The Supplier Profiles outlined in this document detail the efforts of large-area flat panel suppliers to reduce their fluorinated greenhouse gas (F-GHG) emissions in manufacturing facilities that make today’s large-area panels used for products such as TVs and computer monitors. More comprehensive information on how F-GHGs are used in flat panel display (FPD) manufacturing is available on the Center for Corporate Climate Leadership’s website at: https://www.epa.gov/climateleadership/center-corporate-climate-leadership-sector-spotlight-electronics.

Summary of Supplier Profiles

The table below on page six summarizes which panel suppliers publicly report their F-GHG emissions, their most recent F-GHG emissions, and, where available, their F-GHG emissions intensity based on panel production. It also includes information on suppliers’ broader GHG emission reduction goals, since F-GHGs comprise a significant portion of on-site scope 1 GHG emissions,¹ as well as the regulatory/or voluntary efforts by which suppliers are reducing their F-GHG emissions.

Most importantly, the table highlights which suppliers have fully implemented F-GHG emissions reduction measures across their older and newer manufacturing—or fabrication—facilities, also referred to as ‘fabs.’ For panel suppliers that have not fully implemented F-GHG reduction measures, whereby approximately 90 percent of annual F-GHG emissions are avoided or removed, further opportunities for improvement exist.

The summary table and charts below reflect data, assembled from public sources and the suppliers themselves, on F-GHG emissions for calendar year or fiscal year 2019, depending on the supplier’s reporting cycle. Public sources of information include suppliers’ responses to the annual CDP Investor Questionnaire and each supplier’s annual sustainability or corporate social responsibility reports.

Following the summary information, individual profiles provide more information on specific methods, such as abatement, process optimization, and use of alternatives that suppliers are using to reduce their F-GHG emissions.

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¹ Scope 1 GHG emissions are an organization’s direct emissions from sources that are owned or controlled by that organization.
Supplier Market Share

The 12 global flat panel display suppliers named among the profiles produce 96 percent\(^2\) of all large-area flat panel displays sold globally, as shown in the chart below\(^3\). Large area panels are defined as being 9.1 inches or larger.

![2019 Global Market Share of Large Area Panels Production for Featured Suppliers](chart.png)

Note: Market share includes only large area displays, however, emissions reported in subsequent sections may include totals associated with all sizes of flat panel displays.


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\(^2\) Source: IHS Technology 2019. "Large Area Display Production Strategy Tracker."

\(^3\) Total percent of market shares may exceed or be less than 100 percent, due to rounding.
Relative Market Share for Publicly Reported F-GHG Emissions 4,5

![Graph showing market share for reporters and non-reporters over years 2011 to 2019.]

Source: IHS Technology. Large Area Display Production Strategy Tracker.

Key Findings Based on 2019 Data
- Four global liquid crystal display (LCD) suppliers, representing 45 percent of LCDs manufactured in 2019, publicly reported their annual F-GHG emissions and/or reduction efforts. Suppliers AOU, Innolux, and Sharp have consistently reported on their F-GHG emissions since 2012 and LG Display has reported publicly for the third consecutive year. As nine years of data demonstrate (Previous Supplier Profiles), key suppliers have been maintaining and/or improving F-GHG reductions over time. BOE, which reported its F-GHG emissions for the first time in 2018, had not publicly reported its 2019 emissions as of December 30, 2020. BOE’s market share continues to increase and is now the largest flat panel display supplier by market share.
- Some suppliers who previously reported annual F-GHG emissions did not provide their F-GHG emissions for their 2019 calendar year reports. While some LCD suppliers have reported, and continue to report, their F-GHG emissions publicly, others with large and/or increasing market share opt to report their F-GHG emissions either privately or directly to their customers. Thus, greater transparency is still needed on all LCD panel suppliers’ F-GHG emissions to better understand overall trends in F-GHG emissions. An improved understanding is needed on the extent to which F-GHG emissions influence market share.

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4 In 2012, Samsung (18 percent market share in 2012) and LGD (26 percent market share in 2012) reported their F-GHG emissions which contributes to the high market share of reporters. In 2013, LGD continued to report emissions. In 2014-2016 LGD did not report its F-GHG emissions which caused the decline in publicly reported F-GHG emissions. In 2017, LGD resumed reporting its F-GHG emissions, resulting in an increase in publicly reported F-GHG emissions. In 2019, BOE did not report its F-GHG emissions which caused the decline in publicly reported F-GHG emissions.

5 Panasonic exited the Flat Panel Display market in 2015. Panasonic reported emissions consistently while its facilities were producing flat panel displays.
emission reductions result from both the use of F-GHG reduction technologies and the use of lower GWP F-GHGs in key processes. This will better equip brands to understand all methods their suppliers implement to reduce F-GHG emissions. For example, LG has replaced use of SF_6 with NF_3 in the etching process, which has resulted in significant emissions reductions.

- An optimal F-GHG emission intensity, based on full abatement and/or the fullest use of lower GWP gases, could serve as an indicator on whether F-GHG emission reduction efforts have been implemented to the fullest extent possible. In 2019, AU Optronics’ F-GHG emission intensity fell to 0.00034 MTCO_2e/m², an 87 percent decrease since 2017. Since 2005, its F-GHG intensity has been reduced over 99 percent from 0.0057 MtCO_2e/m² in 2005 to 0.00034 MtCO_2e/m². AUO’s F-GHG emission intensity was the lowest publicly reported intensity metric, however only one other supplier, Innolux, reported F-GHG emission intensity for 2019.


Source: Data from publicly available sources as detailed in the individual supplier profiles.

IEEE 1680.1 Standard

- In March 2018, the **IEEE 1680.1-2018 Standard for Environmental and Social Responsibility Assessment of Computers and Displays** was published, replacing a previous version.

- This standard includes new criteria that incentivize improvements across many different environmental impacts. One of the new optional criterion addresses F-GHG emissions reductions by flat panel display suppliers. For a brand manufacturer (Original Equipment Manufacturer (OEM)) to declare that a product containing flat panel displays meets the F-GHG criteria and conforms to the standard, at least 75 percent of its flat panel display suppliers, by amount spent during the annual...
fiscal or calendar year, must demonstrate that they are reducing annual F-GHG emissions by 90 percent.

- The revised IEEE 1680.1 standard aims to foster greater sustainability in the Information Technology (IT) supply chain since the criteria of the standard underpin the Electronic Product Environmental Assessment Tool (EPEAT), a sustainability rating tool for certain electronics. An IT product receives an EPEAT Bronze, Silver, or Gold rating. Bronze-rated products meet minimum required criteria only, whereas Silver and Gold-rated products also meet additional amounts of optional criteria.
- Computer and Display products that are “EPEAT registered” will be required to meet the IEEE 1680.1 standard. A registry of conformant products is publicly available at www.epeat.net as of November 2020.
- Many institutional purchasers around the globe purchase EPEAT-registered products. By searching the registry, purchasers can determine if EPEAT-registered products containing flat panel displays, namely monitors and laptops, meet the optional F-GHG emissions reduction criterion.
  - By December 2020, 11558 EPEAT-registered products from 11 companies (Dell, Acer, AOC International (Europe) B.V., ASUSTeK Computer Inc., ViewSonic, Google, HP, Lenovo, MMD Monitors and Displays Nederland B.V., Teknoservice S.L., and Microsoft) had met the criteria for F-GHG emissions reductions from flat panel display manufacturing.

**F-GHG Emissions in Context of Scope 1 and 2 Emissions Reductions**

**Efforts**

As electronics brand owners increasingly request that suppliers report and reduce their scope 1 and 2 emissions, several LCD suppliers have also begun to implement energy efficiency measures and purchase renewable energy to mitigate their overall GHG emissions. Some suppliers provide detailed insights on energy savings measures in their CDP and/or Corporate Social Responsibility (CSR) reports. In some instances, where noted in the profiles, it is unclear if efficiency measures apply to equipment that utilizes F-GHG more efficiency, or if such measures apply to non-F-GHG equipment. Understanding the tradeoffs between reducing on-site combustion and electricity use and installing F-GHG abatement measures that utilize on-site combustion or electricity use may inform holistic approaches to reducing both scope 1 and 2 emissions. As such, where data are available, information on other energy saving measures is included under the “Emission Reduction Goals and Progress” sections.
## Summary of F-GHG reporting reduction activities by LCD supplier

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BOE</td>
<td>19%</td>
<td>2019 F-GHG emissions data are not publicly available</td>
<td>N/A</td>
<td>Not Available</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>F-GHGs not used</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LG Display</td>
<td>18%</td>
<td>✓</td>
<td>2,236,644</td>
<td>-17%</td>
<td>Not Available</td>
<td>Reduce production phase emissions 50% from 2017 levels by 2030</td>
<td>✓</td>
<td>✓</td>
<td>F-GHGs not used</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Samsung</td>
<td>13%</td>
<td>✓</td>
<td>2019 F-GHG emissions data are not publicly available</td>
<td>N/A</td>
<td>Not Available</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

\(^6\) For more information on GHG emission reduction goals, including the base year and scope of included emissions, see the individual Supplier Profiles.
<table>
<thead>
<tr>
<th>Company</th>
<th>Goal Percentage</th>
<th>Year</th>
<th>Emissions (Tons)</th>
<th>Emissions Change (%)</th>
<th>Emissions Intensity (kg CO2e/USDm)</th>
<th>GHG Emissions Reduced</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innolux</td>
<td>12%</td>
<td>2019</td>
<td>299,289</td>
<td>-6%</td>
<td>0.0085</td>
<td>Yes</td>
<td>Not inventoried</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AU Optronics</td>
<td>11%</td>
<td>2019</td>
<td>24,384</td>
<td>-86%</td>
<td>0.00034</td>
<td>Yes</td>
<td>Deemed too minor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China Star</td>
<td>10%</td>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2019 F-GHG emissions data are not publicly available.</td>
</tr>
<tr>
<td>CEC Panda</td>
<td>5%</td>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2019 F-GHG emissions data are not publicly available.</td>
</tr>
<tr>
<td>HKC</td>
<td>3%</td>
<td>2019</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2019 F-GHG emissions data are not publicly available.</td>
</tr>
<tr>
<td>Sharp</td>
<td>3%</td>
<td>2019</td>
<td>93,971</td>
<td>1%</td>
<td>Not Available</td>
<td>Yes</td>
<td>No info available</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HannStar</td>
<td>1%</td>
<td>2019</td>
<td></td>
<td></td>
<td>N/A</td>
<td>No</td>
<td>F-GHGs not used</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infovision</td>
<td>1%</td>
<td>2019</td>
<td></td>
<td></td>
<td>N/A</td>
<td>No</td>
<td>No info available</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPT</td>
<td>0%</td>
<td>2019</td>
<td></td>
<td></td>
<td>N/A</td>
<td>No</td>
<td>No info available</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

- **Reduce F-GHG emission intensity at the TFT-LCD 30% by 2025 (from 2016 baseline)**
- **Reduce carbon emissions by up to 6.5 million tones CO2e cumulatively by 2025.**
- **Net zero CO2 emissions in business activities by 2050.**
- **2019 F-GHG emissions data are not publicly available.**
### Flat Panel Display Supplier 2019 Profiles

Flat panel display suppliers are presented in descending order of market share.

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG Display</td>
<td>10</td>
</tr>
<tr>
<td>Innolux Corporation</td>
<td>14</td>
</tr>
<tr>
<td>AU Optronics</td>
<td>18</td>
</tr>
<tr>
<td>Sharp</td>
<td>24</td>
</tr>
<tr>
<td><strong>Suppliers With Recent Public Data</strong></td>
<td>27</td>
</tr>
<tr>
<td>BOE</td>
<td>27</td>
</tr>
<tr>
<td>CEC Panda</td>
<td>30</td>
</tr>
<tr>
<td>HannStar</td>
<td>32</td>
</tr>
<tr>
<td>Chungwha Picture Tubes (CPT)</td>
<td>35</td>
</tr>
<tr>
<td><strong>Suppliers Without Recent Public Data</strong></td>
<td>38</td>
</tr>
<tr>
<td>Samsung</td>
<td>38</td>
</tr>
<tr>
<td>China Star</td>
<td>39</td>
</tr>
<tr>
<td>HKC</td>
<td>39</td>
</tr>
<tr>
<td>Infovision</td>
<td>40</td>
</tr>
</tbody>
</table>
LG Display 2019 Data

18% Market Share

F-GHG Emissions Over Time

The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.

- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.

- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts. LG Display does not publicly report F-GHG emission intensity.

F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph, market share is calculated based on production data from IHS Technology.

F-GHG Emission Reduction Activities Overview

- In 2019, LG Display emitted approximately 2,236,644 MtCO\textsubscript{2e} of F-GHG’s as follows:
  - PFCs: 221,781 MtCO\textsubscript{2e}
  - HFCs: 882 MtCO\textsubscript{2e}
- **SF6**: 2,013,981 MtCO₂e

**Gases Targeted**
- SF₆
- PFCs
- NF₃

**Processes Targeted**
- Etching
- Cleaning

**Approaches Used**

**Abatement**
- **Abatement Systems**: LG Display has installed F-GHG abatement systems on all lines of cleaning tools and on lines of etching tools. Electrically heated point-of-use systems were installed for NF₃ in cleaning tools and combustion-type centralized systems were installed for SF₆ and PFCs in etch tools. 31.4 billion won ($28M U.S.) was invested in scrubbers, which are process gas cracking facilities that further reduce greenhouse gas emissions.

**Process Improvements**
- LG Display has applied end-point detection and revised processes to optimize the use of F-GHGs.

**Alternative Chemicals**
- **SF₆ Replacement**: In 2014, LG Display developed a gas application technology as an alternative to using SF₆ and has started implementing the use of the alternative. In 2015, since joining the Korean emission trading program, LG Display replaced SF₆ as a process gas used in dry etching with NF₃, which has a lower GWP. At its Paju, Korea plant, the use of SF₆ in 2017 decreased by 44 percent from 2015 levels. The total amount of SF₆ use in the overall plants in 2018 decreased by 50 percent compared to 2014, and this is equivalent decrease to 1,840,096,54 tons of CO₂. In 2019, LG Display decided to invest about 9.3 billion won (₩) (in 2019, 1 ₩ = 0.00085 USD⁷) to introduce reduction facilities to reduce F-gas used in etching equipment at its Paju plant.
- **Remote Plasma Source Chamber Clean**: LG Display has applied NF₃ remote plasma source chamber clean (RPSC) to all manufacturing lines. RPSC’s utilization rate is 97 percent compared to 70 percent for an ordinary chamber.
- **NF₃ Replacement**: LG Display has replaced NF₃ with F₂ in chamber cleaning on one of its manufacturing lines. LG Display continues to research alternative lower GWP etching gases than SF₆ for the dry etching process.
- In 2016, LGD invested 3.8 billion won (₩) (in 2016, 1 ₩ = 0.00088 USD⁸) for the development of clean production technology to replace SF₆ to respond to the greenhouse gas emissions trading scheme. SF₆ gas replacement technology is applied in major plant facilities to reduce greenhouse gas emissions. In

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2017, about 1.6 billion ₩ was invested in scrubbers, which are process gas cracking facilities to further reduce greenhouse gas emissions.

Emissions Measurement Approaches and Verification

- LG Display uses national GHG emission estimation guidelines issued by the South Korean Ministry of Environment and estimates NF₃ emissions by using the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories Tier 2b guidelines.
- LG Display uses the CDM methodology AM0065 as the verification criteria for its SF₆ replacement processes since the methodology. This verification occurs once per year and applies to domestic facilities which have replaced SF₆ with NF₃.
- LG Display’s GHG emissions are verified by a third party in accordance with South Korean government regulations. NF₃ emissions estimated by the 2006 IPCC Tier 2b Guidelines for National Greenhouse Gas Inventories for electronics industry emissions are not assured by a third party but cross-checked by the World Display Device Industry Cooperation Committee (WDICC) members.

Emission Reduction Goals and Progress

- LG Display set a target to reduce carbon emissions in the production phase by 50 percent compared to 2017 (by 2030) and achievement of carbon neutrality through external carbon reduction by expanding the Clean Development Mechanism (CDM) project. This is an updated target as of 2019.
- In September 2019, LGE USA achieved its goal of reducing carbon emissions by 50 percent from the baseline year of 2017.
- LG Display reduced GHG emissions by 0.41 percent in 2019 compared to 2018 through process gas replacement and energy saving campaigns.
- At its Paju plant, LG Display reduced the use of SF₆ in 2017 by 44 percent compared to 2016 through the alternative use of NF₃.
- LG Display’s F-GHG emissions reduction efforts are part of its broader goals to reduce corporate-wide GHG emissions.
- LG Display is subject to emissions caps under the Korean Emissions Trading Scheme (K-ETS) and has been participating in GHG emissions trading since January 2015. The K-ETS is the first nationwide Cap-and-Trade program in operation in East Asia.
- In 2015, LG Display implemented its Carbon Footprint Calculator to respond to government GHG regulations and respond to customer preference for environmentally friendly products.

Sources


LG Display’s responses to the 2020 Carbon Disclosure Project Investor Questionnaire.

LG Display’s responses to the 2019 Carbon Disclosure Project Investor Questionnaire.

LG Display’s responses to the 2018 Carbon Disclosure Project Investor Questionnaire.

LG Display’s responses to the 2017 Carbon Disclosure Project Investor Questionnaire.

LG Display’s responses to the 2016 Carbon Disclosure Project Investor Questionnaire.

LG Display’s responses to the 2014 Carbon Disclosure Project Investor Questionnaire. LG Display’s responses to the 2011 Carbon Disclosure Project Investor Questionnaire.

“Point of Use Abatement Device to Reduce SF₆ emissions in LCD Manufacturing Operation in the Republic of Korea (South Korea).” LG Display’s SF₆ Abatement Project. Clean Development Mechanism Project: 3440. Available at https://cdm.unfccc.int/Projects/DB/SGS-UKL1266943063.39/view.

The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.
- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.
- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts.

F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph, market share is calculated based on production data from IHS Technology.
Note: While market share data include only the production of large area panels, emissions and intensity totals reported by Innolux are from the production of all sizes of flat panel displays.

F-GHG Emission Reduction Activities

Overview
- In 2019, Innolux emitted approximately 299,289 metric tons of CO₂ equivalent (MtCO₂e) of F-GHGs, as follows:
  - HFCs: 9,605 MtCO₂e
  - PFCs (includes NF₃): 60,113 MtCO₂e (55,901 MtCO₂e (NF₃) + 4,213 MtCO₂e (PFCs))
  - SF₆: 229,571 MtCO₂e
- In 2019, Innolux reported that removal (F-GHG abatement) equipment reduced total annual F-GHG emissions by 2,740,670 MtCO₂e, compared to 2,821,486 MtCO₂e reduced in 2018, and 3,029,691 MtCO₂e reduced in 2017 (a 2.9 percent decrease compared to 2018).
- In 2019, F-GHGs represented 8.5 percent of Innolux’s overall GHG emissions compared to 8.8 percent of total emissions in 2018.

Emissions Intensity:
- F-GHG intensity per substrate at the TFT-LCD stage of Taiwan has been reduced over 30 percent from 0.0094 MtCO₂e/m² in 2010 to 0.0064 MtCO₂e/m² in 2016.
- In 2017, the F-GHG emission intensity per input substrate at the TFT-LCD stage of Taiwan sites was 0.0052 MtCO₂e/m².
- In 2018, the F-GHG emission intensity per input substrate at the TFT-LCD stage of Taiwan sites was 0.0044 MtCO₂e/m², which was reduced 15.4 percent compared with 2017.
- In 2019, the F-GHG emission intensity per input substrate was 0.0043 MtCO₂e/m², which was reduced 2.3 percent compared with 2018.

Gases Targeted
- SF₆
- PFCs
- HFCs
- NF₃

Processes Targeted
- Cleaning
- Etching

Innolux uses a small amount of fluorinated heat transfer fluids but has not inventoried them. In anticipation of the upcoming updates to the IPCC Guidelines, Innolux is documenting the amount of heat transfer fluids purchased in 2015 to 2018.

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9In 2019, Innolux’s total scope 1 emissions accounted for 10 percent of their total emissions, meaning F-GHG emissions make up the majority of Innolux’s scope 1 emissions.
Approaches Used

**Abatement**
- Innolux has installed the tail gas treatment unit to conduct thermal destruction for reduction of F-GHGs emission. Local combustion scrubbers were installed in Fab3 in Tainan to remove SF₆ emitted during the etching process by combustion.
- Innolux has installed local combustion scrubbers. In 2019, Innolux reported reducing 2,740,670 MtCO₂e of F-GHGs.<sup>10</sup>

**Process Improvements**
- Innolux is optimizing the use of F-GHGs in the process chambers. Additional details not available.

**Alternative Chemicals**
- **SF₆ Replacement**: Innolux has planned to replace SF₆ with NF₃ in the etching process in some of its factories.
- Innolux is using lower GWP gases, where possible.

**Emissions Measurement Approaches and Verification**
- Innolux estimates F-GHG emissions based on the Tier 2b method for electronics industry emissions provided in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.
- Innolux received third party verification for its GHG inventory every year until 2019, which was verified in accordance with the ISO 14064-1 standard.
- Innolux has collected data for 13 years and passed the third-party verification according to ISO 14064-1.

**Emission Reduction Goals and Progress**
- In 2013, Innolux released its Product Carbon Footprint (PCF) system to help streamline calculations of emissions on a per product basis.
- In 2019, Innolux audited the carbon emissions of 110 suppliers who inventoried their GHG emissions. Innolux exceeded its 2019 target of reducing carbon emission of suppliers by 138,000 tCO₂e and achieved a reduction of 138,750 tCO₂e.
- Innolux plans to continue monitoring carbon emissions to establish a comprehensive database.
- Innolux applied for early carbon credits for its carbon reduction efforts between 2005 and 2011, receiving 16 million tons in credits in 2015 for Taiwan’s cap and trade program.
- In 2018, Innolux donated 2,048 energy-saving white LED tubes to replace the fluorescent tubes at Private Changtai and Nursing Institute of Taiwan. It is estimated that the new lights will reduce carbon emissions by 56,093 kg CO₂e.
- From 2018 to 2019, Innolux applied to the Taiwan EPA for the carbon offset program. The application for reduction credits was agreed to after initial review, expecting a reduction of emissions by approximately 235,000 MtCO₂e per year.

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<sup>10</sup> F-GHG emission reductions reported by Innolux in February 2020. Innolux’s CDP report includes 0.769 MMTCE, which equals 2,819,667 Mt CO₂e, thus very similar F-GHGH emission reductions.
• In 2019, Innolux purchased three more local scrubbers for F-GHGs from the etching process, which will be operational in 2020.

• Innolux set a long-term goal for all manufacturing sites in Taiwan to reduce F-GHG emission intensity per square meter of glass produced at the TFT-LCD by 30 percent by 2025 compared with 2016. Innolux is still on track to meet or exceed this goal, having reduced emission intensity by 34 percent in 2019 compared with 2016.

Participation in Broader F-GHG Reduction Efforts

• Innolux is a member of Taiwan’s TFT-LCD Association (TTLA). The TTLA participates on behalf of Taiwan’s LCD suppliers in the World Display device Industry Cooperation (WDICC), whose members have agreed to 30 percent F-GHG emission reductions by 2020 relative to 2010 levels.

Sources
Innolux Corporate Social Responsibility 2015 Summary. Available at http://www.innolux.com/Pages/EN/CSR/LOVE/Green_Operations/Climate_Change_Risks_and_Opportunities_EN.html
Innolux’s responses to the 2020 Carbon Disclosure Project Investor Questionnaire.
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Innolux’s responses to the 2017 Carbon Disclosure Project Investor Questionnaire.
Innolux’s responses to the 2016 Carbon Disclosure Project Investor Questionnaire.
Innolux’s responses to the 2015 Carbon Disclosure Project Investor Questionnaire.
Innolux’s responses to the 2014 Carbon Disclosure Project Investor Questionnaire.
Taiwan Environmental Protection Administration. TTLA presentation at APEC meeting, August 2012, Taiwan “The Initiative and Efforts from Electronic Corporations in Taiwan- Semiconductor and TFT-LCD.” Available at http://unfccc.epa.gov.tw/unfccc/english/_uploads/downloads/05_The_Initiative_and_Efforts_form_Electronic_Industry_in_Taiwan.pdf.
AUO (AU Optronics) FY 2019 Data

11% Market Share

F-GHG Emissions Over Time

The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.

- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.

- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts.

F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph, market share is calculated based on production data from IHS Technology.

Note: While market share data include only the production of large area panels, emissions and intensity totals reported by AUO are from the production of all sizes of flat panel displays.
F-GHG Emission Reduction Activities

Overview
- In 2019, AUO emitted approximately 24,384 metric tons of CO₂ equivalent (MtCO₂e) of F-GHGs, as follows:
  - HFCs: 2,132 MtCO₂e
  - PFCs (includes NF₃): 5,999 MtCO₂e (4,183 MtCO₂e (NF₃) + 1,816 MtCO₂e (PFCs))
  - SF₆: 16,252 MtCO₂e
- From 2003 to 2019, AUO reduced total F-GHG emissions by 18.2 million metric tons CO₂e.
- Together, F-GHGs used during the production process and fuel emissions of utility systems comprise most of AUO’s scope 1 emissions, representing 3.14 of AUO’s total GHG emissions.

Emissions Intensity:
- In 2019, AUO’s F-GHG emission intensity was 0.00034 MtCO₂e/m², an 87 percent decrease since 2018. Since 2005 F-GHG intensity has been reduced over 99 percent from 0.057 MtCO₂e/m² in 2005 to 0.00034 MtCO₂e/m².
- From 2010 to 2019, AUO reduced its overall GHG emissions intensity, which includes both scope 1 and scope 2 GHG emissions, by 18 percent, from 58.5 kg CO₂e/m² (0.059 MtCO₂e/m²) of panel produced to 47.7 kg CO₂e/m² (0.048 MtCO₂e/m²).
- AUO has successfully reached its phased 5-year Carbon 2020 Reduction Plan of one million metric tons of emission reductions, which includes F-GHGs and other key greenhouse gases.

Gases Targeted
- SF₆
- PFCs (specifically CF₄)
- HFCs
- NF₃

Processes Targeted
- Etching
- Cleaning
- Cooling: Per the “Guidance for Greenhouse Gas Accounting and Reporting for GHG inventory” published by the Taiwanese EPA, emissions from fluorinated heat transfer fluids are too minor in AUO’s process to account for.

Approaches Used

Abatement
- **Localized Abatement Systems:** As of 2015, AUO has installed localized, point-of-use abatement systems in all fabrication facilities (fabs). AUO uses an Electronic Prevention Maintenance System (EPMS) to ensure that destruction and removal equipment operates at or above 99 percent efficiency.
- **Abatement for Cleaning:** AUO uses combustion abatement systems for cleaning processes in all fabs.
- **Abatement for Etching:** AUO uses combustion abatement systems or membrane separation technology for dry etching processes on all new production lines (built after 2003).
Process Improvements

- **Reduced SF₆ Consumption**: AUO’s process experts worked with its SF₆ supplier to implement ways to reduce the quantity of SF₆ used in etching across all fabs. At one of its fabs, at full production capacity, adjusting relevant SF₆ process parameters can result in reducing the equivalent of 32,000 metric tons of CO₂ annually, which is equal to 18 percent of AUO’s reported SF₆ emissions in 2015.
- **Reduced Gas Waste and Improved Utilization Efficiencies**: By installing flow meters and mass flow controllers at the front of tool chambers, on-site engineers have been able to reduce unnecessary gas waste and improve gas utilization efficiencies.
- **NF₃ Substitution**: AUO uses NF₃ instead of SF₆ in cleaning, since NF₃ has a lower global warming potential (GWP), and it is used more efficiently.

Emissions Measurement Approaches and Verification

- AUO estimates F-GHG emissions based on the Tier 2b method for electronics industry emissions provided in the [2006 IPCC Guidelines for National Greenhouse Gas Inventories](#), including use of default destruction or removal efficiency (DRE) values for abatement.
- A third party verifies AUO’s raw data according to the [ISO 14064-1](#) guidance (verification document included below).
- AUO uses external Energy Service Companies (ESCOs) to apply the IPMVP along with third-party verification for a 3-year period to improve the materiality of the internal energy-saving proposals.

Emission Reduction Goals and Progress

- AUO set a goal to reduce scope 1 and 2 GHG emission intensity in all fabs globally by 25 percent from 2010 to 2015. AUO was able to achieve 20 percent of this goal. F-GHGs are included as part of scope 1 emissions.
- AUO set a subsequent goal for all manufacturing sites in Taiwan to reduce scope 1 and 2 GHG emission intensity per square meter of glass produced by 5 percent by 2020 compared to 2015.
- AUO’s subsequent goal has been to reduce its GHG emissions by 24.7 percent by 2020, with a 2015 base year, for most of its scope 1, 2, and some scope 3 emissions (using the location-based accounting method for scope 2). AUO’s newest goal is a 16.5 percent GHG emission reduction by 2025, with a 2017 base year, for its scope 1 and 2 emissions (using the location-based accounting method for scope 2).
- AUO has a “Green Solutions” initiative that addresses emissions reductions through operations, supply chain improvements, and product design.
- AUO announced its “Carbon 2020” strategy in 2015, which aims to reduce carbon emissions by 1 million tons by 2020 and implement strategies in all areas from the optimization of product design, material usage, manufacturing processes, and logistic options to the provision of energy-efficient solutions to customers. AUO supports the Science Based Targets (SBT) for a 2°C scenario and reports that it “has taken action in this direction.”
- Following AUO EPS 2025 Goals, AUO set reduction goals based on a lifecycle assessment to reduce carbon emissions by up to 6.5 million tones CO₂e cumulatively by 2025.
As of 2019, AUO had achieved its 2020 goals by 142 percent, with 2 percent attributed to green transport and logistics, 29 percent attributed to green manufacturing, and 69 percent attributed to product innovation.

In 2018, AUO began incorporating downstream transportation and distribution into its GHG inventory. They estimated total emissions to be 69,525 Mt CO₂e, which includes product weight per trip, distance traveled, and mode of transport. These emissions will be tracked in further GHG inventories.

In 2018, the Green Production Team under the Green Manufacturing Subcommittee implemented 698 projects and achieved 96,450 MWh electricity saved. In total, these projects helped avoid 53,433 metric tons of CO₂e emissions.

In 2019, AUO began converting the carbon emissions associated with business travel into a carbon price and will provide the business travel colleagues with updated information regularly. Business travel emissions in 2019 were estimated to be approximately 1,025 Mt CO₂e.

Participation in Broader F-GHG Reduction Efforts

AUO is a member of Taiwan’s TFT-LCD Association (TTLA). The TTLA participates on behalf of Taiwan’s LCD suppliers in the World Display device Industry Cooperation (WDICC), whose members have agreed to 30 percent F-GHG emission reductions by 2020 relative to 2010 levels.

AUO participates in the Product Attribute to Impact Algorithm (PAIA) Project to develop lifecycle impact calculation tools for LCDs, capturing F-GHG emissions information. AUO has employed a methodology to manufacture low-carbon LCD products, including 15.6" notebook panels, 65" and 55" curve panels, and 18.5" to 24" desktop monitors.

AUO has engaged in developing the SF₆ abatement verification methodology for LCD industries in Taiwan.

AUO received 9.56 million tons of tradeable carbon credits by the Taiwan EPA for its early action on PFC reductions and third-party verification of its F-GHG abatement. In both 2016 and 2017, AUO signed the largest carbon credit trading deals in Taiwan. A total of 5 million tons were traded through the Taiwan EPA’s domestic carbon trading platform in both years.

AUO carbon credit assets were used to promote carbon neutrality and reduction. As of 2018, a total of 6 companies’ building and activity carbon neutrality projects have been completed along with 15 carbon neutrality applications from external non-profit organizations.
VERIFICATION STATEMENT
OF GREENHOUSE GAS
ASSERTIONS

Statement No.: 00017-2020-AG-TWN
Issued date: 20 May, 2020

This is to verify initiate reporting of Greenhouse Gas Inventory Management Report (2019) of

AU Optronics Corporation

Scope of Verification
DNV GL Business Assurance (DNV GL) has been commissioned by AU Optronics Corporation to perform a verification of the greenhouse gas assertion of Greenhouse Gas Inventory Management Report (2019) (hereafter the "Inventory Report") with respect to the sites listed in Appendix.

Verification Criteria and GHG Programme
The verification was performed on the basis of ISO 14064-1:2006 and CNS 14064-1: 2006, as well as IPCC 2006 Tier 2b methodology for fluorinated GHG emissions inventory, given to provide for consistent GHG emission identification, calculation, monitoring and reporting.

Verification Statement
It is DNV GL’s opinion that with reasonable assurance the greenhouse gas assertion of the Inventory and Inventory Report of March 11, 2020 from material discrepancies in accordance with ISO 14064-1:2006 and CNS 14064-1:2006. DNV GL thus requests the registration of the Inventory Report as a GHG inventory demonstration project.

Chun-Nien Lin
GHG Verifier

Place and date:
Taipei, March 1 – March 27, 2020

For the issuing office:
DNV GL Business Assurance Co., Ltd.
29F1, No. 293, Sec. 2, Wenhua Rd.,
Banqiao District, New Taipei City 220,
Taiwan

Management Representative

Lack of fulfillment of conditions as set out in the Certification Agreement may render this Certificate invalid.

This Verification Opinion is based on the information made available to us and this engagement conditions detailed above. Hence, DNV GL cannot guarantee the accuracy or correctness of the information. DNV GL cannot be held liable by any party relying or acting upon this Verification Opinion.

DNV ZNATW-OP-90, Rev.7, 2015-11
Sources
AUO 2013 Corporate Social Responsibility Report (Section 4.2.1, page 61) Available at http://www.auo.com/upload/download/1/AUO_2013_CSR_EN_All.pdf
AUO’s responses to the 2020 Carbon Disclosure Project Investor Questionnaire.
AUO’s responses to the 2019 Carbon Disclosure Project Investor Questionnaire.
AUO’s responses to the 2018 Carbon Disclosure Project Investor Questionnaire.
AUO’s responses to the 2017 Carbon Disclosure Project Investor Questionnaire.
AUO’s responses to the 2016 Carbon Disclosure Project Investor Questionnaire.
AUO’s responses to the 2015 Carbon Disclosure Project Investor Questionnaire.
AUO’s responses to the 2014 Carbon Disclosure Project Investor Questionnaire.
AUO direct communications.
TTLA presentation at APEC meeting, August 2012, Taiwan.
Sharp 2019 Data

3% Market Share

F-GHG Emissions Over Time

The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.

- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.

- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts. Sharp does not publicly report F-GHG emission intensity.

F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph market share is calculated based on production data from IHS Technology.
F-GHG Emissions Reduction Activities

Overview

- In 2019, Sharp emitted a total of approximately 93,971 metric tons of CO₂ equivalent (MtCO₂e) of F-GHGs, as follows:\textsuperscript{11,12}
  - HFCs: 2,172 MtCO₂e
  - PFCs: 54,629 MtCO₂e
  - SF₆: 30,652 MtCO₂e
  - NF₃: 6,518 MtCO₂e

Gases Targeted

- SF₆
- PFCs (CF₄, C₂F₆, C₄F₈)
- HFCs (CHF₃)
- NF₃

Processes Targeted

- Etching
- Cleaning

Approaches Used

\textit{Abatement}

- \textbf{Abatement Systems:} Sharp has installed abatement systems on all etching and cleaning process equipment.
- \textbf{Scrubbers and Exhaust Treatment:} Sharp has installed scrubbers and exhaust gas treatment systems.

\textit{Process Improvements}

- \textbf{Researching Process Optimization:} Sharp has been researching ways to improve process optimization and manufacturing process conditions at the time that manufacturing equipment is first installed and in daily operations.

\textit{Alternative Chemicals}

- \textbf{Researching Lower GWP Gases:} Sharp has been collecting the latest information from relevant sources and researching the possibility of using lower GWP alternative gases.

Emissions Measurement Approaches and Verification

- Sharp estimates F-GHG emissions based on the Tier 2b method for electronics industry emissions provided in the \textit{2006 IPCC Guidelines for National Greenhouse Gas Inventories}.
- Sharp’s reported scope 1 emissions, which include F-GHGs, have not undergone third party verification.

\textsuperscript{11} Sharp reports annual emissions for its fiscal year, April 1 through March 31, rather than calendar year.
\textsuperscript{12} Reported F-GHG emissions may include production of LCDs and other electronic products.
Emission Reduction Goals and Progress

- Sharp works to reduce F-GHG emissions in accordance with the targets of Ministry of Economy, Trade and Industry; the Japan Electronics and Information Technology Industries Association (JEITA); and other industrial associations.
- Sharp set a goal to reduce annual GHG emissions to below 2007 baseline emissions levels for ten manufacturing fabrication facilities (fabs) by 2011.
- Sharp set a goal to reduce GHG emissions intensity per adjusted production unit (tons of CO\textsubscript{2}e/100 million yen) by 35 percent across the ten fabs by 2012. By end of fiscal year 2011, Sharp met both of its goals by reducing total emissions by 40 percent and emissions intensity by 42 percent.
- In fiscal year 2018, the Sharp Group’s GHG emissions increased by 14.6 percent compared to the previous fiscal year due to an expansion of the tabulation range resulting from the acquisition of a subsidiary.
- Sharp has formulated its Eco Vision 2050 goal, which sets forth a long-term goal of achieving net zero CO\textsubscript{2} emissions in its business activities by 2050.

Sources

Japan Electronics and Information Technology Industries Association (JEITA). See http://www.jeita.or.jp/english/.
Sharp (Sharp Corporation).
Sharp Corporation’s responses to the 2020 Carbon Disclosure Project Investor Questionnaire.
Sharp Corporation’s responses to the 2019 Carbon Disclosure Project Investor Questionnaire.
Sharp Corporation’s responses to the 2018 Carbon Disclosure Project Investor Questionnaire.
Sharp Corporation’s responses to the 2017 Carbon Disclosure Project Investor Questionnaire.
Suppliers with Recent Public Data, but Without Public Data in 2019

BOE, CEC Panda, HannStar, and Chunghwa Picture Tubes (CPT) did not publicly report F-GHG emissions data, F-GHG reduction goals, or progress towards reduction goals in 2019, but have reported F-GHG related information within the last four years. Though 2019 data are missing, some recent historical data are available on the following suppliers’ F-GHG emission reduction activities, including on gases and processes targeted and F-GHG emission reduction approaches.

Below, the suppliers are listed based on their 2019 market share:

**BOE FY 2019 Data**

*19% Market Share*

F-GHG Emissions Over Time

The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.
- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.
- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts.
F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph, market share is calculated based on production data from IHS Technology.

F-GHG Emission Reduction Activities
Overview

• No information is available on BOE’s 2019 F-GHG emissions.
• In 2018, BOE emitted approximately 6,213,824 metric tons of CO₂ equivalent (MtCO₂e) of F-GHGs, as follows:
  o HFCs: 65,940 MtCO₂e
  o SF₆: 6,147,884 MtCO₂e

Gases Targeted
No information is available on gases targeted by BOE’s F-GHG emission reduction activities.

Processes Targeted
• Etching
• Cleaning
• Heating/Cooling

Approaches Used
No information is available on approaches used by BOE to reduce F-GHG emissions.

Emissions Measurement Approaches and Verification
• BOE’s 2018 scope 1 emissions sources include emissions statistics for natural gas, diesel, gasoline, carbon dioxide fire extinguishers, personnel activities, refrigerants, and the use of SF₆ and CO₂ in the production process.
• BOE’s 2018 scope 2 emissions are calculated from the CO₂ emissions generated by the consumption of purchased electricity, using the China Development and Reform Commission’s grid emission factor.
• A third party provides reasonable assurance of BOE’s scope 1 and 2 emissions data according to the ISO14064-3 guidance.

Emission Reduction Goals and Progress
• BOE set a goal to reduce scope 1 and 2 emissions intensity by 20 percent from 2018 to 2028.
• BOE set an energy usage goal to reduce the ratio of energy consumption (kwh) to dollars of output value by ten thousand dollars of output value in 2028 compared to 2017 levels.
• BOE’s green development targets include aiming to become a leading exemplar of green development in the industry by 2022 by demonstrating the lowest levels of energy/water consumption and direct/indirect greenhouse gas emissions per unit of added value or per unit of product in the industry.
• Heat recovery and cooling technology: BOE is using air compressor waste heat recovery to reduce power consumption and improve heat recovery, saving an estimated 9329 metric tons of CO₂ annually as of 2018. BOE also introduced a condenser improvement project, air temperature optimization project, pre-cooling equipment, free cooling project, and low temperature FGI project.

• Process optimization: BOE introduced an air conditioning energy management system and changed its cooling tower fan to an inverter fan to conserve energy. BOE also improved its air compressor group control system, positively reduced its clean room pressure, adjusted FFU speed, reduced APP rated voltage, and began transformer optimization management.

• Equipment modification: BOE increased process efficiency by improving its vacuum inverter and modifying its AN04 equipment, OVEN equipment, CIPI equipment, and PA equipment. Additionally, BOE made improvements to its gluing machine, zero gas consumption desiccants, blower system, module workshop washing machine dryer and pure water system fans.

• Chemical Recycling: At BOE’s CF factory, the organic diluent vapor in the exhaust is condensed and recycled for use in machine cleaning. Additionally, BOE’s scrapped VOCs are returned to the manufacturing factory for recycling.

• Certification of “PAS 2050:2008 goods and services in life cycle assessment of greenhouse gas emissions”, gradually assists in a series of international standard authentication of GB/T23331-2012 energy management system, carbon management system. Currently there are five companies have been authorized the energy management system certification, and three have passed attestation of carbon emissions system.

• In 2018, BOE introduced three new projects to address other types of emissions, which resulted in a reduction of 990 tons CO₂, 298.93 kg CL₂, 2.96 tons nitrogen, 29.64 tons ammonia nitrogen, and 6.34 tons fluorine.

• BOE’s GHG emissions declined from 87.8 kgCO₂/m² in 2018 to 76.45 kgCO₂/m² in 2019.

Sources


BOE’s responses to the 2019 Carbon Disclosure Project Investor Questionnaire.
CEC Panda 2019 Data

5% Market Share

F-GHG Emissions Over Time

The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.

- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.

- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts. CEC Panda does not publicly report F-GHG emission intensity. Note that CEC Panda reported HFC emissions in 2015, but not in 2016, so the chart above shows F-GHG emissions both including and excluding HFC emissions for comparison between years.

F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph, market share is calculated based on production data from IHS Technology.

F-GHG Emission Reduction Activities

Overview

- No information is available on CEC Panda’s 2019 F-GHG emissions.
No information is available on CEC Panda’s 2018 F-GHG emissions.

No information is available on CEC Panda’s 2017 F-GHG emissions.

In 2016, per its second year of reporting F-GHG emissions to the CDP, CEC Panda emitted a total of approximately 53,312 metric tons of CO₂ equivalent (MtCO₂e) of F-GHGs, as follows:¹³

- PFCs: 2,297 MtCO₂e
- SF₆: 11,082 MtCO₂e
- NF₃: 39,933 MtCO₂e

Gases Targeted

No information is available on gases targeted by CEC Panda’s F-GHG emission reduction activities.

Processes Targeted

No information is available on processes targeted by CEC Panda’s F-GHG emission reduction activities.

Approaches Used

No information is available on approaches used by CEC Panda to reduce F-GHG emissions.

Emissions Measurement Approaches and Verification

- CEC PANDA estimates its F-GHG emissions based on the Tier 2b method provided by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for electronics industry emissions.
- CEC PANDA has not undergone third party verification or assurance for its reported scope 1 emissions, which include F-GHG emissions, for its previous years’ GHG inventory data.

Emission Reduction Goals and Progress

- CEC Panda set a goal to reduce scope 2 GHG emissions by 10 percent from 2015 to 2016 and reported that 100 percent of the target was achieved in 2016. No information is available on CEC Panda’s 2017 progress towards F-GHG emission reduction goals.
- In 2016, CEC Panda implemented 37 projects to reduce GHG emissions by an estimated annual 7301 CO₂e savings in metric tons CO₂e.

Participation in Broader F-GHG Reduction Efforts

No information is available on CEC Panda’s participation in broader F-GHG reduction efforts.

Sources

CEC PANDA’s responses to the 2017 CDP Investor Questionnaire
CEC PANDA’s responses to the 2016 CDP Investor Questionnaire

¹³ CEC Panda reported HFC emissions in 2015 but not 2016 or 2017.
The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.

- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.

- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts. HannStar does not publicly report F-GHG emissions but does report total GHG emission intensity, as noted in the section below.

F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph, market share is calculated based on production data from IHS Technology.
F-GHG Emission Reduction Activities

Overview
- No information is available on HannStar’s 2019 F-GHG emissions.
- In 2018, HannStar reduced F-GHG emissions about 39,039 MtCO₂e by abatement equipment.
- In 2018, F-GHGs emissions made up 24.55 percent of total GHG emissions, an improvement from 2017 (26.42 percent).
- In 2019, HannStar emitted approximately 88,047 metric tons of CO₂ equivalent (MtCO₂e) of F-GHGs, as follows:
  - NF₃: 2,063 MtCO₂e
  - SF₆: 85,984 MtCO₂e
- In 2019, HannStar reported that removal (F-GHG abatement) equipment reduced total annual F-GHG emissions by 43,562 MtCO₂e, compared to 39,040 MtCO₂e reduced in 2018, and 29,134 MtCO₂e reduced in 2017.
- In 2019, F-GHGs represented 23.99 percent of HannStar’s overall GHG emissions compared to 24.55 percent of total emissions in 2018.

Gases Targeted
- SF₆
- NF₃

Processes Targeted
- Etching
- Cleaning

Approaches Used
Abatement
- HannStar has installed the thermal abatement to remove F-GHGs emission at thin film process and new etching equipment.

Alternative Chemicals
- HannStar is using lower GWP gases, where possible. Additional details not available.

Emissions Measurement Approaches and Verification
- HannStar estimates F-GHG emissions based on the Tier 2b method for electronics industry emissions provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
- HannStar’s plants in Taiwan have been developing GHG inventories and implementing third party verification with reference to ISO 14064-1 since 2005.

Emission Reduction Goals and Progress
- Since HannStar’s GHG emissions are mostly due to electricity consumption and the use of F-GHGs in flat panel display manufacturing, the company has focused its GHG reduction efforts on these two areas.
- HannStar applied for GHG early action offset credits based on the Taiwan EPA’s Principles for Promoting Greenhouse Gas Pilot and Offset Projects and the Announced GHG Emission Intensity for TFT-LCD Industry.
- In 2015, Taiwan’s EPA awarded HannStar 3.78 million tons of carbon credits for its early action in voluntary GHG reductions.

Participation in Broader F-GHG Reduction Efforts
HannStar is a member of Taiwan’s TFT-LCD Association (TTLA). The TTLA participates on behalf of Taiwan’s LCD suppliers in the World Display device Industry Cooperation (WDICC), whose members have agreed to 30 percent F-GHG emission reductions by 2020 relative to 2010 levels.

Sources
TTLA presentation at APEC meeting, August 2012, Taiwan.
Chunghwa Picture Tubes (CPT) 2019 Data

0.1% Market Share

Note: CPT ceased operations in 2019

F-GHG Emissions Over Time

The chart above shows the following separate but related metrics:

- **Market share** over time shows the size of the supplier relative to all suppliers in the industry based on area of panels produced.

- **Total emissions** over time show total F-GHGs emitted by the supplier each year. Supplier emissions can change due to the implementation of emissions reduction efforts, an increase or decrease in panel production, and/or LCD technology advancements.

- **Emission intensity**, noted where data are available, is a measure of the amount of F-GHG emissions per unit of production. Trends in emission intensity show whether the supplier’s rate of emissions is increasing or decreasing over time and can indicate whether the supplier is implementing emission reduction efforts. CPT does not publicly report F-GHG emission intensity.

F-GHG emissions are publicly reported by suppliers through the CDP (formerly “Carbon Disclosure Project”) and/or corporate sustainability reports. In this graph, market share is calculated based on production data from IHS Technology.

F-GHG Emission Reduction Activities

Overview

- CPT’s 2018 emissions data are not publicly available. 2018 represents the last full year of CPT operations, as CPT closed in 2019.
In 2017, PFC emissions accounted for 30.27 percent of CPTs GHG emissions which were 769,615 MtCO$_2$e. Based on this information, CPTs PFC emissions for 2017 were estimated to be 232,962 MtCO$_2$e, a 5 percent decrease since 2016.

In 2016, CPT emitted approximately 247,112 metric tons of CO$_2$ equivalent (MtCO$_2$e) of F-GHGs, a 55 percent reduction from 2008, compared to a 49 percent reduction from 2008 in 2015 (313,000 MtCO$_2$e).

Between 2002 and 2017, CPT reduced F-GHG emissions by approximately 36.15 million MtCO$_2$e. This is equivalent to removing 7.7 million vehicles from the road for one year.

Gases Targeted
- SF$_6$
- PFCs
- HFCs
- NF$_3$

Processes Targeted
- Etching
- Cleaning

Approaches Used

*Abatement*
- **Abatement Systems:** CPT has installed abatement systems in all newer generation fabrication facilities (fabs).

*Process Improvements*
- **PFC Reduction:** In 2014, CPT implemented PFC reduction methods and evaluated process equipment, targeting its 4.5 generation fabs, an earlier generation of fabs built prior to 2004. CPT conforms to the WDICC resolution set in 2003 requiring that new plants install F-GHGs treatment facilities.
- **Cleaning Process:** CPT completed reconstruction of the cleaning process in its Taoyuan and Longtan plants, resulting in a 38 percent emission reduction of fluorinated compounds in 2011 from 2010 levels, equal to approximately 170,000 MtCO$_2$e.

*Alternative Chemicals*
- **SF$_6$ Replacement:** CPT is using lower GWP gases, where possible. For example, CPT continues to implement carbon reduction activities by replacing SF$_6$ with NF$_3$ in cleaning processes.

Emissions Measurement Approaches and Verification
- CPT estimates its F-GHG emissions based on the Tier 2b method provided by the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* for electronics industry emissions.
- CPT’s GHG inventory undergoes third-party verification and relies on the ISO14064-1 greenhouse gas management system.
- CPT details its GHG emission reporting requirements under the Regulations Governing GHG Emission Reporting in its Corporate Social Responsibility Report.
Emission Reduction Goals and Progress

- CPT set a goal to reduce GHG emissions by 280,000 MtCO$_2$e from 2013 to 2016 through process optimization, adoption of dry etch machinery, and installation of tail gas incinerator facilities.
- In 2017, emissions dropped to 769,615 tons CO$_2$, which represents a decrease by around 411,000 tons CO$_2$ or 34.82 percent compared to 2008.
- In 2016, CPT’s GHG emissions were 778,618 MtCO$_2$e, an increase from 778, 618 MtCO$_2$e in 2016. The majority of CPT’s GHG emissions are from F-GHG process emissions and electricity use.

Participation in Broader F-GHG Reduction Efforts

- CPT is a member of the Taiwan’s TFT-LCD Association (TTLA). The TTLA participates on behalf of Taiwan’s LCD suppliers in the World Display device Industry Cooperation (WDICC), whose members have agreed to 30 percent F-GHG emission reductions by 2020 relative to 2010 levels. CPT will work with TTLA to provide regular emission information of fluorinated compounds and engage in reductions of fluorinated compounds.

Sources

CPT 2017 Corporate Sustainability Report (page 41)

CPT 2016 Corporate Sustainability Report (page 36)

CPT 2015 Corporate Sustainability Report (page 42)

CPT 2014 Corporate Sustainability Report (page 28)

CPT direct communications.
CPT’s responses to the 2009 Carbon Disclosure Project Supply Chain Questionnaire.
CPT’s responses to the 2015 CDP Investor Questionnaire.
CPT Website: Environmental Management:


TTLA presentation at APEC meeting, August 2012, Taiwan.

Suppliers Without Public Data in Recent Years

Samsung, China Star, HKC, and Infovision did not report public data in 2019, 2018, 2017, or 2016. As a result:

- No information is available on these suppliers’ F-GHG emission reduction activities, including on gases targeted, processes targeted, or approaches used.
- These suppliers do not publicly measure or verify F-GHG emissions.
- These suppliers do not have or disclose emission reduction goals and progress.
- No information is available on these suppliers’ participation in broader F-GHG reduction efforts, except for Samsung, which is subject to Korea’s regulatory requirements (i.e., the Korean Emissions Trading Scheme (K-ETS)) to reduce GHG emissions, though it is unclear if they are actively participating.

Below, the suppliers are listed based on their 2019 market share:

Samsung Display

**Samsung's Market Share Over Time**

![Market Share and F-GHG Emissions Over Time](chart_image)

<table>
<thead>
<tr>
<th>Year</th>
<th>Market Share (%)</th>
<th>F-GHG Emissions (MtCO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>14%</td>
<td>1,100,000</td>
</tr>
<tr>
<td>2012</td>
<td>24%</td>
<td>2,000,000</td>
</tr>
<tr>
<td>2013</td>
<td>21%</td>
<td>2,100,000</td>
</tr>
<tr>
<td>2014</td>
<td>23%</td>
<td>2,300,000</td>
</tr>
<tr>
<td>2015</td>
<td>22%</td>
<td>2,200,000</td>
</tr>
<tr>
<td>2016</td>
<td>24%</td>
<td>2,400,000</td>
</tr>
<tr>
<td>2017</td>
<td>17%</td>
<td>1,700,000</td>
</tr>
<tr>
<td>2018</td>
<td>15%</td>
<td>1,500,000</td>
</tr>
<tr>
<td>2019</td>
<td>13%</td>
<td>1,300,000</td>
</tr>
</tbody>
</table>
China Star

China Star's Market Share Over Time

0.1% 2% 4% 4% 5% 7% 8% 8% 10%

HKC

HKC's Market Share Over Time

2018 2019
2% 3%

Global Market Share of Large Area Panels Production (%)

Global Market Share of Large Area Panels Production (%)

0% 5% 10% 15% 20% 25%

Infovision

Infovision's Market Share Over Time

Global Market Share of Large Area Panels Production (%)

- 2011: 1%
- 2012: 1%
- 2013: 1%
- 2014: 1%
- 2015: 1%
- 2016: 1%
- 2017: 1%
- 2018: 0.7%
- 2019: 0.6%