S. HRG. 117–837

DEVELOPING NEXT GENERATION TECHNOLOGY FOR INNOVATION

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED SEVENTEENTH CONGRESS

SECOND SESSION

MARCH 23, 2022

Printed for the use of the Committee on Commerce, Science, and Transportation

Available online: http://www.govinfo.gov

U.S. GOVERNMENT PUBLISHING OFFICE
54–772 PDF WASHINGTON : 2024

SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED SEVENTEENTH CONGRESS

SECOND SESSION

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DEVELOPING NEXT GENERATION TECHNOLOGY FOR INNOVATION

WEDNESDAY, MARCH 23, 2022

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10:03 a.m., in room SR–253, Russell Senate Office Building, Hon. Maria Cantwell, Chairwoman of the Committee, presiding.

Present: Senators Cantwell [presiding], Klobuchar, Markey, Peters, Baldwin, Tester, Sinema, Rosen, Hickenlooper, Warnock, Wicker, Thune, Moran, Young, Johnson, and Scott.

Also present: Senator Wyden.

OPENING STATEMENT OF HON. MARIA CANTWELL, U.S. SENATOR FROM WASHINGTON

The CHAIR. The Senate Committee on Commerce, Science, and Transportation will come to order. We are here this morning to talk about "Developing Next Generation Technology for Innovation." We are joined by a distinguished panel of manufacturers, and people who use this product as a critical part of our supply chain, and we welcome all of them who are with us today.

One witness joining us virtually from PACCAR, Mr. Preston Feight, and we very much appreciate him being able to join us. We are also going to be joined by one of our colleagues who wishes to make a statement. And I will allow him to do that following Senator Wicker and I.

The semiconductor industry is definitely a uniquely American story. It has shown the importance of innovation and building in the United States. The first transistor was demonstrated in New Jersey in 1947. In 1958, Jack Kilby, a Missourian working at Texas Instruments, attended college on the GI Bill, and demonstrated the first integrated circuit.

The semiconductor industry, with the benefit of Federal purchasing power, and Federal R&D, helped us to get to the Moon, it has helped us build our security leadership, and has launched the Information Age economy.

So I am pleased that the United States has played such a leadership role. But when it comes to manufacturing today, here in the United States, we are falling behind. Semiconductors underpin nearly every aspect of our national and economic security, and yet we are short on the amount of advanced logic chips building at scale here in the United States of America. That has to change.

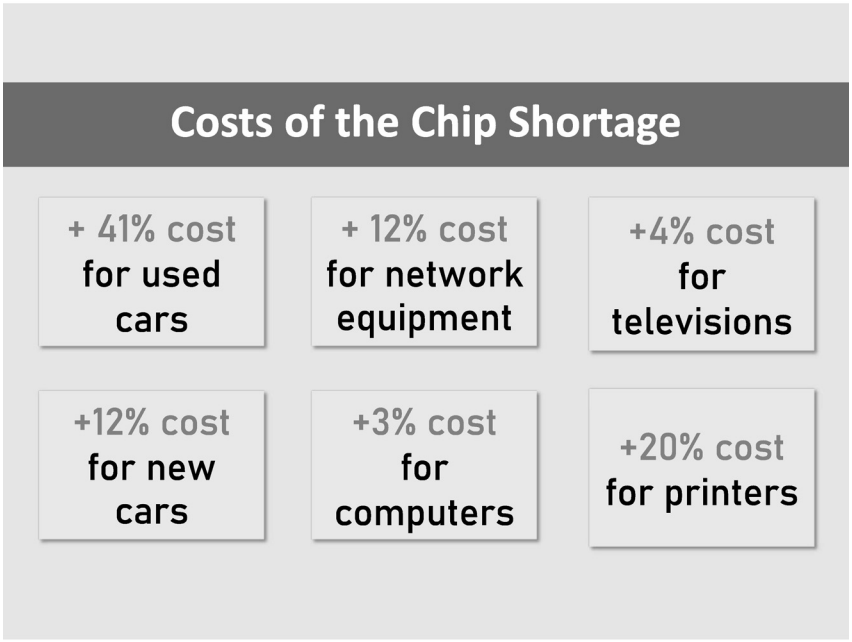
In fact, over 90 percent of the most advanced chips come from one island in the Pacific Ocean, Taiwan. I believe in global trade, but I also believe that chip security is as important as food security. That is why we need to continue to demonstrate leadership, and make investments in R&D, as the USICA Bill, that this committee worked so hard to get out last year, showed.

Our over-reliance on vulnerable global supply chains, without having a U.S. alternative ready to go, is an economic and national security risk. It is a lesson we have already learned and we need to change directions.

With the automotive sector, thousands of Americans have worked and endured layoffs and shortages. The global automotive industry suffered over $200 billion in losses, and Ford was forced to halt or cut production at least eight plants of recent months.

The cost of a used car: I wanted to show this chart. The cost of a used car—I don't know where you could show that, sorry.

[The information referred to follows:]



The CHAIR. The cost of a used car has gone up 41 percent, and new cars 12 percent, a lot of this is due to the semiconductor shortage. Let me repeat that. The cost of a used car has gone up 40 percent.

Now, why would that be? Used cars already have the electronics. It is because if you want to buy a new car right now you are probably going to have to wait because the car companies don't have enough semiconductors.

People who can easily afford a new car, and need one but can't get one due to the shortage, are instead buying the used cars, and

that is driving up the price. So anyone knows that the people who can afford to wait the extra 6 months for the new car probably aren't the people who are really feeling the pain.

It is the person whose radiator blew out last week and just needs anything on four wheels to get them to their job. And that is a basic used car that might have gone up $5,000 in costs, an additional 41 percent. And an extra $2,000 taking that to $7,000 is just a trip the family doesn't get to take, or maybe next month's rent that can't get paid. So the impacts of this are really affecting American consumers.

Our national security front, EUROPOL just reported this month that counterfeiters are trying to exploit the semiconductor shortage by introducing fake chips into the market, raising the chances that critical infrastructure and defense systems could be compromised. The shortage is also a setback for our efforts to remove foreign telecommunications electronics that could be compromised by backdoors from other governments.

According to the telecommunications industry, wait times for some networking equipment is now at 50 weeks. The cost of some networking equipment has risen 12 percent, and price gougers are selling chips for a hundred times their regular price. That is no way to build out the access to our broadband.

In addition, we know that relying heavily on one country, and largely one company creates a lot of targets for hackers. Eighteen months ago, security researchers found hacking campaigns that compromised at least seven Taiwanese chip manufacturers to steal semiconductor chip designs.

All of these are reasons why we need to get USICA done, and make sure that we get to conference with our colleagues. These bills have $2 billion investments specifically for our Department of Defense, to secure the microelectronics supply chain required for our national security missions.

The shortages that we have today, if we don't address them, are going to continue well into the future. That is because the world needs one trillion chips to be produced, actually that was in 2018, in 2021 we need 1.2 trillion chips basically produced every year. In 2031, that will be 2 trillion chips per year.

So our current foundries are already working overtime. Building new foundries has to be part of the long-term solution, and we need to send that price signal today. If we do nothing, these shortages are just an example of what is to come. I know we are going to hear from PACCAR who is going to tell us about how every aspect of freight is being affected, even if it is not a high-tech product, if you don't have trucks to move the products in our supply chain, because you don't have enough trucks, then we are affecting every aspect of the supply chain.

So clearly we are here to talk about the next generation of chips, and how the United States keeps its leadership in advanced manufacturing.

That is why, Mr. Archer, we are obviously going to hear from you as well on lithography, and how important it is for the United States to stay ahead.

But we are so happy to be joined by the witnesses today. It is 288 days since the Senate passed this USICA Bill. It is now time

for us not to wait another day, but to get this done, and keep America's leadership going in the right direction.

With that, I turn to my Ranking Member, Senator Wicker.

STATEMENT OF HON. ROGER WICKER,
U.S. SENATOR FROM MISSISSIPPI

Senator WICKER. Here, here. Thank you, Madam Chair. And good morning. Today's hearing on semiconductors could not be more opportune, and I dare say there is not a more important hearing anywhere on Capitol Hill this morning.

The COVID–19 pandemic exposed the fragility of the supply chains we depend on for public health, national security, and economic prosperity. Semiconductors are the life blood of modern industrial production, and the chip shortage over the past two years has caused and made worse many of our supply chain disruptions.

Today's witnesses play key roles in the broader semiconductor ecosystem, which includes equipment manufacturers, chip producers, and industries that consume large quantities of chips.

I would like to extend a special welcome across the sea to Preston Feight, CEO of PACCAR, a company that is very important to Senator Cantwell and me. For over a decade the PACCAR facility in Columbus, Mississippi, has produced hundreds of thousands of world-class engines for heavy trucks, and provided good-paying jobs for a talented and motivated workforce.

I hope Mr. Feight and our other witnesses can give the Committee a sense of the impacts posed by the chip shortage on their businesses, their workers, and America's global competitiveness. Although semiconductors have become vastly more important to global commerce, the United States has, for decades, neglected the industry. America's share of global semiconductor manufacturing has fallen from nearly 40 percent in 1990, to about 12 percent today.

Foreign governments, including China, seized on the lack of U.S. leadership in this area, and, as a result, we are now entirely dependent on foreign production of the most cutting-edge chip technology. Chip production, R&D, innovation, and high-paying jobs all went overseas, leaving us dangerously exposed.

The Committee would benefit from our witnesses' perspectives on how we got to this situation, and specifically, why other countries have displaced the United States as the center of gravity in semiconductors. The good news is that Congress has an opportunity to restore American leadership in semiconductors, in both the short and long run.

I am hopeful that the House and Senate leaders will soon come together in conference committee to reconcile the differences between the Senate-passed U.S. Innovation and Competition Act, USICA, and the House-passed America COMPETES Act. Both bills include the CHIPS Act, which would provide tens of billions of dollars to incentivize domestic chip manufacturing, stabilize the semiconductor supply chain, and make long-term investments in R&D.

For our part, Senator Cantwell and I helped shepherd USICA to passage in the Senate by a 68 to 32 vote last summer. We are ready to go, and as the Chair indicated, I am confident that a fair conference process will produce landmark legislation to keep Amer-

ica ahead of the pack in R&D and innovation. I would also ask our witnesses to comment on the importance of the CHIPS Act and what it would mean for their businesses.

Vladimir Putin's illegal war on Ukraine has shown what can happen when we rely on dictators to maintain economic stability. Russia's criminal war of aggression has exposed long-term dependencies, and sent the prices for gas, wheat, and industrial metals soaring.

Unfortunately, Russia is not the only strategic competitor with designs on other countries. China has also demonstrated aggressive behavior toward Taiwan, and stated its intent to challenge Taiwan's sovereignty and independence. Taiwan now accounts for 92 percent of the world's most advanced semiconductor manufacturing capacity.

Think of the consequences if China were to invade our Taiwanese partner. Let us keep that scenario in mind, as Congress continues its critical work of restoring American leadership in this vital industry.

Thank you, Senator Cantwell.

The CHAIR. Thank you, Senator Wicker. I also agree with your statement, so you and I are on the same page, and hopefully we are going to get our colleagues on the same page.

We have been joined by the Chairman of the Finance Committee, Senator Wyden, who has played a leadership role in CHIP legislation, and is here to introduce one of our witnesses.

Senator Wyden, welcome to the Commerce Committee, a committee that you served on for quite some time, but still keep very close tabs on you, and you keep very close tabs on us, particularly when it comes to privacy legislation. So thank you for being here.

STATEMENT OF HON. RON WYDEN,
U.S. SENATOR FROM OREGON

Senator WYDEN. Thank you, Chair Cantwell, and Ranking Member Wicker, both for your important remarks, and for the chance to be able to introduce the CEO of Intel, Mr. Pat Gelsinger.

And as Senator Cantwell noted, I am a proud alum of the Commerce Committee. And Senator Wicker, I also recall that brevity is appreciated for the cause. And I will be brief.

It has been nearly 50 years since Intel's first investment in my home state of Oregon, and the company Pat Gelsinger leads is now my home state's largest private employer, upwards of 20,000 Oregonians work at Intel. These colleagues are good-paying jobs that not only add to our state's economic vibrancy, they help to keep Oregon and our country at the forefront of tech leadership around the world.

A little over a year ago, Pat returned to Intel where he spent three decades earlier in his career. He and I have had many discussions about what chip manufacturing means to Oregon, and the entire country.

From the time the typical American gets up in the morning, to when they go to bed at night, and sometimes even while they are sleeping, they interact with thousands of semiconductors. Congress is finally waking up to the fact that computer chips are the beating heart of the 21st century economy. The pandemic era breakdowns

in semiconductor supply chains made it very clear how essential chips are to the health of our economy and our everyday lives.

With that understanding, there is a big bipartisan interest in supporting a domestic, a vibrant domestic chip manufacturing sector. Under Pat's leadership, Intel is stepping up. Intel has committed to continued investments in Oregon, and committed to putting billions of dollars of their money to build new manufacturing capacity in the United States.

Now, as you both have noted, the Congress has got to step up, and do its part to launch America's chip manufacturing revival. There is a big opportunity ahead of us to build a more resilient economy and create many thousands of high skill, high-wage jobs in our country. Pat and his team at Intel are going to be at the forefront of the effort.

Let me close with this. If Congress fails to do its part, you both have made it clear, our country is going to pay dearly. That is why failure here is unacceptable, and it is important to recognize that this is the beginning of a much larger effort.

Everybody up here has got a busy schedule, so thank you for giving me the chance to introduce Pat Gelsinger, CEO of Oregon's largest private employer. And I appreciate the chance that he will have to describe what his company's work is all about, and why it is so critical to my home state of Oregon, and our country's economic future.

The CHAIR. Thank you, Senator Wyden. And again, we know how busy everybody's schedule is today. We appreciate it, and I am sure our witnesses do, and particularly Mr. Gelsinger.

So with that, Mr. Gelsinger, please start us off.

STATEMENT OF PAT GELSINGER, CHIEF EXECUTIVE OFFICER, INTEL CORPORATION

Mr. GELSINGER. Thank you. And good morning, Chair Cantwell, Ranking Member Wicker; and Senator Wyden, thank you for that most kind introduction; and to the members of the Committee, thank you for the opportunity to speak with you today, and for your support for funding the CHIPS for America Act.

Every aspect of human existence is becoming digital, and everything digital runs on semiconductors. We provided you samples of some show and tell, right. You know, our most-advanced, high performance computing components. The latest generation of 7 nanometer server, and client products, and the first-ever samples of our 4 nanometer next-generation client product as well.

This is what we are talking about today. The most advanced components on Earth. Semiconductors are the foundation for technologies, including artificial intelligence, 5G, autonomous vehicles, and IoT. Our economic and national security are dependent on semiconductors, digital transformation has led to unprecedented demand for chips, made more acute by the COVID pandemic, and disruptions in our global supply chain.

The chip shortage cost the U.S. economy $240 billion last year. We now expect the shortage will continue into at least 2024. America showed leadership when Congress passed the CHIPS Act, but the situation has grown even more serious since then, and the supply chain shortage is truly global.

While the EU began its work on their CHIPS Act, a year later than Congress, I am expecting EU funding will be made available this year. Similarly, other governments are aggressively offering significant incentives to semiconductor companies like ours, to build fabs on their shores.

Senators, we must look beyond short-term capacity, and recognize what U.S. chip leadership truly entails, with four areas of focus: Incentivize manufacturing on U.S. soil. Second, supercharge research and development. Third, address the skills gap. And fourth, enhance our national defense.

When it comes to manufacturing, the world needs geographically-balanced resilient supply chains. In 1990, 80 percent of semiconductors were built in the U.S. and Europe. Today 80 percent is in Asia, with only 12 percent in the U.S., and half of that being Intel.

Asian countries moved aggressively to attract this industry with strong incentives sent to policies. As a result the operating cost to manufacture in East Asia is 30 to 50 percent cheaper compared to the U.S. This is particularly significant for an investment of this scale. A modern, advanced, semiconductor fab costs $10 billion to build and equip.

Global semiconductor demand is projected to double by the end of the decade to $1 trillion. Currently only the United States, South Korea, and Taiwan can manufacture the leading-edge chips that power everything from your computer, to the Joint Strike Fighter.

For our entire 53-year history as a company, we have performed the majority of our R&D and manufacturing in the U.S. We have put our chips on the table to help the U.S. regain process technology and manufacturing leadership. In the last year alone, Intel has announced over $43 billion of U.S. manufacturing investments with expansions in New Mexico, two new fabs in Arizona, and our landmark Ohio investment.

Our initial hub in Ohio will establish the first advanced semiconductor in the Midwest. From the company that help create Silicon Valley, we are now creating the Silicon Heartland.

At full build out, assuming we receive support from the CHIPS Act, the total investment from this site could grow to as much as $100 billion over the next decade. We have also thrown our factory doors open wide to provide capacity for U.S. and global foundry companies. We seek rebuild the entire supply chain on U.S. soil.

Intel is one of the world's top R&D spenders. In 2021 we invested more than $15 billion in R&D. Intel strongly supports the creation of the National Semiconductor Technology Center, or NSTC, and the National Advanced Packaging Manufacturing Program, through the CHIPS Act.

I also implore Congress to restore the ability to fully deduct R&D expenses, a policy that has been in place for decades. These research partnerships and the restored R&D deduction will continue to drive a lab-to-fab pipeline. Our workforce consists of well-paying jobs across the spectrum of construction, skilled manufacturing and research. Increasing access to STEM education is essential for building a talented, diverse pipeline of future technologists.

Intel detailed just last week our plans to invest $100 million over the next decade, in partnership with community colleges, universities, and the U.S. NSF.

Last, building up of U.S. commercial capacity is essential for defense and national security. We seek to have vibrant world-leading commercial capacity that could be leveraged for the additional requirements of defense and intelligence. Further, we encourage a strong and increasing partnership with the EU to meet our mutual global needs. Almost all of the critical technologies and semiconductor equipment and manufacturing, are in the U.S. or in the EU.

I want to thank you for this opportunity to testify today, for the Committee's support of the CHIPS Act. We are slated to break ground in Ohio this year. I challenge Congress to find a path forward on CHIPS Act funding before then. I want to go bigger and faster.

Thank you very much. I look forward to your questions.

[The prepared statement of Mr. Gelsinger follows:]

PREPARED STATEMENT OF PAT GELSINGER, CHIEF EXECUTIVE OFFICER, INTEL CORPORATION

Chair Cantwell, Ranking Member Wicker, and members of the Committee, thank you for inviting me to testify to share my perspective on the importance of advanced semiconductor manufacturing, research and development (R&D), and workforce in the United States, and the urgent need to fund the *CHIPS for America Act* (CHIPS Act). I am the Chief Executive Officer of Intel Corporation, a global leader in semiconductor technology and manufacturing, and the only U.S. semiconductor company with the depth and breadth of intelligent silicon, platform, software, architecture, design, manufacturing, packaging, and scale, as well as innovation and leading-edge manufacturing capabilities here in the United States. There is an urgent need for the Federal government to incentivize more private sector investment in the United States to enable a resilient and innovative semiconductor ecosystem, and I thank the Chair and Ranking Member, along with Senators Schumer, Cornyn, and Young, for their support in advancing legislation to fund the CHIPS Act.

Background

Intel Corporation is one of the world's largest semiconductor manufacturers, employing over 120,000 people globally, including over 55,000 in the United States. We are headquartered in Santa Clara, California, and have manufacturing and R&D facilities in Oregon, Arizona, California, New Mexico, Texas, Massachusetts, and—once construction is complete—in Ohio. Intel is the top employer and a major part of the community in every city where we manufacture:

- *In California,* our total annual economic impact is approximately $24.9 billion, based on 2019 data. We have donated nearly $90 million to support California schools and nonprofits and we employ nearly 14,600 full time equivalents (FTEs) as of January 2020.
- *In Oregon,* our total annual economic impact is approximately $19.3 billion, based on 2019 data. We are Oregon's largest corporate employer with nearly 21,000 FTEs as of January 2021, and we've also invested more than $49 billion ain capital to support our operations in the state.
- *In Arizona,* our annual economic impact is approximately $8.6 billion, based on 2019 data. We've invested more than $23 billion in capital to support our operations in the state and we employ nearly 12,000 FTEs there as of January 2021.
- *In New Mexico,* our annual economic impact in New Mexico is approximately $1.2 billion, based on 2019 data. We've also invested more than $16.3 billion in capital to support our operations in the state and employ approximately 1,800 FTEs there.
- *In Texas,* as of February 2021, close to 1,800 FTEs support innovations in cloud computing, Internet of Things, 5G connectivity, memory and programmable solutions.
- *In Massachusetts,* as of February 2021, the 900 FTEs at our research and development center are focused on advanced semiconductor technology, embedding

intelligence in the cloud, network, edge, and myriad computing devices to transform business and society.

Intel is one of only three semiconductor manufacturers in the world making advanced logic chips and the only one with the majority of its R&D and intellectual property in the United States. As an integrated device manufacturer (IDM), Intel is the only company in the United States that can do both leading-edge design and manufacturing in-house. This capability has been foundational to our success, enabling product optimization, improved economics, and supply chain resilience. The semiconductor products that Intel manufactures provide the foundations for technologies ranging from personal computing, cloud computing, artificial intelligence (AI), Internet of Things (IoT), 5G, autonomous vehicles, quantum computing, to high-performance-computing.

Intel ranks sixth among publicly-traded U.S. companies in its individual R&D investment,[1] investing $18.7 billion in capital expenditures and $15.2 billion in R&D in 2021.[2] Overall, Intel directly contributed almost $26 billion to U.S. Gross Domestic Product (GDP) in 2019, with a total GDP impact to the U.S. economy of $102 billion.

Manufacturing at Intel

Intel is making unprecedented new investments in U.S. semiconductor manufacturing capacity. In the last 12 months alone, we have announced investments of $43.5 billion for the construction of new semiconductor fabrication facilities in Ohio and Arizona, and for the manufacturing of advanced semiconductor packaging technologies in New Mexico.[3] This follows our recently completed $3 billion investment to expand our operations in Oregon.

Our most recent U.S. announcement in Ohio amounts to a $20 billion investment in a new greenfield manufacturing site in Licking County, which will result in two new mega fabs with the first one coming online by the end of 2025. A full build-out could grow to eight mega fabs and $100 billion over the next decade, assuming support from the CHIPS Act. The manufacturing operations at the Ohio site will produce chips with our most advanced transistor technologies. In addition to more than 7,000 construction jobs, the fabs are expected to create 3,000 high-paying, long-term Intel manufacturing and engineering jobs ranging from factory operators and equipment technicians to engineers and business support functions, many of which do not require a 4-year college or advanced degree.

Technology Development at Intel

More than fifty years ago, Intel invented the world's first commercial microprocessor. We have led in process technology for more than four decades until recently, and developed all major logic process innovations that the semiconductor industry uses (*i.e.,* strained silicon, Hi-K metal gate, 3D transistors). Intel is executing a plan to recapture the global leadership in process technology by 2025.

Today, Intel's technology roadmap relies on new levels of innovation, including not only deep transistor-level enhancements, but also innovations all the way up the stack to the interconnect and standard cell level. The company has moved to an accelerated pace of innovation to enable an annual cadence of process improvements. Earlier this year, I unveiled one of the most detailed process technology roadmaps that Intel has ever provided, showcasing a new node naming system and breakthrough technologies including:

- *RibbonFET,* our first new transistor architecture in more than a decade
- *PowerVia,* an industry-first new backside power delivery method
- *High NA EUV,* our plans to adapt next-generation High Numerical Aperture extreme ultraviolet lithography

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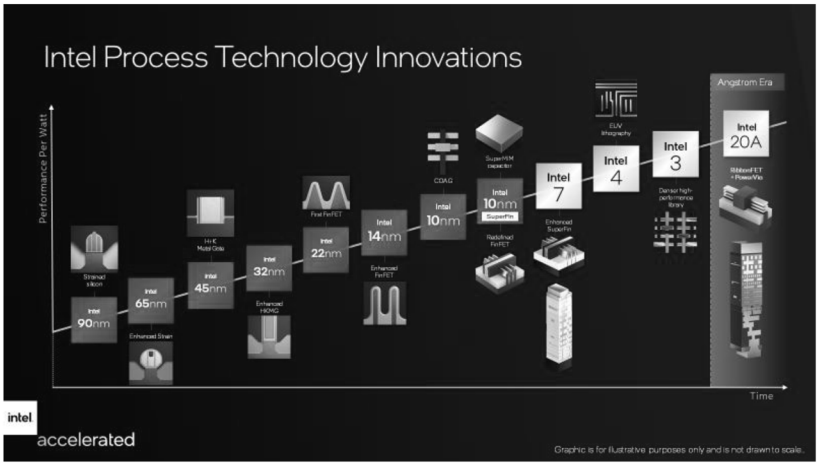
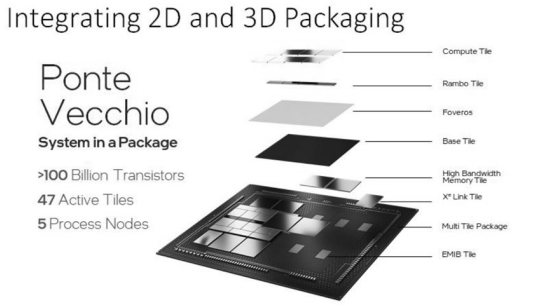
[1] "Intel's Impacts on the U.S. Economy", Report Issued April 2021, using data for FY 2019, available at *https://www.intel.com/content/www/us/en/newsroom/news/us-economic-impact-study.html?wapkw=economic%20impact#gs.tptln6.*

[2] Intel Corporation Annual 10–K for Fiscal Year Ending December 25, 2021, available at *https://www.intc.com/filings-reports/all-sec-filings/content/0000050863-22-000007/0000050863-22-000007.pdf*

[3] See Intel Press Releases available at *https://www.intel.com/content/www/us/en/newsroom/news/intelannounces-next-us-site-landmark-investment-ohio.html; https://www.intc.com/news-events/press-releases/detail/1501/intel-breaks-groundon-two-new-leading-edge-chip-factories; https://www.intel.com/content/www/us/en/newsroom/news/new-mexico-manufacturing.html.*



Technology advances in electronic packaging have supported and sustained Moore's Law silicon scaling and have evolved to become an important enabler of product performance. Intel is a leader in heterogenous integration technology. Our Foveros advanced packaging technology uses 3D stacking to enable logic-on-logic integration, and when combined with our Embedded Multi-die Interconnect Bridge (EMIB) technologies, allows for the interconnection of different chiplets and tiles with essentially the performance of a single chip.



Intel's Ponte Vecchio, a product targeted for Argonne National Laboratory's exascale Aurora Supercomputer, represents the current state of the art in packaging.

Workforce at Intel

Our industry supports a large and vibrant workforce. Each of the new leading-edge fabs we are building in the United States supports approximately 1,500 permanent Intel jobs, in addition to the many thousands of construction jobs created by these projects. And for each permanent Intel job we create, our operations indirectly support an additional 13 jobs among suppliers and partners in the semiconductor ecosystem. More broadly, the U.S. semiconductor industry directly supports 250,000 jobs, indirectly supports another one million jobs, and supplies digital infrastructure to countless employers across the country.

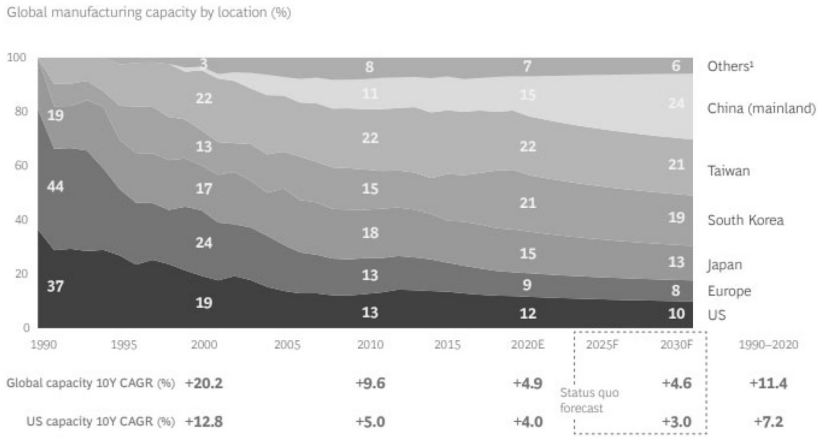
Last week, Intel announced two new initiatives that together will invest $150 million into semiconductor-related research, education, and workforce development programs in two-and four-year institutions across the country.

- Intel announced a new 10-year, *$100 million national partnership with the National Science Foundation (NSF)*[4] to expand semiconductor-related education

[4] See "Media Alert: Intel Launches Education and Research Initiatives for Ohio, US," Mar 17, 2022, *https://www.intel.com/content/www/us/en/newsroom/news/media-alert-intel-launches-education-initiatives.html#gs.ty6ba3*

and research programs. Intel is committing $50 million to this initiative, with $50 million in matching funds from NSF. Funds will be used to create new curricula for associate and undergraduate degrees, certification programs, and reskill and upskill programs for existing workers, as well as to support faculty training, laboratory equipment, and research supporting semiconductor design and fabrication.

- To support the new Silicon Heartland in Ohio, Intel is also investing *$50 million directly into Ohio institutions* over the next 10 years. This investment will fund various programs, including the *Intel Semiconductor Education and Research Program for Ohio,* a collaborative, multi-institution program designed to improve semiconductor innovation and provide real-world experience to students.



Sources: VLSI Research projection; SEMI second-quarter 2020 update; BCG analysis.

Note: All values shown in 8" equivalents; excludes capacity below 5 kwpm or less than 8".

[1] Includes Israel, Singapore, and the rest of the world.

Two weeks ago, Intel also announced a new "*Quick Start*" accelerated workforce development program with Arizona community colleges to train and retrain workers as semiconductor technicians.[5] These and other initiatives build on the work Intel has been doing for years to promote cutting-edge research and prepare students for the industry, such as with local community colleges to develop and maintain microelectronics technology programs for semiconductor technicians. Through partnerships with NSF, Intel regularly funds education and research programs with colleges and universities across the country. And Intel funds numerous efforts like the *Million Girls Moonshot (MGM)* program[6] to expand outreach to, and participation by, traditionally underrepresented groups, including underrepresented minority groups and women and girls.

State of U.S. Semiconductor Manufacturing

The U.S. share of semiconductor manufacturing capacity has dramatically fallen over the last 30 years. In 1990, the United States manufactured 37 percent of the world's supply of semiconductors but today only produces 12 percent, a share forecasted to decline even further without intervention.[7]

So how did we get here? The decline in U.S. manufacturing share was driven in part by countries in East Asia investing in this critical technology and in their do-

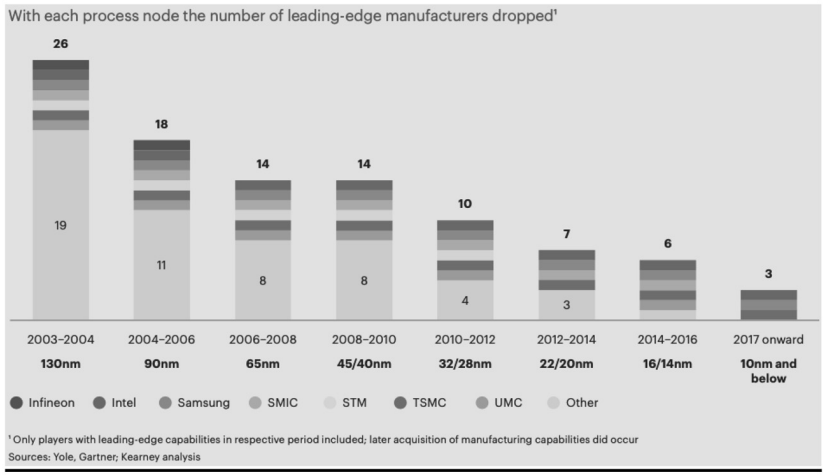
[5] See "Maricopa Maricopa Community Colleges and Intel to Launch New Semiconductor Manufacturing Workforce Development Initiative," March 7, 2022, *https://www.intel.com/content/www/us/en/newsroom/news/maricopa-community-colleges-intel-launch-workforce-development-initiative.html#gs.tzsvej*

[6] More information at *https://milliongirlsmoonshot.org.*

[7] See "Government Incentives and U.S. Competitiveness in Semiconductor Manufacturing," by Antonio Varas, Raj Varadarajan, Jimmy Goodrich, and Falan Yinug, September 2020, available at *https://www.semiconductors.org/wp-content/uploads/2020/09/Government-Incentives-and-US-Competitiveness-in-Semiconductor-Manufacturing-Sep-2020.pdf*

mestic champions, creating vital chipmaking ecosystems in the process. Those investment policies, combined with lower labor rates, effectively created a 30–50 percent cost disadvantage to manufacture chips in the United States. At the same time, the cost just to build and equip a single manufacturing facility that used to cost just $3 billion a decade ago can now cost more than $10 billion, making government incentives critical to site location decisions. As a result, our industry has concentrated itself in East Asia. Intel constitutes more than half of the advanced logic being manufactured in the United States, and we are working to do more, but our competitors have a significant cost advantage that is increasingly difficult to overcome.

Substantial investments into process technology development are also necessary to master the processes required to operate a leading-edge fab, but integrated circuit scaling is getting more difficult as traditional devices reach their scaling limits. As a result, lithography is now the most important step in fabricating integrated circuits and is also the most expensive in terms of total wafer processing cost. Due to these dramatic increases in manufacturing and technology development expenses, fewer and fewer manufacturers globally can absorb the investments required to develop the latest node sizes (see figure below). Today, only three leading-edge logic manufacturers remain. [8]



Advanced packaging technologies are also undergoing a major transition from primarily connecting small geometry wiring on a die to the looser wiring density on a system board to connecting small geometry wiring between many die inside one package. This 3D Heterogeneous Integration, using novel package technology as its core building block, is becoming vital to the semiconductor industry as traditional chip scaling slows down. Currently, less than two percent of the capacity for assembly, test and substrate manufacturing is in the United States. With the reported investments of Asian countries coupled with that of Asian private sector companies in 3D packaging, the United States and U.S. based companies are becoming further challenged to maintain their leadership.

Semiconductor Technology R&D in the U.S.

Intel and other semiconductor companies reinvest on average nearly 20 percent of their revenue into R&D, one of the highest percentages of any sector. Forty years ago, Federal investment in semiconductor R&D was more than double that of private investment, but today, U.S. private investment is nearly 20 times that of public funding. Intel is committed to continuous investment in semiconductor manufacturing, but the private sector cannot do it alone, and time is not on our side. It takes at least three years to build state-of-the-art manufacturing facilities and five to 10 years for supply chains to move. Federal investment is needed urgently and would unlock tens of billions of dollars in private investment here at home.

[8] See Kearney analysis in "Europe's urgent need to invest in a leading-edge semiconductor ecosystem," Nov 2021, *https://www.kearney.com/documents/20152/272966470/Europes+urgent+need+to+invest+in+a+leading-edge+semiconductor+ecosystem.pdf*

A November 2021 paper from the Boston Consulting Group (BCG) identified the two most significant gaps currently facing the United States in establishing those three ingredients: (i) a 30 to 50 percent cost disadvantage with East Asia that U.S. chipmakers face; and (ii) public funding for R&D, which lags both Taiwan and Korea where the most advanced semiconductors are currently manufactured.[9] Not only is technology-specific Federal funding related to semiconductors as envisioned in USICA important, but Congress must also continue to encourage companies to invest private funds in U.S. R&D.

Starting in January 2022, businesses are now required to amortize their R&D expenses over several years. Removing this deduction under the Tax Cuts and Jobs Act (TCJA) created the most regressive treatment of R&D investments globally. U.S. investment in research is already relatively flat. This major change will significantly increase the cost to perform R&D in the U.S., while other governments work to substantially increase R&D investment in their respective countries. I applaud the bipartisan work of Senators Hassan, Young, Cortez Masto, and Portman, whose bill, the American Innovation and Jobs Act, would restore this immediate deduction which has existed for nearly seven decades. As Congress works to reconcile the U.S. Innovation and Competition Act and the America COMPETES, we encourage Congress to incentivize R&D investment in the U.S. by fixing this important provision as well.

U.S. Workforce and Workforce Development

As intended, the CHIPS Act would help the United States close the manufacturing share gap by levelling the playing field so companies would be more apt to choose to build their fabs domestically. Those fabs, however, will require significant expansion of talent pipelines. The industry depends on workers across a range of skillsets, including trade workers to build new fabs and packaging facilities; technicians and trade workers to operate and maintain these facilities; and advanced degree STEM graduates for research and development. Due in part to tight labor markets, hiring in each of these areas is already extremely difficult. These difficulties will only skyrocket as new fabs come on-line. Unless we do more as a country, workforce availability has the capacity to be the principle limiting factor to a strong U.S.-based semiconductor industry.

Intel has already begun to do its part to significantly expand talent pipelines, but more will certainly need to be done if we want to stay competitive as a nation, and the industry cannot do it alone. Federal investment through the CHIPS Act is an important start, as it would unlock additional private investment to increase domestic manufacturing and further drive the research, education, and workforce development efforts needed to support industry expansion. Additional efforts will also be needed to attract and retain students in STEM fields—particularly at the graduate level and in the sub-fields critical to the industry, such as electrical engineering and computer science. U.S. students do not choose those fields at anywhere near the rate needed to support significant industry expansion. And our outdated immigration system makes it extremely challenging to hire and retain foreign students graduating from U.S. universities in these critical fields. If we are to stay competitive as a country, Congress must work to improve the industry's ability to win the global competition for talent, especially at the highest levels.

Supply Chain Resilience

The global chips shortage has been uniquely impactful among the many supply chain woes the world has experienced since March 2020. For two years now, U.S. companies and consumers have had to navigate a global chip shortage and its rippling effects. Semiconductors are a critical part of every digital device, powering our phones, cars, hospitals, and factory floors. Yet the pandemic brought into sharp relief the state of the semiconductor supply chain as neither stable nor durable. A severe supply-demand imbalance led to idled factory lines, bare shelves, empty car lots, and backorders on goods. The global chip shortage cost the U.S. economy approximately $240 billion last year.

Among the many lessons of the pandemic is that chip shortages can sideline both workers and entire segments of the economy, illustrating the national and economic security risks of falling behind. Our economic security depends on reliable, resilient access to semiconductors—access that requires near-term investment, at scale, in domestic capability and capacity. Given that so much of the semiconductor and technology industry supply chain resides in East Asia, future risks are far greater than

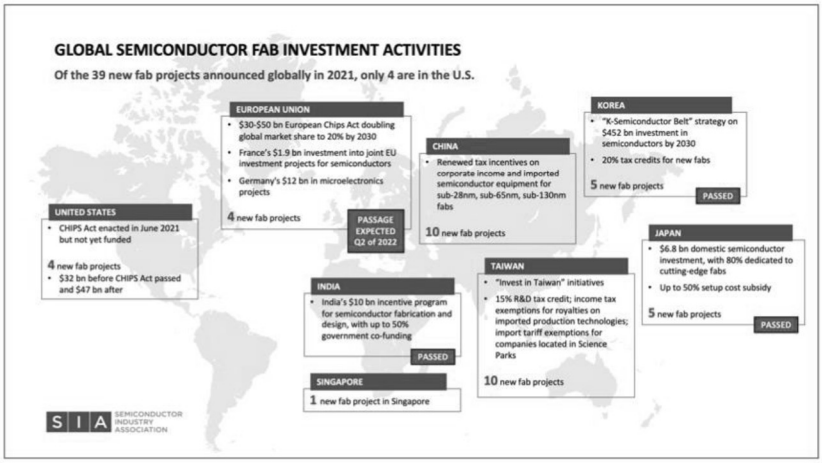
[9] See "Establishing Leadership in Advanced Logic Technology," Raj Varadarajan, Ramiro Palma, and Antonio Varas, Nov 2021, *https://web-assets.bcg.com/8d/cf/6a4a4ab34d5f962e1526337ef691/bcg-establishing-leadership-in-advanced-logic-technology-nov-2021-r2.pdf*

the shortages we are experiencing today. The only way to alleviate the current supply-demand imbalance, prevent future shortages, and ensure resilient access to chips is to increase U.S. chip manufacturing capacity.

Intel is committed to helping rebalance the global supply of chips and reduce current dependencies in East Asia. Increasing manufacturing in both the U.S. *and* EU are key to that goal, and consistent with the U.S. and European governments' desires to work together on supply chain issues. The US–EU Trade and Technology Council (TTC) has established a working group on supply chain issues, and at its first formal meeting issued a Statement on Semiconductor Supply Chains with specific focus areas, including increasing sorely needed investment in both jurisdictions.[10]

Strengthening U.S.–EU partnerships like the TTC is critical to help both regions reach their similar semiconductor objectives. Last week, I announced investment *plans* in the EU (specifically Germany, Ireland, France, Italy, Poland and Spain) of more than $36 billion for semiconductor R&D and manufacturing. These investments will complement the over $43 billion in capital investments we have previously announced in the U.S.

The rest of the world is investing and moving very rapidly. As Congress deliberated how to fund the CHIPS Act over the last year, other countries in Asia and Europe have moved forward with their own new or additional incentive programs, as shown in the graphic below from the Semiconductor Industry Association (SIA). SIA writes, "In 2021 alone, 25 fab construction and expansion projects have been announced among U.S. foreign partners—Europe, South Korea, Japan, Taiwan, and Singapore. In contrast, just 4 have been announced in the United States. Government incentives are enabling foreign competitors to outpace the U.S. in fab construction and investment." [11]



CHIPS Act Implementation Recommendations

The efficient and expeditious implementation of programs under the CHIPS Act, including the financial assistance program for semiconductor manufacturing and R&D facilities ("Grant program"), the National Semiconductor Technology Center

[10] The Statement reads in part: The United States and European Union "reaffirm their willingness to build a partnership on the rebalancing of global supply chains in semiconductors with a view to enhancing their respective security of supply as well as respective capacity to design and produce semiconductors, especially, but not limited to, those with leading-edge capabilities. . .we underline the importance of jointly identifying gaps and vulnerabilities . . . and strengthening our domestic semiconductor ecosystems, from, research, design to manufacturing . . . we intend to focus on reducing existing strategic dependencies[,] especially through a diversification of the supply chain and increased investment." U.S.-EU Trade and Technology Council Inaugural Joint Statement, Annex IV (Pittsburg, PA September 29, 2021); available at *https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/29/u-s-eu-trade-and-technology-council-inaugural-joint-statement/*.

[11] From "Global Semiconductor Incentives," February 2022, by the Semiconductor Industry Association, *https://www.semiconductors.org/wp-content/uploads/2022/02/Global-Semiconductor-Incentives_2-4-2022.pdf*

(NSTC), and the National Advanced Packaging Manufacturing Program (NAPMP), will be essential to alleviate semiconductor supply constraints more quickly and reverse the erosion of domestic capacity for U.S. semiconductors. Our comments on the Commerce Department's Request for Information, due this Friday, include several recommendations some of which are summarized below.

General Grant Program (Section 9902)

The grant program should prioritize and expedite approval for shovel-worthy projects that have already been announced or are already underway to receive the first round of grants, in order to accelerate the impact of Federal funds and see results more quickly.

The Federal government should also expedite Federal permitting requirements under the National Environmental Policy Act (NEPA) for these projects, which can add years to the approval timeline. Such expediting can be accomplished legislatively or administratively with fast-track approval,[12] or more preferably, through a definitive "categorical exclusion"—at least for facilities already under construction where the environmental impact has been thoroughly examined under state law and is not significant. The Department of Energy's experience with the Advanced Technology Vehicles Manufacturing Incentive Program ("Auto Loan Program") is instructive precedent. Under the Auto Loan Program, DOE provided loans to automobile manufacturers and component suppliers for projects that reequipped, expanded, and established manufacturing facilities in the United States to produce light-duty vehicles. In 2009, DOE applied categorical exclusions to manufacturing facilities that received Federal funding under the program after concluding that the activities contemplated were substantially similar to activities covered by the agency's existing categorical exclusions.[13] The U.S. should also look to the fast-track permitting process for environmental and other assessments that the European Commission is asking its member states to implement for first-of-a-kind semiconductor facilities as a best practice.[14]

The grant program should also consider factors in addition to those included in the statute when determining the grant amount for a specific project, such as the project's contribution to American technology leadership and supply chain security; the project's size, broader economic impact, and number and quality of American jobs it creates; more specific national security implications that the project may raise; and the project's ability to sustain itself after Federal assistance is used up and operate independently from foreign government influence and overseas technical assistance.

National Semiconductor Technology Center (NSTC)

The Commerce Department, working through the National Institute of Standards and Technology (NIST), should establish a nationwide network of facilities at U.S. companies, leveraging access to existing infrastructure to save the Federal government cost and time. This network of centers or hubs should focus on conducting research for precompetitive "breakthrough challenges" that align industry around revolutionary goals more than five years out and ultimately can result in competitive products that can be manufactured at high volume in the United States. Intel proposes establishing one such center dedicated to providing access to advanced lithography tools and equipment, a critically important area to enable future process technology advancements.

The Federal government should allow operation of the NSTC consortium to be led by a neutral non-profit entity with the guidance of a technical advisory committee, and should fund NSTC with the private sector jointly, in a manner that enables its long-term sustainment. NSTC should also support precompetitive prototyping to lower the barrier of entry for start-ups. Opportunities also exist for scaling semiconductor education and workforce initiatives at the university level through partnership and access to the NSTC.

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[12] *See* S. 3541, a bill to include certain computer-related projects in the Federal permitting program under title XLI of the FAST Act, and for other purposes; available at *https://www.congress.gov/bill/117th-congress/senate-bill/3451?s=2&r=4.*

[13] *See* Letters between Steven Chu, Secretary of Energy, and Nancy Sutley, CEQ Chair (Mar. 19 and Mar. 20, 2009)(relying on Department of Energy Categorical Exclusion B1.31).

[14] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Chips Act for Europe, at 17, COM (2022) 45 Final (Brussels 8.2.2022); Proposal for a Regulation of the European Parliament and of the Council, European Commission 2022/0032, establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act), at 7–8 (Brussels 8.2.2022).

National Advanced Packaging Manufacturing Program (NAPMP)

The NAPMP should, with the guidance of a technical advisory body, focus on research projects such as those related to product capability, environmental footprint reduction, and supply chain resilience to advance domestic manufacturing. As part of the NAPMP, NIST should establish an Advanced Packaging Manufacturing Center to research new package and assembly/test technologies and manufacturing methods, and to demonstrate a fully integrated manufacturable process. Such a center could incorporate satellite building block projects to perform R&D on core technology elements and could facilitate heterogenous integration research in support of the NSTC along with accelerating innovation in packaging and test technology. It will be beneficial to have technical alignment between the NAPMP and the NSTC to ensure synergies on project prioritization and focus for pre-competitive R&D.

Conclusion

Time is of the essence: American businesses in every sector across the economy are facing a semiconductor shortage, and the only way to alleviate the current supply-demand imbalance long term is to increase manufacturing capacity by funding and implementing the CHIPS Act. Polls consistently show Americans understand the importance of the chipmaking industry to the U.S. economy and national security, and widespread support for Congressional action to allocate Federal funding for the industry.[15]

We hope Congress can soon find a path forward to reconcile the U.S. Innovation and Competition Act and the America COMPETES Act to fund the urgently needed CHIPS Act programs it authorized over a year ago. The rest of the world is moving forward, and the United States must move forward quickly as well.

Intel is fully committed to diversifying the semiconductor supply chain. By the end of the decade we hope to see the U.S. manufacturing share grow from 12 percent to 30 percent, and the European manufacturing share grow from 9 percent to 20 percent. The CHIPS Act is the critical first step to make that happen.

This Committee will play an important role in overseeing the CHIPS Act programs, and we look forward to working with you and the Department of Commerce to provide our perspective on implementation of these programs going forward. Thank you for holding this important stakeholder hearing today; I look forward to answering your questions and working with you to advance U.S. semiconductor manufacturing and R&D.

The CHAIR. Thank you, Mr. Gelsinger. Thank you so much for that testimony, and hopefully we will get to the questions, and we can go drill in on some of this technology, and why it is so important in its application.

Mr. Mehrotra, thank you so much for being here. We appreciate that Micron is a Pacific Northwest business, even though you are located in seven different states. And I know you have been CEO since 2017, and an award winner of IEEE awards for distinguished contributions for your technology. So welcome. Thank you for being here.

STATEMENT OF SANJAY MEHROTRA, CHIEF EXECUTIVE OFFICER, MICRON

Mr. MEHROTRA. Thank you. Chair Cantwell, Ranking Member Wicker, and members of the Committee. I am honored to appear before you to discuss the semiconductor industry, and its importance in helping the United States preventing global—sorry? Let me start over again.

Chair Cantwell, Ranking Member Wicker, and members of the Committee, I am honored to appear before you to discuss the semiconductor industry and its importance in helping the United States

[15] Survey showed 90 percent of Americans either strongly or somewhat support the proposal to allocate funding for domestic chipmaking. Research was conducted by ENGINE INSIGHTS omnibus survey among U.S. adults over 18 based on a sample of 1,008 during November 17–19, 2021.

maintain global competitiveness, and secure a leadership role in semiconductor manufacturing, and critical future innovation and technology. I commend this committee for its leadership on these important issues.

With your permission, I will submit my full statement for the record.

Escalating geopolitical risks have highlighted the urgency to reconcile and pass an innovation and competition bill that includes full funding for the CHIPS Act and the investments tax credit, part of the bipartisan FABS Act.

These two incentives, together, would invigorate domestic manufacturing in the semiconductor industry, and allow companies to invest with confidence for the future. Together, these developments will kick start investment in workforce development, R&D, innovation, and expansion of manufacturing in the near term.

Memory is at the leading edge of semiconductor manufacturing technology, and Micron is leading the world in this technology. We are proud of the almost 50,000 patents that we hold as a company. Memory chips can be found anywhere that data is stored or processed. Cell phones, automobiles, computers, defense systems, and memory is truly foundational for all future technological innovation and development.

Micron is the only company developing leading-edge memory and storage technology in the U.S., with operations in nine different states. We are headquartered in Boise, Idaho, with 43,000 team members worldwide, nearly 10,000 of our employees are U.S.-based. We also recently opened an advanced memory design center in Atlanta, Georgia, our first location in the southeast, giving us access to outstanding and diverse STEM talent.

I hope to leave you with one key takeaway today. The U.S. Government needs to level the playing field and create incentives to support investment in domestic, semiconductor manufacturing facilities. Nearly every other country that has a significant share of semiconductor manufacturing offers major government incentives, including grants and tax breaks.

Our Federal Government does not. Funding under the CHIPS Act and the refundable investments tax credit are both needed to ensure the development and continued visibility of a scaled up industrial base, and to guarantee the domestic supply of semiconductors, both leading edge and legacy chips, into the future.

I want to emphasize that the CHIPS legislation is necessary, but not sufficient. The refundable investment tax credit is equally important to enable confident, long-term investments in significant manufacturing infrastructure.

Micron has announced plans to invest more than $150 billion globally over the next decade in leading-edge memory manufacturing and research and development. We continue to explore plans to build new fabs in the United States. Our expansion plans, if executed, would constitute one of the largest single, semiconductor investments in the history of the United States, require close coordination with Federal and state partners to ensure the economic viability of our operations in a global, competitive marketplace.

However, to be commercially viable over the long term, memory and storage fabs must produce at very high volumes consistently.

Multiple facilities are required to achieve this scale each costing more than tens of billions of dollars fully equipped. Technological advancements are increasingly complex and expensive. Our competitors abroad have benefited from 35 to 45 percent lower operating costs, due in part to the investments of other governments. This is a momentous opportunity to change the trajectory and put the U.S. on competitive ground for the future.

I urge all parties to help pass both the CHIPS Act, and the FABS Act into law. Chips funding and the refundable investment tax credit will set the stage for a transformational investment in large-scale, leading-edge memory manufacturing in the United States, and ensure the United States does not lose out to its competitors abroad.

Thank you, again, Chair Cantwell, Ranking Member Wicker, and members of the Committee for the opportunity to testify today. And I look forward to your questions.

[The prepared statement of Mr. Mehrotra follows:]

PREPARED STATEMENT OF SANJAY MEHROTRA, CHIEF EXECUTIVE OFFICER, MICRON

Chair Cantwell, Ranking Member Wicker, and members of the Committee, I am honored to appear before you to discuss the semiconductor industry and its importance in helping our country maintain global competitiveness and secure a leadership role in semiconductor manufacturing and critical future innovation and technology. I commend this committee for its leadership on these important issues.

The COVID 19 crisis and the ongoing conflict in Russia & Ukraine have underscored the fragility of our supply chain and the national security and economic risks of a decline in chip manufacturing in the United States. In this environment, it is increasingly urgent that Congress move forward on efforts to reconcile and pass an innovation and competition bill that includes full funding for the CHIPS Act. This investment will kick start investment in workforce development, R&D, innovation, and expansion of manufacturing in the near term. It is equally important that Congress passes the refundable investment tax credit, part of the FABS Act, to create a long-term incentive that would invigorate domestic manufacturing in the semiconductor industry and allow companies to invest with confidence for the future. With your permission I will submit my full statement for the record.

I appreciate the opportunity to speak today about the important responsibility that we in the semiconductor ecosystem have in partnership with the government to protect United States Technology Leadership for the future. I testify today as Chief Executive Officer of Micron—the world leader in memory and storage technology. Micron manufactures DRAM chips, which provide rapid access to data for processing, and NAND flash chips, which provide long term data storage. Memory is the leading-edge of semiconductors and Micron is leading the world in both DRAM and NAND memory. Memory chips can be found anywhere that data is stored or processed—cell phones, automobiles, computers, defense systems—and is truly foundational for all future technological innovation and development. Micron is the only company developing leading-edge memory and storage technology here in the U.S., with operations in seven different states—Idaho, Colorado, Texas, Minnesota, Virginia, California, and Georgia.

We are headquartered in Boise, Idaho, and we have 43,000 team members worldwide, with nearly 10,000 of them located in facilities across the country. These facilities include our Manassas, Virginia, plant just 30 miles from here, where we manufacture memory and storage solutions. These products not only unlock innovation across American industries, but also create the much-needed legacy chips for our automotive and defense industry. Our Boise headquarters is home to the world's most advanced memory research center including 6,000 researchers, engineers, technicians, and other support functions.

We also recently opened an advanced memory design center in Atlanta, Georgia, where we will partner with leading institutions like Georgia Tech and the Atlanta University Center Consortium of Historically Black Colleges and Universities to source outstanding and diverse STEM talent. This work is critically important because it helps address the workforce development and national security challenges of the present moment.

Micron is committed to investing in the United States and we have already made significant contributions to leading-edge research and development and other areas that will lay the foundation for the more robust domestic manufacturing programs and facilities of the future.

I hope to leave you with two key takeaways today:

- First: The United States must be self-sufficient in development and production of semiconductors. This is crucial to our technology leadership in the world and imperative to our national security. Our country requires a robust semiconductor industrial base to maintain our global technological leadership in areas from essential consumer products to cloud computing capabilities and defense systems. In particular, memory and storage technologies, which are foundational for all modern computing, are indispensable to a digital and data-intensive future. Incentive programs such as those included in the CHIPS legislation are a good start. This initial funding must be immediately supplemented by long-term incentives, including a refundable investment tax credit, to ensure the continued viability of the scaled-up industrial base and guarantee the domestic supply of semiconductors—both leading-edge and legacy chips—into the future. I want to emphasize that the CHIPS legislation is necessary but not sufficient—the refundable investment tax credit is equally important to enable confident long-term investments in significant manufacturing infrastructure. As this ambitious process will require years, if not decades, of sustained investment, speed is of the essence. Strengthening U.S. capacity to manufacture memory and storage semiconductors will leverage industry's technological leadership to enhance the country's national and economic security;
- Second: A renewed focus on supply chains and American manufacturing must be matched by continued investment in research and development to sustain the technological leadership of American universities and semiconductor companies and to meet the technological demands of the emerging data economy. The semiconductor industry invested $40 billion in research and development in 2020. The industry consistently spends 20 percent of revenue in R&D on average, the highest of any industry. CHIPS Act funding for the National Semiconductor Technology Center (NSTC) and the Department of Defense-led Microelectronics Commons will support these efforts by leveraging the innovation of American researchers and startups to bring new technologies from "lab-to-fab," unlocking the benefit of these technologies for American industry. At the same time, expanded funding for research by the NSF, NIST, and Energy Department's Office of Science among others authorized under the pending innovation legislation will enable the basic research needed to unlock the next generation of advances in microelectronics. An increase in R&D investment supported by the CHIPS Act will generate strong growth in employment and economic output. In fact, according to the Semiconductor Industry Association's research, every dollar invested by the government in R&D creates $16 in GDP growth.

The importance of a domestic industrial base

Two-thirds of silicon wafers produced globally today are in memory and storage semiconductors. Of that total, only 2 percent is produced in the United States, all of it at our Manassas, Virginia fab. The remaining 98 percent is produced in Asia in large-scale fabrication facilities supported by supplier and talent ecosystems that have been developed with extensive domestic government support over the past 20 years. Collaboration between government and industry beginning with CHIPS Act funding and a refundable investment tax credit will kick-start the process of bringing investments back to the United States but will not fully reverse this trend.

As a result, U.S. manufacturers have come to rely on semiconductors produced overseas, primarily in Asia. With global supply chains facing unprecedented pressure in recent years, it is critical that the U.S. address this systemic vulnerability and invest to expand its domestic industrial base across all fronts, including R&D, manufacturing, skilled workforce, and essential component supply chains. In addition, as recent events have demonstrated, U.S. leadership in semiconductor technology is a core component of our country's leverage in defending a peaceful international order.

Memory and storage have grown from 10 percent of the global semiconductor industry twenty years ago to about 30 percent of the semiconductor industry today. We expect this trend to continue. For example, 5G phones have 50 percent more memory (DRAM) and double the storage (NAND) content compared to 4G phones. Today's autonomous vehicles require more than ten times the amount of memory and storage that previous generation cars used to use and this memory consumption will continue to increase as this technology evolves and proliferates.

Given that memory and storage will play an indispensable role in driving innovation and manufacturing not only in the semiconductor industry, but across the global economy, it is essential to create and sustain an environment that will enable ambitious expansion of memory and storage manufacturing capabilities in the United States.

Federal Incentives

Federal incentives are critical to enabling the large scale of manufacturing required in memory and storage at a globally competitive pace. To be commercially viable over the long term, memory and storage fabs must produce at very high volumes consistently over time. Multiple facilities are required to achieve this scale, each costing more than $20 billion fully equipped. Technological advancements come with increasing complexity, requiring ever-higher capital and operating expenses on the part of memory and storage manufacturing companies. Our competitors abroad have benefited from 35–45 percent lower operating costs due to the investments of other governments.

For example, incentives offered by South Korea resulted in the ROK government's announcement that the country's leading semiconductor companies will invest more than $450 billion in the semiconductor industry by 2030. European nations have also been successful in attracting large-scale investment due to their significant government incentives. To ensure the long-term impact of such investments, manufacturing incentives must be coupled with a refundable investment tax credit (ITC). While the CHIPS grant program as currently envisioned will help bridge the cost differential between the United States and other countries in upfront costs, a refundable ITC is critical to bridge the differential in ongoing costs of operation. A refundable ITC will also provide an equitable and efficient means to allocate government funds toward strategic projects with the greatest potential to help build domestic semiconductor self-sufficiency. Micron appreciates efforts in this chamber and in the House to date to introduce robust ITC initiatives such as the FABS Act. The exponential and transformational impact this will have on the U.S. economy should not be underestimated. If semiconductor companies can make these large investments in this country in partnership with the U.S. government, the impact will be significant. The chip industry tends to benefit from colocation and highly concentrated clusters or ecosystems. When fabs are sited in new locations, extensive pools of talent and resources inevitably follow. Those investments have in recent years been primarily in Asia and combined with other economic factors have led to a 35–45 percent cost disadvantage for U.S. semiconductor memory companies to build and operate domestic fabs vs. Asian competitors. This is a momentous opportunity to change that trajectory and put the U.S. on competitive ground for the future.

Micron has announced plans to invest more than $150 billion globally over the next decade in leading-edge memory manufacturing and research and development. As part of this process, we continue to explore plans to build new fabs in the United States. Our expansion plans, which if executed would constitute the largest single semiconductor investment in the history of the United States, require close coordination with Federal and state policies to ensure the economic viability of our operations in a global, competitive marketplace.

Micron is fully aware of its responsibility to the American people whose tax dollars would fund proposed incentives programs. While we anticipate that a significant amount of Federal funding will be required to make a mega-fab viable, a major investment in a new domestic fab would be an investment that benefits the entire U.S. supply chain. For example, building a fab require tens of billions of dollars of capital expenses in manufacturing equipment, construction, and IT systems, as well as billions of dollars annually in operational expenses related to gases and chemicals, technical services, repair and maintenance, utilities, and other materials. These costs manifest as direct, sustained investment in the U.S. supplier base. Further, a new fab would result in tens of thousands of community jobs over the long term, a large proportion of which would be in trade roles for constructing and maintaining these leading-edge clean room facilities. In other words, successful and sustainable investments in new manufacturing will not only benefit the U.S. semiconductor industry, but also the prosperity and national security of the United States as a whole.

Micron and our partners stand ready to work with members of this Committee, the entire Congress, and the Executive Branch to ensure the United States achieves the world's leading digital and data-intensive economy in the decades ahead. I urge all parties to capitalize on the momentum generated by today's hearing and help pass both the CHIPS Act and the FABS Act into law. Doing so will set the stage for a transformational investment in large-scale leading-edge memory manufac-

turing in the United States and ensure the United States does not lose out to its competitors abroad. Thank you again, Chair Cantwell, Ranking Member Wicker, and members of the committee for the opportunity to testify today and I look forward to your questions.

The CHAIR. Thank you so much for your testimony, and we appreciate you being here. We are now going to go Mr. Preston Feight, who is joining us from Europe actually. But PACCAR is located in the State of Washington. We are very proud of them as a manufacturer of medium-and heavy-duty trucks, and leader in that in the world.

I know he wanted to be here in person, but it is so important to get his viewpoint on how this shortage affects the supply chain, and more importantly, the transition to where PACCAR would like to go, if we can continue U.S. leadership on the R&D side. And very much appreciate you joining us.

Thank you, Mr. Feight, we will go to you.

STATEMENT OF PRESTON FEIGHT,
CHIEF EXECUTIVE OFFICER, PACCAR INC

Mr. FEIGHT. Great. Thank you, Chair Cantwell, Ranking Member Wicker, and other distinguished members of the Committee, thanks for inviting me to testify today.

PACCAR is the manufacturer of iconic Peterbilt, Penworth, and DAF trucks. Our truck brands represent nearly 30 percent of the Class 8 market in the U.S. and Canada, and around 16 percent of the heavy-duty truck market in Europe.

PACCAR was founded in 1905 and is an American-owned manufacturer of heavy trucks. We are headquartered in Washington State, and our great people operate state-of-the-art factories that build Kenworth trucks in Washington State and Ohio; Peterbilt trucks in Texas; and PACCAR engines, as noted earlier, in Mississippi.

PACCAR also has engineering and innovation centers in Washington State, Texas, and California, and that is where we develop our technology leading, zero-emissions, autonomous, and connected vehicles.

Thanks for your bipartisan work to address the semiconductor supply shortage. The chip shortage has been limiting the production of commercial trucks for a year now. This has led to a shortage of trucks to move goods throughout the country, disrupted supply chains across numerous industries, raised prices for consumers, and delayed access to critical goods and services for businesses and communities.

Over 70 percent of all the freight tonnage that moves in America is transported on a truck. Over 80 percent of U.S. communities depend exclusively on trucks to deliver food and agricultural products, fuel and medicine, manufacturing inputs, business supplies, and consumer goods from groceries to automobiles.

We all experienced the importance of the trucking industry during the pandemic. And more trucks are needed now to build new housing, highways, bridges, clean energy infrastructure, and communications networks.

Basically, America's economy moves on trucks, and truck manufacturers, and the suppliers need an adequate, predictable, and af-

fordable supply of semiconductors to build and keep trucks on the road. Instead, we continue to face shortages.

Today, throughout the industry, thousands of unfinished trucks are parked across the country waiting for chip-enabled components, and additional trucks are out of service waiting for repair parts.

This is disturbing considering the entire U.S. Class 8 trucking market requires an estimated 13 million semiconductors last year, compared to a total semiconductor industry output of over 1 trillion chips, so just one out of every 86,000 semiconductors are needed to keep America and its supply chains moving.

A year ago, during the pandemic there were legitimate force majeure events, such as COVID-related plant shutdowns, an ice storm in Texas, and a fire in Japan that led to chip delays.

To help mitigate the issues associated with those events, truck manufacturers spent a tremendous amount of money on medium- and long-term engineering redesigns to help reduce the impact of chip constraints, and have engaged with chip producers to align on best practices.

Still, shortages remain, and truck OEMs have paid premium prices to purchase chips on the broker market when it is not possible to purchase chips directly from industry suppliers and chip manufacturers. These broker prices are often 20 to 30 times higher than contract prices. Furthermore, manufacturers continue to receive a lack of clarity on semiconductor delivery schedules and experience cancellations from our suppliers often with inadequate visibility being provided.

These semiconductors are critical to support the necessary production of trucks, and this creates turmoil for all manufacturers who must manage immediate production changes or be forced to shut down plants. Simply put, the fabric of America is adversely impacted when truck factories are forced to shut down or curtail production due to these shortages.

To address the costly impact on America's trucking industry and broader economy, we suggest that companies requesting CHIPS Act funding be required to meet the needs of American critical businesses, including truck manufacturers, before they are approved to receive U.S. taxpayer dollars.

This could be accomplished using the Essential Critical Infrastructure Workforce Guidance developed by the DHS Cybersecurity and Infrastructure Security Agency, which was used throughout the pandemic to ensure continued operations in critical national functions. We are concerned that without up-front conditions on the use of CHIPS Act funding, the ongoing chip supply constraints and allocations could limit trucks from delivering essential goods and services to our communities.

To ensure the accountability of this public funding and provide near-term relief to America's trucking industry and supply chains, we recommend that applicants for CHIPS Act funding be required to submit a plan to the Commerce Department detailing how their existing semiconductor allocation strategy, and investment decisions are currently, and will in the future, prioritize the production of semiconductors, to support critical infrastructure industries and related jobs in the United States.

Thank you again for the opportunity to share our experience and perspective, and for your efforts to strengthen America's economic competitiveness. We look forward to your questions.

[The prepared statement of Mr. Feight follows:]

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Thank you again for the opportunity to share our experience and perspective, and for your efforts to strengthen America's economic competitiveness. I look forward to your questions.

The CHAIR. Thank you, Mr. Feight. And thank you for that suggestion on focusing on critical businesses. I think it is really important in a time of shortage, for us to be very specific about what our needs are and how we accomplish them. So thank you for that, and again, I don't know what time it is in Europe, but we appreciate you communicating with us here.

We will now turn to Mr. Archer. I am so pleased that all our panelists are not only CEOs, but engineers. It gives us a chance to dig deep on to some of the science that we are trying to get right, which is part of the mission of USICA is the innovation side of science, and the R&D investments, and particularly the translational side, that is what USICA is about, how to translate the science faster.

So Mr. Archer, your company, we can't just build fabs, we have to have the equipment and the tools in the fabs that do the work that help us keep our cutting edge here. You bring together physics, and you are a physicist, of materials, robotics, and other fields that we need to be leading edge in the United States in manufacturing. So we look forward to hearing your view on this part of the infrastructure that we need. Thank you for being here.

STATEMENT OF TIM ARCHER, PRESIDENT AND CHIEF EXECUTIVE OFFICER, LAM RESEARCH CORPORATION

Mr. ARCHER. Thank you. Madam Chair, Ranking Member, and Members of the Committee, thank you for the opportunity to appear before you today.

I am Tim Archer, President and CEO of Lam Research. One of the world's largest semiconductor manufacturing equipment companies. Simply put, Lam Research makes the machines that make the chips.

Headquartered in California we have more than 16,000 employees worldwide. We are a world leader in developing state-of-the-art manufacturing equipment that brings together diverse discipline such as plasma physics, material science, advanced robotics, and artificial intelligence to create nanoscale semiconductor fabrication solutions. The complex machines we develop enable companies, like Intel and Micron, to produce their sophisticated integrated chips in high volume.

I would like to thank you and others in Congress for the vision you have shown toward addressing both the challenges and oppor-

tunities facing the U.S. semiconductor industry. While recent events, like the chip shortage, have put a spotlight on the challenges, I would like to stress that U.S. leadership in semiconductor manufacturing technology is strong. Our competitiveness is rooted in the innovation, drive, and resourcefulness of American companies and workers across the semiconductor ecosystem.

And I am proud of the role that Lam Research and our employees have played for more than four decades in setting the pace for innovation and in maintaining U.S. leadership in the global market.

Today, semiconductors form the foundation of our smarter, faster, and more connected digital world. I believe it is vital that we create a secure and resilient supply of semiconductors while also accelerating innovation ahead of the rapidly evolving technological complexity.

Congress recognizes the importance of both supply and innovation, and is taking bold steps to strengthen the semiconductor ecosystem through the CHIPS Act, which will fortify our supply chain, workforce, and domestic research and development.

I believe this partnership of industry and government will contribute to U.S. leadership in semiconductor technology well into the future. As you continue to work on these efforts I would highlight three areas that could benefit from your continued consideration.

First, an all-of-ecosystem approach. The chip shortage we are experiencing highlights the complex and interdependent nature of the semiconductor ecosystem and the need for sustained investment by companies throughout the supply chain. Lam Research has increased our workforce in the United States by over 45 percent in the past 2 years alone, adding more than 3,500 jobs, including high-paying, engineering, and advanced manufacturing jobs at our facilities in California, Oregon, and Ohio. However, we also rely on hundreds of American suppliers, many of whom are struggling to keep up with the rapid pace of growth, while dealing with the lingering effects of the pandemic, and a tight labor market.

We are grateful policymakers recognize these challenges and intend to support the industry comprehensively through the Commerce Department's grant program, established in the CHIPS Act, as well as through important R&D programs, like the Investment Tax Credit found in the FABS Act. We urge Congress to act quickly to pass these measures in support of the entire domestic ecosystem.

Second, leveraging existing infrastructure: Together, government and industry can leverage existing infrastructures that have a history of driving technology development. Partnerships with academia and with the National Labs provide extensive capabilities and expertise critical to any collaborative innovation strategy. In our area, plasma research is particularly key to the future of semiconductor tool development.

We are grateful to see legislative proposals such as the Microelectronics Research for Energy Innovation Act, a move forward to streamline coordination and better deploy Federal resources, including the National Labs, to sustain these partnerships.

And finally, enabling shared innovation: Here is an outstanding opportunity to strengthen U.S. competitiveness, by bringing to-

gether industry, government, academia, and the National Labs in a centralized and collaborative space to enable shared innovation.

The establishment of the National Semiconductor Technology Center, NSTC, will provide a new pathway to sustaining U.S. technology leadership by creating opportunities to explore new ideas and quickly transition breakthrough technologies to the production line.

So, in closing, we believe it is vital that we prioritize innovation, competitiveness, collaboration, and supply chain security, to maintain U.S. leadership in this critical global industry.

Thank you. And I look forward to your questions.

[The prepared statement of Mr. Archer follows:]

PREPARED STATEMENT OF TIM ARCHER, PRESIDENT AND CEO, LAM RESEARCH CORPORATION

Madam Chair, Ranking Member, and Members of the Committee:

Thank you for the opportunity to appear before you today.

I am Tim Archer, President and CEO of Lam Research, one of the world's largest semiconductor manufacturing equipment companies. Simply put, Lam Research makes the machines that make the chips. With more than 16,000 employees worldwide, we manufacture equipment at facilities in California, Oregon, Ohio, representing and elsewhere around the world (with 67 percent of our manufacturing footprint in the U.S.) and conduct groundbreaking research and development in our advanced U.S. labs.

We are a world leader in developing state-of-the-art manufacturing equipment that brings together diverse disciplines such as plasma physics, materials science, advanced robotics, and artificial intelligence to create nanoscale semiconductor fabrication solutions. The complex machines we develop enable semiconductor manufacturers to produce sophisticated integrated chips in high volume.

I would like to thank you and others in Congress for the vision and resolve you have shown toward addressing both the challenges and opportunities facing the U.S. semiconductor industry. While recent events—including chip shortages—put a spotlight on the challenges, I would like to stress that U.S. leadership in semiconductor manufacturing technology is strong. With fabs in 18 states, semiconductors are America's fourth-largest export.[1] The industry employs over 270,000 Americans directly, with an additional 1.6 million employed indirectly in related and adjacent fields.[2] The U.S. competitiveness is rooted in the innovation, drive, and resourcefulness of American companies and workers across the semiconductor ecosystem. And I am proud of the role that Lam Research and our employees have played for more than four decades in setting the pace for innovation and in maintaining U.S. leadership in the global market.

Today, semiconductors form the foundation of a smarter, faster, and more connected digital world. I believe it is vital that we create a secure and resilient supply of semiconductors while also accelerating innovation ahead of rapidly evolving technological complexity.

Congress recognized the importance of both supply and innovation and is taking bold and decisive steps to strengthen the semiconductor ecosystem through the CHIPS Act, which will fortify our supply chain, workforce, and domestic research and development. I believe this partnership of industry and government—with American workers and ingenuity at its heart—will contribute to U.S. leadership in semiconductor technology well into the future. As you work on this and other related efforts to support our ecosystem, I would highlight three areas that could benefit from your continued consideration.

Supporting an "all-of-ecosystem" approach

The current shortage of chips highlights the vital role of semiconductors throughout the entire economy—including aerospace, automobiles, communications, defense systems, information technology, manufacturing, healthcare, and other industries. It

[1] See *https://www.semiconductors.org/wp-content/uploads/2021/10/CHIPS-FABS-Hill-handout-oct-2021.pdf*

[2] See *https://www.semiconductors.org/wp-content/uploads/2021/10/CHIPS-FABS-Hill-handout-oct-2021.pdf*

also highlights the complex and interdependent nature of the semiconductor ecosystem and the need for sustained investment by companies throughout the supply chain.

To ensure a secure, and resilient supply of semiconductors, government and industry must take a holistic view of the value chain. Of critical importance, the CHIPS Act creates a new Federal policy to incentivize domestic semiconductor manufacturing through the Commerce Grant Program. The program will incentivize new U.S. fabs to meet the growing global demand for semiconductors. The U.S. currently has a robust semiconductor manufacturing base. However, the cost of building and operating a fab in the U.S. is now 20 to 40 percent higher than in other countries. As other global markets invest heavily in manufacturing, the Commerce Grant Program will act as a force multiplier for U.S. investment, ensuring that our industry can expand to meet accelerating global demand and maintain our technology leadership.

These new fabs will depend on semiconductor manufacturing equipment and materials. A shortage of the necessary tools would hobble production, limiting the impact of taxpayers' investment, and ultimately pose a setback to U.S. leadership in the industry. A Grant Program with the flexibility to provide incentives across the entire value chain will increase resiliency and maximize the output and efficiency of expanded U.S. production.

Finally, a Commerce Grant program accounting for the whole of the semiconductor ecosystem will ensure we are able to grow, train, and retain a skilled national workforce that will power our competitiveness for decades to come. Lam Research has increased our workforce in the U.S. by over 45 percent in the past two years alone, adding more than 3,500 jobs, including high-paying research and advanced manufacturing jobs at our facilities in California, Oregon, and Ohio. However, in the manufacture of our equipment, we also rely on hundreds of American suppliers, many of whom are struggling to keep up with the rapid pace of growth while dealing with the lingering effects of the pandemic and a tight labor market. We are grateful policymakers recognize these challenges and intend to support the industry comprehensively through the Commerce Department's Grant Program, established in the CHIPS Act, as well as through important R&D programs like the Investment Tax Credit found in the FABS Act. We urge Congress to act quickly to pass these measures in support of the entire domestic ecosystem.

Leveraging existing infrastructure

Together, government and industry can leverage existing infrastructures that have a history of driving technology development. Policymakers have rightfully identified that partnerships with academia and with the National Labs provide extensive capabilities and expertise critical to any collaborative innovation strategy. In our area, plasma research is particularly key to the future of semiconductor tool development, with potentially huge applications and across energy, transportation, cybersecurity, defense, and countless other sectors. Several of our National Laboratories have sterling records of pioneering work in this area. We are grateful to see legislative proposals such as the Microelectronics Research for Energy Innovation Act move forward to streamline coordination and better deploy Federal resources, including the National Labs, to sustain these partnerships.

Enabling shared innovation

Lam invests $1.5 billion annually in research and development (R&D), over 90 percent in our world-class facilities in the United States and we hold more than 8,000 patents globally. Since 2015 we have funded over 160 research projects with 50 leading universities focused on addressing industry challenges. The transfer of revenue into R&D has been the key to Lam's success for more than 40 years. One example, Sense.i™ is a completely transformed plasma etch technology and system solution. The self-aware platform powered by our Equipment Intelligence® technology, using AI and machine learning is the most innovative of its kind.

While Lam and others in the industry make significant individual investments to maintain and grow technology leadership, we believe there is an outstanding opportunity to strengthen U.S. competitiveness by bringing together industry, government, academia, and the National Labs in a centralized and collaborative space to enable shared innovation. The establishment of the National Semiconductor Technology Center (NSTC) will provide a new pathway to sustaining technology leadership by creating opportunities to explore new concepts and quickly transition breakthrough technologies to the production line. The concentration of energy, resources, networks, and opportunity in the NSTC will also help to attract and train the next generation of innovators, strengthening yet another link in the supply chain: our workforce.

Closing

Those of us in the semiconductor ecosystem prioritize innovation, competitiveness, collaboration, and supply chain security—as you do. We appreciate the opportunity to work together on these issues and look forward to collaborating on the important objective to maintain our technology leadership in this critical global industry.

The CHAIR. Thank you, Mr. Archer. Thank you so much for that. I love collaboration focus particularly because I heard a TED Talk about this that collaboration is the next form of innovation, because you can have the innovation but if you don't collaborate to get it in to implement it, then you don't have it. So around here we have to be more collaborative for sure, so.

I am going to yield to my colleague for the first round of questions, and then let our colleagues who might be joining us remotely that we would then go to Senator Klobuchar, and then Senator Thune, and then I will jump in later with my questions. But I will turn to Senator Wicker.

Senator WICKER. Well, Madam Chair, feel free to jump in at any point, because I think you and I are teammates on this.

Let me start with Mr. Gelsinger. America's share of global semiconductor manufacturing is 12 percent today. Where is the other 88 percent? Let us just sort of summarize what we have learned so far. And I think you have to press the button.

Mr. GELSINGER. OK. Thank you. The largest portion is in Asia, right, led by Taiwan, Korea, China and Japan; so approximately 80 percent is in Asia, and about 9 percent in Europe, and about 12 percent in the U.S.

Senator WICKER. OK. And the reason for that, we have gone from 40 percent in 1990 to 12 percent today. It is just more cost-effective for companies to manufacture semiconductors in those Asian locations; is that correct?

Mr. GELSINGER. I believe there are primarily two effects, one is the Asians aggressively pursued this industry with very strong policies and high incentives. It was also much of the——

Senator WICKER. Financial incentives provided by governments?

Mr. GELSINGER. Primarily.

Senator WICKER. Like, what do they do in Taiwan and China?

Mr. GELSINGER. The incentives, you know, typically could be 30 to as much as even 70 percent for some of the capital incentives in China. So very strong capital incentives have been available, and those countries have recently announced major expansions of those programs. For instance, Korea just announced $100 billion capital incentive program for their semiconductor industry.

Senator WICKER. And that is one factor.

Mr. GELSINGER. Yes.

Senator WICKER. The government incentives?

Mr. GELSINGER. And then additionally, many of the lower-end supply chains were already in Asia, and so it is a consolidation of the supply chain, so it ends up being a more efficient, overall, supply chain that they have built up.

Senator WICKER. For example?

Mr. GELSINGER. For example, power supplies, sheet metal enclosures, displays, they have consolidated and a lot of this in China specifically around the supply chain consolidation that has occurred there. So more efficient supply chains, all focused on cost, and as

we say, you know, the focus has been on cost, not on resilience. We believe we need a globally balanced, more resilient supply chain for the future.

And what we are suggesting in the CHIPS Act, essentially, is rebalancing that 30-to 50 percent gap that we spoke about, allowing the U.S. industry to be competitive as we compete for the global market.

Senator WICKER. And the labor costs are part of this?

Mr. GELSINGER. The labor costs certainly are a factor, but for fabs it is primarily capital cost, right, it is the largest portion, the depreciation of capital cost dominates the overall cost. Labor costs play larger portions in other areas of the supply chain.

Senator WICKER. Mr. Mehrotra, do you want add anything to this line of questioning?

Mr. MEHROTRA. I would add, that today in the U.S. there is 2 percent of the semiconductor memory manufacturing, 98 percent of the semiconductor memory manufacturing is in Asia today, for the very reasons that Pat articulated. That over the course of the last 20 years Asian governments have supported bringing semiconductor industry onshore, in various countries that Pat outlined earlier as well.

And the 2 percent that is being produced here in the U.S., actually is being produced by Micron, close by, in Manassas, Virginia. And of course we have leading-edge R&D center in Boise as well. It is imperative that the 35-to 45 percent cost difference that exist for manufacturing in Asia to build and operate these leading-edge fabs that gap is overcome through CHIPS Act, and investment tax credits, in order to be able bring more manufacturing back onshore, and really provide sustainable long-term, resilient operations.

And again, memory is important because memory represents nearly 60 percent of wafer production worldwide in semiconductors. We need to bring more memory production in the U.S., along with the rest of the semiconductor ecosystem advancement in order to really ensure that the economic prosperity and global leadership for semiconductors—and national security considerations—are met.

Senator WICKER. So it is fair to say that governments in these locations around the world have made a decision to spend government funds to incentivize the production of these chips in their jurisdictions?

Mr. GELSINGER. Yes, that is a good——

Senator WICKER. And if we are going to get them back, we are going to have to do, as the CHIPS Act suggests, and as USICA suggests, and spend some government money out of the Federal Treasury, through either grants, loans, or tax incentives, to incentivize manufacturing here in the United States?

Mr. GELSINGER. Yes. We would say that is a very good summary. And I would also emphasize that we have seen recently, that the world is recognizing the criticality of the semiconductor industry, and we have seen actions as part of the Europeans, Indians, Chinese, Koreans, and Taiwan, very recently to further incentivize these industries on their shores. So the criticality and the urgency, as we have said, is nigh before us, the world is moving quickly on the importance of this industry on their soil.

Senator WICKER. Senator Johnson, you are next, but I am going to take some leeway to ask Mr. Feight. Are we ready in the United States with a workforce trained well enough for getting this global percentage back from 12 percent up to where it ought to be? And what do we need to do in that regard?

Mr. FEIGHT. Well, Senator Wicker, I think, you know, from our experience with the U.S. workforce, which is extensive over 100 years, we have an amazing workforce. We have great people in all of our locations that have high skills, whether that is in the Silicon Valley offices we have in California, or whether that is in Mississippi. So yes, we have great workforce, but obviously training is needed on specific skills for these industries as we develop them here.

Senator WICKER. I believe there is a partnership with East Mississippi Community College.

Mr. FEIGHT. Mm-hmm. I have heard——

Senator WICKER. MUW and Mississippi State University that is helpful to your Columbus facility; is that correct?

Mr. FEIGHT. That is very correct. We have had such wonderful experiences with our universities and schools around the area to develop people and put them into great careers and jobs. You are absolutely correct.

Senator WICKER. Thank you very much. More questions later. Senator Johnson, you are recognized.

STATEMENT OF HON. RON JOHNSON,
U.S. SENATOR FROM WISCONSIN

Senator JOHNSON. Hi, Mr. Chairman.

Mr. Gelsinger, so again, these are interesting specifics, only 12 percent of chip manufacturing here in the U.S. primarily because other countries have provided industrial policy basically, and they provide financial incentives for your industry to move overseas. Did the U.S. chip industry, did you ever consider, as you were moving all this manufacturing overseas and the risk to your own industry, not to mention national security?

Mr. GELSINGER. I am very proud to say that Intel has remained primarily on U.S. soil over this period of time, and the vast majority of our investments are in U.S. and European soil, with a very small amount in Asia. Really what has happened is the rest of the industry has moved dramatically over this period of time, largely, responding to these incentives that we have described.

Of our investments, well over half of them land on U.S. soil with approximately a third in Europe. We have been one of the few companies that have remained highly dedicated to U.S. R&D and manufacturing investments over the entirety of our 53-year history. The trends that we have described have clearly affected the rest of the industry in a most dramatic way.

Senator JOHNSON. So of the 12 percent produced in the U.S. what percentage of that 12 percent is Intel?

Mr. GELSINGER. About half.

Senator JOHNSON. About half. You know, obviously this would be considered unfair trade practices, correct; when you have got different countries subsidizing your industry, putting it at a competitive advantage because of government subsidies. And so I guess

there is two ways of approaching that, you can slap tariffs on that, or you can try and start your own industrial policy here in the United States, which is apparently the path we are taking. Does that pretty well sum things up?

Mr. GELSINGER. Well, and we would also emphasize that without such actions, right, we see that foreign countries, as we have already, right, indicated in the testimony, are taking very aggressive steps, and they weigh, they view and understand the criticality of semiconductors underlying every aspect of the digital future.

And that is why we speak for such urgency and passion on this topic, to be restored on American soil. This is foundational to every other industry and every other aspect for, and thus we believe it is justified to take such steps as the CHIPS Act, as the FABS Act. And now we would say that this industry, one that was borne in the United States, right, this is our industry that underscores every aspect of humanity looking forward, now is the time for action.

Senator JOHNSON. I think my concern is when government starts attempting to allocate capital just screws things up. It doesn't do it very efficiently or effectively. So again, I am concerned, as opposed to pushing the unfair trade practice route, going that route, to just, "let us join in. Let us engage in the same type of activity." And so for the misallocation of capital, are you concerned about that; because you have government picking the wins and losses in this case?

Mr. GELSINGER. You know, given what we have seen worldwide, you know, the 30-year trend is dramatic, right. These actions are not overnight actions that have been taken by foreign nations. While, clearly, there are concerns on how capital is allocated, without such steps our industry will be further undermined. We will lose critical mass, I believe, in the near future, and we will never have the opportunity to restore this industry on American soil. So that is why we are here.

Senator JOHNSON. Can you give me just sort of the macro numbers we are talking about here? How many dollars of capital have been provided, in what I would consider unfair trade practices, by our oversea competitors? I mean how many hundreds of billions of dollars?

Mr. GELSINGER. Well, just in the last year we have seen the Europeans suggest $45 billion, the Koreans suggest $100 billion, the Chinese suggests over $100 billion. These are very significant investments. And what we are seeking in the CHIPS Act is to unleash public-private, leveraged investments, where these investments would unleash, you know, $3 to $4 for every dollar that is put into it, as well as the research investments are long term.

You know, our industry was borne out of DARPA investments decades ago. These are long-term investments, as well as near-term reversal in the manufacturing footprint that is most critical to the world.

Senator JOHNSON. There is plenty of capital available to invest in semiconductors in the U.S. though, correct?

Mr. GELSINGER. There is plenty of——

Senator JOHNSON. I mean, it is not like we are short of capital.

Mr. GELSINGER. There is plenty of capital to——

Senator JOHNSON. It is just that there is unfair trade practices being engaged in by other countries?

Mr. GELSINGER. You know, other countries have seen the criticality of this industry, and have invested in it as seed corn for so many other aspects of the technology industry. That is why they have chosen to take such practices aggressively. And we, you know, see that such actions need to be taken in the U.S. to restore this industry. Now is the time to act.

Senator JOHNSON. It is almost mutually shared destruction, isn't it? It is going to be a race to the bottom? Again, I am real unabashed free trader, I don't like tariffs, but I almost hate government allocation of capital worse.

Mr. GELSINGER. Well, as we think about things like tariffs and other export policies, by putting those in place, we are actually further hurting American industry, because other countries are not putting such limitations or practices in place on their industry. So to say that it is not helping our industry, but hurting it instead, it is very odd logic.

We need to take steps to restore American competitiveness, to improve our trade practices, and export practices globally. And to do that, partnering with our friends globally is critical as well. Now is the time to act or this industry may never be back on American shores.

Senator JOHNSON. I am fully aware that tariffs hurt American consumers. I got that. But again, I am just concerned about engaging in this race to the bottom in terms of, now government-to-government across the world is going be doing the capital investment for a particular industry. I just think that, long term is not a good solution.

The CHAIR. Thank you, Senator. I am going to go next. But Senator Wicker wanted to make a quick comment.

Senator WICKER. Just to follow up on something you said, Mr. Gelsinger, in response to a question Senator Johnson raised. When was the significant DARPA investment early on, and to what extent did the government supply funds to get us started there?

Mr. GELSINGER. You know, many of the original elements of the semiconductor industry date back to Bell Labs, date back to the earliest days of DARPA, and many of those investments were made 50, 60 years ago that have produced many of the core technologies that the internet, that semiconductors, that AI runs on today. These are very long-term research investments.

That is why we see things like the NSTC portion of the CHIPS Act a critical aspect, because we are not worried about just the next decade of this industry, but decades of this industry to the future.

Senator WICKER. And this will be the last. Do you know if Trans-Pacific Partnership would have addressed some of these problems that Senator Johnson was asking about?

Mr. GELSINGER. You know, I am a big believer in the TPP. I believe that would be good policy to work closely with both our European allies, as well as our Asian allies. These are countries that want to work with us. Also, as I mentioned in my oral testimony, many of these countries, together, represent almost all of the semiconductor technologies and equipment in the world, right, aligning

with our partners and TPP; also the technology trade corroboration that has been initiated between the U.S. and Europe. We view these policies as very positive ones that we fully support.

Senator WICKER. Well, Madam Chair, maybe the witness could supplement his answer on the record specifically about whether TPP addressed the subsidy of other governments of this type of research, in answer to the inquiry of Senator Johnson. Thank you, Madam Chair.

The CHAIR. Thank you, Senator Wicker. And I am going to take my round now. I know we have other members who are waiting, and hopefully we will get to them. And then if people want a second round, we will be here as long as—as long as people want to be.

I would like to—well, first I would like to say, you know, we had the same debate when we were talking about what happened with COVID and the airlines. And we are about to issue a report showing that the investment the government made and made quickly actually is going to pay the government back into the investment.

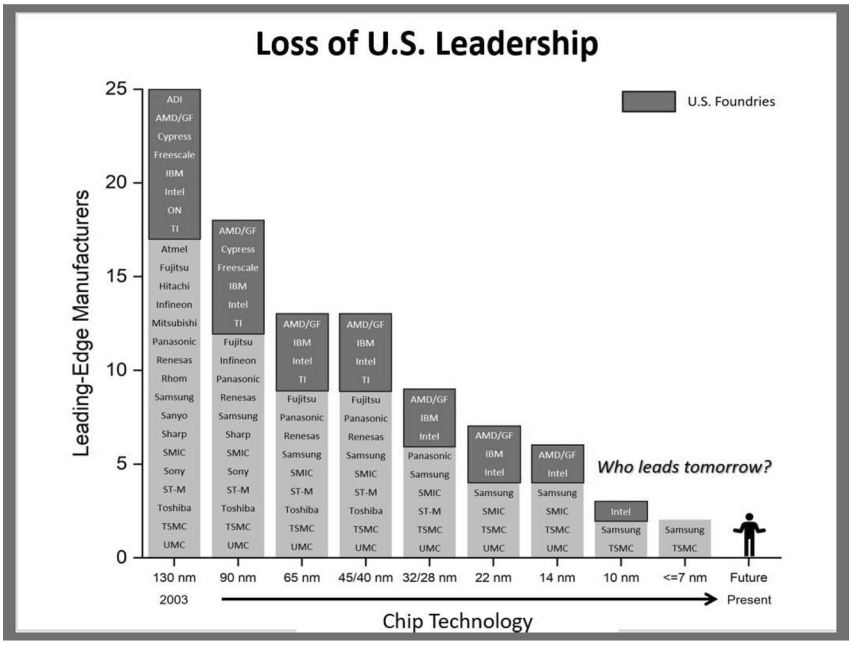
So it was a COVID pandemic, and we had to make decisions about whether to keep a workforce, and keep them running, and the U.S. approach to that worked.

So here, it is kind of, all of you have touched on this in so many different ways. It is about future investment. That is why this hearing is about the advancement of next-generation chips. It is about how does the United States keep its leadership in that? And as you all have noted, we have gone from 36 percent down to 12. And the question remains: If we do nothing right now, where are we going to go?

So I definitely believe in ecosystems, I believe in the manufacturing supply chain that exists for automotives and for aviation. And I certainly want a manufacturing supply chain, and ecosystem to exist on something as essential as chip technology, given the Information Age.

It is, you could say it is the ultimate supply chain, if you will. So the question on this graph here, you can see that the amount of U.S. leadership has continued to fall off as we go to those next-generation chips.

[The information referred to follows:]



The CHAIR. So this isn't asked about how many chips you can produce, or whether you can produce chips that were the last generation of chips. This is about producing the next generation of chips with the higher intelligence.

That is why, I don't know, Mr. Gelsinger, I really liked your detailed testimony about all the advancements that Intel is making. You know, the RibbonFET, the PowerVia, the EUV, that is a partnership with the European company, ASML, and obviously Mr. Archer is talking about this as well, as it relates to plasma.

So this really, envisioned, you are kind of like the ultimate story of translational science that we are trying to capture in the R&D Bill. We are trying to tell our friends here and people in America that we have done a lot of basic research, we have done a lot of advanced research, but China is spending 80 percent of their dollars on commercialization.

So this is about whether we take the next generation of technology and get it deployed faster, and remain on the leading edge, and if we don't, then all of that manufacturing is going to go somewhere else. Not in the United States. And as we can see from what has just happened, I think Americans, like, woke up and understand, intuitively, what supply chain is all about now.

They know exactly what that means. That means they don't get their product. And now if you tell them that the ultimate product of the supply chain chips is all now leading-edge in a country—I mean in Taiwan, then you basically are sitting here with a big vulnerability of the United States. And I think the last events of several weeks make that even more poignant.

So the question is: What is it that we need to keep doing to keep on the leading edge of this technology? So you gave us this—you gave us all these advancements in these chips which I wish I could drill down on, but basically you are talking about IP boost, you are talking about better connectivity, you are talking about more translation of.

So from the first chip to today, what is the difference as far as what it means? And maybe I will ask Mr. Feight what it means to him when it comes to the product that he is trying to deliver today.

But could you just give us, Mr. Gelsinger, or Mr. Mehrotra, what kind of—what are we talking about as far as advancements of chip capability? I mean, I believe in Moore's Law, but help people understand here: The first chip did X, and now here is where we are with this level of advancement.

Mr. GELSINGER. Yes. Thank you. And, you know, on my lapel here I was the chief architect and designer of the 8046 chip for—Intel introduced in 1989. And this chip had 1.2 million transistors on it, right. The most advanced server chip that I just put into your hands here as samples, is on Intel 7, which is: Your chart is now out of date, we are in production on our 7 nanometer products.

You know, this is 25 billion transistors, right; which you know, just is mindboggling the progress that that has made. And as we think about application usages, like in autonomous vehicles, the most advanced AI applications, right, vision detection, and you know, being predictive on management of driving, the most advanced mRNA sequencing capabilities, speech recognition capabilities, of the AI applications across numerous industries.

You know, 5- and 6G connectivity, all of these depend on the most advanced technologies available. They need the highest performance computing at the lowest power capabilities to process these most advanced algorithms. We predict that by the end of the decade, we will have our first trillion transistor chip, right.

And those kinds of capabilities are for many of the immersive experiences of the future that will define the future competitiveness of industries globally.

The CHAIR. Mr. Feight? What do you need, Mr. Feight from them? What do you need them to keep doing that in—as it relates to next-generation technology for your trucks and efficiencies?

Mr. FEIGHT. Sure. I think Mr. Gelsinger spoke well on the high technology end of some of the needs we have for vehicles that are fully electric, or zero emissions, if you are using hydrogen fuel cells. Or in autonomy where visual graphics are so important, and machine learning is so important, we need high-end chip.

But we also, as the industry, the agricultural, the automotive, the truck, many other industries, need some kind of, I will call it more standard chips that keep affordability at the right level, and performance at the right level to make all the cars, trucks, tractors that we need in this country.

And so they shouldn't be left behind in that thinking. It can't have a lifecycle of two to 3 years, otherwise the cost of the products will go up incredibly if we are forced to redesign cars, trucks, and tractors, medical equipment that quickly. So it is kind of at both ends, Senator Cantwell.

The CHAIR. Thank you so much. My time has expired, but I think if Mr. Thune isn't—if Senator Thune isn't available, then I think it is Senator Moran.

STATEMENT OF HON. JERRY MORAN,
U.S. SENATOR FROM KANSAS

Senator MORAN. Thank you, Chairwoman. Thank you, Ranking Member, and our witnesses today, for joining us.

According to a report issued by the Semiconductor Industry Association: Less than 5 percent of the global manufacturing share for packaging, assembly, and testing is done onshore, is done onshore in the United States. We have companies certainly in Kansas and across the United States, I think, that are well positioned, I know are well positioned to increase the capacity alongside chip fabricators, like Intel and Micron, to address shortage issues for the automotive and other industries.

I would ask all three of you can: you comment on the importance of having the CHIPS Act investment address the post-fabrication, or downstream part of the semiconductor supply chain, to reduce the supply chain and security vulnerabilities?

Mr. GELSINGER. Yes. Overall, the indications are exactly, as you say. That package assembly test, which is generally more dependent on low labor cost, has even drifted more aggressively to Asia. We believe it is critical to restore the integrity of the entire supply chain, including advanced packaging, assembly test in America, or at a minimum, in North America.

You know, pieces of the CHIPS Act, specifically, are designed in this area of advanced packaging capabilities. Our objective would be an entire reshoring of the complete supply chain, not only including package assembly tests, but also many of the subcomponents, key minerals, et cetera, all being brought back to U.S. soils. We believe we need a geographically balanced, resilient supply chain for the future, starting with the fabs, the most important thing, but it must also comprehend the entire supply chain.

Senator MORAN. Anyone have anything to add to that?

Mr. MEHROTRA. Yes. I would add that, of course, leading-edge investment—investments in leading-edge technology are the most important, tremendous opportunity to innovate, to differentiate, and to really open up new applications. Of course, priority should be on leading-edge wafer manufacturing as part of CHIPS Act, as well as investment tax credits, both are essential to ensure America's leadership in semiconductor R&D and manufacturing. But certainly, aspects of advanced packaging should also be emphasized as part of the overall development.

I want to highlight here, why investment in leading-edge technology is so important. If you go back to Chair Cantwell's earlier question regarding importance of advancing technology, let me take you back to early 1990s, when NAND technology was taken from the labs into high commercial production. Since then the cost has come down of technology, advancement of technology, by more than 10 million times.

This is what has unleashed tremendous innovation, that memory is today being used in data centers, to smart phones, to PCs, to consumer devices, to electric vehicles in the future, and to continue

to unleash innovation, to continue to provide what technology has delivered, and how it has become the backbone. Leading-edge technology is really, really important, and as part of that leading-edge memory, which is what Micron, as the only company in the U.S. developing and manufacturing semiconductor memory here in the U.S., it is really in important to emphasize this piece as we go forward to bring more leading-edge memory technology onshore.

Senator MORAN. Right.

Mr. MEHROTRA. And these investments, with the support from the government, and CHIPS, and investment tax credits, not only support specific companies, and bringing manufacturing onshore, they create tens of thousands of jobs, hundreds of thousands of jobs over the period of time as well.

Senator MORAN. Mr. Mehrotra, thank you. I am going to try to get a second question in. Before I had to leave for a moment, I heard the importance of research. Where is the funding sources, Federal funding sources that seem to be either available or missing? What is the natural kind of opportunity we have to support research in the United States to keep the technology at its latest advancements?

Mr. GELSINGER. Yes, generally, you know, the research efforts are across, you know, our academic communities, largely National Science Foundation and DARPA have been two sources of sustained government partnerships. We have seen the role of governments funding research to drop dramatically, into the semiconductor industry over the last several decades.

And really that was the seed corn, right, per my earlier testimony that has enabled this industry to emerge. So we believe that those research dollars need to be those long-term material, science, chemistry, creating the future done largely through the academic institutions, the establishment of the National Semiconductor Technology Center, and the CHIPS Act, as well as the Advanced Packaging Technologies, are just great venues to reestablish that kind of focus for the future.

Something that is well established in foreign efforts, we see those in Europe, we see those in Asia, and we have lost that focus in the U.S.

Senator MORAN. Mr. Gelsinger, I am an appropriator for DARPA, I am an appropriator for NSF; I am the lead Republican in that regard, these issues matter to me. And just as an opportunity for you and others, and we have increased the funding for research. Where it is being spent is not necessarily determined by us, but by those agencies.

Mr. GELSINGER. Mm-hmm. Yes.

Senator MORAN. But if there are opportunities that I can be of help, that our subcommittee can be of help to attract the attention necessary to the importance of research in this field, please reach out to me.

Mr. GELSINGER. I would cherish the opportunity to spend more time with you on that topic.

Senator MORAN. Thank you.

The CHAIR. Senator Markey.

STATEMENT OF HON. EDWARD MARKEY,
U.S. SENATOR FROM MASSACHUSETTS

Senator MARKEY. Thank you, Madam Chair. As we consider the $52 billion in taxpayers' money to subsidize the chip manufacturers, we can't ignore the environmental impact of this manufacturing. We need to obviously have a plan in order to deal with all of those issues, so that we are ensuring that we reduce greenhouse gases, that we reduce carbon in the atmosphere.

So my question would be: I know that Lam Research has committed to carbon neutrality by 2050; that is an important step, but it is not enough, you must get to net zero across all greenhouse gas emissions, and to the other witnesses; will you commit that your companies will reach net zero by 2050? Mr. Gelsinger.

Mr. GELSINGER. Yes. We will be shortly describing a detailed plan to accomplish net zero by 2040, and we are laying out a more aggressive plan to, you know, be RE100 in 2030, net zero by 2040. We have also been widely recognized——

Senator MARKEY. Is that all greenhouse gases?

Mr. GELSINGER. Yes.

Senator MARKEY. OK.

Mr. GELSINGER. Yes. And we have also been widely recognized as a company for our leadership work in areas like water reclamation, you know, minimizing of hazardous gas and chemicals, as well as our overall efforts in sustainability, something we have received numerous awards for on a yearly basis now for many decades.

Senator MARKEY. Great. So next, sir?

Mr. MEHROTRA. Micron has a strong program and emphasis on——

Senator MARKEY. Will you make that commitment? Will you make a commitment to reduce down to zero greenhouse gas emissions by——

Mr. MEHROTRA. In the long term, we absolutely will be getting——

Senator MARKEY. In the long—and the "long term" is which year?

Mr. MEHROTRA. We have a program in place regarding, and investments being made——

Senator MARKEY. No. But which year are you——

Mr. MEHROTRA. We will soon be announcing that. We have not yet laid out the year, but we are making strong progress with respect to greenhouse gas reductions, waste management.

Senator MARKEY. Right.

Mr. MEHROTRA. Water recycling, as well as renewable energy usage.

Senator MARKEY. Right. Which is admirable, but we need dates. We need commitments.

Mr. MEHROTRA. We are absolutely aggressively——

Senator MARKEY. If Intel can make these promises, we expect you to make the same promises.

Mr. MEHROTRA. Absolutely.

Senator MARKEY. I just want to say that to you. And we are going to hold you to it, and you will hear from us if you don't, if you don't do that.

Mr. MEHROTRA. Absolutely.

Senator MARKEY. This is a bargain, OK. We can do both at the same time. We can compete on the one end, and also show the rest of the world that you can reduce greenhouse gases.

The CHAIR. Senator Markey, I just want them to produce enough chips so we can electrify all our transportation sector right now, is what I would hope. But I do agree, hold some goals out here. That is great.

Senator MARKEY. Right. Well, they should be the model. OK. We can't expect the rest of the economy to be efficient if the industry that prides itself on providing the technology to make us efficient cannot do it. OK. So they should be able to square that up in terms of their own corporate agenda.

And onto water usage, the production of semiconductors requires millions of gallons of water per day. Semiconductor companies' water usage is skyrocketing. Intel and Micron both use approximately 14 billion gallons of water in 2020, chip manufacturers must work to restore water to their local water systems so that they are replacing the water they use with an equal amount of clean water.

I want to acknowledge Intel for pledging to be net positive on water usage by 2030. Mr. Mehrotra, can you make the same commitment?

Mr. MEHROTRA. We actually in Boise, Idaho, have a program in place with 75 percent reduction in water—waste water improvements with 75 percent. And we have, absolutely, programs in place. And I wanted to also highlight to you that we have made commitment to be investing over a billion dollars over five to 7 years in programs related to sustainable operations. Again, related to all aspects, including water, water recycling.

Senator MARKEY. Can you, can you commit to being net positive on water usage by 2030, Mr. Mehrotra?

Mr. MEHROTRA. So we, again, have timelines outlined in our reports that we publish on sustainability on an annual basis. And we are absolutely committed to continuing to make improvements in these areas.

Senator MARKEY. OK, well, there is an old saying, "To those who much is given much is expected." So a lot is going to be given to the industry by the Congress, and we have high expectations for you to be the model. So we will be looking very closely at the commitments that you are making, because it is critical that we solve the supply chain problems, there are increasing prices and harming consumers.

But we have to do it simultaneously, while solving the climate crisis, and ensuring that the environment is not collateral damage, or just something that is an afterthought. And that has historically been the case. So we just want to let you know that we will want you to——

Mr. MEHROTRA. And Senator, I want to highlight, it is a priority for us. We publish a sustainability report on an annual basis, our milestones and our goals are outlined there. And you will hear more about this, in terms of specific goals coming from us, and higher, and ambitious targets in this regard soon.

Senator MARKEY. OK. The sooner, the better, and the higher, the better; OK. So we look with——

Mr. MEHROTRA. We are aligned.
Senator MARKEY.—anticipation to your announcement.
Mr. MEHROTRA. We are aligned on these goals.
Senator MARKEY. Thank you.
The CHAIR. Thank you, Senator Markey.
Senator Scott.

STATEMENT OF HON. RICK SCOTT,
U.S. SENATOR FROM FLORIDA

Senator SCOTT. First, I want to thank Chair Cantwell for hosting this important hearing. I want to thank each of you for being here. My background is, I ran companies, I build companies, I start companies from scratch. And so I learned pretty early that, if you didn't get a return on investment, you didn't do very well. Also as a business person, you try to look at what is going on around the world, and one thing I would be focused on today if I did business in Communist China is to look at what is happening in Russia right now, where the American public is furious with what is going on with Ukraine. We are expecting our American companies to stop doing business with Russia. So if I was doing business with Communist China today, I would be concerned that the same thing will happen when Communist China decides to invade Taiwan.

So first, Mr. Gelsinger, I want to talk a little about Intel. The company is clearly doing well. You are one of the top 10 most-profitable companies in America. You are the world's second-largest semiconductor producer, and last year you made $20 billion in income with a 25 percent profit margin.

I think everybody in business in the world would be very proud of that. Those are great numbers. You also invested $25 billion last year, including some chip making expansion. Thank you for your expansion, which should have been in Florida, but your expansion in Arizona and Ohio.

So I am a business guy. I like the fact people are investing. When speaking about billions of dollars in Intel's new capital investments last year, you said, quote, "It does not depend on a penny of government support, or state support, or any other investments to make it successful. We are making these commitments without any commitments from the government to accelerate them."

But what is interesting is, you have completely changed your tune recently. You are also quoted as saying, "Let us not waste this crisis," in regard to receiving taxpayer handouts, which should scare all of us. This is on top of your company apologizing to Communist China for the U.S. sanctions on the Xinjiang region, where the Chinese Government is committing genocide on the Uyghur people.

Look, I am a business guy. I have heard countless pitches for capital. Here is my question for you. Number one, I feel like we are fiduciaries for the American taxpayer. They give us their dollars; they want to make sure those dollars are spent well. So tell me, if we put this, all this money in, and my understanding, your company will get $4 billion, if we put all this money in, how does the American taxpayer get a return?

On top of this, why wouldn't you, as the CEO of a company doing significant business in China, be scared to death of what is going on now with whether it is the Uyghurs, stealing the basic rights of Hong Kong citizens, harvesting organs of prisoners, and then you watch what has happened in Russia, knowing that American public is going to be furious with a company that still does business with Communist China if they continue to do those atrocities, and then invest in Taiwan?

So give me your pitch about: Why, as an American taxpayer, we get a return? And two, why your company isn't putting even more money into America, and other allies to get away from Communist China?

Mr. GELSINGER. Thank you, Senator Scott, for those thoughts.

First, I want to emphasize that we are putting our chips on the table. I have lowered our profitability by 600 basis points this year. I have made the company free cash-flow negative for the first time in three decades. I have doubled our capital investments all to the howls of Wall Street. We are investing heavily in rebuilding Intel, but American leadership in this critical industry. I want to go bigger and faster. That is what the CHIPS Act will enable us to do. Go bigger, and faster, and invest for the long term.

Senator SCOTT. Let us go to the return for our taxpayer. We are all fiduciaries for taxpayers. I am glad that Intel is doing this. It sounds like it will be a great investment for Intel, getting a bunch of Federal money. Tell me how I get a return for an American taxpayer?

Mr. GELSINGER. These are extraordinary industries that are leveraged across every other industry. Every job we create creates on average, greater than 10 other jobs, the work that we have done in Arizona and Oregon.

Senator SCOTT. Are you going to report on that?

Mr. GELSINGER. You know, and Senator Wyden was——

Senator SCOTT. Excuse me. Excuse me. You have a report that shows me that—the thing about it, I am a fiduciary for taxpayers.

Mr. GELSINGER. Yes.

Senator SCOTT. So you are saying it is going to create ten more jobs for every?

Mr. GELSINGER. On average it has been well publicized in our sites in Oregon and Arizona, it is what was put forward for the investments around Ohio. These are incredibly leveraged industries.

Senator SCOTT. And that is great. How does that turn into cash for the American taxpayer?

Mr. GELSINGER. Right. Creating jobs across the supply chain in manufacturing, in construction, our Ohio site is creating 3,000 new jobs, 7,000 new construction jobs, and it is——

Senator SCOTT. How much money does the American taxpayer get? You asking for $4 billion for your company. What return does American taxpayer get for that? How much? So you invest these dollars, you are going to make money, I assume, you are not doing it if you didn't make money. How does an American taxpayer get a return?

Mr. GELSINGER. These jobs would drift to other areas. We want them on American soil. They create jobs that are tax-paying, great jobs. And we are happy to go into more detail with you, Senator

Scott, right, on all of the reports and data that we have done. But these are seen as some of the most lucrative job-creating, tax-producing, you know, industry and community creating jobs in America.

Senator SCOTT. Let me just finish that. So I am a CEO. I ran companies. We had to get a return. We had to pay our banks back, we had to get a return for our shareholders. As Governor of Florida, we did probably a thousand economic development deals. I could tell you, I got on an average ten times my money back. So it sounds really nice, but I have never seen one report that says I will ever get a dime back if you get $4 billion.

Mr. GELSINGER. Well, every dollar——

The CHAIR. Senator Scott, I think we have got to move to our next witness. But in this, I am just looking at the written testimony. So I guess you could say that is a submission to Congress, and in Intel's written testimony, California annual economic impact from Intel's $24.9 billion, Oregon is $19.3 billion in annual impact. Arizona is $8.6 billion in annual impact. So New Mexico is $1.2 billion in annual impact, Texas doesn't have the exact number there, and Massachusetts.

So I think the issue is $52 billion from us, and we have a long way to go in this process, but I think you are going to see that it is about building that ecosystem. And I do think you will see annual revenues that will—I think that clarification to Mr. Gelsinger's statement was that they are going to Ohio, no matter what, and building. The question is, could they expedite and build more? And if CHIPS passes, they are likely to do that acceleration, so anyway. Senator Klobuchar.

STATEMENT OF HON. AMY KLOBUCHAR,
U.S. SENATOR FROM MINNESOTA

Senator KLOBUCHAR. Very good. Thank you very much, Chair Cantwell, and thank you for holding this hearing. Thank you to all of you. It is a nice break from judiciary, honestly. There is just a little thing going on in the other hearing room.

I wanted to start with you Mr. Gelsinger, and Mr. Archer, on the subject of workforce shortage, I am obsessed with this. My state has a really low unemployment rate, which is a great problem to have, but we have 18 Fortune 500 companies somewhere in that range.

And I believe the answers are broad. The answers are, of course, immigration reform, lifting visa caps, workforce permits, but also apprenticeships, and one-and 2-year degrees. And Senator Moran and I have a bill, which was included, actually, in the America COMPETES Act over in the House, which would allow workers to earn college credit for completed apprenticeships, creating a pathway for workers to gain skills. Can you talk to the role of public-private sectors working together on this angle of workforce shortages?

Mr. GELSINGER. Yes. We are extremely proud to be partnering. And in fact, just last week we announced $100 million partnership with NSF for job creation, primarily in the Midwest around our Ohio site announcement. This builds on a long history of public-private partnership and job creation. You know, we are making strong

advancements in areas like underrepresented minorities, and females in technology, strong investments in STEM.

I personally am a product of the community college system, a farm boy from Pennsylvania, who is now leading one of the most iconic companies in American history. I deeply believe in these principles.

We have also seen that we have launched our AI for the Future Program, specifically aimed at community colleges. Many of our workforce are hired, you know, with no or minimal technology education. And we provide that in partnership with many of the local community colleges as well. This is core to our future.

Senator KLOBUCHAR. OK. Thank you. My dad went to a community college, as did my sister. So thank you.

Mr. GELSINGER. Yes.

Senator KLOBUCHAR. Mr. Archer, quickly, because I have another question.

Mr. ARCHER. Sure.

Senator KLOBUCHAR. Thank you.

Mr. ARCHER. Well, I think as Mr. Gelsinger said, it is important to the industry. We think about chip shortage and many of the bottlenecks to recovering from this, one of them is the tight labor market that we face today.

Senator KLOBUCHAR. Mm-hmm.

Mr. ARCHER. Not only companies like Lam Research, but also in the hundreds of American suppliers that we depend on. And those suppliers are spread across 37 different states and they are feeling the pain of, not enough workers to fill these high-skilled jobs. So we are very supportive of any type of government program that helps to bolster, yes.

Senator KLOBUCHAR. And immigration reform.

Mr. ARCHER. And immigration reform.

Senator KLOBUCHAR. OK. Very good.

Mr. ARCHER. Of course, that is important for us in California as well.

Senator KLOBUCHAR. Exactly.

Mr. ARCHER. Yes.

Senator KLOBUCHAR. All right. Mr. Mehrotra, I know Micron employs 110 people in Minnesota, who design chips. Thank you for that. Not who is counting, but I am. I also visited SkyWater in Bloomington, Minnesota, in fact, the President at one point held up one of our Minnesota chips, which produces 65 and 90 nanometer chips. Can you talk about the importance of investing in U.S.-based companies in the production of semiconductors and innovation?

The CHAIR. Turn on the mic.

Senator KLOBUCHAR. Yes. Say that again, in the microphone. Yes, that is good.

Mr. MEHROTRA. It is on.

Senator KLOBUCHAR. There we go, yes.

Mr. MEHROTRA. I just want to say again, that we are very proud of our team in Minnesota. They are absolutely leading-edge engineers working on some of the most advanced work that Micron is doing. And Micron today is leading the world in semiconductor memory and storage technologies.

And it is really imperative as part of Micron's announcement of investing more than $150 billion over a decade in leading-edge, semiconductor manufacturing and R&D, that we have the opportunity to bring manufacturing, leading-edge memory manufacturing onshore.

Of course, we are here in Manassas, Virginia, manufacturing with nearly 2,000 team members, and investing in advanced memory manufacturing and storage, and supplying the markets, such as automotive market, defense, and industrial. But we need to bring more manufacturing into the U.S., and Micron is committed to doing it with support from CHIPS Act, and investment tax credits.

As the only company in the U.S. making semiconductor memory and storage, we fully recognize our responsibility, and we seek the support from the government policies to enable us to be able to be part of building resilient, semiconductor leadership here in the U.S.

Senator KLOBUCHAR. OK. Well, thank you. And I will just put on the record a question about Senator Thune's and my Shipping Reform Act. I think it is really important, if we are going to make stuff, and invent things, and export to the rest of the world that you are able to ship to the rest of the world, which means not having empty containers, chips, and having reasonable rates.

And so we are excited under Senator Cantwell, and Senator Wicker's leadership that the bill was marked up, and unanimously got through this committee just a few days ago, and is headed to the Senate floor. So thank you very much, all of you.

The CHAIR. Thank you. Senator Thune, a good follow on to you.

STATEMENT OF HON. JOHN THUNE,
U.S. SENATOR FROM SOUTH DAKOTA

Senator THUNE. Thank you, Madam Chair, for holding this hearing. And let me just start by saying that the United States remains the world leader in technology innovation. It is the birthplace of industries that feed the Nation's economic dynamism, and benefit the lives of Americans, and people across the world.

It is essential that we can ensure our supply chains continue to innovate as well, providing them with the agility to respond to advances in technology, or disruptive events, like the COVID–19 pandemic, or Russia's war in Ukraine, which is why I have worked in a bipartisan manner, and as Senator Klobuchar mentioned, with her and Senator Wicker, on legislative solutions like the Ocean Shipping Reform Act and the FREIGHT Act to ease current strains, and to bolster the global competitiveness of U.S. products and industries. The effects of the semiconductor shortage highlight the importance of supply chains, perhaps most notably in the Nation's auto industry, which produces more than 11 million vehicles annually.

The transformation to automated vehicles, or AVs, is going to place a much greater demand on semiconductors and other crucial products, so it is crucial that the United States remain globally competitive in this space. AVs will radically transform the way Americans move. It is especially true for the elderly and persons with disabilities whose current transportation options are limited, especially in rural areas.

Moreover, it has potential to greatly to reduce the average of more than 40,000 traffic fatalities in our Nation's roadways each year, while American companies currently lead the world, Navy technology, the advantage cannot be taken for granted in allowing China to seize the mantle of innovation is unacceptable. And the U.S. must act boldly to maintain its position.

The U.S. regulatory framework and our supply chains must catch up with private sector innovation in order for these technologies to advance. There are tens of thousands of good-paying jobs, and billions of dollars in investment that are at stake, which is why my colleague, Senator Peters and I have worked together for the better part of 5 years to develop and enact AV legislation, a crucial component in maintaining U.S. leadership in this emerging industry.

AVs have potential to once again, transform the way Americans move and the U.S. must once again lead the world in this transportation revolution.

Mr. Feight, in your testimony, you mentioned engineering and innovation centers working toward the development of autonomous and connected vehicles. Beyond bolstering U.S. technological competitiveness through investments in supply chains and domestic industries, what do you believe Congress or the Department of Transportation can do to encourage the testing and deployment of AVs?

Mr. FEIGHT. Well, first of all, Senator Thune, thanks for the comments. I think you are right on with the opportunities of what AVs can bring to our country and the world, and I think that it is nice that we are, in America, the leader in the technology. And as PACCAR, that we are partnered with leaders in the technology, with Aurora, with Waymo, Kodiak, Embark, and others in our development efforts.

So I think that what we really need is the clear vision of what will be allowed from a legislative standpoint. And that we are going to need to clarify what the judicial requirements are going to be in terms of liabilities as we move forward.

Right now, the industry is in a really good spot in developing level four autonomy, and we are moving it forward. It needs to be done safely. That is the most important thing. Safety has to be the most critical factor, and we will continue to focus that way. And then we will develop capability over a period of time when it is safe, in certain corridors, and those corridors need to be clearly identified.

And then we just need to have a general knowledge sharing between government and industry on how we make sure that we roll this out in an effective way. So I think it is a dynamic conversation that we are happy to engage with on an ongoing basis.

Senator THUNE. Thanks. Mr. Gelsinger, given Intel's work in this space, do you have anything to add on promoting the domestic development of AVs?

Mr. GELSINGER. Yes. Clearly this is an area that the world is moving rapidly. We find some of the regulatory policies in other parts of the world are more favorable now, and some of those nations are moving ahead more rapidly. So we do believe this is an area that requires much more active positioning.

Our Mobileye Division is one of the clear leaders in the world in this area. And right now we are seeing far more progress on other portions of the world in deploying AV vehicles for both commercial fleets, as well as consumer fleets. Much of the technology is being developed here, but the deployment is actually being led at other places in the world. Time to act; this is urgent if you want to stay ahead.

And I would also emphasize that AV is one of the most advanced uses of AI capabilities, requiring the most advanced semiconductor technologies as well. So it reinforces the heart of this hearing today. We need the most advanced semiconductors. Today the auto is about 4 percent semiconductors.

It is estimated to be 20 percent semiconductors, five-X increase by the end of the decade. So the dependency on semiconductors for these advanced areas, like AV, is absolutely essential for the auto, and trucking, and transportation industry of the future.

Senator THUNE. Thank you. Madam Chairwoman, my time has expired. I have got a question on 5G that I will submit for the record, but thank you.

The CHAIR. Thank you, Senator Thune. I saw Senator Tester earlier. He would be next if he is available. If not, we will go to Senator Baldwin. Senator Baldwin.

STATEMENT OF HON. TAMMY BALDWIN,
U.S. SENATOR FROM WISCONSIN

Senator BALDWIN. Thank you, Madam Chair. And like my colleague, Senator Klobuchar, I have been jumping between committees. So it looks like I missed a show and tell at the beginning. But I will wait until after the hearing to catch up on that.

I also want to chime in, along with my colleagues about restoring American leadership in semiconductor manufacturing, that Wisconsin would make an ideal location for some of that expansion, just planting that seed.

But as we are well aware, right now Congress is on the brink of putting together a conference committee to advance the variously named competition bill, and I hope that we will do our jobs without delay. But during the debate over the CHIPS Act many pointed out the generous incentives provided by foreign governments to domestic manufacturers.

However, few have noted the different spending priorities of foreign competitors, particularly on the issue of stock buybacks. For example, over the last 20 years looking, you know, at that time horizon, Intel spent about 64 percent of its net come on buybacks. A whopping $127 billion, while Samsung spent only 10 percent, and Taiwan semiconductors spent 2 percent.

So as a supporter of the CHIPS Act, I want to ensure that the Federal Government gets a proper return on its investment, namely, an increase in the domestic semiconductor manufacturing base. And as such, I would like to ask each of the semiconductor manufacturer witnesses to briefly describe your spending plans for the next few years, and explain how you envision chips funding, potentially, fitting into them. And if I could start with Intel? Mr. Gelsinger.

Mr. GELSINGER. Thank you. I came to the role as CEO slightly over a year ago. I ceased our buyback policy immediately upon my arrival. I laid out to Wall Street, a radical increase in our capital expenditures, more than doubling them, taking the free cash-flow of Intel negative for the first time in over three decades, reducing our profitability by 600 basis points, more than doubling our long term capital investments, and indicating to the Street that I expected to see that level only increase for the rest of the decade.

This is the largest capital build out, probably done by any company in any industry in history. The majority of that will land on American soil, but I do not believe that is enough, and I can't do it myself. The CHIPS Act is intended, from my perspective, to enable me to go bigger and faster than the bold commitments that we have already made that have reached, you know, very negative response from Wall Street.

We want to do more and faster. This is all about restoring U.S. competitive, bringing back this mantle from Asia on a critical industry, not only for our economy, but also our national security. We are all in.

Senator BALDWIN. Thank you. Mr. Mehrotra.

Mr. MEHROTRA. Senator Baldwin, as I highlighted earlier, Micron is the only company in the U.S. that manufactures semiconductor memory and storage. And semiconductor memory and storage represents 60—nearly 60 percent of the worldwide wafer production. And we are the only company here manufacturing and developing leading-edge technologies. Today, we are the global leader in technology for DRAM and NAND, ahead of all other global competitors in developing that technology and putting it into production.

We have done so by making billions and billions and tens of billions more than that investments over the course of the last few years in leading-edge R&D, and investments in manufacturing. We will always prioritize our investments in R&D and manufacturing to be able to secure leadership for Micron in semiconductor memory technology, and to be able to meet the growing needs in this world of data economy, for more data solutions, which we make, memory and storage solutions.

So that will always be our highest priority. As part of that, we have announced in October of last year, that over the decade, we will be investing more than $150 billion in leading-edge R&D and manufacturing. So that is the priority to continue to drive innovation, to continue to invest in R&D, to continue to support the manufacturing. That is our plan. And that is our focus.

Senator BALDWIN. Mr. Archer.

Mr. ARCHER. Yes. So Senator Baldwin, we manufacture the machines that are used to make the chips. And so our priorities for the future is the same as they have been the last couple years, which is to expand our capacity, nearly 70 percent of our manufacturing capacity is in the U.S. We spend about 90 percent of our R&D in the U.S., last year it was at $1.5 billion.

Our priorities for the future are just to continue to invest, to accelerate innovation in support of the domestic and global semiconductor manufacturing industry, in order to try to alleviate many of the global shortages that we have seen in chips. They are affecting

so many different industries. And so we are—we are going to just continue to invest and to maintain our leadership in this space.

The CHAIR. Thank you, Senator Baldwin. Senator Warnock.

STATEMENT OF HON. RAPHAEL WARNOCK,
U.S. SENATOR FROM GEORGIA

Senator WARNOCK. Thank you so very much, Madam Chairwoman. Whenever I am back in Georgia, I hear about the rising costs for families, and I am deeply alarmed by how the global semiconductor shortage is behind many of those rising costs in the automobile industry. We have seen costs increase for new cars by 11 percent, 37 percent for use cars.

Almost everything relies on semiconductors, not just cars, but cell phones, washing machines, which means that due to this chip shortage families have faced sharp increases in the cost of computers and cell phones, which they need for work and school, and many other products.

Mr. Gelsinger, yes or no; do you agree that the semiconductor shortage has likely contributed, at least in part, to higher prices of things that families rely on, like cars, computers, and washing machines?

Mr. GELSINGER. Yes. I agree.

Senator WARNOCK. In fact, rising costs, don't just hurt car buyers, thousands of workers like those at the Kia plant in West Point, Georgia, which had to shut down a couple of times, and have been affected by the shortage. And that is why last May I proudly supported Federal funds to increase domestic semiconductor production. I was proud to work with Senator Peterson on that issue, when the U.S. Innovation and Competition Act went through committee this last May. And I supported it again when the House recently passed the America COMPETES Legislation.

Mr. Gelsinger, do you also agree that providing additional resources to the CHIPS for America Fund would help alleviate the semiconductor shortage.

Mr. GELSINGER. Yes. I believe it would. It takes time to build new factories. So, you know, the urgency associated with this is critical, but unquestionably this will help to alleviate the shortages mostly in the medium and longer term, but immediately helping is a very positive step. We have already wasted several quarters since the Senate acted last year. And now it is time for us to move forward rapidly.

Senator WARNOCK. I agree. I think it is past time. And that Congress move immediately and pass this funding that the President needs to sign into law. Now, related to the semiconductor issue, America of course needs a robust semiconductor workforce that reflects the diversity of the Nation. As Congress makes investments in domestic semiconductor manufacturing, we must make sure that we have the benefit of all of our talent, that we ensure that businesses are doing what they can to make semiconductor jobs more accessible, and attract partners from underrepresented communities.

I am a graduate of an HBCU, I would argue the greatest of all, Morehouse College. But I have long been a champion for all of our

HBCUs, which have been punching way above their weight, doing so much, for so many, for so long, with so very little resources.

I am proud to have fought for $1.2 billion in funding in recent—in the recent competition package to support research, capacity building at HBCUs, and MSIs, including for semiconductor-related research. And I also recently sent a letter with Senator Padilla supporting a provision in the America COMPETES Act that would create an office of opportunity and inclusion at the Department of Commerce to develop standards that will help expand opportunities in the semiconductor industry for traditionally underrepresented individuals.

So I want to ask each of you: As industry leaders, would an office of opportunity and inclusion support the semiconductor industry's efforts to attract more women, more people of color, and rural workers; and do you see this as essential to the work? Mr. Gelsinger.

Mr. GELSINGER. Yes. I would say whether we have the office or not, we are deeply committed to these topics. You know, and we have been increasing our underrepresented minorities, and our female workforce. We set a goal to have 40 percent females by 2030, part of my selection of Ohio, right. And our recent education initiatives that we just announced last week for $100 million investment were specifically because of increasing our minority and female workforce. We would love to discuss this topic with you more deeply.

Senator WARNOCK. Do you think having an office might encourage others similarly positioned to make a similar commitment?

Mr. GELSINGER. We certainly could, and we would look forward to that conversation with you.

Senator WARNOCK. Mr. Mehrotra? Sorry, I hope I didn't butcher your name.

Mr. MEHROTRA. No. You didn't. Thank you. Senator, we are well aware of your and Senator Padilla's letter regarding Office of Opportunity and Inclusion in the Commerce Department. I would like to highlight that Micron has been a strong proponent. It is a core value of Micron to promote greater diversity and to increase representation of minorities within Micron.

We publish a diversity and inclusion report, we call it "For All" every year, and this report highlights our key initiatives, in terms of increasing representation across all diverse groups, in terms of pay equity, not only in terms of gender pay equity, but pay equity not only for salary, but for bonuses, and stocks, for all underrepresented groups in the community, focus on engaging with minority-based suppliers as well.

So we have—and putting our cash, investing it with those that represent minority institutions in terms of financial institutions. So we have several initiatives, we report our progress. Our values are very much aligned with promoting greater opportunity and inclusion, and we continue to be strong supporters.

Senator WARNOCK. So you would—you would support such an office, and you are pledging your own commitment to make sure people of color and women are represented, and provided access to employment opportunities. Mr. Archer.

Mr. ARCHER. Yes. Also at Lam Research, this is an incredibly important topic and, and therefore, we are supportive of any activities that can help us expand the workforce in the United States including tapping into diverse work groups. One of the things that we are most proud of is we partner with organizations like the National GEM Consortium, which has members, many of which are the HBCUs.

And what we promote is trying to help students pursue advanced degrees, masters' and PhDs in science and engineering, so that they can build meaningful and long-lasting careers in companies like ours, and others throughout the semiconductor industry.

Senator WARNOCK. Thank you all so much. I look forward to working with industry leaders to increase semiconductor production in our own country, and that we make good use of all of our talent.

Mr. MEHROTRA. And Senator, I just wanted to highlight to you that we recently opened a center in Atlanta, Georgia, and we are engaged with the HBCUs there as well. And the purpose of this design center that we have opened there, where we will be recruiting 500 engineers over the course of the next few years, is really to, again, tap into outstanding, diverse talent that exists in the region.

Senator WARNOCK. Thank you so much.

The CHAIR. I don't see Senator Fischer or Young. I know Senator Young said he was coming back, but we will just keep going on our side. Senator Peters.

STATEMENT OF HON. GARY PETERS,
U.S. SENATOR FROM MICHIGAN

Senator PETERS. Well, thank you Chair Cantwell. And thank you for convening this incredibly important hearing, and great to have the witnesses here as well.

As we see on our desk here, these semiconductor chips can be small as a fingernail, but we know that these tiny devices have absolutely enormous impact across the economy and our society. And certainly a clear example is the auto industry, something I am very close to as a senator representing the Great State of Michigan.

And I know that before the 1970s, cars simply didn't have any chips, a very few, then started having a handful of chips to deal with just kind of the engine functions, and make that work a little smoother. And then in a few span—or a few years later, cars relied on chips for just about everything. From safety devices, to things like power windows, instead of that crank there, it is a chip that allows us to do that.

They have basically become ubiquitous, and some cars or vehicles now have over a thousand chips in them. And in light of this trend, it is no surprise that the pandemic contributed to a global chip shortage. And when that happened it hurt auto production, and auto workers, particularly hard.

As we look to the future, chips are going to play an even more important role in mobility, as they are essential, as I think was discussed earlier, for both electric vehicles, as well as autonomous vehicles, which represents the future for the auto industry. That is why I am excited to chair a hearing in Detroit this coming Monday,

and we are going to examine the role of semiconductors in the future of automotive innovation.

And I certainly believe it is essential that we make our semiconductor supply chains as resilient as possible, not just efficient, but highly resilient to—and I think my state of Michigan is particularly well positioned to lead this effort. Not only will this grow jobs and economic activity in the semiconductor industry, it will also strengthen the entire economy, especially when it comes to, not just cars, but all products that use these chips.

So Mr. Mehrotra, as you know, and as you have mentioned cars are becoming increasingly electric and autonomous, and Michigan is certainly leading the way in the manufacture of these vehicles. But automakers in Michigan are also going to require more in sophisticated semiconductor chips as we move forward, not just the legacy chips we have now, particularly when it comes to memory and to storage.

Indeed you described the vehicles earlier as a future data center on wheels, which is basically, clearly, what they are now and, will increasingly be. This is just one reason why I expect that Michigan is going to be a significant player, we are a major manufacturing state, home to many other industries that see their products more integrated with chips, from medical devices, to defense applications.

Michigan's future with the semiconductor industry is also rooted in world-class universities and training programs, which prepare workers for these roles, as was discussed earlier, from R&D to making cutting-edge products.

Simply put, another plug for my state, Michigan knows how to make things. So it is no surprise we are seeing a major influx of investment around semiconductor technologies, like KLA operating its second headquarters in Ann Arbor. And without a doubt in my mind, funding for the CHIPS Act will be critical for growing this forward.

So my question for you is, Mr. Mehrotra, can you discuss how Micron's memory and storage technologies will play a role in electric and autonomous cars of the future, as well as all of the other products we make in our manufacturing state?

Mr. MEHROTRA. Senator Peters, thank you for your question, and giving me the opportunity to highlight here that in semiconductor memory and storage, Micron has, globally, number one market share. So we have been strong partners to supplying to the automotive industry globally, and strong partners to the U.S. auto manufacturers.

And during the pandemic with various supply chain, semiconductor supply chain shortages, we worked closely with automakers, and made sure, pleased to say, that we, our memory and storage solutions did not cause any line-down situations. And we continued to be a strong provider of our solutions to them, and will continue to maintain our number one market share leadership in this very important, and fast growing segment for the semiconductor industry.

And we have earned this number one market share based on the high quality that Micron is focused on delivering to this industry, but also high quality that is focused on delivering solutions, wheth-

er in data center, or intelligent edge, or a multitude of user devices that are using more and more memory and storage.

You are absolutely right to point out that I often say that autonomous vehicles are becoming data centered on wheels. Today, you know, they have a roadmap that will be using more than $750 of semiconductor—semiconductor memory and storage content in these vehicles more than 15 times higher than the standard vehicles of the past.

So this is a tremendous opportunity, and Micron's focus on leading-edge technology is important. We are continuing to work with automakers to help them transition to the newer technology nodes faster because that increases the availability of memory supply. And in general, moving faster to leading-edge nodes, help increase the availability of all semiconductors, and avoid the kind of shortages and situations that have occurred in the past.

So this is an important initiative. The partnership with the auto industry is important, and of course making investments here in the U.S. with the support of not only just the CHIPS Act, but also with the investment tax credits is critically important.

And Micron is looking forward to having these legislations get across the finish line, so that with a sense of urgency, we can begin to play catch up in terms of bringing leading-edge memory manufacturing onshore.

Senator PETERS. Right.

Mr. MEHROTRA. And play catch up with Asia, which has been investing, for the last 20 years plus, heavily with the government support, in bringing their semiconductor manufacturing onshore.

Senator PETERS. Well, thank you. Thank you for that answer. Thank you, Madam Chair.

The CHAIR. Senator Rosen.

STATEMENT OF HON. JACKY ROSEN,
U.S. SENATOR FROM NEVADA

Senator ROSEN. I thank you, Madam Chair, for holding this hearing. And I want to say, as a former computer programmer, when I started those disc drives were called platters, they were giant. We had giant rooms that had to be cooled. Everything was big. And now, look, the smallest thing is even smaller than this. It is amazing. It is lighter, cooler, faster, and more powerful. So thank you for bringing those.

And I really want to talk about the semiconductor impact on broadband, because the shortage has far-reaching consequences across sectors, particularly broadband they are an essential part of our telecommunications network, our consumer, our business equipment, our modems, our routers, our gateways, our devices, everything depend on the chips to manage it, to control it, to collect our information, divert information, store it, whatever that is.

And the telecommunications industry has been sounding the alarm on shortages impact on deployment, particularly of our broadband across the country. And I was a member of that group of 22 senators who helped draft the Infrastructure Bill including the state broadband grant program, the Middle Mile Deployment Act.

And I know that these programs will provide critical funding to state and localities for reliable, high-speed Internet to the last mile, really our rural areas, being the frontier rural areas in Nevada being really adversely impacted.

So, Mr. Gelsinger, in your talk about the impact, the semiconductor supply chain issues, and shortages that they have had in the telecommunications industry, and how are the current semiconductor supply chain delays. How do you think they may impact the Federal broadband programs, particularly those ones we just created with the Bipartisan Infrastructure Law?

Mr. GELSINGER. Thank you. And, you know, first I would also want to point out that just 3 years ago, we were desperately fearful if we would have lost control of the technologies associated with our 5G networks.

Today, technologies such as Open RAN, or Open Radio Access Network, are now opening up the 5G networks. And in fact DISH, Verizon, AT&T, Rakuten, are all building those on Intel-based, Open RAN platforms. We have solved this international crisis that faced us in a technology lean-forward way.

Also the period of COVID has shown the criticality that we have on our broadband networks, literally overnight, right, every worker and every school child became an online student or worker, right. It was tremendous. And thus the efforts around building the broadband future, right, are absolutely essential. And we have seen the productivity benefits that result as we have come roaring out of the COVID economic challenges.

That said, the future is still in front of us. And as we look to 5, 6G, you know, deployments of autonomous vehicles, not just smart cities, but also smart factories, with areas like private 5G and 6G, they depend on the most advanced semiconductor technologies. So what we are laying out here is literally the underlayment that is required to keep the U.S. competitive on the next-generation communications and broadband technologies.

This is essential to every aspect of the innovations that we are working on for the future, whether that is autonomous, whether that is, you know, private and consumers, whether that is factories and workers, and literally to be the unquestioned leader at 6G and beyond, this will be supported as a result of the CHIPS Act.

Senator ROSEN. Well, I am glad that you mentioned this, because we have a lot of sectors that depend on it. And so I want to talk about moving on, Mr. Gelsinger, also about our tourism industry, because as the witnesses, as many people have asked about autonomous cars, or just cars in general, a huge chip shortage that increased demand for rental cars as we—tourism boosts back up, we know that rental cars were sold off during the pandemic, new cars aren't being made as quickly. And of course the demand is for individuals to buy cars.

So it is really, really hurting tourist economies like Las Vegas. And so can you discuss the steps you are taking to ensure that chips are being manufactured and distributed to all automakers in a matter that supports those industries critical to supporting tourism, such as our car rental companies? And I would say buses and all of those shuttle buses, vans, taxis, all those things that help our tourist economy in every state.

Mr. GELSINGER. Yes. As we have already indicated in this hearing so far, the importance of future technologies enables the cars of autonomous, connected, infotainment, all of those aspects, but the near-term crisis has been driven more by older nodes, or areas that, you know, many of which has further emphasized the gaps that we have, and our gross dependence on Asian suppliers.

You know, we have recently announced the acquisition of a company Tower Semiconductors that increases our ability to respond to these near-term challenges of the auto industry. You know, our priorities and the allocation of our chips have been to, first, the manufacturers of semiconductor equipment, help us fish for the future; second to the healthcare sector, and third to the auto sector.

You know, we view those as the most critical sectors to rebuild our future. And we will continue to act in that way as we look to the future.

Senator ROSEN. Thank you. I appreciate your comments. I yield back.

The CHAIR. Thank you, Senator Rosen. Senator Young, you would be next, if you want to go; then Senator Hickenlooper. Apparently that is a yes.

STATEMENT OF HON. TODD YOUNG,
U.S. SENATOR FROM INDIANA

Senator YOUNG. Thank you, Chairwoman. Well, I appreciate, Madam Chair, you holding this timely hearing. It was nearly a year ago that this committee passed my Endless Frontier Act, now known as the U.S. Innovation and Competition Act. And we did it with a bipartisan vote of 24 to 4 out of this committee.

The bill is vitally important to the future of our country. There is a national security imperative to advancing this legislation to make sure that we don't fall behind China as it relates to our tech innovation. This of course is, historically, a key driver of our economic growth, and our ability to defend our values, our way of life.

American leadership in science and technology, especially the emerging technologies that are going to dominate the 21st century, will be key drivers of our economy, and our competitiveness with the Communist China moving forward.

Key features of this legislation are the establishment of a new tech directorate, regional tech hubs across the heartland so we can harness the potential, and the creativity, and the work ethic of our individuals, and, of course, the CHIPS Act, which will ensure that our economy is more resilient moving forward.

As I understand, at this moment the U.S. Senate is taking a vote to move us one step closer to, ultimately, passing USICA, or whatever we are calling the final work product. And I really look forward to continuing to work with my colleagues to see this across the finish line.

In order to drive U.S. semiconductor innovation, we mustn't only incentivize growth in the U.S., as USICA and the CHIPS Act aim to do, but it is also imperative that we reduce our reliance on other countries throughout the entire supply chain.

Mr. Gelsinger and Mr. Mehrotra, I am sorry, I butchered your name there; I couldn't help but notice in your written testimonies

that neither of you mention China, and I am going to give you an opportunity to speak to a couple of questions.

What is the current state of the semiconductor industry with regards to China, and where do you see the industry's future in China? Mr. Gelsinger.

Mr. GELSINGER. Yes. China has emphasized the development of this sector on Chinese soil, very significantly. It has been part of every 5-year plan in China for the last two-and-a-half decades of this priority area. And they have made substantial progress in building up their semiconductor industry.

However, given our export license control matters, they are significantly behind, and their position is largely in older nodes, and older industries, not the leading-edge technologies where U.S. and European capabilities are still far more advanced and other Asian countries are advanced.

And thus, we believe that such practices for the future are important to continue the leadership that we have to be very, very thoughtful about, you know, being able to sell products there so that we are maximizing the position of our product revenue, but to continue to keep a substantial technology leadership, for our equipment suppliers, as well as our chip suppliers, to be able to have revenues there.

It is the largest chip market in the world in China. So we need to be able to participate to become the largest companies in the world, even as we, be very careful to protect our intellectual property and leadership position.

Senator YOUNG. Sure. Mr. Mehrotra, do you have anything to add, sir?

Mr. MEHROTRA. I would just add that as China is one of the large markets, it is a large market not only due to Chinese companies using semiconductor products, but it is a large market due to many global businesses operating there and manufacturers, such as Micron, supplying product to them in China as well. So the China market does help provide scale that is important for semiconductor industry. The benefit of scale ultimately goes into investments in R&D.

I would also add, as has been highlighted here earlier as well, that China certainly is very much recognizing the importance of semiconductors, certainly recognizes the importance of memory semiconductors, which Micron is the only company in the U.S. making those, and is investing more than $100 billion supporting their semiconductor industry.

And hence, it is extremely important that U.S. does play catch up with CHIPS Act, with investment tax credits, and timing is of the essence. Other countries are moving forward. We need to catch up in this area to get a level playing field. And as part of level playing field, of course, other aspects of free market access, fair trade policies, protection of intellectual property. These are all aspects that are clearly important as well.

Senator YOUNG. Which is why we are advocating for this USICA legislation.

Mr. MEHROTRA. Yes.

Senator YOUNG. So thank you for affirming that. And, last, maybe very briefly, because my time is coming to an end. But do

any of our panelists have concerns with our reliance on other countries for the rare earth mineral inputs that are used in semiconductor production?

Mr. GELSINGER. The requirements are fairly modest on rare earth. Other areas, like batteries, and you know, some of those are much more significant. That said, we believe we need resilience in the supply chain, and this deserves a lot more investigation. As you say, build the fabs, restore the supply chain, and work through all of the other elements that would feed that supply chain. That is the formula for our long term success.

Senator YOUNG. Thank you.

The CHAIR. Thank you. Well, I should say, thank you Senator Young, to thank you and Senator Schumer for the two of your leadership on the underlying U.S. Innovation and Competition Act, and appreciate all your hard work in shepherding this through the process, and your attention to coming back here today and adding that issue. Senator Young has been very concerned all along about the China impact on this. So appreciate his comments. Senator Hickenlooper.

STATEMENT OF HON. JOHN HICKENLOOPER, U.S. SENATOR FROM COLORADO

Senator HICKENLOOPER. Thank you, Madam Chair.

First, I want to thank each of you for your time today and for your careers. You know, most Americans look at these chips as some combination of machines and magic. And I think that is the consequence of, you know, whole careers dedicated to innovation, and constantly trying to find a better way to do it.

Let me start with Mr. Gelsinger. I appreciate the recent announcement about the plant in Ohio. I think the CHIPS Act is going to create a number of construction, research, and manufacturing jobs all across the United States. I serve as Chairman of the Space and Science Subcommittee of this committee. And I also chair the Employment Workplace Safety Subcommittee of the HELP Committee, Health, Education, Labor and Pensions. And that subcommittee has jurisdiction over workplace education and training.

And I guess I have spent a lot of time looking, as we go into this great transition, into clean energy. We are also going into a great transition of what a job it means, and how people are going to be trained. I think that the workforce development that is required to navigate this great transition is going to be prodigious. Some estimates for skilled STEM workforce needed to manufacture chips ranges from anywhere from 100,000 to 300,000 workers by 2025.

So in your view, how do you—how do we help workers from relevant manufacturing fields upskill, and reskill to satisfy those needs?

Mr. GELSINGER. Yes, and we, we believe that this is a critical topic. One, that there are aspects of the CHIPS Act that are specifically designed to address. But clearly this is an area for public-private partnerships at scale. Just last week we announced $100-million initiative, right, around our Ohio plants, specifically in this area across the skills. You know, from community colleges and, you

know, the most basic entry level manufacturing from focus on K through 12, you know, STEAM and STEM educational programs.

Reaching into, you know, communities that haven't necessarily been affected, such as underrepresented minorities. You know, the position of females in the workplace, particularly in tech fields, you know, has been unacceptable. So these would be some of the examples of what those programs need to address.

You know, we also believe strongly that we need the best and the brightest, right. And with that our higher education workforce, over 50 percent of U.S. STEM, you know, universities are foreign nationals, right. And I believe that every one of those should get a Green Card stapled to their diplomas when they graduate from a higher-level institution in America. We want the best and brightest, right, in the U.S.

Taken together, this will be a challenging endeavor, right, and I look forward to digging into this more thoroughly with you, as well as the efforts that are part of the CHIPS Act more broadly, work across the spectrum, and we are pretty proud of our reputation in this area, but we know it is not nearly enough.

Senator HICKENLOOPER. Well, as you are describing it, even if everything goes right, and we get immigration right. I mean, we begin to do a better job of apprenticeship to get the kids in, especially young women, people of color, if everything goes right, we are going to be—we are going to be pressed. So I appreciate your answer there.

Mr. Mehrotra; and actually Mr. Gelsinger, you can answer this as well. The U.S. decline in global chip manufacturing has already been well documented. Obviously, foreign subsidies and incentives are what we have been hearing about. And they are taking chip manufacturing, and assembly, even many of the design activities, now we see more of that being done overseas. And I appreciate today's discussion on the importance of the CHIPS Act, and the FABS Act, both of which I support strongly.

But Mr. Mehrotra, would you discuss the role of other factors? And you touched on this a few minutes ago. For instance, trade policies that play—will play in the domestic semiconductor industries' rebalancing.

Mr. MEHROTRA. So I think, again, it is important that we have a level playing field here in the U.S., with respect to our global competitors, and level playing field, certainly, is intended to be achieved with the start of chips funding, $52-billion funding, as well as with the support of investment tax credits. Those are important initiatives to play catch up.

Of course, policies related to our workforce development. What you just discussed, are going to be extremely important in terms of driving public and private sector partnerships. And then I think it is definitely important that we have policies that drive greater free trade, open markets, and absolutely a level playing field in terms of IP protection, and partnership with those around the world who do share those same values with us.

Senator HICKENLOOPER. Perfect. Anything you want to add Mr. Archer, or Mr. Gelsinger, or either one?

Mr. ARCHER. No. I think many of the things that you talked about are very important. Just last year—I am sorry—in the last

2 years, Lam Research, we have added more than 3,500 jobs in the U.S. We and our American suppliers are really feeling the pains of this tight labor market. And so, again, anything that can be done to help expand the skilled workforce, everything from manufacturing workers, all the way to the most advanced researchers is very welcome. And some elements of this legislation certainly are very supportive of that.

Senator HICKENLOOPER. Great. And to which, I yield back.

The CHAIR. Thank you Senator Hickenlooper. I will go to Senator Sinema. Thank you.

STATEMENT OF HON. KYRSTEN SINEMA,
U.S. SENATOR FROM ARIZONA

Senator SINEMA. Well, thank you, Chair Cantwell. And thank you to all our witnesses for joining us today to discuss this important topic. Semiconductors are essential for both the economic and national security of the United States. They are necessary technologies that Americans rely on every day, such as our phones, our cars, and our computers. And they are a key resource for our military.

During the pandemic we have seen the chip shortage directly impact everyday families across the country. Arizona is a national leader in semiconductor manufacturing and research and development. The semiconductor industry employees over 20,000 Arizonans, but over the past decades America's domestic semiconductor manufacturing has fallen dramatically compared to the rest of the world, leaving us vulnerable and forced to rely on other countries.

I was proud to be original co-sponsor of the CHIPS for America Act, to help restore America's leadership in semiconductor manufacturing. And in response to the CHIPS Act, we have seen both Intel and TSMC announce significant investments in Arizona manufacturing, but Congress needs to finish our work and fund these chips grants. Our bipartisan bill passed the Senate nearly a year ago, and we need to get this bill to the President's desk.

So my first question is for Mr. Gelsinger. You know, Arizonans are proud of Intel's long history in our state, following passage of our CHIPS for America provisions, I was thrilled at Intel's announcement of a $20-billion expansion in Arizona, which will translate to thousands of new Arizona jobs.

Could you provide an update on Intel's expansion plans in Arizona, the new jobs that will be created and its impact on domestic chip manufacturing?

Mr. GELSINGER. Yes. Thank you very much. And I am very happy and proud to support that our Arizona project is ahead of schedule and, you know, we have even been able to accelerate that by about a quarter. We expect that those facilities will begin coming online in late 2024, we will employ 3,000 new Intel employees, we will support on the order of 5,000 to 6,000 construction jobs for the next couple of years.

And we have been thrilled by the support, you know, in fact, we just had the First Lady join us for our Maricopa County Education Initiative that we just described there, to start building the workforce that we need, and some of the AI for the future training programs.

So overall the project is going well. And, like you, we are proud residents of Arizona, and growing there very rapidly, and finding just a very, very warm welcome from the community as we continue to build this next phase of our manufacturing in Arizona.

Senator SINEMA. Thank you. It is wonderful to hear you are ahead of schedule. As I mentioned previously, Congress has yet to pass the final bill to provide funding for the CHIPS for America grants that will support our critical domestic semiconductor industry.

Mr. Gelsinger, what does it mean for Intel, and particularly for Arizona's expansion project, if Congress cannot pass a semiconductor funding in a timely manner?

Mr. GELSINGER. You know, and as I have described it, you know, we will go slower and smaller without the funding. We will go bigger and faster with the funding. You know, I am putting as much pressure on our profitability and our balance sheet as I possibly can. And I am doing that at the great howls of Wall Street, seeing our stock lowered as a result of these substantial investments.

But even though I am making such substantial investments, it is not enough to restore American leadership on this technology. It is about restoring our position in the world, about bringing this industry back from Asia. And we are proud of our investments in Ohio, in Oregon, and very prominently in Arizona.

And we also have even broader plans and, you know, visions for the next phases of that, that could be enabled by the CHIPS Act beyond what we have already announced, senator, and we would be thrilled to discuss those further with you.

Senator SINEMA. Thank you. You know, I have long supported efforts to advance STEM education, and ensure that Arizona has a highly skilled workforce that can help support technological advancements. So I was very pleased to hear about Intel's new Quick Start Workforce Development Program partnering with Mesa Community College. Can you describe that new program to train semiconductor technicians in Arizona? And thank you again, Mr. Gelsinger.

Mr. GELSINGER. Yes. In summary, what it is, is a public-private partnership, you know, in terms of them helping us to establish the training programs, we are helping with the curricula, and basically with very high probability, the graduates end up in a job as one of our facilities. So it reduces the risks that the students have. It increases the effectiveness of the educational program. And overall, it is building our workforce for the future.

Overall, these types of programs have been seen extremely effectively. And we are thrilled to be able to participate there with Mesa Community College, Maricopa, right, and our other sites. This is the kind of model that lowers the cost of education, increases its effectiveness and prepares the workforce of tomorrow.

Senator SINEMA. Thank you. Thank you, Chair Cantwell.

The CHAIR. Thank you, Senator Sinema. That concludes the first round, as I know it, unless there is a member out there who is either quickly walking over here, or is going to jump online. I see that Senator Scott wanted to ask a second round question. My intention is to allow you to do that. And then we would close out the hearing.

So again, and thank you—that is kind of the schedule, unless somebody is out there who wants to quickly jump in here. So with that, Senator Scott.

Senator SCOTT. Again, Chair Cantwell, I want to thank you for hosting this hearing, this is an important issue. It is a lot of money. I think all of you, all four of you have run successful businesses. And when you go to your Boards and you say "I want to make an investment," what they say to you is: "What are you going to get back? How much cash you get back?"

You don't, go then and say: "Hey, I am going to get a bunch of revenues." That doesn't help you. You don't say: "Hey, it is going to have a great economic impact." Or, "gosh, I am going to add a thousand jobs." They say: "If you are going to invest certain dollars, you are going to get something back." And so I was disappointed that nobody has come back and said, you know, if you guys want us to spend $52 billion. But nobody comes back and says: "OK, for $52 billion, the taxpayers of this country will get a certain dollar back."

None of you, I think would—you know, if you were the fiduciary, you would say: "I am going to do it without getting a return." So if you have something like that, I would love to see it, because I have not seen it.

But Mr. Gelsinger, Intel apologized to Chinese companies about American sanctions. Can you explain why that is appropriate?

Mr. GELSINGER. Yes. Let me just add to the earlier comments on the ROI. You know, obviously, as we have already read in our written testimony we provided economic impact across our states. And we can, you know, certainly dig into that more with you for the future. These are good ROI investments, but also——

Senator SCOTT. Can I just explain that for a second though?

Mr. GELSINGER. But it is also, if I might?

Senator SCOTT. Revenues is not return.

Mr. GELSINGER. All right. These are state economic impact returns.

Senator SCOTT. Revenues are not returns. I mean it is not like you have these revenues for the state.

Mr. GELSINGER. Again we are happy to have that conversation.

Senator SCOTT. I mean, I probably did a thousand economic deals when I was Governor of Florida. I didn't say, or somebody say: Hey, I will bring you revenues.

Mr. GELSINGER. From a state perspective, revenues produce tax benefits. So we are happy to dig into that more with you. But it is also about returning this industry from Asia to American soil, right. It is also about national defense. These are policy issues for the Nation that stretch well beyond just the economic direct benefits associated with it.

Now, with respect to the China comments as well, you know, the situation was in response to our supplier letter. This is a global supplier letter that we put in place to minimize risk, to manage our supply chain globally, no forced labor, no slavery, no other inappropriate actions. That global supplier letter inappropriately included a specific reference to one region in the world. It was a global letter covering many parts of our global supply chain that touches almost

every country in the world. That was inappropriate. We have revised the letter appropriate——

Senator SCOTT. So you think it is inappropriate to say you shouldn't buy products that are created with slave labor?

Mr. GELSINGER. Our letter makes it very clear that we do not support slave labor anywhere in the world. However, as a global letter, we shouldn't have been calling out any particular regions since there are many regions in the world——

Senator SCOTT. I would call out anybody for slave labor, and I would call it out by regions. I think that is inappropriate.

Mr. GELSINGER. We could enumerate those across the world, and we didn't see that as appropriate. The policies are clear.

Senator SCOTT. Slave labor?

Mr. GELSINGER. We have reinforced this very, very aggressively that our policies in such matters are clear, consistent across the world. And that is how we are going to continue to operate, and we have been proud to operate for decades in the past. And for that, you can be confident that we will be enforcing, not just the U.S. policies, obeying the laws of the U.S., but continue to be a great global employer, and managing our supply chain with that in mind.

Senator SCOTT. Buying products created with slave labor is wrong. Let us go to the next question.

Mr. GELSINGER. We agree.

Senator SCOTT. As a company, it seems to me your biggest risk is going to be exactly what has happened to Russia, companies doing business in Russia right now. You can look right now, people are mad that companies are doing business in China because of the human rights issues: putting in a million people in prison for their religion, taking away the organs, involuntarily, of prisoners, taking away the basic rights of Hong Kong citizens, threatening Taiwan.

So already your company, anybody who does business in China has a risk. So aren't you, as the CEO of a company, shouldn't you be going to your Board and saying: "Hey, look, we have got a big problem here, because the American public, the people who live in Europe are going to say: "Hey, you have got to get out of China, because they are about to invade Taiwan."

And when they do, what are you going to do when you have all these operations in China, and the expectation is, you shut down? Why wouldn't you, on your own, without getting the subsidy from the American Government, and the American taxpayers, say: "I have got to get out of there right now?"

Mr. GELSINGER. The Chinese market is almost half of the semiconductor market in the world. Approximately half of that is manufacturing and supply. Approximately half of that is consumption. It is the fastest-growing semiconductor market in the world. So if we are here to be the largest provider of semiconductors in the world, we must be participating in the largest market for semiconductors in the world.

Senator SCOTT. I ran companies. I don't care about it being the largest. I care about: What do I have to do to make sure my company remains viable? What are you going to do when China invades Taiwan, and you are expected to stop doing business in

China? You are just going to say: "Nope, I am just going to keep doing business in China because I don't care?"

Mr. GELSINGER. Our expectation is that, we will continue a long practice of deepening our investments in manufacturing, in R&D in the U.S., and supplying the global market for semiconductors, according to the laws, policies, and exports of the——

Senator SCOTT. So it won't bother you when they invade Taiwan?

Mr. GELSINGER. It will bother me enormously.

Senator SCOTT. Your are just going to keep doing——

Mr. GELSINGER. In fact, the——

Senator SCOTT. But you won't do anything about it?

Mr. GELSINGER [continuing]. Concerns that I have around the geopolitical situation, drive the passion and urgency to build this industry in the U.S. This is a core reason why we are here. We have allowed this industry to shift to Asia. It is time for us to get it back onto American soil.

Senator SCOTT. You should do it.

Mr. GELSINGER. And we are passionate about that.

Senator SCOTT. But why, why does the taxpayer are wondering——

Mr. GELSINGER. That is why the CHIPS Act is so critical to get it done now.

Senator SCOTT. So let us get to the point. You can't tell me how a taxpayer in Florida gets a return.

Mr. GELSINGER. I think we have addressed that.

Senator SCOTT. There is no study, OK. You continue to apologize for American position that we shouldn't be doing business with a Communist country where they have human rights violation, and you won't even acknowledge that you would even stop doing business in Communist China if they invade Taiwan. I think that is wrong.

The CHAIR. And that, Senator Scott, I don't think that that is what Mr. Gelsinger said. I do want to say for the record, there is an analysis that was done by a Boston Consulting Group on the impact. Over 6 years, they project that a $50-billion manufacturing incentive would generate $147 billion to GDP, and 1.1 million jobs.

So I do think that there are some analyses out there, every dollar from the Federal Government put toward the semiconductor research directs about—deliver 1650 to GDP as a dollar to investment ratio.

So there are some analyses out there. I do think that they are important to take a look at this. I also think that these issues are very challenging to us in a global economy. I am a person who supports trade. I actually think trade changes culture, I think.

That doesn't mean that we don't have bright lines. And I think we have a lot of bright lines in the United States. And one of them is about our national security, and basically saying that we don't want to have communication products that have government back doors to them. And we want, anybody can be in the global supply chain, but if your government doesn't honor this aspect of making sure our architectures are protected and secure, then we don't—we don't want to do business.

But this bill is really going to be about us creating a framework in which the United States gets that next generation. Like my chart said, the next-generation supply chain here.

I want to thank all our witnesses. Mr. Feight, thank you for hanging in there from Europe. You didn't get as many questions as the other people, but I want you to know every time you talked, Mr. Gelsinger wrote down what you said. And the reason I am pointing that out is because I think that is symbolic about the ecosystem that we are trying to create.

If this all exists here in the United States and you have those closer relationships, and the whole supply chain is talking to each other, and they are talking about what their needs are. And they are talking about the next generation, I guarantee you, the United States will do the right things to help catch up on this shortage, and lead the way in next-generation technology.

You heard from many of my colleagues who had various takes on this issue. You heard from Senator Rosen about her interest in the broadband system. I, too, have a very keen interest in our grid, in electrification, and what we are going to do to—you know, we are not going to make any of the transformation without our grid providing more of the communication system.

And so there are just so many opportunities before us. So I also want to thank you, particularly you, Mr. Gelsinger, but obviously our other witnesses. Look, this is—we want to see these companies driven by good engineering. It is called the Information Age for a reason. That means that the opportunities are there, but we need the engineers.

So I actually applaud some of the financial decisions you have been making, because it is being based on good engineering. And I guarantee you in the end that is what is going to be rewarded by American investments is solid, good engineering.

We have led in this area in the past. We want to lead again. We appreciate what that will do for us for innovation, and for jobs in the United States of America.

So thank you all very much for being here. The hearing will be open in the record for two more weeks. Senators will have until Wednesday, April 6, at noon, to submit questions for the record. Witnesses will have two weeks to respond to those questions, and we appreciate your diligence on that.

That concludes today's hearing. We are adjourned.

[Whereupon, at 12:31 p.m., the hearing was adjourned.]

A P P E N D I X

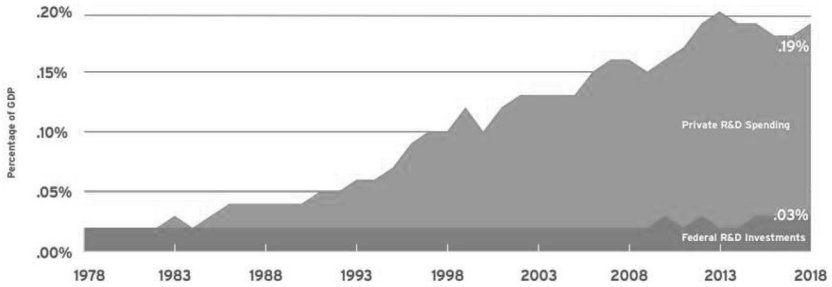
RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. RAY BEN LUJÁN TO PAT GELSINGER

Mr. Gelsinger, as you noted in your testimony, Federal investment in semiconductor research and development (R&D) used to be more than double that of private investment. Unfortunately, public funding has been lacking in this area recently, despite the increasing importance of semiconductor technology to the economy and in our lives.

Question 1. Do you think the Federal Government currently invests enough in advanced semiconductor R&D, relative to private industry?

Answer. The Federal government does not currently invest in semiconductor R&D at the levels necessary to maximize and complement private U.S. semiconductor industry investment. A 2020 report from the Semiconductor Industry Association (SIA) determined that Federal funding for semiconductor R&D has historically lagged behind private sector investments.[1] Forty years ago, Federal funding was more than double the private sector, but today the private sector invests 23 times more in direct semiconductor research than the Federal government. In 2019, private sector investment in semiconductor R&D totaled nearly $40 billion, while the Federal government spent only $1.7 billion on core, semiconductor-specific R&D. This Federal spending equaled only 13 percent of the total U.S. semiconductor R&D, which is significantly below the 22 percent share of Federal government funding across all sectors. While private investment in semiconductor R&D as a percentage of GDP has increased nearly 10-fold over the last 40 years, Federal investment has remained flat (see SIA report figure below).

SIA also found that additional Federal funding for semiconductor R&D would increase private sector R&D investment and overall economic growth, create new jobs, and help the U.S. lead in the technologies of the future. Because semiconductor innovation is becoming increasingly complex and expensive due to the continuous pursuit of Moore's Law, the report concluded that increased Federal funding would help the U.S. sustain its leadership in the industry. In fact, the report noted that the impact of the present funding gap may create a risk for the overall semiconductor industry to maintain its historical pace of innovation.



Source: Calculated based on agency budget data extracted from official budget documents from NSF, DOD, DOE, and NIST; U.S. semiconductor industry R&D figures reported in the 1999 SIA Databook and the 2019 SIA Factbook; and GDP figures reported by BEA through its National Income and Products Accounts, Table 1.1.5 Gross Domestic Product (Annual - 1978 to 2018).

[1] Sparking Innovation: How Federal Investment in Semiconductor R&D Spurs U.S. Economic Growth and Job Creation, SIA, (June 2020); available at *https://www.semiconductors.org/wp-content/uploads/2020/06/SIA_Sparking-Innovation2020.pdf.*

Another recent SIA report, *Strengthening the Global Semiconductor Supply Chain in an Uncertain Era,* found that this history of U.S. investment has differed significantly from that of China:

> In contrast, China is committing large sums to pre-competitive research as part of its effort to build a strong domestic semiconductor industry. In the last 20 years China has been closing the gap with the U.S. on overall R&D spending. According to data from the Organization for Economic Cooperation and Development (OECD), in 2018 China was the world's second biggest spender on R&D in absolute terms: its total R&D investment was just 5 percent below the U.S. in Purchasing Power Parity terms. However, just about 5–6 percent of Chinese R&D spend currently goes to basic research, significantly below all other countries with high investment levels in R&D.
>
> China's new five-year plan for 2021–25 announced in March clearly establishes boosting basic research as a critical priority. Central government spending on basic research will increase 11 percent in 2021, well above the 7 percent planned for the overall R&D investment and the 6 percent target for GDP growth. Semiconductors has been designated as one of the seven areas that will be given priority in terms of funding and resources.[2]

Question 2. How would further Federal investments in nano- and microelectronics R&D programs, such as at the Department of Energy, support innovation in semiconductor development and advanced manufacturing?

Answer. Drawing again from the April 2021 report by the Semiconductor Industry Association, there are many excellent illustrations of generations of technology breakthroughs that came as a results of global research collaboration, including R&D funded by government support:

> [S]ome of the most critical recent advancements in semiconductor technology were the result of several decades of global R&D collaboration. Fin field-effect transistor (FinFET) technology enabled manufacturing at 22 nanometers and is the dominant transistor design for today's leading-edge chips at 5 nanometers. While the U.S. pioneered the development of the FinFET technology and is the source of 48 percent of the related patents, the rest of the world also contributed heavily to applied R&D leading to commercialization. Specifically, Taiwan, which hosts several of the world's leading foundries, has contributed 20 percent of the FinFET patents.
>
> In the case of EUV, the technology that underpins the equipment utilized to manufacture semiconductors on the 7-and 5-nanometer nodes and below, its development started in the 1980s with fundamental research done in the U.S. and Japan on the use of soft X-rays, leading to the first demonstration of the technology in 1986. In the 1990s and early 2000s, NTT in Japan, Bell Labs and Lawrence Livermore National Laboratory in the U.S. and the University of Twente in the Netherlands further pushed the research in this technology. ASML, a company based in the Netherlands, then sought to further develop and commercialize EUV in partnership with institutions like IMEC and corporations including Intel (headquartered in the US), Samsung (South Korea), and TSMC (Taiwan). Together, ASML and its global partners funded R&D during the pre-commercial stage of the technology, and subsequently ASML invested $8 billion to put the technology in production in modern fabs beginning in 2018.
>
> In addition to the global collaboration in the development of the underlying technology, EUV also relies on a global supply chain: as Exhibit 13 shows, today the EUV lithography equipment developed by ASML contains about 100,000 parts provided by over 5,000 suppliers spread across the globe.[3]

SIA' s 2020 report highlighted that additional Federal investment in semiconductor research is needed to help discover the next breakthrough technologies that will allow the U.S. to compete globally and lead in the critical technologies of the future, including artificial intelligence, quantum computing, and 5G. These core

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[2] Strengthening the Global Semiconductor Supply Chain in an Uncertain Era, SIA (Apr. 2021) at 15; available at *https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf.*

[3] Strengthening the Global Semiconductor Supply Chain in an Uncertain Era, SIA (Apr. 2021) at 29; available at *https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf.*

technologies will fuel future innovations in other fields essential to future economic growth such as robotics and intelligent products.[4]

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARIA CANTWELL TO PAT GELSINGER

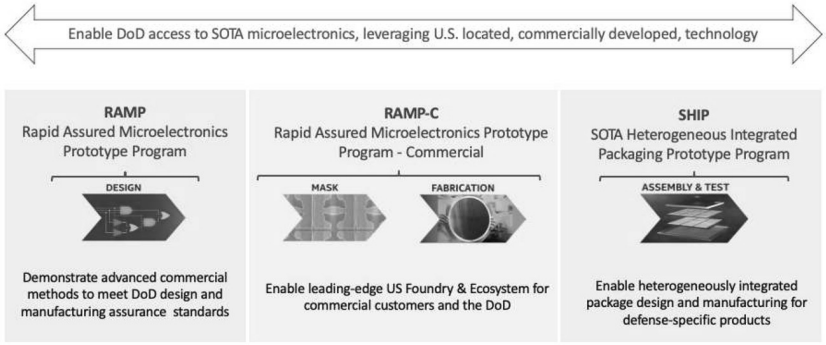
The Government has helped to keep the United States at the leading edge of semiconductor manufacturing, with benefits both to national security and additional positive impacts on the economy. For instance, Department of Defense (DoD) investments helped to advance lithography and chip design.

Question 1. USICA and COMPETES each contain a $2 billion investment specifically for the DoD to secure the microelectronics supply chain required for our national security missions. Considering that Intel has already started partnering with the DoD on efforts like the State-of-the-art Heterogeneous Integrated Packaging (SHIP) Prototype Project and the Rapid Assured Microelectronics Prototypes—Commercial (RAMP–C) Program, how will Intel help ensure that DoD has access to leading-edge chips?

Answer. Intel has a long history of working with the U.S. Government, including DoD, to provide leading-edge chips. DoD must benefit from the rapid pace of innovation offered by Moore's Law when creating new microelectronics private sector partnerships that ensure the design, manufacture, distribution, and integration of "measurably secure microelectronics" per Section 9903(a) of the *CHIPS for America Act.* In other words, DoD must compete to secure both state-of-the-art innovation and capacity. In the global technology innovation race related to artificial intelligence/machine learning, quantum computing, high performance computing, and advanced communications infrastructure, DoD cannot afford to fall behind. This means DoD must support and gain access to domestic development of leading-edge chip technology.

Intel commends the DoD for Trusted and Assured Microelectronics programs and projects that allow it to source high assurance microelectronics from multiple commercial semiconductor suppliers. Specifically, the State-of-the-art Heterogenous Integrated Packaging Prototype Program (SHIP), Rapid Assured Microelectronics Prototype (RAMP), and RAMP–C programs lay the groundwork for ensuring DoD has access to such microelectronics through leveraging U.S. origin and commercially developed technology. The DoD should scale and enable the more complex and resource intensive next phases of these programs through the new partnerships authorized under Section 9903(a) of the *CHIPS for America Act,* which Intel stands ready to execute.

More specifically, RAMP–C is targeted to enable a U.S.-based, commercially viable, economically responsible, leading-edge logic foundry to make product for both commercial and DoD customers. SHIP, a complementary program focused on packaging, shares the same goal to enable leading edge, commercial foundries to execute package design and manufacturing projects for defense-specific products. Both programs are essential to accelerate innovation in developing "measurably secure microelectronics" for DoD by leveraging commercial capability.



[4] Sparking Innovation: How Federal Investment in Semiconductor R&D Spurs U.S. Economic Growth and Job Creation, SIA, (June 2020) at 9; available at *https://www.semiconductors.org/wp-content/uploads/2020/06/SIA_Sparking-Innovation2020.pdf.*

These novel programs, when combined with assurance efforts and measurement initiatives like Microelectronics Quantitative Assurance and any additional layers of security that may be required, offer DoD the opportunity to both rely on and drive progress in state-of-the-art technology developed by the private sector. It is important to note, however, that DoD will require significantly more funding to drive the output of these developmental programs into products for high volume manufacturing. It is unclear whether the DoD has access to the necessary funding, and Intel encourages Congress to consider opportunities to prove DoD a dedicated funding stream for Section 9903(a) to scale projects like these.

Question 2. Mature semiconductors are critical to various sectors of the United States economy, including aerospace and defense, telecommunications, transportation, and healthcare. How might Intel and the broader CHIPS investment support fabrication of mature technologies, so critical to the above sectors?

Answer. Semiconductors play an increasingly large part in every sector of the economy as our lives become further digitized. In early 2020, some sectors reduced forecasts for semiconductors and other materials just as demand was about to spike, and order lead times for mature chips have risen steadily throughout the pandemic. Although Intel had predicted that the chip shortage would plateau in 2022 and subside in 2023, we now expect the chip shortage to persist into 2024.

Unfortunately, the 16-months it has taken thus far since enactment of the *CHIPS for America Act* to pass funding has cost the United States precious time. U.S. national security and the U.S. economy are more vulnerable to these shortages today. The only solution to the ongoing shortage is to increase manufacturing capacity, but it takes 2–4 years to construct a new fab.

We are doing our part—completing a $3 billion expansion project in Oregon, starting work on new or expanded capacity in Arizona and New Mexico, and announcing two new leading edge fabs in Ohio, which—if CHIPS Act funding moves forward—will exceed $20 billion in Intel investment in Ohio.

Intel also announced efforts to diversify its product offerings with a pending acquisition of one of the world's leading providers of foundry services for mature and analog chips for use in markets such as high-end mobile, automotive, medical, industrial, and aerospace and defense. If Intel secures funding under the CHIPS Act, it will support our ability to accelerate our investments and help address unmet chip demand in these sectors.

But it will take more than the four new fabs and foundry acquisition Intel has announced in the last year to secure U.S. economic and national security. The United States needs significant additional U.S. capacity, which will be spurred by the *CHIPS for America Act,* and it is critical for Congress to provide funding as soon as possible.

Make no mistake: America's future competitiveness in technology from AI to quantum computing to high performance computing requires that the U.S. have a chipmaker building leading-edge chips in the U.S., but the chip shortage will not end until mature chips are also available to meet demand. CHIPS Act funding will encourage more investment in new facilities that will make both leading edge and mature chips that are in the interest of the United States.

Question 3. The Congress recognizes the urgent need to invest in domestic semiconductor manufacturing. The Congress is also accountable to American taxpayers and needs to ensure adequate oversight of those investments. Given the importance of protecting taxpayer investments, what steps will Intel take to ensure that taxpayer funds maximize benefits to the United States taxpayer, to national security, and to the continued innovation required for U.S. technological leadership?

Answer. The *CHIPS for America Act will* unleash significant private sector investment that will broadly benefit the U.S. economy. The law includes important safeguards to ensure government funds are used to advance the public interest and protect the taxpayer, and we look forward to working with the Department of Commerce on the effective implementation of these important programs. Moreover, Intel is the lead U.S. manufacturer of advanced logic chips, with the majority of our manufacturing, R&D, and intellectual property conducted or held in the United States. Intel is working to accelerate that leadership. We recently announced plans to build two new fabs in Ohio, in addition to the two new fabs already under construction in Arizona. These fabs will feature state of the art technology capable of producing chips at the leading edge. Upon completion, I expect each of these fabs to operate at about 20,000 wafer starts per month.

Construction of these four facilities alone will create over 12,000 construction jobs in the near term, and upon completion will create and support tens of thousands of long term, full-time jobs at Intel, in the semiconductor supply chain, and in various service sectors supporting these facilities. Specifically, each of the four new fabs

in Arizona and Ohio will provide direct employment for about 1,500 Intel employees, for a total of approximately 6,000 new Intel employees. The facilities will also provide employment for thousands of additional trade workers and other personnel who are needed on-site to directly support facility operations. Tens of thousands of additional jobs will also be created among the suppliers, partners, and other businesses that support the semiconductor ecosystem. A recent economic study indicates that for every Intel full time employee position we create, our operations support an additional 13 jobs.[5] In total, we estimate that these four new fabs alone will create and sustain up to 78,000 total direct and indirect U.S. jobs.

We have a long history of working with government partners, educational institutions, vocational institutions, and other stakeholders to expand talent pipelines for the semiconductor industry that then benefit the economy at large. In Arizona, for example, Intel has funded and partnered closely with two-and four-year institutions to create and scale the research, education, and workforce development programs needed to train individuals for rewarding careers in the semiconductor industry. We are now working to further expand those and other programs to support our growing operations there, and we are doing the same in Ohio. Even before breaking ground in that state, Intel announced that it will invest $50 million directly in Ohio educational and vocational institutions to train the workers of tomorrow. In fact, we have already issued a call for proposals, which are due at the end of May. In addition, Intel announced a $100 million partnership with the National Science Foundation (NSF) to expand semiconductor-related research, education, and workforce development across the country. Intel will directly invest $50 million in this effort, with $50 million in matching funds from NSF.

While these actions demonstrate our ongoing commitment to both manufacturing and workforce development in the United States, Intel can do more and move faster with partnership from the U.S. government. With CHIPS funding, Intel's Ohio investment could grow to over $100 billion to build and equip eight total new fabs over the next decade, creating tens of thousands of additional jobs—above and beyond those outlined above—at Intel and among our partners, suppliers and in various supporting service sectors.

Lastly, your question also asked about Intel's contribution to continued innovation to ensure U.S. technology leadership. Intel is one of the largest R&D spenders in the world, and the majority of our R&D spend occur in the U.S. We made specific recommendations to the Department of Commerce on how Intel could contribute to the National Semiconductor Technology Center (NSTC), the major R&D program set up under Section 9903(c) of the *CHIPS for America Act.* The NSTC, to be operated by a public/private consortium, is designed to "conduct research and prototyping of advanced semiconductor technology to strengthen the economic competitiveness and security of the domestic supply chain."

Specifically, we suggested to the Department of Commerce that Intel could set up and operate an Advanced Lithography Center (ALC), funded by the NSTC and private sector, which would provide access to advanced lithography tools and photoresist characterization equipment to enable novel process technology pre-competitive research. Any researchers from qualified NSTC member companies and research groups could have access to the ALC.

Intel also has proposed to the Department of Commerce that, as part of the National Advanced Packaging Manufacturing Program (NAPMP) in CHIPS Act section 9906(d), an Advanced Packaging Manufacturing Center (APMC) be set up and funded by the NAPMP, as a center to research new integrated package and assembly/test technologies and manufacturing methods. Researchers from qualified NSTC member companies and research groups should have access to the APMC. With our leading advanced assembly, test and substrate technologies, Intel is interested in helping to establish such a center as some of the base technologies are in place and are available through Intel's foundry services. Like the ALC, the APMC is necessary to bridge the gaps that exist between lab to fab, or innovation to commercialization in the United States.[6]

Question 4. What requirements does Intel recommend that Congress and the Department of Commerce impose on funding recipients?

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[5] Intel Corporation, *Intel's Impacts on the U.S. Economy,* available at *https://download.intel.com/newsroom/2021/corporate/intel-impact-us-economy.pdf.*

[6] For more detail on the ALC and APMC recommendations, see Intel Corporation Comments on "Incentives, Infrastructure, And Research and Development Needs to Support a Strong Domestic Semiconductor Industry," Department of Commerce, Parts 2 and 3, at pp. 17–34 (Federal Register Notice of January 24, 2022, DOC–2021–0010), available at *https://www.regulations.gov/comment/DOC-2021-0010-0196.*

Answer. Intel commends the authors of the *CHIPS for America Act* for including robust transparency and claw back mechanisms in the authorizing law, including provisions requiring grant recipients to meet committed timelines and avoid specified research and technology licensing with a foreign entity of concern. The grant eligibility requirements in Section 9902(a)(2)(B) of the *CHIPS for America Act* also define strong protections for taxpayers and represent assurance for Congress that the Department of Commerce will create a virtuous cycle of semiconductor innovation. Intel recommends caution when considering imposing unilateral restrictions on grant fund recipients, which could undermine the legislative intent and discourage potential applicants from investing in the United States. However, as the Department of Commerce begins implementation of the program, we would encourage the development of requirements beyond the legislative grant eligibility criteria that focus on how proposed projects would most effectively:

1. Build up American-controlled semiconductor manufacturing capacity and U.S. technology leadership by developing advanced or leading-edge semiconductors;
2. Create a more secure, stable domestic supply chain for essential semiconductors to meet U.S. economic and national security needs;
3. Help ensure technological innovation and IP funded under the CHIPS Act remain and grow in the U.S.; and/or
4. Ensure a level playing field for American companies trying to compete in the global semiconductor market.

In addition, the *CHIPS for America Act* contains important requirements to ensure that incentive recipients have educational and workforce development plans and secure local community commitments to support expanded semiconductor operations. For instance, applicants must provide evidence that they (1) will financially support training and education initiatives in regional communities, including programs to expand opportunities for economically disadvantaged individuals; and (2) have secured commitments from regional educational and training entities to provide workforce training, including programming designed for economically disadvantaged individuals. Robust and pragmatic administration of these provisions will help ensure the availability of educated and skilled workers capable of maintaining and improving new design, manufacturing, and packaging operations.

Congress and the Department of Commerce should strongly emphasize the education and workforce development requirements codified in the *CHIPS for America Act* to maximize the taxpayer value. At a minimum, to sustainably address talent pipeline issues, applicants should be required to demonstrate: (1) extensive collaborations with community colleges and other educational institutions to develop sufficient pipelines of technicians and technologists to support facility operations; (2) extensive collaborations with regional colleges and universities to support scholarships, joint research, and internship/mentoring programs dedicated to semiconductor design, manufacturing, and packaging; and (3) specific initiatives to attract and retain individuals from traditionally underrepresented demographic and economic groups.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. TAMMY DUCKWORTH TO PAT GELSINGER

Topic: Semi-conductor Manufacturing Capabilities in the Midwest

Question 1. Intel is one of only three semiconductor manufacturers in the world that makes advanced logic chips. Your recent $20 billion investment in a new greenfield manufacturing site in Licking County, Ohio is a great opportunity to produce chips with advanced transistor technologies. My home State of Illinois in the Midwest is home to several advanced and semiconductor manufacturing sites. In fact, State Senator Suzy Glowiak Hilton of Oakbrook Terrace introduced legislation to offer potentially huge tax credits to manufacturers who establish facilities in the State of Illinois. This bill cleared the State Senate Revenue Committee and has rapidly gained support over the past few months. Not only does such legislation attract companies, but it also has the potential to create thousands of jobs and stimulate the American economy.

At the Federal level, how can Congress continue to help accelerate the provision of benefits and leverage public-private partnerships to help us manufacture these advanced logic chips in the United States?

Answer. It is difficult to overstate the urgency for Congress to fully fund the *CHIPS for America Act.* The 16-month wait for Congressional since the passage of the *CHIPS for America Act* to fund the Act has cost the United States precious time.

U.S. national security and the U.S. economy are more vulnerable to interruptions of semiconductor supply today. Congress must move expeditiously to reach a compromise on the pending competition package to accelerate investment in U.S. chip manufacturing.

The *CHIPS for America Act* is, in itself, one of the most important public-private partnerships designed in decades. That said, three important aspects of the *CHIPS for America Act* will help accelerate beneficial public-private partnerships that will improve U.S. access to leading-edge semiconductors today and for the long run:

1. *Chipmaking:* Once funded, the *CHIPS for America Act* will help chipmakers immediately take steps to address shortages of logic chips that have persisted for too long. Intel expects public sector investment in U.S. chipmaking, which will stimulate and supplement private sector funding, to help level the playing field with foreign investment programs. This is especially true in East Asia where governments provide strong public sector support for national champions that contributes significantly to the creation of a 30 to 50 percent cost differential compared to the U.S. that persists today. Over time, this imbalance created a vulnerability for the U.S., leaving the U.S. without adequate domestic chipmaking.
2. *Advancing R&D:* Investments funded in part by *CHIPS for America Act* grants will create new research opportunities that will advance U.S. capability and manufacturing know-how. In particular, Section 9906(c) and (d) of the CHIPS for America Act, authorizing the National Semiconductor Technology Center (NSTC) and National Advanced Packaging Manufacturing Program (NAPMP), will create renewed leadership opportunities for U.S. companies and organizations. In January, Intel submitted recommendations to the Department of Commerce on our views for the NSTC's and NAPMP priorities, and how to structure the NSTC and NAPMP to combine private and public funding in effective management structures to help bridge the gaps between lab to fab, or innovation to commercialization, and thus advance U.S. technology leadership.[7]
3. *Jobs and workforce development:* During Intel's January 2022 announcement creating the Silicon Heartland, we highlighted the significant demand we would create for highly skilled workers in the region:

> As the largest single private-sector investment in Ohio history, the initial phase of the project is expected to create 3,000 Intel jobs and 7,000 construction jobs over the course of the build, and to support tens of thousands of additional local long-term jobs across a broad ecosystem of suppliers and partners.[8]

Intel is already working on creating the research, education, and workforce development programs needed to meet these workforce demands. We announced a $50 million direct investment in Ohio educational and vocational institutions to train Ohioans for the semiconductor industry. Additionally, Intel announced an additional $50 million investment, with $50 million in matching funds from the NSF, to scale similar efforts across the country.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. AMY KLOBUCHAR TO PAT GELSINGER

Semiconductor Sourcing Challenges. The past two years have highlighted significant supply chain disruptions and vulnerabilities for U.S. shippers, who saw the price of shipping containers increase exponentially, especially on Asia-Pacific routes. American exports are sitting at ports while ocean carriers return to Asia with empty containers. My bill with Senator Thune, the Ocean Shipping Reform Act, will address these supply chain challenges by making it harder for ocean carriers to arbitrarily turn away goods at ports that are ready to be shipped abroad.

Question 1. Semiconductors consist of several different components sourced from across the world. What challenges has your company had either exporting chips or importing components for production?

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[7] Intel Corporation Comments on "Incentives, Infrastructure, And Research and Development Needs to Support a Strong Domestic Semiconductor Industry," Department of Commerce, Parts 2 and 3, at pp. 17–34 (Federal Register Notice of January 24, 2022, DOC–2021–0010), available at https://www.regulations.gov/comment/DOC–2021–0010–0196.

[8] See Intel Press Release, available at *https://www.intel.com/content/www/us/en/newsroom/news/intel-announces-next-us-site-landmark-investment-ohio.html.*

Answer. First, I think it's imperative to thank and recognize the often forgotten heroes of the current supply chain crises—from the longshoremen, truckers, and ship crews, who are working long weeks away from family, to the supply chain risk managers at companies working to create new solutions to incredibly difficult problems. As MIT Professor Yossi Sheffi says, the COVID crisis was the supply chain manager's finest hour. It is inspiring to see so many throughout our economy working together to solve problems in ways that minimize those empty shelves in stores. America owes these folks a debt of gratitude and a celebration of their heroics.

On exports, Intel has faced many of the same challenges others have faced with some complicating factors. For example, the Administration's 100 Day report on the Semiconductor Supply Chain[9] highlighted the fact that complex chipmaking supply chains entail transporting intermediate stage and partially completed chips across borders multiple times. Certain inputs have experienced particular delays or only a small number of suppliers have been able to meet the tough requirements of supplying inputs for chip making, including substrate for semiconductors and wafer blanks. Intel commends the Administration for its outstanding analysis of these issues in the 100 Day report, and for its ongoing efforts to work with Congress to approve funding for the *CHIPS for America Act.*

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO PAT GELSINGER

Question 1. In March, Senator Kelly and I introduced the Micro Act, which aims to provide for a comprehensive and integrative program to accelerate microelectronics research and development at the Department of Energy. Senator Kelly and I believe this legislation will be key for securing America's future as the leader in semiconductor manufacturing. Will you commit to working with us on this important legislation?

Answer. The Micro Act focuses on important opportunities to enhance U.S. R&D and to accelerate technology transfer in critical research areas. The Department of Energy has long played an essential role in partnering on research efforts to support its demanding requirements for semiconductor power-performance. Intel sees particular value in the proposal to establish microelectronics science research centers—both because it focuses on important foundational research and because it promotes workforce development. The Micro Act would be a step forward for microelectronics research, especially in combination with the *CHIPS for America Act.* I respectfully suggest clarifying the "Sense of Congress" language in Section 3(1) of the Micro Act, which expresses concern about the future of Moore's Law. Intel sees a bright future for extending Moore's Law—a future that can be accelerated with investments offered by the Micro Act.

Question 2. The semiconductor chip shortage showed how vulnerable our supply chains are in the U.S. to disruption, whether from a global pandemic or logistics issues. I am concerned this Administration has been unable to get policies over the finish line to help industries fix their supply chain problems. How does the semiconductor shortage inform policy actions the U.S. should take going forward to bolster our manufacturing supply chains?

Answer. While many industries face similar pandemic-related or other disruptions, the situation with semiconductors is, uniquely, the result of state-sponsored competition for chipmaking capacity and semiconductor leadership. For our industry, the most effective policy measure the U.S. can take to bolster the semiconductor supply chain is to increase domestic chipmaking capacity and capability for chipmaking, especially at the leading edge. As challenging as today's problems seem, future disruptions could be significantly greater without prompt leadership and action from the U.S. government. A report last year from consulting firm Kearney highlighted the precipitous decline in the number of chipmakers at the leading edge: in 2003, more than two dozen firms made advanced chips, but today only three remain.[10] Intel is the only American company among those three, and the only company in the world making advanced chips in high volume in the U.S. today. But our operations are not enough, and we need Congress to fully fund the

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[9] Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-based Growth, The White House, June 2021, available at *https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf.*

[10] Kearney, "Europe's Urgent Need to Invest in a leading-edge semiconductor ecosystem," October 2021, *https://www.kearney.com/documents/291362523/291371424/Europes+urgent+need+to+invest+in+a+leading-edge+semiconductor+ecosystem.pdf/f3ec1e30-b8ff-b367-417c-62cf476342ea?t=1636562554000*

CHIPS for America Act to stimulate more manufacturing capacity and semiconductor capability so that we build up both supply chain resilience and American technology leadership.

Question 3. How will you ensure that the CHIPS Act dollars are allocated to a variety of different applications, technologies, and industries across the board that have been negatively impacted?

Answer. The *CHIPS for America Act* directs the Department of Commerce to consider funding the construction, expansion, or modernization of a broad array of semiconductor manufacturing facilities, including wafer fabrication, advanced packaging, and assembly test facilities, as well as research and development, which are "in the interests of the United States." The Department of Commerce also can take into account the grant applicant's "responsiveness to national security needs or requirements." Intel commends the authors of the *CHIPS for America Act* for identifying these important priority areas, as they will help ensure that U.S. investments are dedicated to areas that have been most negatively impacted by the ongoing supply-demand imbalance and that will benefit the most from *CHIPS for America Act* investments.

We note that one of the main motivations behind the *CHIPS for America Act* was the major decline in the U.S. share of semiconductor manufacturing, from 37 percent in 1990 to less than 12 percent today with no capacity at the leading edge. Thus, supporting new fabs with *CHIPS for America Act* grants is critical, especially since such investments will ensure that grant dollars flow through the entire chipmaking ecosystem. However, Intel recently announced efforts to diversify its offerings with a pending acquisition of one of the world's leading providers of foundry services for mature and analog chips. If Intel secures funding under the CHIPS Act, it will support our ability to accelerate and help address this unmet demand.

Question 4. I am an original cosponsor of Senator Peter's legislation, S. 3331, to clarify that CHIPS Act funds may be utilized to support upstream manufacturers. Do you share our concerns with America's reliance on other countries, particularly China, for critical material inputs, including polysilicon, that are essential to the semiconductor supply chain?

Answer. We support Congressional efforts to ensure we have a strong U.S. semiconductor ecosystem. Building a semiconductor fab without a secure supply of chipmaking materials or chipmaking equipment would be like building a Chick-fil-A restaurant without a secure supply of chicken to purchase. Senator Peter's legislation is an important recognition that the semiconductor supply chain is complex and multi-phased, and a large portion of grants directed at semiconductor fab expansion or new fab construction will necessarily be used to purchase manufacturing equipment and materials. This is due to the significant expense of the equipment needed to fabricate chips. For example, public news reports describing Intel's technology development plans estimate the cost of current EUV lithography machines at around $150 million each, while such machines for future generations of chipmaking will cost around $300 million each.[11]

Question 5. Automated vehicles (AVs) require cutting-edge processors to handle the computing loads present in software. The U.S. currently leads the market for AV development and the design of chips that are capable of facilitating the advancement of the U.S. autonomous vehicle sector. Why is this investment critical for the U.S. to remain the word leader in AVs?

Answer. The U.S. can benefit from continued advancements and innovations in automotive technology as autonomous vehicles will be an essential part of the future of safety and mobility. However, enabling the widespread benefits of AVs and other transformative technologies will require additional semiconductor production and capacity.

Broadly speaking, cutting edge processors will be required to enable U.S. leadership in autonomous vehicles—and also for other essential-to-win applications ranging from artificial intelligence (an essential enabling technology for autonomous vehicles), quantum computing, advanced telecoms networks, high performance computing, and others. Until recently, the U.S. *was* the decades-long leader in cutting-edge processors. *CHIPS for America Act* investments will help put the U.S. on equal footing with other countries who have offered significant incentive programs for years.

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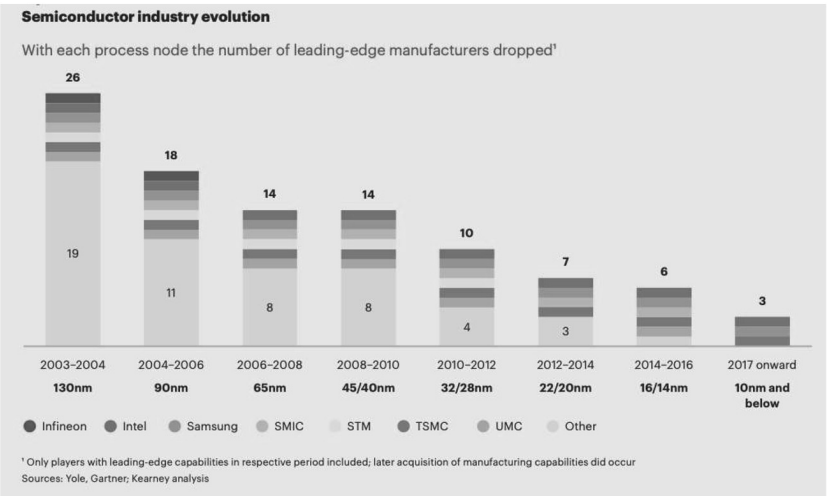
[11] See "Intel orders ASML system for well over $340 mln in quest for chipmaking edge" at *https://www.reuters.com/technology/intel-orders-asml-machine-still-drawing-board-chipmakers-look-an-edge-2022-01-19/*.

The chart below from a report by consultancy Kearney shows what is at stake for the U.S. As chipmaking advances for important technologies such as autonomous vehicles, fewer and fewer companies can keep pace with the capital investment and R&D required to compete. Since 2003 there have been roughly half a dozen generations of advances in chipmaking technology, but fewer and fewer companies have been able to stay at the leading edge.



Question 6. How do siting, permitting, and other infrastructure-related issues slow down your ability to open and operate new facilities?

Answer. In our response to the Department of Commerce's request for input on implementing the financial assistance program under the CHIPS Act, Intel made clear that delays in the Federal permitting of new semiconductor facilities supported by *CHIPS for America Act* could seriously undermine the objectives of the law.

Specifically, we recommend that the Federal government should further expedite, or better yet exclude, any applicable Federal permitting requirements under the National Environmental Policy Act (NEPA) for CHIPS Act-funded semiconductor projects, which can add years to the approval timeline. The current process to "fast track" NEPA requirements helps,[12] but it is not enough in our dynamic industry because even in such cases it could take up to two years to receive required approvals. Such delays mean the U.S. could lose new projects to other locations that offer a more competitive cost structure without delays.

Consequently, given the urgent need to strengthen our industry, we urge the Commerce Department to implement a definitive "categorical exclusion"—at least for facilities already under construction where the environmental impact has been thoroughly examined under state law. The Department of Energy's experience with the Advanced Technology Vehicles Manufacturing Incentive Program (commonly known as the Auto Loan Program) is instructive precedent. In 2009, DOE applied categorical exclusions to manufacturing facilities that received Federal funding under the Auto Loan Program. DOE provided loans to automobile manufacturers and component suppliers for projects that reequipped, expanded, and established manufacturing facilities in the United States to produce light-duty vehicles. DOE and CEQ concluded that the activities contemplated under the Auto Loan Program were substantially like activities covered by the agency's existing categorical exclusions.[13] As another best practice, the U.S. government also should look to the fast-track permitting process for environmental and other assessments that the European Commission is asking its member states to implement for first-of-a-kind semi-

[12] *See* S. 3541, a bill to include certain computer-related projects in the Federal permitting program under title XLI of the FAST Act, and for other purposes; available at *https://www.congress.gov/bill/117th-congress/senate-bill/3451?s=2&r=4.*

[13] *See* Letters between Steven Chu, Secretary of Energy, and Nancy Sutley, CEQ Chair (Mar. 19 and Mar. 20, 2009) (relying on DOE Categorical Exclusion B1.31).

conductor facilities as part of the newly published EU Chips Act.[14] Analogous to our proposed categorical exclusion, the EU Chips Act also allows "derogations in permit granting procedures, including in certain environmental assessments" if other conditions are met.[15]

Question 7. Can you talk about the facilities Intel has opened in China over the past few decades, compared to the facilities Intel has opened in the U.S. over the past few decades?

Answer. Intel operates a global factory network but we develop our manufacturing IP and capabilities primarily in the United States. Our advanced manufacturing research efforts are centered in Oregon, and we perform our advanced logic manufacturing at our fabs in the U.S., Ireland, and Israel.

We rank sixth among publicly-traded U.S. companies in individual R&D investment.,[16] In 2021, we invested $18.7 billion in capital expenditures and $15.2 billion in R&D.[17] Overall, Intel's domestic operations directly contributed almost $26 billion to U.S. Gross Domestic Product (GDP) in 2019, with a total GDP impact to the U.S. economy of $102 billion. The majority of our manufacturing and R&D investments are in the U.S.

Beyond our existing operations, Intel is making unprecedented new investments in U.S. semiconductor manufacturing capacity. In the last 12 months alone, we have announced investments of $43.5 billion for the construction of new semiconductor fabrication facilities in Ohio and Arizona, and for the manufacturing of advanced semiconductor packaging technologies in New Mexico.[18] This follows our recently completed $3 billion investment to expand our operations in Oregon.

Our most recent U.S. announcement in Ohio amounts to a $20 billion investment for two new fabs at a new greenfield manufacturing site in Licking County, with the first fab coming online by the end of 2025 (business conditions permitting). A full build-out of the Ohio site could include eight fabs and a $100 billion investment over the next decade, assuming support from CHIPS Act funding. The manufacturing operations at the Ohio site will produce chips using our most advanced transistor technologies. In addition to about 7,000 construction jobs, the two initial fabs are expected to create approximately 3,000 high-paying full time Intel manufacturing and engineering jobs ranging from factory operators and equipment technicians to engineers and business support functions, many of which do not require a 4-year college or advanced degree.

In contrast to our investments in the U.S., Intel opened just one fab in China in its history and we have never performed advanced logic manufacturing in China. The fab opened in 2010, equipped to build semiconductors (chipsets, not microprocessors) that were two to three generations behind the leading edge chipset technology that was in production at Intel's lead fabs outside of China. In 2015, Intel converted the fab to build memory products, and, in 2020, Intel announced the sale of the Dalian fab to SK Hynix; that sale is underway and is proceeding according to plan.

Question 8. Can you explain your relationship with ByteDance? Please provide an explanation of your company's partnership with ByteDance to improve their AI systems and data storage.

Answer. ByteDance purchases Intel commercial off the shelf (COTS) products.

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[14] *See* Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Chips Act for Europe, at 17, COM (2022) 45 Final (Brussels 8.2.2022); Proposal for a Regulation of the European Parliament and of the Council, European Commission 2022/0032, establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act), at 7–8 (Brussels 8.2.2022).

[15] Proposal for a Regulation establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act), Art. 14.

[16] "Intel's Impacts on the U.S. Economy", Report Issued April 2021, using data for FY 2019, available at *https://www.intel.com/content/www/us/en/newsroom/news/us-economic-impact-study.html?wapkw=economic%20impact#gs.tptln6.*

[17] Intel Corporation Annual 10–K for Fiscal Year Ending December 25, 2021, available at *https://www.intc.com/filings-reports/all-sec-filings/content/0000050863-22-000007/0000050863-22-000007.pdf*

[18] See Intel Press Releases available at *https://www.intel.com/content/www/us/en/newsroom/news/intelannounces-next-us-site-landmark-investment-ohio.html; https://www.intc.com/news-events/press-releases/detail/1501/intel-breaks-groundon-two-new-leading-edge-chip-factories; https://www.intel.com/content/www/us/en/newsroom/news/new-mexico-manufacturing.html.*

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. RICK SCOTT TO PAT GELSINGER

Question 1. As seen in the response to Russia's unjust and unlawful invasion of Ukraine, the American people expect U.S. companies to stop doing business with murderous regimes. On top of its egregious human rights abuses, Communist China has made clear that it intends to invade Taiwan. If Communist China invades Taiwan, would Intel continue to do business with and in Communist China?

Answer. Intel is an American company with a global footprint. We comply with all U.S. sanctions, regulations, and laws affecting its operations, sales of its products, and trade.

Question 2. What is Intel doing right now to decouple its operations in Communist China and decrease its dependence on this market?

Answer. As previously announced, Intel's primary manufacturing presence in China was a memory manufacturing fab in the City of Dalian. At the end of 2021, Intel announced completion of the first closing of the sale of its NAND and SSD business, including the Dalian, China NAND memory manufacturing facility. While Intel performs some assembly and test functions in China, we do not maintain any logic fabrication facilities in-country.

Question 3. During the hearing, I asked what Intel's return on investment would be if Congress funded the CHIPS Act at $52 billion. You did not directly answer my question. (a) For the record, in exact dollar amounts, what would the expected return on investment to U.S. taxpayers be if the CHIPS Act is funded at $52 billion, of which Intel is expected to receive nearly $3–4 billion? (b) How will you ensure that any U.S. taxpayer investments in your company do not, in any way, benefit Communist China? (c) Will you commit to complete transparency with regard to Intel's use of any U.S. taxpayer funds?

Answer. We approach projecting economic impact of investments in U.S. chipmaking by looking at Intel's impact in states where it currently maintains significant manufacturing operations. As highlighted in my written testimony:

- *In California,* our total annual economic impact is approximately $24.9 billion, based on 2019 data. We have donated nearly $90 million to support California schools and nonprofits, and we employ more than 13,000 full time equivalents (FTEs).
- *In Oregon,* our total annual economic impact is approximately $19.3 billion, based on 2019 data. We are Oregon's largest corporate employer with more than 22,000 FTEs, and we've also invested more than $49 billion in capital since we first arrived to support our operations in the state.
- *In Arizona,* our annual economic impact is approximately $8.6 billion, based on 2019 data. We've invested more than $23 billion in capital to support our operations in the state and we employ nearly 12,000 FTEs there as of January 2021.
- *In New Mexico,* our annual economic impact in New Mexico is approximately $1.2 billion, based on 2019 data. We've also invested more than $16.3 billion in capital to support our operations in the state and employ approximately 1,800 FTEs there.

Intel has announced $43.5 billion in major expansions or new fab construction in Arizona, New Mexico, and Ohio—projects which can be amplified, expanded, and accelerated by grants from the *CHIPS for America Act* programs. Intel will invest more than $3 for every $1 in CHIPS funding we would receive. In Ohio, for instance, we selected a site that could accommodate up to eight fabs, which will allow Intel to inject up to $100 billion in investment into the local, state, and regional economy.

Without CHIPS for America Act funds, however, Intel likely would be forced to build fewer facilities at a slower pace in Ohio and may build the remaining fabs outside of the U.S. (*e.g.,* Germany, Ireland, or Israel). The chart below illustrates the tremendous economic growth that can be created by the U.S. government providing grants through the *CHIPS for America Act.* The chart uses Intel Arizona operations (comprising four operating fabs and generating about $8.6 billion in annual economic impact) as a baseline to project the annual effect of grants on the economic impact from Intel's planned Ohio fabs. Without *CHIPS for America Act* grants, economic impact in Ohio would fall by half (assuming Intel can build only two fabs); with *CHIPS for America Act* grants, the economic impact doubles (assuming grants enable building up to eight fabs in Ohio).

Visualizing the projected annual economic impact of CHIPS for America Act Grants

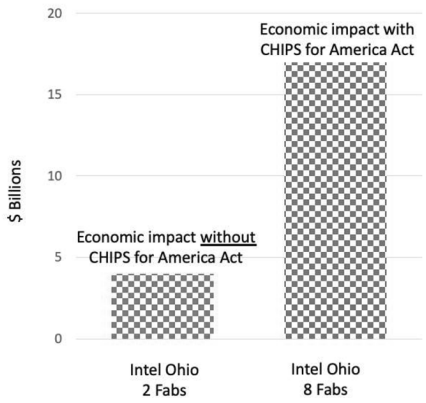


Figure 1 Projection of annual economic impact of CHIPS for America Act grants. Projections based on extrapolation of Intel Arizona U.S. economic impact, which is about $8.6 billion annually (four fabs).

Moreover, and more specifically, a single new fab in the U.S. will contribute roughly $4.0—$4.5 billion in Federal income and payroll taxes over 10 years (dependent upon product mix and whether the fab is operating at max capacity). Support from the *CHIPS for America Act* that enables the construction of eight new fabs could result in $32 billion to $36 billion in Federal tax revenue.

CHIPS for America Act grants will have a multiplying effect, unlocking many more billions of dollars in private sector investment. For example, a single leading-edge fab may cost $12 billion in capital investment over its first 10 years, and the Department of Commerce may award up to a cap of $3 billion for such a project (the maximum allowed per project under the *CHIPS for America Act*), leaving other sources to fund the remaining $9 billion or more, which would be at least 3x the U.S. Government's investment. Beyond the initial capital investment, the *CHIPS for America Act* grants would also unlock enormous ongoing spending on operations and eventual retooling of a fab—spending in excess of $12 billion over the first 10 years. This means that private investment to build, to equip, *and* to operate a leading edge fab over its first 10 years would be about 6X that of the U.S. government's grant (~$18 billion vs. $3 billion or a ~6:1 investment ratio).

Thus, in building a leading edge fab, Intel and other investors involved would take the vast majority of the financial and economic risk.

Intel commends the authors of the *CHIPS for America Act* for including robust transparency and claw back mechanisms in the legislation authorizing grants, including provisions requiring that grant recipients meet committed timelines, have a viable plan to sustain the federally subsidized project long term, and avoid certain research and technology licensing with a foreign entity of concern.

Response to Written Questions Submitted by Hon. Shelley Moore Capito to Pat Gelsinger

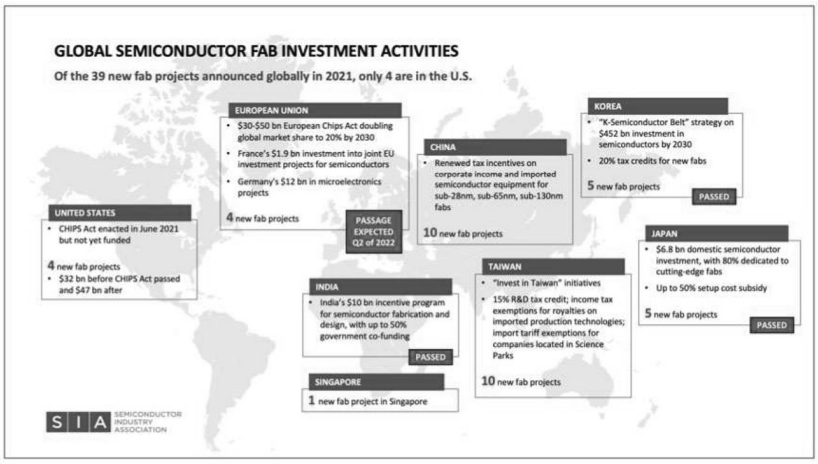
Question 1. The COVID–19 pandemic highlighted the fundamental fragility of the semiconductor supply chain and the risks of concentrating the manufacture of these critical components in only a few geographic areas. Emerging technologies and innovative infrastructures, such as 5G/6G and smart electrical grids, will require the smallest and most complex processors. So the issues we are seeing today will only worsen as the demand for more advanced chips increases.

Answer. America's leadership and future competitiveness in advanced technologies such as artificial intelligence, quantum computing, high performance computing, autonomous mobility, and 5G and beyond, requires the U.S. to have domestic chipmaking ability at the leading-edge chips. It is imperative that the U.S. posi-

tion itself to win in advanced and emerging technologies. For the U.S. to succeed, the U.S. must increase resilient, stable access to semiconductors fabricated in the U.S.—especially domestically manufactured leading edge chips that are the foundational blocks of emerging and innovative technologies.

Question 2. In your testimony, you mention Intel's new investments in the United States—like the new fabrication facilities in Ohio and Arizona and the packaging facility in New Mexico. As we come out of the COVID–19 pandemic, what are some of the lessons learned to ensure that that we do not experience the same shortages?

Answer. The most important lesson may be that COVID laid bare the state of the semiconductor supply chain, but COVID was not the main cause of chip shortages. The semiconductor shortage is the result of years of underinvestment in chip fabrication capacity in the United States. New investments in fab capacity will correct this situation eventually, but it will take time. Funding the *Chips for America Act* is crucial to unlocking billions of dollars of private investment in chipmaking capacity in the U.S. by competing with jurisdictions who are actively wooing semiconductor manufacturers to their shores with billions of dollars in subsidies.



Question 3. What is the average length of time it takes to build a new fabrication facility?

Answer. Generally, it takes 2–4 years to build a new fab, but that time may be extended by Federal permitting approvals triggered for projects receiving CHIPS Act grants. In its response to the Department of Commerce's request for input on the grants program, Intel made the following recommendation:

> The Federal government should also expedite any applicable Federal permitting requirements under the National Environmental Policy Act (NEPA) for these projects, which can add years to the approval timeline. Such expediting can only be partially accomplished with fast-track permitting approval,[19] but even in such cases it could take up to two years to receive the go ahead. In the meantime, the U.S. could lose out to another location that offers a more competitive costs structure today.
>
> Thus, preferably, given the urgent need to strengthen our industry, we believe the Commerce Department can implement a definitive "categorical exclusion"—at least for facilities already under construction where the environmental impact has been thoroughly examined under state law and is no longer significant. The Department of Energy's experience with the Advanced Technology Vehicles Manufacturing Incentive Program (commonly known as the Auto Loan Program) is instructive precedent. In 2009, DOE applied categorical exclusions to manufacturing facilities that received Federal funding under the Auto Loan Program. DOE provided loans to automobile manufacturers and component suppliers for projects that reequipped, expanded, and established manufacturing facilities in the United States to produce light-duty vehicles. DOE and CEQ con-

[19] *See* S. 3541, a bill to include certain computer-related projects in the Federal permitting program under title XLI of the FAST Act, and for other purposes; available at *https://www.congress.gov/bill/117th-congress/senate-bill/3451?s=2&r=4.*

cluded that the activities contemplated under the Auto Loan Program were substantially like activities covered by the agency's existing categorical exclusions.[20] As another best practice, the U.S. government also should look to the fast-track permitting process for environmental and other assessments that the European Commission is asking its member states to implement for first-of-a-kind semiconductor facilities as part of the newly published EU Chips Act.[21]

Question 4. What are some of the obstacles Intel has experienced when choosing a location in the United States?

Answer. The process for selecting a site is a complex and iterative process that weighs many factors. For our greenfield fab site, Intel conducted a global search for potential locations and invited initial proposals from interested parties. Intel evaluated proposals against the following general criteria to arrive at final options:

- Availability of a sufficiently large plot of land that is level and free of disturbances;
- Adequacy of required infrastructure (power, water, waste water treatment, roads, etc.);
- Expected construction costs;
- Availability of public sector incentives;
- Talent availability and labor market;
- Maturity of the semiconductor ecosystem in the concerned region; and
- Climate and geographic concerns (*e.g.,* water availability, flood risks, snow load risks, etc).

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO SANJAY MEHROTRA

Question 1. In March, Senator Kelly and I introduced the Micro Act, which aims to provide for a comprehensive and integrative program to accelerate microelectronics research and development at the Department of Energy. Senator Kelly and I believe this legislation will be key for securing America's future as the leader in semiconductor manufacturing. Will you commit to working with us on this important legislation?

Answer. Micron would be pleased to work with you and Senator Kelly on the Micro Act. Micron is supportive and appreciative of all efforts to support semiconductor R&D and secure U.S. technological leadership.

Question 2. The semiconductor chip shortage showed how vulnerable our supply chains are in the U.S. to disruption, whether from a global pandemic or logistics issues. I am concerned this Administration has been unable to get policies over the finish line to help industries fix their supply chain problems. How does the semiconductor shortage inform policy actions the U.S. should take going forward to bolster our manufacturing supply chains?

Answer. Investment in new domestic semiconductor manufacturing capacity is the most effective way to strengthen the U.S. semiconductor supply chain and minimize future disruptions. Funding provided through CHIPS legislation will be critical in helping the semiconductor industry launch a new, ambitious round of investment and manufacturing capacity expansion. Federal investments must be significant enough to offset the longstanding, substantial investments by Asian governments in their own countries' manufacturing capacity, as well as the 35–45 percent differential in upfront start-up costs between the U.S. and Asia.

For memory and storage specifically, incentives must account for the large scale of manufacturing required, as memory and storage fabs must produce at very high volumes consistently over time in order to be commercially viable over the long term. Multiple facilities are required to achieve this scale, each costing tens of billions fully equipped. Technological advancements also come with increasing complexity, requiring ever-higher capital and operating expenses on the part of memory and storage manufacturing companies.

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[20] *See* Letters between Steven Chu, Secretary of Energy, and Nancy Sutley, CEQ Chair (Mar. 19 and Mar. 20, 2009) (relying on DOE Categorical Exclusion B1.31).

[21] *See* Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Chips Act for Europe, at 17, COM (2022) 45 Final (Brussels 8.2.2022); Proposal for a Regulation of the European Parliament and of the Council, European Commission 2022/0032, establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act), at 7–8 (Brussels 8.2.2022).

Furthermore, to ensure the long-term viability of the investments, manufacturing incentives must be coupled with an investment tax credit (ITC) included in proposals such as the FABS Act. While the CHIPS Act grant program as currently envisioned will help bridge the cost differential between the U.S. and Asia in start-up costs, a refundable ITC is critical to bridge the differential in ongoing costs required to operate a fab in the U.S. as compared to Asia. A refundable ITC will also provide an equitable and efficient means to allocate government funds toward strategic projects with the greatest potential to help build domestic semiconductor self-sufficiency and strengthen the semiconductor supply chain. In other words, the ITC will enable the government to provide a certain and scalable form of support for semiconductor producers to invest domestically in long-term requirements and ensure reliable supply.

Question 3. What is the importance of memory in the semiconductor supply chain? Why is American leadership in memory semiconductors important?

Answer. Memory and storage are an important pillar of the semiconductor industry and are critical to all parts of the U.S. economy and national security. They underpin virtually every compute system, and, by providing foundational capability for all data-centric infrastructure demand fueled by AI and 5G, unlock innovation across industries—from healthcare to automotive, communications and defense applications. In other words, advancements in memory and storage set the pace for technological development.

Because of this, memory and storage have grown from approximately 10 percent of the global semiconductor industry in the year 2000 to about 30 percent today. This trend is expected to continue and currently memory accounts for nearly 60 percent of the world's 300mm semiconductor wafer output. For example, 5G phones have 50 percent more memory (DRAM) and double the storage (NAND) content as compared to 4G phones. Despite this, U.S.-based chip manufacturing only accounts for two percent of global memory production. This follows a trend of steady decline for domestic semiconductor manufacturing. For example, in 1990, the U.S. accounted for 37 percent of global chip manufacturing capacity. Today, it only accounts for 12 percent.

Therefore, investment in expanding U.S. memory and storage manufacturing and R&D capacity is critical to ensure that our country's industrial base will be able to not only produce devices that currently exist, but also develop new, innovative devices of the future that will be critical for U.S. national security and quality of life.

Question 4. How will you ensure that the CHIPS Act dollars are allocated to a variety of different applications, technologies, and industries across the board that have been negatively impacted?

Answer. Domestic investments in semiconductor manufacturing will support our ability to develop and supply products for industries, such as automotive, that have been impacted by supply chain shortages. By bringing advanced manufacturing back on shore, CHIPS Act dollars will help us to even more effectively support these partners.

Micron is the leading supplier globally of auto-qualified memory and has been proud to continue on-time deliveries to our auto customers throughout the ongoing supply chain shortage. We benefit greatly from our relationships with industry partners and are committed to providing the highest quality products to our customers in a consistent and timely manner. While the United States continues to lead in research and development, advanced domestic manufacturing of leading-edge memory is non-existent. Growing a manufacturing ecosystem would substantially increase supply chain resiliency, and create long-term, stable jobs in the communities where advanced manufacturing fabs exist. Modern fabs cost $10 billion (about $31 per person in the US) to build directly employing approximately 1500 people with an additional 1500 contractors supporting the fab employed by associated suppliers. We estimate these high paying jobs have a multiplier effect of up to 5.7 on the community; thereby creating thousands more jobs.

With respect to CHIPS Act investments more broadly, we should focus on areas where the U.S. can lead in a commercially viable manner in the long-term. To that end, the U.S. should invest in leading-edge process technologies and manufacturing—areas with the highest rate of change and highest level of complexity (capital intensity). Investments should be in leading-edge technologies, including cutting-edge process/manufacturing steps like EUV, advanced dry etch, chemical mechanical planarization (CMP), and precision film deposition, given the longer lifecycle, lower risk of obsolescence, and longer time needed to secure a return on investment. Incentivizing domestic leading-edge manufacturing would generate cascading salutary effects for the entire U.S. industrial base by promoting faster adop-

tion of new technologies creating resilience, cost efficiency, and flexibility to prevent or mitigate shortages when combined with improved demand signaling.

It is also essential to note that a major investment in a new domestic fab will also be a powerful investment in the entire U.S. supply chain. Each fab would require tens of billions of dollars of capital expenses in manufacturing equipment, construction, and IT systems, as well as billions of dollars annually in operational expenses related to gases and chemicals, technical services, repair and maintenance, utilities, and other materials. These costs manifest as direct, sustained investment in the U.S. supplier base. A new domestic fab would also employ thousands in high-paying and highly technical jobs, creating a vendor ecosystem that would bring tens of thousands of additional jobs, including trade roles.

Question 5. I am an original cosponsor of Senator Peter's legislation, S. 3331, to clarify that CHIPS Act funds may be utilized to support upstream manufacturers. Do you share our concerns with America's reliance on other countries, particularly China, for critical material inputs, including polysilicon, that are essential to the semiconductor supply chain?

Answer. Micron is grateful for your support of S. 3331. We are supportive of all measures that would promote diversifying sources of critical material inputs and ensure that no single company, location, or region would be a chokepoint of critical material inputs. Efforts to develop alternative sources of supply, either domestically or among the U.S.'s international partners, will play an instrumental role in boosting the resilience of the U.S. semiconductor supply chain.

Question 6. Automated vehicles (AVs) require cutting-edge processors to handle the computing loads present in software. The U.S. currently leads the market for AV development and the design of chips that are capable of facilitating the advancement of the U.S. autonomous vehicle sector. Why is this investment critical for the U.S. to remain the word leader in AVs?

Answer. Semiconductors are indispensable to ensuring the advanced functionality and safety of AVs. As the auto industry continues its push for ambitious new AV capabilities, memory consumption will continue to increase for each vehicle. Today's autonomous vehicles already require more than 10 times the amount of memory and storage that previous generation cars used. An average car manufactured next year will contain memory chips worth approximately $1,000 and $3,000 of all chips. Therefore, expanded domestic memory and storage manufacturing and R&D capacity will help boost the U.S. auto industry's ability to innovate and maintain its leadership in AVs.

Question 7. How do siting, permitting, and other infrastructure-related issues slow down your ability to open and operate new facilities?

Answer. Permitting regulations, particularly the lengthy assessment timelines they require, are part of the reason why the United States currently builds fabs at a slower rate than its competitors. Therefore, as part of its effort to invest in expanding semiconductor manufacturing capacity, the U.S. government must coordinate regulatory support across the local, state, and Federal levels to facilitate and expedite fab construction. More broadly, the government should review Federal permitting regulations to identify areas where they are redundant with state rules and may therefore be revised or harmonized. The EPA should also create new "fast track" permitting options that allow fabs to undertake some operational changes without being required to file environmental permit applications. A potential template for this approach is the State of Oregon's Plant Site Emissions Limit (PSEL) program.

Response to Written Questions Submitted by Hon. Rick Scott to Sanjay Mehrotra

Question 1. In exact dollar amounts, what would the expected return on investment to U.S. taxpayers be if the CHIPS Act is funded at $52 billion?

Answer. Analysis conducted by the Semiconductor Industry Association (SIA) and Oxford Economics has estimated that a $50 billion dollar incentive package similar to that planned under CHIPS could generate $25 billion per year in expanded GDP per year between direct, indirect (supply chain), and induced (wage spending) economic activity in the first six years following the passage of such a policy. Micron's own economic impact analyses of U.S. projects under consideration indicate that GDP contributions of projects supported by CHIPS are likely to be at least as high in years seven through ten following such a program as semiconductor companies ramp their operations.

Data collected by the OECD suggests that the United States has a tax-to-GDP ratio of on average 25 percent. Based off of this, and the assumptions above, taxpayers would expect to receive an additional $6.25 billion in tax revenue per year based on the program. Under these assumptions, such a program would fully pay itself off for taxpayers after eight years in dollar terms alone, with additional revenue benefits accruing to taxpayers in the years that follow. Over the first ten years of such a program, taxpayers would expect to receive $12.5 billion in excess tax revenue, with the total increasing further in the years that follow with tax receipts having effectively paid of the "principal" of government investment.

This is to say nothing of the benefits to employment, innovation, national security, and economic resiliency that would result from such a scenario. SIA/Oxford projects that such an investment by industry would generate 185,000 temporary jobs during fab construction plus 42,000 direct industry jobs and 280,000 permanent jobs in the U.S. economy by the end of their analysis. Relocating supply chains to the United States would provide resiliency to the U.S. economy in the event of further geopolitical and economic dislocations around the world, providing further upside to U.S. voters.

Question 2. How will you ensure that any U.S. taxpayer investments in your company do not, in any way, benefit Communist China?

Answer. Micron has never fabricated semiconductors in China and has no plans to do so. CHIPS legislation funding would support Micron's ongoing efforts to expand semiconductor manufacturing and R&D capabilities within the U.S. and contribute to the development of a strong domestic STEM workforce that can meet the needs of the economy of the future. As an example of this, in January 2022, we opened a new memory design center in Atlanta, Georgia that will create up to 500 jobs across various STEM disciplines in the coming months. CHIPS funding would also strengthen U.S. national security by bolstering the resilience of our supply chains and ensuring that the U.S. industrial base can access the semiconductor supplies that it needs to drive our economy and maintain American technological leadership.

Micron supports the robust taxpayer protections and claw-back provisions included as part of the CHIPS Act. We will work closely with the Department of Commerce as they codify these policies and fully comply with all requirements.

Question 3. What is your plan to limit risk in Communist China by decreasing your business there? Do you plan to stop doing business in Communist China?

Answer. Micron has never fabricated semiconductors in China and has no plans to do so. In fact, we were founded in Boise and grew by consolidating the industry. Our facilities in China are only responsible for performing packaging, testing, and assembly operations for of our products. If we do not sell to our customers, our foreign competitors would take our place, especially as a significant portion of these products are industry-standard products that are compatible between all the memory suppliers. We are careful to maintain our global competitive edge and take aggressive measures to protect our IP around the world.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. SHELLEY MOORE CAPITO TO SANJAY MEHROTRA

Question 1. My colleague Senator Rosen and I launched the Senate's first Women in STEM Caucus which focuses on advancing women's participation in science, technology, engineering, and math (STEM) education and careers. STEM fields are where the in-demand jobs are right now and where they will be in the future. I believe that is it is incredibly important for us to develop a STEM workforce to meet the workforce demand we will see in the near future.

Answer. Micron agrees that the semiconductor industry has an essential role to play in creating a STEM workforce that will meet future demands, particularly with women and other underserved populations. Micron has developed several initiatives supporting women's participation STEM fields, including the "Girls Going Tech" program, which focuses on younger students, and the "Women in Technical Career Events" initiative, which is tailored to students Grades 9–12. In addition, through our Global Women's Mentorship Program, Micron is working to increase the pipeline of young women applicants in the industry by inspiring future talents. Micron also takes pride in collaborating with the Society of Women Engineers to determine how Micron can best contribute its leadership in cultivating a STEM workforce that truly represents our country.

Micron has also launched a "Rural STEM" initiative aimed at helping students in rural communities gain a deeper understanding of STEM disciplines. Micron also plans to establish a cybersecurity scholarship program designed to allow rural and

community college students to gain a degree without physically being on a college campus.

More broadly, through the Micron Gives STEM Education program, Micron is dedicated to investing up to $10 million over the next five years through Inspire Learning Grants to connect students to the careers of the future.

Based on Micron's successful experience with the above initiatives, greater Federal funding to support STEM education could make a tremendous impact on building a workforce that our country needs to grow and remain competitive in the future. The U.S. Government should continue and expand funding to increase STEM education at all levels, enable the expansion of vocational programs at community colleges, promote re-skilling programs, and facilitate public-private partnerships to train and employ new entrants in the industry.

Question 2. How has Micron developed the STEM workforce you need at your company?

Answer. Micron has developed a wide variety of programs to build the workforce needed for our future growth. We have committed to providing approximately 10,000 enhanced career opportunities over the next three years through apprenticeships, work-based learning programs, continuing education, on-the-job training, and re-skilling. For instance, we have partnered with nonprofit group Year Up to administer a program to help prepare talent for joining the workforce. After six months in the program, participants are given an internship at Micron. Qualified candidates are then given full-time technician offers.

Micron is also planning to design a similar internship pathway targeted specifically at veterans. Veteran re-skilling and transition programs, such as SkillBridge, have been particularly successful for Micron—we have found that many of the technical skills that servicemembers in certain specialties develop are also strong foundations for success at our company. Over the years, we have recruited significant numbers of former service members.

On a longer-term basis, Micron has partnered with academic institutions at all levels—K–12, community colleges, and universities—to build curricula; provide internships, scholarships, and the equipment and materials students need to prepare for work in today's industry; and help onboard them into long-term careers. Our university programming aims to provide industry-relevant curriculum for faculty, as well as learning experiences and research opportunities for students to encourage them to pursue engineering and keep them engaged through graduation.

Our efforts have been focused on the communities where we are present, including the states of Virginia and Idaho. Micron's partnership with Northern Virginia Community College (NOVA) provides an illustrative example of how Micron has successfully partnered with community colleges. Micron partnered with Year Up and NOVA to create a Fab Lab and a Mechatronics A.A.S. and Certification, which is targeted towards underrepresented groups and unemployed/underemployed young adults. Micron representatives also serve on NOVA's board—in general, many Micron employees serve on several K–12 education foundation boards and higher education Career & Technical Education (CTE) advisory boards. Micron's engagement with Norfolk State University (HBCU) and our financial support of the Micron Cleanroom has also allowed for a semiconductor certification program for students and veterans.

In addition, through a joint initiative with Boise State University, Micron is helping build long-term student programs and career centers to recruit, retain, and graduate more STEM students, especially those from underrepresented and rural backgrounds.

Question 4. You mention the partnerships between Micron's memory design center in Atlanta with leading institutions and universities in Georgia. Toyota Motor Manufacturing has a similar partnership with Bridge Valley Community and Technical College which has built a pipeline for students to go from the classroom to an in-demand, well-paying career.

Answer. We are eager to expand our partnerships with universities wherever we operate, as these programs help us to attract and develop the best talent that our country has to offer. Expanded manufacturing operations in the United States by the CHIPS Act would rely on manufacturing training initiatives at community colleges similar to the partnership that you mention. For example, as part of the development of our new memory design center in Atlanta, we are working to establish strong partnerships with many institutions in the region including Emory University, Georgia Tech, Morehouse College, Spelman College and University of Georgia. Semiconductor manufacturing at scale requires thousands of technicians trained to perform complex tasks in clean room environments that are sealed and purified to prevent contamination that leads to manufacturing defects. Expanding the existing

U.S. clean room workforce will be a major priority for industry and for Micron if policy conditions support an expansion of domestic semiconductor manufacturing capacity.

Question 5. How can the United States encourage and support similar partnerships across the United States?

Answer. The strongest step that the U.S. government can take to support the development of similar partnerships is to introduce policies promoting domestic investment such as CHIPS Act funding, which includes new support for workforce development initiatives, and an Investment Tax Credit for semiconductor manufacturing. Large companies factor in employment requirements to investment decisions and work closely with federal, state, and local governments and institutions of higher education to develop employment pipelines similar to the partnership between Toyota and the Bridge Valley Community and Technical College that you mention.

Additionally, the U.S. Government should expand funding to promote re-skilling programs and facilitate public-private partnerships to train and employ new entrants to the industry in the immediate term, while also increasing funding for STEM education and promoting the expansion of community college vocational programs in the longer term. In all of these efforts, close collaboration with industry will ensure the investments align with employers' evolving requirements and provide the foundation for long-term, productive employment.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARSHA BLACKBURN TO TIM ARCHER

Question 1. In your testimony, you noted that the Micro Act will be an important tool in streamlining coordination and better deploying Federal resources, including the National Labs. Can you explain why the Micro Act is key to securing America's future as the world leader in deploying next generation microelectronics?

Answer. A robust domestic semiconductor supply chain has become vital for U.S. national security and global competitiveness. While the U.S. industry accounts for nearly half of total global chip sales, much of the actual manufacturing of this critical technology takes place in facilities overseas.[1] To achieve a secure domestic supply line for microelectronics, the U.S. must make significant investments in research to expand the capacity of semiconductor equipment supplier companies responsible for making the sophisticated and expensive machines used in the manufacturing process.

The Micro Act would address this need, leveraging an interconnected and collaborative set of universities in diverse geographic locations, national laboratories, and industry representatives. Of particular focus, the Micro Act would support plasma processing leadership in the semiconductor industry—a critical component of the process technology that enables the entire semiconductor ecosystem.

This legislation would establish a government funding strategy for plasma processing in semiconductor manufacturing, targeted towards breakthroughs 5–10 years from now in order to strengthen the Nation's competitive advantage. Such a powerful innovation incubator would stimulate new technology, generate valuable U.S. intellectual property, and create products to further domestic leadership in the global market. For the country to retain this leadership position, we urge Congress to pass the Micro Act.

Question 2. I am an original cosponsor of Senator Peter's legislation, S. 3331, to clarify that CHIPS Act funds may be utilized to support upstream manufacturers. Do you share our concerns with America's reliance on other countries, particularly China, for critical material inputs, including polysilicon, that are essential to the semiconductor supply chain?

Answer. The Investing in Domestic Semiconductor Manufacturing Act (S. 3331) is a critical tool to bolster the U.S. innovation economy. Supply imbalances in the global market have demonstrated the necessity of an adequate and resilient supply of semiconductors to many large industries that comprise a substantial portion of our economy. To ensure a lasting, secure supply, we must take a holistic view of the value chain. Of critical importance, the CHIPS Act creates a new Federal policy to incentivize domestic semiconductor manufacturing through the Commerce Grant Program. The CHIPS Act will promote new U.S. fabs to meet growing global demand for semiconductors. These new fabs will be dependent on an adequate supply of semiconductor manufacturing equipment and materials. S. 3331 would provide the Grant Program the flexibility to incentivize new and expanded facilities to

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[1] *https://www.semiconductors.org/wp-content/uploads/2020/09/Government-Incentives-and-US-Competitiveness-in-Semiconductor-Manufacturing-Sep-2020.pdf* (pg 5)

produce manufacturing equipment and materials and ensure that expanded U.S. production is not restrained by shortages of these critical components. Industry durability requires a whole-of-ecosystem approach. We are grateful policymakers have recognized this requirement and intend to bolster the supply chain broadly.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. RICK SCOTT TO TIM ARCHER

Question 1. In exact dollar amounts, what would the expected return on investment to U.S. taxpayers be if the CHIPS Act is funded at $52 billion?

Answer. As one of the world's largest semiconductor equipment companies, with the majority of our manufacturing footprint in the U.S., we appreciate Congressional attention to competitiveness in the market and our position in the global ecosystem. U.S. leadership in semiconductor equipment is a strategic advantage for the country and one that we aim to advance. The research and development investments required to achieve and maintain U.S. competitiveness in semiconductor manufacturing technology has been overwhelmingly funded by the companies themselves—resulting in massive contributions to U.S. economic strength, jobs, and GDP. A thoughtful investment in the industry by the government will result in a commensurate economic benefit to the country. We expect the incentives and investments authorized in the CHIPS Act to significantly amplify industry's existing R&D efforts and provide significant return on investment to the U.S. economy and taxpayer.

Question 2. How will you ensure that any U.S. taxpayer investments in your company do not, in any way, benefit Communist China?

Answer. Federal expenditures supporting domestic facilities for semiconductor manufacturing as well as the equipment and materials critical to those facilities will strengthen U.S. competitiveness and should serve to bolster U.S. national security. Protecting the U.S. technological lead is of paramount importance to Lam and we support policy that protects critical technology, intellectual property, and ensures a fair and competitive playing field. As a proud American company, we inherently prioritize national and economic security as you do and welcome the opportunity to work together on these issues.

Question 3. What is your plan to limit risk in Communist China by decreasing your business there? Do you plan to stop doing business in Communist China?

Answer. As global leader in the semiconductor equipment market, Lam Research serves customers around the world. As earlier stated, protecting the U.S. technological lead is of paramount importance to Lam and we support policy that protects critical technology, intellectual property, and ensures a fair and competitive playing field.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. SHELLEY MOORE CAPITO TO TIM ARCHER

Question 1. You mention in your testimony that the U.S. has a robust semiconductor manufacturing base, but the cost of building and operating is 20 to 40 percent higher than in other countries.

Answer. U.S. leadership in semiconductor manufacturing technology remains strong. With fabs in 18 states and more on the way, Congress has a unique opportunity to provide the level of support traditionally seen in other economies. Importantly, a resilient supply chain to support these fabs remains an imperative, making a whole-of-ecosystem approach a critical component of Congressional action. The U.S. remains the global leader in semiconductor manufacturing equipment. As Congress seeks to increase domestic chipmaking capacity, America's dominant domestic equipment base cannot be overemphasized.

Question 2. What is your understanding as to why these costs are so much higher in the United States than in other countries?

Answer. The rising costs associated with building and operating facilities which handle complex manufacturing processes have put the U.S. at a competitive disadvantage. In many countries, government incentives have emerged as a common and robust tool to drive industry investments in semiconductors.

Question 3. What factor contributes to the most to this disparity?

Answer. Foreign governments have recognized the semiconductor industry as the pathway to technological advancement and sought to attract and develop a home-grown industrial base. Investments in a domestic industry through subsidization, favorable taxation, and other incentives—combined with lower labor rates—have contributed to the disparity in operating expenses we see today.

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