

Reducing F-GHG Emissions from Flat Panel Display Suppliers

Questions for Suppliers: Tools for Panel Purchasers and Retailers

Product assemblers, brands and retailers can play an important role in reducing the climate impacts of the products they sell by sourcing from suppliers with a demonstrated commitment to reducing F-GHG emissions.

Important: Currently it is difficult and unadvisable to compare panel suppliers' F-GHG emissions due to a lack of consistency in estimating emissions, estimating emissions reductions, and monitoring the efficacy of installed abatement systems. Therefore, the following sets of questions are intended to be a starting point to help customers understand how their panel suppliers are reducing their F-GHG emissions and, in doing so, may help identify opportunities for furthering mitigation efforts. Customers are encouraged to understand the extent to which future flat panel display technologies will use F-GHGs in production, and if F-GHG emissions are expected to increase, decrease, or remain the same on a per panel basis.

1. Describe the steps your company is currently taking and/or any goals that are in place to reduce F-GHG emissions. Describe how your company is reducing F-GHG emissions via process optimization, use of alternate chemistries, capture/recycling, and/or abatement technologies.
2. Is your company reducing F-GHG emissions for each key manufacturing process (i.e. etch and chamber clean)? Where applicable, do your company's F-GHG emissions reduction efforts also address fluorinated heat transfer fluids (F-HTFs) and N₂O used and emitted in the manufacture of flat panel displays?
3. Is your company reducing emissions from all F-GHGs used (i.e. SF₆, NF₃, PFCs, and HFCs)? If not, which F-GHGs are being reduced? Does your company plan to reduce those F-GHGs currently not addressed?
4. Are F-GHG emissions reduction efforts implemented across all of your company's fabs, across only new generation fabs, or only in select fabs? If applicable, what future reduction efforts does your company have planned for any F-GHG using fabs currently not addressed?
5. Does your company participate in any national or international consensus-based or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing? If not, are there any national regulations in your country that require F-GHG emission reductions in flat panel display manufacturing? If so, when will they take effect?
6. What is the estimated aggregated amount of F-GHG emissions, in CO₂ equivalents (CO₂e), emitted across all flat panel display manufacturing fabs for the most recent year? Has this figure increased or decreased compared to prior years?
7. What is the estimated annual F-GHG emissions intensity (if possible, in kg CO₂e per m² of flat panel displays (array glass) produced) across manufacturing fabs?

8. What methods does your company use to estimate aggregate annual F-GHG emissions? Specifically, does your company use default emission factors or actual measured emissions? What activity data, if any, is the basis for emission estimates (e.g., gas used or glass area produced)? What is the source of the global warming potentials used?
9. Regarding abatement technologies, what are the destruction or removal efficiencies (DREs) of the abatement systems installed at your company's fabs for each of the F-GHGs used? How does your company estimate the DREs of the abatement systems? Does your company use default DRE values, and if so, what is the source? If your company directly measures the DRE, what measurement protocol or method is used? How often does your company monitor the effectiveness of the abatement technology (i.e. continuous monitoring, periodic monitoring, etc)?
10. Have your company's emission estimates and reductions been third party verified?
11. Does your company publicly report its F-GHG emissions (e.g., to the Carbon Disclosure Project or in your company's annual report)?

Supplemental Technical Questions for Suppliers

to Help Improve Understanding of Current Practices for Reducing F-GHG Emissions

The following detailed technical questions are intended to help stakeholders in the electronics industry improve their technical understanding of current practices for reducing F-GHG emissions from the manufacture of flat panel displays. Information gleaned from the questions below can help identify best practices as well as opportunities for further research.

1. *Process optimization:* Has your company implemented (or is it planning to implement) process optimization efforts to reduce F-GHG emissions (e.g. end point detection, reduction in gas consumption, or improvements in gas utilization efficiencies). If so, please describe your company's optimization efforts and how efforts have reduced, or are expected to reduce, F-GHG emissions.
 - o Has your company conducted (or is it conducting) emissions characterization for its CVD and/or etching processes by measuring the utilization efficiency and the by-product formation factors of F-GHGs? If so, what measurement protocol is being used?
 - o If your company uses NF_3 remote chamber cleaning in any of its flat panel manufacturing fabs, has it performed any measurements to verify the default utilization efficiency value of 97% for NF_3 (2006 IPCC Guidelines)?
2. *Alternate chemistries:* Has your company implemented (or is considering implementation of) the use of alternate chemistries with lower or no global warming potential (e.g., creating a process change to be able to use NF_3 in CVD chamber cleaning or to use C_3F_8 , $\text{c-C}_4\text{F}_8$, or F_2 based chamber cleaning instead of SF_6 , CF_4 or C_2F_6 based chamber cleaning)?
 - o If so, what percent of chemical vapor deposition (CVD) tools are equipped with lower/no GWP gases? Can you describe the emission reductions achieved, or expected to be achieved through using alternate chemistries?

3. *Capture and recycling:* Has your company implemented (or is considering the implementation of) capture and recycling technologies (e.g., SF₆ capture and recycling)?
 - If so, can your company identify the F-GHGs and describe the amounts that have been captured and recycled and the extent to which such processes have resulted in F-GHG emission reductions?

4. *Abatement:* Have you installed F-GHG abatement systems across all of your flat panel display manufacturing fabs or only across some of them? What fraction of CVD and etch tools across your company is equipped with abatement?
 - Please describe the types of abatement technologies being employed (e.g., combustion, catalytic, plasma, etc.). Is the technology point-of-use or centralized?
 - Are F-GHG abatement technology(ies) installed in your fabs specifically designed to remove F-GHGs used in clean and etching processes (e.g., instead of being installed for other purposes, such as safety reasons)?
 - Have you verified that your company's abatement systems have been properly installed, operated, and maintained according to manufacturers' specifications? If so, how?