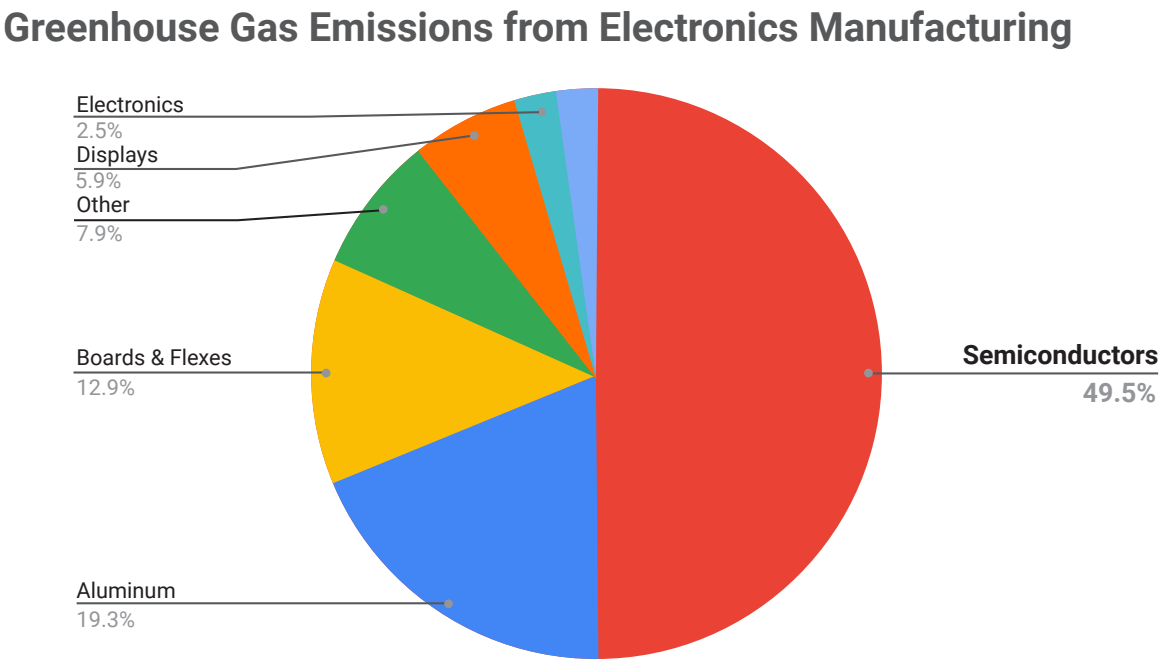


Figure 1: Apple GHG Emissions from Manufacturing. Apple Environmental Responsibility Report (2018)

demand from data centers and semiconductor factories is met will play an outsized role in determining whether the IT sector will be a meaningful catalyst toward a rapid phase out of fossil fuels, or lead us in the opposite direction, toward a long term dependence on fossil fuels for electricity generation, and much higher human health and climate impacts associated with them.

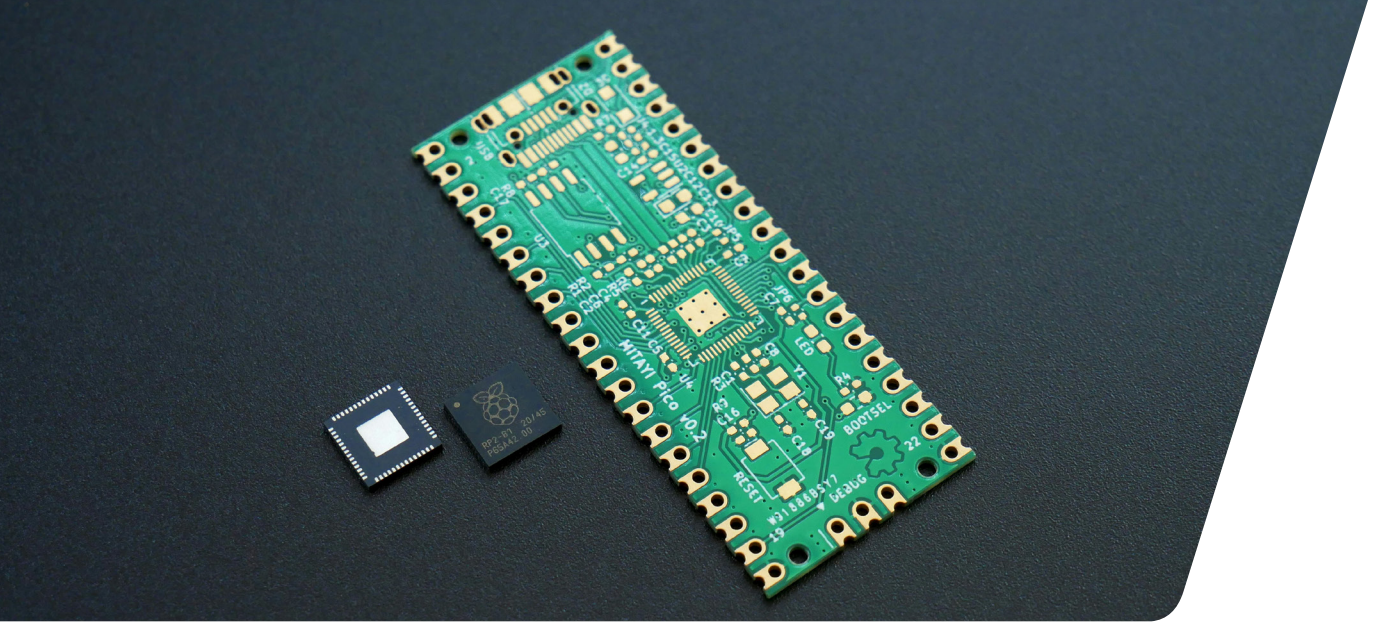
Major Semiconductor Manufacturing Expansion in the United States

Triggered by recent semiconductor supply chain disruptions and growing geopolitical security concerns surrounding Taiwan, the need for domestic semiconductor manufacturing has become an urgent economic and political concern in the United States, resulting in massive new federal and state government incentives to attract new US based factories for manufacturing semiconductors. At the federal level, the US Chips and Science Act is budgeted for over $53 billion to support new semiconductor manufacturing in the US, with additional tax relief and infrastructure incentives being offered by state and local governments to attract semiconductor factories.[12]

The world's largest semiconductor manufacturers have responded, triggering a massive expansion in investment in fabs across the U.S., with 37 new or expanded facilities announced since the signing of federal legislation.[13] The three largest, Taiwan Semiconductor Manufacturing Company (TSMC), Intel, and Samsung, have collectively committed over $100 billion to build eight new megafactories in four different states, with even more factories anticipated, and with fourth biggest Micron planning a $100 billion mega-fab in New York State. The total electricity demand of just the first phase of these 9 megafactories is estimated to be 2.1 Gigawatts, more than double the annual electricity demand of the City of Seattle,[14] with plans for even much larger expansion slated for the Micron, Samsung and TSMC factories.

Semiconductor Megafactories Under Development in the U.S.

	Committed Investment	Estimated Electricity Demand	Location(s)	Local Renewable Grid Mix	U.S. 100% Renewable Commitment?
intel	$20B[15] $20B[16]	361MW 160MW[17]	Arizona Ohio	3% 5.5%	✓
Micron	$100 Billion $15 Billion	900MW 120 MW	New York Idaho	26% 47%	✓
SAMSUNG	$25 Billion[18]	200 MW	Texas	33%	✓
tsmc	$40 Billion	380 MW	Arizona	22%[19]	✓



Comparison of Renewable Strategies: Data Centers vs Semiconductors

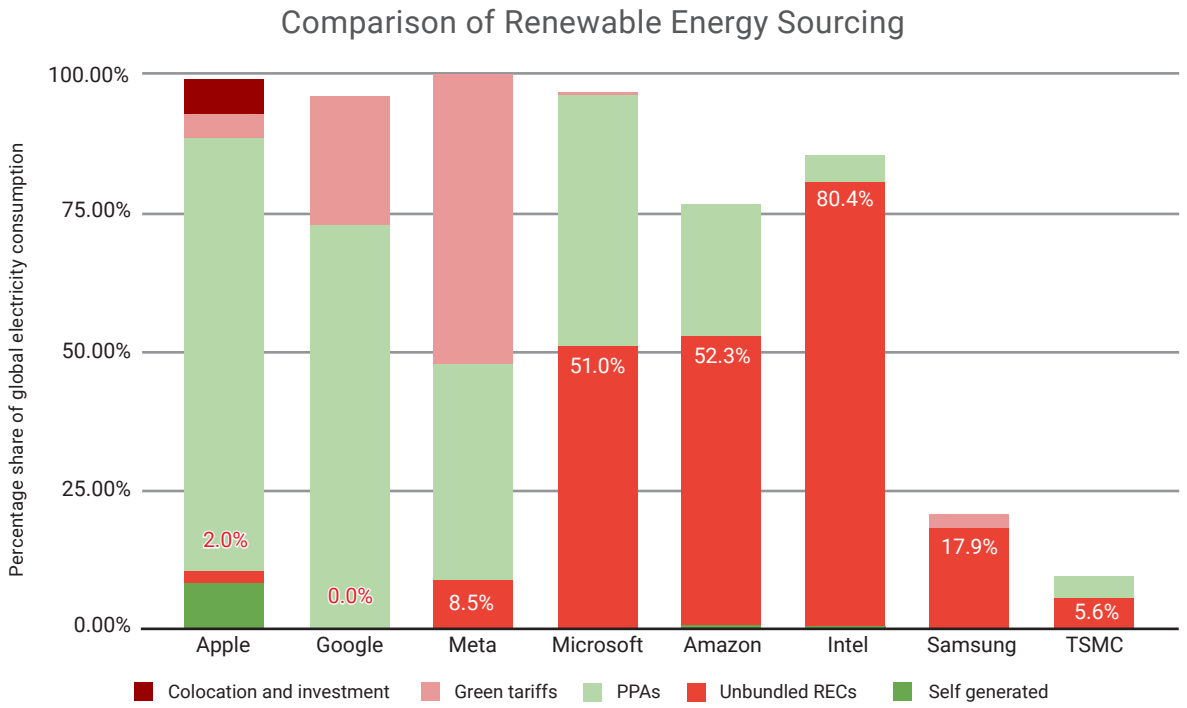
The rapid expansion of massive "hyperscale" data centers by Apple, Google, and Meta that began over a decade ago was the first wave of a significant IT sector increase in electricity demand that was most often met by an increase in coal and fossil gas generated electricity. Faced with rapidly rising emissions and growing public scrutiny, Meta (Facebook at that time) followed by Apple and Google became the first to adopt commitments to power their rapidly expanding fleet of data centers with 100% renewable energy. Rather than relying on the purchase of unbundled REC(s), which was the practice of Intel and a number of other IT companies at the time, all three tech giants focused on securing (a) a new supply of renewable energy, that was (b) in the same location they built a data center, and (c) sufficient to match the increase in demand for electricity.

Despite seemingly similar commitments by Intel,[20] Samsung Electronics[21], Micron,[22] and TSMC,[23] to 100% renewable energy, the track record and renewable energy strategy of semiconductor giants in the United States to date is markedly different from IT leaders in the data center space. As exemplified by the renewable energy strategy of Intel, despite the availability of higher impact options such as renewable PPAs, semiconductor manufacturers have continued to rely heavily on the purchase of "unbundled" Renewable Energy Credits (RECs) to claim progress on their renewable energy and carbon reduction goals, overlooking the considerable evidence that the purchase of unbundled RECs do not add significant new renewable generation to the grid or help reduce emissions.[24]

Unbundled RECS: Continued Reliance on a False Solution

The distinction between RECs and PPAs is crucial to understanding why the renewable energy goals of Intel, TSMC and other semiconductor manufacturers have thus far failed to shift the electricity demand of their operations away from fossil fuels. A REC is a claim to a certain quantity of renewable energy production. In markets where a REC tracking system exists, when a power company generates one megawatt-hour (1 MWh) of electricity from renewable sources, it has two products to sell: the electricity itself, and the REC. These can be sold together (bundled) or can be transferred or sold separately from power produced (unbundled). Unbundled RECs can allow companies to buy a claim to renewable energy associated with renewable electricity produced on a different grid, even from a previous year, typically at a fraction of the cost of the electricity itself, while continuing to increase demand for fossil fuel based electricity where their facility is located.

With the steady expansion of renewable energy in the US, unbundled RECs have flooded the market. In 2016, the oversupply of RECs drove REC prices to reach a record low of $0.36/MWh.[25] While voluntary REC prices in the US have since rebounded to approximately $3/MWh,[26] numerous studies have shown that the relatively small revenue generated from the sale of unbundled RECs at this price has done little to expand renewable energy capacity.[27] Recent studies indicate that the purchase of unbundled RECs rarely results in the addition of renewable energy to the grid, and in fact are significantly undermining the credibility of voluntary corporate targets under the Science Based Target initiative.[28]



Other major IT companies heavily reliant on unbundled RECs have recognized the low impact associated with buying unbundled RECs, and have committed to phase them out. For example, in 2020 Microsoft's leadership committed to shift the company's renewable procurement to PPAs,[29] and have significantly increased the rate of PPA signings over the past two years, raising Microsoft's total renewable PPAs to over 13 GW.[30] However, due to the rapid increase in electricity demand associated with the deployment of artificial intelligence (AI) models, Microsoft's still depends on unbundled RECs for a majority of its renewable energy claim.[31]

GHG Reporting Standards Enabling Greenwashing of Dirty Energy Demand

While company policies can determine whether a company's transition plan is built around high impact renewable electricity deployment, the current voluntary reporting standards that govern corporate reporting of GHG emissions from electricity that were adopted in 2015 created several loopholes that are enabling and incentivizing low impact renewable energy purchases like unbundled RECS. This standard, the GHG Protocol Scope 2 Guidance to the Corporate Standard, was adopted in 2015 to amend the GHG Protocol, making a crucial change in how corporations calculated their GHG emissions from electricity. Originally, companies were required to use a "location-based" approach to calculating their GHG emissions from electricity consumption, with the average emissions profile of electricity on the local grid each year being used to calculate emissions from electricity consumption. The 2015 Scope 2 Guidance established a secondary way of reporting, allowing companies to adjust GHG emissions from electricity via "market-based emissions reporting", to reflect the intervention by the company in deploying or buying renewable energy, allowing companies to change the emissions factors for their electricity consumption, significantly lowering their reported pollution.

While this amendment created an important incentive for companies to reduce emissions through the purchase of renewable energy, in designing a standard that would be accessible to companies globally across widely disparate energy markets it left the door open on the nature of renewable electricity purchases that would count under the market based option. The 2015 Scope 2 Guidance left significant weaknesses in the reporting structure that are masking rising demand for fossil fuels, allowing companies to radically alter their GHG footprint though renewable energy purchases that are having little to no impact in changing the amount of fossil fuels powering their operations. The biggest weaknesses include:

- Additionality: Crediting of unbundled or standalone RECs that do little to support the addition of deployment of renewable projects
- Geographic: Broad definition of "market" that means renewable energy can be purchased to adjust the emission factor of a facility, allowing adjustment of emissions when grid interconnections between supply and demand do not exist or are impractical.
- Time: Allowance for the counting of purchased renewable credits generated far before the reporting year

High Impact Renewable Procurement Strategies:

Direct Deployment /Onsite Generation of Renewable Energy Projects

While restrictions on available land may limit this option for many corporate customers, company deployed renewable energy projects offer a clear opportunity for companies to ensure they are bringing new and additional supply of renewable energy to the local grid, particularly in locations where there are limited options for buying renewable electricity. While still maintaining a grid connection to data centers or factories, solar projects onsite or on nearby land have been used successfully by Apple, TSMC, and Samsung to meet local energy demand.

Power Purchase Agreements (PPAs)

Over a decade ago, Meta, Apple[32] and Google[33] began to support new renewable energy projects to power their data centers by signing PPAs with renewable energy developers or utilities. A PPA is a long-term contract that allows a company to purchase renewable energy from a supplier at a fixed rate. A signed PPA provides a steady income stream to the electricity supplier and enables financing for the renewable energy project development. For the buyer, renewable PPAs can provide an effective hedge against rising energy costs.

Building on early leadership by data center operators, dozens of companies have followed a similar path, with corporate renewable energy PPAs now one of the largest drivers of new renewable electricity development in the US, with more than one-third (35%) of corporate renewable claims reportedly backed by PPAs.[34] While the shift toward corporate renewable energy PPAs has pressured electric utility partners and site facilities to expand renewable energy capacity, opening dozens of new markets for corporations to buy renewables to power their operations, not all renewable energy PPAs have the same high impact in displacing the fossil fuel demand from the data center or factory. Examples of lower impact PPAs include synthetic PPAs where the underlying project is being added to one grid, and the large electricity demand of the customer lies on a completely different grid(s), still increasing demand for fossil fuels. The customer is still allowed to claim to be renewable powered under market based reporting because it is in the same "market" as defined under the Greenhouse Gas Protocol.

Utility Green Tariff Programs - High or Low Impact?

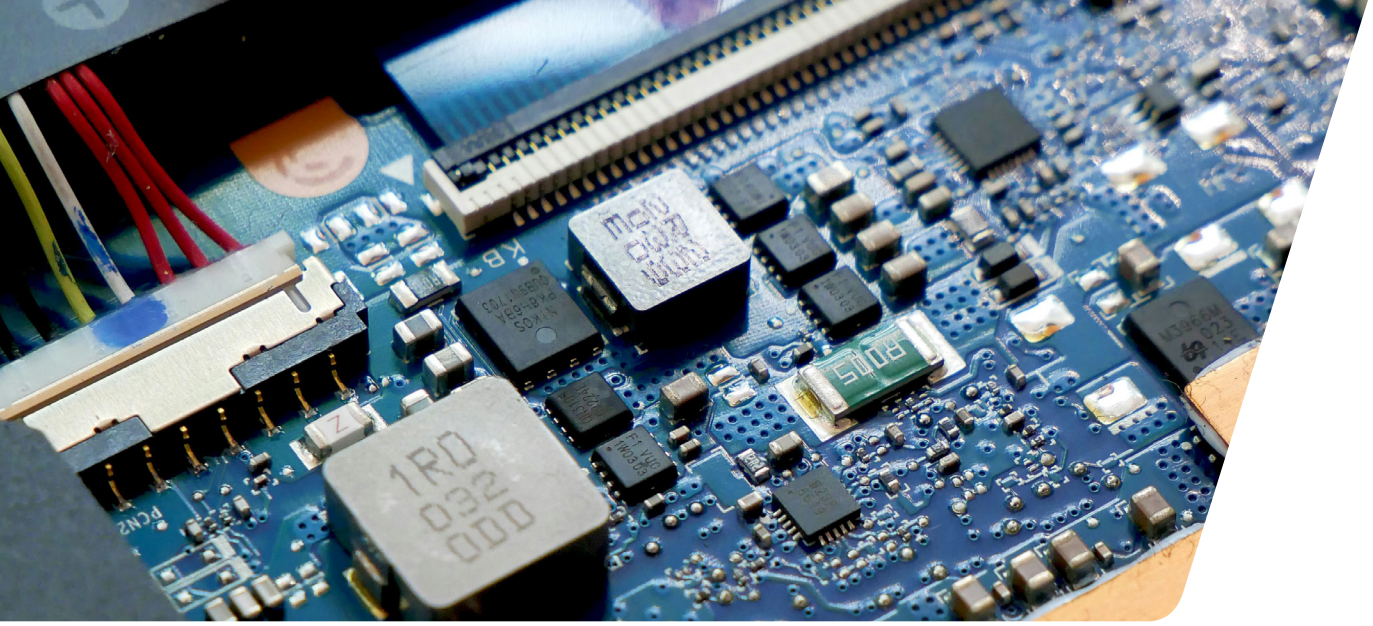
Utility Green Tariff programs offer a pathway for companies to buy renewable energy through their local utility, but vary greatly in their design and impact. In their initial incarnation, many utility green pricing programs had little additionality, often used by utilities as an avenue for capturing a price premium in exchange for RECs from renewable generation assets that were already in service and not needed for compliance purposes. Other utility green tariff or green pricing programs buy unbundled RECs from third party providers as an additional service to customers, while continuing to provide electricity from fossil based sources.[35]

Faced with increased demand from corporate customers and regulators, the 2.0 version of green tariffs has emerged in the US over the last decade in several markets where the utility effectively serves as a broker between the customer and the renewable project developer in managing a renewable PPA, with reciprocal PPA long term contracts signed by the utility to the project developer and the customer to purchase the output of the project, and providing guaranteed revenue to the project developer much like a corporate renewable PPA does.[36] Recent examples of green tariff deals signed by global IT companies include Samsung (Austin Power), Apple (NV Energy and SRP) and Intel (Arizona-SRP, Oregon-PGE).

Recent studies have shown that such corporate-utility PPAs signed under 2.0 Utility green tariff programs can be an effective means of catalyzing additional renewable generation capacity when structured for measurement on an annual basis.[37] However, similar to corporate only PPAs, their additional impact is lessening in the United States due to the scaling of renewable projects in response to the IRA.[38]

Highest impact - 24/7 renewables

Shifting to an hourly or 24/7 basis for measuring a company's renewable energy supply is shown to have significant increases in the amount of additional renewable energy being brought onto the grid, and reduction in emissions as additional fossil based generation is displaced. A select number of utilities have already begun to offer 24/7 clean or renewable energy based green tariffs to customers in response to growing interest by IT leaders like Google, progressive municipalities (Palo Alto), and adoption at the federal level on new standards requiring the measurement and tracking of renewable electricity supply on a 24/7 basis to be eligible for federal tax incentives standards for green hydrogen production[39] (see 24/7 Renewable, page 24)



Case Study: Intel and TSMC's Growing US Electricity Demand in Arizona

Driving New Fossil Expansion & Extending Reliance on Coal

In Arizona, the IT sector is driving a dramatic increase in electricity demand, led by the massive semiconductor factories by Intel & TSMC. In response to these semiconductor megafactories, the state's two largest utilities, Arizona Public Service (APS) and Salt River Project (SRP) are planning a major expansion of generation capacity to meet the growing electricity demand from IT companies. While some of the proposed additional generation capacity includes a significant increase in renewables and storage, both utilities are moving forward with significant new investments in fossil gas generating capacity (See SRP and APS, below).

Other IT brands operating data centers in Arizona, such as Apple, Microsoft, and Meta, have signed contracts to support the development of new renewable energy projects to match a significant portion of their electricity demand in Arizona with new utility-scale renewable energy projects. TSMC and Intel have thus far created very little new renewable energy capacity relative to demand they are expected to draw from the Arizona grid.

Intel is one of Arizona's largest employers with 13,000 employees, with two campuses in Chander[47] with four existing fabs that already make it the largest electricity customer of the local utility, **Salt River Project, or SRP**. Despite the growing number of utility scale renewable energy contracts signed by Apple and other tech companies to add additional renewable electricity onto the Arizona grid, Intel has only recently signed its first renewable electricity PPA for a 100 MW solar project in 2020.[48] The local SRP grid is on average only 3% renewable powered, with fossil gas (33%), coal(9%), and nuclear (54%) providing the vast majority.[49]

Intel Expansion:

The addition of the two Intel megafabs[50] under construction are expected to add over 360 MW of demand to its Ocotillo Campus, a 150% increase of Intel's Arizona electricity demand, with an additional expansion of nearly 300 MW already anticipated in SRP's transmission upgrades to the site.[51]

Company (City)	Current Estimated Arizona Power Demand	Estimated Demand from Additional Expansion	Additional Arizona Renewable Generation (Nameplate Capacity)	Arizona Utility	Local % Renewable Electricity	Net Demand to Arizona Utility (annual measurement)
TSMC (Phoenix)	190 MW	190 MW	+5 MW Onsite Solar (17 MW)	APS	22%[40]	+375 MW
Intel (Chandler)	243 MW[41]	361MW[42]	+33 MW (100 MW)	SRP	3%	+606 MW
Apple (Mesa)	43 MW[43]	–	+20MW (62.2MW)[44] +23 MW (NV + OR)	SRP	3%	0MW
Microsoft (Goodyear, El Mirage, Phoenix)	50 MW[45]	–	+50MW (150MW)[46]	APS	22%	0MW

SRP also serves the Apple and Meta data centers in nearby communities. Both Apple and Meta have partnered with SRP to bring large scale renewable energy projects onto the Arizona grid to help them match their expected electricity demand with 100% renewable electricity as measured on an annual basis:

- Apple itself developed a 50MW solar project near its global data command center in Mesa that SRP agreed to a 25 year PPA to buy the output, with Apple retaining RECs generated by the project.[52] Apple has also contracted for 7MW of solar through SRP's Sustainable Energy green tariff program.[53]
- With a five hall data center under development near Mesa, Meta recently signed a contract with Ørsted for the majority output of the Eleven Mile Solar Center, a 300MW Solar project combined with 300MW of four hour battery storage developed by Ørsted, which will be supported by SRP.[54]

Intel finally signed its first renewable contract with SRP in 2020 for a 100 MW solar project under the utility's Sustainable Energy green tariff[55], adding one-third that amount onto the grid once capacity factors are included. Intel has not reported any additional purchases of renewables via PPA or utility tariff, choosing to purchase unbundled RECs for the vast majority of its 100% renewable claim for its two Arizona campuses.

TSMC's New Factories

The nearly 400 MW of expected electricity demand from TSMC's two Arizona's Fabs will be served by **Arizona Public Service (APS),** who also serves as the electric utility for Microsoft's new data centers in Goodyear and El Mirage. In the load forecast for its 2023 Integrated Resource Plan, APS projects that electricity demand from large electricity customers will jump from 3% in 2023 to 34%, driven primarily by data centers and industrial customers like TSMC's semiconductor fabs.[56] APS indicates that the electricity demand of the first two TSMC fabs is projected to reach 380 MW, according to proceedings before state regulators.[57] With the addition of the second phase, TSMC's expected electricity demand in Arizona will be equivalent to that of nearly 260,000 homes.[58] According to the same proceedings, a total of six phases are anticipated, resulting in a total potential demand of over 1200 MW.[59]

While Intel and TSMC have failed to deploy utility-scale renewable projects alongside their expansion

in Arizona as Apple, Google, Meta and major IT companies with much smaller facilities in Arizona have done, both SRP and APS are using the dramatic increase in electricity demand by Intel and TSMC to justify additional investment in fossil fuels or long term procurement of fossil-based generation capacity.

Pointing to the expected significant increase in electricity demand associated with Intel's new factory, SRP convinced regulators to in May 2023 to move ahead with the expansion of a 575 MW gas power plant to meet rising demand from Intel and data center operators in its territory[60], overriding objections from the local community, the majority of whom are low income and people of color.[61] The Integrated System Plan that SRP's board adopted in October 2023 has further expanded on the build out of fossil gas generation capacity, greenlighting 2,000 MW of new gas plants and delaying the retirement of older coal generation and ultimately replacing them with new gas plants.[62]

APS's integrated resource plan for meeting rising electricity demand over the next fifteen years recently filed with regulators does call for a significant increase in renewable generation and battery storage.[63] But rather than moving to phase out both coal and gas fired electricity generation, APS's plan further extends its reliance on fossil based generation well beyond the 2035 threshold that IEA's Net Zero Scenario indicates must be when advanced economies phase out fossil based electricity generation by in order to maintain a 1.5°C total temperature change. APS points to large new demand from TSMC, data centers, and other new demand from energy intensive manufacturing customers over the next five years[64] in part to justify a delay in a coal plant retirement and replacement with gas fired generation, forecasting a projected 1.8GW in load growth by large Industrial customers in the next five years and its significant impact on peak demand requiring new investments in new fossil gas generation capacity.[65]

Shifting to 24/7 measurement of 100% Renewable

Comparing the renewable additions IT companies' renewable procurement in Arizona highlights how far behind the renewable energy strategies of TSMC and Intel are from some of their biggest customers.

Matching rising electricity demand on an annual basis with new local renewable supply from high impact PPAs would be a big step forward, and important for reducing the need for fossil generation to support higher peak demand. However, the impact of the IT sector in Arizona and the fact that both data centers and semiconductor factories maintain high rates of demand 24 hours a day is clearly illustrated in the recently published long term system plan of both SRP and APS. While both utilities are adding large amounts of solar, both are also extending coal generation and adding significant amounts of fossil gas to supplement and ultimately replace coal, rather than phase out fossil fuels, both to meet the significant increase in peak demand triggered by the expansion of large IT companies, as well as to cover demand when solar generation goes offline in the evening hours.

For such high electricity demand customers like data center operators and semiconductor manufacturers, a shift away from an annual measurement of renewable supply and electricity demand to a more granular 24/7 measurement of their 100% renewable targets is critical to prevent the build out of new fossil based generation and drive much deeper decarbonization across the grid. (see 24/7 Renewables, p.28)

Intel

Major Customers: Dell, HP, Lenovo, Microsoft , NVIDIA
U.S. Fab Expansion Locations: Arizona, Ohio, Oregon
Reported US Renewable: 100%
U.S. RE from High Impact Sources: 9%
U.S. RE from unbundled RECs: 91%

Beginning in 2013, Intel has claimed that it has purchased 100% renewable electricity for its US operations, with the vast majority of the renewable energy purchased secured through the purchase of unbundled RECs.[66] While Apple, Meta, Google, and others shifted their renewable energy strategy away from unbundled RECs, Intel has used the permissive nature of the Scope 2 Guidance to maintain its heavy reliance on unbundled RECs to dramatically reduce its emissions under market based reporting. Despite its largest customers (HP, Dell, and Lenovo) having set science based targets under the Science Based Target Initiative (SBTi) and encouraging suppliers to also set targets approved by SBTi, Intel has expressly declined to commit to setting a SBTi approved target, citing the lack of recognition by SBTi for early action to reduce emissions, and the continued rapid growth of semiconductor demand.[67]

Climate Transition Plan Enabling Increased Demand for Fossil Fuels:

Intel's expansion of its US semiconductor manufacturing stretches across three U.S. states: with a significant expansion of existing manufacturing hubs in Arizona and Oregon, and new hub in central Ohio, representing over $50 billion in new investment already committed and still further expansion anticipated in both Arizona and Ohio[68]. Prior to the announcement of the Ohio hub, Intel's two largest manufacturing hubs have been in Arizona and Oregon. While Apple, Google, and Meta with significant operations in Arizona, Ohio and Oregon

respectively have created and pursued opportunities to purchase renewable energy from local sources that drive additional renewable energy onto the grid, Intel has continued to heavily rely on unbundled RECs to support its claim to be 100% renewable powered in the United States.[69] Intel's recent decision to sign PPAs to drive the deployment of solar in Oregon and Arizona are an important step in the right direction, but represent just 10% of Intel's annual US renewable energy purchases.[70]

When announcing a $20 billion investment to build two new leading-edge chip factories in Ohio near Columbus,[71] Intel committed to powering the facilities with 100% renewable energy by 2030, five years after it opens.[72] Google, Meta, and Amazon have all built sizeable data center campuses very close to the new Intel factory in New Albany, Ohio. With only 5% renewable energy produced by the local utility (America Electric Power) in Ohio,[73] Meta, Amazon[74], and Google have all signed significant contracts for renewable energy to the local grid to offset the increase in electricity demand needed to power these massive new data center facilities and support their 100% renewable electricity goals. However, despite the low levels of renewable energy on the Ohio grid, statements thus far by Intel indicate they intend to again rely on purchasing unbundled RECs.[75]

TSMC

Major Customers: Apple, AMD, Microsoft, Google, NVIDIA, Qualcomm
U.S. Fab Expansion Locations : Arizona
Reported US Renewable: 100%
U.S. RE from High Impact Sources: 0%
U.S. RE from unbundled RECs: 100%

Currently the world's largest semiconductor manufacturer, TSMC's factories are heavily concentrated in Taiwan. The announcement committing $40 billion (USD) to build two major new chipmaking fabs in the United States near Phoenix, Arizona is TSMC's largest investment outside of Taiwan to date. TSMC has taken advantage of opportunities to purchase renewable electricity from local sources in Taiwan to cover a sizable portion of its electricity demand in Taiwan, including signing a world record corporate PPA for over 900 MW of offshore renewable electricity, its growth continues to outstrip its supply of renewable energy locally. TSMC has also shown some innovative renewable energy procurement in Taiwan in the form of an aggregation renewable energy PPA to unlock renewable electricity procurement options for its local Taiwan suppliers.

In September 2023, TSMC significantly increased its ambition level for renewable energy,increasing its 2030 target to 60% renewable (up from 40%) and 100% renewable by 2040 (previously 2050).[76] However, while TSMC has signed several large renewable PPAs to power a portion of its operations in Taiwan, it has primarily relied on unbundled RECs for its overseas operations in China and the United States, which it reports to be both 100% renewable powered and zero emissions associated with its electricity demand.[77]

TSMC's electricity demand in the United States is expected to increase dramatically with the completion of each new fab. In 2020, TSMC announced that it would build its first fab in the United States. The company committed to construct a USD 12 billion facility in Phoenix, Arizona, which is projected to begin operations in 2023 and to reach full capacity by 2025.[78] In December 2022, TSMC announced that it would build a second, more advanced factory in Arizona, to be completed in 2026, reportedly bringing TSMC's total investment in the Arizona fabs to USD 40 billion.[79]

While TSMC says it has installed an onsite solar array in the parking lot of its facility, the array has just 14.75 MW of nameplate capacity,[80] representing approximately 1.3% of the total electricity needed to power TSMC's first two Arizona fabs.[81] Despite the strong local renewable energy resource in Arizona and the massive amount of electricity demand expected from its two new fabs, TSMC has not taken action to match the electricity demand with additional large-scale sources of renewable energy though PPA or other high impact strategies. The initial TSMC factory (Fab 21) was expected to require nearly 200 MW of electricity demand,[82] the equivalent of the electricity demand of approximately 140,000 Arizona homes. With the addition of the second phase, TSMC's electricity demand in Arizona will be equivalent to that of nearly 260,000 homes.[83]

SAMSUNG

Major Customers: Apple, Google, Microsoft
U.S. Fab Expansion Locations: Texas
Reported U.S. Renewable%: 100%
U.S. RE from High Impact Sources: 5%
U.S. RE from unbundled RECs: 95%

Facing growing pressure from customers and increased public scrutiny on its rising emissions and lack of renewable energy supply, Samsung has twice increased its renewable energy targets in the past five years.

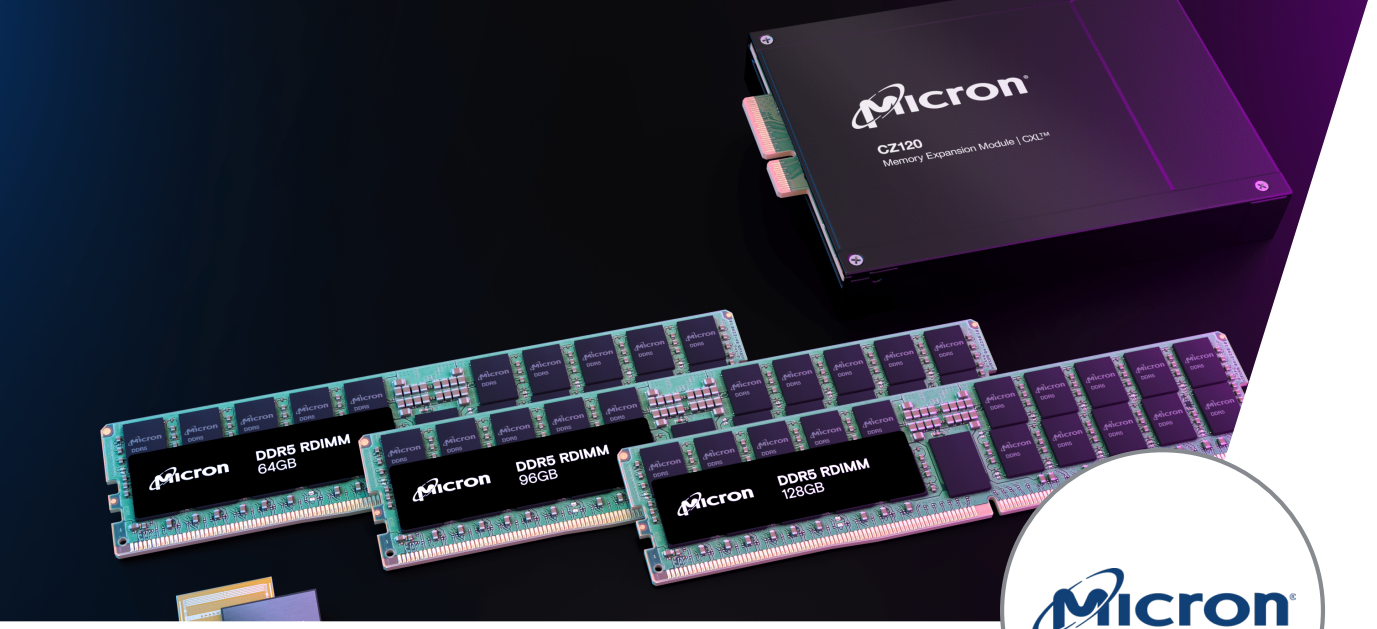
- In 2018, Samsung committed to transition its operations in China, US, and the EU to 100% renewable energy by 2020.[84]
- In 2022, Samsung adopted a Net Zero commitment, extending its 100% renewable commitment to include all of its semiconductor manufacturing facilities, but giving itself until 2050 to achieve this goal,[85] far exceeding the timeline for decarbonizing the electricity grid by the 2035 target for advanced economies the IEA has identified as essential to avoid exceeding the 1.5 degree temperature threshold.

Impact of Commitments on US Emissions

While Samsung reports to be 100% renewable powered across its facilities and factories in the US, and adds that "our mission is to work with developers to add new large scale renewable generation sources to the grid to offset our load completely……[and] claim 100% renewable power through localized generation sources by early 2024"[86]. Using market based accounting and the dramatic scaling of purchases of unbundled RECs, Samsung now reports a 97% decline in emissions from electricity consumption across the americas as compared to its location-based reporting based on local electricity grid data.[87]

While not uncommon for companies to lean on unbundled RECs more in the first year or two of a renewable energy target to be able to report some progress due to the time it can take time to get a renewable PPA in place, in the five years since committing to be 100% renewable powered across its US operations, Samsung has signed only one renewable PPA in the US. This PPA was a multi-company aggregation deal for 75MW of a Texas wind project orchestrated by Apple as the anchor tenant, with Ebay, Sprint, and Samsung taking smaller pieces[88], with Samsung taking only a 10MW share.[89] While Meta, Microsoft, and Google have signed utility scale renewable PPAs to take advantage of low cost wind and solar to power their rapidly expanding Texas data centers in the same time frame,[90] Samsung remains over 90% reliant on unbundled REC purchases to support its claim to be 100% RE powered in the US. Currently, only 10% of Samsung's 100% renewable claim for the U.S. and related emissions reductions are linked to high impact renewable energy procurement strategies likely to bring additional renewables on to the grid.[91]

Samsung's announcement of the Taylor fab signals a major expansion of Samsung's US operations. As details of Samsung's new mega factory in Taylor began to emerge, it also appeared that Samsung was finally going to come through on its commitment to power its Texas operations with new renewable energy, as Samsung C&T, who is building the Taylor factory, revealed it was developing three massive solar farms totalling 750MW less than 30 miles from Samsung's new factory. However, Samsung C&T ultimately abandoned the project, passing the development off to SB Energy, who signed Google to a massive solar PPA to power its data center in Dallas.[92] The lack of meaningful action to pursue high impact renewables for its existing factory in Austin do not bode well for Samsung's $25 billion new factory in Taylor, which is its first phase is likely to exceed 200 MW of electricity demand, with an expansion being considered for up to ten facilities, secured land and tax treatment for up to 10 facilities in Taylor, for total expansion of $200B.[93]



MICRON

Major Customers: Apple, Dell, HP, IBM, Lenovo, Microsoft
U.S. Fab Expansion Locations: New York & Idaho
Reported U.S. Renewable %: 53%
U.S. RE from High Impact Sources: 8%
U.S. RE from unbundled RECs: 45%

While making a broad commitment to be Net Zero for its own operations by 2050, Micron has set a goal for its U.S. facilities to be 100% renewably powered by 2025. Micron has recently begun to explore securing renewable energy for its facilities in the U.S. and Asia as part of its Net Zero by 2050 goal for its own operations. While it has set a 2030 absolute reduction target for Scope 1 (42%), it has not set 2030 GHG targets for scope 2, and as a consequence has not submitted its targets to SBTi for validation as 1.5°C aligned.

How much of Micron's US renewable purchases is through high impact options remains unclear. Micron's recent deal for a 40MW solar project with Idaho Power under its Clean Energy Your Way program seems to be a high impact source for its existing headquarters and research labs.

While it recently announced a 178MW virtual PPA for a US wind energy project being developed by Terra-Gen, it is not clear if this project is high impact or low impact, i.e. whether it is on the same grid as Micron's operations, or is in Texas or other parts of the United States that has low cost wind, but is not connected to Micron's US manufacturing facilities. Micron would be permitted in either case to reduce its scope 2 emissions under the broad definition of market under current scope 2 guidance, and count the renewable energy credits received under the virtual PPA toward its 100% renewable electricity goal by 2025 for US operations.

New York and Idaho Expansion

With the adoption of the CHIPS Act, Micron has announced two new manufacturing sites, a $15 billion fab near its Boise, Idaho headquarters, and a massive $100 billion four fab facility in New York State.

Micron's $100 billion New York facility would be the largest in the United States at current plan, anticipating two phases to be constructed over a twenty year period. The first phase (fabs 1 & 2) alone would generate just over 900 MW of new electricity demand in the next 10 years, with the potential for total demand of 1846 MW with the completion of phase two.[94]

While the Federal Green Chips Act requires companies to include details on how their greenhouse gas mitigation plan, to be eligible to receive support under New York State Green Chips legislation, companies building new fabs must build "green" plants that limit greenhouse gas emissions[95] and utilize 100% renewable energy.[96] Micron has committed to power its new fabs with 100% renewable energy as a condition for receiving over $5 billion in tax credits under this program. The New York State Power Authority (NYPA) has allocated 140MW of existing hydro-based power to the first fab of the Micron expansion,[97] but Micron has not indicated where the additional 340 MW in demand needed by 2025 for the first fab will be sourced from, or the additional 480 MW that will be needed by 2032 for the second fab.

Similar to Arizona, depending on which path it pursues to achieve a 100% renewable energy supply, Micron's massive build out of semiconductor manufacturing in New York can have a significant impact on the investment plans of local utilities and grid operators. A low impact path dependent on unbundled RECs that does not add renewable energy to the grid will threaten to delay the retirement of existing fossil fuel based power plants. New York statewide grid operators are already expressing concern on the system impact of the large electricity loads needed by the Micron facility, particularly as NY State is currently in process of phasing out its fossil based generation to achieve its goal of 70% renewable energy by 2030.[98]

The NY Green Chips program encourages companies to utilize in-state renewable sources and 24/7 measurement and matching of renewable energy supply, but does not mandate it. Given the existing commitment by local government partners to rapidly decarbonize the electricity grid, Micron has an opportunity to set a new standard for 24/7 renewably powered semiconductor manufacturing, abandoning the sector's reliance on unbundled RECs as Intel and Samsung have used as the primary strategy for claiming to be renewable powered, and focus instead on adding much needed renewable energy generation to the same grid where it is creating huge new demand. While Micron's recent PPA in Idaho is promising, it must significantly scale its capacity to contract for large utility scale renewables to keep pace with its New York expansion.

Putting US Semiconductor Factories on a Path to Renewables

With a large renewable resource base and mature renewable energy markets capable of meeting the electricity demand, the rapid expansion of semiconductor manufacturing in the United States currently underway should be seen as a critical opportunity to transition a significant portion of one of the most energy intensive parts of the IT sector's energy footprint to renewable energy, and a catalyst to phase out fossil fuels from the electricity grid. Yet despite public commitments by Intel, TSMC, Samsung, and Micron to power their US facilities with 100% renewable energy, the continued reliance on the purchase of unbundled RECs to support their 100% renewable energy claims is masking how their rapid expansion is actually being fed by a greater reliance on fossil fuels, and rather than enabling a clean energy transition, may instead lock in a continued reliance on dirty sources of electricity generation in the states that host them.

24/7 Renewable: Moving beyond annual accounting for Renewable Energy Targets

Measuring renewable targets by matching electricity demand with renewable electricity supply on an annual basis was at one time effective in catalyzing the opening of electricity markets to higher impact renewable energy procurement strategies. But now that utilities need to focus on phasing out fossil fuel based electricity generation, measurement of renewable energy targets on an annual matching basis is longer the right tool for measuring progress toward grid decarbonization.

More granular measurement, both on a geographic and temporal basis is needed to meaningfully track and catalyze the investments needed to move toward a 100% renewable powered grid. This is particularly true for energy intensive facilities like data centers and semiconductor fabs, whose rapid expansion are driving a significant growth in electricity demand in a growing number of US states.[99] This IT sector growth is directly driving utility investments in generation and transmission to meet their rapidly growing demand, and increasingly resulting in the addition of new fossil gas based generation capacity or a delay in retirement of fossil fuel based generation.

Several global IT brands including Google and Microsoft have already reoriented their clean energy goals to be measured on hourly basis, calibrating

their procurement to secure local supply on an hourly or less basis, 24 hours a day. A growing number of studies have shown that 24/7 clean energy procurement strategies will achieve far greater emission reductions than annual matching, and create much needed incentives for companies to include storage and transmission capacity strategies in their roadmap for a clean energy transition.[100] [101] [102]

This is growing increasingly true in the United States, with recent studies illustrating how PPAs being deployed on an annual matching basis are having increasingly less additional impact due to the growth of renewables following the adoption of the Inflation Reduction Act (IRA), finding that in an increasing number of markets, annual matching PPAs are serving to cannibalize demand for projects that would have otherwise gone forward anyway as a result of the incentives being offered by the IRA [103]

Interventions at multiple levels are needed to redirect the renewable electricity procurement strategies of global IT companies to ensure they are in fact supporting and enabling a rapid transition to a 100% renewable powered grid. Rather than masking higher levels of fossil fuel demand through a continued reliance on unbundled RECs, the expansion of semiconductor manufacturing must be built upon a strategy for 100% renewable electricity supply that is:

- Local - on the same grid as the factory
- Additional - adding new generation capacity
- Measured on a 24/7 basis

(1) Aligning Industrial and Decarbonization Policies: US CHIPS and State Programs

The $54 billion in taxpayer support under the US Chips and Science Act is set to provide significant financial incentives to spur the creation of semiconductor manufacturing hubs in the U.S. This program, along with the complimentary state programs to incentivize the creation of new factories that are required in order to be considered for federal funding, provide a unique opportunity to require Intel, Samsung and other major semiconductor manufacturers to link factory expansion with a high impact strategy for securing a renewable energy supply.

The recently published draft federal regulations[104] for providing federal tax incentives to support the generation of green hydrogen(45v) provide a clear model for how the US Chips and Science Act and related state programs could build into their programs to ensure taxpayer dollars are aligning to support both federal and state climate and renewable energy goals.

Under the proposed regulations, to qualify for the green hydrogen production tax credit, producers must secure renewable energy supply that meets three core criteria:

- **Sourced from New Clean Power:** Renewable energy brought into service within three years of hydrogen facility coming into service
- **Deliverable Clean Power:** New renewable energy sourced from the same region as the hydrogen production facility
- **Matched to Electricity Demand**–renewable supply must be matched to hydrogen production, annually until 2027, then matched on an hourly basis by 2028.

(2) Clear Standards and Collaboration by Major Customers:

Clear expectations and standards by major customers for measuring the environmental performance of semiconductor manufacturers can be a powerful driver for triggering the right investments at the factory level. Yet despite the near universal adoption of “Net Zero” targets by the largest US consumer electronics brands and the fact that semiconductors typically represent roughly half the greenhouse gas footprint of our electronic devices, semiconductor manufacturer like Intel and Samsung have remained heavily reliant on unbundled RECs in place of a meaningful strategy to transition their factories to renewable energy.

Despite the focus on high impact renewable procurement strategies by leading data center operators like Apple, Google, and Meta for their own operations, with the exception of Apple, this same expectation has not been maintained for large suppliers in their supply chain. Among the

largest US consumer electronics brands, only Apple and Google have consistently prioritized high impact renewable energy procurement strategies in their own decarbonization plans, while Amazon, Dell, HP, Lenovo and Microsoft all continue to rely heavily on purchased Renewable Energy Credits to support their renewable energy claims.[105]

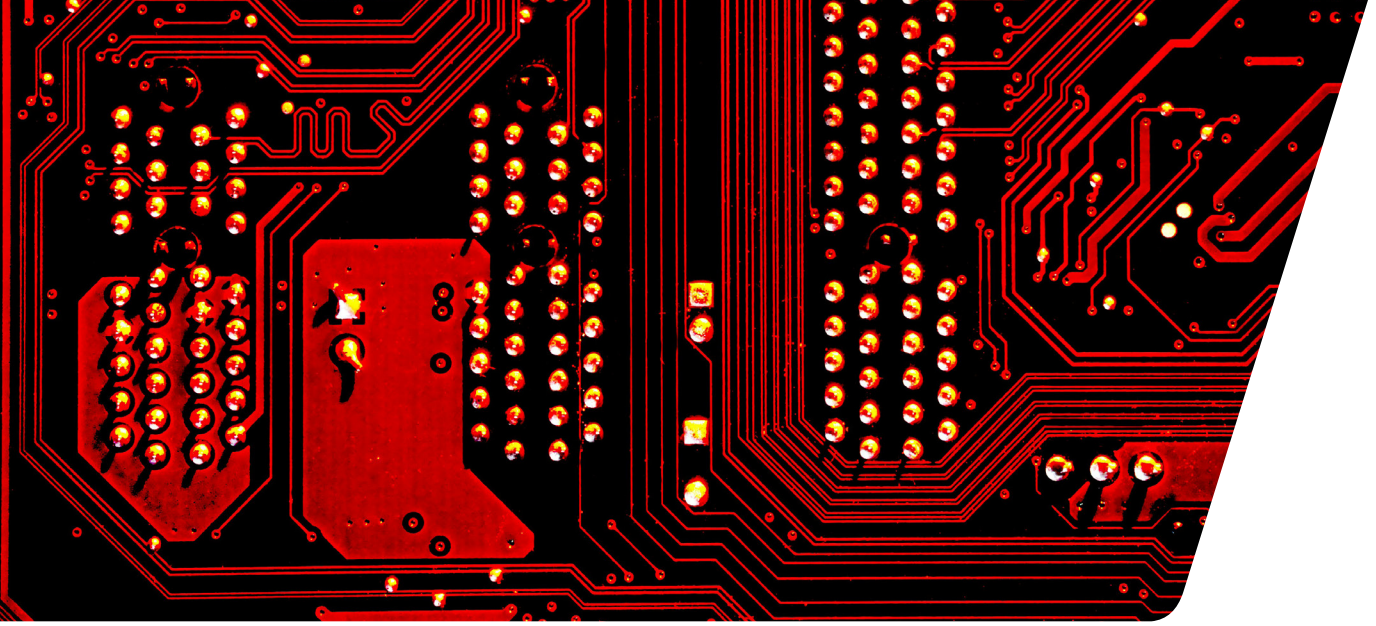
The lack of consistent leadership by global electronics brands in pursuing high impact strategies for purchasing their own renewable electricity supply in the United States and other markets where high impact options for purchasing renewable energy are available certainly shapes expectations among their semiconductor and key component suppliers. Suppliers will look first at what actions their largest customers have taken to advance their own environmental claims in considering what strategies to include in their own decarbonization plan.

While Apple is to be commended for the investment and success thus far of its Clean Energy Supplier Program, which includes an emphasis on high impact renewable procurement strategies, a significant limitation of this program is that participating suppliers must secure renewable energy only for their energy demand associated with the manufacturing of Apple products, but not those of other brands it may be manufacturing, even if in the same facility. Such a narrow approach has the potential to put suppliers in a position where it merely allocates the existing amount of renewable energy it receives across its factories to its most demanding customers, leaving other customers of the same supplier the higher carbon residual mix. Rather than allow for customer specific slicing, facility level tracking of electricity supply should define to what extent a supplier chain has been successfully decarbonized.

(3) Strengthening Reporting Under GHG Protocol

The GHG Protocol is launching a process in 2024 to update the standards by which corporations report their GHG emissions, one that is likely to take at least two years. This provides a once in a decade opportunity to strengthen the core reporting standards for how corporations measure and track their electricity related emissions under the GHG Protocol Scope 2 Standard, which is currently disconnected from the realities of how renewable electricity is produced and delivered to corporate customers. Key points of connection that must be addressed in the coming update to significantly increase accuracy and transparency in corporate emission inventories, positioning the protocol to drive high impact renewable electricity procurement and align with best regulatory best practice:

- **Reality Based Definition of Market:** the current definition of "market" under the market based reporting standard does not correspond to the physical market a company can purchase or consume electricity, allowing companies to transact for renewable electricity far beyond what can be physically delivered to where the company operates. This has allowed companies to effectively pursue offsets via renewable energy purchases to dramatically reduce their emissions, focusing on lowest cost rather than contributing to a phase out of fossil fuel power plants that are continuing to produce to power their operations. Geographic boundaries for renewable energy projects used to reduce scope 2 emissions should be restricted to those that are physically linked to the regional grid the company is drawing electricity from.
- **Hourly Measurement of Electricity Emission Factors:** Given the significant variation in the mix of generation sources throughout a given day, particularly given the intermittent nature of renewable electricity generated by solar and wind, the Scope 2 Guidance must also evolve to encourage and ultimately require more granular measurement of renewable electricity supply under procurement. This will provide much stronger incentives for companies to combine solar and wind energy procurement along with battery storage deployment, and to become more invested in the policy advocacy needed to enable a fossil free grid.



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