

Section 57 of the Competition Act (Cap. 50B)

Grounds of Decision issued by the Competition Commission of Singapore

In relation to the proposed acquisition by SK Holdings Co. Ltd. of LG Siltron Inc. pursuant to section 57 of the Competition Act

12 May 2017

Case number: CCS 400/003/17

Confidential information in the original version of this Decision has been redacted from the published version on the public register. Redacted confidential information in the text of the published version of the Decision is denoted by [§<]
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I. Introduction

The Notification

1. On 8 March 2017, SK Holdings Co. Ltd. (“SK Holdings”) (the “Applicant”), an entity of the SK group, filed a notification pursuant to section 57 of the Competition Act (Cap. 50B) (the “Act”) for a decision by the Competition Commission of Singapore (“CCS”) as to whether its proposed acquisition of 51% of LG Siltron Inc. (“LG Siltron”) (collectively the “Parties”) from LG Corporation (the “Transaction”) will infringe the section 54 prohibition, if carried into effect. On 8 May 2017, the Applicant informed CCS that it is likely to undertake an additional acquisition of shares in LG Siltron shortly after the completion of the Transaction, (the “Additional Acquisition”). The Applicant submitted that the Additional Acquisition does not affect the Transaction that has been notified to CCS.¹ As the Additional Acquisition does not form part of the Transaction notified and assessed by CCS in this decision, no decision by CCS is made in relation to the Additional Acquisition.
2. In reviewing the Transaction, CCS conducted a public consultation which included contacting twenty-five (25) third-parties in total, comprising²: five (5) competitors engaged in the business of manufacturing and selling silicon wafers to semiconductor manufacturers³ and thirteen (13) customers who purchase these silicon wafers; and seven (7) competitors engaged in the business of manufacturing and selling of semiconductors and nine (9) customers who purchase the semiconductor products.⁴
3. Of the third-parties contacted, eleven (11)⁵ replied, with seven (7)⁶ third-parties providing substantive responses to CCS’s queries. Most third-parties indicated they have no concerns with the Transaction.
4. In relation to the supply of silicon wafers, customers of silicon wafers generally purchase from multiple sources and find it generally easy to switch between different silicon wafer suppliers. Most customers also noted that buyer power is strong and would likely continue to remain so post-Transaction.

¹ Applicant’s Email Response dated 9 May 2017 to CCS RFI dated 8 May 2017 read with Applicant’s Email Response dated 11 May 2017 to CCS Email dated 11 May 2017.

² Some third-parties were contacted in their capacities of holding multiple roles, e.g. as both a customer who purchases silicon wafers and a competitor engaged in the business of manufacturing and selling of semiconductors.

³ Manufacturers of memory and non-memory semiconductors and specialty foundries. Paragraph 19(c) of Form M1.

⁴ Customers who purchase DRAMs and NAND Flash are manufacturers of PCs, smartphone devices, wearable technologies and peripheral products. Paragraph 19(d) of Form M1.

⁵ [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; and [REDACTED].

⁶ [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; [REDACTED]; and [REDACTED].

Customers were therefore of the view that the Transaction is unlikely to have any major impact on their business. Most competitors similarly provided feedback that they have no concerns with regard to the Transaction or that the Transaction would have limited effect on the sales for their business. In relation to the supply of semiconductors, feedback from customers and competitors was also broadly similar to that received in respect of silicon wafers, either no concerns were raised in respect of the Transaction or that the Transaction would have limited impact on their business.

5. One area of concern raised was in respect of possible vertical links between entities within the SK group. Post-Transaction, LG Siltron will become an entity within the SK group together with SK Hynix Inc. (“SK Hynix”), which is in the business of manufacturing and selling semiconductors. The Transaction may give rise to the possible vertical integration of the upstream and downstream businesses of silicon wafers and semiconductors operated by LG Siltron and SK Hynix respectively. These concerns will be addressed in Section VIII (Competition Assessment) below.
6. At the end of the consultation process and after evaluating all the evidence, CCS concludes that the Transaction, if carried into effect, will not infringe section 54 of the Act.

II. The Parties

SK group: SK Holdings and SK Hynix

7. The Applicant is an entity within the SK group, a conglomerate headquartered in Seoul, South Korea. The SK group is comprised of SK Holdings as a holding company and several subsidiaries and affiliated companies that share the SK brand. A number of these companies, including SK Holdings, SK Telecom and SK Hynix, are listed on the Korea Stock Exchange. SK Holdings’ principal activities are investment holdings, IT service, security service and used-car distribution business.⁷
8. SK Hynix is an affiliate of the SK group and is in the business of manufacturing and selling semiconductors. SK Hynix’s key products are DRAMs (Dynamic Random Access Memory) and NAND flash memory.⁸ SK

⁷ Paragraph 7 of Form M1.

⁸ The Applicant submitted that SK Hynix has other ancillary products that are semiconductor memory devices such as Multi-chip package (“MCP”), and complementary metal-oxide-semiconductor image sensor (“CIS”) which is a non-memory semiconductor product. According to the Applicant, in 2016, SK Hynix recorded [X] from customers located in Singapore for MCPs and [X] revenue in respect of CIS from

Hynix is engaged in the manufacturing, research and development and sale of semiconductors across Asia, Europe and the United States. SK Hynix is headquartered in Icheon, Korea.⁹ SK Hynix has a sales subsidiary located in Singapore, SK Hynix Asia Pte. Ltd. which conducts marketing and sales activities and supports multinational enterprise customers in Southeast and Southwest Asia.¹⁰

9. Global turnover for SK Hynix was approximately S\$ 20.61 billion in the financial year 2016. Turnover in Singapore for the same period was approximately S\$ [X].¹¹
10. Global turnover for SK Holdings was approximately S\$ 100.19 billion in the financial year 2016. Turnover in Singapore for the same period was approximately S\$ [X].¹²

LG Siltron

11. LG Siltron is a member of the LG group. LG Corporation, a South Korean multinational conglomerate, is the holding company of the LG group. LG Corporation is engaged in the production of electronics and petrochemical goods and provision of telecommunication services. The LG group companies include LG Electronics, LG Display, LG Chemical and LG Uplus, among others.¹³
12. LG Siltron's principal business is in manufacturing and selling of silicon wafers and operates out of offices in Korea, Taiwan, United States, China and Europe. LG Siltron is headquartered in Gumi, Korea.¹⁴ LG Siltron does not have an office or facilities in Singapore but supplies silicon wafers to customers in Singapore through its other Asian offices.¹⁵

customers located in Singapore. The Applicant submitted that due to the insignificant amount of revenue involved in Singapore in relation to the MCP and CIS products, MCP and CIS have not been included in its notification to CCS.

⁹ Paragraph 9(c) of Form M1.

¹⁰ Paragraph 10 of Form M1.

¹¹ Paragraph 13 of Form M1; Annex A of Applicant's Response dated 21 April 2017 to CCS RFI dated 10 April 2017; and Paragraph 2 of Applicant's Response dated 26 April 2017 to CCS RFI dated 24 April 2017.

¹² Paragraph 4 of Applicant's Response dated 15 March 2017 to CCS RFI dated 10 March 2017.

¹³ Paragraph 3 of Applicant's Response dated 15 March 2017 to CCS RFI dated 10 March 2017.

¹⁴ Paragraph 9(c) of Form M1.

¹⁵ Paragraph 9(d) of Form M1.

13. Global turnover for LG Siltron was approximately S\$ [X] in the financial year ending 31 December 2016. The total group turnover in Singapore for the same period was approximately S\$ [X].¹⁶

III. The Transaction

Nature of the Transaction

14. The Transaction will involve the proposed acquisition by the Applicant of 51% shares in LG Siltron from LG Corporation for approximately S\$ 743 million, pursuant to the terms set out in the sale and purchase agreement (“SPA”).¹⁷ The Transaction is expected to be completed as soon as regulatory approvals are obtained from all relevant jurisdictions, but in any event shall be no later than [X].¹⁸ The Transaction has been notified to the relevant regulatory authorities in Korea, Japan, China and Taiwan.¹⁹

Commercial rationale of the Transaction

15. The Applicant submitted that LG Siltron is the only South Korean producer and seller of silicon wafers and by acquiring shares in LG Siltron, it is able to indirectly enter the Korean semiconductor silicon wafer market, thereby allowing it to expand its presence in the supply of semiconductor silicon wafers and strengthen its competitiveness in the domestic Korean semiconductor industry.²⁰

Merger under section 54 of the Act

16. As a majority shareholder, the Applicant will have board nomination rights in respect of LG Siltron and will be able to influence the decision making of LG Siltron through such board nomination rights. Based on the Applicant’s submission that it will acquire full control of LG Siltron pursuant to the Transaction²¹, CCS is of the view that the Transaction constitutes a merger pursuant to section 54(2)(b) of the Act.²²

¹⁶ Paragraphs 13(a) and 13(b), Annex A of Applicant’s Response dated 6 April 2017 to CCS RFI dated 17 March 2017.

¹⁷ Paragraph 11(a) of Form M1.

¹⁸ Paragraph 11(g) of Form M1.

¹⁹ Paragraph 5 of Form M1.

²⁰ Paragraph 12 of Form M1; and Paragraph 3 of Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

²¹ Paragraph 11(a) of Form M1.

²² Paragraph 11(b) of Form M1.

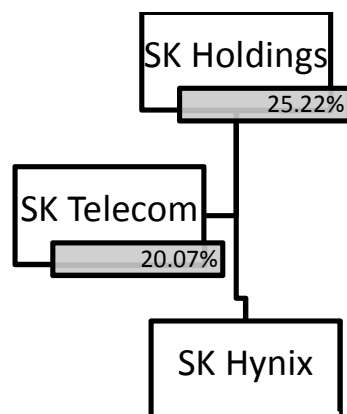
17. CCS notes that the Additional Acquisition is not likely to change CCS's assessment of the change in control of LG Siltron, as the Applicant has submitted that it will acquire full control of LG Siltron pursuant to the Transaction.

IV. Competition Issues

18. The Applicant submitted that it does not have any activities related to the silicon wafer market or the semiconductor memory market other than very remotely through SK Hynix.²³ According to the Applicant, the business activities of LG Siltron and SK Hynix are fully non-overlapping and there are no overlapping goods or services sold by LG Siltron or SK Hynix globally (including in Singapore). Neither LG Siltron nor SK Hynix sells each other's products or services, nor offer each other's products or services as part of any packages offered to their respective customers.²⁴ The Applicant also submitted that notwithstanding the common "SK branding" between the Applicant and SK Hynix, SK Hynix should not be considered relevant to the Notification in view of the tenuous legal and commercial relationship between the Applicant and SK Hynix.²⁵

Relationship between the Applicant and SK Hynix

19. Within the SK group, the relationship between the Applicant and SK Hynix is as follows:
- (a) The Applicant holds 25.22% shares in SK Telecom Co., Ltd. ("SK Telecom"); and
 - (b) SK Telecom in turn holds 20.07% shares in SK Hynix.



²³ Paragraph 3 of Applicant's Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

²⁴ Paragraph 15 of Form M1.

²⁵ Paragraph 1 of Form M1.

SK Hynix's ownership structure is as follows:

Name	Shareholding Interests (%)
SK Telecom	20.07
National Pension Service	9.94
Share Management Council	0.70
Others* (Each holding is less than 5%)	66.27
Treasury shares	3.02

20. The Applicant submitted that it neither has actual nor *de facto* control over SK Hynix. Based on its shareholding interests, the Applicant effectively only has 5.06% indirect interest in SK Hynix.²⁶ Further, SK Hynix, SK Telecom and SK Holdings are public companies listed on the Korea Stock Exchange, governed by their respective board of directors which makes independent corporate decisions.²⁷ As such, the Applicant submitted that it does not have any decisive influence or control over the business decisions of SK Hynix. The Applicant further submitted it also does not have any *de facto* control over SK Hynix in the form of any direct or indirect board nomination rights, veto rights or contractual rights which may give it influence over the strategic decisions of SK Hynix.²⁸

CCS's assessment

21. The issue of whether the Applicant, through SK Telecom, has decisive influence over SK Hynix will have a bearing on whether LG Siltron and SK Hynix will be under the control of the same undertaking i.e. the Applicant post-Transaction and accordingly, whether the Transaction involves vertical integration between the upstream silicon wafer supplier, LG Siltron, and downstream semiconductor manufacturer, SK Hynix.
22. Pursuant to section 54(3) of the Act, control over an undertaking exists if decisive influence may be exercised over the activities of that undertaking, in particular, by reason of ownership of, or the right to use all or part of the assets of an undertaking,²⁹ or any rights or contracts which enable decisive influence to be exercised with regard to the composition, voting or decisions of the organs of an undertaking.³⁰

²⁶ Paragraph 1(a) of Form M1.

²⁷ Paragraph 1(b) of Form M1.

²⁸ Paragraph 1 of Form M1.

²⁹ Section 54(3)(a) of the Act.

³⁰ Section 54(3)(b) of the Act.

23. The existence of control is determined by whether decisive influence is capable of being exercised, rather than the actual exercise of such influence. In determining whether decisive influence exists, CCS will not look only at the legal effect of any instrument, deed, transfer, assignment or other act done or made (legal control), but will consider the entire factual matrix surrounding the acquisition of such control (*de facto* control).³¹
24. Control may also be acquired in the case of a minority shareholder if the minority shareholding confers decisive influence with regard to the activities of the undertaking.³²

Legal control

25. CCS considers that where there is ownership of between 30% and 50% of the voting rights of the undertaking, there is a rebuttable presumption that decisive influence exists.³³ This presumption can be rebutted if the Applicant adduces sufficient evidence to convince CCS why it may not have decisive influence notwithstanding that they meet the voting rights thresholds indicative of control. In addition, CCS will take into consideration all other relevant factors which provide evidence of control, or the lack thereof.³⁴
26. In this regard, CCS notes that as submitted by the Applicant, SK Telecom holds 20.07% voting rights in SK Hynix based on its shareholding interests and in accordance with a share purchase agreement entered into between SK Telecom and the Share Management Council, the Share Management Council is to exercise its voting rights on its shares in accordance with SK Telecom's decision in designating officers of SK Hynix or other matters unless this conflicts with their interest. The Share Management Council holds 0.7% shareholding interest. In aggregate, assuming that the Share Management Council votes in the same manner as SK Telecom in all matters requiring shareholders' approval, the combined voting rights would be 20.77%, which falls below the rebuttal presumption of decisive influence.

De facto control

³¹ Paragraph 3.8 of the *CCS Guidelines on the Substantive Assessment of Mergers 2016* ("CCS Merger Guidelines 2016"). See also section 54(6) of the Act.

³² Paragraph 3.17 of the *CCS Merger Guidelines 2016*.

³³ Paragraph 3.10 of the *CCS Merger Guidelines 2016*.

³⁴ Paragraph 3.10 of the *CCS Merger Guidelines 2016*.

27. Besides legal ownership through the acquisition of property rights and shares, *de facto* control may also be established.³⁵ In assessing whether a party has *de facto* control over an undertaking, CCS may consider whether any agreements with the undertaking allow the party to influence the undertaking's activities that affect its key strategic commercial behaviour.³⁶
28. In assessing the Transaction, CCS considered whether, despite having a minority shareholding interest, SK Telecom may be in a position to assert *de facto* control over SK Hynix as a result of the dispersed nature of the remaining shareholders. In this respect, CCS notes that [REDACTED]³⁷ and resolutions that are adopted require [REDACTED].³⁸ CCS also notes that [REDACTED].³⁹
29. SK Hynix's board of directors is made up of ten (10) directors and one (1) director is a representative director of SK Telecom.⁴⁰ The Board of Directors makes the strategic commercial decisions relating to budgets, business plans and major investments in SK Hynix and [REDACTED].⁴¹ [REDACTED]⁴² and [REDACTED].⁴³ CCS notes that [REDACTED].⁴⁴

Assessment of the Transaction

30. CCS notes that regardless of whether the Applicant has legal or *de facto* control over SK Hynix, the Applicant and SK Hynix may have vertical links between them as both companies are entities within the SK group. Consequently, for the purpose of its assessment, CCS has considered the impact of these possible vertical links in its evaluation of the Transaction.
31. In its assessment, CCS has also noted the Applicant's submission, verified by third-parties, that there are no overlapping goods or services sold by the Parties globally, including Singapore. In evaluating the potential impact of the Transaction, CCS considered whether the Transaction will lead to coordinated, non-coordinated and vertical effects that would substantially lessen competition or raise competition concerns in any market in Singapore.

³⁵ Paragraph 3.11 of the *CCS Merger Guidelines 2016*.

³⁶ Paragraph 3.12 of the *CCS Merger Guidelines 2016*.

³⁷ SK Hynix's response dated 13 April 2017 to Question 6(a) of CCS RFI dated 7 April 2017.

³⁸ SK Hynix's response dated 13 April 2017 to Question 6(b) of CCS RFI dated 7 April 2017.

³⁹ SK Hynix's response dated 13 April 2017 to Question 6(c) of CCS RFI dated 7 April 2017.

⁴⁰ SK Hynix's response dated 5 April 2017 to Question 10 of CCS RFI dated 30 March 2017.

⁴¹ SK Hynix's response dated 5 April 2017 to Question 11 of CCS RFI dated 30 March 2017.

⁴² SK Hynix's response dated 13 April 2017 to Question 7(a) of CCS RFI dated 7 April 2017.

⁴³ SK Hynix's response dated 13 April 2017 to Question 7(b) of CCS RFI dated 7 April 2017.

⁴⁴ SK Hynix's response dated 13 April 2017 to Question 7(c) of CCS RFI dated 7 April 2017.

V. Counterfactual

32. As stated at paragraph 4.4 of the *CCS Merger Guidelines 2016*, CCS will, in assessing mergers and applying the Substantial Lessening of Competition (“SLC”) test, evaluate the prospects for competition in the future with and without the merger. The competitive situation without the merger is referred to as the “counterfactual”.
33. The *CCS Merger Guidelines 2016* also states that in most cases, the best guide to the appropriate counterfactual will be prevailing conditions of competition, as this may provide a reliable indicator of future competition without the merger. However, CCS may need to take into account likely and imminent changes in the structure of competition in order to reflect as accurately as possible the nature of rivalry without the merger.⁴⁵

The Applicant’s submissions

34. The Applicant submitted that, in the absence of the Transaction, SK Hynix and LG Siltron will continue to operate separately and independently. The Applicant also submitted that competitors are likely to continue to compete for customers with, or without, the Transaction.⁴⁶

VI. Relevant Markets

35. The Applicant submitted that the relevant markets for the purpose of this notification are:
- a. the supply of silicon wafers to Singapore;
 - b. the supply of DRAMs to Singapore; and
 - c. the supply of NAND flash memory to Singapore.
36. Although there are no horizontal overlapping goods or services sold by the Parties globally, including Singapore, CCS notes the Applicant and SK Hynix may have vertical links between them as both companies are entities within the SK group. Accordingly, CCS’s competition assessment in relation to market definition is focused on the upstream (i.e. supply of silicon wafers) and downstream (i.e. supply of DRAMs and NAND flash memory) products that may be vertically integrated as a result of this Transaction.

The Applicant’s submission

⁴⁵ Paragraph 4.14 of the *CCS Merger Guidelines 2016*.

⁴⁶ Paragraph 23 of Form M1.

(a) **Product market**

(i) ***Silicon Wafers***

37. Silicon wafers are thin plates made by slicing monocrystalline silicon ingots formed by melting highly pure polycrystalline silicon. Silicon wafers, together with masks and lead frames, constitute the three key raw materials for the manufacturing of semiconductors.⁴⁷

38. Silicon wafers may be sub-classified by diameter size and type⁴⁸:

(a) **Diameter size.** Silicon wafers may be classified as 300mm, 200mm or \leq 150mm products.⁴⁹

(b) **Type:** Depending on whether the silicon wafer surface undergoes further processing, silicon wafers may be classified as **polished, epitaxial, silicon-on-insulator (“SOI”) or annealed wafers**⁵⁰:

- i. A **polished wafer** is a thin disc-shaped single crystal silicon, made from highly pure polycrystalline silicon through melting, crystal growth, cutting, polishing and washing processes. Polished wafers are primarily used to make semiconductor devices such as DRAM, flash memory, and liquid crystal display (LCD) drivers. These products provide high levels of flatness and cleanliness to ensure the smooth manufacturing of highly integrated semiconductor devices, as well as prevent fine crystal defects during the manufacturing process.⁵¹
- ii. An **epitaxial wafer** is very similar in shape to a polished wafer, but has an additional multi- μ m-thick layer of single crystal silicon deposited on a polished wafer. Epitaxial wafers are usually used to make semiconductor devices such as microprocessors, image sensors, and power devices. These products allow for the substrate structure needed for a variety of highly functional semiconductor devices, provide uniform resistivity and prevent contamination.⁵²

⁴⁷ Paragraph 19(a) of Form M1.

⁴⁸ Paragraph 19(a) of Form M1.

⁴⁹ Paragraph 19(a) of Form M1.

⁵⁰ Paragraph 19(a) of Form M1.





⁵¹ Paragraph 5 of Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁵² Paragraph 5 of Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

- iii. **SOI wafer** is a three-layer sandwich structure including a surface layer of silicon (silicon layer) on top, a buried oxide layer (insulating SiO₂ layer) in the middle, and a “handle” silicon wafer (bulk silicon) at the bottom, which can be applied in a semiconductor device requiring the functionalities of high integrity, low power consumption, high speed, etc.⁵³
- iv. **Annealed wafer** is a type of polished wafer which is manufactured through a high-temperature heating process. The purpose of manufacturing annealed wafer is to substitute low-performance logic of epitaxial wafers.⁵⁴

39. Table 1 below summarises the functionalities of different diameter sizes and types of silicon wafers.⁵⁵

Table 1. Types, sizes and applications of silicon wafers

	Polished wafer	Annealed wafer	Epitaxial Wafer	SOI wafer
Product Concept	 COP controlled	 COP annihilation at near surface	 Epitaxial layer	 Top Si layer on buried oxide of Base wafer
Application	<ul style="list-style-type: none"> •MEMORY(DRAM) •MEMORY(FLASH) •LOGIC 	<ul style="list-style-type: none"> •MEMORY(FLASH) •LOGIC •High end logic •ANALOG 	<ul style="list-style-type: none"> • MICRO • LOGIC/ANALOG • OPTOELECTRONICS • DISCRETE 	<ul style="list-style-type: none"> • LOGIC/ANALOG • High end logic
Available diameter	<ul style="list-style-type: none"> • ≤150, 200, 300mm 	<ul style="list-style-type: none"> • ≤150, 200, 300mm 	<ul style="list-style-type: none"> • ≤150, 200, 300mm 	<ul style="list-style-type: none"> • ≤150mm (Thick SOI) • 200, 300mm (Thin SOI)

40. The Applicant submitted that despite the different sub-classifications of silicon wafers based on diameter size and type, the silicon wafer market should be defined as a single relevant product market based on the following considerations⁵⁶:

- (a) Most semiconductor manufacturers purchase silicon wafers of differing diameter sizes and variety at the same time as each semiconductor vendor will use silicon wafers with different diameters and variety in the same product according to its own design strategy;

⁵³ Paragraph 5 of Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁵⁴ Paragraph 5 of Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁵⁵ Paragraph 5 of Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁵⁶ Paragraph 20(a) of Form M1.

- (b) Silicon wafer vendors all compete to manufacture and supply silicon wafer products of different diameters and variety at the same time; and
 - (c) While there are different types of wafers depending on the presence or absence of a specific surface treatment process, the overall production process remains the same.
41. As a result of the considerations set out at paragraph 40 above, the Applicant submitted that market participants generally recognise silicon wafers as constituting products in a single market.

CCS's assessment on silicon wafer product segments

42. CCS notes that LG Siltron currently supplies and/or has been supplying polished, epitaxial and annealed silicon wafers in both 200mm and 300mm sizes⁵⁷; while SK Hynix currently requires [REDACTED].⁵⁸

Demand-side substitutability

43. Third-party feedback suggests that there may be weak demand-side substitutability for different types of silicon wafers. For semiconductor manufacturers, different types of silicon wafers are typically not substitutable, as plants and production lines are designed to use a specific type of silicon wafer.⁵⁹ Specifically, memory products (such as DRAM, NAND flash) use only polished silicon wafers.⁶⁰ Third-party feedback also suggests that it would not be commercially viable to re-design an existing production line to use a different type of silicon wafer to produce memory products.⁶¹
44. Similarly, third-party feedback suggests weak demand-side substitutability for different sizes of silicon wafers. First, it would not be possible for existing semiconductor manufacturers to switch across different sizes of silicon wafer (i.e. from 300mm to 200mm) within the same plant or production line as semiconductor manufacturers have dedicated production lines for specific sizes of silicon wafers.⁶² Secondly, while different sizes of silicon wafers may be used to produce DRAM and NAND flash products, CCS understands from

⁵⁷ Paragraph 4 of Applicant's Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁵⁸ Paragraph 8 of Applicant's Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁵⁹ Paragraph 25 of [REDACTED].

⁶⁰ Paragraph 25 of [REDACTED].

⁶¹ Paragraph 25 of [REDACTED].

⁶² Paragraph 13 of [REDACTED].

the Applicant and third-party feedback that 300mm silicon wafers are generally preferred due to increased productivity and consequent cost savings.⁶³

Supply-side substitutability

45. Switching between supplying polished and epitaxial silicon wafers is theoretically possible as epitaxial wafers are derived through additional processing of polished wafers. It is therefore possible for suppliers of silicon wafers to purchase additional equipment to produce more epitaxial wafers from polished wafers⁶⁴ or to reduce the production of epitaxial silicon wafers in favour of more polished wafers. However, the Applicant submitted that in practice, there is little diversion of production capacity from epitaxial to polished silicon wafers⁶⁵ and this is corroborated by third-party feedback that suppliers tend to fully utilise their epitaxial wafer capacity due to demand needs for these wafers.⁶⁶
46. Third-party feedback also noted that switching between manufacturing different sizes of silicon wafers within the same production line or plant is not commercially feasible.⁶⁷ This is because suppliers of silicon wafers typically have dedicated equipment to manufacture different sizes of silicon wafers.

Observations on product market structure

47. CCS notes that from the demand-side perspective, the different types and sizes of silicon wafers are available to customers from all the major suppliers and major semiconductor manufacturers (including SK Hynix) generally purchase a portfolio of different types and sizes of silicon wafers from all the major suppliers of silicon wafers.⁶⁸ From the supply-side perspective, the major suppliers of silicon wafers all supply different types and sizes of silicon wafers.⁶⁹ CCS notes that no competition concerns have been specifically raised in relation to any specific type and/or size of silicon wafers. Two (2) third parties provided a breakdown of their purchases of the various types and sizes of silicon wafers from suppliers. CCS notes that the proportion of their

⁶³ Paragraph 9 of Applicant's Response dated 24 March 2017 to CCS RFI dated 17 March 2017; and Paragraph 13 of [§<].

⁶⁴ Paragraph 17 of [§<]; and Paragraph 26 of [§<].

⁶⁵ Paragraph 4 of Applicant's Response dated 5 April 2017 to CCS RFI dated 24 March 2017.

⁶⁶ Paragraph 17 of [§<]; Paragraph 26 of [§<]; and Paragraph 4 of Applicant's Response dated 5 April 2017 to CCS RFI dated 24 March 2017.

⁶⁷ Paragraph 9(a) of [§<]; and Paragraph 16 of [§<].

⁶⁸ Paragraph 13 of [§<]; and Paragraph 1 of [§<].

⁶⁹ Paragraph 5 of [§<]; and Paragraph 9 of [§<].

purchases from LG Siltron is generally commensurate with its global market share.⁷⁰

CCS's conclusion on silicon wafer product segments

48. CCS considered the possibility of a narrower product market definition by different types and sizes of silicon wafers. On balance, CCS is of the view that for the purposes of its assessment of the current Transaction, even under a narrower product market definition, the Transaction does not raise competition concerns.

(ii) DRAM

49. DRAM products are semiconductors used for storage of binary data used mainly in computer hardware.⁷¹ DRAM products are high-density, low-cost-per-bit random access memory devices that provide high-speed data storage and retrieval. The ultimate end customers of DRAM integrated circuits are customers who purchase PCs, consumer electronics, networking and server, mobile devices, automotive and industrial application products.
50. Types of DRAM would include commonly used DDR3 and DDR2 products as well as specialty DRAM memory products including LPDRAM, SDRAM, RDRAM and PSRAM.⁷²
- (a) DDR3 and DDR2 are standardised, high-density, high-volume DRAM products that are sold for use as main system memory in computers and servers. DDR3 and DDR2 products offer high speed and high bandwidth at a relatively low cost compared to other DRAM products; and
 - (b) Specialty DRAM products include DDR and DDR2 Mobile LPDRAM, DDR, SDRAM, RDRAM and PSRAM in densities ranging from 64 Mb to 2 Gb. LPDRAM products are used primarily in laptop computers, tablets and other consumer devices that require low power consumption. Other specialty DRAM products are used primarily in networking devices, servers, consumer electronics, communications equipment and computer peripherals as well as computer memory upgrades.

⁷⁰ Paragraph 7 of [§<]; and Paragraph 7 of [§<].

⁷¹ Paragraph 19(a) of Form M1.

⁷² Paragraph 19(a) of Form M1.

51. The Applicant submitted that a single market for DRAM products exists and notes that this is consistent with the view taken by the European Commission (“EC”).⁷³ From the demand-side perspective, the EC noted that DRAM products are commodity products with specifications standardised by the Joint Electron Device Engineering Council.⁷⁴ The same type of DRAM could be supplied by various suppliers around the world. The Applicant further submitted that customers have the ability to design-in any type of DRAM based on requirements regarding functionality and that customers often design in one or more chipsets which enable easy transitions and substitution from generations or types of DRAM.⁷⁵
52. From the supply-side perspective, the Applicant submitted that it is generally not difficult for a producer to switch production between different types of DRAMs. Equipment used to manufacture DRAMs can be used to make most product types. Hence, as long as a supplier is qualified⁷⁶ by the customer for the particular type of DRAM, a supplier can relatively easily switch from manufacturing one type of DRAM to another simply by adjusting its internal operations. According to the Applicant, the qualification process for each type of DRAM usually takes only [X] months and entails customers verifying the stability of the product through [X] testing.⁷⁷

CCS’s assessment on the DRAM product segment

53. CCS considered the possibility of a narrower product market definition by different types of DRAM. For example, third-party feedback suggests that at the post-design stage, there are challenges to switch to using other types of DRAM for the products that they manufacture as compatibility, performance and functionality issues may arise.⁷⁸ However, switching between types of DRAM used may be easier at the pre-design stage as the supplier and customer of DRAM may work together to design the type of DRAM to be used.
54. On balance, CCS is of the view that for the purposes of its assessment of the current Transaction, even under a narrower product market definition, the Transaction does not raise competition concerns. CCS notes that no competition concerns have been specifically raised in relation to any specific type of DRAM.

⁷³ Paragraph 20(a) of Form M1.

⁷⁴ The EC decision in Case No. Comp/JV.44 - Hitachi/NEC-DRAM/JV at paragraph 18.

⁷⁵ Paragraph 20(a) of Form M1.

⁷⁶ In the semiconductor industry, the qualification process refers to the technical testing and approval by a customer in order to use a supplier’s product as an input.

⁷⁷ Paragraph 20(a) of Form M1.

⁷⁸ Paragraph 7 of [X].

(iii) NAND flash

55. NAND flash stores data in a large array of cells where each cell holds one or more bits of data.⁷⁹
56. There is a variety of NAND flash memory products, with significantly different performance capabilities and features across a number of process nodes, the key ones being SLC NAND flash, MLC NAND flash and TLC NAND flash⁸⁰:
- (a) SLC NAND flash stores one bit of data per memory cell, and offers relatively fast read and write capabilities, good endurance, and relatively simple error correction algorithms, but can be more expensive per bit when compared to other NAND technologies since each bit cell stores only one bit of data. SLC NAND meets the demands of internet of things, automotive and emerging embedded applications;
 - (b) MLC NAND stores two or more bits per memory cell. MLC NAND offers twice the capacity as SLC NAND in the same size device and comes at a significantly lower cost-per-bit. Designers will have to make some trade-offs in terms of performance and reliability since SLC NAND is about three times as fast as MLC NAND and offers over 10 times the endurance, but for many applications, MLC NAND offers the right combination of price and performance. MLC NAND is the dominant flash memory of choice for consumer class SSDs because its performance is superior to magnetic hard disk drives; and
 - (c) TLC NAND has the highest cell density, but generally lower performance and endurance specifications. Storing three bits per cell, TLC NAND devices are value-minded parts used primarily in consumer products that do not require top-tier NAND performance and endurance, such as USB thumb drives, client SSDs, and other portable media devices.
57. The Applicant submitted that the NAND flash market should be defined as a single relevant product market due to the similarity in functionality of the different types of NAND flash products and that the varying performance capabilities and features across the types do not materially change the fundamental nature and utility of the product.⁸¹ The Applicant also submitted

⁷⁹ Paragraph 19(d) of Form M1.

⁸⁰ Paragraph 19(d) of Form M1.

⁸¹ Paragraph 20 (a) of Form M1.

that buyers generally perceive NAND flash as a single product and will mix different types of NAND flash in the same application.

58. On the supply side, the Applicant submitted that while there is a difference in the production processes of different types of NAND flash products, it is possible to switch production lines almost immediately, with no additional cost, due to production automation

CCS's assessment on the NAND product segment

59. CCS notes that DRAM and NAND flash constitute separate product markets, as they have specific functionalities that cannot be used interchangeably.⁸²
60. CCS considered the possibility of a narrower product market definition by different types of NAND flash. Specifically, third-party feedback suggests that the type of NAND flash product used depends on the end-product and is customised to the customers' needs.⁸³ Furthermore, CCS understands from third-parties that changing the type of NAND flash product used in an existing production process may involve a lengthy qualification process.⁸⁴
61. On balance, CCS is of the view that for the purposes of its assessment of the current Transaction, even under a narrower product market definition, the Transaction does not raise competition concerns. CCS notes that no competition concerns have been specifically raised in relation to any specific type of NAND flash.

MCP and CIS

62. CCS notes that SK Hynix has other ancillary products that are semiconductor memory devices such as MCP⁸⁵ and CIS⁸⁶ which is a non-memory

⁸² Paragraph 7 of Applicant's Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁸³ Paragraph 13 of [3].

⁸⁴ Paragraph 14 of [3].

⁸⁵ MCP is a simple packaging/stacking of different types of semiconductor chips to increase the memory capacity per unit area. MCP collectively refers to all stacking/packaging technologies from the past technology of single chip packaging to the advanced multi stacking technology from two layers to twenty or more layers. 200mm and 300mm polished type wafers are used; Paragraph with "Footnote 1", Annex A, in Page 8 of Applicant's Response dated 6 April 2017 to CCS RFI dated 17 March 2017.

⁸⁶ CIS is an optic device, which is a system semiconductor converting light signal into an electrical signal. Most smart phones use CIS device as the module of webcam. 200mm and 300mm epitaxial wafers are used; Paragraph with "Footnote 1", Annex A, in Page 8 of Applicant's Response dated 6 April 2017 to CCS RFI dated 17 March 2017.

semiconductor product.⁸⁷ The Applicant submitted that due to the insignificant amount of revenue involved in Singapore in relation to the MCP and CIS products, MCP and CIS have not been included in its notification to CCS.⁸⁸

63. Accordingly, MCP and CIS do not fall within the product markets considered in CCS's assessment and no decision by CCS is made in relation to MCP and CIS products.

(b) Geographic Market

64. The Applicant submitted that the relevant geographic markets for silicon wafers, DRAMs and NAND flash should all be worldwide in scope since customers are generally able to source from different suppliers without any geographical constraints. The portion of transportation cost to the product price is immaterial and the difference in prices of the same product between different territories is negligible, as transportation and distribution costs across geographical borders are low and trade barriers are marginal.⁸⁹

CCS's assessment on the geographical scope

65. CCS agrees with the Applicant's submission that the geographical scope of the markets is global for the purpose of this notification. Suppliers and customers of silicon wafers, DRAM and NAND flash typically sell or purchase worldwide, and cross-border transportation and tariffs are not considered to be significant.⁹⁰

OVERALL ASSESSMENT ON RELEVANT MARKET

66. CCS is of the view that the assessment of the current Transaction is not affected by the precise definition of the market and therefore it is not necessary to conclude on this. However, for the purpose of the assessment in the following sections, CCS will consider the markets for:

- (a) the global supply of silicon wafers;

⁸⁷ Paragraph 2 of Applicant's Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

⁸⁸ In 2016, SK Hynix recorded [§<] from customers located in Singapore for MCPs and [§<] revenue in respect of CIS from customers located in Singapore; Footnote 1 of Form M1; Paragraph with "Footnote 1", Annex A, in Page 8 of Applicant's Response dated 6 April 2017 to CCS RFI dated 17 March 2017; and Annex A of Applicant's Response dated 21 April 2017 to CCS RFI dated 10 April 2017. [§<] MCP products typically contribute less than [§<]% of business revenue in the semiconductor products business and that this is likely to be consistent with other suppliers of semiconductor products including MCP.

⁸⁹ Paragraph 20(b) of Form M1.

⁹⁰ Paragraph 22 of [§<]; Paragraph 13 of [§<]; and Paragraph 15 of [§<].

- (b) the global supply of DRAMs; and
 - (c) the global supply of NAND flash.
67. In assessing the Transaction, CCS examined the impact of the Transaction on competition within Singapore.

VII. Market Structure

Market shares and market concentration

The Applicant's submission

68. The Applicant has submitted market shares for silicon wafers, DRAMs and NAND flash based on the markets set out above at paragraph 66 amongst the key suppliers for the last three years, on a worldwide basis (i.e. global supply to worldwide), as shown in Table 2 to Table 6.
69. Although Singapore-specific market shares (i.e. global supply to Singapore) are not readily available, the Applicant submitted that given that the relevant geographic markets for silicon wafers, DRAMs and NAND flash are worldwide in scope, it is not meaningful to artificially segregate the market on a regional or national level. As such, for the purpose of this application, the Applicant submitted that the Singapore market share amongst LG Siltron and its competitors, and SK Hynix and its key competitors respectively, may be assumed to correlate to their respective global market share.⁹¹

⁹¹ Paragraph 22 of Form M1.

Table 2. Silicon Wafers – Market shares by revenue (2014-2016)⁹² in Singapore Dollars⁹³

Vendors	2014		2015		2016	
	By Revenue (S\$' million)	Market Share	By Revenue (S\$' million)	Market Share	By Revenue (S\$' million)	Market Share
Shin-Etsu	[<]	[20-30]%	[<]	[20-30]%	[<]	[25-35]%
SUMCO	[<]	[20-30]%	[<]	[20-30]%	[<]	[25-35]%
Siltronic	[<]	[10-20]%	[<]	[10-20]%	[<]	[10-20]%
SunEdison	[<]	[5-15]%	[<]	[5-15]%	[<]	[5-15]%
LG Siltron	[<]	[5-15]%	[<]	[5-15]%	[<]	[5-15]%
Others	[<]	[10-20]%	[<]	[10-20]%	[<]	[5-15]%
Total	[<]	100%	[<]	100%	[<]	100%

Table 3. DRAM – Market shares by volume (2014-2016)⁹⁴

Vendors	2014		2015		2016	
	By Volume (4Gb Eq Millions)	Market Share	By Volume (4Gb Eq Millions)	Market Share	By Volume (4Gb Eq Millions)	Market Share
Samsung Electronics	4,980	41%	6,379	44%	6,216	47%
SK Hynix	3,544	29%	4,388	30%	3,877	29%
Micron Technology	2,794	23%	2,905	20%	2,579	19%
Others	705	6%	787	6%	644	5%
Total	12,024	100%	14,460	100%	13,317	100%

⁹² Paragraph 21, Annex A of Applicant's Response dated 6 April 2017 to CCS RFI dated 17 March 2017. Data is internal information based on investor relations materials of competitors and SEMI-SMG. Information on market share of silicon wafers by volume is not available as the Applicant submits that it does not have access to the volume or square inch details of the competitors of LG Siltron, nor is such information available from industry agency reports and there is no meaningful method of calculating the volume from the revenue data.

⁹³ Converted from Korean Won based on S\$1 = ₩ 831.75 (2014); S\$1 = ₩ 828.09 (2015); S\$1 = ₩ 834.6 (2016). Source: The Bank of Korea Economic Statistics System, as submitted in Paragraph with "Exchange Rates", Annex A, of Applicant's Response dated 6 April 2017 to CCS RFI dated 17 March 2017.

⁹⁴ Paragraph 21 of Form M1. Source: (a) Volume statistics from Gartner (December 2016) and (b) Revenue statistics from Statistics Portal (2016).

Table 4. DRAM – Market shares by revenue (2014-2016)⁹⁵ in Singapore Dollars⁹⁶

Vendors	2014		2015		2016	
	By Revenue (S\$' million)	Market Share	By Revenue (S\$' million)	Market Share	By Revenue (S\$' million) ⁽¹⁾	Market Share
Samsung Electronics	24,693	41%	28,693	45%	25,897	47%
SK Hynix	16,641	27%	17,627	28%	14,141	26%
Micron Technology	15,145	25%	12,539	20%	10,649	20%
Others	4,439	7%	4,244	7%	4,022	7%
Total	60,919	100%	63,105	100%	54,712	100%

(1) The 2016 revenue figures are available only up to the third quarter of 2016 and are annualised.

Table 5. NAND Flash – Market shares by volume (2014-2016)⁹⁷

Vendors	2014		2015		2016	
	By Volume (Millions of Gb)	Market Share	By Volume (Millions of Gb)	Market Share	By Volume (Millions of Gb)	Market Share
Samsung Electronics	20,859	33%	31,843	35%	50,467	38%
Toshiba Semiconductor	15,160	24%	20,147	22%	27,402	21%
Western Digital	10,582	16%	15,268	16%	20,847	16%
Micron Technology	8,410	13%	10,608	12%	14,157	10%
SK Hynix	6,413	10%	10,710	12%	15,901	12%
Others	2,605	4%	2,881	3%	3,639	3%
Total	64,030	100%	91,459	100%	132,416	100%

⁹⁵ Paragraph 21 of Form M1. Source: (a) Volume statistics from Gartner (December 2016) and (b) Revenue statistics from Statistics Portal (2016).

⁹⁶ Converted from US Dollars based on US\$1 = S\$1.3216 (2014); US\$1 = S\$1.4153 (2015); US\$1 = S\$1.448 (2016). Source: The Bank of Korea Economic Statistics System, as submitted in Form M1.

⁹⁷ Paragraph 21 of Form M1. Source: (a) Volume statistics from Gartner (December 2016) and (b) Revenue statistics from Statistics Portal (2016).

Table 6. NAND Flash – Market shares by revenue (2014-2016)⁹⁸ in Singapore Dollars⁹⁹

Vendors	2014		2015		2016	
	By Revenue (S\$' million)	Market Share	By Revenue (S\$' million)	Market Share	By Revenue (S\$' million) ⁽¹⁾	Market Share
Samsung Electronics	12,458	31%	15,440	33%	17,180	36%
Toshiba Semiconductor	9,206	23%	9,205	20%	10,037	21%
Western Digital	6,140	15%	7,026	15%	7,522	16%
Micron Technology	5,660	14%	6,770	14%	5,739	12]%
SK Hynix	4,222	10%	5,172	11%	4,409	9%
Others	2,878	7%	3,756	7%	3,217	6%
Total	40,567	100%	[47,374]	100%	48,108	100%

(1) The 2016 revenue figures are available only up to the third quarter of 2016 and are annualised.

70. In respect of the market shares for silicon wafers, DRAM and NAND flash, the Applicant submitted that there does not appear to be significant year-on-year variations amongst the key players from 2014 to 2016.¹⁰⁰

CCS's assessment of market shares and market concentrations

71. There are no overlapping goods or services sold by LG Siltron or SK Hynix globally (including in Singapore). CCS notes that polished silicon wafers are inputs used in the manufacture of different types of DRAM products¹⁰¹ and in the manufacture of different types of NAND flash products.¹⁰²
72. In the upstream supply of silicon wafers, LG Siltron is one of the five major suppliers. Ranked fourth (refer to Table 2), it has approximately [5-15]% of the market share by volume and revenue for the years 2014 to 2016. In comparison, the top two largest suppliers of silicon wafers (i.e. Shin-Etsu and SUMCO) have market shares in the range of [20-30]% to [25-35]% each.

⁹⁸ Paragraph 21 of Form M1. Source: (a) Volume statistics from Gartner (December 2016) (other than for the conversion from US\$ into S\$, which is based on the exchange rates set out in the annex herein). (b) Revenue statistics from Statistics Portal (2016) (other than for the conversion from US\$ into S\$, which is based on the exchange rates set out in the annex herein).

⁹⁹ Converted from US Dollars based on US\$1 = S\$1.3216 (2014); US\$1 = S\$1.4153 (2015); US\$1 = S\$1.448 (2016). Source: The Bank of Korea Economic Statistics System, as submitted in Form M1.

¹⁰⁰ Paragraph 21 of Form M1.

¹⁰¹ Paragraph 3 of Applicant's Response dated 5 April 2017 to CCS RFI dated 30 March 2017.

¹⁰² Paragraph 3 of Applicant's Response dated 5 April 2017 to CCS RFI dated 30 March 2017.

73. In the downstream supply of DRAM, SK Hynix is the second largest supplier of DRAM with a market share of around 30% by volume and revenue for the years 2014 to 2016 (Table 3 and Table 4).
74. In the downstream supply of NAND flash, SK Hynix is a relatively smaller player, ranked fifth with a market share of about 10 to 12% for the years 2014 to 2016 (Table 5 and Table 6).
75. Having regard to the possible vertical links between the Applicant and SK Hynix, CCS considered whether market power could exist at one (or more) of the parts of the supply chain for silicon wafers, DRAM and/or NAND flash, thereby giving rise to vertical, coordinated and non-coordinated effects.

Barriers to entry and expansion

76. In assessing barriers to entry and expansion, CCS considered whether entry by new competitors or expansion by existing competitors may be sufficient in likelihood, scope and time to deter or defeat any attempt by the merger parties or their competitors to exploit the reduction in rivalry flowing from the Transaction (whether through coordinated or non-coordinated strategies).¹⁰³

The Applicant's submission

77. The Applicant submitted that a new entrant will be faced with high initial set-up and capital costs to develop and license the intellectual property rights to produce the silicon wafer or semiconductor memory products.¹⁰⁴ For existing players, LG Siltron's key competitors in the silicon wafer market, and SK Hynix's key competitors in each of the DRAM and NAND flash markets, are sufficiently large in scale and have strong technological capabilities to increase production capacity as they deem desirable to absorb any expected increase in demand for silicon wafers, DRAM and NAND flash respectively. The Applicant cited the following examples of capacity expansion:¹⁰⁵
 - (a) for the silicon wafer market: by SUMCO in 2007, Shin-Etsu in 2006, and Siltronic in 2005; and
 - (b) for DRAM and/or NAND flash: by Micron Technology in 2016, Samsung Electronics in 2014 and 2015, and Toshiba in 2013.

¹⁰³ Paragraph 5.46 of the *CCS Merger Guidelines 2016*.

¹⁰⁴ Paragraph 28 of Form M1.

¹⁰⁵ Paragraph 24(e) of Form M1.

78. In terms of capital expenditure required to enter the relevant markets or expand capacity for existing players, the Applicant estimates the following costs:¹⁰⁶
- (a) to secure a 5% share of the silicon wafer market: approximately S\$ [X];
 - (b) to expand capacity by 5% for DRAM products: approximately S\$ [X];
and
 - (c) to expand capacity by 5% for NAND flash products: approximately S\$ [X].
79. According to the Applicant, it generally takes between [X] years for the building of a new silicon wafer production plant, a DRAM fabrication facility or a NAND flash memory fabrication facility.¹⁰⁷ The Applicant also observed that to be competitive in the semiconductor memory market, players must have large scale and strong technological capabilities. These requirements have created high (although not insurmountable) barriers to entry.¹⁰⁸
80. Other than this, the Applicant submitted that there are no significant regulatory barriers, whether in Singapore or otherwise, that makes entry into the silicon wafer, DRAM or NAND flash markets particularly cumbersome. An entrant need not be present in Singapore physically to enter the Singapore market. Transportation and distribution costs across geographical borders are low and trade barriers are marginal.¹⁰⁹
81. The Applicant accordingly submitted that while barriers to entry and expansion into the DRAM or NAND flash markets exist, they are not insurmountable. The Applicant referred to market commentators' observations that new Chinese players may rise to "significantly alter the memory segment's future structure and economics through its investments" and have shown serious intentions of doing so on the back of a supportive government.¹¹⁰
82. In respect of the silicon wafer market, according to the Applicant, China's National Silicon Industry Group, a state-backed semiconductor investment fund, has disclosed its interest in acquiring a majority stake in German silicon-wafer maker Siltronic AG.¹¹¹ Additionally, to the best knowledge of the Applicant, there are already companies that currently manufacture $\leq 200\text{mm}$

¹⁰⁶ Paragraph 26 of Form M1.

¹⁰⁷ Paragraph 21 of the Applicant's Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

¹⁰⁸ Paragraph 19(g) of Form M1.

¹⁰⁹ Paragraph 28 of Form M1.

¹¹⁰ Paragraph 28 of Form M1.

¹¹¹ Paragraph 30 of Form M1.

silicon wafers in China, and although not currently producing 300mm silicon wafers, are considering to expand their capabilities to manufacture 300mm silicon wafers as well.¹¹² According to the Applicant, Chinese silicon wafer manufacturers will likely need at least a [X]-year development period to switch to manufacturing 300mm silicon wafers, even if they currently have technology to manufacture 200mm silicon wafers, in view of the huge quality gap requirement between 200mm and 300mm silicon wafers.¹¹³

83. On potential entrants into the DRAM or NAND flash markets, according to the Applicant, new players from China have been aggressively pursuing a significant role in the memory segment. For example, Tsinghua Unigroup made a US\$23 billion bid for Micron and a bid for minority investment in SK Hynix but both were unsuccessful. Tsinghua Unigroup has also hired leading executives from the Taiwanese DRAM industry.¹¹⁴

Feedback from third-parties

84. Third-party feedback generally confirmed that the capital entry costs for the production of silicon wafers and semiconductor memory products are high. In particular, in respect of the production of silicon wafers, the capital expenditure and technological know-how required are significant, and new entry can be difficult and time-consuming. Capital expenditure for the expansion of capacity by existing silicon wafer suppliers is also significant, although the extent can vary depending on the additional infrastructure/equipment that would be required. A key barrier to entry or expansion is also the expected return on investment (“ROI”), which in turn is dependent on prevailing and expected market conditions.¹¹⁵
85. On the timeframe required for market entry or expansion, the feedback received from third-parties is generally consistent with the Applicant’s submissions. In particular, for the expansion of capacity for silicon wafer production by existing suppliers, third-parties generally responded that around 2 years may be required for the building of the new plant, or less if there is existing infrastructure that a supplier can utilise.¹¹⁶
86. With regard to potential competition from Chinese players in the silicon wafer market by way of organic new entry or expansion, third-party feedback

¹¹² Paragraph 23 of the Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

¹¹³ Paragraph 5 of the Applicant’s Response dated 5 April 2017 to CCS RFI dated 30 March 2017.

¹¹⁴ Paragraph 24(b) of Form M1.

¹¹⁵ Paragraph 28 of [X]; Paragraphs 21 and 24 of [X]; Paragraphs 19 and 54 of [X]; and Paragraph 14 of [X].

¹¹⁶ Paragraph 11 of [X]; Paragraph 19 of [X]; Paragraph 20 of [X]; and Paragraph 9 of [X].

generally indicated that such players currently do not produce silicon wafers of the grade and/or size(s) typically required for semiconductor manufacturing. Any existing Chinese manufacturers of silicon wafers are generally producing smaller sizes of silicon wafers than the sizes typically required by semiconductor manufacturers (i.e. 300mm, and 200mm to a lesser extent). There is also uncertainty in respect of whether such players will be able to produce silicon wafers of the standards and quality required by semiconductor manufacturers, and if so, the timeframe of such entry. New entry is generally not expected to take place within the next 1 to 2 years, although third-parties did not rule out the possibility of credible entry occurring after this timeframe. Third-parties also generally confirmed the trends observed by the Applicant of Chinese players pursuing development in this industry.¹¹⁷

CCS's assessment

87. CCS notes that the extent of barriers to expansion in the form of incentives to enter the market or invest in building new capacity, may in part vary depending on the prevailing market conditions, having regard to the cyclical nature of the market. In times of low demand, prices are depressed and existing market players will be reluctant to expand and invest in new capacity. There is also little incentive for new entrants to enter the market. In times of heightened demand, the converse is true; that existing market players and new entrants may be incentivised to add new capacity to the market, albeit that there will be a time lag before supply can meet current demand.
88. Based on the information received, CCS is of the view that the barriers to entry into the relevant markets, in particular in respect of silicon wafers, are high. While the entry barriers are not insurmountable, CCS notes that the extent of time required, in particular for credible new entry, can be significant. In this regard, potential new entry by Chinese players in the silicon wafer market in particular for semiconductor-grade 300mm silicon wafers, generally does not appear to be imminent although entry may be possible in the longer term. That said, CCS is of the view that the barriers to expansion in the relevant markets are moderate, and while there is potential for expansion of capacity by existing silicon wafer suppliers in the near future, this is subject to sufficient ROIs for existing suppliers to justify the building of new capacity.

Countervailing buyer power

¹¹⁷ Paragraph 6 of [REDACTED]; Paragraph 18 of [REDACTED]; Paragraph 25 of [REDACTED]; Paragraphs 56 and 57 of [REDACTED]; Paragraph 10 of [REDACTED]; and Paragraph 15 of [REDACTED].

89. The *CCS Merger Guidelines 2016* provides that the ability of a merged entity to raise prices may be constrained by the countervailing power of customers.¹¹⁸

The Applicant's submission

90. The Applicant submitted that the demand-side of each of the silicon wafer and the DRAM and NAND flash product markets is characterised by large, concentrated sophisticated buyers who have sufficient countervailing bargaining power to negotiate purchases.¹¹⁹ The procurement procedure in the semiconductor industry involves customers individually approaching suppliers and engaging in multiple rounds of discussions and negotiations about the technical specifications of the required materials, the technology to be used and the production costs, amongst others, and how to best deliver on the specific needs of that customer.¹²⁰
91. According to the Applicant, the market practice is for customers of silicon wafers, DRAM and NAND flash products to maintain a “multi-sourcing strategy”, and have supply relationships with multiple suppliers, to spread the risk of interruption to supply.¹²¹ The Applicant emphasised this “multi-sourcing strategy” particularly in respect of the silicon wafer market, and that semiconductor manufacturers may easily rebalance its weightage of supply from different vendors in the event of interruption in supply by one vendor.¹²² The Applicant also highlighted that, in respect of silicon wafers, the industry has suffered from a period of excess capacity, price pressures and low margins, with an inability to raise prices despite sustained demand growth.¹²³ On LG Siltron’s own capacity utilisation, the Applicant has submitted that [X].¹²⁴

Switching costs

92. In respect of silicon wafers, the Applicant submitted that a semiconductor memory product customer generally takes [X] months (for customers who manufacture semiconductors) or [X] months (for foundry companies) to switch between suppliers, including the time for the supplier to get a new qualification. This varies depending on the type of customer and whether additional qualification approvals are required (e.g. foundry company

¹¹⁸ Paragraph 5.60 of the *CCS Merger Guidelines 2016*.

¹¹⁹ Paragraph 32 of Form M1.

¹²⁰ Paragraph 25 of Form M1.

¹²¹ Paragraph 24(c) of Form M1.

¹²² Paragraph 32(b) of Form M1.

¹²³ Paragraph 32 of Form M1.

¹²⁴ Paragraph 5 of the Applicant’s Response dated 5 April 2017 to question 14(g) of CCS RFI dated 17 March 2017.

customers who additionally require the approval of the fabless semiconductor companies, who originally placed the purchase orders).¹²⁵

93. According to the Applicant, the main costs incurred in switching suppliers relate to the qualification process and that more cost may be incurred by both supplier and customer in the case of a qualification of a completely new supplier. The associated cost for qualification will be borne by the respective parties in the ordinary course of business and no costs are levied by either party on the other. For example, for LG Siltron, the costs incurred for qualification relate to the costs of the [X]. However, according to the Applicant, given the market practice of “multi-sourcing”, customers would already have existing supply relationships with multiple suppliers so there would not be any additional switching costs.¹²⁶
94. In respect of DRAM and NAND flash, according to the Applicant, it generally takes between [X] months (for DRAM) or [X] months (for NAND flash) to change suppliers due to qualification requirements (inclusive of the approximate time for the production of a sample, and the time required for customer review and approval of a sample). According to the Applicant, [X] costs are incurred by either the supplier or customer for the qualification process.¹²⁷

Long-term contracts and incentivising of capacity expansion

95. The Applicant submitted that, depending on market players’ sentiments on the future pricing for silicon wafer or semiconductor memory, customers may opportunistically seek to enter into long-term supply contracts with suppliers if a tight supply of silicon wafer or semiconductor memory is expected in the short-term. Conversely, silicon wafer or semiconductor memory suppliers may be incentivised to agree to multi-year supply contracts to reduce risk of oversupply in view of the high fixed costs. In the absence of such mutually agreed long-term contracts, customer switching is otherwise subject to the qualification process of a supplier, and customers’ “multi-sourcing strategy”.¹²⁸

¹²⁵ Paragraph 24(c) of Form M1; and Paragraph 6 of the Applicant’s Response dated 5 April 2017 to questions 17 to 19 of CCS RFI dated 17 March 2017.

¹²⁶ Paragraph 24(c) of Form M1, and Paragraph 6 of the Applicant’s Response dated 5 April 2017 to questions 17 to 19 of CCS RFI dated 17 March 2017.

¹²⁷ Paragraphs 20(a) and 24(c) of Form M1; and Paragraph 6 of the Applicant’s Response dated 5 April 2017 to questions 17 to 19 of CCS RFI dated 17 March 2017.

¹²⁸ Paragraph 32(b) of Form M1.

96. For silicon wafers in particular, long-term supply contracts would generally have a duration of [X] years. It is not uncommon for such long-term contracts to specify [X] to be supplied by the supplier or purchased by the customer. The Applicant submitted that in view of their enormous financial resources, it is also not uncommon for semiconductor manufacturers to incentivise silicon wafer manufacturers to expand their silicon wafer fabrication facilities by [X].¹²⁹
97. According to the Applicant, a multi-sourcing strategy would still be adopted by customers in circumstances where long-term supply contracts have been entered into or where full upfront payment has been made to suppliers.¹³⁰

Feedback from third-parties on procurement

98. Third-party feedback confirmed that customers generally practise a “multi-sourcing strategy” of silicon wafers to mitigate the risks of any disruptions to their supply. In relation to the procurement of silicon wafers in particular, some third-parties provided feedback that customers are able to switch suppliers relatively easily, subject to the suppliers having been qualified by the customer for the silicon wafer product in question. In view of the “multi-sourcing” strategy, such “switching” takes place by way of the customer deciding on and adjusting the share of its requirements that it will procure from the different suppliers, taking into account factors such as price, among others. Customers would generally also have multiple suppliers qualified for each silicon wafer product they require.¹³¹ In respect of the existence of large customers, [X] also indicated that, for 300mm silicon wafers in particular, the top five customers may account for a substantial portion (around [X]%) of global market demand.¹³²

Feedback from third-parties on switching costs

99. The ease of switching by customers is dependent on whether a supplier has already been qualified for the specific silicon wafer product in question. If a supplier has not already been qualified, there will be a delay in customers being able to switch suppliers. Particularly in respect of silicon wafers, the qualification process needs to be undertaken specific to new suppliers/sources, new types of silicon wafers, new semiconductor products, and/or each of the

¹²⁹ Paragraph 32(b) of Form M1; and Paragraph 26 of the Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

¹³⁰ Paragraph 26 of the Applicant’s Response dated 24 March 2017 to CCS RFI dated 17 March 2017.

¹³¹ [X]; Paragraph 19 of [X]; and Paragraphs 11, 12 and 33 of [X].

¹³² Paragraph 47 of [X]

customer's own manufacturing facilities. According to third-parties, the qualification process itself broadly entails customers testing the silicon wafer samples from the supplier by manufacturing their semiconductor products using the sample wafer, and testing the resulting product. Further qualification steps may also be required if the customer's product also needs to be qualified in turn by their downstream customer.¹³³

100. In this regard, the feedback from third-parties on the duration required for qualification is generally consistent with the Applicant's submission, i.e. generally, the qualification process can take several months, and potentially around or more than a year (depending also on the nature of the end-product that the semiconductor product is used for). Generally, third-parties also indicated that the costs involved in the qualification process are not prohibitive (e.g. for suppliers, the cost of the silicon wafer samples; for customers, the cost of running their production process using the sample wafer and testing the resulting product, etc).¹³⁴

Feedback from third-parties on extent of buyer power and prevailing market conditions

101. Other than the qualification process, the feedback from third-parties also indicated that the extent of buyer power, including the ability of silicon wafer customers to exert downward pressure on prices, and switch between suppliers by adjusting customer requirements from different suppliers, will depend on the supply and demand conditions in the market. In particular, in times of excess capacity when supply exceeds demand, third-parties generally agreed with the Applicant's submissions that customers would be in a position to exert downward price pressure. However, third-parties also highlighted that, conversely, when there is tight supply in the market, silicon wafer suppliers will instead manage their supply of silicon wafers by allocating the amount of silicon wafers supplied to each customer, and customers' ability to switch would accordingly be limited by the availability of wafers as allocated by different suppliers. In situations of tight supply, customers are accordingly less able to negotiate on terms with suppliers. Indeed, notwithstanding the Applicant's submissions that the silicon wafer industry has suffered from a period of excess capacity, third-parties indicated that the market most recently (from around 2016/2017 to date) has been in a situation of short supply, with demand coming close to, if not exceeding, supply.¹³⁵

¹³³ Paragraphs 9, 21 and 26 of [§<]; Paragraphs 12 and 13 of [§<]; and Paragraphs 49, 52 and 53 of [§<].

¹³⁴ Paragraphs 12 and 13 of [§<]; Paragraphs 12, 33, 50 and 51 of [§<]; and Paragraphs 12 and 13 of [§<].

¹³⁵ Paragraphs 3 and 4 of [§<]; Paragraphs 5, 23 and 32 of [§<]; Paragraphs 38 and 39 of [§<]; Paragraph 24 of [§<]; and Paragraph 3 of [§<].

102. In this regard, CCS notes that, on balance, the feedback received from third-parties indicated that customers are generally still able to obtain their required amounts of silicon wafers, with most third-parties not expressing any concerns on customers' ability to meet their demand post-Transaction. For example, some third-parties indicated their belief that, post-Transaction, customers may still be able to, on an overall basis, negotiate with suppliers (including the merged entity) to meet their demand requirements, such as by leveraging on their long-term relationships with suppliers and fair dealings even in times of low demand (e.g. as indicated by [X]).¹³⁶ Two (2) third-parties have expressed concerns of customers not being able to meet their demand requirements post-Transaction given the current situation of tight supply, although one (1) [X] also indicated that customers would respond to any decrease in supply by the merged entity by increasing their procurement from other existing suppliers. While [X], also subsequently expressed that customers' ability to increase procurement from other existing suppliers is dependent on such other suppliers' total capacity being sufficient to meet the demand requirements of other customers (which their observations indicated may not be the case at present), CCS notes that [X] 300mm silicon wafers are the more advanced technology and are generally preferred by customers due to increased productivity and consequent cost savings, demand for 200mm silicon wafers at present may also, in any event, eventually shift towards 300mm silicon wafers, which may potentially free up existing 200mm silicon wafer supply to meet the demand of 200mm silicon wafer customers [X].¹³⁷

Feedback from third-parties on long-term contracts and incentivising of capacity expansion

103. On the use of long-term contracts as part of customers' procurement strategy for silicon wafers, the third-party feedback generally indicated that there is significant variance in how customers procure silicon wafers (i.e. by long-term supply contracts, by shorter-term contracts, by spot or purchase orders, and/or by a mix of such procurement arrangements). Feedback from three parties [X] also indicated that there can be disadvantages to entering into long-term contracts (e.g. due to volatility in prices), or otherwise difficulties in entering into such long-term supply arrangements in situations of short supply (e.g. with other customers seeking to similarly secure their silicon wafer requirements from limited supply globally, or suppliers not being likely to enter into such contracts).¹³⁸

¹³⁶ Paragraphs 4, 5 and 7 of [X]; Paragraphs 3, 6, 7, 8 and 23 of [X]; and Paragraphs 27 and 60 of [X].

¹³⁷ Paragraphs 3, 17 and 31 of [X]; Paragraphs 7 and 11 of [X]; and Paragraphs 6 and 7 of [X].

¹³⁸ [X]; [X]; [X].

104. In relation to whether silicon wafer customers are able to incentivise or encourage suppliers to expand manufacturing capacity, CCS received mixed feedback from third-parties both indicating the possibility of customer and supplier being able to reach such an outcome (e.g. [X] which opined that they could discuss and build a business plan together with the suppliers, based on [X] views of future demand; and [X], which noted that such sponsorship or incentivising by customers would mostly turn on the prices of silicon wafers, as [X] investment decisions would ultimately be about the economics of price or its equivalent), and potentially an inability to do so (e.g. [X], on the basis that, according to [X], the price levels of silicon wafers would have to increase by [X]% of current prices in order to justify the ROIs for capacity expansion, which in turn would affect [X] margins in the downstream markets; and [X] foundry, is not in a position to provide firm commitments of demand in the long term without having the surety that demand will continue from its customers, although [X] also acknowledged that their position is unlike that of other silicon wafer customers that are semiconductor manufacturers, who can project their own demand requirements over time).¹³⁹

CCS's assessment

105. Based on the information received, CCS is of the view that there is generally some degree of countervailing buyer power that, on an overall basis, may pose a competitive constraint on the merged entity post-Transaction. Customers have the ability to sponsor entry or incentivise capacity expansion, and generally practise a “multi-sourcing” strategy and are able to switch among suppliers that have been qualified by the customer, or otherwise qualify additional suppliers. This is discussed further in non-coordinated effects. The structure of demand for silicon wafers is also characterised by large customers accounting for a substantial portion of demand. However, CCS notes that, in the immediate future after the Transaction, the extent of countervailing buyer power may be limited in view of the current short supply market situation. CCS has further considered, in the following sections, the cyclicity of the silicon wafer market and the extent to which the current short supply market situation may be anticipated to last.

VIII. Competition Assessment

- (a) Non-coordinated effects and vertical effects (in relation to supply of silicon wafers and use of the silicon wafers for production of semiconductors)**

¹³⁹ Paragraph 21 of [X]; Paragraph 48 of [X]; Paragraphs 24 and 25 of [X]; and Paragraph 13 of [X].

106. Non-coordinated effects may arise where, as a result of the Transaction, the merged entity finds it profitable to raise prices (or reduce output or quality) because of the loss of competition between the merged entities.¹⁴⁰
107. In assessing whether a vertical merger could result in a substantial lessening of competition in a market, CCS will consider whether the vertically-integrated merged entity may be able to foreclose rivals from either an upstream market for selling inputs or a downstream market for distribution or sales. Foreclosure does not only refer to a vertically-integrated firm excluding a non-vertically integrated firm from a market (although this may be the case), but may include a range of behaviour, including but not limited to:¹⁴¹
- (a) if the merged entity is an important downstream customer for a product that it also supplies upstream, it may be able to dampen competition from rival suppliers of that product in certain circumstances, for example, by sourcing its future needs entirely from its own production facility; and
 - (b) if a merged entity supplies a large proportion of an important input to a downstream process where it also competes, it may be able to dampen competition from its rivals in the downstream market, for example, by diverting its production of the input entirely to its own downstream process (input foreclosure).

The Applicant's submission

108. The Applicant submitted that there is no competition between SK Hynix and LG Siltron before the Transaction as their products are fully non-overlapping and belong to different parts of the supply chain.¹⁴²
109. In respect of non-coordinated vertical foreclosure effects, the Applicant submitted that anti-competitive downstream foreclosure is unlikely for the following reasons:
110. SK Hynix would not have the ability to substantially restrict or hamper access to silicon wafers: This is on the basis that:¹⁴³

¹⁴⁰ Paragraph 5.21 of the *CCS Merger Guidelines 2016*.

¹⁴¹ Paragraph 6.11 of the *CCS Merger Guidelines 2016*.

¹⁴² Paragraph 33 of Form M1.

¹⁴³ Paragraph 34(a) of Form M1; and Annex A of the Applicant's Response dated 6 April 2017 to question 11 of CCS RFI dated 17 March 2017.

- (a) LG Siltron commands only approximately [5-15]% of the global supply market share of the silicon wafer supply market and accordingly lacks any significant degree of market power;
- (b) SK Hynix's purchase of silicon wafers constituted merely approximately [X<]% of the entire silicon wafer market in 2016, of which [X<]% presently comes from LG Siltron. Therefore, even assuming that SK Hynix actively restricts the supply of LG Siltron's silicon wafers to SK Hynix's downstream competitors, after deducting the amount of silicon wafers sold by LG Siltron to SK Hynix, the input restriction would constitute only [X<]% of the entire silicon wafer market;
- (c) SK Hynix's competitors will have no difficulty finding alternative suppliers as it is market practice for semiconductor manufacturers, including SK Hynix, to adopt a "multi-sourcing strategy", to spread the risk of interruption to supply. As such, even if SK Hynix were to shift all its demand for silicon wafers to LG Siltron, SK Hynix's competitors may conversely satisfy their respective needs for silicon wafers from other manufacturers of silicon wafers;
- (d) Other silicon wafer suppliers should broadly have sufficient capacity to meet the increase in demand by SK Hynix's competitors if LG Siltron ceases to supply them. Silicon wafer suppliers have tended to arrange their production capacity, including procurement of production facilities, in accordance with medium to long-term production plans of semiconductor manufacturers, given the direct link between the supply of silicon wafers and production volumes of semiconductors by semiconductor manufacturers. SK Hynix's decision to rely solely on LG Siltron's supply of inputs may also free up capacity on the part of the remaining silicon wafer suppliers, resulting merely in a reshuffling of purchase patterns among competing firms. The Applicant has also submitted that the silicon wafer industry has suffered from a period of excess capacity, price pressures and low margins, with average selling prices for silicon wafers decreasing by around 27% from 2009 to 2015;¹⁴⁴
- (e) Given that the current trend is for semiconductor manufacturers to enter into long-term supply contracts with silicon wafer suppliers, semiconductor manufacturers are able to secure a minimum or default supply of silicon wafers. Where semiconductor manufacturers need to increase their purchase volumes of silicon wafers, semiconductor manufacturers have also in the past used their enormous financial

¹⁴⁴ Paragraph 18(f) of Form M1.

resources to incentivise silicon wafer manufacturers to expand their silicon wafer production facilities by paying them for silicon wafers upfront; and

- (f) Finally, given that LG Siltron commands only approximately [5-15]% of the global supply market share, even if LG Siltron were to cease supplying silicon wafers to SK Hynix's competitors, the Applicant submitted that it will not result in any significant impact to the supply market concentration of silicon wafers nor any material increase in market power of the remaining suppliers of silicon wafers that would enable them to raise the price of silicon wafers charged to SK Hynix's competitors.

111. SK Hynix would not have the incentive to substantially restrict or hamper access to silicon wafers: The Applicant submitted that SK Hynix and LG Siltron would not have material incentive to substantially restrict or hamper access to silicon wafers by SK Hynix's competitors in view of the following:¹⁴⁵

- (a) Consistent with market practice, SK Hynix adopts the "multi-sourcing strategy" where raw materials are sourced from multiple vendors in order to spread the risk of interruption in supply due to unforeseeable events. SK Hynix has no incentive to stop purchasing from other silicon wafer manufacturers and divert all its risk of supply to a single source; and
- (b) SK Hynix's competitors will have no difficulty finding alternative suppliers given the market practice of "multi-sourcing strategy", and it is accordingly highly unlikely for SK Hynix to be able to benefit from a foreclosure strategy to raise downstream rivals' cost and accordingly raise price levels downstream.

112. A foreclosure strategy of silicon wafers by SK Hynix would not have a significant detrimental effect on downstream competition: The Applicant further submitted that a foreclosure strategy, even if adopted by SK Hynix (which it is not), would not have a significant detrimental effect on downstream competition for the following reasons:¹⁴⁶

- (a) SK Hynix's competitors will have no difficulty finding alternative suppliers given the market practice of "multi-sourcing strategy", coupled

¹⁴⁵ Paragraph 34(b) of Form M1.

¹⁴⁶ Paragraph 34(c) of Form M1; and Annex A of the Applicant's Response dated 6 April 2017 to question 11 of CCS RFI dated 17 March 2017.

with the fact that merely up to [X]% of the entire silicon wafer market could *theoretically* be re-directed away by SK Hynix from its competitors. SK Hynix's competitors are highly likely capable of switching to adequate alternative inputs and accordingly not be foreclosed out of the downstream market; and

- (b) after the completion of the Transaction, a large majority of the global silicon wafers remain supplied by non-vertically integrated silicon wafer manufacturers, and rivals who wish to compete in the downstream market would have no lack of silicon wafer suppliers. Similarly, rivals who wish to compete in the upstream market would have no lack of purchasers for their silicon wafers. The Applicant emphasised that silicon wafers are used not only for memory semiconductors such as DRAM and NAND flash, but also non-memory semiconductors such as microprocessors amongst others. Based on the broader semiconductor market as a whole, SK Hynix commands less than 5% global market share.

113. No loss of pricing confidentiality: On the possible concern that the merged entity may, through the Transaction and vertical integration, gain access to commercially sensitive information regarding the downstream activities of rivals (e.g. information relating to the pricing of silicon wafers offered to SK Hynix's competitors), the Applicant submitted that on a general level, prevailing silicon wafer prices are relatively transparent, where both actual market prices and forecast prices are subject to extensive industry analysis. Further, given the market practice of "multi-sourcing" by semiconductor manufacturers, SK Hynix's knowledge would only be limited to the portion of the silicon wafers that are supplied by LG Siltron to SK Hynix's competitors, which would not present a comprehensive picture of SK Hynix's competitors' actual cost base.¹⁴⁷

Feedback from third-parties

114. Third-party feedback confirmed that customers generally practise a "multi-sourcing strategy", and are able to switch suppliers relatively easily among qualified suppliers. On the extent of capacity by other silicon wafer suppliers to absorb the increase in demand by SK Hynix's competitors if LG Siltron ceases to supply them, third-parties have indicated that the market most recently (from around 2016/2017 to date) has been in a situation of short supply, with demand coming close to, if not exceeding, supply.¹⁴⁸

¹⁴⁷ Paragraph 34 of Form M1.

¹⁴⁸ See paragraphs 98 to 104 above.

115. In this regard, on the current market situation of tight supply, the feedback from third-parties has indicated that the wider semiconductor market is cyclical, although the specific duration of each cycle is generally less predictable. For around the past 10 years, the silicon wafer market has generally been in a situation of oversupply, with the last period of tight supply and demand (other than periodic wafer shortages) occurring prior to this. On an overall basis, demand for semiconductors, and accordingly silicon wafers, is generally growing.¹⁴⁹
116. There was no clear indication or consensus from the feedback received from third-parties on the expected duration of the current situation of tight supply, although the tight supply is expected to alleviate should there be an addition of manufacturing capacity by silicon wafer suppliers. This, in turn, is subject to sufficient ROIs for existing suppliers to justify the building of new capacity. Should existing suppliers have sufficient ROIs to justify adding new manufacturing capacity, it is generally expected to take around 2 years for the new capacity to be available to supply the market.¹⁵⁰
117. On whether customers are generally still able to obtain their required amounts of silicon wafers, most third-parties have not expressed any concerns on customers' ability to meet their demand post-Transaction.¹⁵¹ While two (2) third-parties have indicated such concerns, one (1) [X] also indicated that customers would respond to any decrease in supply by the merged entity by increasing their procurement from other existing suppliers. While [X] also subsequently expressed that customers' ability to do so is dependent on other suppliers' total capacity being sufficient to meet the demand, CCS notes that [X] demand for 200mm silicon wafers at present may also, in any event, eventually shift towards 300mm silicon wafers, potentially freeing up existing 200mm silicon wafer supply (see also paragraph 102 above).¹⁵² Most third-parties also indicated that they do not think that the merged entity would have the ability to raise prices or decrease the quantity of silicon wafers supplied to the market, or the incentive to do so (from the perspective of both LG Siltron and SK Hynix). In particular, most third-parties had indicated that any diversion of supply of silicon wafers by LG Siltron to SK Hynix would also merely result in a redistribution of supplies of silicon wafers by other suppliers to other customers, with customers accordingly not likely to have difficulty in meeting their demand post-Transaction.¹⁵³

¹⁴⁹ Paragraphs 18 and 19 of [X]; Paragraph 3 of [X]; Paragraphs 37 and 40 of [X]; [X]; and Paragraphs 3 and 6 of [X].

¹⁵⁰ Paragraphs 18 and 19 of [X]; Paragraph 3 of [X]; Paragraphs 37, 40 and 42 of [X]; Paragraphs 15, 19 and 23 of [X]; and Paragraph 3 of [X].

¹⁵¹ Paragraphs 4, 5 and 7 of [X]; Paragraphs 3, 6, 7, 8 and 23 of [X]; and Paragraphs 27 and 60 of [X].

¹⁵² [X]; [X]; and [X].

¹⁵³ Paragraph 2b of [X]; [X]; Paragraphs 60 and 61 of [X]; and Paragraph 3 of [X].

118. On the possibility of other competitive advantages accruing to the merged entity post-Transaction, one (1) third-party [X] had expressed concerns that there may be circumstances, albeit limited, when [X] may have to share proprietary technical information with LG Siltron in order to discuss technical issues affecting the silicon wafers supplied. Although such information is non-price in nature, they may be commercially sensitive. Another third-party [X] had also indicated the possibility of advantages to the merged entity from having direct access to silicon wafers, although [X] does not take into account whether a supplier of DRAM or NAND flash has access to silicon wafers as a raw material, when deciding which supplier to procure from. One further third-party [X] had also noted the possibility that LG Siltron may have better visibility into the downstream demand for silicon wafers, and potentially also lower investment hurdles to invest in additional silicon wafer capacity on the basis of the SK group forgoing or reducing prudent ROI/margin requirements for such investments.¹⁵⁴

CCS's assessment and conclusion on non-coordinated effects and vertical effects

119. CCS is of the view that non-coordinated effects are unlikely to arise as the products of SK Hynix and LG Siltron are fully non-overlapping.
120. With respect to non-coordinated vertical foreclosure effects, CCS notes that it is unclear from the third-party feedback how long the current situation of tight supply is expected to last, although most third-parties have not expressed any concerns on customers' ability to meet their demand post-Transaction. CCS notes that LG Siltron has a market share of approximately [5-15]% and therefore may have limited impact on silicon wafer customers should it cease supplying to the market. However, in view of the multi-sourcing strategy of silicon wafer customers, this would result in the loss of one out of five main suppliers of silicon wafers. CCS is of the view that, on balance, in the immediate future, any diversion of supply of silicon wafers by LG Siltron to SK Hynix post-Transaction is likely to be offset by a redistribution of supplies of silicon wafers by other suppliers to other customers.
121. While there is, at present, uncertainty on the timeframe for when suppliers will have sufficient ROIs to justify adding new manufacturing capacity, CCS is of the view that, given the cyclical nature of the market and the recent history of oversupply and low prices in the silicon wafer market, the current situation of tight supply may be part of the market returning to an equilibrium between supply and demand. In this regard, it would be up to suppliers and customers

¹⁵⁴ Paragraph 30 of [X]; Paragraphs 4, 17 and 18 of [X]; and Paragraph 59 of [X].

to commercially negotiate and reach mutual agreement on the level of prices and ROIs in returning to this market equilibrium, and CCS's market inquiries have not indicated any specific impediments to such commercial negotiations directly arising from the Transaction. Accordingly, the timing of the market returning to such an equilibrium would also be separate from any incremental concerns in this regard directly arising from the Transaction. Further, in any event, it is generally expected that the addition of new capacity to the market will take around 2 years.

122. CCS notes that SK Hynix's purchase of silicon wafers constituted approximately [X] % of the entire silicon wafer market in 2016, of which [X] % presently comes from LG Siltron¹⁵⁵ and therefore the Transaction may have limited vertical foreclosure impact on other silicon wafer suppliers.
123. Given the above, CCS is of the view that it is unlikely that the Transaction will give rise to non-coordinated vertical effects which lead to SLC concerns in the relevant markets.

(b) Coordinated effects

124. A merger may also lessen competition substantially by increasing the possibility that, post-Transaction, undertakings in the same market may coordinate their behaviour to raise prices, or reduce quality or output. Given certain market conditions, and without any express agreement, tacit collusion may arise merely from an understanding that it will be in the undertakings' mutual interests to coordinate their decisions. Coordinated effects may arise where a merger reduces competitive constraints from actual or potential competition in a market, thus increasing the probability that competitors will collude or strengthening a tendency to do so.¹⁵⁶ Vertical mergers may create or strengthen coordinated effects, for example by allowing the merged entity to gain access to commercially sensitive information about the activities of non-integrated rivals, which may facilitate collusion.¹⁵⁷

The Applicant's submission

125. The Applicant submitted that, notwithstanding the oligopolistic nature of the silicon wafer, DRAM and NAND flash markets, coordinated effects are unlikely for the following reasons:

¹⁵⁵ Paragraph 34 (c)(i) of Form M1.

¹⁵⁶ Paragraph 5.35 of the *CCS Merger Guidelines 2016*.

¹⁵⁷ Paragraph 6.14 of the *CCS Merger Guidelines 2016*.

126. The constant and rapid changes in technology are not conducive to coordination: Semiconductor manufacturers are in an aggressive race to win major new designs and meet their customers' demands for rapid time to market, which has led them to accelerate the process of bringing a new technology from development to full-scale production, with increasing frequency. Manufacturers that are first to market with an innovative technology are expected to gain a lasting commercial advantage, to compensate for the massive investments for building and retooling of manufacturing sites. Given that the products in the semiconductor memory market are constantly evolving and advancing at a rapid pace, the competitive landscape of these markets is inherently not conducive to coordination.¹⁵⁸
127. The demand drivers and cost structure of the relevant markets are not conducive to coordination: The semiconductor segment (and those in the upstream supply chain) is highly cyclical, with profitability typically rising and falling in tandem with overall economic trends. Even when demand falls, manufacturers may continue to run fabrications at full capacity as fixed costs are high. This results in oversupply when markets slowed, thereby putting pricing and margins under pressure when players try to gain a competitive edge by decreasing prices sharply especially for the more commoditised products. As such, the nature of the demand drivers and cost structure of the relevant markets are not conducive to coordination, as historical trends have shown.¹⁵⁹
128. The Transaction will not lead to anti-competitive downstream foreclosure and accordingly will not increase the ease of coordination: SK Hynix has no ability to substantially restrict or hamper access to silicon wafers and has no incentive to do so. As such, the Transaction will not result in the reduction in players in the relevant downstream markets and accordingly will not result in the increase in the ease of coordination.¹⁶⁰
129. The Transaction would not give rise to deterrent mechanisms to adhere to any terms of coordination: Given that LG Siltron commands only approximately [5-15]% of the global supply market share of the silicon wafer supply market, LG Siltron (as a supplier) lacks any degree of market power to punish rival companies of SK Hynix, which in any event also diversify their supply sources through a "multi-sourcing strategy". Conversely, given that SK Hynix's global silicon wafer purchase constitutes only approximately [X]% of the entire

¹⁵⁸ Paragraph 35(a) of Form M1.

¹⁵⁹ Paragraph 35(b) of Form M1.

¹⁶⁰ Paragraph 35(c) of Form M1.

silicon wafer market, SK Hynix (as a customer) similarly lacks any degree of market power to punish rival companies of LG Siltron.¹⁶¹

Feedback from third-parties

130. The third-party feedback generally did not indicate any concerns of coordinated effects arising in the relevant markets as a result of the Transaction. As noted above, the feedback confirmed that customers generally practice a “multi-sourcing strategy” and are able to switch suppliers relatively easily among qualified suppliers, and also that the wider semiconductor market is generally cyclical in nature, with the specific duration of each cycle generally being less predictable. While one (1) third-party [X] indicated the possibility of reduced competition among silicon wafer suppliers arising from less non-captive wafer supply capacity being available post-Transaction,¹⁶² CCS notes that most third-parties have indicated that any diversion of supply of silicon wafers by LG Siltron to SK Hynix would merely result in a redistribution of supplies of silicon wafers by other suppliers to other customers.

CCS’s assessment and conclusion on coordinated effects

131. As there are no overlapping products supplied by SK Hynix and LG Siltron, CCS notes that the market structure in relation to each of the relevant markets is not materially affected by the Transaction. Further, as noted above, CCS is of the view that the Transaction is not likely to give rise to non-coordinated vertical effects which lead to SLC concerns in the relevant markets, and in turn, the Transaction is accordingly not likely to increase the risk of coordination as a result of reduced competition.
132. Accordingly, CCS considers that the Transaction is unlikely to raise concerns in terms of coordinated effects on competition in the relevant markets.

IX. Efficiencies

133. The Applicant has submitted that the Transaction is envisaged to bring about considerable efficiencies. The Applicant noted that the semiconductor industry is characterized by extreme competition in price and product features and that as a result of the Transaction, the integration of complementary products within the SK group is expected to decrease transaction costs and allow for better coordination in terms of product design, organization of the production

¹⁶¹ Paragraph 35(d) of Form M1; and Annex A of the Applicant’s Response dated 6 April 2017 to question 11 of CCS RFI dated 17 March 2017.

¹⁶² Paragraph 29 of [X].

and distribution processes and lead to savings on inventories costs for LG Siltron.

134. Further, as a result of the Transaction, LG Siltron will be able to benefit from the experience of the SK group in their dealings in the semiconductor industry, management know-how and additional investments to strengthen its competitiveness in the silicon wafer market.

CCS's assessment

135. Given that the above competition assessment did not raise SLC concerns in any of the relevant markets, CCS is of the view that it is not necessary to make an assessment on the claimed efficiencies by the Applicant.

X. Ancillary Restraints

136. Paragraph 10 of the Third Schedule to the Act states that “the section 34 prohibition and the section 47 prohibition shall not apply to any agreement or conduct that is directly related and necessary to the implementation of a merger” (the “Ancillary Restriction Exclusion”). In order to benefit from the Ancillary Restriction Exclusion, a restriction must not only be directly related, but also necessary to the implementation of the merger.¹⁶³ A restriction is not automatically deemed directly related to the merger simply because it is agreed at the same time as the merger or is expressed to be so related¹⁶⁴ but needs to be connected with the merger but subordinate to its main object.¹⁶⁵ In determining the necessity of the restriction, considerations such as whether its duration, subject matter and geographical field of application are proportionate to the overall requirements of the merger will be taken into account.¹⁶⁶
137. The Applicant has submitted that the following non-compete and non-solicitation obligations on the part of LG Corporation contained in the SPA constitutes ancillary restrictions to the Transaction:

(a) Non-compete restriction

138. [REDACTED]¹⁶⁷:

(a) [REDACTED]

¹⁶³ Paragraph 9.6 of the *CCS Merger Guidelines 2016*.

¹⁶⁴ Paragraph 9.9 of the *CCS Merger Guidelines 2016*.

¹⁶⁵ Paragraph 9.7 of the *CCS Merger Guidelines 2016*.

¹⁶⁶ Paragraph 9.10 of the *CCS Merger Guidelines 2016*.

¹⁶⁷ Annex C of Form M1.

(b) [X].

CCS's assessment regarding the non-compete obligations

139. The *CCS Merger Guidelines 2016* state that non-compete clauses, if properly limited, are generally accepted as essential if the purchaser is to receive the full benefit of any goodwill and/or know-how acquired with any tangible assets. CCS will consider the duration of the clause, its geographical field of application, its subject matter and the persons subject to it. Any restriction must relate only to the goods and services of the acquired business and apply only to the area in which the relevant goods and services were established under the previous/current owner.¹⁶⁸
140. The non-compete restriction prevents LG Corporation from competing with the Applicant. The Applicant has submitted that this is directly related and necessary to the Transaction in order for the Applicant to receive the full benefit of any goodwill and/or know-how acquired through LG Siltron, [X]. The Applicant further submitted that the subject matter, the geographical field of application, the persons subject to it, the duration and the scope of restriction, is proportionate to protect the business acquired.¹⁶⁹
141. In the circumstances of the case, CCS is of the view that the non-compete restriction is directly related and necessary for the Transaction. CCS also considered that the relevant objective cannot be achieved in a less restrictive way. CCS notes that the subject matter, scope of the restriction, as well as the persons subject to it is limited to [X]. CCS further notes that the geography of the restriction is consistent with [X].
142. CCS notes that the Applicant has submitted that it would take approximately [X]. CCS considers that a [X] year duration is generally sufficient to ensure that an acquirer obtains the full benefit from the goodwill and know-how acquired as part of a transaction. In this case CCS notes that the [X] year period coincides with the minimum period of time required for [X]. CCS is therefore of the view that a [X]-year duration is proportionate.
143. To the extent that the restrictions affect Singapore, CCS therefore considers that a [X]-year non-compete obligation on LG Corporation in respect of [X] is an ancillary restraint that falls within the exclusion in paragraph 10 of the Third Schedule of the Act.

¹⁶⁸ Paragraph 10.15 of the *CCS Merger Guidelines 2016*.

¹⁶⁹ Paragraph 43(b) of Form M1.

(b) Non- solicitation restriction

144. [X]¹⁷⁰:

- (i) [X]
- (ii) [X]
- (iii) [X].

145. It is the Applicant's submission that the non-solicitation restriction is directly related and necessary to the Transaction as it protects the legitimate proprietary interest of SK Holdings in [X]. The non-solicitation restriction also preserves the goodwill and know-how, [X].

CCS's assessment regarding the non-solicitation restriction

146. In the circumstances of the case, CCS notes that the non-solicitation restriction is intended by the Applicant for the purposes of [X]. CCS is of the view that the [X]-year duration for the non-solicitation restriction post completion is reasonable and allows the Applicant to protect the value of the business.

147. In view of the above, CCS concludes that the non-solicitation restriction constitutes an ancillary restriction and consequently falls within the exclusion under paragraph 10 of the Third Schedule of the Act insofar as they apply to Singapore.

XI. Conclusion

148. For the reasons above and based on the information available, CCS has assessed that the Transaction, if carried into effect, will not infringe section 54 of the Act. In accordance with section 57(7) of the Act, this decision shall be valid for a period of one year from the date of this decision.



Toh Han Li
Chief Executive
Competition Commission of Singapore

¹⁷⁰ Annex C of Form M1.