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Thank you for inviting me here today to speak on this important topic. On behalf of all of us at SEMATECH, I would also like to offer our heartfelt gratitude to you, Mr. Chairman, for your strong support over the years. We well remember your efforts in the early years, not only to support our funding, but also to advocate for the principles of industry autonomy and management, which have been so critical to our ultimate success. Your vision was prescient then, and now, twenty-five years later, you are still asking the right questions. Senator Murkowski, we so deeply appreciate your commitment to our nation's energy security and your leadership in supporting efforts to improve our industrial competitiveness.

Today we find ourselves once again facing stiff global competition as well as severe budget pressure. I understand the Committee's charge to be: what can we do affirmatively to improve our industrial competitiveness. We believe the SEMATECH experience is a big part of the answer.

Even in the midst of a historic global economic slowdown, the US remains the font of innovation, leading the world in patents, and indeed, garnering as many patents as the rest of the world combined. While we lead the world in discovery, we do face a real danger of becoming merely a producer of intellectual property that is ultimately commercialized elsewhere. Such an outcome denies the American economy the tremendous economic benefit that comes with transforming IP into products –both revenues and jobs—and ultimately denies the American taxpayer a return on the investments in the underlying research. Several trends, including outsourcing and growing competition from low cost producers overseas have eroded the U.S. industrial base and, along with it, the engineering and manufacturing capabilities needed to produce next generation products. Erosion in know-how, skilled personnel, and the supplier base has jeopardized or contributed to the loss of U.S. leadership in several key high-tech products including solar cells. Foreign producers now dominate these component and product markets, and are rapidly developing the know-how and capacity to capture next generation technologies.

The United States cannot cede leadership in future game-changing technologies such as nanotechnology-based products, smart materials, biopharmaceuticals, energy storage, and digital devices for ubiquitous computing. Both our economic and our national security depend on our industrial competitiveness. But, increasingly, development of leading edge products is intertwined tightly with manufacturing know-how and development of production processes. Simply put, the erosion of U.S. manufacturing capacity must be reversed to preserve America's ability to innovate.

THE SEMATECH MODEL

The competitive challenges we are facing today – while formidable – are not unprecedented. We have faced similar challenges before and we have met them. The conditions that gave rise to SEMATECH –most notably our trade deficit with Japan – were similarly daunting. Twenty-five years later, the SEMATECH story shows us that industrial consortia are both necessary and effective. But at that time, much of what we now know was in question. Whether the government should fund SEMATECH to help bolster the U.S. semiconductor industry, and how involved the government should be in SEMATECH's operations were seriously debated issues. The strength of the foreign competition and DOD's interest in having a domestic supply of both semiconductor devices and equipment, however, drove the government to undertake this public-private partnership that has since become the standard for many others.

In 1987, Congress authorized the bold SEMATECH (SEmiconductor MAnufacturing TECHnology) experiment, and subsequently appropriated $100M per year, matched dollar for dollar by industry, to fund an industry-led consortium of leading chipmakers to help restore U.S. leadership in semiconductors. By the mid-1990's, SEMATECH had accomplished its mission and withdrawn from federal funding; the bold experiment had succeeded, and through collaborative programs to improve manufacturing tools and processes, SEMATECH had indeed played a key role in pulling the industry together and re-establishing U.S. competitiveness in the global market.

Today, twenty-five years after its founding, SEMATECH is a global consortium of semiconductor device, equipment, and materials manufacturers, continuing to explore ways to advance current semiconductor manufacturing technologies and build the infrastructure for emerging next-generation technologies, to transform novel ideas into manufacturable and marketable solutions. SEMATECH's long-time mission has been to focus on pre-competitive or non-competitive R&D – cooperatively developing standards, building infrastructure, assuring that key components (tools, materials, processes) are in place when needed by industry – always with an eye toward improving manufacturability and accelerating commercialization.
With strong support of the State of New York, where we are headquartered, we work closely with a collaborative network of over 150 global partners – including our strategic partners, the College of Nanoscale Science and Engineering of the University (CNSE) at Albany, as well as semiconductor companies, equipment and materials manufacturers, national laboratories, universities, research institutes and other organizations throughout the industry ecosystem – to leverage resources and develop innovative research, development, and manufacturing solutions. Through SEMATECH, members cooperatively fund and conduct R&D projects to fill key gaps in R&D/manufacturing infrastructure, such as developing new manufacturing processes and equipment, standards, and training programs.

SEMATECH remains one of the world's most successful industry-led R&D consortia, with significant experience in managing large-scale industry-government-university alliances. Our member-driven collaborative model and best practices are standard-bearers for industrial R&D consortia, and have been emulated and replicated both nationally and internationally.

SEMATECH is often cited as the model for successful public-private partnerships, based on our pioneering of the industrial R&D consortium model and our success in helping the U.S. semiconductor industry regain market share in the face of stiff competition from foreign competitors. SEMATECH has spurred both technology innovation and economic growth, including the creation of tens of thousands of high-wage jobs and billions in capital investment. SEMATECH is one of the few entities around the world that has continuously accelerated the RD&D timeline and delivered substantial value to its participants on an annual basis.

In our view, given the history of SEMATECH we have just described, several organizational features have been integral to the success of the SEMATECH industrial consortium model:

Commitment from senior executives, long-term support: Through their financial support, participation in programs, and assigned personnel, member companies make a substantial investment in SEMATECH, which in turn ensures that our activities are directly relevant to their needs and priorities.

Industry leadership: While SEMATECH was established as a public-private partnership, industry has retained the management lead, ensuring that the consortium's activities are aligned with industry priorities.

A clear, pre-competitive mission: SEMATECH accelerates commercialization by addressing common challenges, which are enumerated by the industry roadmap. This means a focus on building technology infrastructure and strengthening the manufacturing base.

Broad representation of the industry: SEMATECH engages the whole supply chain, including manufacturers, universities, national labs, research institutes, equipment/materials manufacturers and other suppliers. This engagement allows each entity to improve its understanding of its customers' needs, and helps drive alignment and consensus across the broader industry.

Leveraging of government and industry funds: Government funding does not displace industry funding; rather, it leverages it for the purpose of accelerating technology development. SEMATECH's initial federal funding of $100M per year was matched by industry, dollar for dollar. In the years that followed, the industry increased its share and SEMATECH became self-sufficient. This ongoing commitment is all the more notable in light of the tremendous financial pressures most national and international technology companies face.

A manufacturing development facility: The key here is scale. A shared facility where companies can practice manufacturing in a real-world manufacturing environment is a critical component, making it possible to test equipment, materials, processes and innovate new products at the scale that is necessary in order to demonstrate performance, reliability, and cost savings. Such a facility provides access to capabilities that enable next generation start-up companies to succeed and provide the critical validation of product performance for venture capital funding.

Membership model: SEMATECH is a member-driven organization. Participating companies provide technical personnel ("assignees") on two- or three-year rotations in

addition to their financial contributions. Most immediately, this exchange of technical talent keeps SEMATECH attuned to member company priorities, but it is also is the critical means of transferring technology and manufacturing best practices.

SEMATECH has evolved over its 25-year history. In order to keep pace with and help lead a dynamic industry, it has expanded its program scope and its engagement with the supply chain, and diversified its funding sources. As a result, SEMATECH has:

- Helped recapture the US lead in semiconductor manufacturing,
- Successfully managed $870M in federal funding, ramping up membership, transitioning to self-sufficiency,
- Led industry-wide initiatives to enable industry transitions (next-generation patterning, next wafer size, novel materials and device structures), and
- Catalyzed technology commercialization and economic development.

APPLYING THE SEMATECH MODEL TO PHOTOVOLTAICS

At SEMATECH we see the incredible promise of renewable energy, and have already started to extend our experience in this direction, with the creation of the U.S. Photovoltaic Manufacturing Consortium (PVMC). Last year, the Department of Energy selected SEMATECH to establish the PVMC to accelerate the development, commercialization, and manufacturing of next generation solar photovoltaic (PV) systems. In keeping with the SEMATECH model, PVMC will provide a means for testing and demonstrating new technologies and manufacturing processes at production scale.

PVMC is leading a groundbreaking paradigm that will catalyze the 21st century solar PV industry, developing and commercializing innovations in renewable energy thin film technology to enhance performance and reliability while reducing the cost of manufacturing. This unique effort builds on the approach successfully demonstrated in the semiconductor industry, through the powerful combination of SEMATECH's collaborative industry consortium model and CNSE's public-private partnerships and unparalleled infrastructure.

PVMC private sector partners include companies from across the solar industry representing equipment, materials and metrology suppliers, module producers and integrators and end users. Working together with institutional partners, PVMC companies will provide the knowledge, experience and critical mass necessary to align the industry and propel it forward.

PVMC's goal is to increase the performance and speed the implementation of PV technologies while improving manufacturing processes and driving down costs. PVMC is working towards this goal by:

- Developing and disseminating technology roadmaps and standards in order to identify priorities and coordinate the technical agenda of the U.S. PV manufacturing industry,

- Establishing and supporting manufacturing development facilities to improve manufacturing productivity and increase U.S. PV manufacturing market share, jobs and technology innovation,
- Linking research labs, universities and industry to establish an effective PV commercialization support structure, and
- Developing a highly trained PV workforce.

Each of these strategic goals is supported by aggressive technical objectives, with detailed deliverables, metrics and milestones. Through its programs and advanced manufacturing development/prototyping facilities, PVMC will be a proving ground for innovative, disruptive solar technologies and manufacturing processes. Aligned and working together, the PV industry can overcome technology and manufacturing challenges, lower costs, regain market leadership, and spur the transition to a low-carbon renewable energy economy. Based on our decades of experience, we believe that this model of an industrial consortium working in partnership with universities and national labs can establish – or restore—national competitiveness in clean energy technologies.

INDUSTRIAL CONSORTIA: KEYS TO SUCCESS

SEMATECH was conceived by industry and government to stop and reverse the exodus of the semiconductor industry from the U.S.; the mission was ultimately successful, and SEMATECH has continued to evolve, adjusting to a dynamic industry and a dynamic world and economy, for the last quarter century. Our experience over that time tells us that the following are required to be successful:

- In any emerging/disruptive technology sector, a U.S. **prototyping capability** is needed to supplement R&D and bridge to manufacturing – that is, a manufacturing development facility (or facilities) that provides researchers and companies with the capability to test and prove out innovative technologies and manufacturing processes, either collaboratively or as part of a proprietary program or fee-for-service arrangement. This service goes well beyond what universities and national labs provide, with capabilities at sufficient scale to provide the data necessary to determine whether to adopt an innovation. A manufacturing development facility provides companies shared access to analytical, metrology, and advanced pilot line equipment required for integrating new materials, developing new equipment, and prototyping new products – services and manufacturing infrastructure not available in a lab environment.
- **Collaboration with, and alignment of, a U.S. supply chain** is needed to provide insight and guidance on the strategic investments required to achieve consortia goals; suppliers' direct engagement in collaborative R&D fosters innovation and accelerates progress toward commercialization. This is what Pisano and Shih have identified as the development of the industrial commons. ("Restoring American Competitiveness", HBR, July-August 2009)
- **An efficient allocator of R&D funding** is required – a consortium model provides a pre-competitive mechanism to bring the industry together, prioritize and narrow technology options, reduce the risks of technology R&D, and maximize return on investment, to assure

that funds are driven to productive applied research resulting in the acceleration of advanced manufacturing. It is difficult to evaluate long-term R&D programs, or adapt to rapid changes in technology. In these circumstances, the informed judgment of a combined cross-functional team of experts in a consortium is a better method of allocating R&D funding than a simple analytical model based on arbitrary assumptions when data or even reasonable estimates do not exist.

- **A bridge between innovative research and funding/commercialization** (e.g., across the Valley of Death) is needed, through a consortium model that spreads benefits/risk across all stakeholders, working with universities and national centers to pull critical research into the industry mainstream, working with industry to reduce costs/risks and accelerate precompetitive technology and process development, and working with government to realize the potential for economic benefit and job creation.
- **Building and sustaining links to international partners** is required. Industries are global; U.S. firms rely on global suppliers and have operations abroad, while many international firms make significant contributions to the development of U.S. innovation and manufacturing. While protecting our national interests and building our national technology and manufacturing capabilities, there are areas where international collaboration makes sense. To develop solutions that will be globally competitive, a consortium must have engagement with the global supply chain, especially in areas such as establishing common roadmaps, and providing access to critical materials and equipment sets. In particular, the issues of Environment, Health and Safety (EHS), standards, and quality/reliability are ones in which we all have a vested interest in establishing and maintaining a baseline standard. Ultimately, we have the know-how and methodologies to collaborate globally, while protecting national interests and protecting IP.
- The organization's success or failure rests on the integrity of the **intellectual property management**. A consortium must have an effective structure and methodology allowing collaborative, pre-competitive work while maintaining the integrity of the contribution of consortium members' IP and enabling the continuation into the competitive phase.
- A consortium is a collaborative effort that **leverages resources**; by combining both public and private resources, the consortium can expand the scope of its programs, investigate multiple technology options, and produce higher quality solutions, thereby multiplying many times over the undertaking that any single entity could afford.
- At the same time, the consortium must have a glide path to **financial sustainability**. We believe the membership model that draws member companies from all along the supply chain is critical to ensure that the consortium remains responsive to industry needs.
- A successful consortium must have the **trust and confidence** of the federal government, private corporations, and researchers/idea generators to provide the framework for, and realize the benefits of, our next generation of innovation-driven manufacturing. Trust and confidence comes from experience; the SEMATECH model has evolved with proven success in fostering technology innovation, reducing the costs of R&D, enabling advanced manufacturing, and creating high wage jobs and is respected worldwide.

CONCLUSION

In conclusion, we want to emphasize that for all of the challenges we face, we have faced similarly formidable challenges before, and we have the tools and the experience to overcome them. The Administration's National Network of Manufacturing Innovation holds a lot of promise in this regard. We believe that the NNMI can replicate SEMATECH's success across many industries, provided that it is guided by the core principle of industry management and that it utilizes the membership model.

The SEMATECH experience has reaffirmed that we as a nation can benefit from an ambitious national strategy to drive broad collaboration at sufficient scale to create technology roadmaps and standards; build R&D and manufacturing infrastructure; reduce cost across the supply chain; conduct both collaborative and proprietary technology programs; and provide access to pilot facilities to demonstrate innovations at manufacturing scale. In our view, public-private initiatives – that focus on investments that are too large for any single company or organization, and too long-term for companies that need to demonstrate quarterly results – are critical for the United States. In addition to leveraging our country's strong universities and venture capital system, we as a nation must nurture disruptive technology development and robust manufacturing, if we are to build the infrastructure for sustainable growth and leadership in the global economy. Given that the American taxpayer still funds the bulk of the underlying research, these activities return a significant ROI: in terms of generating revenue and high-value jobs, attracting companies to form a virtuous cycle of innovation-driven economic development, and thus enabling taxpayer-funded research to be commercialized here in the United States.