



SEMI Europe comments on the European Parliament's ENVI draft report and proposed amendments on the proposal for a regulation of the European Parliament and of the Council on fluorinated greenhouse gases (F-Gas), amending Directive (EU) 2019/1937 and repealing Regulation (EU) No 517/2014

Recommendations to the European Commission, Parliament, and Council



Introduction

SEMI Europe, the global industry association representing more than 300 European companies from across the global electronics manufacturing and design supply chain, would like to bring to your attention the priorities of the semiconductor industry in context of the European Commission's amendment of Regulation (EU) No 517/2014 (F-Gas Regulation) proposal.

As critical building block of Europe's digital economy, the semiconductor industry places environmental sustainability and protection as highest priority in every facet of business. We strive to build a resilient, green future by developing innovative components and systems that help Europe's most critical industries such as automotive, medical, aerospace and defense deliver sustainable technology solutions to resolve our region's most pressing issues and advance environmental stewardship across fast-growing global markets.

With the European Chips Act, EU has recognized the strategic importance of the semiconductor industry as a critical sector essential for advancing Europe's digital competitiveness in the development of critical technologies such as artificial intelligence, quantum computing, green mobility and energy solutions. It is therefore important that green initiatives, such as the proposed amendments to the F-Gas Regulation, do not affect the ability of the European semiconductor industry to grow and deliver products that can help Europe to turn the tide on components shortage affecting our most critical industries.

SEMI members recognize that the existing F-Gas regulation has been very successful in reducing the damaging effect of high Global Warming Potential (GWP) Hydrofluorocarbon (HFC) gases entering the atmosphere. SEMI members fully support the European commitments to the Kigali amendment to the Montreal Protocol and the contribution this makes to achieving the legally binding Greenhouse gas (GHG) reduction targets set by the 2021 European Climate Law (Regulation (EU) 2021/1119).

The EU Commission's impact assessment, (SWD(2022) 96/97 final April 2022), reviews policy options 1, 2 and 3 and balances the commitment to the legally binding GHG reduction targets with the needs of European industry to remain competitive. This demonstrates that policy options 1 and 2 can deliver the required GHG reduction targets. The amendment proposal from the Environment, Public Health and Food Safety (ENVI) incorporates additional measures within policy option 3 ("Steepest phase-down ensuring maximum HFC replacement where feasible at any cost") of the EU Commission's impact assessment that will result in a very marginal improvement over policy options 1 & 2 but with a substantial and irrecoverable impact to the EU Semiconductor industry.



SEMI Europe would like to bring to your attention six areas of concern that threaten the competitiveness and survival of the EU's semiconductor industry.

1. Lack of definitions for refrigeration and air conditioning systems.
2. Lack of clarity on the definition of Fluorinated F-Gas in relation to mixtures.
3. Servicing and Maintenance restriction on equipment using F-Gas that will prematurely obsolete semiconductor manufacturing equipment.
4. Market prohibitions that are not technically feasible within the stated time frame impacting the ability to manufacture semiconductors within the EU.
5. Loss of the semiconductor quota exemption e) in Article 16 (2) that results in uncertainty for supply of critical process chemicals.
6. Loss of the supply of high GWP F-Gas for low temperature refrigeration systems for semiconductor dry etch applications.

Industry Background Information

The European Chips Act as a critical legislation for our sector, envisions to provide incentives for substantial inward investments into the EU's Semiconductor industry. A new manufacturing facility typically requires \$2B - \$6B investment with a typical operation of 30+ years. With a lifetime spanning several decades, it is essential that Europe avoids the creation of a regulatory environment that adversely impacts the productivity and output of semiconductor manufacturing facilities over their anticipated lifetime, but ensures that Europe's chip industry as well as critical material supplies are met with a forward-looking and growth-enabling regulatory environment when investing in existing and new European semiconductor infrastructure.

Within the semiconductor industry, equipment manufacturers represent a critical segment of the value chain. With cost between \$2M - \$150M per unit, semiconductor equipment manufacturers design specialized products and systems allowing chip manufacturers to carry out a specific, highly precise process operations in the delivery the final semiconductor-based products. The processes and precision automated systems within the equipment require precise control of temperature and humidity to ensure the manufactured products meet the required electrical specification, reliability, and manufacturing yield. A variation as small as $<1^{\circ}\text{C}$ result in loss of the product (i.e., semiconductor chip).

The process chiller and air conditioning systems used to provide temperature and humidity control are therefore a critical part of the semiconductor manufacturing equipment. The process chillers and air conditioning systems used in semiconductor manufacturing typically have a charge size of $<40\text{T CO}_2$ equivalent and have an expected service life of 20-25 years. Process chiller applications, particularly for dry etching applications, often require low temperatures ($<-50^{\circ}\text{C}$) and high heat loads (7-20kW). The air conditioning systems typically operate at room temperature with large heat loads ($>20\text{kW}$) and precision temperature/humidity control is required. Please refer to the supporting information 'Process Control Chiller and air conditioning configurations (SEMI supporting information) slide deck.

The design and performance specification of the process chiller and air conditioning systems are an integral part of the design and performance specification of the semiconductor manufacturing systems. The design cycle typically takes 3-6 years requiring extensive system qualification by the equipment manufacturers and by the end users (semiconductor device manufacturers). Changes to the performance specification and to the physical size of the refrigeration and air conditioning systems require full process



requalification and may be impossible to implement on the original semiconductor manufacturing equipment. This is critical to the EU semiconductor industry where there is a heavy reliance on existing technology equipment for use in high power and automotive semiconductor devices, market segments where the EU has a significant presence. EU regulations that force early obsolescence of such equipment would significantly impact the EU's ability to compete in these market segments.

SEMI Europe's proposed amendments and priorities to the European Commission's proposal

1) Lack of definitions for refrigeration and air conditioning systems.

SEMI supports the proposals as suggested by the Czech Presidency compromise text to include definitions of refrigeration, air conditioning, self-contained and split systems.

Article 3 Definitions (SEMI Europe revisions):

37) 'self-contained' means complete factory-made system in a suitable frame and/or encasing that is fabricated and transported complete and in which no gas-containing parts are connected on site, but which may contain isolation valves;

38) 'split system' means a system consisting of a number of refrigerant piped units that form a separate but interconnected unit, requiring the installation and connection of refrigerant circuit components at the point of use;

41) 'refrigeration' means the process of cooling a product, substance, system or other items to lower or maintain its temperature;

42) 'air-conditioning' means the process of treating air to meet the requirements of a conditioned space by controlling its temperature, humidity, cleanliness, and distribution.

Justification: Clarity on definitions is essential to ensure control of use prohibitions or exemptions and placing on the market prohibitions or exemptions are applied to the correct type of equipment.

NOTE: Process chillers are not defined in the F-Gas Regulation. However they are defined in 'implementing Directive 2016/2281 of the European Parliament and of the Council with regard to eco-design requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers', Article 2(f)

'process chiller' means a product integrating at least one compressor and one evaporator, capable of cooling down and continuously maintaining the temperature of a liquid in order to provide cooling to a refrigerated appliance or system; it may or may not integrate the condenser, the coolant circuit hardware and other ancillary equipment;

With the addition of definitions 37-42 within the F-Gas regulation process chillers and air conditioning systems used in semiconductor manufacturing equipment are defined as Stationary, self-contained refrigeration equipment and stationary, self-contained air conditioning systems.

2) Lack of definition for fluorinated gases in mixtures.

SEMI supports the ENVI amendment 199 to reintroduce the definition from the current Regulation (EU) No 517/2014.

European Commission proposal Article 3 Definitions:

(2) 'mixture' means a fluid composed of two or more substances, at least one of which is a substance listed in Annexes I, II or III;

(4) 'hydrofluorocarbons' or 'HFCs' means the substances listed in Annex I, Section 1, or mixtures containing any of those substances;

SEMI proposed amendment:

(4a) 'Fluorinated greenhouse gas' means the hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride and other greenhouse gases that contain fluorine, listed in Annex I, II and III or mixtures containing any of those substances;

Justification: Manufactures of refrigeration and air conditioning systems have introduced a range of F-Gas mixtures whose GWP calculated according to annex VI are <2500. However these mixtures may contain individual F-Gas with GWP >2500.

e.g R407c has a GWP of 1774. The mixture contains R-32 GWP 677, R-125 GWP 3500 and R-134 GWP 1430
Clarity on the definition of mixtures is required to ensure mixtures with a GWP less than a defined threshold are not unnecessarily restricted or prohibited if they contain a specific F-Gas above a defined GWP threshold.

3) Control of Use Article 13.3 Restrictions on servicing and maintenance.

Removal of the <40T charge size threshold combined with a time limited exemption for servicing and maintenance will result in unnecessary early obsolescence of refrigeration and air conditioning systems. This is potentially catastrophic for the EU semiconductor industry.

European Commission proposal:

3. From 1 January 2024, the use of fluorinated greenhouse gases listed in Annex I, with a global warming potential of 2 500 or more, for the servicing or maintenance of refrigeration equipment is prohibited.

This paragraph shall not apply to military equipment or equipment intended for applications designed to cool products to temperatures below - 50 °C.

The prohibition referred to in the first subparagraph shall not apply to the following categories of fluorinated greenhouse gases until 1 January 2030:

(a) reclaimed fluorinated greenhouse gases listed in Annex I with a global warming potential of 2 500 or more used for the maintenance or servicing of existing refrigeration equipment, provided that they have been labelled in accordance with Article 12(6);

(b) recycled fluorinated greenhouse gases listed in Annex I with a global warming potential of 2 500 or more used for the maintenance or servicing of existing refrigeration equipment provided they have been recovered from such equipment **and provided that they have been labelled in accordance with Article 12(6)**. Such recycled gases may only be used by the undertaking which carried out their recovery as part of maintenance or servicing or the undertaking for which the recovery was carried out as part of maintenance or servicing.

SEMI proposed amendment:

3. From 1 January 2024 the use of fluorinated greenhouse gases listed in Annex I, with a global warming potential of 2 500 or more, for the servicing or maintenance of refrigeration **and air conditioning equipment** is prohibited.

This paragraph shall not apply to military equipment, equipment intended for applications designed to cool products to temperatures below - 50 °C **or equipment used for semiconductor manufacturing applications with <40T GWP equivalent charge size.**

Justification: Refrigeration and air conditioning equipment used for semiconductor manufacturing applications typically have a charge size <40T CO₂ equivalent and an expected service life of 20-25 years. Equipment placed legally on the market prior to the GWP>2500 prohibition in 2020 would become obsolete by 2030 with only 50% service life. The Presidency compromise proposal allows servicing and maintenance of refrigeration systems with charge size <40T CO₂ equivalent up to 2027 but also sets an end date of 2030.

It is noted that ENVI amendment 401, supported by 7 ENVI committee members, extends the time limited exemption to 2034 but this is insufficient to avoid early obsolescence.

Servicing and maintenance of semiconductor refrigeration and air conditioning equipment is carried out by professional certified companies and any loss of F-Gas is expected to be negligible. It is unclear how forcing early obsolescence of existing semiconductor manufacturing equipment will contribute to the GHG reduction targets set by the European Climate Law, Regulation (EU) 2021/1119. Placing on the Market prohibitions will force a switch to lower GWP alternatives and is the primary driver to meet the GHG reduction targets.

NOTE:

Maintaining the exemption for equipment intended for applications designed to cool products to temperatures below - 50 °C is critically important for semiconductor manufacturing, particularly in dry etch applications. Such equipment is currently exempt from 'placing on the market prohibitions'. Removing the servicing and maintenance exemption, as proposed by a number of ENVI committee members, would result in the closure of semiconductor manufacturing within the EU in 2030.

Please refer to the supporting information 'Process Control Chiller & air conditioning configurations (SEMI supporting information).pptx'.

4) Placing on the market prohibitions, article 11 & appendix IV.

Current proposal lacks clarity due to inconsistent definitions, particularly between 'self-contained' and 'stationary'. The timeline to achieve a switch to GWP<150 by 2025 is considered to be unachievable for semiconductor equipment.

European Commission proposal:

(12) Any self-contained refrigeration equipment that contains fluorinated greenhouse gases with GWP of 150 or more.

1 January 2025

(14) Stationary refrigeration equipment, that contains, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 2 500 or more except



equipment intended for application designed to cool products to temperatures below – 50 °C. 1 January 2024

(17) Plug-in room and other self-contained air-conditioning and heat pump equipment that contain fluorinated greenhouse gases with GWP of 150 or more. 1 January 2025

SEMI proposed amendment:

(12) Any **stationary self-contained refrigeration and air conditioning** equipment that contains fluorinated greenhouse gases with GWP of 150 or more, **except refrigeration equipment intended for applications designed to cool below – 50 °C** 1 January 2030

Justification:

Design of equipment with GWP<150 for use within the semiconductor equipment industry is at an early stage. Initial feedback indicates that such equipment will be substantially larger than current equipment using higher GWP gas to allow the equipment to manage the same heat loads. The refrigeration and air conditioning equipment must be sufficiently responsive to heat load variations in order to maintain the required precision for temperature and humidity control.

Please refer to the supporting information 'Process Control Chiller & air conditioning configurations (SEMI supporting information).pptx'.

Integration of the refrigeration and air conditioning systems with the main equipment can only be considered when a stable design has been proven. Once integrated the semiconductor manufacturing equipment undergoes extensive qualification testing to ensure long term reliability and stability. This is followed by extensive customer qualification to ensure process stability and associated device performance. The industry considers 2030 to be a more realistically achievable date.

Refrigeration equipment designed to cool to temperatures <-50C using Nitrogen is technically feasible. However, Nitrogen systems are significantly larger than equivalent F-gas systems.

Please refer to the supporting information 'Process Control Chiller & air conditioning configurations (SEMI supporting information).pptx'. A semiconductor manufacturing facility is designed for optimum productivity and throughput and significant changes to equipment size can lead to lower throughput and loss of competitiveness on the world market. The industry is putting in place technical road maps to develop suitable nitrogen based refrigeration systems but at this early stage in development it is not possible to commit to a fixed time line.

SEMI proposed amendment:

(14) Stationary **self-contained refrigeration and stationary self-contained air conditioning equipment**, that contains, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 2 500 or more except equipment intended for application designed to cool products to temperatures below – 50 °C. 1 January 2024

Justification:

It is important to align the prohibition 14 with the proposed new definitions.

SEMI proposed amendment (3):



(17) Plug-in ~~room~~ and other self-contained **room** air-conditioning and heat pump equipment **for comfort cooling** that contain fluorinated greenhouse 1 January 2025 gases with GWP of 150 or more.

Justification:

To ensure clarity on the applications subject to prohibitions and avoid overlap with prohibition 14. SEMI recognizes that the Presidency compromise text contains more options for room air conditioning and heat pump equipment but these applications are outside the scope of SEMI members.

5) Loss of the semiconductor quota exemption e) in Article 16 (2) that results in uncertainty for long term supply of critical process chemicals

SEMI recognizes that the Commission's proposal and Presidency compromise proposal maintains the quota exemption 16(2)(e)

(e) supplied directly by a producer or an importer to an undertaking using it for the etching of semiconductor material or the cleaning of chemicals vapour deposition chambers within the semiconductor manufacturing sector.

However, many ENVI members are proposing that the exemption is not justified by the impact assessment. SEMI would like to reiterate the importance of maintaining the quota exemption requirements.

Page 181 of the Impact Assessment, A6.2(B) 'Measures to align with the protocol': -

'At present, no viable measures to reduce HFC demand in semiconductor industry for etching or cleaning of chemicals vapour deposition chambers are available. The EU semiconductor manufacturing industry is supplied with HFCs by specialised gas traders providing special-grade gas qualities. Those specialised trades have no or low reference values. If included in the quota system, these gas traders would need to rely on quota transfers from other quota holders in order to maintain HFC supply in case of constant HFC demand. A lift of the quota exemption for semiconductor manufacturing could thus possibly contribute to a supply risk for the semiconductor industry, beyond rising HFC prices'

Based on this analysis the Impact assessment concludes (Ref footnote 70 for Military and Semiconductor exemptions) 'Maintaining these exemptions in Option 1 and 2 does not endanger Protocol compliance as these small amounts can be compensated by a slightly higher phase-down ambition for all other sectors'.

6) Loss of the supply of high GWP F-Gas for low temperature refrigeration systems for semiconductor dry etch applications. Article 19.

European Commission proposal: Article 19

Pre-charging of equipment with hydrofluorocarbons

1. *Refrigeration, air conditioning and heat pump equipment charged with hydrofluorocarbons shall not be placed on the market unless hydrofluorocarbons charged into the equipment are accounted for within the quota system referred to in this Chapter.*

SEMI Proposed amendment:



1. Refrigeration, air conditioning and heat pump equipment charged with hydrofluorocarbons shall not be placed on the market unless hydrofluorocarbons charged into the equipment are accounted for within the quota system referred to in this Chapter.

This paragraph shall not apply to refrigeration equipment designed for dry etching applications in semiconductor manufacturing designed to operate <-50 °C

Justification:

The phase down of HFC F-Gas and market restrictions on other high GWP Fluorocarbons pose a significant supply threat for refrigeration systems designed to operate at <-50C. The semiconductor industry is working with refrigeration equipment suppliers to develop nitrogen-based systems for semiconductor dry etch applications but until the design concepts are proven it is essential to the EU semiconductor industry that existing refrigeration systems can be supplied.



Conclusions

SEMI Europe would welcome the opportunity to discuss the recommendations with the Members of the European Parliament, Council and Commission. The microelectronics sector is a key enabler and remains ready to work together with all interested stakeholders to develop new avenues of growth to maintain technological competitiveness.

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