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The Navigator

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The semiconductor industry and the new goldrushes

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The semiconductor industry was once thought to be an unexciting and declining industry in the 2000s. However, the industry has revitalized itself since 2016, driven by large-scale migrations into cloud computing and hyperscale data centers, the booming of artificial intelligence (AI), deep learning, the internet of things (IoT), hardware innovations such as virtual reality (VR), augmented reality (AR), and wearables.

Even though these multi-year trends are still in play, they have also become well-understood. In the quest to search for future growth drivers for this industry, we have found gold in new areas such as green technology, the metaverse, and blockchain & cryptocurrency.

While these up-and-coming markets present an enormous opportunity for investors in the long term, they are without a doubt new to many and full of hypes, risks, and even fraud. They are akin to the new goldrushes.

During the California Gold Rush of 1849, some miners struck it rich. However, most of the money was made by “shovel makers” who sold shovels, equipment, supplies, tents, and jeans (remember Levi Strauss?) to the gold miners. In the same way, semiconductor companies are the “shovel makers”. Although investors could make good returns investing directly into metaverse companies, blockchain projects, and EV car manufacturers, chip-makers will certainly stand to reap the benefits as new ecosystems and supply chains are being built up.

From zero to hero

Semiconductor products have become ubiquitous in our daily life. They are the basic building blocks of many electronic devices surrounding us. Since the outbreak of the Covid-19, we have increasingly seen that many nations now have prioritized ramping up their semiconductor capacity not only for economic development reasons but also for national security ones. Robust demands have driven the revenues of many companies such as Nvidia, TSMC, Micron, Broadcom, ASML, or Infineon to record highs.

However, that wasn't the case before 2016. As recent as 6-10 years ago, this industry was thought to be boring and even "dying" in the eyes of many investors. Revenue of the SOX (Philadelphia Semiconductor Index) was stuck at single-digit growth rates from 2002 to 2015 with a long downdraught from 2011 to 2013 (figure 1), thanks to the maturity of PC and smartphone markets and the lack of new drivers.

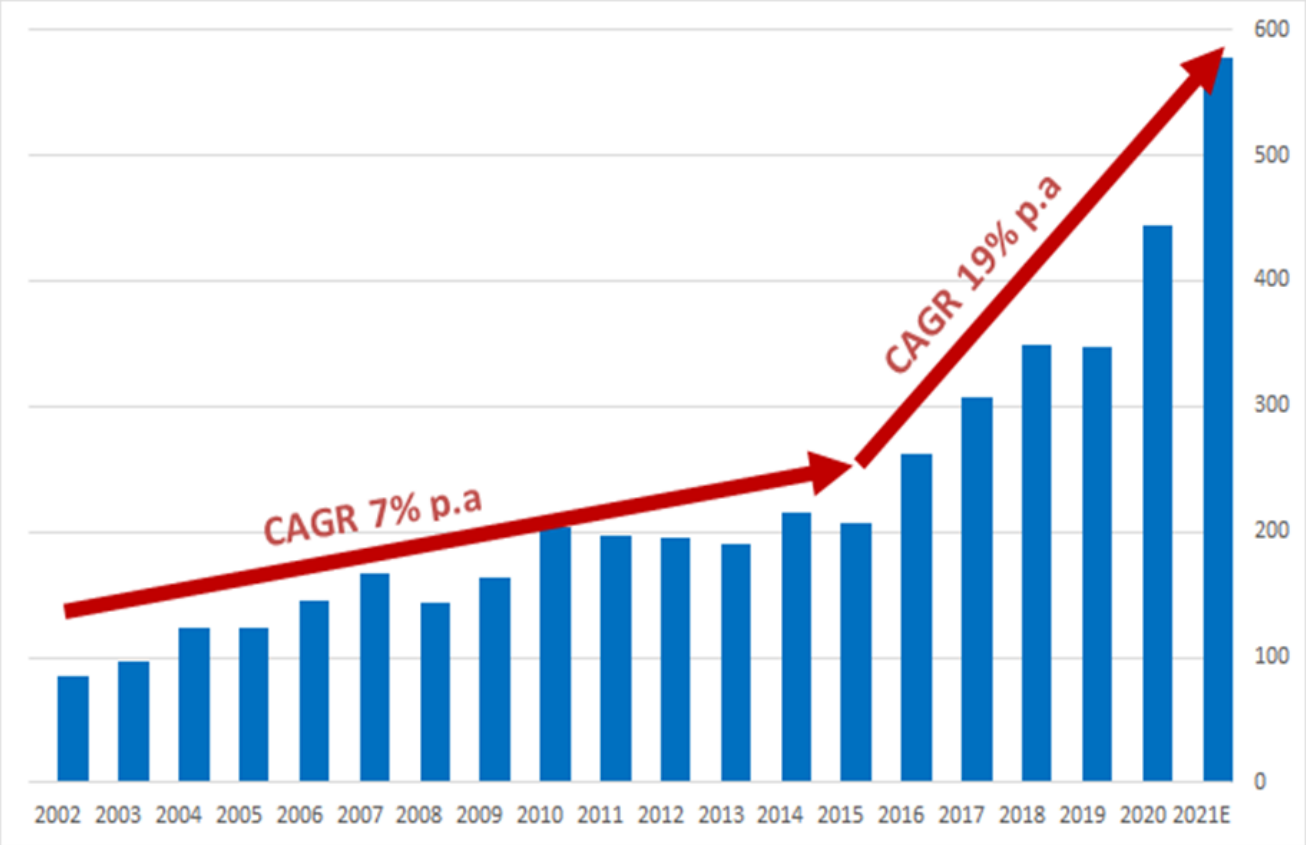

Figure 1. SOX revenue (in USD bn) and growth rates. Source: Bloomberg.

The SOX index delivered a mere 2.9% p.a. return in the same period, underperforming the S&P 500 significantly at a 6.3% p.a. return.

Figure 2. Performance of SOX vs S&P 500 from 2002 to 2015. Source: Bloomberg.

Decades-long industry consolidation, well-spent R&D and faster, more reliable connectivity gave rise to the proliferation of cloud computing, SaaS, AI & deep learning, AR/VR, wearables, and streaming. Since 2016, SOX's revenue growth has risen to 18.7% p.a. (figure 1), 3x the rate from 2002 to 2015!

In this period, the SOX index has posted an impressive 37.5% p.a. gain vs 17.4% p.a. for the S&P 500 (figure 3).

Figure 3. SOX's performance vs S&P 500 from 2016. Source: Bloomberg.

This industry certainly is still in its early innings. Let's dig deeper into the developments of green technology, metaverse, and blockchain & cryptocurrency to understand how these gold rushes will propel our shovel makers' future growth.

Goldrush #1: Green technology

Buzzwords are flying around in this space - ESG investments, renewable energy, electric vehicles, the COP26, the race to net zero emissions … Governments have increasingly ramped up their green power grid, reduced fossil fuel usage, cut down coal power plants, and rolled out more EV charging stations. Corporates have no choice but to march in lockstep with the governments. They talk about their own ESG approach and commitment to net-zero emissions. Many of them are walking their talk to upgrade their equipment to be less energy-intensive and build energy self-sufficient factories and fabs.

Let's explore some green technology trends here.

Electrical vehicle (EV): Credit Suisse estimates EV cars to grow from 8.3mn units in 2020 (~10% of global car production) to 63.5mn units in 2030E (~60% of global car production). Other banks such as Goldman Sachs have similar estimations.

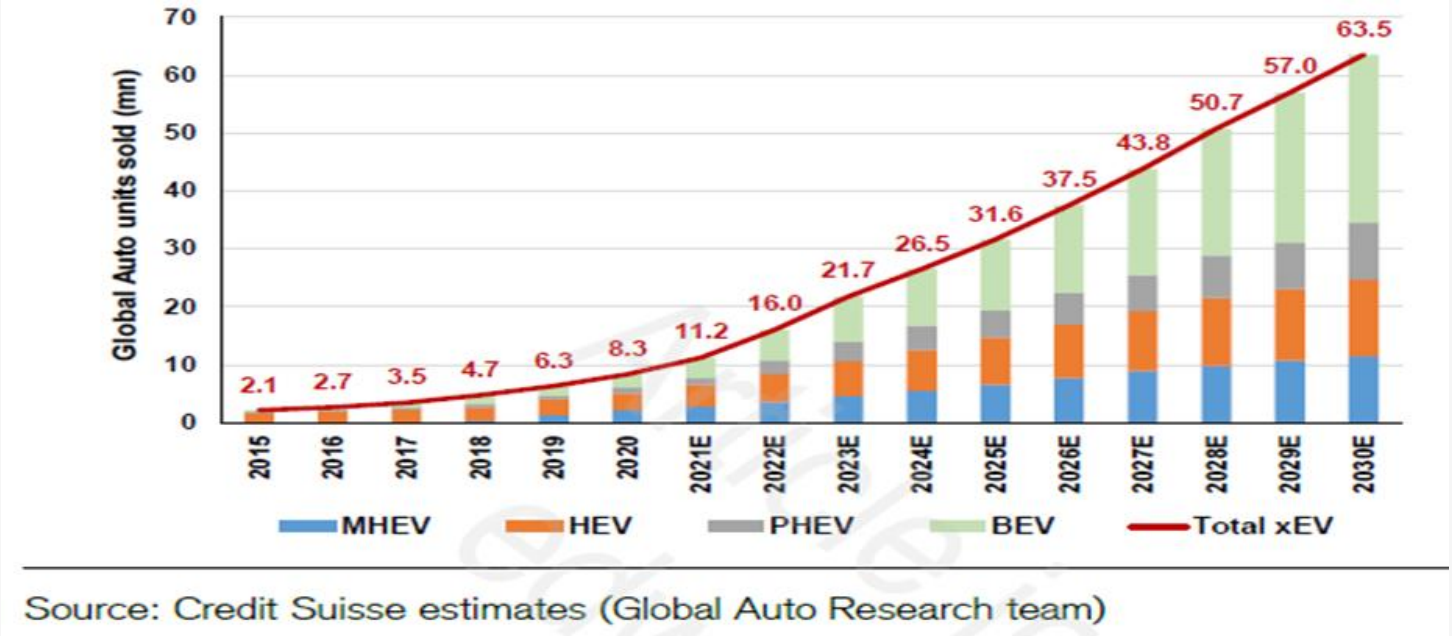

Figure 4. Credit Suisse's estimates of EV cars. Source: Credit Suisse.

Automotive semiconductor companies such as Infineon, ST Micro, ON Semi, NXP, and Texas Instruments will capitalize on higher semi dollar contents when consumers upgrade to EV cars from ICE (internal combustion engine) or hybrid models. For example, Infineon expects total semi BoM (bill of material) to rise to $834 for an average full plug-in BEV (battery EV) from $572 for a mild hybrid car – a 46% content gain (figure 5).

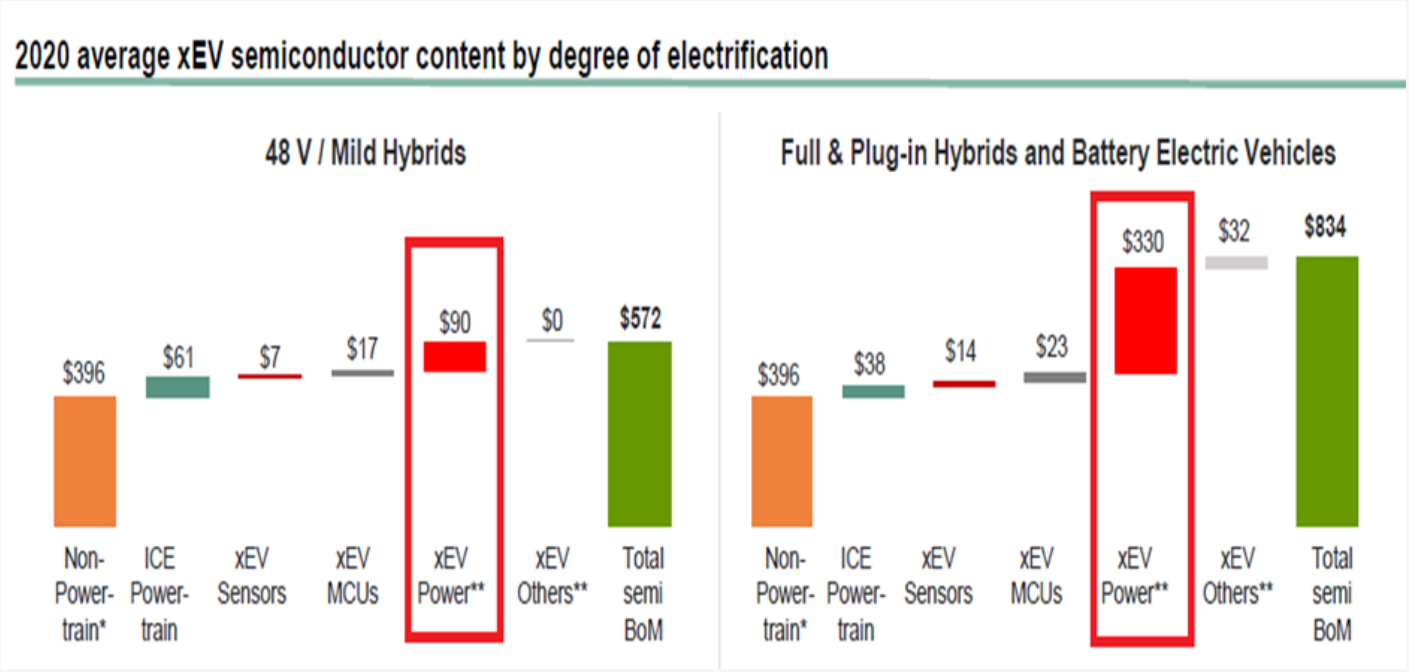

Figure 5. Semi content gain in EV car. Source: Infineon.

Renewable energy: collective pushes from governments around the world have enlarged the size of onshore, offshore wind, and solar markets (figure 6). Infineon as well as other green-enablers have secured contracts with the top players in solar and wind energy such as Vestas, Siemens Gamesa, GE, Sungrow, and Solar Edge to provide innovative power management components.

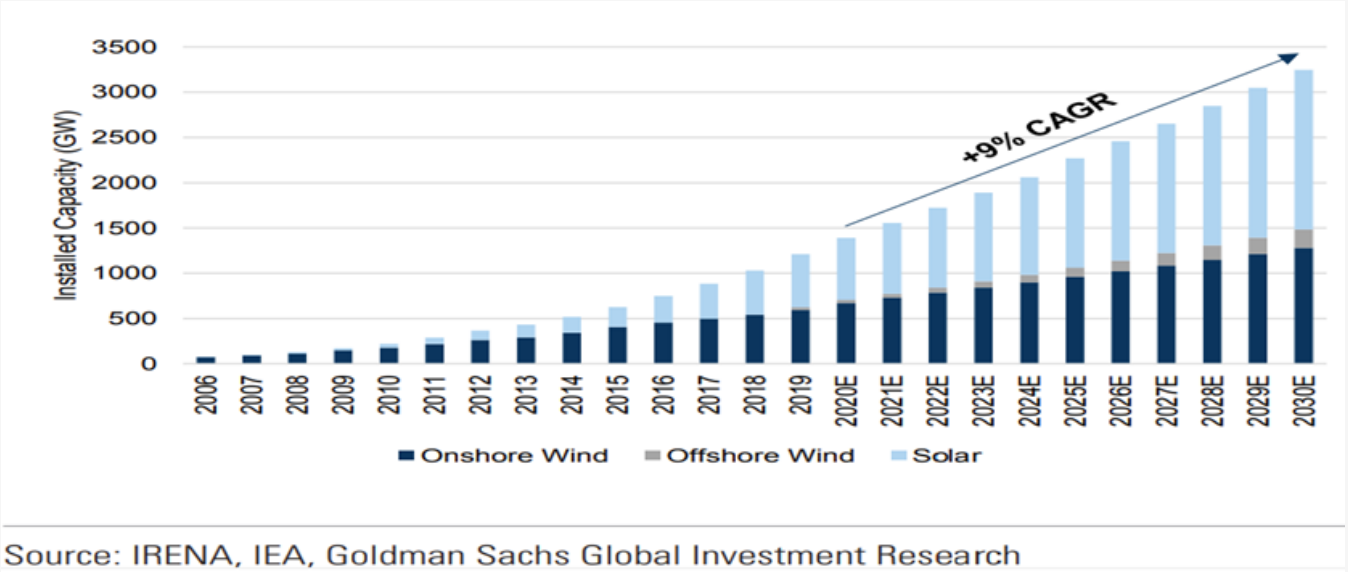

Figure 6. Wind and solar installed capacity. Source: IRENA, IEA, Goldman Sachs.

Investments from Infineon, ST Micro, ON Semi, NXP, and Qorvo into new Silicon Carbide (SiC) and Gallium Nitride (GaN) fabs will be well paid off. These technologies are emerging to support applications that require more energy-efficient, higher voltage & current, and higher temperature such as EV, renewable energy, and data centers.

Power efficiency for Data centers and PCs: according to Goldman Sachs, global data centers' power consumption could have increased ~10x from 210 TWh in 2020 (~1% of global power consumption) to 2,020 TWh in 2025 (~7.2% of global power consumption). However, thanks to innovations in energy efficiency, the actual figure in 2025 will likely be reduced to 308 TWh, which means ~1,700 TWh of electricity will be avoided (~6.1% of global power consumption). In a similar fashion, PCs' annual consumption in 2020 is 108 TWh (0.4% of global consumption). GS expects an additional 21 TWh will be avoided by 2025 from efficiency gains for PCs.

Advancements in chip structures such as CPU, GPU, and memory play a crucial role. For example, Samsung estimates that 1.5 TWh would have been saved in 2020 by replacing all server HDDs with power-efficient SSDs.

Working with DRAM companies such as Micron, Samsung, and Hynix, chip designers – AMD, Nvidia, Intel, and Broadcom are increasingly shifting toward more efficient structures such as HBM (high bandwidth memory). HBM-PIM (processing-in-memory high bandwidth memory), the latest technology, is expected to deliver 2x the speed and decrease system energy by 70% compared to the HBM predecessor (figure 7).

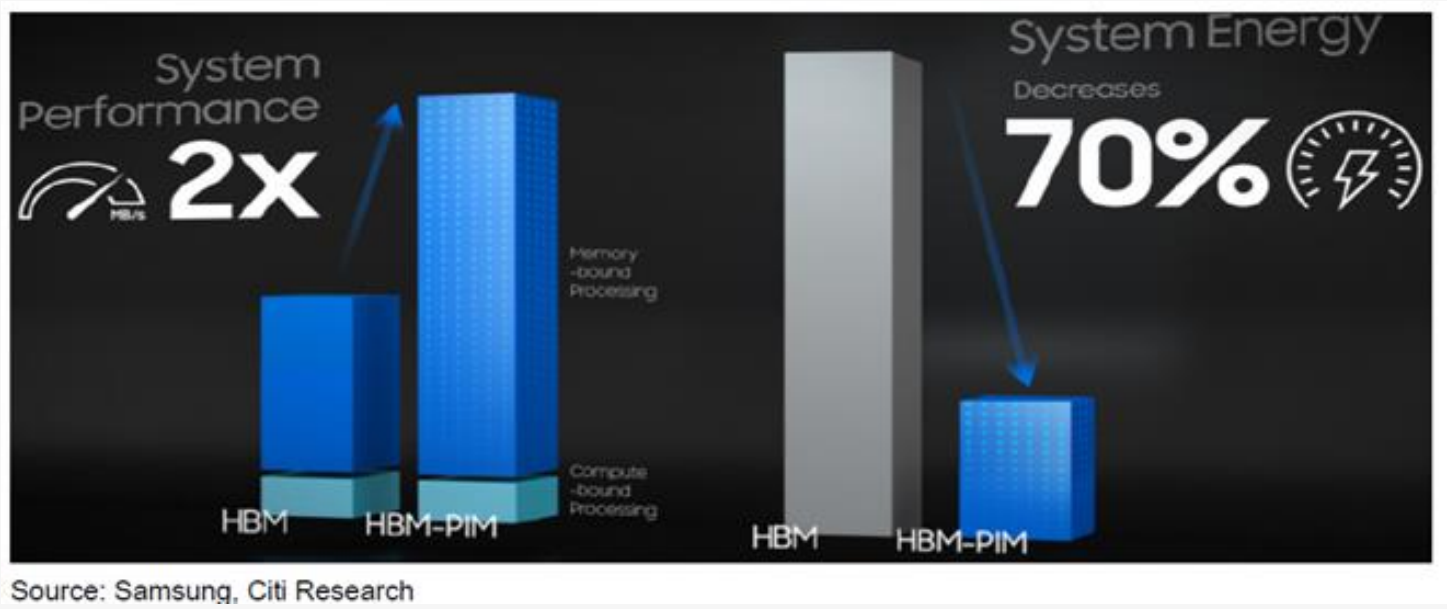

Figure 7. HBM-PIM vs HBM - performance, and energy consumption comparisons. Source: Samsung, Citi.

Goldrush #2: Metaverse

Metaverse is a virtual world where people can build, socialize, work, collaborate and play. This concept is not new but a series of recent events by mega-tech firms from Meta Platforms (formerly Facebook), Microsoft to Nvidia has breathed life into the "Metaverse" rally. Without meandering into the debate whether Metaverse is the future or a fad, let's explore our direct and indirect options to profit from this trend.

Figure 8. Microsoft's Metaverse office. Source: Microsoft.

A direct play into this trend is apparently the "Metaverse creators". These "creators" in the listed space range from Meta Platforms, Microsoft, Roblox to gaming companies and Unity software game engine. In the "Wild Wild West" land of cryptocurrencies, Metaverse projects - Sandbox, Decentraland, and Enjin have skyrocketed "to the moon" 🚀🚀🚀, fuelled by the Metaverse craze.

From a hardware perspective, devices such as Meta Platforms' Oculus, Google Glass, and Microsoft's Hololens will be the direct play to help users enter the virtual world. Take a deeper look, we will come to the realization that underlying semiconductor components including display (Samsung, Sony), SoC (Qualcomm), processors (Intel, AMD), graphics (Nvidia), memory (Samsung, Micron, Hynix), acoustics (Goertek) and power management (ON Semi, Texas Instruments) take up a large chunk of these devices' BoM (bill of material).

Metaverse applications are extremely data, connectivity, and graphic intensive. Therefore, after Facebook changed its name to Meta Platforms and announced its Metaverse ambition, the company also raised Capex from ~$19bn this year to $29-$34bn in 2022 to fund investments in data centers, servers, and network infrastructure. Apart from Meta Platforms, we also expect the top 4 US hyperscalers to increase their data center Capex by 30% to north of $90bn in 2022.

Higher data center Capex means more switches (Broadcom, Marvell), CPU (AMD, Intel), GPU (Nvidia), and memory especially DRAM (Micron, Samsung, Hynix) (figure 9). Faster connectivity either via 5G or via WiFi 6 will rely on chips made by Xilinx, Texas Instruments, Qualcomm, Broadcom, Qorvo, Skyworks, and Infineon as well.

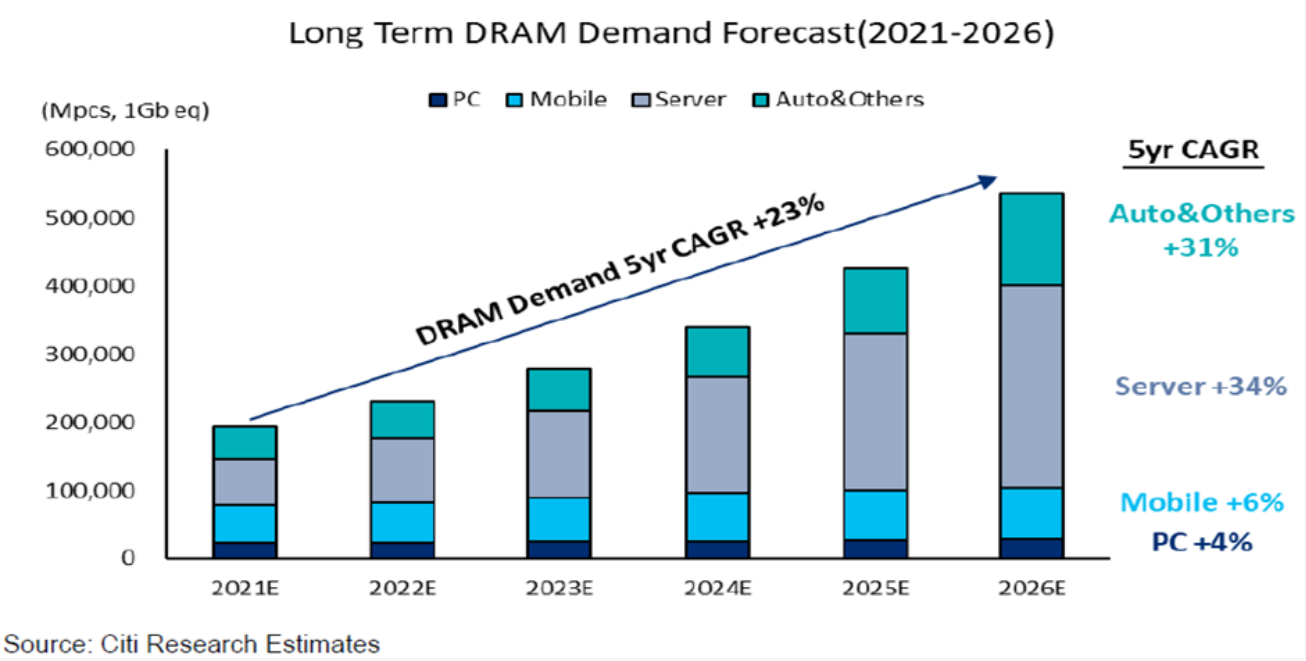

Figure 9. Citi's forecast of long-term DRAM demand driven by Servers and Data-centers. Source: Citi

Moreover, graphic intensity in the Metaverse world will certainly require Nvidia's solutions such as new GPUs or Omniverse platform (check out their super cool Omniverse platform on YouTube - figure 10).

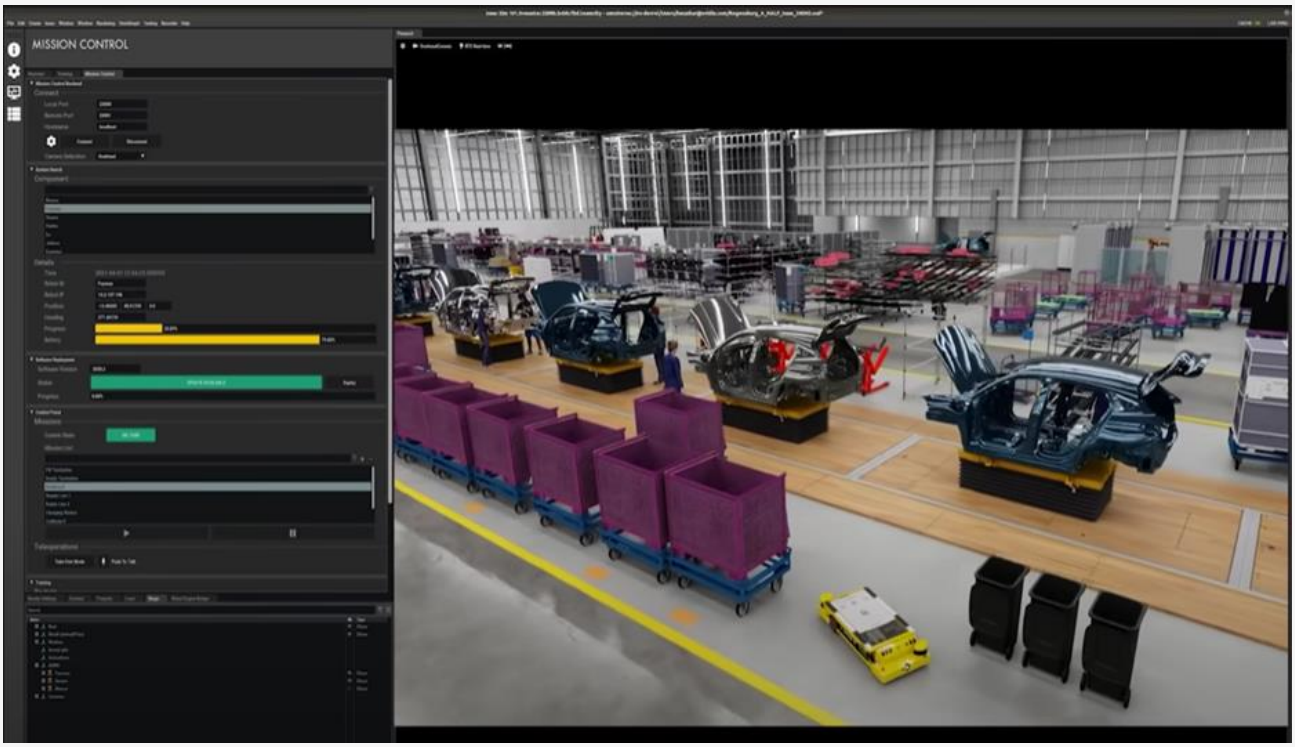

Figure 10. Nvidia's Omniverse factory. Source: Nvidia.

Burgeoning demand for chips trickles down to foundry business where firms such as TSMC, Samsung, GlobalFoundries, and UMC are dominating. Eventually, new foundry fabs will depend upon ASML, Lam Research, and Applied Materials to build and supply their cutting-edge equipment.

Goldrush #3: Blockchain and Cryptocurrencies

The first thing that pops up in everyone's mind when talking about blockchain and semiconductor demand is cryptocurrency mining. BTC and ETH 1.0 are still on PoW (Proof-of-Work) consensus mechanism and thus involve an energy-intensive mining process. Although this mining activity will lead to a higher demand for GPU (Nvidia, AMD) and ASIC chips which will also flow down to TSMC's revenue, we are not a fan of crypto-mining at any level. The reason is twofold. Firstly, the majority of blockchain projects have shifted to more energy-friendly consensus mechanisms such as PoS (Proof-of-Stake). ETH 2.0 is expected to transit to PoS by 2022. Secondly, cryptocurrency mining goes against our belief in ESG to be energy-efficient and environmental.

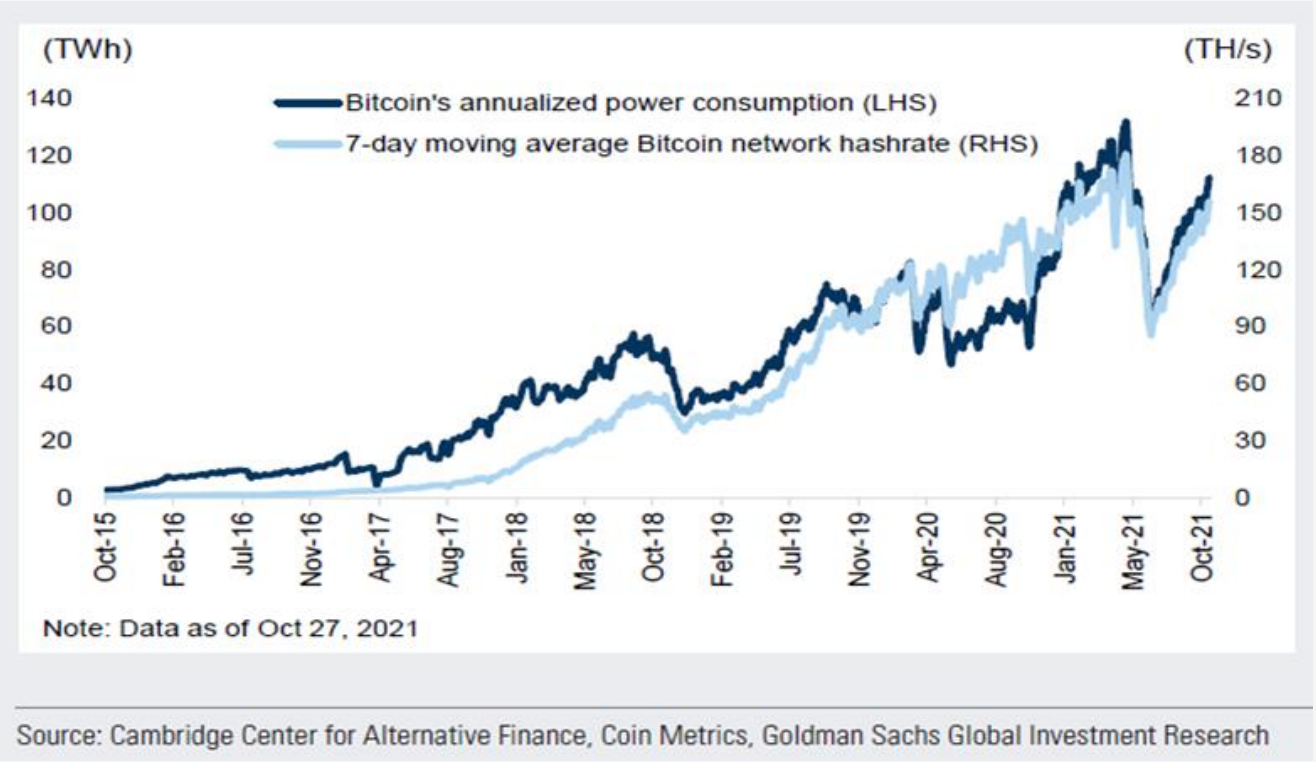

Figure 11. Bitcoin's annualized energy consumption. Source: Goldman Sachs.

The cryptocurrency market has grown into a staggering $2.6tn economy, spreading across a great deal of applications – DeFi (decentralized finance), lending, derivatives, stablecoins, wed 3.0, decentralized storage & data management, gaming, and NFT (non-fungible token).

Suffice to say, this market is a computing, storage, and connectivity-demanding hot feast for all semiconductor companies ranging from data-centers, processors, accelerators, memory to smartphones and PCs. We will zoom in to a few up-and-coming areas of blockchain to analyze the potential roles of our "shovel makers".

Web 3.0: The internet progressed from Web 1.0 (static web) in the 1990s to Web 2.0 (social and interactive web) in the mid-2000s that subsequently paves the way for applications such as Facebook and YouTube. And now, Web 3.0 is underway, thanks to decentralized blockchain technology.

In Web 3.0 (semantic web), the internet will be built on decentralized protocols and enable machine-based understanding of data and interaction. What are the implications?

- Decentralized data: app data will no longer be stored in centralized servers of Amazon AWS or Google. This will give rise to the proliferation of decentralized storage and data management that we will take a deeper look at shortly.
- Higher AI (artificial intelligence) and machine learning interactions between the internet users and the applications. We have already examined the impacts of AI and deep learning on semiconductor demands earlier on.
- More connected devices across smartphones, PCs, wearables, smart speakers, and edge devices (IoT – internet of things).
- All these advantages come at the expense of slower processing time as Web 3.0 is decentralized. Data or transactions require extra steps to validate and propagate throughout the network. This issue will require firms including Broadcom, Marvell, Xilinx, and Nvidia (BlueField) to build new cutting-edge chips to address.

Decentralized data and storage: Blockchain projects – Filecoin and Arweave are at the forefront to develop decentralized data platforms. Decentralized applications (dApps) such as Theta Network (decentralized video streaming and consuming) and NFT entail decentralized storage systems. Figure 12 shows the NFT ecosystem with highlighted storage stack.

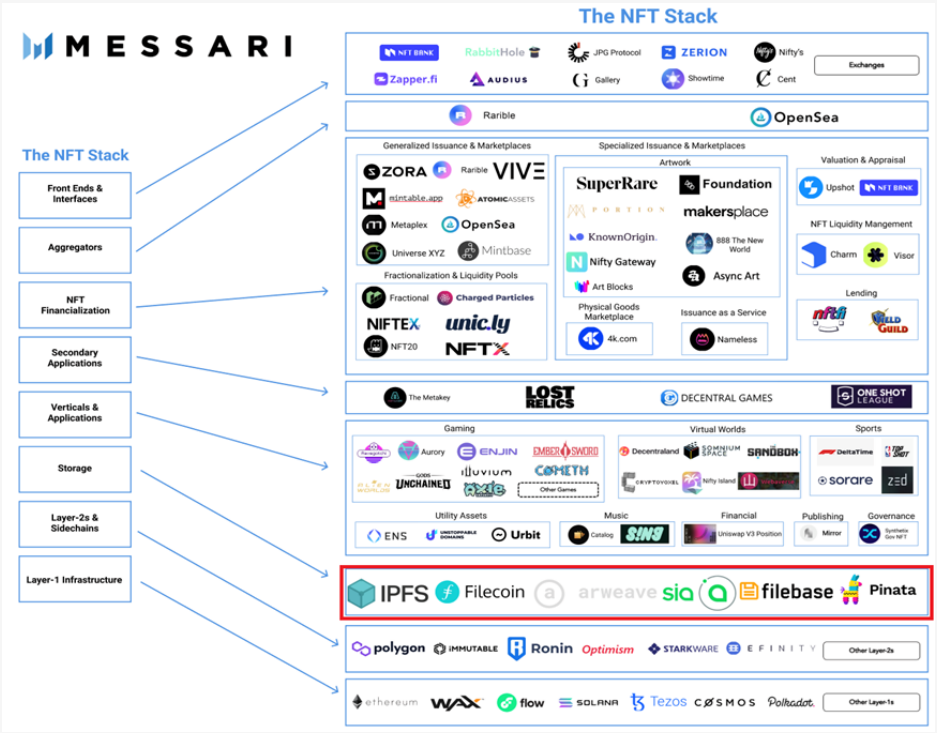

Figure 12. NFT ecosystem with storage stack. Source: Messari.

Certainly, decentralized data lift demand for memory – NAND & SSDs (Kioxia, Western Digital, Hynix, Micron, Samsung) and storage solutions (Broadcom, IBM, Dell).

Once again, foundry companies (TSMC, Samsung, UMC) and semi equipment manufacturers (ASML, Lam Research, Applied Materials) will stand to reap the harvest.

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