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EDITED TRANSCRIPT

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PRESENTATION

Tyler D. Gronbach *- Cree, Inc. - VP of IR*

Good morning, and thank you for joining us this morning. I'm Tyler Gronbach, I'm the Vice President of Investor Relations for Cree, and we'd like to thank you and welcome you to our 2019 Investor Day. You will see by the agenda that's on the table, we have a very interactive, fun discussion today, but we're also going to do a little education, but it's really important for you to have an opportunity to ask us some questions.

So we would encourage you that during the break, take part in the demonstrations that we have outside.

Gregg is going to take you through the agenda in a little greater detail in a second, but I have a few housekeeping things to take you through this morning.

Number one, I've found in my line of work, it's very important to keep your general counsel happy. So he would like me to read you a few things this morning. So this morning, we're going to be presenting non-GAAP financial results, which is consistent with how management views performance internally.

Non-GAAP results are not in accordance with GAAP and may not be comparable to non-GAAP information provided by other companies.

So the non-GAAP information this morning should be considered a supplement to, but not a substitute for financial statements prepared in accordance with GAAP.

A reconciliation of the information directly comparable to GAAP measures will be included in the appendix of the presentation that we're going to publish a little bit later today on the web, along with a historical summary of other key metrics.

Also, during today's discussion, we're going to be making some forward-looking statements about the business and future performance.

Such forward-looking statements, of course, are subject to numerous risks and uncertainties.

During today's Q&A session, we would like to ask that you limit yourself to one question and one follow-up question so that we can try and get through as many questions today as possible.

Just so you know, we plan to conclude at about 1 p.m. today.

We are going to take a break midway through this morning's session, so that you can go out and partake of the demonstrations. And once again, I would really like to thank you on behalf of the management team for making the time today to come and hear a little bit more about the company and where we're -- what we're up to.

So we're going to start today's session with a quick video, and then Gregg is going to join us on stage. Thank you.

(presentation)

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

All right. Well, good morning, everyone, and welcome to our 2019 Investor and Analyst Conference. We appreciate you taking your time to be with us today, but more importantly, we appreciate your interest and your support of us at Cree. We put together an agenda today that I think you'll find very, very informative and very helpful.

I'm going to kick it off with sort of a strategic overview of the company, how we've done over the last 18 months since our last investor conference, what's our direction moving forward.

And then Dr. John Palmour, a co-founder of Cree and our CTO, will come up and give sort of a tutorial on silicon carbide.

He's going to bring you back to some fond memories of high school physics, he's going to scare you a little bit with some words like covalence bonds and band gap.

But I think you're going to leave his presentation understanding 3 things, 3 really important things. One is, what is so unique about silicon carbide? Why is it so much better than silicon? What markets does it enable? Two, why is it so -- such a difficult material to work with?

And so therefore, why does it have such strong sort of barriers to entry? And 3, how our 30 years of experience in this business gives us a unique position and a unique advantage as the world converts from silicon to silicon carbide.

After that, Cengiz Balkas, who heads up our Wolfspeed business, will give an overview of Wolfspeed, all 3 businesses, our materials business, our RF business and our Power business. After that, we'll dive in a little bit deeper into power and especially the automotive side with Jay Cameron, who runs our power business; and Kenric Miller, who runs our automotive sales organization jointly presenting the opportunity that we have in automotive.

We've got a giant pipeline of opportunity and almost half of it's automotive. So we thought it would be very important for you to understand how we develop that market.

Then we'll step back on the pipeline and have Thomas Wessel come up. Thomas heads up Global sales for us. He'll step back and talk about the entire pipeline, the entire $9 billion device pipeline that we have right now, how we develop that pipeline and more importantly, how we convert the opportunities in that pipeline into real business from 2 different perspectives: directly by engaging with customers; and indirectly through our channel by engaging in a very exclusive relationship with Arrow.

We'll take a break. And during that break, we'd encourage you to go out to the lobby and check out some of the demos. All of the demos will have folks explaining each of the demos, and you'll get sort of a hands-on feel for the difference customers get when they utilize silicon carbide versus silicon.

When we come back from the break, we're very pleased to have Tobias Keller with us today. Tobias works at ABB. You may have seen we did an announcement with ABB just 2 days ago, where we're jointly partnering in silicon carbide. Tobias is the Vice President of Product Development for ABB. He's going to feel -- we're going to do a little bit of a fireside chat, but he's also welcome to take questions from the audience.

ABB is one of the largest industrial power companies in the world, and they're utilizing silicon power -- silicon carbide in industrial type applications as well as EV.

We'll then have Rick McFarland and Lisa Fritz come up on stage. Increasing our capacity has been a very, very important thing for our customers. You saw from the video, we're increasing our capacity 30x. So Rick and Lisa are going to come up and give you an update as to how that capacity expansion is coming and how we intend to build the world's largest silicon carbide wafer fab, highly automated, automotive quality.

We'll then wrap up the product presentations with Claude Demby, who runs our LED business, how he's focusing in certain areas and seeing good success in areas like automotive.

And then finally, Neill Reynolds, our CFO, is going to come up and kind of tie it all together and give you kind of an outlook of the financial model moving forward.

So we hope you'll have a very informative day today. Following all the presentations, Neill and I will come back up on stage.

We'll field any questions, and you can ask questions to any of the presenters today.

All right. So our transformation began about 2 years when we took a strategic look at the company and said, where do we really want to go long term. We then rolled that out at our last Investor Day in February of 2018. And it basically had 3 pillars. First pillar was Wolfspeed, the primary growth engine of the company.

We were going to turn Cree into a powerhouse semiconductor company focused on silicon carbide and GaN technologies and the primary growth driver of the company is going to be Wolfspeed, silicon carbide and GaN.

From an LED perspective, it was all about focus. Focus on areas that are going to be stickier, areas where customers really value our technology, and we can, therefore, make a little bit more money.

Claude's going to give you an update on that as well. And then finally, with lighting, we had a very broken business. And our focus on the lighting business was simply to fix it.

We've made a lot of progress in the last 1.5 years since our last Investor Day. So again, the Investor Day was in February. And coinciding with that Investor Day, we announced our very first long-term supply agreement for silicon carbide materials. This was with Infineon Technologies. It was over $100 million materials deal.

It was our largest deal that we've ever announced in silicon carbide at that time.

We then followed that up in March with the acquisition of Infineon's RF business.

That gave us a full portfolio from silicon carbide and GaN wafer technology to devices, to packaging, to customer engagement to enable us to go after the tremendous opportunity we see in 5G base stations.

We announced our second long-term agreement with another power semiconductor company in October. That was worth $85 million, another materials deal.

And then in January, we followed that up with our largest deal to date at that time with STMicro.

That was a materials long-term agreement, silicon carbide, gallium nitride -- or silicon carbide and epi. And that was worth $250 million. We announced that in January of this year. Following that in March, we -- well, in between the announcement of our strategy in March, the lighting team did a tremendous amount of work repairing that business. Quality improvements, new product improvements, gross margin improvements. And that put us in a great position to be able to sell the business, and we did that in March of 2019 to IDEAL Industries. This was a great deal for both companies. Our lighting business is now the largest business inside of IDEAL, it's a great focal point for them. They've got new products coming out, higher margin, et cetera. And it gave us funds to be able to plow back into Wolfspeed to drive growth.

And we've had a tremendous amount of interest in silicon carbide building up over this time as we built the pipeline. And it really became very, very clear to us that what was holding us back was capacity.

And so we announced in May of this year, a significant capacity expansion, a 30x increase in our silicon carbide crystal growth and materials capability and the announcement of a new wafer fab that was also going to give us a 30x increase in our wafer fab capability. This was met with tremendous amount of enthusiasm.

In fact, Kenric Miller, who runs our automotive sales organization, is going to talk a little bit about his personal experience that he's had with customers since that announcement.

And ironically, that week, we were announced as the exclusive silicon carbide partner for Volkswagen's FAST program.

The FAST program, it's Future Automotive Supply Tracks. It's not an award per se, it's an elevation into to a subset of suppliers at Volkswagen.

Volkswagen has over 50,000 suppliers. And they have about 65 that are part of this program. It gives us unique access to engineering and management, it gives us unique access to their plans moving forward and it helps us align our technologies with them moving forward.

In fact, I'll be visiting with Volkswagen next week as part of that program. And then in August, we announced our fourth long-term supply agreement for silicon carbide materials, and this was with ON Semiconductor, an $85 million deal. So a lot of progress happened over that time period and this was not without a number of headwinds.

In April of 2018, of course, we had the ZTE ban, which lasted many months prohibiting us from engaging and supplying to them. In May of 2018, began the trade war with the first set of tariffs that happened. That was followed up in August with the second set of tariffs and a bunch of tariff back and forth between China and the U.S. In May of 2019, we have the commencement of the ban on sales to Huawei, which, of course, impacted our RF business.

In June of 2019, we have the changing of EV incentives in China, which reduced the consumption of electric vehicles, at least, in the short-term in China.

And then in September, we've got the slowdown in 5G. And by the way, just to remind everybody, I see a lot of people writing everything down. We are going to give you copies of the presentation.

So feel free to kind of relax a little bit as we're presenting. So a lot of progress over the last 18 months, despite the fact there were a number of headwinds. And in fact, despite these headwinds, actually, over the last 7 weeks, we've had a tremendous amount of success.

We've announced 5 really important deals over the last 5 weeks starting with Delphi Technologies, our first announced device win for silicon carbide MOSFETs that are going into Delphi's 800 volt automotive inverter.

And they've announced design wins with European high-end car manufacturers as well. Really excited about that.

It's going to be a great program for us. Again, it was our first device win that we announced in silicon carbide for inverters.

That was followed up then with a tremendous opportunity that New York presented us to create the world's largest silicon carbide device manufacturing facility in upstate New York.

We were up in Utica. Earlier this week, we actually broke ground. On Monday of this week, there were a dozen or so trucks moving dirt all over the place. That facility is going to ramp in 2022, just in time as our customer ramp begins in many of these automotive programs.

The opportunity with New York enables us to build a bigger factory for less capital. So it's a really good win-win.

Recently, we announced a design win with ZF. ZF is one of the top 5 largest automotive Tier 1 suppliers based out of Germany. They are using us, our silicon carbide MOSFETs, for their inverters, for automotive. They announced earlier this week several design wins as well.

And we'll hear from them a little bit later as well. So 2 big automotive design wins. Recently, in fact, Monday of this week, we announced another device win with ABB.

ABB is one of the world's largest industrial power companies. They've partnered up with us for silicon carbide as well, for industrial applications, as well as enabling them to get into the electric vehicle market. And again, we'll have Tobias here with us shortly. And then just yesterday, we announced an extension -- an expansion of our deal with ST. Recall, this was announced earlier in the year as $250 million and just 11 months later, it's now doubled in size to $500 million worth of silicon carbide materials business.

So really great progress just in the last 7 weeks. And what's driving all this? Well, you're going to hear a lot more about this from John Palmour, but it's really simple.

Silicon carbide as a substrate is substantially better than silicon in power electronics. It is 10x more efficient. It is 3x -- it offers 3x the power density.

Again, John is going to get into this in a lot more detail. But basically, what it means is, when you're using high-voltage and power electronics, things are going to be lighter, they're going to be smaller, they're going to be more efficient. And as Kenric will talk about and Jay will talk about, at the system level, they can be less expensive. There's a substantial amount of savings that you get when you use silicon carbide in the automotive inverter, and we'll talk about that. So basically, it's a better material.

All right. And we're seeing application for silicon carbide across a number of different end equipments. Automotive, of course, is front and center, represents about half of our device pipeline. Right now, a tremendous opportunity you're seeing and I'll talk a little bit more about automotive. And again, we'll dive into that in a little bit more detail with Kenric and Jay.

Automotive applications are for the inverter, onboard charging, DC to DC, and of course, the needed network of chargers and rapid chargers. In RF, silicon carbide with gallium nitride is ideal for base stations, the rollout of 5G. We'll eventually kick into high gear.

And that will be a great opportunity for our RF business. And then as I said before, we're seeing a growing amount of interest in silicon carbide in industrial applications. As we expand our position and drive the cost down of silicon carbide, it's enabling more and more equipments and equipment segments to be interested in silicon carbide. If you just take a look at the automobile market itself, tremendous amount of traction right now.

Just in the last 18 months, automakers around the world have made announcements totaling more than $300 billion of investment in the electrification of the powertrain of the car.

Of course, Tesla led that years ago and has been really at the forefront of it, but all of the leading brands have made announcements. Some of these leading brands have made announcements that they will do no more investment in internal combustion engines.

Some have said that every single one of their cars will have an electric version by a certain date. You saw yesterday or the day before at the LA Auto Show, Ford introduced the Mustang as an electric car as well. So tremendous amount of excitement on that.

So why is this all happening? Well, I get asked this a lot, what are the key drivers for the electrification of the powertrain? And I think when you think about it, there's actually a multitude of different things that are kind of coming together at one time.

One is range. You talk to somebody about electric cars, they'll eventually talk about "range anxiety" and this issue of, gee, am I going to run out of range and so forth. Just 4 years ago, 2015, there was a grand total of 1 car in the United States that could get over 200 miles of range.

In 2020, just a few years later, that's going to increase 10x. 10x increase just in that short amount of time.

And by 2025, that's going to triple again. And in fact, in 2025, most of those cars are going to have a range over 300 miles and one is projected to have a range of over 600 miles.

So you're seeing a tremendous increase in range. That's good for us because when you use silicon carbide instead of silicon in an inverter, your car is going to go further, anywhere between 5% and 10% further.

So range is starting to become less -- I don't want to say less of an issue, but I think they're resolving range a lot more. Substantial increase, 10x increase just in the 4 or 5 years and then tripling again by 2025.

The second is charge time. It used to be, you had to charge overnight, slow chargers, level 2 chargers and so forth. More and more companies are introducing fast chargers.

Porsche introduced one, Tesla introduced one. In fact, version 3 of the Tesla will add 75 miles of range in just 5 minutes of charge.

Now in the technology world, we always think about doubling things, and doubling things is sort of a, I want to tell you, kind of a short putt. But most technologists would say, could you double that in a few years? Most likely, yes.

If that gets doubled to -- from 75 to 150 miles in 5 minutes, you're kind of talking about a gas station. Not quite, but pretty close.

It's 150 miles of charging in 5 minutes with cars that can go 300 or more miles, I think that equation is starting to get solved. You have incentives and cost, and incentives play a big role. We see incentives across various different states.

The state of California has just decided that as a state, they will only buy electric vehicles.

I think they just announced that earlier this week. But you have different states, different countries have incentives. And some of those incentives are dollar incentives, tax incentives, some of them are time incentives.

There is a 0 wait time to register a car that's electric in most cities in China.

And if you're registering a nonelectric or an internal combustion engine car, it's a longer period of time, I've heard as much as a year. So some of these incentives are monetary, some of them are not.

There's also cost. And if you look at the cars that are going to be introduced in -- by 2025, I just took a look at it the other day, of the 40 cars that are going to be introduced, almost half of them cost less than $45,000. And many of them are less than $40,000. So $38,000, $39,000, starting to get into the realm of real adoption.

There's something that a lot of people don't think about, and it's performance.

When you drive an electric vehicle, you get a performance advantage. The Mustang that was just announced, 3.5, I think, seconds, 0 to 60. Some of the teslas are 2-point-something seconds, 0 to 60. The cars are quieter. You don't take them in for an oil change, less moving parts. These are high-performance vehicles.

In fact, one of our board members is a big fan of electric vehicles, and he said, "I don't think I'll ever buy another vehicle. It's just the experience is so great." So you get performance as well. And then the final is emissions regulations that are happening around the world.

There are -- State of California, again, is kind of leading in the U.S. The Europeans have emission standards or standards in China and throughout the world. And let me dive into this a little bit deeper just for Europe.

In Europe, they have emission standards now that are set. Today, the emission standards is 130 grams of CO2 emissions per kilometer driven across the fleet. And if you don't hit that number, there are fines associated with that for every car that you produce.

So today, it's 130 grams of CO2 per kilometer.

That goes down to 95 grams of CO2 per kilometer in 2021, and it goes down to 81 grams of CO2 per kilometer in 2025.

All right. So what does that mean? Well, the average vehicle in Europe right now gets right around 118 grams of CO2 per kilometer.

But that's -- and by the way, that's actually growing, that's increasing. And it's because more people are buying SUVs.

So you have an increasing emission happened from internal combustion engines. But that's the average. If you look at the top 5 selling cars in Germany, the average of those top 5 is actually 144 grams of CO2 per kilometer.

But let's just say it's 118. A battery -- a plug-in hybrid vehicle averages around 44, 45 grams of CO2 per kilometer.

And a battery electric vehicle is 0. So those are your 3 equations or 3 numbers, 118, 44 and 0. So you're going to have to go from 130 to 95 to 81, you're going to have to increase the amount of electric vehicles or hybrids or you won't be able to get that on average.

So let's do a case study. And you can pick any case you want. We just picked one and we said, okay, we're going to make an assumption that over the next 5 or 6 years or so, that there's going to be a 10x increase in electrified cars in Europe.

Plug-in hybrids or battery electric vehicles. And what that would take you from, today, there's roughly about 3.5% of the cars in Europe are electrified in some fashion.

So that would mean, 35% of your cars are hybrid or electric, which, of course, mathematically says 65% of your cars are gasoline or diesel. All right. You're with me? All right. So that's what would happen if 10% of the cars would become electrified.

And now you've got a simple math equation. And what's counterintuitive is that of that 35%, in order to hit the 81, if you're starting with 118, actually, most of your cars are going to need to be electric. Just -- it's a math equation.

So 25% of those. Now there are some other things that car manufacturers can do, they can buy incentives, there are some other different schemes, but this is roughly the equation that's going to happen. And that's if 35% of the cars are converted into electrified.

If a lower percent are electrified, a higher percent of those that are electrified are going to need to be battery electric vehicle. So this is just how the math works on it.

And I think that's why you're seeing a tremendous amount of enthusiasm coming out of Europe with Volkswagen announcing, I believe, 70 new electric cars coming on to the market over the next 5 or 6 years or so.

And you've seen announcements from Audi and the other companies as well. So I think this is really what's really driving things.

And what's also interesting is that we're going 130, 95 to 81. It doesn't stop there.

By 2030, that number gets even lower, 59 grams of CO_2 per kilometer. And again, not a lot of investment going into internal combustion engine. So that 118 number probably isn't changing. The 44 or 45 might change a little bit, probably not that much. You're going to need a whole lot more battery electric vehicles to hit that number by 2030. I think that's why you're seeing a lot of enthusiasm there. So all of this has driven a really great pipeline for us. We've got a $9 billion pipeline right now.

And again, we'll talk a lot more about that pipeline, but a significant portion of that is automotive. You see we've got industrial, we've got RF and so forth. We've got a couple of wins already out of that pipeline with Delphi, ZF and ABB.

And as I've mentioned on a couple of our conference calls, a significant portion, about half of the portion of that pipeline is going to be decided in the next sort of 6 to 18 months. And that's just simply based on when things are going to go into production, they're going to have to make the decision pretty soon.

So we've been out working really, really hard to transition the opportunity into actual wins. We've announced several deals, as I mentioned, on materials. Got $500 million deal with ST, $100 million with Infineon, $85 million with ON Semiconductor and then another unannounced power semiconductor company at $85 million.

So all told, some very good deals on there. But on top of that are a whole bunch of things that we haven't announced.

And actually, if you add up all the announced deals. And these -- many of these deals have kind of upside potential, if you will. And you look at the unannounced deals that we've had. The total amount of our long-term agreement pipeline now is an opportunity that basically is greater than $1 billion.

Tremendous amount of enthusiasm for silicon carbide across the semiconductor industry. And so we're expanding our materials footprint. We're doing 2 things, and Rick and Lisa will get into this in a lot more detail. We're taking our existing facility, the one up on the left, which is in Durham, North Carolina and converting that into a materials mega factory.

And then we're taking our second empty shell in Durham, North Carolina and converting it into a second materials factory, increasing our capacity 30x over the next few years.

We're also then building our new facility in the Mohawk Valley. That will be a new wafer fab, significantly bigger than our current wafer fabs. Highly automated, automotive quality. We've hit the ground running. We broke ground earlier this week in the Mohawk Valley. We've already engaged with the local universities, SUNY Poly, with the Mohawk Valley Community College, with a number of the different universities that are up there.

We have posted our first 11 or 12 positions. We have well over 100 applicants for those positions. We've also posted our first intern program for college students to come down to North Carolina, learn about Cree, learn about silicon carbide technology, go back to upstate New York, finish their degree, become employees of us in New York. We have over 400 applicants for those intern programs.

So we've hit the ground running. We're really excited about it. We're going to be ramping up that production in 2022.

So today, you're going to get a lot more of a deep dive into our strategy, into our execution and where we're going.

And I think -- we hope you leave the day with 4 key things. One is, we're executing against our strategy to transform our company and translate it into a powerhouse semiconductor company focused on silicon carbide and gallium nitride. We're growing and diversifying our pipeline of opportunity and working real hard to convert that opportunity and design win as evidenced by Delphi, ABB and ZF.

We're investing to expand our capacity in silicon carbide materials and in our wafer fabrication capability. And we're expanding our leading position that we have in silicon carbide to take advantage of this opportunity.

And all of this is centered on 30 years of experience in this very unique capability, an incredible IP position and an ability to know so much more about this capability to be able to deliver to our execution.

So with that, we're now going to give -- I'd like to introduce John Palmour. John is a founder of Cree. He's a -- he's probably one of the 5 most renowned experts in silicon carbide technology, especially for the power industry. He's got a whole bunch of patents. And he's going to give you a tutorial on silicon carbide. John Palmour. Hi, John.

John W. Palmour - *Cree, Inc. - Founder & CTO - Wolfspeed*

Okay. Thank you very much, Gregg. And I also want to acknowledge one of our -- one of Cree's other cofounders, John Edmond, who is somewhere in here, right there. So what I'm going to try to do is give you a little background on the physics of silicon carbide and try to explain why this material is revolutionary in terms of its capability.

So we're calling it silicon carbide 101. And hopefully, I don't scare you with some physics.

But what is a wide band gap? And why is it important? So that's going to be the first part of my talk is really explain, electronically, what does this mean and for the applications. And then I'm going to go into silicon carbide crystal growth. Why is it so difficult to grow? This is a material that does not occur in nature and give you some of the details about the difficulties of dealing with silicon carbide.

And then how are cycles of learning absolutely key to making cost and quality improvements in silicon carbide.

So very incremental technology. So I'll get into some of that. And then how does our 30 years of experience really uniquely position us to take advantage of this market.

So silicon carbon, silicon and carbon are both group 4 elements. If you remember the periodic chart of the elements, they were in this group 4, meaning they have 4 electrons in their outer valence shell. So there's silicon and its 4 electrons. So carbon also has 4 electrons. So there's the silicon with it. Each carbon has 4 around it and they share. And a covalent bond really is just saying that 2 electrons share and that gives 8 electrons in the valence shell and everybody is happy.

So that's really -- almost all semiconductors have -- are covalently bonded. So what does that mean?

When -- in a semiconductor, the band gap, which is what we talk about, wide band gap semiconductors, is really just a measure of how much energy does it take to rip an electron out of that bond and have it conduct.

So everything is stable here, but then you can pop an electron out and have it conduct electricity, hence the term, a semiconductor. Sometimes it's on as an insulator.

I mean, on as conducting, sometimes it's off. So band gap is the measure of the energy to pop that out. And there's a number of other key properties that we use. And in particular, electric breakdown field, the stronger that bond is, the more energy it takes to make it break down. And also, the stronger -- this is -- in general, the stronger that bond, the higher the thermal conductivity. And thermal conductivity is a big deal that I'll talk about.

So when you look at the common semiconductor, silicon and gallium arsenide. It's -- in silicon, you have a 1.1 eV band gap; in the gallium arsenide, 1.4. Wide band gap semiconductors are silicon carbide and gallium nitride. So they're significantly higher in band gap, 3.2 eV and 3.36 eV. So all that means is it takes 1.1 electron volts to pop an electron out of that bond between 2 silicon atoms. And there are several ways to make an electron come out of that bond.

One is photon energy, light. So light comes in. If the light has an energy higher than 1.1 eV, which is basically our visible light, it will pop an electron out and allow that electron to conduct. That is a solar cell.

Light comes in and you generate electricity coming out of the semiconductor. You can also do the same thing in reverse. You can inject carriers, eject electrons in here and then make them recombine. And in gallium arsenide, when an electron drops from the conduction band to the valence band, it releases a photon of that energy. 1.4 eV is red.

So gallium arsenide makes a red LED. So that's an LED. In silicon carbide, we can do the same thing. But visible light just passes right through silicon carbide. If you look at our wafers, they're clear. They don't absorb light until the ultraviolet spectrum. So you can make an ultraviolet detector or cell. And then in gallium nitride, when we have a photon -- an electron drop here releases a photon at 3.3 eV, which is blue. We make blue LEDs. We put a yellow phosphorous over it, you get white light.

Now the biggest deal for power and RF is what's called electric breakdown field. So what that means is you put a very -- you put a strong positive field here, and these electrons want to run to it, negative run into a positive. In silicon, it takes much less of a field to rip an electron out of that bond.

In silicon carbide, it takes a lot more. So it's actually 10x the electric breakdown field. So an electron is pulled out of that bond, and it runs over to that positive charge.

So the key for us, for power and RF, is that we have a 10x higher breakdown field than silicon or gallium arsenide.

And that is really what we're utilizing to get very high-power density, silicon carbide power devices and gallium nitride RF devices.

The third way to get electrons to come out is temperature. So silicon really stops being a semiconductor above about 200 Celsius. And silicon carbide, that's about 1,000 degrees C.

So those -- that's generally what we're using. And one thing I want to point out because you look at this, the band gap's only 2.5, 3x higher. Why is the electric field 10x higher? It's because electric field, when you calculate what that is, it's actually an exponential function of band gap.

So band gap -- wider band gap is a very big deal. All right. So how do we use that? So this is a HEMT, high electron mobility transistor is what we use for RF devices, and you've got a source here, the electrons come out of the source under this gate region and out the drain. And you just modulate the current on and off by putting a bias on this gate. So this gate here is 1 millimeter long. So we kind of call that a basic unit cell, a 1 millimeter gate periphery device. Now if this material was gallium arsenide, which is a typical RF device with -- for these dimensions, you'd have a breakdown of about 15 volts for -- of the dimensions shown. But in gallium nitride, it's 10x higher, same exact structure but 10x higher breakdown voltage.

So what does that give us? We get the same amount of current, but with 10x higher voltage. That's much higher power density.

And so the way it all works out eventually is gallium nitride is 5 to 8 watts per millimeter. So this 1 millimeter of width here would give you 5 to 8 watts.

And if you were doing it in silicon LDMOS or gallium arsenide, the other 2 common RF semiconductors, it's only 0.5 to 1 watt per millimeter.

So we get a much higher power density in terms of per millimeter of device.

So I've explained to you how we use the high-voltage or high breakdown field to get a high watt per millimeter. Well, that's great. But that also means you're dissipating a very high watt per millimeter. So now the thermal conductivity of the substrate that you're on is very key because you've got to get rid of all that excess heat. And so what really matters, ultimately, for an RF device is how many watts per square centimeter or per square millimeter you can dissipate because that really dictates the ultimate power level you can hit. Fortunately, for us, silicon carbide is 3x higher thermal conductivity than silicon. And we have a demo outside where we can show you that in a very visceral way by cutting ice with wafers. So please stop by.

So this shows an RF device, and this is -- basically shows -- this is how tightly you can pack those fingers. Imagine each finger is 1 millimeter and if you were in an LDMOS device getting 0.5 to 1 watts, this would be about, let's say, a 4-watt chip. It's 6 fingers, putting out, whatever, 0.7 watts per millimeter. You can't really pack these much tighter because you can't get rid of the heat. When you go to silicon carbide, not only are we getting a much higher watts per millimeter, we can also put those fingers in tighter because we can dissipate a much higher watts per square centimeter.

So in gallium nitride grown on the silicon carbide substrate, instead of a, say, 4- or 5-watt device, this would be more like a 50-watt device. And so it's both the high breakdown field that's key and the high thermal connectivity. And we have the same advantage in power devices as well.

So let's go to power devices, how do we utilize this high breakdown field to make a power device. So I'm going to start by showing you a MOSFET in either silicon or silicon carbide.

The MOSFET is the closest thing we have to a perfect switch. MOSFETs are very fast. In either technology, they're very good devices. And it would be the one you would want, all things considered. But let's say, you want to make 1,000 volt MOSFET in silicon. That means you have to have a very low doped, very thick drain layer.

So that's the dimensions. It takes 100 microns of epi, of epitaxy of very low doped, so this -- the doping here is 10 to the 15. That means, there's 10 to the 15 electrons available to conduct current in that layer.

Well, in silicon carbide, if you wanted to make that same voltage device, 1,000 volt device, that's what it would look like. So we can have 1/10th of thickness, 10 microns and 10x more carriers available.

So what that means is the on-resistance of this device in silicon carbide is 1/100th. So it's actually 1/200th, the on-resistance. That effectively means the die can be 1/200th the size.

So this is how it looks graphically as a function of breakdown field or breakdown voltage, that is. So as you go up in voltage, those layers, you have to get thicker and thicker and the carriers get lower and lower.

So for die size, lower is better. You always want to be as low as you can be. So again, for that, 1,000 volt device, you can see up here, this is what a silicon MOSFET would be. And if you calculate based on this on-resistance, the die size that would be required for 100 amps, it'd be 10 square centimeters. That is a chip about that big. It's just not practical. You can't print anything that big, and this was just not going to work. So you don't see 1,000 volt devices or 1,000 volt MOSFETs in silicon. What they have to do is go to a device called an IGBT.

So this is a trade-off. IGBT is not an ideal switch. It uses what's called minority carrier conduction or -- and so you've got a bunch of excess charge that brings the resistance down. But every time you switch it, it has to dissipate that charge while you're blocking voltage. So there's a lot of excess energy being burned when you're switching it. But it brings you down about an order of magnitude. So now instead of 10 square centimeters, you've got a 1 square submeter chip for your IGBT, all right? That's practical. It can be used. So in silicon, at low voltages, MOSFETs are used all the time, very common. But at 600 volts and higher, they use IGBTs. And it's a trade-off they make for cost. And they're trading performance for cost.

So in silicon carbide, where are we? Well, that's where we are. So now to get that same 100 amp device, instead of 1 square centimeter, we're down around 1/4 of a centimeter. So it's a much smaller device, and we're not having the trade-off, the performance trade-off. This is a MOSFET. It's a pretty perfect switch. We don't have to dissipate that excess energy every time you switch it. So 10,000 times a second or 100,000 times a second, you don't have to dissipate that wasted energy. So it performs better, and it's a smaller chip.

So how does that manifest itself for the end customer. So this was a study done by Delphi, where they took our devices. They built an 800-volt inverter and a 400-volt inverter, and they compared it against the same version with the silicon IGBT.

So the flat line across, in either case, is 100% -- this is the losses they got with IGBTs. And if you look at full load, 500 amps, you can see that at full load, we have about 50% lower losses compared to a silicon IGBT.

So in an inverter for an EV, this is when you're really romping on the gas or electricity to get onto the highway. But you spend very little time there actually. Most of the time you're driving, you're going to be down in here. You're just trying to keep the same speed on the highway or whatever. And here, we get 70% lower compared to the IGBT. So it's a massive drop in losses. So -- and at 400 volts even, it's not quite as dramatic here, but it's still 40% lower at full load. But again, where you spend most of your time down here is in low load, and you have the same advantage, 70% lower. So that's a huge advantage for silicon carbide over the silicon IGBTs.

This is another example. This is where Ford took one of our power modules. They built up a 90-kilowatt electric motor, and then they ran it through simulated EPA driving cycles. You can see in the city cycle, they got 77% reduction in losses versus IGBTs. And in the highway cycle, they got 85% lower inversion -- lower switching losses. So you put that all together and for the EPA metro highway cycle, it ended up being 78% reduction versus -- in losses versus the IGBT.

So how does that translate? Because you still got to do the work. The motor still has got to push the car down the road. But when you really get down to it, what it means is that silicon carbide enables about a 5% to 10% further range for the same battery pack. So that helps to leave the range anxiety that Gregg referred to, or a 5% to 10% reduction in the battery cost, the batteries in a battery electric vehicle, are the most expensive part of the car. So you can trade off -- you can drop battery and get lower cost. And we have companies who are pursuing one way or the other or a combination of both.

So with that, I'm going to queue up a video, and we're going to talk about silicon carbide crystal growth.

(presentation)

John W. Palmour - *Cree, Inc. - Founder & CTO - Wolfspeed*

All right. So I'm going to try to go into more detail on some of the points brought up in that video. And again, silicon carbide doesn't occur in nature and dare I say without other worldly help because this is one of the few known natural deposits of silicon carbide on earth. This is Canyon Diablo in Arizona. About 50,000 years ago, a meteorite came in, hit hard, created a very high temperature environment, low oxygen content, high pressure, et cetera, and there are some silicon carbide crystallites that formed. But that's pretty much one of very few places where you can find silicon carbide on Earth. So if we want to grow silicon carbide, we got to try to emulate what happened right there, and that's not easy.

So silicon, as it turns out, is very easy relative to silicon carbide. Silicon, you just -- you take silicon, you put it in a vac and you melt it. It melts at about 1,400 C, kind of orange, hot. And then you can dip a little tiny seed, 3 millimeters in width, into that melt. And then by controlling the pull rate, silicon will deposit on that seed, and you can make it neck out very, very quickly, and then pull it. This would be probably a 200-millimeter boule coming out, but you can see up here is this tiny little seed that they start with. And why that's important is this -- the defects, the crystalline defects in that seed will very quickly neck out and just basically move out to the outside of the boule, and you can get a pretty perfect crystal. And that's the beauty of being able to pull from a melt.

Silicon carbide is quite different. Silicon carbide does not melt. It actually sublimes. So the way we have to do this is we -- you get a polycrystalline source material, and we take it to extremely high temperatures. So we have to go up to 2,400, 2,500 Celsius, and it will turn into vapor. And that vapor can be SiC, Si2C, SiC2 and a variety of other species, but it will sublime off and migrate across a temperature differential to where you have your seed. And those -- that vapor will deposit on here, and you grow the boule that way. All of this is a very high temperature. And the other big thing is we have to start with a big seed. We can't start with a tiny little 3-millimeter seed because there's very little crystal expansion during this sublimation growth. So the seed quality is extremely important because whatever that seed is, it's going to be replicated in the boule. So you got to start with a really good seed and then not mess it up when you grow the boule.

So how hot is hot? As the video said, we're growing at 2,500 c. That's half the surface of the sun. So this is a white, white hot growth. You cannot look at it. And most materials that the good Lord gave us want to fall apart at that temperature, so there's a lot of know-how that goes into keeping everything together while you're doing that. We're emulating a meteor strike, and we design and build all our growers in-house. So we've been doing this for 30 years. We've learned a lot about how to control this pretty extreme environment, and we feel that's really a key differentiator for us, and we take advantage of that.

So one of the other big issues with silicon carbide is that it has a lot of different crystal structures called polytypes. So what does polytype mean? The -- all silicon carbide looks identical in 2 dimensions. So if you were to look at the surface of a wafer, you couldn't tell what polytype it was. They distinguish themselves by the stacking sequence in the third dimension. So we have hexagonal crystal structures, 2H, 4H, 6H and many, many more. And the H is hexagonal, and 2 refers to how many layers before the pattern repeats. So 2H, it repeats every 2 layers; 4H, repeats every 4; 6, every 6 layers. There's rhombohedral crystal structures. This is a common one called 15R. It's a rhombohedral structure that repeats its stacking pattern every 15 layers. There's also a cubic structure that's called 3C. These are the -- probably the most common 5 crystal structures, but there's a lot more. So all of these things want to form at the same time. Thermodynamically speaking, there is very little that differentiates one polytype from another, but they all have different electrical properties, some of them quite different. And we only want one for power. We want that one. 4H silicon carbide is what we're using for the power device. It has the best combination of electrical properties.

So you can't have a different polytype in your wafer an inclusion of different polytypes. You won't yield. So controlling -- getting a single polytype throughout the entire boule is a big deal. So how do you do that? It's like how do you get to Carnegie Hall? Practice, practice, practice. This is -- we have to start with a very good seed, which we get to very incrementally, then you have to do the growth. You don't want to add new defects, and you'd like to reduce the existing defects. So you get a boule that comes out of that, then you can cut it into wafers. And we can sell those wafers externally. We can use them for our devices. But if we've done our job well, you can also use that same material to do an improved seed and feed that back in and how many times around that cycle can you go and continually improve things. And if you don't do well, obviously, maybe you can get some wafers, maybe you can't, but you don't get a seed, and you got to pull from your seed stock and try not to mess it up the next time. And I can tell you that this is really key. And we've been doing this for a very long time and much higher volume than most people realize, I think. And we have a lot of these cycles of learning under our belt.

So what if things go wrong? If we've done our job right, a boule is pretty boring, 6-inch diameter ingot of silicon carbide. If we've done something wrong, it might be a 6-inch ingot that's been cracked in half. If we've done something really wrong, it might look like that. So this is a bunch of different crystals that can come out. You can see the hexagonal shape. We've got one out there if you want to look at it and different polytypes. This probably has 6H and 4H and the little 15R, so it's a mix of different polytypes. This is not usable. You can't make a seed out of this. Well, that's not a big deal if it's one grower. What if your whole fleet of growers started to spit that out? Well, then you got a problem because you only got so many of these. So you got to shut things down, figure out what's wrong and then start back up. We've been through this cycle a lot. These are things that do happen.

So to show that, we're -- this shows the current market for silicon carbide wafers. This is the merchant market for power and RF, and this was from Yole 2018. Says that Cree supplies 62% of the wafers into that merchant market, and our closest competitor is about a factor of 4 behind. So we are very, very large in this market. But remember, this is a merchant market, feeding power and RF. What I think is very underappreciated in the field is how many wafers we've been using for LEDs. We've been building billions and billions of LEDs a year all on silicon carbide substrates for a long time. So what I did was went back through our MES systems for the last 22 years and added up how many total wafers have we made, how many cycles of learning have we had versus the rest of the world because we're the only ones selling in LEDs on silicon carbide substrates. And I was pretty shocked by this. So I'll let that soak in.

Of all the silicon carbide used by man in the last 22 years, 96.5% of it has been made by Cree. Everyone else combined is about 3.5%. That doesn't say these people can't compete. Clearly, they do. But we have about 30x more cycles of learning under our belt and are very prepared to ramp up production on a very large scale because we've been doing it on a much larger scale than I think most people realize.

So silicon carbide and GaN are ideal materials for power and RF applications due to the wide band gap and high electric breakdown field. It's extremely difficult to grow with high quality, and it's taken 30 years to get where we're at. Cree has, by far, the most experience in learning and manufacturing on a high -- on a large scale in silicon carbide, and we have a tremendous lead over competitors in terms of high-volume production of silicon carbide boules.

So with that, I'm going to hand the mic over to Dr. Cengiz Balkas. He is Senior Vice President, and he's the General Manager of the Wolfspeed business. Cengiz came to us through an acquisition in 2006. He has started a company named Intrinsic Semiconductor in 2002, and Cree acquired that company in 2006. He's an inventor and coinventor on several patents and patent applications in the field of wide band gap semiconductors and has pretty much been doing silicon carbide, I think, since he got out of school.

So with that, I will hand it over to Cengiz. Yes, there you are.

Cengiz Balkas - *Wolfspeed, Inc. - SVP & General Manager*

Thank you, John, for the great presentation and the introduction. As John said, I'm Cengiz Balkas. I run the Wolfspeed business unit for Cree. So I'll try to walk you through more of a commercial story of Wolfspeed, what we do in the 3 business units. And hopefully, you'll get a better view on how our products are fitting in the marketplace.

So a couple of years ago, we start a transformation path at Cree. And as Gregg mentioned and from a Wolfspeed perspective, we have 3 pillars inside the Wolfspeed transformation path. The first one was really selection of the markets. So we looked at which market silicon carbide and gallium nitride fits the best, and then we picked electric vehicles, energy, communications infrastructure, industrial and aerospace and defense areas. Second thing we looked at, we had to build some scale, both on the materials side as well as on the device end of the business. And third, the last but not least, we had financial targets to grow the business as fast as we can with good margins and good profitability. So when you look at the Wolfspeed business today, all 3 pillars are still in place and highly validated with -- in the marketplace in the past 2 years.

So let's start with the markets. As I said, one of the key markets for us is the automotive space. And automotive is heavily dominated by the EV adoption, and you'll hear a little bit more on this from me as well as from Jay and Kenric as well. And then we have the communications segment of the business. So this really almost exclusive to our RF business, and it has 2 pieces. There's a communication infrastructure piece as well as the aerospace and defense where our GaN products fit in. Then we have the energy sector, which is a very fruitful sector for silicon carbide as we provide

tremendous amount of efficiency in power conversion. So applications in the energy sector will be things like fast charging, solar inverter cells, solar inverters and better storage facilities. And the fourth segment is industrial. That is a little bit of a catch-all category for us. We have probably tens, if not, hundreds of different applications, and we serve thousands of different customers in that segment. And as you can see from our revenue progression since fiscal '16, where we were in the mid -- $175 million or so. There's a fantastic traction with our products in the market. And last fiscal year, we closed -- of this year in June, we did $538 million with our -- on our revenue.

So a couple of points I wanted to make as silicon carbine and gallium nitride are moving into the mainstream of semiconductors. When you go up against a semiconductor like silicon, which is pretty strong, well-established, costs have been taken out in time, you have to have very clear value propositions to the customers. The technology may be interesting. But really to ramp it up in a commercial way, you have to have a good value proposition. So we have seen very good validation of this for our products. Second thing is, as we look at the markets, we've seen significant growth in both the serviceable market that we have for our products as well as the pipeline that we've established for the silicon carbide and gallium nitride devices and materials. You will hear more about this. Our materials business has great scale, and we're continuing to support both our internal device activities with this, but also equally important, we're supporting the industry's transition from silicon to gallium nitride and silicon to silicon carbide. And in terms of our device capacity goes, again, this is a theme that you will see throughout the day, we've made significant announcements and capacity expansions on the device side of the business as well. So when you look at our global technology leadership, we continue to lead the industry in 2 really important areas. One, if you look at our product portfolio, it's the broadest that you will find for these technologies today. And also, we have a lot of field-tested hours under our belts, making these technologies suitable for further expansion.

So let's start with the materials business, and I'll try to give you a little bit of an idea on what our strategy here is. First of all, the scale that we have in materials is really unique. So this is something that we will continue to build as we support the rest of the industry. And you'll hear more on the transition of our capacity improvements in the presentations that you'll see. And then, really, the third and really important piece of our materials business is the scale that we have gives us a unique advantage in terms of accelerating innovation and also the quality of the material that is needed. So -- and when you look at industries like automotive and adoption of silicon carbide in automotive business, you also have to project your cost road maps quite accurately, and we do think that we have a unique advantage here with the scale that we have.

So when you look out to 2024 in terms of serviceable markets, we see a market that is about $1 billion for our materials business. And as you can imagine, this market is no different than the device markets that we're going after. So it's driven by power electronics demand that is using materials. A big piece of that is the EV adoption that is going on and then industrial applications. And also on the RF side, there is significant amount of gallium nitride and silicon carbide market demand out there. And the fourth category is something that we haven't talked about much before is our epitaxial services that is part of our materials business. So when we look at the serviceable market, we see the epi business being quite significant part of it.

So on the capacity expansion, we've announced a couple of different plans, and we've referenced to the first fiscal quarter of '17. And we are basically doubled our capacity twice since that announcement, so we're at 4x and continue to add. That brings us to 30x capacity on our Durham campus. And in addition, we have a shell building in the -- on our Durham campus as well that will give us even further, probably north of 2x expansion on the materials business as well. So one of the things really here to connect is with -- if you noticed in John's presentation, development cycles, you really need to go through these in a quite efficient way. And especially when you're adding capacity and doubling and doubling twice in 2 years, the expertise that we have in the field really becomes important because if you're not careful, you will have a very big capacity available, but you may not have the quality that you want. So here, really, our long experience in the business helps us how fast we can add capacity for the industry.

So I've talked about the epitaxial business that we have here a little bit. So epitax is a very thin layer of either silicon carbide or gallium nitride that is deposited on the substrates. And really, the epi quality, how well you do this, will define how good your devices are, both from a quality and a performance perspective. Typically, companies will use machines that have multiple wafers in them. And you deposit this, and then you ship it to your device fabrication and then your devices are produced. And here also, we use highly customized platforms that are optimized for quality and also throughput. And a couple of years ago, we made a slight change in the way we were approaching epitaxial material sales, and we decided to make more of our materials available and add more capacity. And you can see in this chart here in a matter of 2 years, we have increased our sales in the commercial epi business by more than 4x. So we intend to keep this capability and make it available both, obviously, internal businesses as well as to external businesses.

So as Gregg mentioned, we had an announcement earlier yesterday with STMicroelectronics. So this is an important account, obviously a great partner in the market for us. And the first announcement was back in January, quite large deal, over $250 million. And then recently, we've doubled that going forward. So -- but other than this being a very important deal for Cree, it's also a fantastic validation point for silicon carbide going into the marketplace in a very serious way against silicon solutions. So I just wanted to point this point -- make this point about this one more time.

So the next business we'll talk about is the RF business unit and the strategy behind it. Really the first pillar of our strategy here is we are completely vertically integrated. We're the only business in the world in the RF space that starts with wafers, epitaxy, wafer fabrication and packaging all in-house. And we believe this gives us a couple of really unique advantages. One is speed, and the other one is creating value for our customers. Then when you look at the 2 other elements of our strategy, one is really centered around the communication infrastructure piece or telecom, and we are supporting these customers worldwide. And then the third piece is the aerospace and defense markets, and I'll show a couple of examples of how our products are fitting into that marketplace.

So shortly after our February Investor Day back in 2018, we did an acquisition. And I just wanted to talk a little bit more about that acquisition, what it did for our business. Being in the GaN RF space, we didn't have access to package products as well as customer access on the communication infrastructure side. So you'll see here, pre-acquisition, the capabilities we had and the capabilities we have today, both as a result of the acquisition as well as the investments we've made to date. So starting from complete work and integration from the materials side, technology portfolio, application center and customer access throughout the world and a leading IP portfolio in this space, today, when we look at our RF business, we have all the elements to continue to scale it as the market grows.

Now as Gregg mentioned, there are some near-term headwinds as well. One of our key customers is under the shipment ban. So that clearly -- given the importance of the accounts, it's impacting our business in the near term. However, if you look at the 5G deployments, and we'll talk about how GaN plays into 5G, over the last couple of years, there's been significant amount of investment announcements that are totaling about $200 billion. And in addition, the last time we gave you an update, our serviceable market was around $1 billion. Today, when we look at GaN serviceable market, it tops $2 billion. So there's some great movements in the market in terms of gallium nitride adoption. So despite the near-term issues that we will have, we're not stepping off the gas at all. We're actually increasing our R&D efforts and development efforts to serve the market better, and we believe we will get through this period soon.

As I mentioned, the serviceable market is about $2 billion by 2014. And the pieces that go into it are really -- there are 2 categories. One is the communication infrastructure and the deployment of different systems related to the 5G revolution, and then there is a tremendous amount of interest in the high-performance, next-generation aerospace and defense systems where GaN adds really significant value. And we'll talk about what GaN does in these applications also in the coming couple of slides.

So this slide, on the right-hand side, it shows the evolution of the network, starting from 1G, 2, 3, and then you're probably seeing a lot of 4 and 5G-related advertisements and announcements nowadays. And so here, really, there are a couple of main themes in the marketplace. One is the mobile data growth is incredible. The speeds that are needed for this application are every day going even higher. And then you have to have enough capacity for a lot of users and also provide connectivity basically anywhere. And if you look at this market, it's been -- in the early days, it was -- silicon LDMOS played a great role. Now, though, when you see it, the demands of the application, gallium nitride really becomes very clearly the most logical choice to go after, especially in the 5G platform. Your systems are more compact. You have more bandwidth and really more important is the cost per bit per second for the operators is lower with the GaN systems. So here, we have a couple of different metrics on power -- the amount of power that you will use per megabyte, it's 87% less power, 10x more data. And in certain 5G massive MIMO configurations, you can have 16x more high-density video users using the system. So it's quite convincing value proposition, and that is really behind all our activities on the communication infrastructure side.

Next is, really, GaN fits in a lot of different applications in industrial, aerospace and defense, anywhere from satcom, weather radars, broadcast systems, all the way to RF heating. And it has a very similar impact on the application like silicon carbide does. Your systems are smaller. They are more efficient, and you can provide more capability. So here, we have a demonstration. And if you didn't get a chance to look at it earlier in the morning, please come by at the break. This is a weather radar that the original version was built with a magnetron, and it's a 4 KW magnetron. And the GaN version is 25 -- only 25 watts. And Jim Milligan will explain to you how all that comes together. But if you look at the system's weight and

the size and the capability it has, the differences are really incredible. This has -- also on the operating lifetime, GaN-based systems are 60x longer lifetime projected to be having a longer lifetime.

Okay. So the third business that we have in the Wolfspeed business is our power business. And here, our strategy, really, one of the key elements of our strategy is when you look at the power space, which voltages you can apply your technology to. So we've decided it will be 600 volts and above. And here, really, the space is quite open for silicon carbide. Our commercial portfolio is between 600 and 1,700 volts. But if you follow our presentations and conference proceedings and so on, you will see silicon carbide has fantastic advantages in the higher voltage as well at 3.3, 6.5 and so on. And in time, you will see we will commercialize these platforms as well. And the second piece to our strategy is, really, we have a high focus on the automotive business given the advantage that we bring in there. And also, we will continue our expansion in the industrial and energy businesses given it gives us a nice diversity of revenue. And the third piece to our strategy on the power side is really investment. Looking at the markets that we're going after, scale is one of the common themes for us for the last couple of years. So we have been hiring in the -- expanding in the R&D area and also in the sales and marketing space, and we'll continue to increase our investments here.

And when you look at the available market for our silicon carbide power products, it is around $5 billion. A good amount of it is silicon carbide for automotive applications, but we also have a great -- we see a great variety of applications in the industrial and energy space contributing to this market opportunity for us.

So let's talk about the industrial and energy side first. As I said, this is a market that has thousands of customers in it, and so it provides a great revenue diversity for our business. And so how we approach this market is a little bit different than the other market segments that we're looking at. And here, we have a very focused channel strategy, and Thomas will talk about this a little bit more. And also, we have a number of industrial partnerships that -- developing the ecosystem for silicon carbide to get the designers more comfortable with designing with silicon carbide. And applications here, as I mentioned, fast charging, solar inverters, energy storage systems and really a really wide range of power supply applications that you can find. And value proposition here for the products are quite similar in the other markets that we talked about. You have some carbide systems that are higher efficiency. They weigh less. They're smaller. And in every case, the effect on the end user is quite significant given the advantage that silicon carbide brings.

Okay. So let's quickly talk about the automotive opportunity, and Kenric and Jay will give you a better view on this as well. But here, our strategy is really to drive scale of our capability up as fast as we can given the amount of opportunity that is out there. And also, along with that, the value proposition is quite key. So when you look at it, the cost-reduction activities, we have also a need to stay in focus. And on a electric vehicle application, we fit in 3 places. And we have some demos out there at the break, if you would like to come and see those, is the inverter is the largest real estate we have for silicon carbide, then you have the onboard chargers as well as the DC-DC converters. And as Gregg and John mentioned, the advantage we bring in to this application is quite significant because of the efficiency advantage of silicon carbide. Your battery could be either -- you can use a smaller battery, increase your range. You also get quite a bit of size and weight benefits on the car, and the OEMs will choose to use that benefit as they see fit.

And an adjacent market to automotive is charging. So I think Gregg talked about charge anxiety and also the range anxiety and the charge times. So -- and really, a good market that we see that is developing is in fast charging. And I think this will -- one of the reports that we have here puts the charger deployments at north of 3 million units by 2024. So as you can imagine, silicon carbide brings all the benefits that we talked about into this particular application as well. And so while we probably will share this market with silicon, the advantage of silicon carbide in charging are quite significant as you use basically less energy to do the same job. And in terms of content, it's also a very rich area for silicon carbide. While the amount will depend on the wattage of the systems, plus or minus, it's about $1,000 per charging system for silicon carbide content. So this is an area that we have a lot of activity going on.

All right. So my last slide is really a summary of what I talked about here. We have -- we're a unique semiconductor company because we have a strict focus on silicon carbide and gallium nitride. We really don't have any other incumbent technologies that are impacting our decision-making, so we'll be driving this adoption quite strong. And when you look at the markets that we're going after and silicon carbide's placement in them, it's really looking quite attractive for the years to come. And investment in the scale is ongoing. You'll get a little bit more view on that from Rick when he talks about. And then the last, but certainly not the least, is we're building a world-class team. In the last 2 years, we've added a tremendous

amount of industry talent, not only in the areas that they are experts in, but they've also seen large-scale businesses as we embark on this journey. This is really a key part of our strategy.

With that, I would like to invite Kenric and Jay. So Kenric Miller, he runs our worldwide automotive sales and marketing activities. And he joined us from NXP and Freescale, where he led a similar position. And Jay Cameron joined us in 2018 May, and he was at Texas Instruments, running various different businesses. And so he had, I think, 17 years or so at TI with a lot of scale experience.

So with that, I will turn it over to Jay and Kenric.

Jay Cameron - *Cree, Inc. - VP & GM of Wolfspeed Power*

Thank you, Cengiz. All right. Good morning, everyone. Thanks for joining us today. My name is Jay Cameron. I'm pleased to be joined by Kenric Miller, and we're excited to talk with you about the opportunity that we have for our silicon carbide power devices, specifically in the automotive space.

We're in the middle of 2 industry transformations that are unlike anything that Kenric and I have ever experienced. The first is this transition from internal combustion engine vehicles over to electric vehicles, and the second transformation inside that electric vehicle space is the transition from silicon to silicon carbide. And this market environment is really setting us up to have a tremendous opportunity.

The growth that we have -- the growth opportunity that we have is really driven by 3 things. The first is the benefits that silicon carbide has to offer make a direct impact on the things that automakers care about. The value propositions carry forward to real value for the car companies. The second, like Gregg talked about earlier and Cengiz mentioned as well, is the silicon carbide benefits also play a direct impact on the end-user experience, the drivers for the cars. The higher power efficiency and the greater power density translate directly to these benefits in longer-range and faster charging times. And then the third real driver for us, and Kenric is going to talk a little bit more about this, is the commitment that Cree has made in terms of capacity expansion has really helped car companies gain confidence that this is the transition that they want to go through, to capture these benefits that we've talked about and also know that they'll have a secure supply chain. So those growth drivers, in combination with the technology that John Palmour presented to you earlier and the scale advantage that we'll have with what Rick McFarland and Lisa Fritz will talk about later, are really setting us up to have a great opportunity in the automotive market space.

Kenric Miller - *Cree, Inc. - Automotive VP of Global Sales & Marketing*

So as Jay mentioned, there are a couple of important transitions that are happening in the automotive space, and I'll talk about the first one. It's the transition from internal combustion engines to electrification. And if you look in 2015, you see that 98% of the vehicles made were made with internal combustion engines as their main source of propulsion. But by the time we get out to 2030, this is going to drop to less than 40%. Now at Cree, we care a lot about this dark purple shade. That's the battery electric vehicle side of the business. And what you've heard and what you'll see is that, by 2022, there starts to be a dramatic uptick in battery electric vehicles. And by 2025, it's 7% of the market. And by 2030, it triples. We actually think there's upward pressure on these numbers. Already in China, we see that battery electric vehicles are outselling the rest of the EV market by a factor of 5:1, and we think that will happen in other regions as well over time.

The second transition that we want to talk about is the transition from silicon to silicon carbide inside of the inverter. Now the inverter, you're going to see some inverters out there in our demo space. The reason we care about the inverters, that's what drives the motor, and it's loaded with silicon carbide. We went around the world, and we talked to OEMs. And when we're talking to them, we were asking them a basic question: When do you plan to implement silicon carbide in your inverter? Will you have a car on the road before 2025? When we were asking this question in 2017, only one company, Tesla. We know the Model 3 is out there. Only one company was committed to putting a car on the road with silicon carbide. A year later, 40% of the car companies we spoke to from around the world were committing to put cars on the road with silicon carbide in their inverter. And today, as we go out and talk to car companies, 90% of the companies we're speaking to are either committed to or will probably have silicon carbide in their inverters by 2025. It's a significant shift.

Jay Cameron - *Cree, Inc. - VP & GM of Wolfspeed Power*

All right. So let's talk about what this means for the car manufacturer in terms of switching from silicon to silicon carbide. John Palmour introduced it earlier when he talked about the 5% to 10% efficiency improvement that you're able to gain versus a silicon system when you implement with silicon carbide, so let's take that back to the automotive system. If you've got a battery in a battery electric vehicle that's on the order of 80-kilowatt hours and if you project out forward a battery cost of around $100 per kilowatt hour of battery and you're able to capture 5% to 10% savings in terms of what -- to get the same range for an equivalent battery, that translates into a savings on the order of $400 to $800 for the -- at the car level. So that alone is a substantial driver of why car companies are interested in silicon carbide relative to silicon as they think about their inverter designs.

Now you think about the space and the weight savings. This is a little bit harder to quantify, but that greater power density that you're able to get to in a car, potentially a smaller battery, so there's less weight there. Now you've saved a lot of valuable real estate. That real estate inside a car has a value. And if you're not using it for your electronics or your battery, then you've got the opportunity to use it for something else. So there's value at the system level for that space and weight savings. John also talked about how silicon carbide-based inverters are more efficient, and what that ultimately means is you're wasting less energy from the battery when you're using it. That wasted energy comes out in the form of heat. And so all of these electric vehicle architectures have cooling systems that are designed to extract that heat out. If you're producing less heat to begin with because you're more efficient, that means that you can design to a lower level of cooling requirement than what you'd have to do if you were extracting a significantly greater amount of heat. So you couple all those things together, and you've got a tremendous system-level value from switching to silicon carbide.

Now one of the things that initially held back adoption with silicon carbide was there was a perception that silicon carbide devices are more expensive than similar silicon power devices. And yes, that's absolutely true. Now when we quantified that for our customers and said, yes, you're going to have incremental silicon carbide cost. In our example, we've suggested that there's approximately $200 of incremental silicon carbide costs for an equivalent inverter. You net that off against the benefits that I've just talked about in terms of your ability to capture savings on the battery, the cooling system and the space and weight, and now you've got a savings per car on the order of $200 to $600 for the vehicle. Over the course of a program lifetime that might run 100,000 vehicles, now you're talking about a very significant savings on the order of $20 million to $60 million.

Kenric Miller - *Cree, Inc. - Automotive VP of Global Sales & Marketing*

We presented this exact slide to customers around the world. And on multiple locations, this becomes an aha moment. Right in the middle of the meeting, the whole dynamics change when the customers realize that the battery savings pays for the silicon carbide and gives you additional benefits. Sometimes the meeting stops. The customers start talking in their native language. And usually, when the meeting picks up again, their next question is, "Can you help us get started on the transition?" This is an amazing slide for us.

Jay Cameron - *Cree, Inc. - VP & GM of Wolfspeed Power*

All right. So that was a little bit about the benefits for the car manufacturers. If you think about the benefits to the consumer, these are equally tangible, both to accelerate this transformation from combustion engines to electric vehicles but also from silicon to silicon carbide. Being able to get longer range and being able to charge faster are clearly the 2 things that end users are most concerned about when they're thinking about an electric vehicle purchase decision. Silicon carbide's higher power efficiency and greater power density directly address both of these.

You need look no further than Tesla, who's long been a front runner in the electric vehicle space and has been very public about their interest in silicon carbide and their use of it. They've now got multiple models of cars on the market that are delivering over 300 miles of range. And if you look at their newest fast charger, fast DC charger, their third generation Supercharger, they're now advertising that, that has the ability to add 75 miles of incremental range in 5 minutes. So for the time it takes you to go in and get a cup of coffee, you can extend your travel range quite a bit in just a short amount of charging time.

Kenric Miller - *Cree, Inc. - Automotive VP of Global Sales & Marketing*

So Rick McFarland will speak in just a bit about our capacity expansion plan. What I want to speak to you about is how this was received out with our customers. Frankly, it was a game changer. Before we announced our capacity expansion, the meetings with customers are great. They're really interested in silicon carbide. They tell us, "Your devices are great. We benchmarked them. They're fantastic." But there was always a but, and the but was, "Will there be enough capacity? Do you have enough to cover us?" These are some of the comments we've received. But I will tell you, as we traveled around the world, the feedback typically when we met face-to-face with customers was, "Wow, you've really surprised us in a positive way. Thanks for taking such a bold step." In fact, our capacity expansion plan, coupled with the technology that silicon carbide is and our cost savings that we were demonstrating to customers, the combination of that has increased the momentum of OEMs wanting to accelerate their adoption of silicon carbide in the inverter. And that acceleration shows up in our pipeline. In the last 12 months, we've added over $2.6 billion to our pipeline for automotive. And Thomas will speak a little bit later about our overall pipeline. We now represent -- automotive now represents 45% of the overall total pipeline.

Jay Cameron - *Cree, Inc. - VP & GM of Wolfspeed Power*

All right. In automotive, silicon carbide is going to defeat silicon for the reasons that we talked about. You've got the ability to deliver value propositions to the car manufacturers from savings associated with smaller batteries, space and weight savings and cooling system advantages, and you're directly addressing the end consumers' concerns of longer ranges and shorter charging times.

Kenric Miller - *Cree, Inc. - Automotive VP of Global Sales & Marketing*

And Cree's winning in the automotive space because we're focused on the automotive needs. We've also got great devices. And with our expertise and our capacity expansion plan, our commitment to reliability and quality, we're enabling a quicker transition to silicon carbide.

Now I'll turn it over to Gregg.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

All right. Thanks a lot there -- all the presenters for the morning session. A couple of weeks ago, we announced a joint partnership with ZF. They're one of the top 5 leading Tier 1 auto suppliers based in Germany. They've partnered with us on silicon carbide MOSFETs for their inverter technology, and they've announced, in fact, this week, some design wins. All right. Jörg and his team have been great to work with, and he's been so gracious to do a little video for us. So before we take the break, we'd like to show the video. Thank you.

Jorg Grotendorst - *ZF Friedrichshafen AG - Head of E-Mobility Division*

We at ZF are one of the major global powertrain technology providers to our customers. For more than 100 years, we design and produce sustainable powertrain solutions. Today, we offer a portfolio from hybrid solutions to full electric drivetrains. And with these portfolios, we help our customers to provide sustainable and affordable powertrain technology.

Now it is about the breakthrough e-mobility. Breakthrough in e-mobility means we have the challenge to make the e-drivetrain even more efficient as we are today, so we are quite happy that we have partnered up with Cree to bring latest technology for silicon carbide into our inverter technology. Cree is a company that is well-known for silicon carbide technology. And we do believe, as one of the most powerful powertrain suppliers in the world, the best partner we can find is, of course, the best one in the world for silicon carbide technology. And so we have been together with the team of Cree, discussing how can we make our powertrain and invertor technology more efficient, at least to save battery costs for our customers. And at the end, we have come up to an agreement that, together with both engineering teams, we can make the full electric drivetrain more efficient and offer more sustainable e-mobility for the future.

ZF's and Cree's engineering team has designed our next generation of future inverters. We have shown this concept to our customers which are global automakers, and we are quite happy that we have won significant awards going into production 2022. The partnership, ZF and Cree, will enable us to really increase the efficiency in our inverters, and overall, by reducing battery effort in the powertrain help our customers to reduce costs in their overall powertrain solutions. I really do look forward to work together with Gregg's team, a high passionate engineering team and our teams to work out latest and greatest edge technologies for electric drivetrains of the future. Gregg and me, we are convinced the future is electric.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Great. Thank you very much, Jörg, for doing that for us. We're now going to take a break. And we've got the demos out in the back. And what I would suggest we do is we take a half-hour break. That will give you plenty of time for the demos and so forth, and then please come back in, say, at about 10 after 10:00. Thank you.

(Break)

Tyler D. Gronbach - *Cree, Inc. - VP of IR*

Welcome back, everybody. If I could ask for those of you in the back of the room to please take your seats. So really appreciate everyone's attention this morning. I know we're trying to cram in a lot in a short period of time. So -- but I think we still have some really interesting stuff to talk about. But at this time, what I'd like to do is I would like to ask Gregg to come to the stage and kick off the next segment.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Thank you. Thank you, everyone. And I hope you enjoyed the demos. I saw there were a lot of folks around the various different demos. Hope you learned a lot this morning as well.

Earlier this week, in fact, yesterday, we announced an expansion and extension of our supply agreement with STMicro, and we've been working with them and partners with them for quite a long time. Jean-Marc and I have met a number of different times. And Jean-Marc has graciously done a video for us. I'd like to thank them for that, and we'd like to show that video.

Jean-Marc Chery - *STMicroelectronics N.V. - President, CEO & Member of Managing Board*

Hi, Gregg. We'd like to really thank you about the opportunity you gave me to speak about my company, STMicroelectronics, silicon carbide, which is a great technology and of course, our partnership with Cree.

STMicroelectronics is a leading supplier of semiconductor products and solutions for a range of end markets. So we have a broad offer for the automotive and industrial markets as well as more targeted technologies for personal electronics and communication infrastructure. We offer our customers innovative solutions that help them achieve their goals, increasing performance and improving the efficiency of their systems. We have been doing this for over 3 decades, especially for automotive and industrial applications. And silicon carbine is now a very important technology process in our toolkit.

We have been believer in silicon carbide for a long time. We began research and development activities in the 90s in Catania in Sicily, an area known for expertise in power technologies. We built expertise across the entire value chain of silicon carbide, including the raw materials, the epitaxy process and the specific design and manufacturing constraints. So we were ready when we met a customer who was willing to push the envelope and use this disruptive technology. ST was the first, and today, still the only company with automotive-grade silicon carbide in real mass production. And we are now ramping for the industrial. We are entering production with our third generation of silicon carbide technology, and we are actively working on the next generation.

Silicon carbide is a key area of investments and growth for ST. This year, we will double our revenue in silicon carbide MOSFETs and diodes versus 2018 to $200 million. And this is just the beginning of our growth and leadership. This is a market estimated at more than $3 billion in 2025. To support this strategy, we are working with the best substrate supplier to provide immediate and mid-term capacity. This is why at the beginning of the year, we signed a multiyear wafer supply agreement with Cree. And we are now expanding in terms of volume and duration.

In parallel, we are also investing to build internal capacity to improve the flexibility of our silicon carbide substrate supply chain with the acquisition of a Swedish company, Norstel. For me, this is a proof of 3 things: First, this is a proof that our silicon carbide-based products have significant traction in the market. Our customers are engaging in large long-term programs for both automotive and industrial applications. Second, this is proof that Cree and ST share the same long-term vision of the silicon carbide market. We invested early, and we are continuing to invest for further success. Third, this is also proof that Cree is a key trusted partner of ST, helping us meet our customer needs in terms of security of supply and quality.

I really want to thank Gregg, and of course, his team for their continued support as we continue to do more business together and provide leading-edge technology and product to our customers. Thank you.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

All right. Well, thank you, Jean-Marc, and to your whole team for our partnership, and we look forward to continuing to expand that.

All right. So with that, we're very, very excited today to have a customer come join us here on stage. Tobias Keller is the Vice President of Global Product Management for ABB. He's been with ABB for 20 years. We announced our corporate partnership together with ABB on Monday of this week. ABB, if you don't know, is one of the world's largest industrial power companies. They're going to be taking silicon carbide into the industrial markets as well as giving them an opportunity to get into the EV market.

So please, Tobias. How about a hand?

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Hello, Gregg.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

That's a good greeting for me in New York.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

(foreign language)

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

(foreign language)

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

(foreign language)

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

(foreign language)

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

(foreign language)

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Okay. Good. All right. We'll switch back in English. So thank you very much, Tobias. It's really great to have you here in New York at our conference So tell us a little bit about yourself.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Well, maybe let's start with an overview on ABB first, then I can guide into this company and tell what I'm doing. ABB, a company with 147,000 people worldwide with 5 businesses. One business is industrial automation. That's where we deliver systems for industrial automation like paper printing, newspaper printing, but also applications like marine. Then we have electrification products. This is the miniature breakers you might have at home, the low-voltage breakers. Then a very important business, especially in our discussion here today as well, is the motion business. Motion, that's where we have the drives for trains, but we have it also for the industrial applications, low voltage and medium voltage. Then it's a business called robots and discrete automation. That's where we have the robots, the famous ABB robots. And last but not least, there is one business called power grid. Power grid, that's where we have the power solutions within ABB, the high-voltage DC transmission lines, the transformers. And as well, there are 1,000 people dedicated to the semiconductor business. ABB started building semiconductors 106 years ago. It was not silicon carbide at that time. It was also not silicon but this was mercury.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Okay. We're finally with the program now.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Exactly. 106 years ago, we built the first mercury rectifier. With this history, we are moving with our own semiconductor business, bringing the devices we need within our company in various other businesses as well for our outside customers.

And in this semiconductor business being located in Landsberg, Switzerland, roughly 20 minutes east of Zurich Airport, I'm responsible for the global product management, driving the road maps forward, defining the new products, defining the phase-outs and being responsible also for all R&D activities and the R&D budget within ABB semiconductors.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Great. Well, it's great to have you here. Thank you very much for that. You talked about the various different applications, and you mentioned grid. This Monday of this week, we announced our partnership. And I happened to meet with the Head of the New York Power Authority, and you're a big supplier to them, and they were very excited to have us as a supplier to you. And of course, we're going to be producing these products in New York. So it must be a great opportunity for you. It meshes well.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Yes. It meshes altogether, huh?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes, exactly. Can you tell us about your leadership in industrial type applications and how you're going to build kind of this ecosystem?

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Let's start with an example. Being out for holidays, a few years back, returning back to the office, going through the emails, I think we all know this feeling, having hundreds of emails. I'm not sure, reading everything or just delete it. I received an e-mail from a colleague from ABB in Norway. And he was -- it was just one sentence. "Would you be able to make a converter for a DC ship, a direct current ship?" I write the e-mail and started to think about what is this guy planning to do.

Let's think about the ship. A ship is like a city. You have a power generation area where you typically have diesel generators. You have diesel engines. Then you have transmission. You have transformers. And you have certain loads, like main propulsion, control system and so on. Up to then, in these ships, there were 3 phase alternating current use, the same as we have here in New York, everywhere. And he thought about doing it with DC, having a converter, being able to do DC. Thinking about this idea, immediately, you can think about reducing cables. Instead of 3 phases, 3 cables, you have only 2: plus and minus. Having more than 5-kilometer cables -- power cables on a ship, it's already a significant reduction on weight. Thinking doing everything in DC instead of AC, there is no reactive power to be transmitted, only active power, what you can really use to drive. And furthermore, you can have all your diesel engines running on the best speed for the dedicated power unit. You don't need to have them on a fixed frequency.

A few months later, we had the first setup available in our lab. And a few more months later, we had the first ship. We called it green ship. And measurements, independent measurements as well and more than 5 years in operation, it shows that with this setup, you are able to reduce the fuel consumption of such a ship by 20%. Nowadays, there are dozens of these green ships. There will be more and more. And not just think about using instead of silicon, silicon carbide there. Not yet done, but already calculated and thought about. And then you're not talking about fuel consumption reduction of 20%, but of more than 30%. And this helps a lot with the possibilities we have out of silicon carbide to bring this technology into this segment, as example, marine segment and to make miles most out of it.

Well, for many of you, it might be brand new that ABB is entering EV, electrical vehicle market as well as a supplier of power modules. ABB as a supplier of power modules in traction, application, trains for many, many years. We had a look at EV market itself, and we believe that with our technology we have and the partnership with Cree, that we are able to bring a very good, very reliable -- it's quite a lot about reliability as well. Think about the train. You're sitting in a train and the train stops because there is a failure on a power module. That's a disaster. That means on a train, we are discussing or we're talking about or specifying lifetimes of 30, 35 years, starting at temperatures minus 40 degrees centigrade in the morning, early in the morning, going up to 60 degrees centigrade in the late afternoon. And that's for the whole life cycle of 30 years. And this life cycle, if you have a look at the EV, it is very, very similar. And you need to consider it into the module design. And that's where we decided to go and to bring this technology also to the EV market on the automotive itself.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

You're -- there are various different markets you're going after. You talked about the ship and moving to DC and how that saved money, fuel consumption. And then moving from silicon to silicon carbide takes it from a 20% to more than 30%. I find it interesting that you're seeing cost savings, but probably also emission savings as well. So how does the impact of eco-friendly power impact your company and its need for more efficient solutions?

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

We have a long-term vision, and it's about sustainable solutions, what means also eco-friendly solutions at the end. If you have a look at what we have done so far, we are all traveling a lot by plane, by marine -- by ships, by car. And if you have a look at the ranking on the pollution, you will find the marine at the top end. And it's so easy to go in there and to change with really simple changes as this DC create what is nothing very complicated but it's rather straightforward as well. With such small changes, you can change the world at the end. And that's what we are looking for. It's very important that we are doing that to have also a sustainable business and an environmental-friendly solution at the end.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

We talked earlier, and I know you've been at the conference the whole time, we talked earlier about the transition from the gasoline and diesel or internal combustion engine to electric. We talked about the transition from silicon to silicon carbide. How does silicon carbide play a role in your company's future?

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

We had a dream already 10 years ago, and it was about silicon carbide. If you have a look at the power density you can reach with silicon carbide, especially in medium to high-voltage applications, it allows incredible possibilities. It allows HVDC, high-voltage DC links with much higher power transmissions with higher voltages. It allows to build smaller converters. It allows to have faster switching, and therefore, reduce significantly all the environmental chokes and capacitors for filtering.

And with these ideas in the back, think about having converter on a train, electrical trains. There are quite a lot of electrical trains already. You might have heard about Shinkansen train, the famous Japanese high-speed train. They started to use silicon carbide as well to decrease the size of the converter significantly and to be able to have more space for people or payload at the end. It's all about the drive at the end.

Have a look at industrial applications, there are still too many motors directly online. That means you have the grid. You have the motor connected directly to the grid. And the motor is just running always at the same speed. Let's take climate -- our AC solutions, cooling down buildings. Why does these motors needs to run always at the same speed? On the weekends, less people are working than during the week. And with a drive, you can change the speed, and you can make it, therefore, more efficient in various operating points. And for such applications, silicon carbide, that's exactly the way to go.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

I've heard in previous slides, I've heard motors are some of the biggest wasters of energy. I don't know if you have any statistics on that. But having more efficient motors is going to reduce the amount of strain on the grid pretty significantly.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

And it's not just the motor, but it's typically the motor and its environment. And the drive is an integral part of the motor. Therefore, if we can combine the silicon carbide fast-switching technology and high-current density together with the motors, this is once again a package, what can really be optimized and what helps us for the future, first of all, also to enter into new segments to replace the direct online motors and to have this environment-friendly solutions.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Across motors, across grid, across boating applications -- I wouldn't have thought of that one, ships, I guess, is maybe a better way of saying it, traction and trains and so forth, it seems like silicon carbide is playing a pretty big role across many of the different segments inside of your company.

And now you're moving towards the electric vehicle. How do you guys feel -- what's your vision or how do you see the development of the electric vehicle market?

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Well, there is one word to shortly summarize it. It's exciting. We believe that also some of the work we have done in traction. A huge portion on the traction market itself is already electrified. And we believe and we see that some of these effects and some of these lessons learned we had out of there, they are now moving also to EV. And this is really a great opportunity to go there, to bring in this reliable solution, all the learning cycles. It's -- we already heard 30 years' experience in silicon carbide on Cree side. And it's also the 106 years on our end building reliable modules, also building the housing, building the connections, everything what you need around the silicon carbide, MOSFETs to have then later on in application, to optimize the applications, to think about controlling circuits, the gate units, and that's the way to go. And that's exactly where we believe that we can make the difference.

We released the so-called road pack, that's the ABB EV module. We released it and showed it during the PCIM what is -- the semiconductor fair taking place in May in Nuremberg. We released these modules in Nuremberg. And the feedback we got out there, it was amazing. I had sleepless nights, a lot of talks. Wasn't able to eat anymore because I was not able to leave the booth. And what is important, inside, it's Cree; outside, it's ABB. And it's important that we partner in this way to make such things happen. It's not one of us but it's both of us driving it forward to have a very compact -- I would say, the most compact EV module, 900 amps, 1,200 volts out of a very small footprint.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

We've got a customer here that doesn't sleep a lot. But when he does sleep, he dreams of silicon carbide. So that's right up our alley. Tell me just a little bit of why Cree. You could have gone a number of different ways.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

ABB is a technology leader. We are driving our business with passion. I hope you also felt the passion from my side. It's a lot about passion. It's about the willingness to make the extra mile. There are no easy solutions. It's always an extra mile. You need to go to do it. And if you're able to do it, then you will win. And meeting with Cree, having the R&D collaboration already quite long, having this exchange, I have met people with Cree having the same passion and the same willingness to make the extra mile. And that's what we need to do.

In industrial, in traction, most probably also in EV, it's not the direct way to go and to be successful. There might be problems coming up, let's call them challenges, and we need to have the passion and we need to have the willingness to make it happen. And that's exactly why we decided to partner with Cree, we, as industrial leader, Cree as silicon carbide leader. And I think it perfectly fits together. And I'm very happy that we are part of your family. You are part of our family. And let's drive industrial, traction, train, marine and all other applications as well as EV forward together.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

That's awesome. When we were together signing the agreement, we actually talked about this, that there's going to be challenges and issues and things like that moving forward and we have to work together. And if you remember, I said, my philosophy on that is it's not your problem, it's not my problem, it's the problem. And together, we need to work on that. So I think we share an alignment on that.

We do have a couple of minutes for any questions that some of you might have in the audience. If you do have a question, raise your hand. I got one right over here.

Thank you, Craig. And if you wouldn't mind, Craig, just name and where you're from.

QUESTIONS AND ANSWERS

Craig Edward Irwin - *Roth Capital Partners, LLC, Research Division - MD & Senior Research Analyst*

I'm Craig Irwin from Roth Capital Partners. So Tobias, over the last couple of decades, Cree has done some really exciting research in silicon carbide that we don't often hear about. There have been not just 1200-volt chips, but chips -- 5,000 volts, 10,000 volts. I've heard from people in the Raytheon fab that they were even working on 25000-volt chips. These all would be a much better match for grid scale. Can you maybe talk to us sort of the other technology that Cree has developed over the last several years, how this fits into your future growth plan at ABB?

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Thank you very much for that. ABB Semiconductors, we start at the voltage level of 1,200 volts. We have nothing lower. 600 volts, that's not interesting for us. But we start at 1,200 volts. Our highest current voltage class is 6,500 volts. These are the applications we have typically on the power grid side. We have high-voltage DC transmission links. We have arc rectifiers using industrial applications. And especially in this area, the use of silicon carbide brings a huge advantage, making large converters much smaller, allows much higher frequencies. Therefore, you can reduce significantly the chokes, the filtering chokes.

If you have a look at an HVDC station, a high-voltage DC transmission line from one point to one point, on one end, you have a base station. On the other end, you have a base station as well. If you have a look at the base station, it is typically the area of a football area and the filter part where you have the chokes and where you have the capacity just to filter. It's 3 -- 75% of this area. Going to higher switching frequencies with silicon carbide, 6.5-kilovolt chips, we already discussed about that. We also talked about 10-kilovolt chips because that's even more helping us at the end with the higher power. Using these silicon carbide chips, you could reduce the size of this filtering part to about being 20% of the total size and not 75%. I'd say it's a huge decrease.

Space is a problem, especially if you're talking about base stations on HVDC, because they are typically -- especially if it's offshore, they are either on a platform. It means very cost-expensive platforms. You need to build and you need to install somewhere. And also on the countryside, on the land side, the base station on the land side, it's typically in areas where to build the foundation, to put all these heavy stuff on costs a lot of money. And if you can significantly reduce this size while using silicon carbide, that helps a lot. And it reduces cost, overall cost, life cycle cost as well significantly.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Common theme with silicon carbide, lower costs, higher switching frequencies and so forth. We have another question over here.

Edward Francis Snyder - *Charter Equity Research - MD and Principal Analyst*

Ed Snyder, Charter Equity. The applications you're talking about seem to be a bit more diversified. There's a lot of applications for this in power. Maybe you could help us understand how is the channel to -- and Gregg, jump in anywhere here because you were with TI, the challenge of a diversified market requires a big field engineering support, an extreme of someone like TI. I know Cree is not there yet. But -- and I know ABB is large, so you have pretty deep engineering, [which should may be enough]. But maybe you could help us understand how new technologies like that get to you, and by an extension, maybe Gregg, how they're going to get to all those other companies that are doing -- that are smaller than ABB that need kind of that handholding. New technology is complicated. Usually the engineering team has heard about it, but -- unless you've got an apps engineer coming there to help you figure it out. And if that's the case, if industrial is -- and it's one of your largest areas right now, if that's going to grow, what does that do to OpEx maybe? Is there a change of dynamic?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. So a couple of things. So our very next speaker is going to hit that topic, Thomas Wessel, who runs global sales for us. Two things. One is we're increasing the size of our sales force so that we can call on the bigger customers directly. He'll give some specifics on how we're doing that in terms of the number of people that are customer-facing, how many app engineers to salespeople, et cetera. But the truth is we will never have a dramatically large footprint for direct sales. We're just too small for that. So we have partnered up with Arrow Electronics. They are our single global supplier or partner in terms of channel to the market. They've got probably 100, if not, 1,000x more people than we do in terms of calling on customers and so forth. We've got a very, very strong partnership with them. They're working very, very -- the partnership is going very well. And in fact, you're going to see some data here in just a second. And so we do plan on -- and Neill will talk about the OpEx and so forth as well during his presentation. So we are going to be continuing to grow our own sales force and our own engineering partnership, but there's no aspiration to be like a TI. It's just -- it's too far of a putt.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

And I believe with this collaboration, ABB can also use -- can be used as a kind of multiplier because we have the people being on the front end daily talking to our customers in various area, industrial applications, power, trains. And these people, they're coming back with very interesting ideas. If we could work a little bit in this direction, it would help us there. And in ABB, we are very well aligned and organized in a way that these kind of technology inputs, product inputs, they are going through from one product management down to the product management of the product, let's assume here, semiconductors. And it helps us, first of all, to file our own road map, but also to be able to produce on short term, short notice as well, modules, silicon carbide lean packs. As one example, on 3.3 kilovolts, just for one demonstrator, just right out of our fab, bring it to a customer, install it there, test it out and generate additional market, generate a differentiation because of higher performance, whatever, and create customer value directly out of this value chain. And there, I'm very happy that we can help also Cree in this area as a multiplier with our experts and our direct customer access.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Thank you. We probably have time for one last question. And Jed, I think, is right behind you.

Jonathan Edward Dorsheimer - *Canaccord Genuity Corp., Research Division - MD & Analyst*

Jed Dorsheimer from Canaccord Genuity. I guess -- thank you, by the way, for the perspective. I'm not sure if either of you have read Vaclav Smil's perspective on energy generation. But it's an interesting one, one of energy density. And if we look at the inverse on the efficiency side, silicon carbide and more efficient materials seem to have the same premise. But both of the main -- or in your example, Thomas (sic) [Tobias], of the boat and also in the auto, it's an example of a fixed bucket of electrons and how to manage that more efficiently.

When we look at the grid system, it's so highly inefficient. And I'm wondering, though, because that often seems like a very poor value proposition because it's such cheap generation that's almost infinite. And so how do you get that industry to convert? And then second part is, I didn't hear you mention solar. But on inverters, ABB has a big position there. And so are you looking at that as a beachhead to use silicon carbide to get into that market?

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Okay. Thank you. Let's go to the first part of the question regarding the power industry. You're absolutely right. There is a huge challenge on the cost side as well. What we see there is that EV will be the enabler to use silicon carbide exactly in these areas as well. We have been trying to bring 6.5 kv silicon carbide chips directly into the transmission lines. And based on the volume we have right now, the volume is too low. The costs are too high. The changes you need to do on a converter, especially on the gate unit, they are quite dramatic. They are expensive. No-go at the moment.

But EV, high-volume, very well -- very well known, very well-accepted technology as well. And with this enabling amount, the cost will decrease and we can bring this technology also as well known and well accepted. It's another conservative business as well. It needs to be reliable. We are talking about short downtimes, a few seconds per year. Otherwise, all of us will immediately feel it. And that's exactly the way we see it to go. And we started with the announcement, with the collaboration agreement with Cree as well. A lot of these customers, we have already on our daily visit list. They showed up and said, "Hey, now we need to start to talk about silicon carbide as well." Because it can help from the space perspective, what I said, front performance side. And do not think about -- or do not forget to think about the losses. If you talk about on a 1000-gigawatt high-voltage DC transmission link, if you're talking about 1% losses, it's an incredible high number of losses. And if you can significantly reduce these losses, you also save a lot of money. And that's what is behind there.

On the solar side, right, ABB converters are also in solar. In solar, we see 2 trends. We see 1 trend going for the silicon carbide still -- the silicon one, sorry, or the silicon path; but more and more also converting to silicon carbide. There is even more about the space, especially the remote-located solar generation. It is on houses. It's space-sensitive. Therefore, silicon helps a lot. And the power quality, what is an essential requirement in every power grid as well, connecting many of these remote connected solar inverters, it is very important that you have very good power quality, something like a sinusoidal voltage. And silicon carbide, with the higher switching frequencies and less filtering, it will be the breakthrough there, for sure, especially in weak grids you have in certain countries.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Tobias, thanks for your partnership that we've announced earlier this week, and thanks for taking the time to be with us.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Thank you, Gregg. I have a present. It's the ABB road pack. It is Cree inside, ABB outside. Not in this module because this module -- and as we all know, Switzerland is famous for cheese, chocolate and semiconductors. I would like to hand over one of these road pack to you for the last 30 years, all the learning cycles you have done and [2 of our coming] future the next, I hope, more than 30 years.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Thank you very much, Tobias. Thank you, Tobias.

Tobias Keller - *ABB Ltd - VP of Global Product Management, Semiconductors*

Thank you.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

You know they're passionate about the technology when they want to eat it up, so chocolate. Thank you very much. Really appreciate that.

PRESENTATION

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Well, our next presentation is going to step back now and look at the total amount of pipeline. I'd like to introduce Thomas Wessel to the stage. Thomas joined us actually right around the time of our last conference in February of 2018. Thomas has 28 years of experience in semiconductors. He and I actually worked together in Germany both as sales folks for TI. He worked on automotive during that time. He also has a lot of experience at Analog Devices as well. So please welcome Thomas Wessel, Senior Vice President, Global Sales and Marketing.

Thomas Wessel - *Cree, Inc. - SVP of Global Sales and Marketing*

All right. Thanks, Gregg. Good morning, everybody. So like Gregg said, the last time I was here was actually in February 2018, and I was on in week 2. And it was really exciting like today, I hope you feel the same, hearing my colleagues -- now my colleagues talk about the opportunity that is arising from the transition to silicon carbide from silicon. And I remember telling myself, I hope someone has put in place a process to document, track the opportunities, build a pipeline and tell us how we are doing. Well, guess what? I got that task.

So today, it's my pleasure to talk about the opportunity pipeline and how the opportunity pipeline spans across numerous market segments. I will tell you how the opportunity pipeline developed and what the key drivers are. And then last but not least, I will talk about the sales organization, changes that we were driving, initiatives that we've taken and what resulted in.

But let's start with the focus segments. We talked already quite extensively about automotive, clearly the largest opportunity that we have as a corporation. In communication infrastructure, I think data demands, and in particular, wireless data demands, will continue to grow exponentially. And therefore, our gallium nitride on silicon carbide technology will continue to enable not only 5G but future communication standards. Aerospace and defense is really an early adopter. And if you haven't done so already, please take a look at the marine radar system that we show outside and see firsthand what GaN on silicon carbide does in terms of performance, cost, size, weight to an application like that. Industrial, Cengiz touched on this early on a little bit. This is really the area where we have hundreds of applications and thousands of customers, and it continues to grow. On the energy side, it's really led by solar, but the principles for silicon carbide and power conversion that John Palmour described this morning are applicable to more than just solar to many other forms of renewable energy. Last but not least, on the lighting side, we continue to provide the largest high-performance LED portfolio to the industry. And we focus as a sales organization on those applications where this performance matters and where we get the value for that.

Changing gear to the device opportunity pipeline. You heard Gregg numerous times talk about the $9 billion pipeline that we have today. And just over the last 12 months, we have added $2.9 billion on new opportunities that we identified in automotive. $2.5 billion have been contributed by our broad market team, the geographies. We found also another $1 billion of LED opportunities, and $1.2 billion had been contributed on new opportunities by Arrow. Arrow is the distributor with whom we have an exclusive partnership and exclusive global franchise with them. And I think this is a testament to how well we're progressing with them.

Now how did we do that? Well, easy. We added 1,000 years of semiconductor sales experience. We have -- 82% of our hires customer-facing. It's really important that we reach out to more customers and at a higher frequency. And it's not only done by our own sales organization as you will see later. But it's really important that we understand what are the customer objectives and bring the outside into Cree Wolfspeed to understand what we need to develop to be prepared for the future.

Our FAE team, and I think somebody asked about the technical support, it's 3x of what it used to be and we continue hiring extensively in that field. But this team is critically important to drive and help our customers, support our customers with the transition from silicon to silicon carbide and the adoption of gallium nitride in the RF field.

For automotive and communication infrastructure, we built 2 dedicated teams. We call them the verticals. And what we have here is teams that operate globally. They are applying a very high touch model, sales model to selected -- few selected accounts.

About 9x the resources are now representing Wolfspeed, our own resources in the field through the geographical sales that I mentioned earlier. It's what we do for the broad market coverage. But an important part, and Gregg mentioned it, we will not hire ourselves out of this challenge of being more present in our customers in every place. Part of the objective for this team is to work with Arrow, in particular, to broaden our reach and engage thousands of feet on the street that we get access to through Arrow. And you see here, 50% of our broad market opportunity resides now within Arrow. I think this is another proof point that we are doing remarkably well with this collaboration.

A question that we very often get is, well, how do we have to think about these opportunities, how long does it take? What -- progress, how do you measure that? And I've taken a case study here from automotive that's a real opportunity. And starting at the lower left, it's beginning with

the identification and the documentation in our system of that opportunity. Once it's in there, we call it an NBO, new business opportunity, and we'll track it from cradle to grave.

What follows next is the supplier selection process. And here, we are going through sometimes numerous RFI, RFQ cycles, select vendor elimination rounds. And then finally, we are getting the commitment, the design in, that's what we call the opportunity, once we get the customer commitment. So we win the award and move the opportunity onto the design in.

Now I want to notice at this point, about 50% of our opportunity pipeline is entering this phase in the next 6 to 18 months. After that, we are starting the design and the qualification together with our customer. And in the case of automotive, you go through numerous sample cycles, numerous stages of qualification until you reach the SOP date, the start of production date, and we start calling this opportunity the design win. Now you see the pipeline profile, and this is how the revenue should follow that profile, with the ramp, peak and then the phaseout hopefully many, many years from now.

Now I don't want to leave you with the impression that our pipeline is saturating in the near term and there's no continued growth. So in order to show you that, I have added the next 255 projects that we have in automotive to that. And what you can see is there are a couple of inflection points. 2021, clearly, we are taking off. You see there very few early projects that have a great longevity. You see that the aggregate of these 255 -- and there are more, by the way, that's the limitation of Excel. So you see the 255 get this trajectory. And then from '24 on, you see others are starting to kick on. It's slowing down a little bit, but that will be corrected as we progress. So this is how this pipeline looks. I think another great thing to show you here is that not a single opportunity is dominating, right? It's a really diverse pipeline through many customers and many projects that the team has identified.

So coming back to the $9 billion. What is making this -- or how is this $9 billion built up? Certainly, automotive is almost 50% of our opportunity pipeline, the inverter, onboard charger and DC/DC conversion in the electric vehicle, but there's also lighting applications in there. Communication infrastructure is and will continue to be a key contributor with 5G being at the brink of taking off. Aerospace and defense, it's a great segment for us. It's got long design cycle. It's got longevity. Once you're in, you're in for a very long time, and they truly value performance. Lighting, I said it. We continue to provide the best LED solutions in the industry, and it's a significant contributor to our pipeline as you can see here. And industrial and energy, this is really the segment where you see there's a couple of examples here that's by no means complete. But with us expanding our product portfolio, with the new products that we are releasing, every time we do this, we're expanding the possibilities for us in this industrial and energy market. And I mentioned it before, 50% of this opportunity pipeline will be decided upon in the next 6 to 18 months.

So in summary, why do we win? We win because we capitalize on electrification of the drivetrain and the clear value proposition that you have learned everything you need to know about today. The GaN on silicon carbide solutions that we produce and develop for communication standards like 5G and beyond will enable this next technology in the market and continue to contribute to our pipeline. We're expanding our capacity to scale for future growth. You will hear more about this with the next 2 presenters. And last but not least, we continue to build the sales organization. We continue to build these partnerships with the channel with Arrow, in particular, to grow and win in this global market.

That's the end of my presentation. Thank you very much for your attention.

So the next thing is to invite Rick McFarland and Lisa Fritz on stage. They will be talking about the operational side of things and Lisa about quality. Rick McFarland has served as the Senior Vice President of Global Operations since February 2018. He joined Cree in 2011, and he brings over 25 years of experience from companies like Freescale into Cree Wolfspeed. And Lisa, Lisa's bio was cut off at the bottom. But I remember very well. Lisa joined us, I think, in September 2018. And she comes -- we worked together at TI. She has over 20 years' experience in Texas Instruments among other management roles, she led the quality department there, has great experience in automotive quality and how to work with those customers. And yes, with that said, I want to invite the 2 next presenters to the stage. Thank you very much.

Rick McFarland - *Cree, Inc. - SVP of Global Operations*

Yes. Thank you, Thomas.

Thomas Wessel - *Cree, Inc. - SVP of Global Sales and Marketing*

Thank you.

Rick McFarland - *Cree, Inc. - SVP of Global Operations*

Okay. Well, thank you. Appreciate it, Thomas. That was great. So Lisa and I would like to talk today about how the operations team will enable our capacity, our cost and our quality to allow us to support the large growth that both Thomas and the business leaders have talked about in silicon carbide. And one of the things that is a key enabler of that growth and one that we really are very excited about is our recent announcement to add a new wafer fab in the state of New York. This wafer fab will bring significant capacity and capability to Cree, and it will allow us, and the combination with that capacity and scale, to really -- and also partnering with the Empire State Development to really get to a really competitive wafer cost very quickly.

In addition, a second piece of the strategy that came out of this was, when we announced the new wafer fab, it created an opportunity for us to really repurpose our original factory that we had planned in our Durham campus. This factory was the shell building that is really a nice factory that will fit our requirements in terms of growing our material capacity, and I will give more details on that.

And then finally, Lisa will talk about how from the beginning, as we move forward in adding these capacities, we will do so in a way that enables a right quality culture to be in these factories from the beginning and investing in the tools and the processes necessary. And that will be real critical as we add because the customers we're working with have a really high demand and expectations for quality.

Okay. If you look -- today, we've seen this slide a couple of times in the presentations. And we've made a communication that we intend to spend $720 million net dollars of capital over the next 5 years, investing in our factories' capacities and expansion. And in total, this gives us a 30x increase in our total capacity capability both for the wafer fab as well as the actual materials capacity capability. This 30x increase will come in the form on the wafer fab with that very large-scale factory in Mohawk Valley that we've talked about. This factory will be a very large-scale factory. It will be fully automated. It's an automotive targeted factory. That means we will have the quality requirements and systems in place to support the automotive environment.

When we first started looking at adding capacity into our factories, we were looking at our Durham campus and using this building shell that I discussed. And this factory here that we're talking about, Mohawk Valley, will now give us about a 25% increase in total capacity capability relative to what we were looking at in Durham, so a very large-scale capability we'll be putting in place.

And just to go in a little bit deeper in terms of our overall factory strategies. If you look today, for the Wolfspeed business, we are supporting the majority of the products that we sell today out of what we call our RTP factory. This RTP factory is in the Research Triangle. And if you look at it, it's a fairly small subscale stock-type of factory. To augment that, we have been bringing up and qualifying capacity and capability in our Durham factory that's located on our Durham campus. And again, similar to RTP, it's bigger, but it's still a smaller subscale factory. What's exciting is when we bring online our new Mohawk Valley factory that Gregg has mentioned we are actually breaking ground for this week, when we bring that on, it adds significant capacity capability to us and gives us a great scale to grow our business with.

Why is that important? So the importance of that really is not only to serve the revenue. But if you're looking at how to get cost out of your factory, a critical element of it is to get to that size and capacity and scale necessary to go through the cost learning curves that we want to go through. If you look at the silicon world, silicon has been going through that curve for a very long time. That cost learning curve for them, they are currently at the very bottom of that curve. And if you look at how they change over time, it's in the small percentages year-over-year. Silicon carbide today is really in that very steep portion of the curve. So if you look at it, we're up here today. And as we start adding the capacity, growing our volumes, we will start rapidly coming down that curve. As we get more and more cycles of learning through our processing and learning, we will gain even more efficiency and we'll continue to move down that curve. So it's our expectation that silicon carbide will go through a very similar cost learning curve that silicon has moved through.

Now moving more into the materials space itself. If you look at it today, the entire supply chain for our materials business today comes out of a building complex that we call buildings 1, 5 and 8. And that's up in the top left-hand corner of this image. That factory supplies our world's capability for silicon carbide and is a very large-scale factory. Inside that factory today, there's not only the materials business but our Durham wafer fab. One of the benefits that comes out of us announcing the Mohawk Valley factory is that as we ramp that Mohawk Valley factory and we grow that capacity, we'll be able to close that Durham factory. When we close that factory, we'll be able to repurpose that space. We'll retool it, make it capable of supporting the materials business, and then we can grow for the next several years, continue to grow our materials business in that factory and have a very consolidated, high-growth, high-volume capacity capability for materials beyond that.

But one of the other benefits that we mentioned earlier is that we have a shell of a building on our Durham campus that we call building 21. And that's in the lower right-hand corner of the image. What's interesting about it is that building looks very, very similar to the building 1, 5 and 8 complex. And it does so because we use the exact same basis of design when we designed building 21. And so it makes a very good expansion opportunity to add a second materials factory. So our intention is we will add our second factory in the Durham site for materials. And those combinations of growing the space and filling it out and going to this new space for the materials business in building 21, we'll be able to double our total footprint capability for materials and give us a huge leadership position -- continue to add to our leadership position in terms of total capacity.

So why does all this matter and how does it play out in terms of expansion of this capacity? And what does it mean to the customers we serve? If you look at it today, if we were to take and put silicon carbide into automobiles, out of our wafer fab in the Mohawk Valley, we would be able to support 5.5 million vehicles annually out of that factory or about 5% of the total world's automotive supply. If we looked at the materials, we'd be able to support about 22 million automobiles in silicon carbide or about 20% of the world's automotive run rate. These are huge volumes and capability.

And an important thing to understand, when you're adding capacity, there's really 2 critical elements to it: The first element is the actual facilities or building in itself. And when you're looking at building the facility you're building, it's the longer lead time of the 2. The second element is the equipment capacity. And so what we've done with our strategy is we've defined the longer lead time element of it with the new buildings and the facilities we're putting in place in Mohawk Valley and Durham. And so that will give us the building capacity. And what we're going to do is modulate the equipment capacity to add it over time based upon the demand signals that we see. And as that demand grows, the shorter lead time for equipment, which is typically 6 to 9 months, would give us the runway to say we've got the building, we have the facility, we just need to add the equipment as needed to basically allow our growth to continue.

Now there's a point in time that may come up where we hit that point and we need more capacity. Because today, if you look at it, we will have about 50% of our building capability filled out by 2024. So that seems like a pretty good runway still to continue to grow in those buildings. However, one of the things that keeps occurring is the demand signal we keep seeing continues to grow. So if it occurs that, hey, 2024 is not the time frame, that, that need for more building space pulls in, then we would need about 1 to 3 years to add more building facilities capacity. And if you saw from Thomas' presentation the typical time frame from a design in to volume production is around 2 to 4 years. So we believe that within that 1- to 3-year time frame, we will have the ability to respond and enable more building facility capacity as well in time.

So now I'm going to transition to Lisa and let her give us a quality strategy update.

Lisa Fritz - *Cree, Inc. - VP of Global Quality*

Great. Thanks, Rick, and good morning, everybody. Today, I'd like to share with you our focus on quality at Cree and how we're building that into our culture. So our strategy is to integrate our people, our systems and our culture to drive quality as a competitive advantage. We'll be building out our quality engineering teams with experienced folks such as myself. And as mentioned in my bio and in my introduction, I bring a wealth of experience to Cree across manufacturing, across business and across automotive quality. And I'm working to do the same, build up the same within my teams. We're also investing in our quality systems and processes. And one key highlight there is the state-of-the-art quality management system software package that is actually being installed this month. So I'm very excited about that. And we're advancing our automotive culture through key quality initiatives, which I'll talk a bit more about on the next slide.

So where are we today? So from an industry standard perspective, we're leading the silicon carbide engagement in the industry standards organizations, organizations such as JEDEC. There we chair actually 2 of the key subcommittees: one on silicon carbide power conversion, the other on wide bandgap for RF quality and reliability. Other committees we participate in is the Automotive Electronics Council and the European Power Electronics Council as well.

From a Cree perspective, our businesses and our factories are automotive-certified. I believe we got a question on that earlier from one of our earlier earnings calls. We are certified to the IATF 16949 standard, which is a requirement to do business in automotive, and it's an external certification. We also have deployed industry standard qualification and metrics, and we're continuously auditing and monitoring ourselves for compliance and continual improvement. And our customers are as well. In fact, we average about 1 audit per week, whether it's an internal audit of our ourselves or external certification body or the customers. In fact, many of the customers that we've mentioned already today have been out to audit us, to visit us this year already.

And do we find gaps? I'll admit, yes, we do. Every company does. But that's the purpose of these audits. We make them rigorous. So we find any gaps, big or small, and we fix them with a high degree of urgency.

We are also implementing our key quality initiatives to advance our automotive culture through the investment in the quality management system through 0 defect strategies such as statistical process control, factory defect reduction programs, testing strategies. We're also doing supplier assessments and development with our suppliers, if we find gaps there, and overall customer satisfaction focus.

And then the last slide I have to share with you today is one that I share with our OEMs when I meet with them. And this is a slide that really tells them that we get it. In fact, a few weeks back, we had one of our top German automotive OEMs visiting with us. And when they saw this slide, they said, "Oh, my goodness, you read our mind." And what it's saying is that we understand it's not just about an investment in processes and systems. Those are a key foundational piece. They're very important. But we have to look at the people aspect as well. We have to have the right behaviors with active engagement, the right attitude with a proactive mindset to drive the culture that we must have for automotive. And that is where we will achieve quality as a competitive advantage.

And with that, I'll hand it back to Rick.

Rick McFarland - *Cree, Inc. - SVP of Global Operations*

Okay. Well, thank you, Lisa. And so just in summary, why will we win in operations? The strategy that we've outlined in terms of our manufacturing capacity and capability will really drive the large scale that we need to be able to drive a very competitive cost structure. And then if you combine that with what Lisa is talking about in terms of as from the beginning, as we are building these new factories and these new capacities, that we start with focusing on making certain that our investments are in the people, the processes and the tools necessary to create the right quality environment to allow us to be a 0 defect-focused company.

Okay. So with that, we're going to end our piece of the presentation.

And next, I'd like to introduce Claude Demby. Claude Demby is our Senior Vice President and General Manager of the LED business. And Claude joined us in October of 2014. As part of his joining of Cree, he's held several positions within Cree. He has led and managed our standard chips and materials business, and he's also been the Head of our business development organization before he joined the LED team and led that team. And prior to joining Cree, he was the President and CEO of the Noël Group. And then prior to that, he was actually the President and COO of the L&L Products team.

So with that, please welcome Claude Demby. Thank you.

Claude Z. Demby - *Cree, Inc. - Senior VP & GM of LED Products*

Thanks, Rick and Lisa. Good morning, everybody. As Rick mentioned, I'm Claude Demby and -- Senior Vice President, General Manager for the LED business. And I've been in that role for a little under a year. Exciting time.

Cree LED has built one of the strongest brands -- one of the strongest LED brands in the industry. There's clearly no doubt about that. And our plan is to continue to build on that brand to deliver modest growth in revenue and gross margin expansion in our business.

So how are we thinking about that, how are we planning to do that? First, we're going to continue to deliver the best-in-class high-power technology that the market has to offer, differentiating ourselves from our competitors. You can be very clear about that. Not only are we going to continue to deliver those products, but with our overall culture and innovation and research and development, we're going to continue to develop world-leading product road maps that not only extend our leadership in the high-power space, but also enable us to extend into other segments.

On top of that, we're going to overlay our sales, our global sales and marketing channel to enable us to deliver to our 1,000 customers and beyond those 1,000 customers as we extended into the marketplace.

And then finally, we're going to fundamentally transform the way that we manufacture our products, moving from our legacy base of silicon carbide to sapphire. That will create a more resilient company for our business.

Let's take a closer look at that. First of all, in the $16.4 billion LED market, it matters where you focus. We want to drive towards high-margin end markets where our products are differentiated and valued. So fundamentally, we're going to build on the foundation of high power. We get that. We lead there. We know that. That then, with our continued development on that platform and developing the right product road maps, allow us to extend to more attractive markets that are growing.

So we -- it enables us to -- our foundation enables us to lean into the automotive market, especially where LED adoption is accelerating, where we're able to not only to develop standard products for outside the vehicle, but advanced products that allow the vehicle and the driver to interact with the world around it and create a safer driving experience. Extending that platform, we're also able to take our high-power products and lean into the video segment. Look, the world is a stage and a lot of that show is being played out on video screen, whether it's at One Times Square or Piccadilly Circus or the single hung screen at the new arena in San Francisco, by the way, all powered by Cree.

You know, dependability, reliability, vibrancy is very important in that market. But also what we see is when we develop these product road maps, we see a fundamental way to transform how they assemble those screens, simplifying the supply chain, taking out overall labor cost. Again, how we focused in those markets that allow us to deliver application-optimized solutions that are valued. And then taking that broad-based portfolio and leaning into the specialty markets. Whether it's in portable lighting or horticulture or architectural and entertainment where aesthetic and performance is important. We believe fundamentally that those are attractive markets that value optimized solutions where we definitely believe we can deliver a differentiated value proposition. And we fundamentally enable our focus in those areas by becoming substrate agnostic, moving from our traditional silicon carbide platform to a more cost advantage sapphire platform that creates a more resilient company for us. Look, we no doubt figured out a way with silicon carbide to produce market-leading performing products. And we didn't stop there. Our scientists, 3 or 4 years ago, went on a journey to enable our company even further by making sure we could deliver the same performance leading kind of products on a sapphire substrate that will further enable our cost competitiveness, that will further enable our ability to deliver a differentiated value proposition to the marketplace. So let's take a look at how we think that plays out for us.

First of all, modest growth. Over the forecast horizon, $500 million to $600 million in growth. At the same time, we believe that moving from silicon carbide to a sapphire platform will drive down our overall cost. But something more important happens as well. Sapphire, when we're on the sapphire platform, it enables us to engage in a fabless model. We're able to use worldwide capacity, drive our cost down further and then get a nice bump in our gross margin. So when we look at our gross margin profile from FY '19 to FY '24, we see us going from 28% to the mid-30s over the forecast horizon. And of course, it's been a tough year. Our first quarter margins were, as you can see, 19%. A lot of that has to do with the macro economy and the tariffs and the impact that it's had on our business volume and fundamental plant utilizations. And so our 2000 -- our first quarter '20 number is impacted by utilizations. As that moderates, and we bring on our -- we make the transition from SiC to sapphire and then we make the transition from sapphire to fabless, we're really able to expand our gross margins in a positive way.

I think the key takeaways here is that we improve our profitability by driving silicon carbide to sapphire. We drive our overall cost -- overall average wafer cost down as we move to the fabless model. And then from an overall Cree standpoint, we create a more resilient business. Fundamentally, we have a fabless model in the Cree LED business, while at the same time opening up and creating an opportunity for silicon carbide capacity to be used in the silicon carbide-enabled industries that Wolfspeed is really attacking in our market today. So a really symbiotic relationship from an overall strategy standpoint.

So our plan is pretty simple. Simple doesn't mean always easy to execute, but we think we've got good optics to that. But it's -- our plan is pretty simple. We're going to focus on attractive markets where our best-in-class technology is the only solution, and it's valued. We're going to improve our profitability through the conversion of our silicon carbide to a sapphire substrate, and we'll create a more resilient business by engaging a fabless model over time. So we're pretty excited about what we have in front of us. We can see it very clearly. And it's just about the team going out and executing it. So we're having fun with this.

Okay. All right. At this point, I'd like to introduce you to our CFO, Neill Reynolds. He's been our CFO since August of 2018. He joined us from NXP where he was the Senior Vice President of Finance, Strategy and Procurement. Prior to that, he had 15 years of leadership experience in finance at international technology companies, including GE, where he held various CFO positions in different businesses.

Okay. So I introduce you to Neill.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

Thanks, Claude, for the introduction. Appreciate it. It's great to be here with you today. I had a chance to interact with a lot of you out in the breaks and a lot of great questions and interest in Cree, so we really appreciate that. So what I'll do is, I'll take you through a financial overview. We'll hand it over to Gregg for a few closing comments, and then we'll continue that dialogue during the Q&A.

So what I wanted to do today was -- you heard a lot of information. And I want to kind of narrow that down a bit and give you an overview of the transformation that we're going through right now. And what that means for our financial outlook over the next 5 years. So let me just jump into that.

There's a few key messages that we want you to walk away with. So when you leave today, there's a few key things we want you to walk out that door with. And the first one is the transformation of Cree is accelerating. There's going to be a lot of changes in our markets, there's going to be a lot of changing in the internal company that we have today. But the transition is accelerating and we're still in the very early stages of that transition.

Now because of that, our growth is going to happen in stages. And there's going to be 3 of those. The first one is going to be transform, which means we're going to invest; the second is, we're going to ramp, and we're going to drive the business to scale; and the third is, we're going to execute, and we're going to execute as a fully scaled semiconductor company. All of that's going to result in a target model out in 2024, and that target model is going to result in a high-growth business with strong margins and significant cash flow generation capability. And that growth isn't going to stop in 2024. We expect it to continue beyond that as battery electric vehicles continue to be adopted, 5G and RF deployments continue, and battery -- or sorry, in infrastructure, energy and charging infrastructure continue to adopt. So as those things continue to happen, we'll see growth out beyond 2024.

Now for modeling purposes, given the short-term issues and circumstances with China, we've judged that down in this model to roughly less than -- I think Gregg mentioned it earlier, less than 10% of revenue. If you think about the $9 billion pipeline that Thomas mentioned earlier, roughly 30% of that pipeline is China. So we've judged it down substantially to give a view of how Cree will look with a lower view on China. So with that, let me get into some of the details.

As I said, Cree's transformation is accelerating, and you can see that, you've heard it throughout the day, at the top of this chart. We have developed a $9 billion device pipeline. We've had 4 announcements related to partnerships with various OEMs on the device side, and we've signed long-term agreements in our materials business for roughly $1 billion. And all of that is supported by the bottom of this chart, a $720 million CapEx build for a significant capacity expansion, highlighted by our fab with the partnership with the state of New York in Mohawk Valley the team just talked

about. We've had 2 M&A transactions. We purchased the RF business from Infineon, and in addition, we divested our lighting products business while significantly adding to the leadership at Cree. So while we've made substantial progress, and there's a lot to underpin that, there are still plenty of opportunity in front of us, and this is just preparing us for that.

So what you have here is a snapshot, a snapshot of our transformation roadmap. And you can see various pieces here. If you go up to the top, what that basically says is just a little over a year ago using gross margin dollars as a basis for profitability, most of our business was lighting and LED-focused. And if you fast forward to today, just a little over a year -- a quarter ago, 70% of our profits on a gross margin dollar basis are already part of -- or based on Wolfspeed. And we're able to do that because the lighting business -- we divested of our lighting business, and we took those proceeds and we're reinvesting that back into Wolfspeed. And the reason we do that is the middle of the chart. The markets that Wolfspeed participates in are going to grow substantially between now and 2024. But not just that, the silicon carbide content in those markets will grow 5x. So we've talked about it today in many ways, battery electric vehicles, 5G, charging and energy infrastructure will all make a bigger part because silicon carbide's a better answer for those markets.

So with that, that results in a target model. And that target model that says we can eclipse $2 billion in revenue by 2024. Our EBIT percent will be north of 20%. I'll dive into the details here in a minute. But that's going to be supported by a Wolfspeed business that's still growing at 30% in 2024. We'll have gross margins between 50% and 54%, and the business will be able to generate significant cash flow. So let me take you through those pieces.

From a revenue standpoint, we believe Wolfspeed can achieve $1.5 billion in revenue. And we've used what I would say is a reasonable assumption on battery electric vehicle adoption of about 5%. On top of that, as I mentioned earlier, we've judged down China. So that's the kind of $1.5 billion range. Now I think the question that most of you have is what is the timing of that growth? And I'll talk about that here in a minute, but that's going to happen in stages. Let me just briefly hit on LED. Our assumption on LED is -- and Claude talked about it is low to mid single-digit growth and we'll continue to operate and focus on areas where our customers value our IP.

Now back to Wolfspeed. Wolfspeed is going to happen, or its growth is going to occur in phases. And the first phase is transform. And what that means is, and that's the stage we're in now. That's roughly $500 million to $700 million in revenue. What that means is, we need to identify opportunities like long-term material agreements and device partnerships, and we'll continue to update you on those as we continue to execute in those areas, but it also means we need to invest. We need to invest in capacity, we need to invest in R&D and we need to invest in sales and marketing resources to make sure we're prepared for the opportunity that's in front of us. And that will shift out in the '22 to '23 time frame. We'll hit an inflection point, and that will be aligned with a lot of the ramps we were talking about today on major announcements, which will happen in that kind of time frame, and we'll start to see the inflection point. And we'll start to see improvement in the revenue at a greater rate, up to which point we get to 2024, and we'll see that revenue accelerate as a fully scaled semiconductor company. And then again, as I mentioned, out beyond 2024 as battery electric vehicles go out beyond 5%, and we start to see more adoption of 5G and RF, as well as increases in energy and charging infrastructure.

From a gross margin view, we have an opportunity to improve gross margin in both our Wolfspeed and our LED business. On Wolfspeed side, we have made significant progress on our cost execution programs, and we're going to generate significant scale with our partnership with the state of New York with the Mohawk Valley fab. So both on the material side and cost execution programs and now having a scaled fab up in New York is going to give us a substantial advantage there from what we've had previously.

Moving down to LED, and we talked about it, we'll move to more of a fabless outsourced model, and that's going to do 2 things. One is it's going to lower our cost and to drive the margins up. But the business will no longer be susceptible to the fluctuations and utilization, which is driving our margins down today.

From an OpEx viewpoint, our OpEx is also undergoing a significant transformation. We heard about it again today, we're investing more right now in R&D. And increasing our sales and marketing reach. We're also investing to improve the scale within our G&A functions, we're going to drive through digital transformation. So what you'll see over the period is an increase in the dollars that we'll spend in OpEx. We're going to drive to a more scaled and capable operation on our OpEx side, so we can scale into more profitability to get to roughly a 22% OpEx percent of revenue as we move out to 2024.

Capacity expansion and cash flow. So from a CapEx standpoint, and I've talked to many of you about this, we expect to spend $200 million this year on CapEx. And as we move forward, and we start to invest in capacity and long lead time items like building the factories we talked about, we'll spend more than $200 million over the next couple of years. But as you get out to the 2023 and 2024 time frame, that CapEx bill starts to come down. And the reason for that is we start getting the benefits and some of the incentives and a partnership we have with New York. Now that 2022 and '23 time frame, if you recall the timing of what we think the Wolfspeed ramp will do, that will happen in conjunction with the ramp. So we'll be spending less CapEx as we begin to ramp the business. And you can see the impact of that on the right-hand side of the chart. We expect free cash flow to be negative this year and next year. But as those ramps occur, we start to flip and the business becomes substantially more cash flow accretive as you move into the later years based on those benefits.

Let me just hit one more point here. So the last piece on that is, we have a strong balance sheet. We have over $900 million in cash. We have a convert that's due in 2023, and we're in a net cash position. So we plan to execute this plan with no additional debt funding throughout the period.

So lastly, that leaves us with our target operating model. And as I mentioned earlier, that's north of 2.1 -- roughly $2.1 billion in revenue, but we believe the Wolfspeed growth rate will be north of 30% at this time frame. So as you start to continue out to 2024, the growth rate continues to accelerate and continues to improve. The margins improve substantially, and that's underpinned by Wolfspeed being in the 50% to 54% kind of range. While the OpEx scaled for growth of roughly 22%, and we'll be able to generate free cash flow in about the 20% range while we're growing roughly 30%.

Now there's going to be a couple of areas to watch. I mentioned China earlier. We have judged that down in the model. But again, we have great partnerships, and we have great technology for that market. And we believe if that situation changes, we could have substantial upside in terms of China.

And then the last thing I'll say here is just that, look, there's a number of factory transitions. We often say this to you when we meet with you. Is there -- it's not going to be a straight line. There's going to be a few bumps along the way, we'll manage those. We see those as temporary in nature, and that gives us a lot of confidence to hit the long-term model that we're working on.

So with that, let me just leave you with a couple of last thoughts before I turn it back over to Gregg. Number one is, we see this as a multi-decade growth opportunity and we see that accelerating out beyond 2024. We've got a substantial opportunity in both materials and in devices. So where we don't win in devices, we've got a great shot of making some hay in materials. We've got a great position in technology, with over 30 years of experience and just a ton of learning cycles, and all of that will result in a target model that will have substantial growth, that'll have high margins, as well as generating significant cash flow for the business over the period.

So with that, let me turn it back over to Gregg.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Thank you. Just hang out over there. Just hang out over there. All right. Thanks a lot. So that concludes the presentations. And I'd just like to kind of wrap up with the slide that I showed before, we set out on a strategic direction 1.5 years ago. We're executing on that strategic direction. We fixed and sold the lighting business, we focused the LED business. We've grown the Wolfspeed business and grown the pipeline and so forth. We've got a growing and diversified pipeline. I think Thomas' chart showed it very well, not any single design win impacting it in any kind of a dramatic way. So a significantly growing and a significantly diversified pipeline. We're investing to expand, and you saw that with Lisa and with Rick in terms of the operations. And we're expanding our leading position in this. And again, all of this kind of surrounded based on a foundation of 30 years of experience, a ton of IP and a ton of know-how in what's -- as you saw from John Palmour's presentation, a pretty tricky technology.

With that, I invite Neill to come back up on stage. We'll take questions for the next 30, 40 minutes. We have -- all of the presenters are still here, too, so if you have questions from any -- for anybody, please just let us know. Raise your hand if you have a question, we'll bring a mic to you. If you don't mind just saying who you are and where you're from and then address your question. Thank you. And we've got some mic runners that are running around here.

QUESTIONS AND ANSWERS

Ambrish Srivastava - *BMO Capital Markets Equity Research - MD of Semiconductor Research & Senior Research Analyst*

My name is Ambrish. I'm with BMO. Two questions. One, on the operating model side on the gross margin. So where we are today and the near-term challenges notwithstanding, how do you get to the target model? And what are the big levers? Rick talked about the cost curve that you all are very familiar with on the semi side. But there's pricing pressure also. So just kind of help us understand and how do you give confidence to investors that we get to the target model versus where we are today. And the second question for you, Gregg, you divested the lighting business, but the vision is to create a scaled semiconductor company. I just struggle with how does LED figure into that. And then also on the M&A front, you said that the plan doesn't include any more debt financing. So does that mean that you would be looking at -- you would not be looking at M&A opportunities to bolster that vision to create a semi company?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Let me maybe start with the second question and then we can work to the first one. First off, we're focusing our LED business in areas that are going to be better opportunity for us. We're moving it to a fabless model that will make it more resilient to the normal ups and downs. And really importantly, and Claude mentioned this point, but as we move off of silicon carbide, we're taking the silicon carbide crystal growth machines that are currently focused on LED, and we're transitioning it to Wolfspeed. So we're doing that at the pace that we can do that as it relates to moving off of silicon carbide and on to sapphire. The amount of time it takes us to repurpose a silicon carbide crystal growth machine from LED to Wolfspeed is a couple of weeks. So these are very, very fungible assets, and we're making that transition as we speak. So that's really the core of that transition. As it relates to M&A, we've obviously done M&A already. We've sold a business, we've bought a business. So that can be part of our future. There's no question that it's part -- it can be part of our future. It's not in what we have for the modeling, I guess, is maybe the best way of saying it. So this is sort of an organic plan.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

Yes. And then on the gross margin front, it's a good question. I think one of the things that we need to think about is the business that we're running today, the size of the factories that Rick talked about is very different from what we're going to look like in a couple of years. So there's certainly a scale piece to this that's going to take place. We have an intense amount of focus on our cost down initiatives and we have to have that. And a lot of times, people say, what is your outlook or what does that look like on cost. But by driving down -- particularly on the material side, by driving down those cost curves, we do those types of deals. We offer that kind of pricing discounts as we sign up those long-term agreements and materials. And what that does is it changes the equation on silicon carbide. And as the team pointed out, that makes it a more affordable option for OEMs to use in their vehicles. So the combination of those 2 things, by lining up more long-term agreements, we have better visibility out into the future in terms of what the pricing might be. And we have a better view on not just on our cost down initiatives, but the scale we're going to get on the device side related to driving down costs. So I think the more that we announced initiatives, and I think today that we're saying we're going to be likely within the 50% to 54% range on gross margin on Wolfspeed, there's a lot of that that's under our control. We have a business that we've already won. And we have cost road maps that we have pretty good line of sight to.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Maybe I'll just add a little bit to that on both perspectives, materials and on the fab side of it. From a materials perspective, we obviously have a scale advantage. You saw John Palmour talking about the number of times that the world has gone through cycles of learning on silicon carbide crystal growth, 96.5% of that learning has been done by us. So there's a significant advantage that we have. We've got $1 billion worth of LTAs on materials. We know what prices we have those at. We know what our cost structure is on that. And we've got very good faith in our 50% to 54% gross margin targets on that. So we're pretty good on that. From a wafer and a device perspective, we currently are disadvantaged, quite frankly. We have small fabs that are old and not very efficient from a layout perspective and so forth. Our smallest fab we're moving out of and moving into the derm factory. It's a better fab, it's a better cost position. But even without including the incentives from New York, going to a ballroom

shape, large facility is going to be substantially more efficient. And obviously, you put on top of that the incentives, we're going to be in a really great cost position from a wafer fab perspective.

Yes. I'll just let you guys pick wherever you guys go on. There's a lot of hands going up.

David O'Connor - *Exane BNP Paribas, Research Division - Analyst of IT Hardware and Semiconductors*

It's David O'Connor from Exane BNP. A question about the announcement earlier this week from Soitec, AMAT and Audi who are looking to split the silicon wafers by factor 10 or even more. What's the risk there to the materials business and how do you view that? And then maybe a question on the margins again. Some of the customers that you have presented earlier today, they're at scale and have gross margins in the 40s. How can you have confidence that you can achieve 50% to 53% gross margin when these guys are operating in the power conversion business closer to low to mid-40s?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

We have -- we're in an industry that's at an inflection point. It's transitioning from silicon to silicon carbide. And as you heard from Tobias earlier, and you heard from Jörg on the video and even Jean-Marc, there's a lot of traction in moving to silicon carbide. And any time you have something like that, you have people wanting to get into that business. We have the Soitec announcement that was the other day. Jean-Marc actually talked about Norstel. Infineon has the Siltectra program. ON Semiconductor has been very vocal about its desire to have its own silicon carbide crystal growth capability. So I think it's very natural that people would want to be able to do that. And so we don't have a position that says, no one is allowed to do that. I mean they're going to try. And I think what they're going to find is, it's a lot more difficult than they would anticipate. And so what do we do? The #1 thing we don't do is relax and pretend like if we just do what we keep doing, we're going to maintain that position. We are driving scale up substantially, we're driving our cost down substantially. And talk to Rick during one of the -- during the break or after the session here, we have reviews on cost on silicon carbide all the time. The team has done a remarkable job of hitting those cost objectives and then lowering where we're going to go next quarter or next quarter and so forth. We have very, very good line of sight to continued substantial cost reductions of silicon carbide materials, and that's based on engineering projects that we've got underway. So in other words, we understand what we need to do, we need to put a team on it and drive that cost down. So I feel very, very good about that. So what I would say is, in a market that's growing substantially, you're going to have a lot of people trying to get into that market. John Palmour's presentation should have left you with the impression that this isn't for the faint of heart. This is not an easy market to get into. The technology has grown at unbelievably harsh temperatures, the amount of what you can get, the amount of different things that you can get with the same recipe to 200 different forms of the crystal, one of them is what we want, very, very difficult thing to measure. We build our own machines. This is an industry that takes quite a bit of knowledge. And the fact that 96.5% of the learning has been done by us is pretty helpful.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

Yes. And then on the comp side, I think it's difficult to compare us to a company like a -- that's a lot, I guess, at a higher or bigger scale than we have at this point. We're relatively small at this point in time, and we're growing. Also, our cost structure is different. Gregg just talked about it. We make our own materials, and we do that in a way where we've got very good line of sight to what the margins would be there. The second piece of that, and Gregg talked about it earlier, is on the fab side. I would say right now, we're probably advantaged on the material side just because we make our own wafers. But on the fab side, we're fairly subscale. And the reason we're investing in New York is to kind of catch-up on that side of the house. So once we have a scaled fab and we have a line of sight on our materials business. So the device business on the fab side, we get the benefits on both with the materials business. We got pretty good line of sight to what that would be. So I think a simple comparative to someone else who's more scaled and maybe more mature in certain areas would be -- wouldn't necessarily be the right comp.

Gary Wade Mobley - *Wells Fargo Securities, LLC, Research Division - Senior Analyst*

Gary Mobley with Wells Fargo Securities. I didn't hear a whole lot of mention about the time frame for the transition to 200-millimeter. Is it still your intention to ramp up the Utica facility at 150-millimeter? And could you give a time frame for the 200-millimeter transition and where you stand relative to some of your competitors on the materials side?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. What I would say -- what we've said publicly about that facility is we're building a 200-millimeter line with the notion that if we need to ramp it at 150, it's a lot easier to downscale a line from 200 to 150 than to upscale it with -- from 150 to 200-millimeter. We obviously have a lot of work going on in 200-millimeter. We haven't announced any timing in terms of that. But right now, we're ramping 150 millimeters. So we're building a 200-millimeter factory, downscale it to 150 and convert it over to 200 when that time comes.

Craig Edward Irwin - *Roth Capital Partners, LLC, Research Division - MD & Senior Research Analyst*

Craig Irwin from Roth. So Gregg, when we talk to some of the largest mainstream buyers of IGBTs today, they're not as aggressive about adopting, right? The adopters we're seeing are -- silicon carbide adopters we're seeing are people that have strategic applications where they don't want to miss out on the savings and system on cost and efficiency. But there's a very large market where if you had a second source or comparable chips where these customers could be dual sourced, you would start picking up potentially quite a lot of business. Can you maybe describe for us how this takes shape over the next couple of years, whether or not there are opportunities to share reference designs with partners out there in your ecosystem or maybe even through contract fabs or other avenues?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. Okay. So we do have partnerships across the ecosystem in silicon carbide in the context of things like MOSFET drivers or gate drivers and things like that. We're working with silicon companies that are partnering with us, working with our engineering teams. We have no desire to get into that side of the business. We want to stay focused on compound semiconductors, silicon carbide, gallium nitride and work with some of the better semiconductor companies in silicon to do that sort of stuff. We work with Arrow Electronics as really our sole global supplier of Wolfspeed products. They're putting engineering resources on reference designs and things of that nature as well. They've done a fabulous job for us. You saw over $1 billion worth of design pipeline and really a rapid growth in number of customers reaching those broader folks as well. And so that's really where we're focused on that. We don't have a notion of second sourcing silicon carbide chips to somebody else or anything like that. Our designs are pretty special. If you look at the metrics like RDS(on) and some of the specific performance attributes of our devices, they're pretty good compared to the competition. And we feel like we want to really sell on value.

And then for a runner over here, we've got some folks down here, but I think we have a question right over here.

Jonathan Edward Dorsheimer - *Canaccord Genuity Corp., Research Division - MD & Analyst*

Jed Dorsheimer from Canaccord. Just a follow-up. You had a chart in one of the -- a slide early on that showed the perception of silicon carbide. And I thought it was interesting that in 2018, the OEMs that you -- that you pulled that less than 10% had plans for silicon carbide. And then today, I think it's -- like 70% have planned for silicon carbide by 2024. So I was a little bit surprised with the take in, which you have a fantastic car that's kind of a flagship without a whole lot of price sensitivity that's using IGBTs as the inverter. And so I'm wondering if -- to Craig's question on second sourcing, we'll see tomorrow the cyber truck from Tesla that's introduced that we'll have silicon carbide as its inverter for that. And so that's a company that seems to be more comfortable with the technology. And so do you think it's a function of the sourcing or do you think it's a function of just where we are? Because in a 2-year period of time, we've seen a fairly sea change mindset by the OEMs in terms of the [comfortability]. And I'm guessing that the take in started in terms of that design iteration 5 years ago. Is it kind of a different -- yes.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. Let me address this a little bit, and then I'll invite Kenric up to talk a little bit more about his view of the take rate on silicon carbide. Certainly, a car that's brought to the market today was looking at what to put in it 3, 4 years ago. 3 or 4 years ago, if you were looking at a company like Cree for -- as a potential supplier, the largest business inside of our company was a lighting fixture business. The next largest was an LED business, and the next largest was one we were selling. So we're probably not going to be on the list of folks that they're going to be talking to 4 years ago and so forth. And so I think it's really that. I think the other issue, and this is what Kenric can talk to certainly a lot in terms of some anecdotal points. Four years ago, the supply and demand situation in silicon carbide, there was 0 possibility. A bunch of the OEMs were going to jump on board with that. So it's just a tough putt. So with that, I'll invite Kenric to add a few more words to that.

Kenric Miller - *Cree, Inc. - Automotive VP of Global Sales & Marketing*

Yes. So I think it's a convergence of a lot of things happening at the same time, one, the price of silicon carbide coming down to a price point in the vehicle at a system-level that makes sense. I think our capacity expansion plan was a huge impact to give assurance of supply to OEMs and Tier 1s. And I think it was also just the realization as we put pen to paper, the industry, that in 2022, the market would probably have a tipping point in that it made more sense by that time frame that the inverter should be made with silicon carbide. But actually, the design cycle for that started back, like you said, 5 years ago. And we didn't realize 5 years ago probably where we'd be at and how fast we'd progress on some of the issues that we've addressed. So I think today, as car companies look at starting designs, I think many, many more car companies with a blank sheet of paper are saying silicon carbide is where we're going to go with our inverter. And certainly, Tobias could talk to that. You've heard Jörg talk about it, Delphi, that there's a lot of Tier 1s out there also that are addressing the marketplace with silicon carbide-based inverter solutions now.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Great. Thanks, Kenric. Okay. Other questions?

Ivan Philip Feinseth - *Tigress Financial Partners LLC, Research Division - Director of Research*

Ivan Feinseth, Tigress Financial Partners. As you move to go more fabless, what are the processes that you're doing now that you're going to be moving? Like, what's the timeline? And how do you think that'll improve margins? And also the capital that you have invested in production facilities as you move to become more fabless, what would you do with that?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

So in terms of the LED business moving fabless, there's 2 important pieces. One is the redesigning of the chips to work on sapphire. And so it's moving off of silicon carbide and onto sapphire. We're about halfway through that a little bit. I think, Claude, we're on halfway through that.

Claude Z. Demby - *Cree, Inc. - Senior VP & GM of LED Products*

Right. Yes.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Plus or minus already today. And we've got pretty good line of sight of getting to almost nearly all the way through it over the next 4 quarters. And so that's point number one. And then the second will be then qualifying external suppliers as wafer fabs for our LED business on sapphire-type devices. That will take a little bit of time as well. So think of it as over the next 2 years, there's a transition out of those. And then what happens with the equipment, we repurpose the crystal growers immediately, super straightforward repurposing. And a lot of the -- and Rick, correct me if I'm wrong, but the majority of our wafer fab machines for LED can also be repurposed as well.

Rick McFarland - *Cree, Inc. - SVP of Global Operations*

That's right.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. So we're going to repurpose that equipment as well to work as our Wolfspeed line moves up inside of the Durham factory. Now the repurposing of that is less straightforward in terms of you're out there, build the line to produce and run the Wolfspeed products, same basic equipment but different recipes. That takes a little bit. You have to qualify those products, which is a process as well. And then you have to get those products to customers, where they qualify them. So that's more like a 1- to 2-year type transition as we make that move.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

Yes. Let me just add to that. On the gross margin side then, we talked earlier about -- and this affects both Wolfspeed and LED, the fabs we currently have today are under scaled, and we talked about that. So as we move out, that will actually be a cost advantage. So in LED business, where they're fighting for margin, I think that's going to put them in a better position as we move forward to achieve our margins. And as we said, the impact from utilization will be less as well. So overall, it's a great position for the LED business and also really helps us on the Wolfspeed side.

Ivan Philip Feinseth - *Tigress Financial Partners LLC, Research Division - Director of Research*

Thank you. I thought it was a nicely detailed presentation.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Thank you. Okay. Another question right here.

Colin William Rusch - *Oppenheimer & Co. Inc., Research Division - MD and Senior Analyst*

Colin Rusch from Oppenheimer. As you guys look at your long-term agreements and then the 2024 targets and look at the mix of bare wafers versus epi wafers, can you talk a little bit about how your customers are going to be deciding on what they're going to be taking from you? How much control do you have in that and then both the revenue and the margin profile for the separate businesses?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

We do have with these long-term agreements an agreement on bare wafers and at what percentage of that is going to be epi. And different customers have different appetite for how much epi they want. What I would say is, with most of these agreements, they begin with sort of -- give us a lot of bare and not so much epi because we think we can do epi ourselves. And then it kind of changes a little bit as they realize that epi is a little trickier with silicon carbide than it is with silicon. So we end up with a transition where it's more epi and Cengiz showed that actually, the adoption rate of epi are growing over time. In terms of the long-term model, we baked in what is currently in the plan for these long-term agreements. So the long-term agreements will say, okay, here's the total amount you're going to take. We want this much as bare wafers and we want this much as epi. And so there's potentially some upside if customers take more epi or if they figure out epi themselves, they would stick to what we've got in the agreement.

Colin William Rusch - *Oppenheimer & Co. Inc., Research Division - MD and Senior Analyst*

And how is the margin profile for....

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Margin profile is resilient to that.

Harsh V. Kumar - *Piper Jaffray Companies, Research Division - MD & Senior Research Analyst*

Thanks, first of all, for hosting this. Very informative. Harsh Kumar, Piper Jaffray. What kind of pricing assumptions are you building in? Materials is a decent portion of your Wall Street business in 2024. What kind of price declines are built in for the 6-inch wafer between, let's say, now and call it, '23, '24? And then also, because this is such a small industry and kind of developing now, there's not a lot of good data in terms of what the demand is in, let's say, in thousands of wafers globally or millions of wafers for 6 inches. And would you paint for us the best picture that you can maybe of what is the supply for silicon carbide today versus the demand and how much that gap may be?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Well, first off, on your question on pricing, we're obviously not going to give out specifics on that because we actually sell these products to different customers with different volumes and so forth. What I would say, though, is if you say there's a graph like this and the normal sort of semiconductor cost curves, think of us as more here. We're in more of the early phase of cost reduction. So you're seeing a relatively substantial decrease in the cost of silicon carbide materials driven by improvements in scale, improvements in quality. If you take a look at the amount of wafers we're getting out of each individual crystal grower, it's significantly more today than it was 2 years ago. And we have line of sight to increase that as well. So same amount of material going in, same amount of machine time, a lot more wafers out. The quality coming out of the technology is a lot better as well. And so kind of to the earlier point of others getting into this business, we know that to the extent that we can continue executing on a fairly steep cost reduction curve with the scale that we currently have, it's going to make it a tougher challenge for folks to be chasing us as we're moving down that curve. And we've got good line of sight to what those costs are going to be. And folks that sign up with us for long-term agreements, we give them access to those cost curves. We take, obviously, a little bit for ourselves but we largely give them access to those cost reductions. And so it's a really good win-win benefit.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

Yes. And we have to give them access to those cost reductions. That's what's building the $9 billion pipeline, right? By driving that down and driving that gap between silicon carbide and silicon in terms of cost, then that makes the conversion. It makes that math equation the team showed you the same battery electric vehicles that much easier, and that's what's converting the industry. So by driving those cost curves down, there's a lot of benefits. And by getting a line of sight to that over time, we can start to get an idea of what those margins will look like.

Harsh V. Kumar - *Piper Jaffray Companies, Research Division - MD & Senior Research Analyst*

And the second question was about the industry itself. Any thoughts on where the supply versus the demand imbalance might be? Because I know the price of wafer is over $1,000 right now. So just curious if you have any thoughts there.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

We are expanding our silicon carbide materials capacity 30x between where we started in '17 and 2024. And so -- and you saw Rick talk about if the only thing we do is supply the auto industry, we can supply 20% of the cars becoming electric. So you can think about that and say, okay, we

also have RF, we also have industrial, we also have all this other stuff. There's -- in my view, there's likely going to be a need some time before 2024 to start talking about a further increase in capacity as more cars become electric.

Shek Ming Ho - *Deutsche Bank AG, Research Division - Director & Senior Analyst*

Sidney Ho with Deutsche Bank. First question I have is, you talked about silicon carbide power devices, TAM is about $5 billion by 2024. So that's the largest piece of the 3 businesses. Can you talk about how you complete -- compete in that business, especially given some of the larger customers that -- suppliers that are also your customers in the substrate business?

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. You saw we had Jean-Marc do his video. He's obviously a big customer of ours on materials, and ST, of course, is a competitor of ours on the device side of things. This is just the way it is in silicon carbide. With our position, we are a majority supplier of this technology. You saw from John Palmour's presentation, we've got pretty significant experience in it. And the way I think about it is we're both -- our materials customers and us are both competing against silicon. And what's happening is a transition from silicon to silicon carbide. And that market is expanding very rapidly. And so I think our customers in the silicon carbide wafer business really view that as the opportunity and not so much, well, gee-whiz, Cree's also doing this, and how is that going to work and so forth. I think that's less of an issue. I think they're -- where their bigger focus is, and you're welcome to talk to them about it, obviously, is there is a transitioning happening. And their business is going to need to transition. ST signed their first agreement with us in January of this year, $250 million, 11 months later, have doubled it. So we've got a great partnership with them. And I think collectively, we share the same vision with all of our materials suppliers that the high-voltage power market is moving to silicon carbide. And I think that's the way most people think about it.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

And yes, the market is growing pretty substantially, and we showed that and is growing within silicon carbide. There's nothing I would say that I've seen in looking at the markets and the trends and what we have here in this model that says, certainly, we can achieve these levels that our customers can't win there, too. So there's substantial opportunity for both us and our materials customers.

Shek Ming Ho - *Deutsche Bank AG, Research Division - Director & Senior Analyst*

Great. My follow-up question is maybe a little near term. You've talked about fiscal '19 to '21 being a period of transform. I'm curious why you're not more bullish, maybe not on the electric vehicle side, but more on the 5G infrastructure side. Does that have to do with you judging down the China revenue? Maybe a little update on that side will be great.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

Yes. I think number one is, yes, that's a piece of it. So we've judged it on the China revenue. And I think, obviously, we're not shipping to Huawei right now. So in order to ensure we've got a simple view of things I guess I would say, that's what's kind of mastering that kind of period or gating it, I guess, I would say, to a certain extent. But we should see substantial growth. Now 5G is in bit of a pause right now in terms of spending. When that picks back up, we should participate in that. We feel good about that. And it's going to be really, then again, about the timing of the BEV ramps and how fast our engineering teams can work together to hit certain design cycles. And I think Thomas showed a great chart in terms of the number of opportunities and when those would hit. And we are working feverishly, not just on the opportunities we've announced, but we're looking at other opportunities as well in terms of where we can go execute on that. So there's going to be a number of different pieces that play in here as that time goes on, which is driving a little bit of uncertainty. But as you mentioned, if the China situation changes, then there could be some opportunity there.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Okay. There's a question over here.

Edward Francis Snyder - *Charter Equity Research - MD and Principal Analyst*

Ed Snyder, Charter Equity. I want to maybe focus a little bit more on the demand side. You talked a lot about EV, it's your largest growth prospects, obviously, for the next many years. And you brought this up, maybe this is a question for Kenric, but you start off by saying that the biggest drawback for most EVs is the range issue. If you actually look at load multiplied by range divided by cost, load range factor, it's still very pronounced in the favor of gas cars, especially SUVs, which [are probably] being adopted, I'm sure. But the closest EV that comes to rivaling that, as you point out, were the ATVs, the hybrids, but your content in those is much lower than it would be in BEVs. So I'm trying to get my arms around the idea. First of all, what is in your assumption about growth if the market mix moves even further to hybrids and not BEVs, which tend to be well below the range that most people are looking. And secondly, as you just saw with China, as we know, there's these incentive programs out there that spur adoptions. They have been mildly successful, but if you look at the penetration of EVs into new car sales, it hasn't been spectacular by any stretch. And then many of these are geared to come out of the incentive. China has moved out, all these others. Could you help us understand how your assumptions are affected by value, assuming if these incentive programs all unwind the way they're scheduled to right now, you're still good with these forecasts where it's going to cause some disruption.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. I think in the model, you've got a 5% [BEV] adoption, and I'm pretty sure we're not going to win all of that. So it's a very modest adoption rate of 5% by 2024. Most people think that's a pretty reasonable number. So I think it's pretty modest. What I would tell you, the discussion right now on hybrid in Europe is actually going the opposite direction because what the regulators have found out is that many people don't plug in. And so they're -- they get their hybrid incentive, but they just drive it as a gasoline car. And so that -- I think they're already kind of onto -- this is maybe not doing what we thought in terms of CO2 emissions and so forth. So there's going to be some puts and takes on that. We're not expecting heroic adoption rates of 20% by 2024, something like that. It's 5%. We've got a pipeline of opportunity, we've got some actual wins that are supporting our revenue projection as well. So I think we're feeling quite good about that. And the second thing that I just kind of amplify, Neill's talked about it, we've mentioned it on the earlier thing, it's a substantial judge down of China. We spend a lot of time internally talking about that. And the truth of the matter is, we don't know what's going to happen. So all we know right now is it's depressed and there's trade war and every time somebody sends out something that says a deal is pretty close, it doesn't happen. So I think this tension, the best way for us to think about it is we can't anticipate that it's going to end soon. We hope it's going to end soon, we believe it should end soon. But we can't plan on it ending soon. And so we've just taken a more modest approach to what going to happen there.

Edward Francis Snyder - *Charter Equity Research - MD and Principal Analyst*

Okay. So if I'm keying on 1 factor to try to -- or investors are keying on 1 or 2 factors to try to determine more of the long-term prospects for your EV relative to what we're hearing today, should I be keying on BEV adoptions over hybrids? You say 5%, but that mix is 49 -- 4.999% hybrids, it's going to be a lower market for you than if it's BEV. So I do look at BEVs on the one hand; on the other hand, emission standards. If those don't move, right, we can assume that there's going to have to be some acceleration in whatever incentive programs or subsidies to get there. That's positive for your outlook.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

The math in Europe says increasing adoption of hybrid versus BEV, the math doesn't work. So it just doesn't work. And so I don't see that changing. In the last German election, the highest number of votes went to the green party. Do you think they're going to support changing things? I doubt it. I think more and more people across the globe are worried about global warming, emissions either from a global warming's perspective or just simply a human health perspective. So it could change, maybe, I don't know. But I don't think there's a big sea -- I don't think the -- most of the people would really support something like that. And so -- and then also with battery electric vehicles, there's 1 engine with hybrid. There's 2, it's

more complicated, et cetera. So I think we're not anticipating heroic-type numbers. There could be some changes a little bit this way or that way, but I think it's actually a pretty good line of sight for what we think. The additional thing I'd say, and Thomas talked about it, and of course Tobias talked about it as well, is we're also seeing adoption outside of battery electric vehicles into more industrial-type applications, shipping, trains. We've got customers that are working on solid-state circuit breakers, using silicon carbide way more reliable than a metal switch, grid-type applications and so forth. So I think there's a change in this high-voltage arena from silicon to silicon carbide. Vehicles are certainly a huge part of it. It's 50% of our pipeline right now. But I think there's going to be growing adoption outside of that.

Edward Francis Snyder - *Charter Equity Research - MD and Principal Analyst*

So if I could squeeze one more in. To that point, and this is in your $9 billion opportunity. Obviously, EVs are the largest, but there was other sections. And Cree was born in a way on defense. I mean your funding for Cree was in the defense front because they understood what's going on. And you talked about long gestation periods for cars, which is true, but it's even longer in defense. In all of our research, it looks like you're about to hit an upward trend here because a lot of the systems that took GaN from you initially and took forever to get in there. But you've got like [SPY-6V] and all these big systems come out, but we don't hear a lot about defense. And there's 1 market where the clear advantage of SiC or GaN on SiC and they're pricing sensitive. So should -- are we underestimating it or we don't talk on that much? Should that be something that...

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Let me ask Cengiz to come up and talk just a little bit about that. We are super excited about our position in the mil-aero space. We've got -- or the defense space, we've got a substantial footprint and some really great growth prospects.

Cengiz Balkas - *Wolfspeed, Inc. - SVP & General Manager*

Yes. If you look at our planning, we certainly have those applications in there. As you said, they don't come in at 1 chunk. Over the years, we've definitely put that in our planning, and it will be part of our growth plan for sure, yes, on the GaN side.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

So we agree with you that we've got a lot of design-in activity and actually some very nice growth projections right now for the defense business.

Joseph Amil Osha - *JMP Securities LLC, Research Division - MD & Senior Research Analyst*

Joe Osha from JMP. Two questions. First, looking at that 2024 marker you've put out there in terms of the size of Wolfspeed, wondering if you might be able to comment at least qualitatively on the materials versus device and maybe even within devices, the power versus RF. And then the second question is, listening to talk about China, it's hard to say what's going to happen. But isn't it the case maybe that even if things do ease up a bit here near term, you have to ask yourself whether it's worth ramping back into that market, again, going through all of that hassle when there's perhaps the risk that the rug gets yanked out from you underneath again. Maybe at some point, you say we're just not going to -- we're not going to do this. We have better things to do with our time.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. In terms of -- in between now and 2024, we'll see growth of our power, RF and materials business. In the early phase of that, I think we'll see more rapid growth of our materials business. And that's simply because our partners or our customers in materials have substantially larger channels to market than we do. And so there's going to be a lot of that. So I think the early phase, we'll see materials growth pretty substantial. And then by 2024 -- well, actually, 2022, you heard Jörg talk about it, we'll be ramping up the device wins that we're picking up right now. In terms of China, we've got great relationships with folks. I'll be over there in December meeting with some car manufacturers and some other folks as well. And

they like our products, they like our technology and so forth. And so we're going to continue -- we continue to engage with that market. And I think it makes sense. China is going to be -- or is the largest market for electric vehicles right now, and it's going to be a large and important market in the future. What we're saying today is, we're just saying we just -- with the situation the way it is, we're just being prudent and just saying, let's just take our pipeline and imagine we're going to be in this strained relationship for quite some time and let's judge it down quite a bit. And that's what we've done. So we haven't left China and then we have to come back in. We're still engaged over there, and we're engaged with a lot of folks from a design end perspective. Thomas talked about 30% of the pipeline and so forth. So it's not a matter of that. But it's just a matter of being prudent.

Okay. We got time for 1 more question. We can -- we will have time for one-on-one questions afterwards as well.

Karina Alexandra Byrkjeland Sutija - *Arete Research Services LLP - Analyst*

Karina Sutija from Arete Research in London. I'm just wondering about the sort of transition from LDMOS to again on the base station side. You talked about a $2 billion SAM for GaN. I was just wondering what you're assuming in terms of penetration rate for GaN on 5G base stations. And also, if you can comment a bit on the content side. I mean what type of uptick are you seeing when you move from LDMOS, if you can share anything there.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Yes. Well, we have -- Gerhard Wolf is here with us today. And Gerhard runs our communications infrastructure business. So I'll invite him up to talk just a little bit about that. What I would say as a preface as he's coming up on stage is, there's a significant amount of interest -- net interest and design work that has been done for base stations on gallium nitride and continues to be done.

Gerhard Wolf - *Wolfspeed, Inc. - VP & General Manager of RF Product Line*

My name, again, Gerhard Wolf. So the question was how do I see the transition from LDMOS to gallium nitride applications. So there's mainly 2 trends in the 5G. So one is that the systems go to higher frequencies and going to higher frequencies, the advantage of gallium nitride and silicon carbide increases because the efficiency of gallium nitride on silicon carbide versus LDMOS is significantly better. So at higher frequencies, those advantages really increase. So therefore, in that transition to higher frequencies, we see gallium nitride and silicon carbide being benefiting. The second one is that the operating advantages at wider frequencies, at wider bands is better on gallium nitride and silicon carbide. And with the need of more bandwidth through the systems, making more efficient use of the spectrum the operators have, also gallium nitride and silicon carbide is benefiting. And therefore, with those trends towards 5G, more data, more bandwidth use, as well as to higher frequencies, the need for gallium nitride and silicon carbide is increasing, and we're seeing that trend in all the design work.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

[Feel I'm done]. All right. So that's all the time we have for Q&A. We have time for individual...

Unidentified Company Representative

Outside though.

Gregg A. Lowe - *Cree, Inc. - President, CEO & Director*

Outside. So we're going to step outside. We'll have some question-and-answer for you outside if you have some more questions.

Thank you very much for your time today.

Neill P. Reynolds - *Cree, Inc. - Executive VP & CFO*

Thank you.