

# SEMICON West 2023 Keynote: A Collaborative Playbook For Net Zero

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Good morning and welcome to San Francisco. I’ve been in this industry for more than 40 years, and I’ve never been more excited about the opportunities ahead for the semiconductor industry. Technology is transforming every aspect of our lives, and chips are at that foundation of everything. But, we have to do this in a sustainable way; it’s something that we’re all accountable for in our lives.

Applied’s vision is to make possible a better future. Certainly all of this tremendous technology transformation – healthcare, education – everything is going to make a great difference in our lives. San Francisco is one of the first cities in the world that has self-driving taxis in daily use. Did anyone actually take a robotaxi to get to the Moscone Center this morning? It’s a truly amazing technology, but did you put any thought into how much energy that journey consumed?



Here’s the comparison of a robotaxi vs. a human driver. Let’s eliminate the car from our calculation – it’s the same for both. The AI consumed about 2.5 kilowatts – just for the inference and the communications; I didn’t include training the model. The human brain consumed 3 watts. So, the robotaxi brain consumes about 800 times more energy.

Let me give you another example of an amazing new technology that is a huge step forward but also consumes significantly more computing power



On average, a regular Google web search consumes 0.0003 kilowatt hours of energy. A similar ChatGPT enquiry consumes 0.004 kilowatt hours – that’s 13 times more. So, why am I sharing these examples?



I believe this is the most exciting time to be working in technology. Incredible advances in IoT and AI are enabling the digital transformation of the economy. The applications for AI are essentially infinite and that means it is going to touch every area of our lives – business, healthcare, research, retail, transportation, education, manufacturing, agriculture.

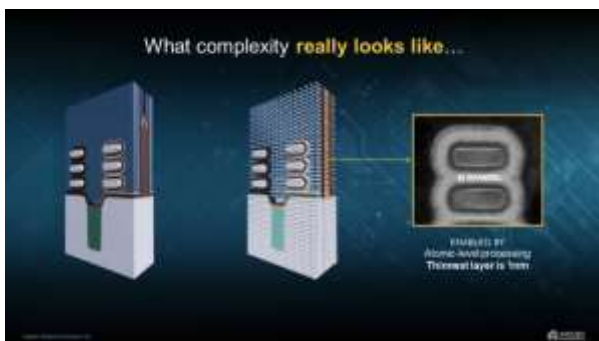
As AI adoption accelerates, edge devices and data centers are using more and more energy. In fact, total energy usage by electronics and computing systems could grow from about 10 percent of global electricity supply today to more than 30 percent by 2030.

So that is driving demand for better silicon – higher performance and more energy efficient chips. We call this PPACT – power, performance, area-cost and time-to-market. Some of our customers call this the energy-efficient computing roadmap. Different names, but the same thing. This completes a virtuous circle that creates better IoT devices and AI.

Semiconductors are the foundation of these incredible advances that can solve so many of the world’s big challenges. Our industry really can make possible a better future for everyone. With this comes large responsibilities. This is really an imperative to drive energy-efficient computing. We can’t solve grand challenges, while creating other challenges at the same time. Advancing semiconductor technology is fundamental to global carbon reduction.



One of the major advances in the industry today is the transition from FinFET to Gate-All-Around (GAA) transistors. This enables a tremendous improvement in lower power consumption. If you look over the next several years, we will be inventing many new innovations on top of this technology.



When you look closely at this structure, you can see you're really working at the atomic level. Creating materials, models, modifications, shaping these structures, analyzing them – just to create this one innovation. You're using 25 different materials combined in more than 100 different ways. It's why I think what we do is so much like magic. There are many layers, many interfaces that you're optimizing to get the best performance. That's why it is so challenging and so difficult in this industry to drive innovation because we are manipulating the materials at an atomic level with incredible precision. The grand challenge for the industry is to drive this innovation in a sustainable way.

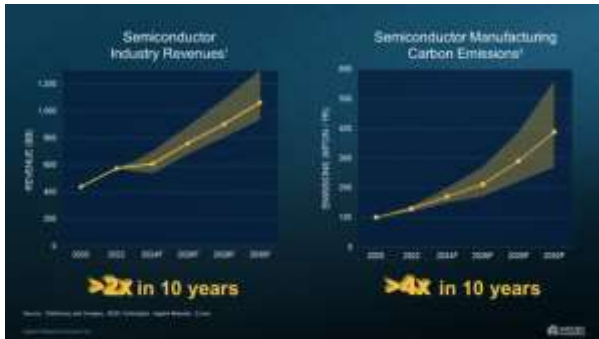


In 2020, we introduced a simple framework that describes our industry's responsibilities and the relative size of our impact – we called it 1x, 100x, 10,000x.

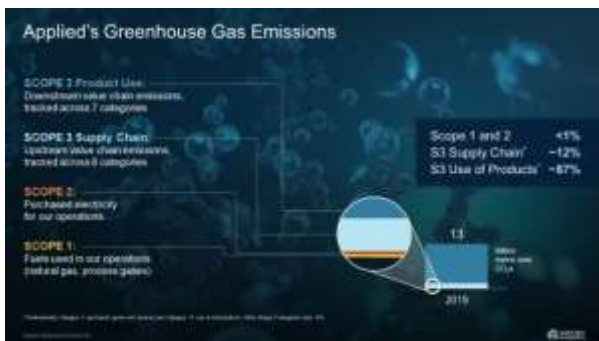
1x is our company's environmental footprint. And we're making great progress there which I'll talk about more in a moment. 100x is our industry's footprint. The carbon impact from our customers and our suppliers. That's

much larger. 10,000x is the impact of chips on a global scale – all the energy being used by devices and datacenters.

I love talking about 10,000x technologies, but today, I am going to focus on 1x and 100x – the industry’s manufacturing footprint and how Applied and companies like ours can forge a path to Net Zero emissions. And that’s why I say we can’t do this alone. We must collaborate. Let’s start with the big picture and then I’ll explain the role that Applied is playing.

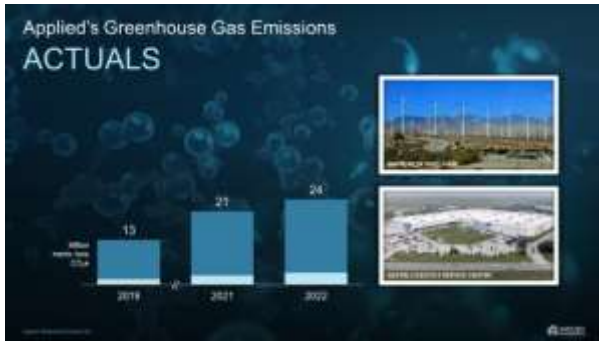


Growing demand for silicon has put the industry on a trajectory to reach \$1 trillion of revenue by the end of the decade. But, if you look at the industry’s carbon footprint, it is on a path to quadruple in the same time period – with half of the increase being driven by volume and half by increased manufacturing complexity. So, what does this mean for Applied? Let’s start with some definitions.



Using the accepted standards of the Science-based Targets Initiative, Applied’s Scope 1 and 2 emissions are the emissions produced from running our company – our offices, labs and factories. Scope 3 is the upstream emissions from suppliers and the downstream emissions from customers using our products over their lifetime. This is from Applied’s perspective, meaning our scope 3 is our customers’ and suppliers’ scope 1 and 2.

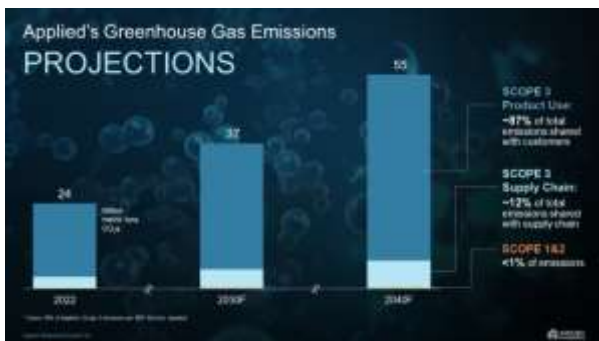
So, why should we care about Scope 3 – isn’t that someone else’s problem? We will argue that you need to look at the entire situation and that’s what the Science-based Targets Initiative forces you to do. And you can see why in our numbers. When we started working on this in 2019, we measured actual annual emissions at 11 million tons of carbon. 99 percent of these emissions are Scope 3: 12 percent in the supply chain and 87 percent customers.



Since then, we have made significant progress on our Scope 1 and 2 even as the business has grown. We now use 100 percent renewable energy in the U.S. and 70 percent globally, and we're on track to reach our 2030 goal of Scope 1 and 2 Net Zero by 2030.

Our wind Power Purchase Agreement in Texas supplies 60 percent of our U.S. footprint and is cash-flow positive for us. Our new Austin logistics center will have the largest privately owned solar installation in Texas. I want to emphasize to you that these are not only the right things to do. We also have a good financial return on the investment. A lot of these strategies make tremendous sense for all of us.

We are driving our actions based on science which is very important. We're on track for Scope 1 and 2 by 2030, but, as I said, we cannot do this without our suppliers and customers.



In the same time period, as we have grown, our installed base of systems has increased significantly. We now have more than 46,000 systems operating at over 1,000 fabs globally. As a result, our total Scope 3 emissions have doubled to 22 million tons.

As we prepare to double the size of our business again in the coming years, it is important that we have an accurate model of our future emissions. Taking into consideration mitigation plans we already have in place, our model forecasts that we will generate 37 million tons of carbon per year by 2030 and 55 million tons by 2040. I want to emphasize again that our teams put tremendous effort into the modeling and analytics involved in these projections. You need to invest that effort so you can build a plan of action that's rooted in science.

In both of these years, 99 percent of our emissions are Scope 3. In other words, 99 percent of our emissions are shared with our customers and our suppliers. This is our primary challenge when it comes to setting a definitive goal for Net Zero: we cannot do this in isolation. This will come down to partnerships – long-term partnerships – that are focused on collaborative work to reduce emissions together.



With this challenge in mind, for the past two years, our teams have been working on developing a Net Zero playbook – a clear pathway and detailed plan for us to work together with our partners to reach our aspirational goal. Today, we are ready to share that playbook with you.

To hit the 1.5-degree pathway as defined by the Paris Agreement, we need to reduce our real emissions by 90 percent and produce an absolute linear reduction of about 4.2 percent per year starting now. In round numbers, that’s a reduction from 55 million tons to about a million tons.

Our playbook has four main elements. First, grid decarbonization – overall improvements in the global clean energy mix. Second, our customers meeting their Net Zero goals. Third, driving efficiencies in our products so they use less power, gases and water for each wafer processed. And fourth, working with our suppliers to re-engineer the supply chain.

Today, in summer 2023, we have line-of-sight or detailed plans in motion to mitigate 45 million of our 55 million tons of 2040 emissions. But, there is another way to look at this – what if we could do more in each of these categories?



What if we, as an industry, were more proactive at driving grid decarbonization? What if we accelerated our low carbon product solutions or more aggressively re-designed the way our supply chain works? This creates new opportunities for our Scope 3 reductions. The biggest opportunity is for all of our customers to set Net Zero goals, and we are standing by ready to help with that. Once again, none of us can do this alone. We have to work together. Let me give you a flavor of how this playbook works – I’ll walk you through it block by block.



An advanced fab with a capacity of 50,000 wafer starts per month consumes roughly one terawatt-hour per year – that’s close to the electricity use of a city of 100,000 residents. So, where that power comes from is really important. Across the world the power grid is being modernized and decarbonized, with clean energy replacing fossil fuels, more efficient transmission, more storage of renewables, and smart technologies helping with grid management.



Accelerating the transformation of the grid is important to the semiconductor industry in several ways. We have made the argument that fab location – building fabs where there is access to clean energy – should be a heavily weighted consideration for our customers and for governments providing financial support for new fab construction. However, we know this isn’t always possible. We have joined CEBA and RE100 and we encourage other companies to do so too. These are organizations working to improve clean energy options globally by amplifying the industry’s communal voice as buyers of energy.

There is a big upside to accelerating grid transformation in that it is a driver of semiconductor demand. Smart grid connectivity drives the need for sensors and power devices. Grid intelligence drives foundry-logic and memory demand. Each megawatt of wind and solar produced requires \$3,000 to \$4,000 of power chips. We believe this could translate to \$50 billion of annual semiconductor demand by 2030. As I said, these are the right things to do, but they’re also business opportunities for those of us that are focused on enabling those innovations.



Let's move to the second element of our playbook: our customers' plans.



Today, about 65 percent of chipmakers by volume have laid out their plans to accomplish Net Zero operations. So when you look at this gap, the additional opportunity is that additional 35 percent of fabs by volume.

Our job is two-fold. First, to support our customers who already have a Net Zero plan to be successful on their journey. Second, to help customers who have not yet developed a Net Zero playbook to formulate their plans.

Let's hear from two of our customers who will explain how they see their path to Net Zero.

**Scott DeBoer – Executive Vice President, Technology and Products, Micron Technology**

*Thanks Gary. I really appreciate the opportunity today to share a little bit about Micron's sustainability journey. At Micron we've laid out a comprehensive sustainability strategy that puts the company on a path to Net Zero emissions from our global operations by 2050. In addition to these long-term commitments, we have set shorter-term targets as well. By 2030, we aim to reduce our Scope 1 emissions by more than 40 percent versus our 2020 baseline. Micron has manufacturing sites in 17 different countries, so, as you can imagine, it's a very complex endeavor and we face many unique challenges in each of the regions. As a technology leader, we believe it's our responsibility to set aggressive goals that demonstrate our commitment to a low-carbon future. Between 2022 and 2028, we intend to invest more than one billion dollars to deliver on these goals, but we can't do this on our own. Sustainability is very much a team sport and requires a multifaceted strategy. We have to work with our technology partners, government partners and suppliers to find novel solutions to some very complex problems. Gary, as you know, Micron is an early adopter of Applied's next-generation systems, and we look forward to building on our longstanding collaboration with Applied Materials on our journey to a sustainable future. Thanks very much for the opportunity to share some thoughts today.*



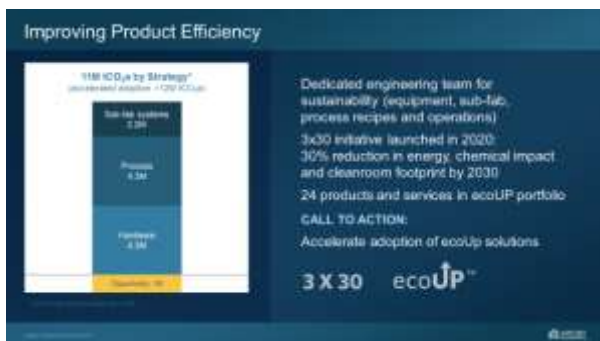
**Jean-Louis Champseix – Group Vice President, Head of Sustainability, Learning & Development, ST Microelectronics**

*At ST Microelectronics, we believe that semiconductor has a strong responsibility and a key role to play in enabling a better world. This is the reason why, for more than 30 years now, we have been creating technology in a sustainable way for a sustainable world, focusing, for example, on electric mobility for energy or smart cities. We are committed to be compatible with the 1.5 degrees Celsius scenario of the COP21 by 2025, to carbon neutrality by 2027, together with 100 percent renewable electricity sourcing and 33 percent of our revenue coming from recognized responsible product. To achieve our ambitions and make a positive contribution to the world, collaborating between us is absolutely essential. Applied Materials' longstanding partnership with us and also sharing a sense of urgency is a great example of what we can achieve as a crucial industry. So let's accelerate sustainability together.*

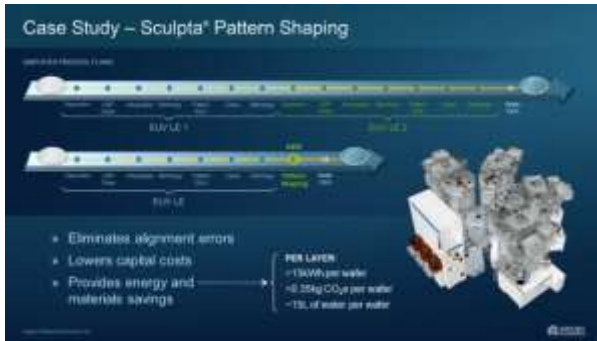
Thanks Scott and Jean-Louis. We deeply appreciate our Net Zero and many year collaborations with Micron and ST Micro.



Moving on to our third category – Applied's products. We can improve the sustainability of the products we provide customers. We can also offer them products and services that help them reduce emissions from their own operations.



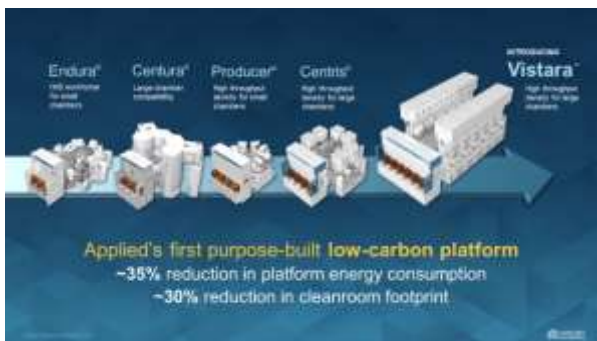
In 2020, we created a new engineering team in the company to focus on what we call 3x30. Their mission is to reduce the electricity consumption, chemical consumption and fab footprint of our systems by 30 percent, averaged over our entire portfolio, by 2030. This is an audacious goal, but they are making great progress. We have more than 24 products and services that customers can buy today and an exciting pipeline of new developments. Let's look at some of these solutions.



The Sculpta® system is a very innovative patterning technology that eliminates an EUV step. And in that process there are economic advantages, about \$50 per wafer with no placement errors as you reduce those steps. Also, there are tremendous energy and material savings with this technology. This is a brand new technology that's never existed in the industry before.



EcoTwin™ is a digital twin that can monitor and model recipes and operations so that chipmakers can drive energy optimization in their fabs. EcoTwin™ is a software tool that helps customers compare and track the chemical and energy usage of alternative process recipes. It lets them see the chemical and energy consumption of all cleanroom and subfab systems in real time. It tracks all of this over time and helps customers report on progress toward their sustainability goals.



Our most exciting announcement is our first purpose-built, low-carbon platform, which we call Vistara™. This is Applied's most significant new platform in over a decade, architected for flexibility, intelligence and sustainability.

Vistara™ is purpose-designed to support Integrated Materials Solution® recipes using more types and sizes of chambers than before. We are combining and co-optimizing multiple process steps within a single tool under

vacuum. There are thousands of sensors throughout the Vistara™ platform that provide massive data to help speed R&D, accelerate process transfer and ramp, maximize output and yield, and minimize downtime.

Our ecoefficiency engineering teams redesigned the gas panels and optimized the way the platform uses subfab components, which lowers the platform’s energy consumption by as much as 35 percent compared to previous platforms. The design increases throughput density by as much as 30 percent allowing chipmakers to build smaller fabs and potentially save 1 million metric tons of carbon for every 100,000 wafer-starts-per-month fab built.

There is a lot that can be done to the existing installed base of tools to optimize eco-performance. For instance, our iSystem® controller monitors resource consumption and greenhouse gas emissions and automatically adjusts the energy needs in the subfab based on what’s happening with a tool. Our customers love this product and we already have more than 6,000 tool connections installed.

Our Aeris®-G abatement system is a pre-pump plasma abatement solution that uses less energy by treating the actual process gas volume, and we have almost 4,000 units operating in the field.

We sell more than 25 different upgrade kits that can be used to make installed-base tools more carbon efficient.



Applied is making significant investments in our next generation of products and solutions. We are also making significant investments in our supply chain.



In 2020, we launched our supply chain SuCESS2030 program, which stands for Supply Chain Certification for Environmental and Social Sustainability. This is our shared 10-year roadmap and there are three key components.

First, we now hold our supply chain partners to the same standards as we hold ourselves in the areas of environmental impact, labor practices, and diversity and inclusion. Second, we're working together to improve handoffs between our suppliers and ourselves. Here the call to action is "Reduce, Reuse, Recycle". Third, we partner with our suppliers to share best practices and key learnings. In fact, we have an annual supplier award for Excellence in ESG – awarded to Entegris in 2022.

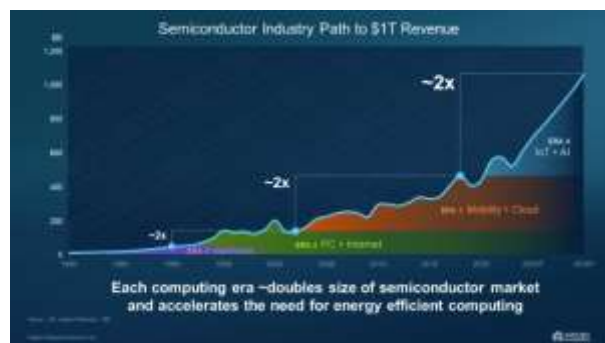
The response has been great, and we have made significant progress. We are working with over 100 suppliers to collect greenhouse gas data. We have greenhouse gas reduction programs in place with almost all of our top suppliers. We have also increased our spending with diverse supplier by half a billion dollars a year since 2020 and we are on track to our goal of \$1 billion by 2030. We collect data on performance and where there are any gaps, we work together to close them.

Today, we are demonstrating how we are taking our supplier partnerships to the next level. Please welcome a short video from the CEO of Schneider Electric.

**Peter Herweck – CEO, Schneider Electric**

*Decarbonization requires the engagement of the complete value chain. Since Schneider Electric started on our own sustainability journey roughly 20 years ago, we learned that the vast majority of our emissions come from Scope 3. To address this challenge, we've had the opportunity to play a part in deploying industry-level programs to build engagement and make an impact across the whole supply chain. Meeting our sustainability ambitions requires a major acceleration towards digitization. Therefore, the importance and responsibility of the semiconductor industry is very clear to us. We look forward to being part of the solution, working together with many of you to create a more decarbonized and sustainable future. Thank you very much.*

Thank you, Peter.



Let me wrap-up by going back to where we started. This chart describes why it is the best time to be working in the semiconductor industry, and the best time to be an innovator or an engineer. With each age of computing – mainframes, PC and internet, mobility and cloud – the market for semiconductors has approximately doubled in size. As we enter the fourth era of computing – the IoT/AI era – the market can grow to a trillion dollars or more.

IoT and AI offer almost endless possibilities to make possible a better future, but there are also incredible challenges, including how to get to Net Zero. I strongly believe the best way – perhaps the only way – to overcome these challenges is to change the way we work together as an industry. In other words, the IoT and AI era should really be called the era of collaboration. Net Zero is a poster child for this. No one company can go it alone.

At Applied, 99 percent of our carbon footprint is Scope 3 – shared with our customers and suppliers. The only way we can accomplish Net Zero is by working together, and we have developed the playbook to do just that. We are happy to share this playbook and be transparent. We'll share what's working and what isn't as we make this journey.



We are putting significant investment behind these new high-velocity collaborative models. In May, we announced our EPIC™ platform – Equipment and Process Innovation and Commercialization. We are bringing together our customers, university partners, suppliers and even our peers to accelerate innovation and commercialization of next-generation technology. One of EPIC's critical missions will be rapid development and qualification of new low-carbon process and equipment solutions.

In June, we announced our India Engineering Collaboration Center that will be focused on critical supply chain technologies for equipment. And, as part of our EPIC platform, we are partnering with leading universities in the U.S. and beyond to create innovation hubs. Each of these will be focused on a key market area or set of technologies. On Tuesday, we announced a significant expansion of our collaboration with Arizona State University to create a new innovation hub focused on materials deposition technologies.



At Applied, we are innovating the way we innovate. So many of the things I talked about today are great for business and also great for our future as a society. The future is bright and we look forward to working together with all of you to make it possible.