

Comments of SK Hynix

On the Department of Commerce

“Notice of Request for Public Comments on Risks in the Semiconductor Supply Chain”

86 Fed. Reg. 53031 (Sept. 24, 2021)

[Docket No. BIS 2021-0036] RIN 0694–XC084

Submitted Nov. 8, 2021

SK Hynix Responses to Questions “For semiconductor product design, front and back-end manufacturers and microelectronics assemblers, and their suppliers and distributors”

Question A: Identify your company's role in the semiconductor product supply chain.

SK hynix is a global and leading producer of semiconductors, primarily in the design and production of memory products for our global customers. As an integrated device manufacturer (IDM), SK hynix operations include research, semiconductor design, and front-end manufacturing, which we conduct in our own facilities in various locations around the world. We also operate facilities for back-end assembly, testing, and packaging (ATP) for our products, though we also outsource a portion of ATP to Outsourced Assembly and Test (OSAT) facilities. Our primary products include dynamic random access memory (DRAM) for a variety of critical information technology industries, and non-volatile memory (NAND).

SK hynix has significant presence in the U.S. semiconductor ecosystem. SK hynix is the third-largest semiconductor producer in the world, with ~\$26 billion in revenue in 2020.¹

Top 10 Semiconductor Makers by Revenue				
CY19 Rank	CY20 Rank	Company	CY19 Revenue (\$M)	CY20 Revenue (\$M)
1	1	Intel	67,754	72,759
2	2	Samsung Electronics	52,191	57,729
3	3	SK hynix	22,297	25,854
4	4	Micron Technology	20,254	22,037
6	5	Qualcomm	13,613	17,632
5	6	Broadcom	15,322	15,754
7	7	Texas Instruments	13,364	13,619
13	8	Media Tek	7,958	10,988
16	9	NVIDIA	7,331	10,643
14	10	KOIXIA	7,827	10,374

Source: Gartner report 2021. Note that Gartner's rankings do not include pure-play foundries.

¹ Gartner 2021 semiconductor report

SK hynix has diverse and complex operations, requiring sourcing from over 2,900 suppliers to enable our research, design, and manufacturing capabilities.² Outside of South Korea where SK hynix is headquartered, the United States is a leading recipient of SK hynix's operating and capital expenditures. We work closely with our U.S.-based suppliers to achieve semiconductor technology breakthroughs and ensure resilient supply of our products for our customers.

Our presence in the U.S. semiconductor ecosystem is most directly measured by our economic impact. IHSMarkit estimated that SK hynix "upstream" activities in the U.S. semiconductor ecosystem resulted in, on an annual average between 2016 and 2020, ~\$9 billion in sales activity and ~\$5 billion in GDP, and supported more than 46,000 jobs in the United States.³

SK hynix supports critical information technology industries in the United States and enables significant U.S. economic activity. The United States is a leading region for SK hynix's customer base. As such, developing and ensuring a resilient supply of memory products for U.S. customers is paramount to SK hynix's success.

Critical industries and technology applications in the United States are supported by products developed and supplied by SK hynix, including: cloud computing, high performance computing, mobile communications, advanced manufacturing, advanced graphics, automotive, and artificial intelligence (AI) and machine learning.

Further, SK hynix enables significant economic activity by our customers. IHSMarkit estimated that on an annual average between 2016 and 2020, SK hynix products enabled "downstream" activities that resulted in \$116 billion economic activity and \$70 billion in GDP, and supported more than 696,000 jobs in the United States (see chart below).

Economic contributions of SK Hynix's US downstream activities (avg. 2016-2020)				
(millions of USD and workers)				
	Output	Contribution to GDP	Labor Income	Employment (workers)
Direct	\$32,068	\$21,047	\$12,942	125,244
Indirect	\$49,760	\$28,412	\$16,693	333,797
Induced	\$34,810	\$20,215	\$11,493	237,087
Total	\$116,638	\$69,674	\$41,128	696,127

Source: estimates by IHSMarkit. "Downstream activities" include economic activity from direct sales enablement by SK hynix products by its customers, primarily DRAM and NAND sales.

We work closely with our U.S. customers to ensure resilient supply of advanced memory semiconductors. As a global leader in memory semiconductors, SK hynix develops cutting-edge memory products that meet the needs of our U.S. customers who are global technology leaders in their respective industries. For example, SK hynix recently developed the third generation High-

² See our public 2021 sustainability report: [\(link\)](#)

³ Estimates by IHSMarkit. "Upstream activities" include economic activity from direct purchases of semiconductor equipment, materials, and services from U.S.-based companies.

Bandwidth Memory 3, the world's best-performing DRAM.⁴ This new product has significant applications for advanced graphics as well as AI/machine learning, with the ability to process 819GB (or 163 full-length high-definition movies) transmitted per second.

SK hynix participates in and directly supports the U.S. semiconductor research ecosystem. SK hynix maintains active R&D personnel in San Jose, California. SK hynix also participates in and financially supports the U.S.-based Semiconductor Research Corporation. In addition, SK hynix has partnered with and supported semiconductor research in 13 major U.S. universities in the past 10 years.

Question B: Indicate the technology nodes (in nanometers), semiconductor material types, and device types with which this organization is capable of operating (design and/or manufacture).

[data omitted for public submission]

While this data is omitted for public submission, we note that related information is also available in public industry reports.

Question C: For any integrated circuits you produce--whether fabricated at your own facilities or elsewhere--identify the primary integrated circuit type, product type, relevant technology nodes (in nanometers), and estimates of annual sales for the years 2019, 2020, and 2021 based on anticipated end use.

[data omitted for public submission]

While this data is omitted for public submission, we note that related information is also available in public industry reports.

Question D: For the semiconductor products that your organization sells, identify those with the largest order backlog. Then for the total and for each product, identify the product's attributes, sales in the past month, and location of fabrication and package/assembly.

[data omitted for public submission]

*While this specific question asks for products with "the largest order backlog," it is important to state that in the last 3 years, **there was no backlog for any of SK hynix's products**. SK hynix products are primarily in memories (i.e., DRAM and NAND). There is a sufficient degree of substitutability among products made by competing memory producers, due to the commoditized and standardized characteristic of most memory products.⁵*

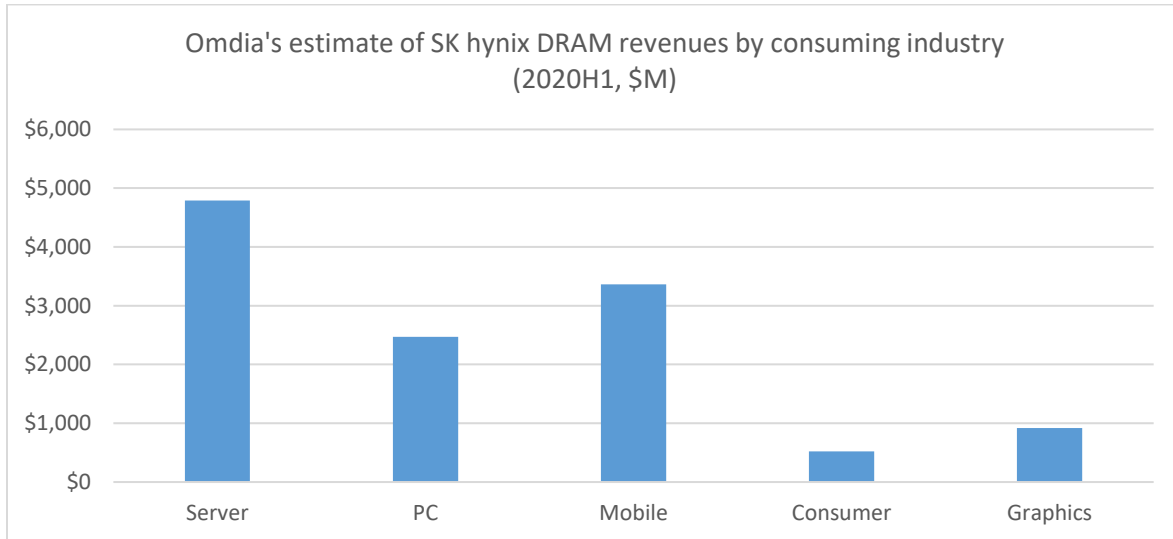
Although there is no current backlog of SK hynix products, in the confidential submission we have provided broadly aggregated supply information. We aggregated the product information at the "industry" level, instead of "customer name" level, as noted in the instructions. Specifically, we identified consumption categories commonly found in industry analysis reports. For example, DRAMs are primarily consumed by five categories of consuming industries: PC, server,

⁴ <https://news.skhynix.com/sk-hynix-announces-development-of-hbm3-dram/>

⁵ There are exceptions where product differentiation occurs due to technological advantages achieved by certain companies. Some products have specific advanced features in which one producer cannot be easily substituted by another producer due to competitive technology gaps.

graphics, consumer, and mobile.⁶ This level of aggregated reporting provides the information sought by the Department of Commerce, while not disclosing information specific to customers.

Similar information can also be found in publicly available reports. For example, Omdia and Yole Developpement provide quarterly estimates of revenues for each DRAM producer, categorized by the five customer industries noted above, as well as by geographic locations of customer headquarters (see example of Omdia's estimates below).



Source: Omdia 2021, DRAM monitor

We reiterate that we did not disclose any information specific to our individual customers. As noted in our conversations with Department of Commerce staff, information related to our customers is not solely the information of SK hynix (i.e., the information is held by both SK hynix and the customer), and therefore it is not within our sole discretion to disclose such information. We appreciate that the submission instructions provided sufficient flexibility for us to provide transparency into our supply chain **without** specifying customer names or data, which allows us to protect our customers' interests.

Question E. For each phase of the production process, identify whether your organization carries out the step internally or externally. For your organization's top semiconductor products, estimate each product's (a) 2019 lead time and (b) current lead time (in days), both overall and for each phase of the production process. Provide an explanation of any current delays or bottlenecks.

[data omitted for public submission]

We are not currently experiencing any delays or bottlenecks.

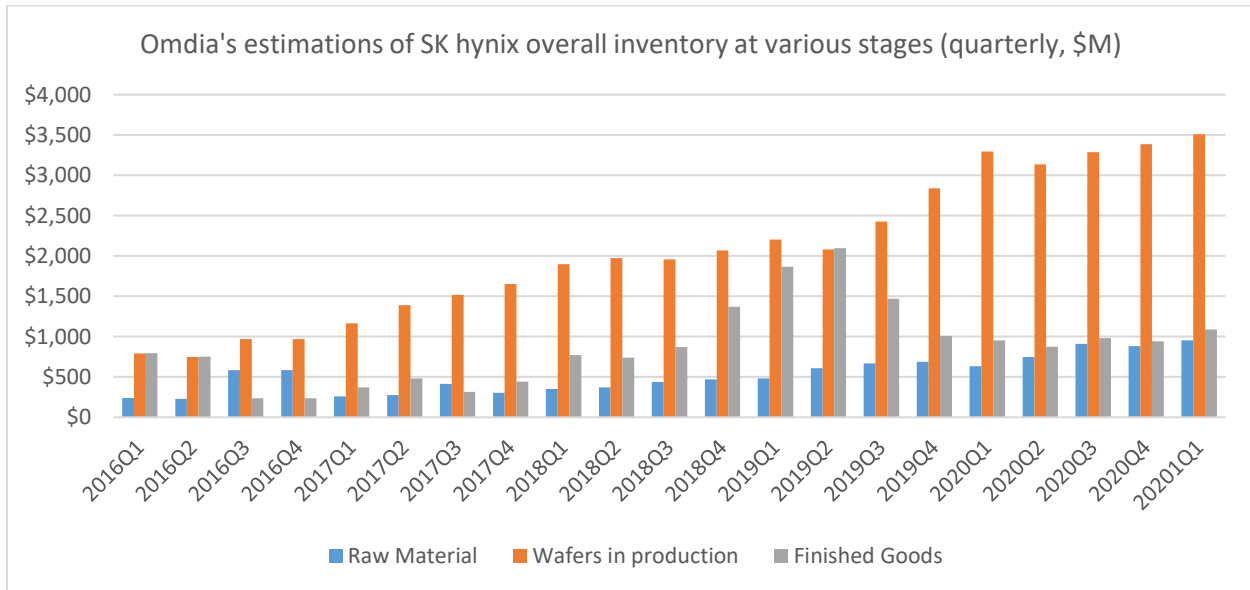
⁶ See, for example, industry reports by Omdia, Yole Developpement, and Gartner.

Question F. For your organization's top semiconductor products, list each product's typical and current inventory (in days), for finished product, in-progress product, and inbound product. Provide an explanation for any changes in inventory practices.

[data omitted for public submission]

We have not recently made significant changes to our inventory practices.

As noted in our conversations with the Department of Commerce staff, general inventory data estimates can be found in publicly available reports. For example, Omdia and VSLI estimate that SK hynix inventory has generally increased alongside our sales and wafer capacity in the past 5 years (see example from Omdia below).



Source: Omdia report, 2021.

Question G. What are the primary disruptions or bottlenecks that have affected your ability to provide products to customers in the last year?

We continuously monitor potential supply bottlenecks, and in 2021, we have resolved potential supply and demand issues with advance discussions with our customers.

Question H. What is your organization's book-to-bill ratio for the past three years? Explain any changes.

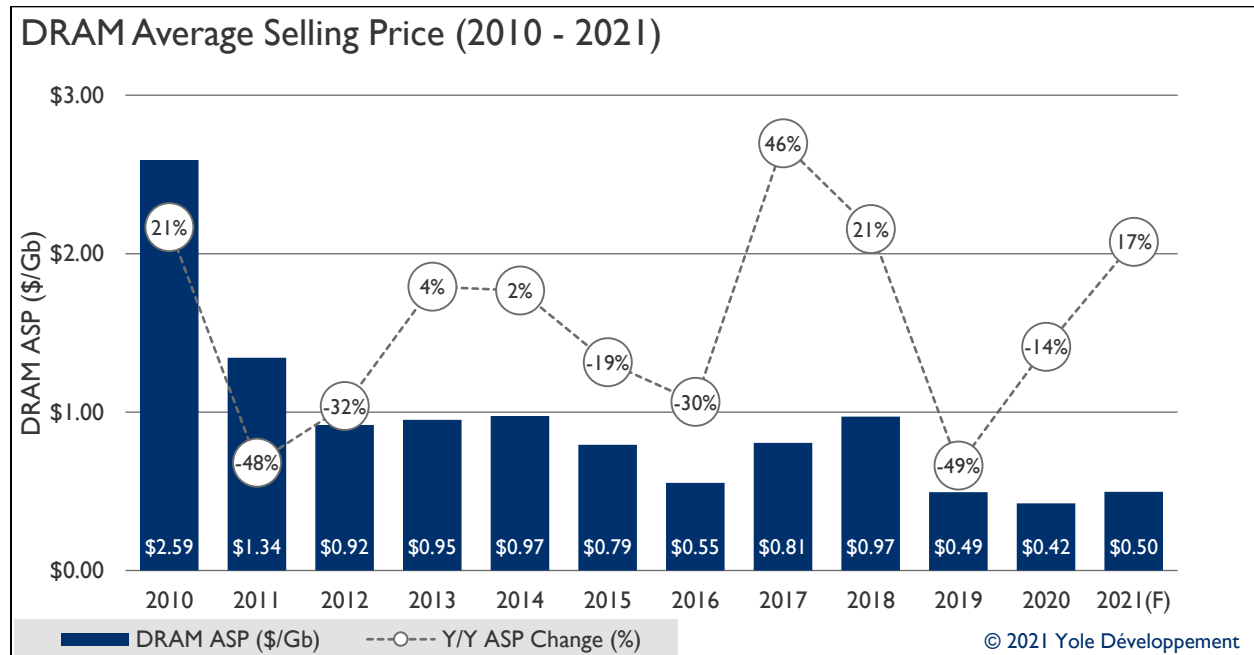
Memory products are generally commodity products, which are produced in advance, then sold to customers. Because there are several substitute suppliers for most memory products, backlog in this industry is rare. Because of this, the memory industry, including SK hynix, does not track or report book-to-bill ratios.

Question I. If the demand for your products exceeds your capacity, what is the primary method by which your organization allocates the available supply?

Market driven prices generally work effectively in the memory industry to balance supply and demand. Like other memory producers, if customers' demands exceed SK hynix's capacity, we have the option of prioritizing supply according to customers' willingness to purchase at higher prices. However, since memory products are primarily commodity products, customers that prefer not to pay the higher prices to SK hynix usually have the option of choosing a substitute supplier in the short-term.

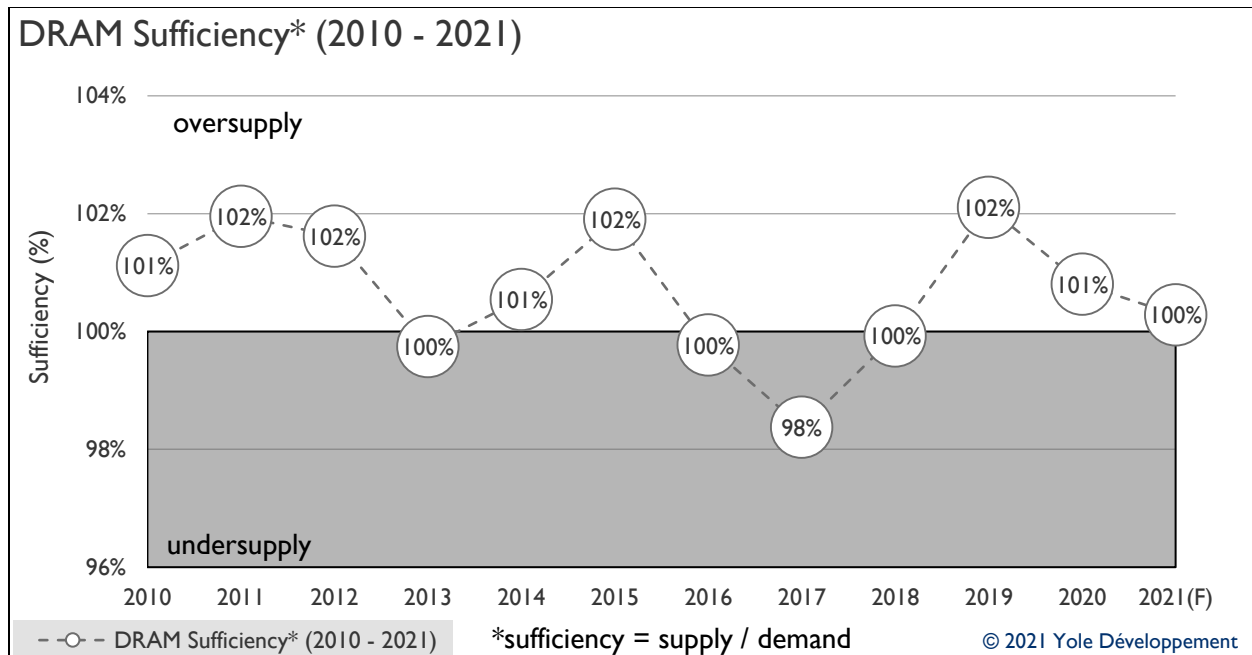
Memory prices, often known for large fluctuations, play an important role in balancing supply and demand. If the entire memory industry is experiencing a supply shortage, the overall price of memory products may increase to moderate demand. For certain product categories in the short-term, it may be possible for some customers to adjust demand by reducing the density per product purchased. With relative flexibility among supplier choices, market driven prices, and short-term options of adjusting demand by customers, the memory industry has maintained a stable supply/demand ratio (measured as a percentage of demand over supply) in the low-single digits.

The balance in supply and demand, as well as market driven prices that help balance them, has been a consistent feature in the memory market in which SK hynix operates. In the DRAM market, for example, Yole Développement estimates that the average DRAM selling prices between 2010 and 2020 has increased and decreased as much as 49% year-to-year (see below).



Source: Yole Développement, 2021

Meanwhile sufficiency rates, as measured by industry supply/demand, has fluctuated within 1 or 2 percentage points from 100% in the past 10 years (see figure below).



Source: Yole Développement, 2021

Question J. Does your organization have available capacity? If yes, what is preventing the filling of that capacity?

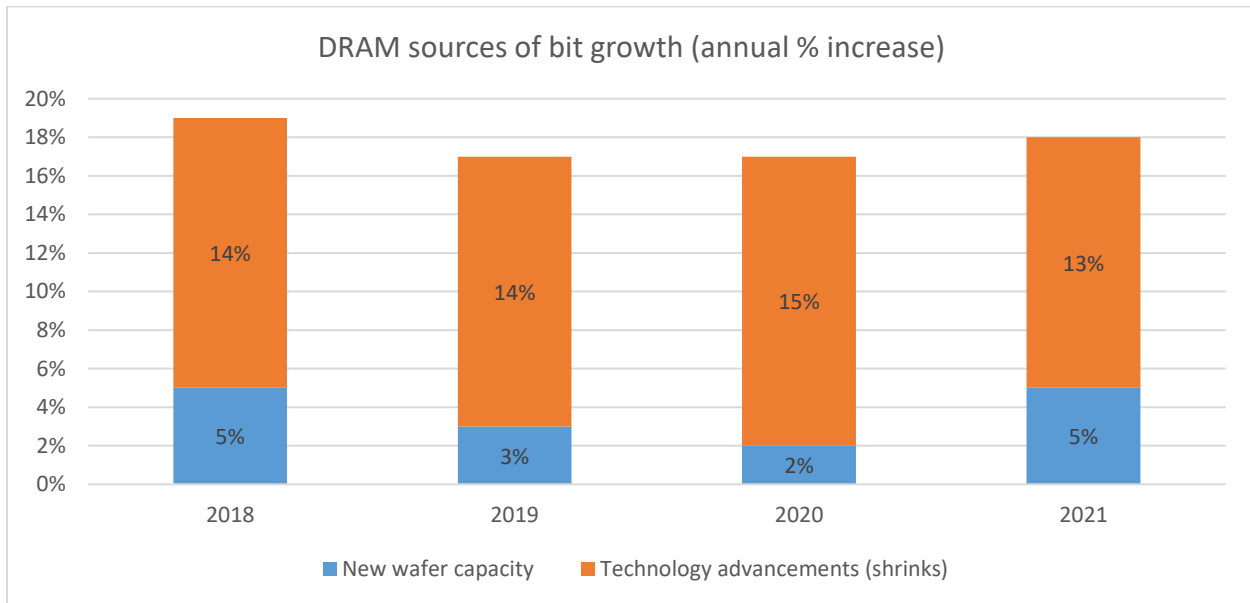
We understand this question is referring to whether SK hynix has **excess** capacity. SK hynix rarely has excess capacity. Because memory semiconductor production has very high fixed costs, excess capacity leads to an unnecessary increase in production costs. All memory semiconductor companies typically produce at maximum capacity utilization rates. In case of product-specific decrease of demand, memory producers can generally prevent excess capacity by changing the product mix in manufacturing facilities (for example, switching production among different categories of memory products) with sufficient lead time. Finished products not sold are maintained in inventory.

Given the memory producers' motivation to produce at maximum capacity and the resulting lack of excess capacity generally, an inability to fill available capacity has not been a source of shortage issues in the memory market. As noted previously, shortages rarely occur in the memory industry. The ability of customers to choose among producers that make primarily commoditized products, market driven prices, and short-term consumption flexibility among customers have led to consistently well-balanced supply and demand. This is reflected in continuous single-digit supply/demand ratios in the industry over the last several years (see figure above in question I).

Question K. Is your organization considering increasing its capacity? If yes, in what ways, over what timeframe, and what impediments exist to such an increase? What factors does your organization consider when evaluating whether to increase capacity?

SK hynix continuously assesses the need to increase its production capacity and has announced significant expansions, including fabrication in the newly announced Yongin, South Korea site that is expected to become operational in the next few years.

In the memory industry, production capacity (as defined by increase of “bit supply”) increases in two ways: (1) manufacturing technology advancements, and (2) production facility expansions. For example, Yole Developpement estimates that in 2021, global DRAM production (as measured by bits) will grow by 18% from last year: 13% by transistor shrinks (technology upgrades), and 5% by new wafer capacity (see graph below).



Source: Yole Developpement, DRAM monitor 2021Q1

Increasing production capacity through construction of a new fabrication facility would require several years of lead time (including project evaluation, facility design, construction, equipment installation, and customer certification of manufactured products). Therefore, capacity expansion is primarily based on long-term supply and demand trends. Options of responding to short-term demand changes by simply building new capacity are quite limited.

Question L. Has your organization changed its material and/or equipment purchasing levels or practices in the past three years?

Purchasing levels of materials and equipment correspond directly to the steady increases in memory semiconductor demand and fab expansions.

Question M. What single change (and to which portion of the supply chain) would most significantly increase your ability to supply semiconductor products in the next six months?

Because memory semiconductor production capacity planning is conducted on an annual basis based on customer demand projections, it is difficult to increase supply by a large amount within a short period of time (i.e., 6 months). If necessary, it is possible to achieve a small increase in

supply through technology advancements and productivity improvements (e.g., foregoing scheduled maintenance, though this is not optimal or sustainable in the long-term).

Question 2: Questions for intermediate users and end users of semiconductor products or integrated circuits:

As a producer of semiconductors, SK hynix is not a major end-user of semiconductor products. As such, we do not have any relevant information to submit in response to question 2.

General comments

Comments regarding our data:

As noted above, while **there is no backlog** of any SK hynix semiconductor products, we have submitted aggregated data to provide additional transparency into our resilient supply chain, after consultation with the Department of Commerce leadership and staff. In considering our supply data for confidential submission, we identified “industry” by consumption categories commonly found in industry analysis reports. This aggregation provides the information requested by the Department of Commerce, while not disclosing information specific to any customer. We appreciate that the submission instructions provided sufficient flexibility for us to avoid specifying customer names or data in order to protect our customers’ interests.

The Office of the SK hynix Chief Economist welcomes outreach from the Department of Commerce staff for further discussion of industry data and analysis that are available from public sources.

Comments regarding memory products and shortages:

In the memory industry, products are relatively easier to adjust for short-term changes in supply and demand. If there is a short-term under-supply and increase of prices, demand can be adjusted by having customers switch to a lower-density product in the short-term. If there is a decline in demand, the corresponding decline in prices enables customers to purchase higher-density products and thus increases quantity of purchases. Currently, memory products have not been a source of chip shortages to downstream consumers.

Due to the generally commoditized nature of memory products, the relative diversity of suppliers, and market driven prices, memory supply/demand ratios have remained stable within single digits for the last several years. In particular for SK hynix, there has never been an instance where our availability of supply caused issues for our customers’ electronics systems production.

There may be portions of the semiconductor industry that do not share the aforementioned resilient characteristics of the memory industry. Some customers of non-memory semiconductors may be harmed by reliance on single-sourced production, unpredictable backlogs, broken price signals, or the inability to quickly expand production of specific chips in particular production nodes, particularly when chip shortages negatively impact downstream production.

In such circumstances of potential market failures, it is understandable that policy makers or industry participants would seek creative solutions to correct such market failures in order to ensure supply to critical industries, including assessing whether excess capacity should be “built-in” as a feature of certain portions of the semiconductor supply chain. Because excess capacity inevitably increases average costs of production, such solutions would make the unavoidable trade-off between “resiliencies” and generally lower prices. In an industry with extremely high fixed costs, enforcement and coordination to maintain excess capacity would also be challenging.

The memory segment, on the other hand, has historically shown that supply resiliency is structurally built-in, with diverse suppliers, commoditized and standardized products, market driven prices, and a trend of expanding capacity among leading companies, including SK hynix. This is the case despite the economic motivations to maximize production capacity, with rarely any excess capacity. In such circumstances, incentivizing or forcing **excess** capacity would be forcing a solution to a problem that does not exist. It would be more effective to devote resources to memory technology advancements, workforce development, and market-driven capacity expansion to ensure resilient supply.

SK hynix will continue to maintain sufficient production capacity by developing next-generation technology and investing in equipment and fab construction. We will continue to respond to customer demand, and anticipate supply issues to resolve them before they occur. Further, SK hynix will continue to play an important role in the U.S. semiconductor ecosystem, contribute to advancements in critical information technology industries, and maintain a significant economic presence in the United States.

Respectfully submitted,

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SK hynix