Chips Dip

By John Benson

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1. Introduction

Everyone has probably heard about the chip-crisis that the auto industry (and others) have been experiencing. I have been looking for a really good explanation of this that I could share with my readers. I finally found one in IEEE Spectrum (yes, I'm an Electrical Engineer).

You probably thought that the Electric Utility Industry was immune from this. Ha! Read Section 2 below.

2. Electric Utilities and Advanced Electronics

I spent most of my career in an area that required computer systems to implement: Supervisory Control and Data Acquisition (SCADA) systems and related functions. See the earlier paper described and posted below.

Supervisory Control and Data Acquisition (SCADA): *SCADA systems are still very important, and many potential readers that work for electric utilities and large facilities are likely to encounter them in the future, thus this six-part series was posted.*

The link below is to part six of this series, which relates directly to the subject being considered by "Chips Dip" and this section: the sensitivity of Electric Utilities to the shortage of advanced electric devices.

https://www.energycentral.com/c/pip/scada-%E2%80%93-part-6-transmission-and-distribution-network-management

Large Network Management Systems such as those used by CAISO, are already huge, extremely complex, and are extending their tentacles into other areas, resulting in the complexity of their missions becoming more challenging. For an example of this go to the earlier paper described and linked below.

CAISO Part 6a – Expansion, Update: *This paper is an update to the six-part California Independent System Operator (CAISO) series posted in the late summer through early fall of 2018 (see below). This specifically addresses the evolving the Energy Imbalance Market and Security Coordinator West functions that CAISO supports.*

https://www.energycentral.com/c/iu/caiso-part-6a-%E2%80%93-expansion-update

Larger more complex energy monitoring and control systems definitely require larger more complex computer hardware and also more advanced electronic devices like communicating protective relays, meters, and network communication controllers for these devices via 4g cellular, 5g cellular and advanced metering infrastructure (AMI) systems.

Also, renewables, increased electrification and other technology advancements are bringing increased demands and capabilities that are driven by advanced electronics at the base of the grid. See below.

NREL's advanced power electronics and smart inverter research enables high penetrations of renewable and distributed energy resources on the U.S. electricity grid to make it cleaner, reliable, and more efficient.[1]

Integrating renewable and distributed energy resources, such as photovoltaics (PV) and energy storage devices, into the electric distribution system requires advanced power electronics, or smart inverters, that can provide grid services such as voltage and frequency regulation, ride-through, dynamic current injection, and anti-islanding functionality. To enable this integration, NREL is designing novel wide-bandgap smart inverters, developing robust control algorithms for better inverter functionality, determining interactions between multiple smart inverters and between inverters and utility distribution systems, supporting standards development for smart inverter functionalities, and analyzing the impacts of smart inverters on distribution systems.

Capabilities:

- *Modeling and simulation of smart inverters*
- *Design of smart inverter hardware and firmware*
- *Development of smart inverter control algorithms*
- *Development of wide-bandgap smart inverters*
- *Use of control and power hardware-in-the-loop techniques to determine interactions between multiple inverters at multiple points of common coupling*
- *Development and validation of test procedures for smart inverters to support IEEE 1547 and UL 1741*
- *Power system impact studies for smart inverter-interfaced distributed energy resources*

3. Five Charts

The following text and graphics are from the IEEE Spectrum article that I mentioned in the Introduction, and reference below.

3.1. Diversification Has a Price

The components in a semiconductor can travel well over 50,000 kilometers and cross more than 70 international borders before a chip finally reaches its end customer, according to a 2020 report by the Global Semiconductor Alliance. "The metaphor of a supply chain simply doesn't apply here," says George Calhoun, director of the Hanlon Financial Systems Center at the Stevens Institute of Technology, in New York. "It's an incredibly complicated global ecosystem, with some points in that grid that are critically important." One key point of vulnerability is the Netherlands, where the photolithography leader ASML Holding produces the only extreme ultraviolet (EUV) lithography machines in the world. Another is Taiwan, where three firms produce over 90 percent of the world's most advanced (5-nanometer and 7-nanometer) semiconductors. However, globalization in itself is no bad thing, according to a 2021 report from the Semiconductor Industry Association (SIA). It estimated that moving to a self-sufficient local semiconductor supply

[1] National Renewable Energy Laboratory (NREL), Advanced Power Electronics and Smart Inverters, https://www.nrel.gov/grid/power-electronics-inverters.html?msclkid=90b43d44d15811ec8a4496da68182fb0

chain could take the United States a decade, cost a trillion dollars, and increase semiconductor prices by up to 65 percent.[2]

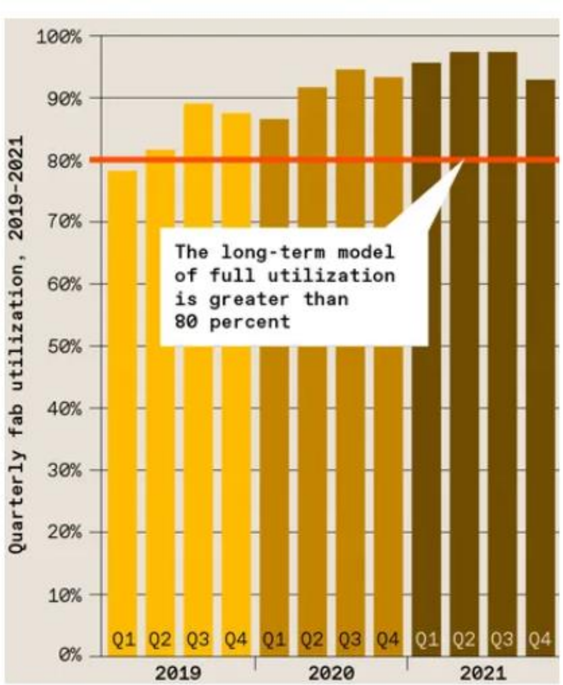
Author's Comment: Above referenced reports are linked below. The first chart is below.

https://www.accenture.com/_acnmedia/PDF-119/Accenture-Globality-and-Complexity-Semiconductor-POV.pdf

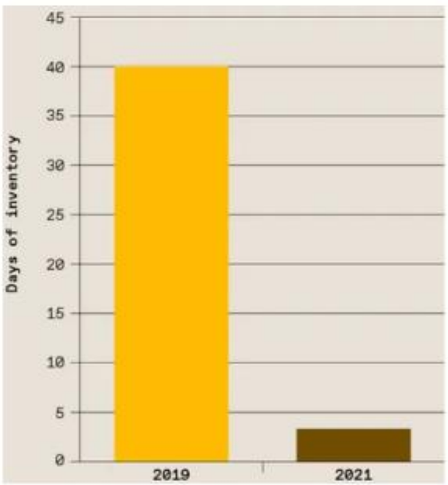
https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf

[2] Mark Harris, IEEE Spectrum, "These 5 Charts Help Demystify the Global Chip Shortage ...and reveal why even infusions of cash from the U.S. and European Union won't solve it," Feb 14, 2022, https://spectrum.ieee.org/global-chip-shortage-charts

3.2. The Perfect Storm



The semiconductor industry has always been cyclical, undergoing gluts and shortages as the market for personal computers, and then home electronics and smartphones, followed the ebb and flow of the global economy. But even before the COVID-19 pandemic struck in early 2020, there were signs that the "market was very, very tight," says Russell Harrison, director of government relations at IEEE-USA. Semiconductor factories (a.k.a. fabrication facilities, or fabs) typically run at about 80 percent of their rated capacity, allowing time for maintenance, upgrades, and staffing variations. As early as the summer of 2019, the industry-wide utilization level was nearing 90 percent. That is a reflection, says Calhoun, of a growing appetite for connected home appliances and increasingly sophisticated automated driving features and digital connectivity in cars. Utilization hasn't fallen below 90 percent since the summer of 2020, according to the SIA.



Just as demand for semiconductors began outstripping supply, the pandemic made it a perfect storm. Every part of the supply ecosystem was hit, from the sourcing of raw materials to the complex global logistics for moving components around and getting finished chips to customers. Last month (January), the U.S. Department of Commerce published a report from a survey of over 150 companies in the semiconductor supply chain, including nearly every major chipmaker, and consumers such as Google, Ford, and Verizon. The report noted that the median inventory of semi-conductor products fell from 40 days in 2019 to less than 5 days in 2021, leaving these companies vulnerable to even the slightest extra setback. "And that's probably a bit of a bogus average," says Calhoun. "It's like the old saying that the river is six inches deep on average, but you can still drown in the middle of it." Deepest underwater are those companies relying on heavily disrupted "legacy nodes": not the cutting-edge hardware found in laptops but older, less sophisticated, and analog chips that are nevertheless critical for medical devices, broadband, and autos. "Those chips aren't as profitable and are certainly not as prestigious, so companies aren't investing in them," says Harrison[3].

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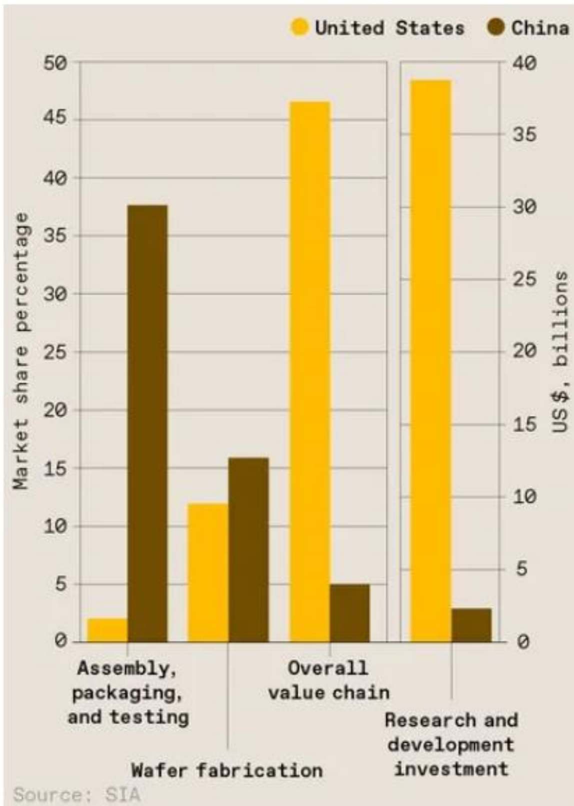
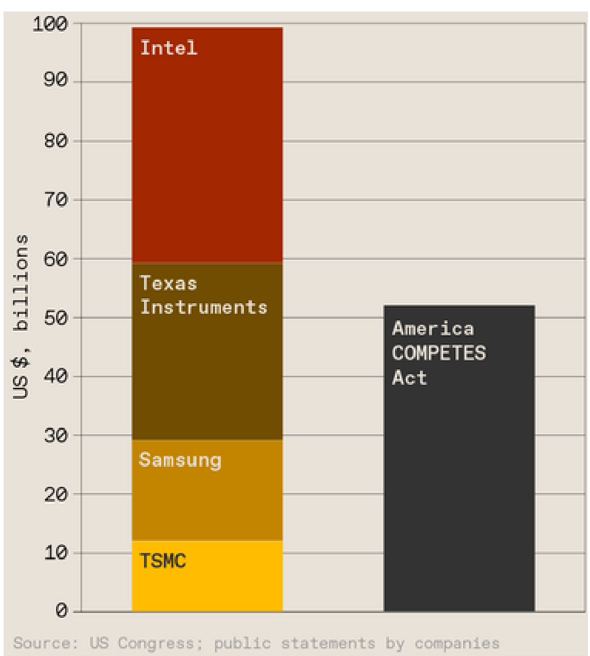
[3] Russell Harrison, director of government relations at IEEE-USA

Author's Comment: The DOC report referenced above is linked below.
https://www.commerce.gov/news/blog/2022/01/results-semiconductor-supply-chain-request-information

3.3. The Good News



"If we want to compete globally, we invest domestically, and specifically in revitalizing the semiconductor industry," Commerce Secretary Raimondo said last fall, while noting that the United States has slumped from a 40 percent share of the global chip production in the 1990s to 12 percent last year—and now lags well behind China. "Every day we wait is a day we fall further behind," she added. To the rest of the world, however, the U.S. semiconductor industry appears anything but moribund. While the United States does have fewer fabs than China (and many fewer than Taiwan), it continues to dominate in the most valuable parts of the semiconductor industry—such as the design and development of new semiconductors as well as the machinery to build them. China, meanwhile, remains a net importer of semiconductors, largely from the United States, to the tune of $350 billion in chips in 2020. The United States is also significantly outspending China in research and development, dedicating $39 billion to it last year, according to the SIA.



If the United States is already a healthily profitable global leader in semi-conductors, does it need the COMPETES Act's $52 billion set aside for semi-conductors—an incentive package bigger than 2009's General Motors bailout? "It won't fix the short-term problem, obviously," says Harrison[3], as fabs take years to build and spin up. "But if companies are looking around the world where to put a plant, I think it helps." Even without those funds, some of the biggest semiconductor companies are already planning large U.S. fabs. Intel, Samsung, Texas Instruments, and the "pure-play" fab Taiwan Semiconductor Manufacturing Co. have recently announced fab projects in Texas, Ohio, and Arizona totaling $99 billion. Intel suggests its Ohio plant may grow to a $100 billion investment over the next 10 years—but only if it receives government assistance. Globally, Calhoun calculates that private-sector investments will bring over $850 billion to bear on chip shortages in the years ahead. “It's a huge number that makes $52 billion look like just a little extra, even if it were invested perfectly…” he says.