F-GHG Emissions Reduction Efforts: Flat Panel Display Supplier Profiles

Introduction

U.S. Environmental Protection Agency
Office of Air and Radiation
September 2016

Fluorinated greenhouse gases (F-GHGs) are among the most potent and persistent greenhouse gases (GHGs) contributing to global climate change. These gases play a vital role in the manufacture of flat panel displays--most commonly liquid crystal display (LCD) panels-- that go into televisions, computer monitors, and many other display products. The overall climate impact of the millions of display products Americans use can be greatly reduced if suppliers of these components take steps to mitigate releases of these F-GHGs to the atmosphere.

Over the last decade, many key flat panel display manufacturers have undertaken commendable voluntary efforts to reduce their F-GHG emissions. In the interest of encouraging further emissions reductions, the U.S. Environmental Protection Agency (EPA) is profiling efforts by flat panel display suppliers to reduce their F-GHG emissions, consistent with its purpose of sharing industry best practices and emerging efforts to reduce corporate GHG emissions through its Center for Corporate Climate Leadership. Additionally, in late 2013, leading electronics brands and retailers Walmart, Dell, HP, Lenovo and Best Buy began taking steps to foster further voluntary F-GHG reductions among their LCD suppliers. Consistent with the mission of the Center, EPA commends these companies for having submitted a proposal to their suppliers calling for them to 1) develop a standard method for measuring and recording F-GHG emissions for the industry, 2) establish a voluntary long-term F-GHG emissions reduction goal with public timelines for demonstrating progress, and 3) develop an annual progress report that can be shared with them and/or other supporting organizations.

EPA assembled the information presented in each profile from publicly available sources, including suppliers' corporate sustainability reports and their responses to the Carbon Disclosure Project's Investor or Supply Chain questionnaire, and from information provided by the suppliers themselves or by trade associations representing the flat panel display industry. Where information on suppliers' F-GHG emissions reduction efforts was assembled, suppliers then had the opportunity to review their draft profiles and provide feedback before profiles were completed. EPA intends to update the following profiles from all flat panel suppliers on an as-needed basis when new information or updates to existing information become available.

To better understand the information presented, below are some key points to consider.

Definitions:

- Flat Panel Displays: Today flat panel displays that use F-GHGs during manufacturing are mostly liquid crystal display (LCD) panels. Some suppliers refer specifically to LCD manufacturing when describing their efforts to reduce F-GHG use in production. For purposes of capturing future products or other displays that may use F-GHGs in production, EPA has opted to use the broader term of 'flat panel displays' instead of 'LCDs.' To EPA's knowledge, production of OLEDs uses F-GHGS but production of plasma displays does not use them.
- F-GHGs and PFCs: The F-GHG emissions of primary concern are from perfluorocarbons (PFCs), trifluoromethane (CHF_3 or HFCs), nitrogen trifluoride (NF_3), and sulfur hexafluoride (SF_6); these are sometimes collectively called perfluorocompounds (also termed PFCs). In some publicly available information, suppliers use the term 'PFCs' instead of 'F-GHGs' to refer to all of their F-GHGs used. EPA has chosen to use the term 'F-GHGs' instead of 'PFCs' (for perfluorocompounds) to address all known F-GHGs used in flat panel display manufacturing.
- Fab: Fabrication facility for panel production.

F-GHGs in the Context of Corporate GHG Inventories and Reporting:

Many flat panel display suppliers have implemented corporate-wide GHG emissions reduction goals and developed GHG inventories, encompassing both Scope 1 emissions, namely those from on-site combustion and processes, and Scope 2 emissions, those from purchased electricity and/or steam. The F-GHG emissions used in flat panel manufacturing reflect a subset of suppliers' Scope 1 emissions and are usually referenced in terms of CO_2 equivalent (CO_2e).

Key Manufacturing Processes to Consider

Panel etching and CVD chamber cleaning are the key processes that use F-GHGs in manufacturing flat panel displays.

Fluorinated heat transfer fluids (HTFs) are often used to cool equipment, resulting in emissions due to evaporative losses. Some manufacturers indicate that they do not use such fluorinated HTFs, or that emissions from fluorinated HTFs are minimal compared to those from etching and chamber cleaning processes. EPA is interested in understanding the extent to which such HTFs are used, how their potential emissions compare to those resulting from other key processes, and options for reducing F-GHG emissions from their use.

Reducing F-GHG Emissions

Over the last decade, electronics manufacturers have made significant progress in identifying effective technological solutions to reducing F-GHG emissions. The following approaches to reducing F-GHG emissions from the manufacture of flat panels are in use today or are being explored:

1. **Process improvements/source reduction:** Manufacturers optimize their processes to use F-GHGs more efficiently, especially in CVD clean processes, resulting in smaller amounts of gas that are unreacted and emitted.

2. **Alternative chemicals:** Manufacturers use alternative gases that are more efficient (more of the applied gas served its intended purpose versus being left unreacted) with a lower global warming potential (GWP) to accomplish the same result. For example, many manufacturers have modified certain key processes to use NF_3 instead of SF_6; NF_3 is a replacement gas for in-situ use for CVD and is also used in CVD remote plasma chamber cleaning. Though NF_3 still has very high GWP of 17,200, it is lower than that of SF_6 (which has a GWP of nearly 23,000) and is used more efficiently. Some companies are piloting the use of F2 to replace NF_3 in the remote plasma chamber cleaning process and are seeking to surmount some of challenges associated with transport, storage and use of F_2.

3. **Capture and beneficial reuse:** Manufacturers capture F-GHGs and process them to remove impurities and refine them for reuse. Some suppliers have piloted gas recycling in the past two years; however, reuse/recycling has so far not been implemented widely due to limitations on the effectiveness and cost of available recycling technologies.

4. **Abatement via gas destruction technologies:** Both point-of-use abatement, where the abatement system is attached to a process tool(s), and centralized abatement systems, where gases are sent to, and destroyed in, a centralized system, are being used by major panel suppliers. Abatement remains one of the most effective ways to reduce the majority of F-GHG emissions. There are many different types of destruction technologies that are used to abate F-GHGs, however, most abatement systems today use combustion.

Measuring Emissions and Monitoring Abatement Systems:

Measuring the efficiency of an installed abatement system to destroy or remove gases such as F-GHGs--known as the destruction or removal efficiency (DRE)-- directly relates to how suppliers can account for their annual F-GHG emissions and subsequent reductions. Most suppliers today use default factors from the 2006 IPCC Guidelines to account for the DRE of abatement systems. However, suppliers may also directly measure DREs using measurement guidelines or protocols. An example of such a protocol is EPA's "Protocol for Measuring Destruction or Removal Efficiency (DRE) of Fluorinated Greenhouse Gas Abatement Equipment in Electronics Manufacturing" (EPA's DRE Protocol). Published in 2010 and internationally peer-reviewed, EPA's DRE Protocol provides a reliable method for measuring DRE's of

point-of-use abatement systems for F-GHGs used during the manufacture of electronics. In other cases, for both point-of-use and centralized abatement systems, suppliers may monitor their systems on an ongoing basis to acquire on-site real-time data. Suppliers may also test their abatement systems by monitoring specific parameters such as temperature, process gas and exhaust gas flow rate.

Voluntary F-GHG reduction efforts:

Flat panel display suppliers are to be commended for undertaking F-GHG reductions voluntarily, as many companies have been implementing F-GHG emissions reductions for over a decade. Most suppliers represented in the following profiles have been participating, through their respective trade associations, in the World LCD Industry Cooperation Committee, now called the World Display Industry Cooperation Committee (WDICC), which agreed to voluntary reduction activities in 2001-2010 that would reduce 2000 baseline levels by approximately 90 percent down to 0.82 MMTCE. To meet the reduction goal, many suppliers in participating countries implemented strategies to address their emissions including installing abatement technologies on production lines in their newer generation fabs, namely those built within the last decade. As a result, F-GHG emissions were reduced by 10.1 MMTCE, to where aggregate emissions totaled 1.75 MMTCE. Though these reductions demonstrated significant accomplishments, the WLICC fell short of its goal due to a rise in emissions resulting from a rapid increase in production for LCD panels that were integrated into products such as televisions faster than initially anticipated.

Since the WDICC converged to set its initial goals, newer suppliers with growing market share emerged, where information on their F-GHG emissions reductions efforts is currently unknown. In addition, it appears that some key suppliers, are still in varying stages of implementing comprehensive F-GHG emission reductions efforts across their fabs. As worldwide demand for flat panels continues to increase, F-GHG emissions may also be projected to rise, depending on the F-GHG emissions reduction efforts in place. To mitigate a potential rise in emissions, it is important that reduction efforts across all major panel suppliers are implemented.

In late 2015, LCD suppliers who are members of the World Display Industry Cooperation Committee (WDICC) committed to a new goal of reducing F-GHG emissions intensity by 30% by 2020. EPA commends LCD suppliers for taking this important step to further reduce F-GHG emissions.

Suppliers:

Currently, twelve suppliers (listed below) are the major producers of large-area flat panel displays used to make TVs and display products. The profiles that follow highlight efforts of these suppliers to reduce their F-GHG emissions in flat panel manufacturing across key areas covering mitigation measures and goals, the extent of their reduction efforts (whether they include all processes and gases used), the extent to which abatement technologies are installed on newer fabs, and public disclosure of F-GHG emissions and/or emissions reductions. Profiles were only

developed for suppliers where information on their F-GHG emissions reduction efforts in flat panel manufacturing was publicly available. The emissions data are reported in either tons or metric tons to reflect how suppliers reported on their emissions.

AU Optronics (AUO)

BOE Technology

CEC-Panda

ChinaStar

Chunghwa Picture Tubes (CPT)

HannStar

Infovision

INX (Innolux)

LG Display

Panasonic

Samsung Display

Sharp

AUO (AU Optronics)

Overview

Specific F-GHG emissions reduction efforts and/or goals	AUO reduced F-GHGs emissions, namely NF_3, SF_6 and CF_4 (PFCs), by 10.6 million metric tons of CO_2e from 2003–2014. AUO considers itself a pioneer of F-GHG abatement in Taiwan. Since 2003, AUO voluntarily installed IPCC-recognized F-GHG abatement devices with destruction removal efficiencies (DRE) over 90 percent in dry etching and chemical vapor deposition (CVD) processes for all newly built fabs to reduce F-GHG emissions from gases such as SF_6 and NF_3. Over the previous two years, AUO also installed local scrubbers to remove F-GHG emissions at older fabs built before 2003. Currently the installation rate of F-GHG abatement equipment at older, lower-generation fabs, is approaching 100%. *Sources:* *AUO 2014 Corporate Social Responsibility Report (section 4.2.1, page 58). (www.auo.com/upload/download/1/AUO_2014_CSR_EN_All.pdf)* *AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.*
+ F-GHG emissions reduction efforts/goals target the following key processes that emit F-GHGs	Etch and Clean processes. On fluorinated heat transfer fluids (HTFs): AUO follows the "Guidance for Greenhouse Gas Accounting and Reporting for GHG inventory" published by the Taiwanese EPA. In the guidance, HTFs are listed as emission sources for semiconductor industry, but not for optoelectronics industry, meaning that emissions from HTFs are too minor in AUO's process. *Sources:* *AUO* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
+ F-GHG emissions reduction efforts/goals target the following F-GHGs emitted	SF_6, PFCs (specifically CF_4), HFCs, NF_3. *Source:* *AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.*

Overview

Participation in national and/or international mandatory and/or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing

AUO is a member of the Taiwanese TFT-LCD Association (TTLA). TTLA participates on behalf of Taiwan's LCD suppliers in the World Display Device Industry Cooperation Committee (WDICC), an international industry initiative that previously set goals to reduce F-GHG emissions (formerly the World LCD Industry Cooperation Committee).

In 2004, TTLA and Taiwan's Environmental Protection Agency signed an memorandum of understanding (MOU) where TTLA agreed to choose 2002 as the base year for reducing F-GHG emissions and to reduce F-GHGs emissions intensity to 0.0335 tons of CO_2e/m^2 of glass substrate area by 2010 (this target is TTLA's collective goal and does not necessarily reflect each individual supplier's goal).

The TTLA and Taiwan's Industrial Development Bureau, Ministry of Economic Affairs signed a "Voluntary GHG Reduction Agreement," for 2011–2015, which set a target to achieve additional GHG reductions by 12 million metric tons of CO_2e within 5 years. In Taiwan, F-GHG emission reductions by flat panel display manufacturers are still voluntary. However, as of 2012, Taiwan's EPA listed PFCs, HFCs, and SF_6 (including non-F-GHGs CO_2, CH_4, and N_2O) as air pollutants and has indicated that it will implement emissions control measures under the Air Pollution Control Act in the future. Taiwan's government has launched the Principles for Promoting Greenhouse Gas Early Action and Offset Program to encourage carbon reduction. AUO has engaged in developing the SF_6 abatement verification methodology for LCD industries, and received 9.11 million tons of tradable carbon credits based on the amount of PFCs reduced in the past.

The Taiwan EPA created the Carbon Credit Program which rewards companies that implemented early carbon reduction actions and carbon offset projects, as well as establishes a domestic carbon trading platform. AUO was issued approximately 9 million tonnes of carbon credits by Taiwan EPA for its early action on PFC reductions and third party verification of its F-GHG abatement.

AUO discussed with the Taiwan EPA an emissions intensity baseline for benchmarking reductions, which methodology should be used to calculate the SF_6 emissions reductions in CO_2e using burn-type abatement used to destroy F-GHGs, and how to avoid double counting in carbon tax schemes. AUO is currently undergoing SF_6 abatement verification of its SF_6 abatement, having used a methodology to calculate emissions reductions with the Taiwan EPA. Otherwise, we also expect to influence others in acting GHG reduction.

Sources:
AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.

"SF_6 Abatement Strategy in Taiwan". Presentation by Taiwan's Industrial Technology Research Institute (ITRI), 2004.

TTLA

Overview	**Corporate-wide GHG emissions reduction goals and reduction initiatives**	AUO set an intensity goal to reduce its Scope 1 and Scope 2 GHG emissions in all its fabs worldwide by 25 percent from 2010 to 2015, where its most recent base year GHG emissions, based on the 2010 national electricity emission factor, were reported as 69 kg CO_2e/m^2. AUO recently revised the GHG emissions intensity baseline to 58.5 kg CO_2/ square meter input area, with a goal of attaining 47.3 kg CO_2/square meter at the end of 2014. This change was due because the GHG emissions baseline announced in AUO's 2014 AUO CSR report chapter includes emissions from both manufacturing sites and office buildings. The new baseline reflects manufacturing emissions only. AUO updates its GHG inventory based on the latest national electricity factors published by the Bureau of Energy. AUO's "Green Solutions" initiative addresses emissions reductions from all of its manufacturing and other operations, from within its supply chain, and via improved product design to create lower-carbon products. In 2011, AUO initiated a carbon footprint management system to assist its global customers in calculating the carbon footprint of individual products, as they seek PAS 2050 third party verification. AUO also developed its own electronic system to collect vendors' carbon footprint data. AUO participates in the Product Attribute to Impact Algorithm (PAIA) Project to develop calculation models for LCD-related products. *Source:* *AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.*
F-GHG Reduction Efforts	**Process optimization**	AUO's process experts worked with its SF_6 supplier to investigate ways to reduce the quantity of SF_6 used in dry etching manufacturing processes for manufacture of its TFT-LCD panels. AUO found that by adjusting process parameters, SF_6 consumption could be considerably reduced. For example, at its G6 fab in Taichung, Taiwan, if the fab is in full production capacity, by adjusting relevant process parameters, the amount of SF_6 gas can be reduced by 720 kgs per year, equal to reducing 32,000 metric tons of CO_2 emissions annually. AUO expanded this SF_6 reduction scheme across all its fabs, including those located in other regions. In addition, AUO installed flow meters and mass flow controllers at the front of reaction chambers, enabling on-site engineers to reduce unnecessary gas waste in chambers and improve gas utilization efficiencies. *Source:* *AUO 2011 Corporate Social Responsibility Report.* *(http://auo.com/upload/download/1/AUO_2011_CSR_EN_CH2_v1.pdf)*
	Use of alternatives	Though it is more expensive, AUO uses NF_3, which has a lower global warming potential, instead of SF_6 in clean vapor deposition (CVD) chambers. AUO also started using NF_3 when fabs were newly built. AUO continues to research the possibilities of using alternative gases with lower or no GWP in conjunction with optimizing process efficiencies and implementing abatement systems. *Source: AUO*

F-GHG Reduction Efforts

Capture and recycling	In 2012, AUO tested gas recycling technologies and recycling efficiency at one fab, where the utilization efficiency of the recycling system was measured directly by monitoring the recycled gas flow. In 2013, AUO's Longtan site introduced a membrane separation method, previously approved by the IPCC, which purifies SF_6 so that it can be re-used in the manufacturing process. This recycling technology reduced F-GHG emissions and saved on operating and material costs. However, due to a higher maintenance demand and lower efficiency in general, the recycling system has been replaced by the abatement system. *Sources:* *AUO* *AUO 2013 Corporate Social Responsibility Report (section 4.2.1, page 61). (www.auo.com/upload/download/1/AUO_2013_CSR_EN_All.pdf)* *AUO's responses to the 2014 Carbon Disclosure Project Investor Questionnaire.*
Abatement	
+ Full or partial installation of abatement systems across all new generation fabs	AUO has installed abatement systems in all newer generation fabs. CVD processes in all fabs are equipped with abatement systems. For dry etching processes, abatement systems have been gradually installed since 2003 on new production lines. Types of abatement technologies being employed include combustion (for CVD, dry etching) and membrane separation technology (for dry etching and is regarded as a recycling technology). AUO uses localized, point of use (POU) abatement systems. *Sources:* *AUO* *Taiwan Environmental Protection Administration. "The Initiative and Efforts from Electronic Corporations in Taiwan: Semiconductor and TFT-LCD." (http://unfccc.epa.gov.tw/unfccc/english/_uploads/downloads/05_The_Initiative_and_Efforts_form_Electronic_Industry_in_Taiwan.pdf)* *TTLA presentation at APEC meeting, August 2012, Taiwan.* *AUO's responses to the 2014 Carbon Disclosure Project Investor Questionnaire.*

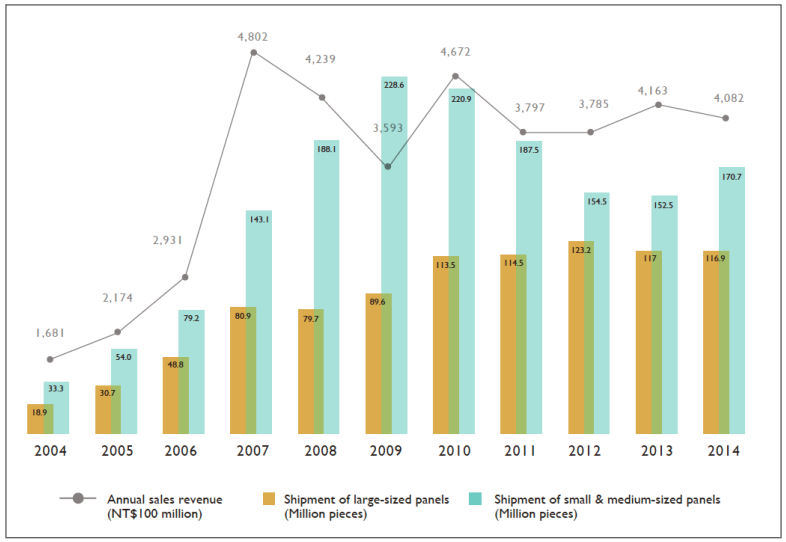
F-GHG Reduction Efforts		
	+ Ensured that abatement systems are installed, operated, maintained, according to manufacturer specifications	For abatement systems, the destruction or removal efficiency was checked once first installed. *Source: AUO*
	+ Indicate whether default factors or actual measurements were used to estimate the DRE Reported destruction or removal efficiency (DRE)	Default factors used. AUO applies the 90 percent default DRE value for SF_6, HFCs and PFCs abatement technologies and the 95 percent default DRE value for NF_3 abatement technologies, taken from the 2006 IPCC Tier 2b Guidelines for National Greenhouse Gas Inventories for electronics industry emissions. *Source: AUO*
	+ Practices for monitoring abatement systems	When abatement systems were first installed, AUO randomly selected devices from each machine type per site, and measured their utilization efficiencies and DRE using Fourier Transform Infra Red (FTIR). To ensure the effectiveness of the CVD and dry etching abatement systems, both systems were measured even if they were located in the same site. The outcomes of the FTIR measurements were verified by a third party, the Industrial Technology Research Institute of Taiwan (ITRI). However, due to the high cost of FTIR testing, AUO uses an operation recipe instead as a method to monitor abatement devices after installation. Engineers check and record the operation recipe. Parameters include temperature, process gas, and exhaust gas flow rate. By types of devices, different parameters are monitored. For most devices, AUO found that air fuel ratio is a key indicator to determine if more fuel is needed. If the abatement system does not have a thermometer, then the volume of gas flow will become an important indicator. *Source:* *AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire, (section ICT3.6).*

Total annual F-GHG emissions in CO_2e, emitted across all flat panel display manufacturing fabs (2014)

The total amount of F-GHG emissions attributed to panel manufacturing is not publicly available.

As part of its **2015** disclosure to the Carbon Disclosure Project, which discloses GHG emissions from J**an 1, 2014–Dec 31, 2014**, AUO lists its total Scope 1 emissions. These Scope 1 emissions represent its organizational boundary, using an operational control approach that includes facilities within Taiwan and in other countries. Its F-GHG emissions, as reported, are as follows, in metric tons of CO_2e:
HFCs: 6,171.93 (increase compared to 4,487.30 in CY 2013)
PFCs (includes NF_3): 24,094.22 (increase compared to 21,285.95 in CY 2013)
SF_6: 206,099.58 (decrease compared to 212,597.60in CY 2013)

Context:
AUO's large panel shipments decreased slightly from 117.0 million units in 2013 to 116.9 million units in 2014, and small and medium panel shipments increased from 152.5 million units in 2013 to 170.7 million units in 2014.

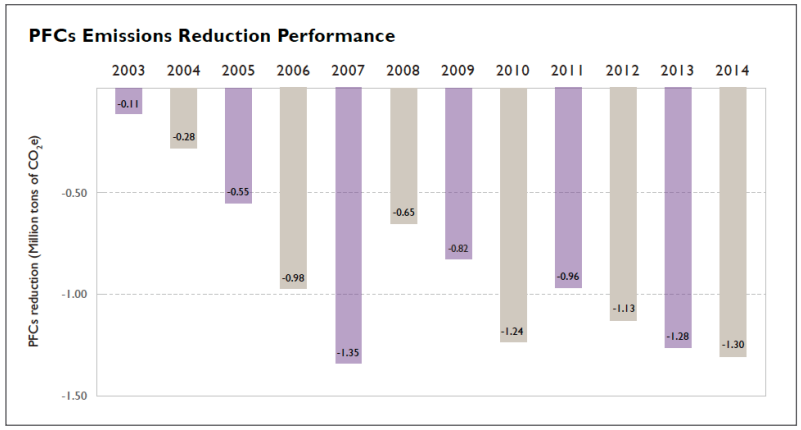


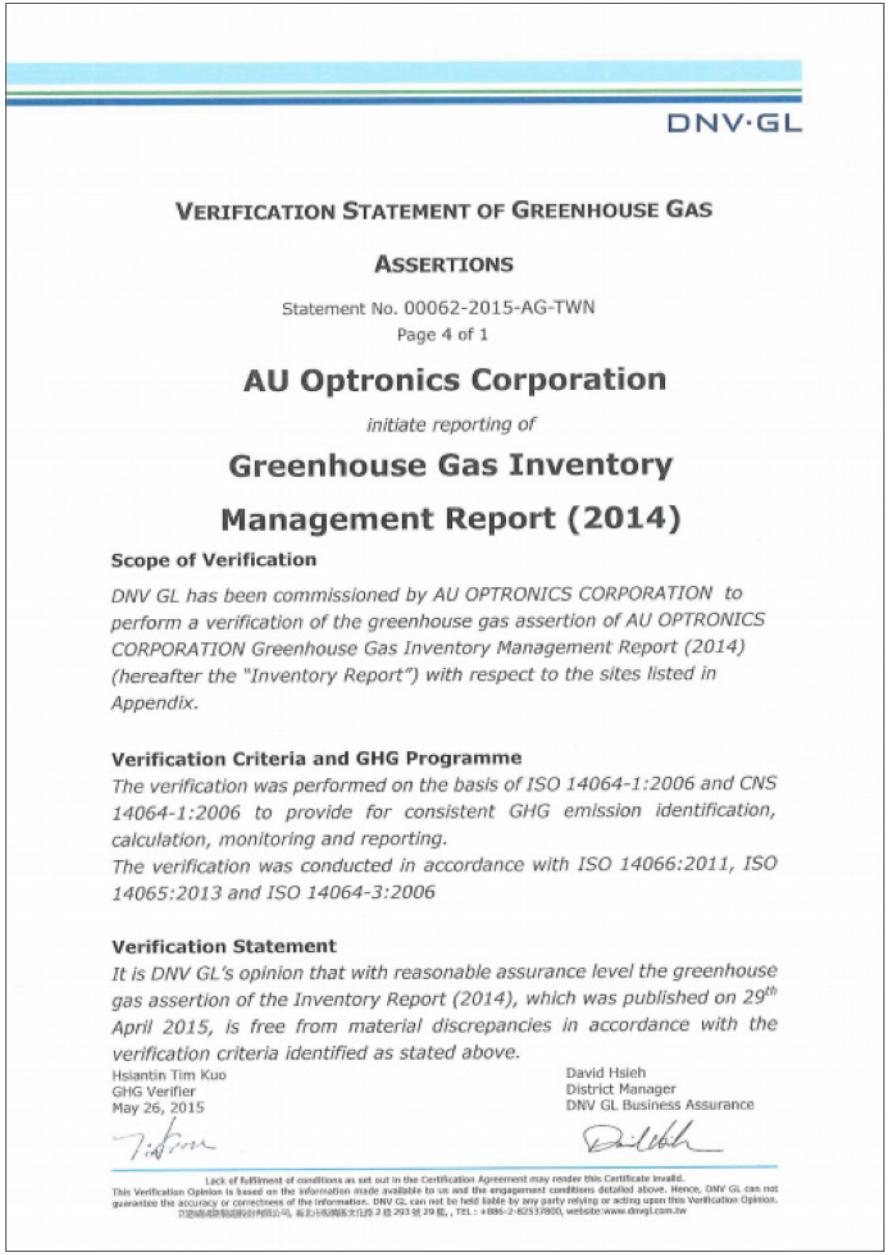
Important: The emissions listed cannot be compared to the emissions from other suppliers because they may use different estimation methods and monitoring practices to calculate their emissions. These process emissions may also reflect manufacturing processes that create additional products other than large-area flat panel displays.

Sources:
AUO 2014 Corporate Social Responsibility Report (section 2.1.1, page 21). (www.auo.com/upload/download/1/AUO_2014_CSR_EN_All.pdf)

AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.

F-GHG Emissions Measurements

Total annual F-GHG emissions reductions and/or rate of emissions reductions	 *Source:* *AUO 2014 Corporate Social Responsibility Report.* *(www.auo.com/upload/download/1/AUO_2014_CSR_EN_All.pdf)*
Methodology used to estimate F-GHG emissions	AUO 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. The uncertainty of the emission factors are estimated from 6% to 50%. *Source:* *AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.*
Third party assurance for F-GHG emissions estimates	AUO's raw data is verified by a third party according to the ISO 14064-1 guidance, where the uncertainty assessment in scope 1 is estimated from -5% to 5%. The following pages are part of AUO's "Verification Statement of Greenhouse Gas Assertions" for 2014. *Source:* *AUO's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.*



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VERIFICATION STATEMENT OF GREENHOUSE GAS

ASSERTIONS

Statement No. 00062-2015-AG-TWN

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AU Optronics Corporation

initiate reporting of

Greenhouse Gas Inventory Management Report (2014)

Scope of Verification

DNV GL has been commissioned by AU OPTRONICS CORPORATION to perform a verification of the greenhouse gas assertion of AU OPTRONICS CORPORATION Greenhouse Gas Inventory Management Report (2014) (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 to provide for consistent GHG emission identification, calculation, monitoring and reporting.
The verification was conducted in accordance with ISO 14066:2011, ISO 14065:2013 and ISO 14064-3:2006

Verification Statement

It is DNV GL's opinion that with reasonable assurance level the greenhouse gas assertion of the Inventory Report (2014), which was published on 29th April 2015, is free from material discrepancies in accordance with the verification criteria identified as stated above.

Hsiantin Tim Kuo
GHG Verifier
May 26, 2015

David Hsieh
District Manager
DNV GL Business Assurance

Lack of fulfilment 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 the engagement conditions detailed above. Hence, DNV GL can not guarantee the accuracy or correctness of the information. DNV GL can not be held liable by any party relying or acting upon this Verification Opinion.
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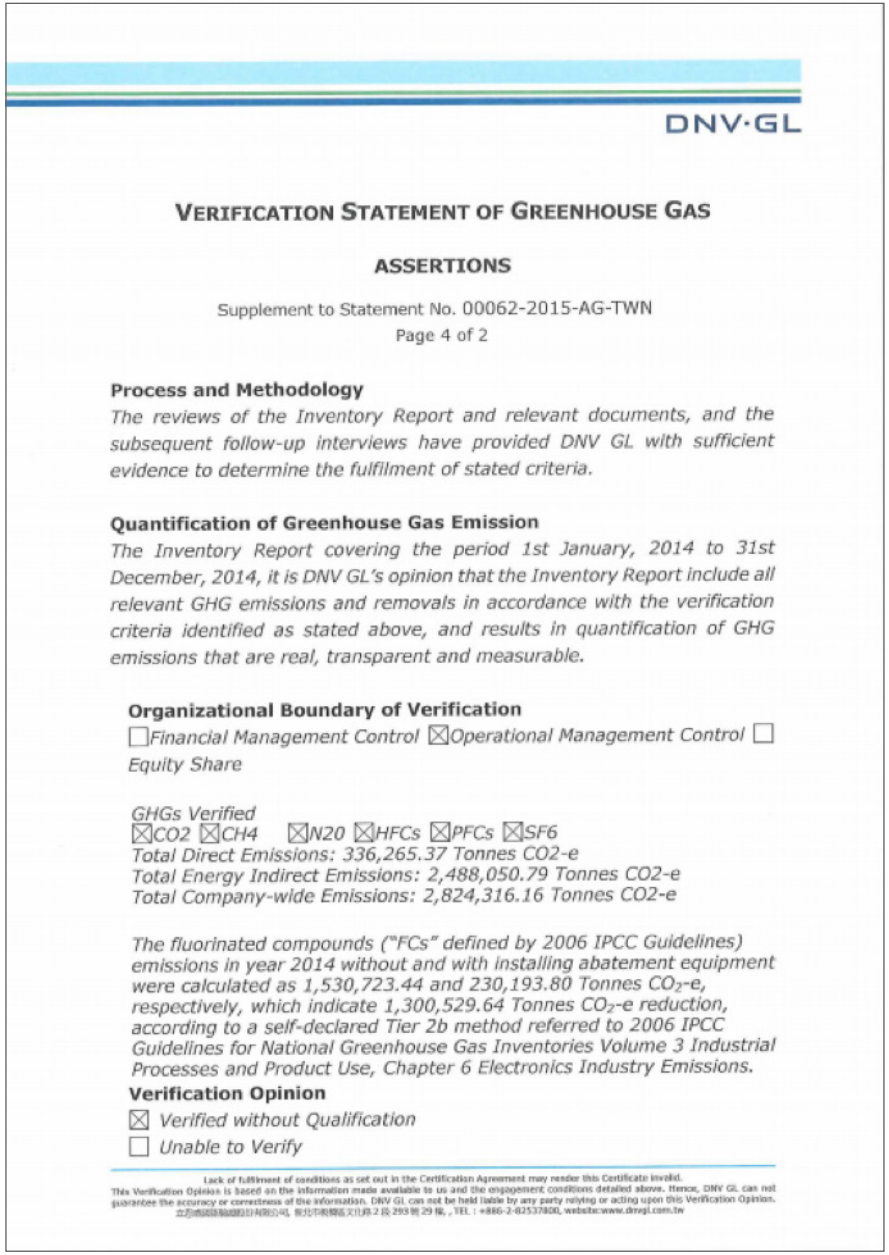
Information assembled by the U.S Environmental Protection Agency's Office of Air and Radiation.
Current as of September 2016.



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VERIFICATION STATEMENT OF GREENHOUSE GAS

ASSERTIONS

Supplement to Statement No. 00062-2015-AG-TWN
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Process and Methodology

The reviews of the Inventory Report and relevant documents, and the subsequent follow-up interviews have provided DNV GL with sufficient evidence to determine the fulfilment of stated criteria.

Quantification of Greenhouse Gas Emission

The Inventory Report covering the period 1st January, 2014 to 31st December, 2014, it is DNV GL's opinion that the Inventory Report include all relevant GHG emissions and removals in accordance with the verification criteria identified as stated above, and results in quantification of GHG emissions that are real, transparent and measurable.

Organizational Boundary of Verification

☐ *Financial Management Control* ☒ *Operational Management Control* ☐ *Equity Share*

GHGs Verified
☒ *CO2* ☒ *CH4* ☒ *N20* ☒ *HFCs* ☒ *PFCs* ☒ *SF6*
Total Direct Emissions: 336,265.37 Tonnes CO2-e
Total Energy Indirect Emissions: 2,488,050.79 Tonnes CO2-e
Total Company-wide Emissions: 2,824,316.16 Tonnes CO2-e

The fluorinated compounds ("FCs" defined by 2006 IPCC Guidelines) emissions in year 2014 without and with installing abatement equipment were calculated as 1,530,723.44 and 230,193.80 Tonnes CO_2-e, respectively, which indicate 1,300,529.64 Tonnes CO_2-e reduction, according to a self-declared Tier 2b method referred to 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 3 Industrial Processes and Product Use, Chapter 6 Electronics Industry Emissions.

Verification Opinion

☒ *Verified without Qualification*
☐ *Unable to Verify*

Lack of fulfilment 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 the engagement conditions detailed above. Hence, DNV GL can not guarantee the accuracy or correctness of the information. DNV GL can not be held liable by any party relying or acting upon this Verification Opinion.
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Chunghwa Picture Tubes (CPT)

Overview

Specific F-GHG emissions reduction efforts and/or goals	As part of the memorandum of understanding (MOU) in 2004 with the Taiwan TFT-LCD Association (TTLA) and Taiwan's Environmental Protection Administration, CPT promised to install abatement equipment with over 90 percent destruction and removal efficiency (DRE) in all new fabs designed after 2003 and to reduce F-GHGs emissions intensity to 0.0335 tons of CO_2e/m^2 of glass substrate area by 2010. To further reduce its GHG emissions, 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 completed reconstruction of the chemical vapor deposition (CVD) process in the Taoyuan and Longtan plants, resulting in a 38% emission reduction of fluorinated compounds from 2010 levels, equal to approximately 170,000 tons of carbon dioxide. *Sources:* *CPT's Responses to the 2015 CDP Investor Questionnaire.* *CPT 2014 Corporate Sustainability Report (page 28).* *(www.cptt.com.tw/cptt/english/html/2014_ebook_CSR_EN/index.html#p=32)* *CPT Website: Environmental Management.* *(www.cptt.com.tw/index.php?option=com_content&task=view&id=447&Itemid=180)* *CPT's responses to the 2009 Carbon Disclosure Project Supply Chain Questionnaire.* *"SF_6 Abatement Strategy in Taiwan." Presentation by Taiwan's Industrial Technology Research Institute (ITRI), 2004.*
+ F-GHG emissions reduction efforts/goals target the following key processes that emit F-GHGs	Etch and Clean processes. Information on fluorinated heat transfer fluids not available. *Sources:* *CPT Website: Environmental Management.* *(www.cptt.com.tw/index.php?option=com_content&task=view&id=447&Itemid=180)* *TTLA presentation at APEC meeting, August 2012, Taiwan.*

Overview

+ F-GHG emissions reduction efforts/goals target the following F-GHGs emitted	SF_6, PFCs, HFCs, NF_3. *Sources:* *CPT Website: Environmental Management.* *(www.cptt.com.tw/index.php?option=com_content&task=view&id=447&Itemid=180)* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
Participation in national and/or international mandatory and/or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing	CPT is a member of the Taiwan TFT-LCD Association (TTLA). TTLA participates on behalf of Taiwan's LCD suppliers in the World Display Industry Cooperation Committee (WDICC), an international industry initiative that previously set goals to reduce F-GHG emissions (formerly the World LCD Industry Cooperation Committee). In 2004, TTLA and Taiwan's Environmental Protection Administration signed an MOU where TTLA agreed to choose 2002 as the base year for reducing F-GHG emissions and to reduce F-GHGs emissions intensity to 0.0335 tons of CO_2e/m^2 of glass substrate area by 2010 (this target is TTLA's collective goal and does not necessarily reflect each individual supplier's goal). Recently, the TTLA and Taiwan's Industrial Development Bureau, Ministry of Economic Affairs signed a "Voluntary GHG Reduction Agreement," for 2011–2015, which aims to achieve additional GHG reductions by 12 million metric tons of CO_2e within 5 years. In Taiwan, F-GHG emission reductions by flat panel display manufacturers are still voluntary. However, as of 2012, Taiwan's EPA listed PFCs, HFCs, and SF_6 (including non-F-GHGs CO_2, CH_4, and N_2O) as air pollutants and has indicated that it will implement emissions control measures under the Air Pollution Control Act in the future. According to CPT's website, "TTLA signed its first cooperative memorandum for voluntary reductions with the Environmental Protection Administration in 2004. In 2007, it signed the "Voluntary Greenhouse Gas Reduction Agreement" with the Ministry of Economic Affairs. CPT will also work with TTLA to provide regular emission information of fluorinated compounds, and engage in reductions of fluorinated compounds. Our management procedures include: 1. Reconstruction of the chemical vapor deposition (CVD) process in the Taoyuan and Longtan plants have been completed, which results in emission reduction of carbon dioxide. 2. Manufacturing processes that use fluorocarbons (FCs) are a major source of greenhouse gas emissions during the production process of thin membrane liquid crystal display devices. Currently, processes for end gases from machines include increasing production usage rate and adding local scrubbers (LS)."

Sources:
CPT's Responses to the 2015 CDP Investor Questionnaire.

CPT Website: Environmental Management.
(www.cptt.com.tw/index.php?option=com_content&task=view&id=447&Itemid=180)

"SF_6 Abatement Strategy in Taiwan". Presentation by Taiwan's Industrial Technology Research Institute (ITRI), 2004.

TTLA

Corporate-wide GHG emissions reduction goals and reduction initiatives

Currently, CPT's goal is to reduce GHG emissions by 280,000 tons of CO_2e by 2016 (a 23.6% reduction from a 2013 baseline year of 1,185,646 tons of CO_2e) through process optimization and adoption of dry etch machinery and tail gas incinerator facilities. The majority of CPT's GHG emissions are due to F-GHG emissions (process emissions) and electricity use. In 2013, CPT's Scope 1 process emissions, across its operational boundary, amounted to approximately 584,200 metric tons of CO_2e and its Scope 2 emissions from purchased electricity amounted to 601,446 metric tons of CO_2e.

Greenhouse gas inventory by year: unit (ton CO_2 e/year)

Scope	Emission source	2011	2012	2013	2014
Scope 1	Direct emission sources include GHG sources owned or controlled by CPT (stationary combustion sources, mobile combustion sources, process emission sources, and fugitive emission sources)	427,728	390,313	584,200	371,554
Scope 2	Purchased electricity represents the main indirect emission source	712,777	609,842	601,446	585,258
Scope 3	Other emissions (raw material transportation, supplier manufacturing operations, staff business travel, and waste treatment are not included in the scope of inventories – only qualitative inventories are conducted)	–	–	–	--
Total emissions		1,140,505	1,000,155	1,185,646	956,812

PS: Scope 3 emission information has not been included in the emission reports yet. In recent years, CPT has made constant efforts to include this category and disclose emission amounts generated by the supply chain with a view to optimizing inventory operations. The Hukou plant was sold in 2010. CPT Malaysia and Kinpo Malaysia were sold in 2011. The Shenzhen company was sold in 2013; therefore, they are not included in the statistics.

Overview		CPT has been participating in reporting to the CDP from 2007–2014. Certification of Carbon Footprint for LCD Panel Products: Since August 2009, relevant CPT departments have been planning and exerting efforts for the product carbon footprint verification. After about half a year of investment and preparation, with the cooperation of nearly 15 suppliers, CPT was finally able to disclose and analyze the environmental impacts associated with its LCD products. CPT followed the international carbon footprint standards such as ISO 14040, ISO 14044, ISO 14064-1, and PAS 2050 standard to determine the carbon footprint for its 22" desktop LCD panel product and the result was verified by the Environment and Development Foundation (EDF) before public declaration. This is CPT's first carbon footprint declaration for its LCD panels. After CPT acquired carbon footprint certifications for its 15.6 notebook boards in 2010, CPT officially initiated carbon and water footprint certification for its vehicular boards in June 2011 to account for its transformation towards medium and small size applications. CPT secured dual carbon and water footprint certifications for its 6.9 inch vehicular board products from international certification agency SGS in December 2011. *Sources:* *CPT 2013 Corporate Social Responsibility Report (page 30).* *CPT 2014 Corporate Sustainability Report (page 28).* *(www.cptt.com.tw/cptt/english/html/2014_ebook_CSR_EN/index.html#p=32)* *CPT's Responses to the 2015 CDP Investor Questionnaire.*
F-GHG Reduction Efforts	**Process optimization**	According to CPT, "Reconstruction of the chemical vapor deposition (CVD) process in the Taoyuan and Longtan plants have been completed, which results in a 38 percent emission reduction of fluorinated compounds from 2010 levels, equal to approximately 170,000 tons of carbon dioxide… Emissions produced by manufacturing processes that use fluorocarbons (FCs) are a major source of greenhouse gas emission during the production process of thin membrane liquid crystal display devices. Currently, processes for end gases from machines include increasing production usage rate and adding local scrubbers (LS)." *Source: CPT*
	Use of alternatives	CPT is using lower GWP gases, where possible. Additional details not available. *Sources:* *CPT* *TTLA presentation at APEC meeting, August 2012, Taiwan.*

F-GHG Reduction Efforts		
	Capture and recycling	Information not available.
	Abatement	
	+ Full or partial installation of abatement systems across all new generation fabs	CPT has installed abatement systems in all newer generation fabs. CPT committed to install abatement systems in all fabs established after 2003 to reduce more than 90 percent of its F-GHG emissions. According to CPT, "the process gases used by the Taoyuan and Lungtan plans for the chemical vapor deposition (CVD) and dry etching processes of TFT production processes are SF_6 and NF_3 gases. During these processes, not fully reacted perfluorocarbon gases are emitted. To guarantee effective treatment of PFC gases, CPT uses high temperature combustion to break down the gases' molecules. Secondary solid pollutants generated in the combustion process, namely silicon monoxide and dioxide, are then captured with bag-filter, dust-collection facilities. Finally, the cleaning tower is used to clean out special gas molecules in the waste gas. The efficiency of this process exceeds 90% (calculations are based on official statements of IPCC)." *Sources:* *CPT 2014 Corporate Sustainability Report (page 43).* *(www.cptt.com.tw/cptt/english/html/2014_ebook_CSR_EN/index.html#p=32)* *CPT Website: Environmental Management.* *(www.cptt.com.tw/index.php?option=com_content&task=view&id=447&Itemid=180)* *CPT's responses to the 2009 Carbon Disclosure Project Supply Chain Questionnaire.* *Taiwan Environmental Protection Administration. "The Initiative and Efforts from Electronic Corporations in Taiwan-Semiconductor and TFT-LCD." (http://unfccc.epa.gov.tw/unfccc/english/_uploads/downloads/05_The_Initiative_and_Efforts_form_Electronic_Industry_in_Taiwan.pdf)* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
	+ Ensured that abatement systems are installed, operated, maintained, according to manufacturer specifications	Upon installation at the facility and before CPT begins operating the abatement system, the abatement equipment manufacturer verifies that the system can meet the default DRE. *Sources:* *CPT* *TTLA*

F-GHG Reduction Efforts

+ Indicate whether default factors or actual measurements were used to estimate the DRE Reported destruction or removal efficiency (DRE)	Default factors used. CPT applies the 90 percent default DRE value for SF_6, HFCs and PFCs abatement technologies and the 95 percent default DRE value for NF_3 abatement technologies, taken from the 2006 IPCC Tier 2b Guidelines for National Greenhouse Gas Inventories for electronics industry emissions. CPT reports the DRE of its abatement systems at 90 percent or higher. *Source: CPT*
+ Practices for monitoring abatement systems	Information not available.

F-GHG Emissions Measurements

Total annual F-GHG emissions in CO_2e, emitted across all flat panel display manufacturing fabs (2014)

In 2014, CPT's Scope 1 emissions amounted to 371,554 metric tonnes of CO_2e. In contrast, in 2013, CPT's Scope 1 process emissions, across its operational boundary, amounted to approximately 584,200 metric tons of CO_2e. The majority of CPT's Scope 1 emissions are F-GHG emissions.

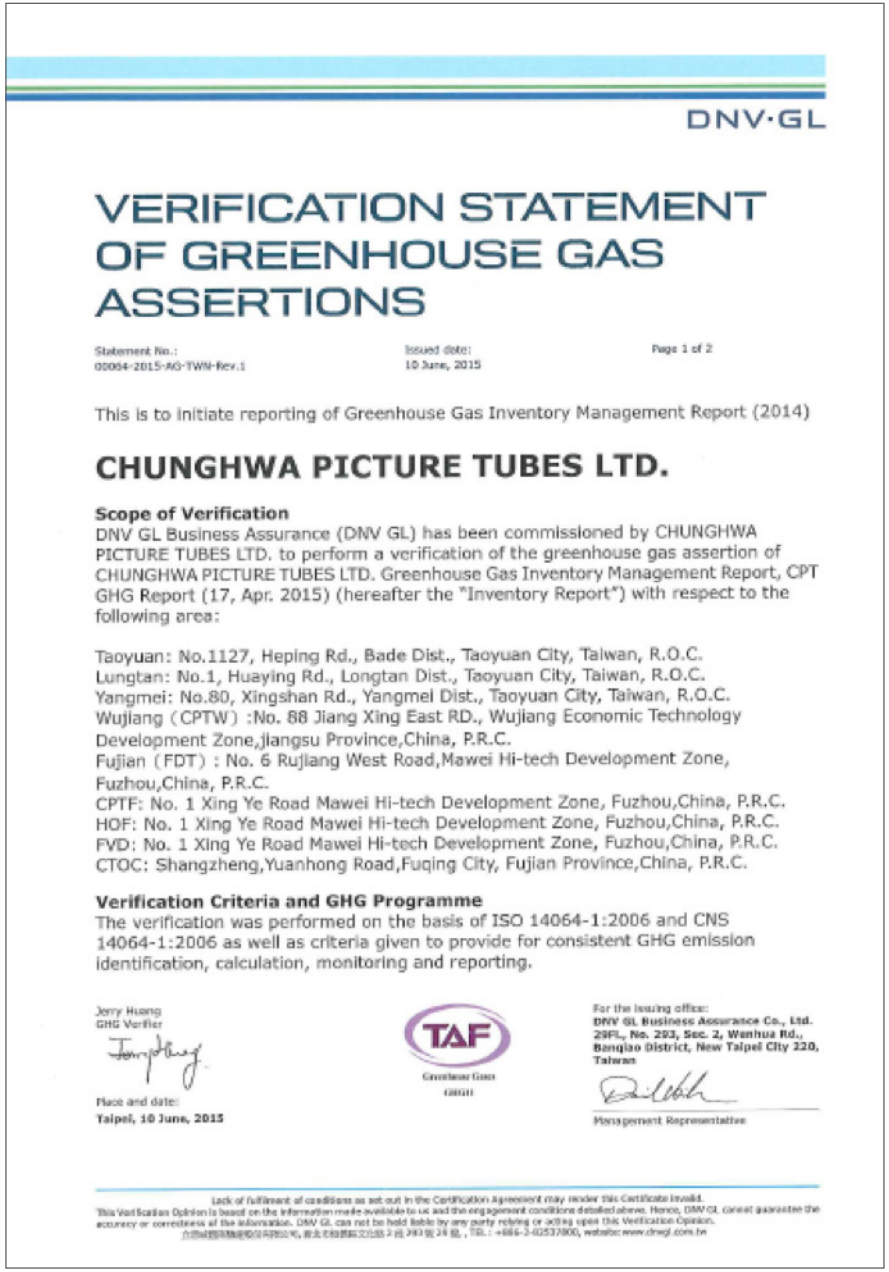
2013 Data:

Facility	Scope 1 emissions (metric tons CO_2e)
CPTT	151,053
CPTL	422,052
CPTY	6,141
CPTW	1,834
FDT	119
FVD	95
CTOC	223
CPTF	2,718

F-GHG Emissions Measurements		
		For context, in 2008, its base year, CPT's F-GHG emissions amounted to 505,000 tons of CO_2e. In 2013 emissions equaled 483,000 tons of CO_2e, a decrease from base year emissions, but an increase over F-GHG emissions in 2012. CPT attributes the increase to improved production capacities that led to higher F-GHG consumption and process yield issues required a switch back to SF_6 from NF_3 for certain machinery (SF_6 has a higher global warming potential). In 2012, CPT's F-GHG emissions accounted for 30.17 percent of the company's total GHG emissions. In 2011, CPT's F-GHG emissions accounted for 24 percent of the company's total GHG emissions.* **Important:** The emissions cannot be compared to the emissions from other suppliers because they may use different estimation methods and monitoring practices to calculate their emissions. These process emissions may also reflect manufacturing processes that create additional products other than large-area flat panel displays. *Sources:* *CPT's Responses to the 2015 CDP Investor Questionnaire.* *CPT 2013 Corporate Social Responsibility Report (page 30).* **Information available on CPT's website in prior years.*
	Total annual F-GHG emissions reductions and/or rate of emissions reductions	Per CPT's GHG reduction commitments, reconstruction of the chemical vapor deposition (CVD) process in the Taoyuan and Longtan plants were completed, resulting in a 38% emission reduction of fluorinated compounds from 2010 levels, equal to a reduction of approximately 170,000 tons of carbon dioxide. CPT estimates reducing F-GHG emissions by approximately 30 million tons of CO_2e between 2002 and 2014, up from approximately 28 million tons of CO_2e by 2013 and approximately 24.7 million tons of CO_2e by 2012. *Sources:* *CPT* *CPT's Responses to the 2015 CDP Investor Questionnaire.* *CPT Website: Social Responsibility—Environmental Management. (www.cptt.com.tw/index.php?option=com_content&task=view&id=447&Itemid=180)*

F-GHG Emissions Measurements

Methodology used to estimate F-GHG emissions	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. *Source: CPT*
Third party assurance for F-GHG emissions estimates	CPT's annual total GHG inventory undergoes third party verification. The following pages are part of CPT's "Verification Statement of Greenhouse Gas Assertions" for 2014. *Source:* *CPT Website: Environmental Management.* *(www.cptt.com.tw/cptt/english/images/stories/08_CSR/CSR_07/GHG.pdf)*



DNV·GL

VERIFICATION STATEMENT OF GREENHOUSE GAS ASSERTIONS

Statement No.:
00004-2015-AG-TWN-Rev.1

Issued date:
10 June, 2015

This is to initiate reporting of Greenhouse Gas Inventory Management Report (2014)

CHUNGHWA PICTURE TUBES LTD.

Scope of Verification
DNV GL Business Assurance (DNV GL) has been commissioned by CHUNGHWA PICTURE TUBES LTD. to perform a verification of the greenhouse gas assertion of CHUNGHWA PICTURE TUBES LTD. Greenhouse Gas Inventory Management Report, CPT GHG Report (17, Apr. 2015) (hereafter the "Inventory Report") with respect to the following area:

Taoyuan: No.1127, Heping Rd., Bade Dist., Taoyuan City, Taiwan, R.O.C.
Lungtan: No.1, Huaying Rd., Longtan Dist., Taoyuan City, Taiwan, R.O.C.
Yangmei: No.80, Xingshan Rd., Yangmei Dist., Taoyuan City, Taiwan, R.O.C.
Wujiang（CPTW）:No. 88 Jiang Xing East RD., Wujiang Economic Technology Development Zone,jiangsu Province,China, P.R.C.
Fujian（FDT）: No. 6 Rujiang West Road,Mawei Hi-tech Development Zone, Fuzhou,China, P.R.C.
CPTF: No. 1 Xing Ye Road Mawei Hi-tech Development Zone, Fuzhou,China, P.R.C.
HOF: No. 1 Xing Ye Road Mawei Hi-tech Development Zone, Fuzhou,China, P.R.C.
FVD: No. 1 Xing Ye Road Mawei Hi-tech Development Zone, Fuzhou,China, P.R.C.
CTOC: Shangzheng,Yuanhong Road,Fuqing City, Fujian Province,China, P.R.C.

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 criteria given to provide for consistent GHG emission identification, calculation, monitoring and reporting.

Jerry Huang
GHG Verifier

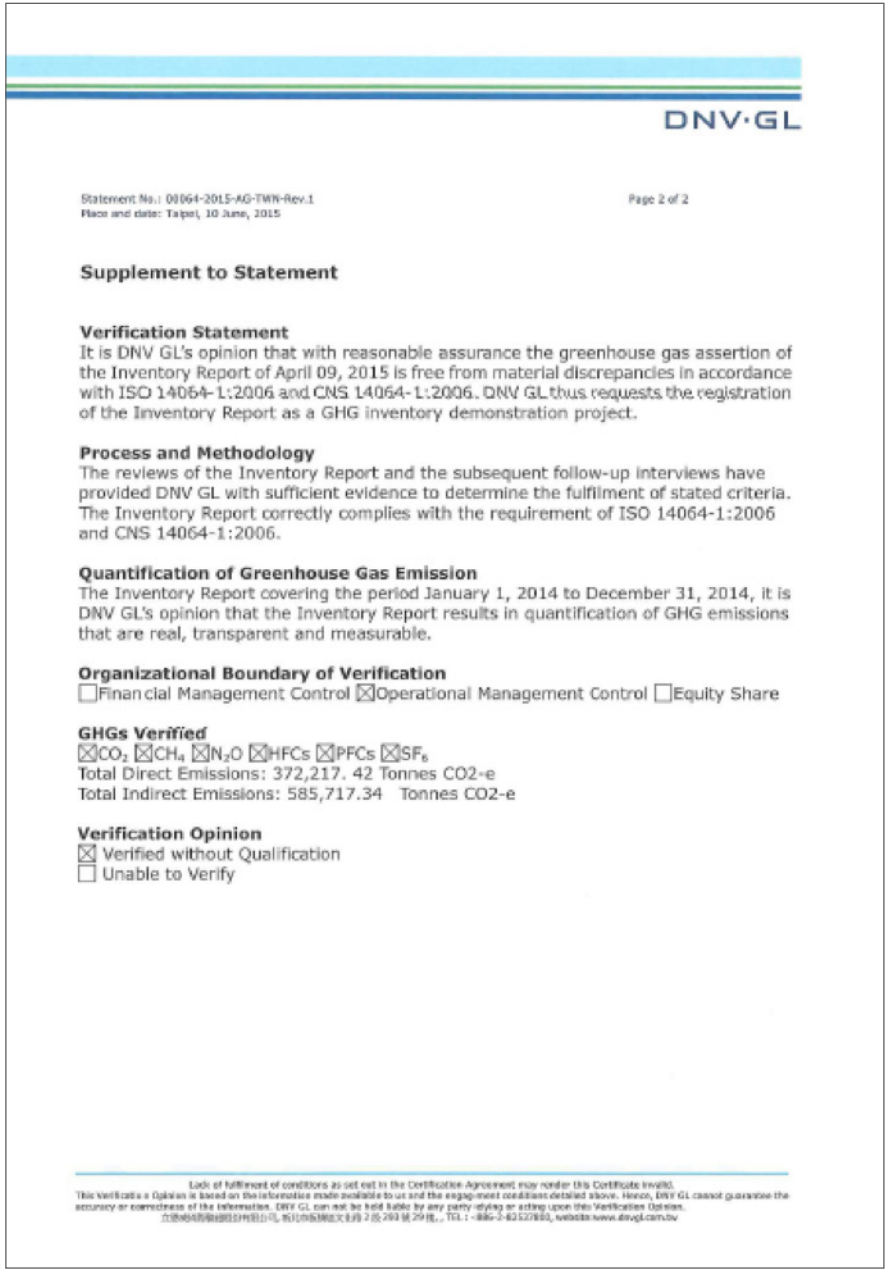
Place and date:
Taipei, 10 June, 2015

TAF
Greenhouse Gases

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

Management Representative

Lack of fulfilment 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 the engagement conditions detailed above. Hence, DNV GL cannot guarantee the accuracy or correctness of the information. DNV GL can not be held liable by any party relying or acting upon this Verification Opinion.
[illegible], TEL: +886-3-0253800, website: www.dnvgl.com.tw



DNV·GL

Statement No.: 00064-2015-AG-TWN-Rev.1 Page 2 of 2
Place and date: Taipei, 10 June, 2015

Supplement to Statement

Verification Statement
It is DNV GL's opinion that with reasonable assurance the greenhouse gas assertion of the Inventory Report of April 09, 2015 is free 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.

Process and Methodology
The reviews of the Inventory Report and the subsequent follow-up interviews have provided DNV GL with sufficient evidence to determine the fulfilment of stated criteria. The Inventory Report correctly complies with the requirement of ISO 14064-1:2006 and CNS 14064-1:2006.

Quantification of Greenhouse Gas Emission
The Inventory Report covering the period January 1, 2014 to December 31, 2014, it is DNV GL's opinion that the Inventory Report results in quantification of GHG emissions that are real, transparent and measurable.

Organizational Boundary of Verification
☐Financial Management Control ☒Operational Management Control ☐Equity Share

GHGs Verified
☒CO_2 ☒CH_4 ☒N_2O ☒HFCs ☒PFCs ☒SF_6
Total Direct Emissions: 372,217. 42 Tonnes CO2-e
Total Indirect Emissions: 585,717.34 Tonnes CO2-e

Verification Opinion
☒ Verified without Qualification
☐ Unable to Verify

Lack of fulfilment 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 the engagement conditions detailed above. Hence, DNV GL cannot guarantee the accuracy or correctness of the information. DNV GL can not be held liable by any party relying or acting upon this Verification Opinion.
[redacted], TEL: [redacted], website:www.dnvgl.com.tw

HannStar

Overview

Specific F-GHG emissions reduction efforts and/or goals	At the beginning of the construction of a TFT-LCD manufacturing plant in Taiwan in 2002, HannStar actively made voluntary investment in the installation of the high efficiency Local Scrubber to reduce the emission of SF_6, NF_3 and other PFCs. As part of the memorandum of understanding (MOU) in 2004 with the Taiwan TFT-LCD Association (TTLA) and Taiwan's Environmental Protection Administration, HannStar promised to install abatement equipment with over 90 percent destruction and removal efficiency (DRE) in all new fabs designed after 2003. HannStar reduced approximately 1.33 million tons of F-GHG emissions in CO_2e from 2007–2012. In 2013, HannStar reduced 89,000 tons of CO_2e by voluntarily installing high-efficiency burning local scrubbers to reduce F-GHG emissions, namely SF_6 and NF_3 emissions. In 2014, HannStar reduced 91,000 metric tons F-GHG emissions in CO_2e. *Sources:* *HannStar* *HannStar 2014 Corporate Social Responsibility Report (page 63–64).* *(www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2014CSR_en.pdf)* *"SF_6 Abatement Strategy in Taiwan". Presentation by Taiwan's Industrial Technology Research Institute (ITRI), 2004.*
+ F-GHG emissions reduction efforts/goals target the following key processes that emit F-GHGs	Etch and Clean processes. HannStar does not use fluorinated heat transfer fluids. *Source:* *HannStar*
+ F-GHG emissions reduction efforts/goals target the following F-GHGs emitted	SF_6, PFCs, HFCs, NF_3. *Sources:* *HannStar 2013 Corporate Social Responsibility Report.* *(www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2013CSR_en.pdf)* *TTLA presentation at APEC meeting, August 2012, Taiwan.*

Overview

Participation in national and/or international mandatory and/or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing	HannStar is a member of the Taiwan TFT-LCD Association (TTLA). TTLA participates on behalf of Taiwan's LCD suppliers in the World Display Industry Cooperation Committee (WDICC), an international industry initiative that previously set goals to reduce F-GHG emissions (formerly the World LCD Industry Cooperation Committee). In 2004, TTLA and Taiwan's Environmental Protection Administration signed an MOU where TTLA agreed to choose 2002 as the base year for reducing F-GHG emissions and to reduce F-GHGs emissions intensity to 0.0335 tons of CO_2e/m^2 of glass substrate area by 2010 (this target is TTLA's collective goal and does not necessarily reflect each individual supplier's goal). Recently, the TTLA and Taiwan's Industrial Development Bureau, Ministry of Economic Affairs signed a "Voluntary GHG Reduction Agreement," for 2011–2015, which aims to achieve additional GHG reductions by 12 million metric tons of CO_2e within 5 years. In Taiwan, F-GHG emission reductions by flat panel display manufacturers are still voluntary. However, as of 2012, Taiwan's EPA listed PFCs, HFCs, and SF_6 (including non-F-GHGs CO_2, CH_4, and N_2O) as air pollutants and has indicated that it will implement emissions control measures under the Air Pollution Control Act in the future. *Sources:* *"SF_6 Abatement Strategy in Taiwan". Presentation by Taiwan's Industrial Technology Research Institute (ITRI), 2004.* *TTLA*
Corporate-wide GHG emissions reduction goals and reduction initiatives	The results of the inventory conducted in 2014 show that about 97.7% of GHG emissions are due to electricity consumption and F-GHGs emissions. Approximately 28.2% of emissions are attributed to direct GHG emissions (namely F-GHGs) and 71.8% are attributed to Scope 2 emission (purchased electricity and steam consumption). HannStar's overall GHG emissions of both Scope 1 and Scope 2 emissions in 2014 amounted 0.381 million mt of CO_2e, and the inventory area covers the production factories in both Taiwan and China. 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 efforts on reducing energy use and F-GHG emissions. Among the GHG, Perfluorinated Compounds (PFCs) are only used and emitted in the TFT-LCD manufacturing process in Taiwan factories. HannStar lowered its overall GHG emissions intensity by 61 percent from 2005 to 2012 down to 0.069 tons of CO_2e/m^2 of glass input. In 2013, it lowered overall GHG emissions intensity again, down to 0.067 tons of CO_2e/m^2 of glass input. In addition, with the continued implementation of the energy conservation measures, the GHG emission intensity of TFT-LCD manufacturing covers the production factories in both Taiwan and China.

Overview		In addition, "HannStar has proceeded ISO 14064-1 inventory and external verification since 2005 and reduces GHG voluntarily." *Sources:* *HannStar 2012 Corporate Social Responsibility Report. (www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2012CSR_en.pdf)* *HannStar 2013 Corporate Social Responsibility Report. (www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2013CSR_en.pdf)* *HannStar 2014 Corporate Social Responsibility Report (pages 63–64). (www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2014CSR_en.pdf)*
F-GHG Reduction Efforts	**Process optimization**	HannStar is optimizing the use of F-GHGs in the process chambers. Additional details not available. *Sources:* *HannStar* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
	Use of alternatives	HannStar is using lower GWP gases, where possible. Additional details not available. *Sources:* *HannStar* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
	Capture and recycling	Information not available.

F-GHG Reduction Efforts

Abatement	
+ Full or partial installation of abatement systems across all new generation fabs	HannStar has installed abatement systems in all newer generation fabs. HannStar promised to install abatement equipment in all fabs established after 2003 to reduce more than 90 percent of F-GHG emissions. Additional details not available. *Sources:* *HannStar 2012 Corporate Social Responsibility Report. (www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2012CSR_en.pdf)* *Taiwan Environmental Protection Administration. "The Initiative and Efforts from Electronic Corporations in Taiwan-Semiconductor and TFT-LCD." (http://unfccc.epa.gov.tw/unfccc/english/_uploads/downloads/05_The_Initiative_and_Efforts_form_Electronic_Industry_in_Taiwan.pdf)* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
+ Ensured that abatement systems are installed, operated, maintained, according to manufacturer specifications	Upon installation at the facility and before HannStar begins operating the abatement system, the abatement equipment manufacturer verifies that the system can meet the default DRE. *Sources:* *HannStar* *TTLA*
+ Indicate whether default factors or actual measurements were used to estimate the DRE Reported destruction or removal efficiency (DRE)	Default factors used. HannStar uses the 2006 IPCC Tier 2b Guidelines for National Greenhouse Gas Inventories for electronics industry emissions, which apply a 90 percent default DRE value for SF_6, CH_4, HFCs and PFCs abatement technologies and a 95 percent default DRE value for NF_3 abatement technologies. *Source:* *HannStar*
+ Practices for monitoring abatement systems	Information not available.

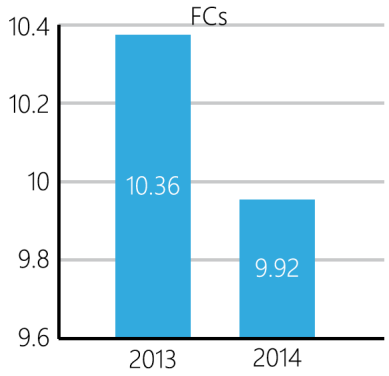
Total annual F-GHG emissions in CO_2e, emitted across all flat panel display manufacturing fabs (2014)

In 2013, HannStar's F-GHG emissions from SF_6 and NF_3 used in LCD manufacturing totaled 103,600 metric tons of CO_2e, a decrease from F-GHG emissions in 2012. F-GHG emissions account for 33.7 percent of HannStar's total GHG inventory and for 95 percent of HannStar's Scope 1 emissions.

GHG Emission Reduction in 2013 and 2014.

Unit: metric ton

	2013	2014
Total	30.7	36
Scope 1	10.87	10.15
Scope 2	19.83	25.81
FCs	10.36	9.92



For reference, listed below is HannStar's 2012 inventory.

GHG	Emissions (t-CO_2-e)	Ratio to total emissions (%)
CO_2	196,894.76	62.1%
CH_4	433.58	0.1%
N_2O	1.65	0.0%
HFC	1,191.79	0.4%
PFCs	1,863.98	0.6%
SF_6	116,463.25	36.8%
Total	**316,849.01**	**100%**

Important: The emissions listed cannot be compared to the emissions from other suppliers because they may use different estimation methods and monitoring practices to calculate their emissions. These process emissions may also reflect manufacturing processes that create additional products other than large-area flat panel displays.

F-GHG Emissions Measurements

Sources:
HannStar

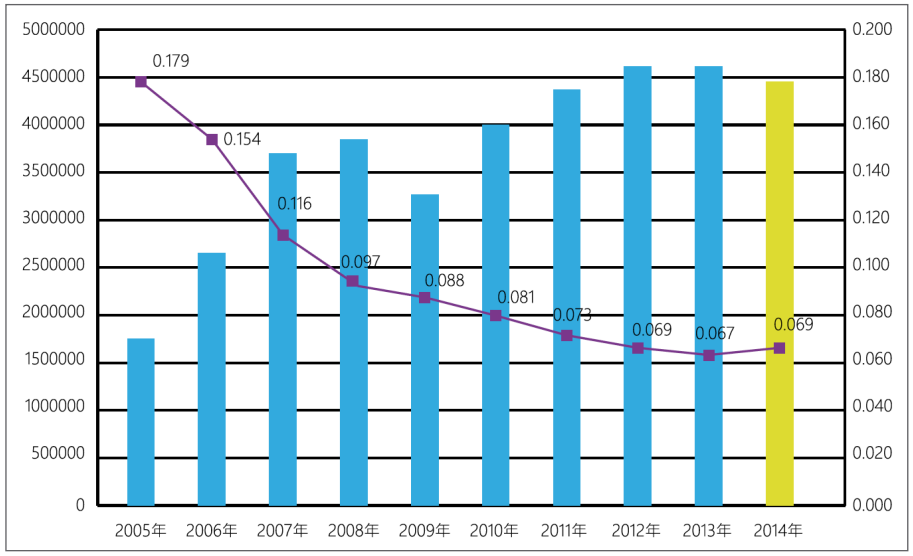
HannStar 2013 Corporate Social Responsibility Report (page 25).
(www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2013CSR_en.pdf)

HannStar 2014 Corporate Social Responsibility Report (pages 63–64).
(www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2014CSR_en.pdf)

Total annual F-GHG emissions reductions and/or rate of emissions reductions

With regard to F-GHG emissions, HannStar reduced approximately 1.33 million tons of CO_2e from 2007–2012. In 2013, HannStar reduced F-GHG emissions by 89,000 tons of CO_2e.

In 2014, HannStar reduced 91,000 metric tons F-GHG emissions in CO_2e.



Sources:
HannStar 2013 Corporate Social Responsibility Report (page 25).
(www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2013CSR_en.pdf)

HannStar 2014 Corporate Social Responsibility Report (pages 63–64).
(www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2014CSR_en.pdf)

F-GHG Emissions Measurements

Methodology used to estimate F-GHG emissions	HannStar 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. *Source:* *HannStar*
Third party assurance for F-GHG emissions estimates	"[All of] HannStar's plants in Taiwan have been implementing GHG inventory and third party verification with reference to ISO 14064-1 since 2005. The Touch Sensor plant in Taiwan incorporated into HannStar in March, 2014 will be included into the GHG inventory system and third party verification from 2015. Our plants in China have been implementing GHG Third Party Inventory Verification since 2012 but have not yet implemented third party verification." *Source:* *HannStar 2014 Corporate Social Responsibility Report (pages 63–64).* *(www.hannstar.com/HannStarUserFile/files/Quality/Hannstar_2014CSR_en.pdf)*

INX (Innolux Corporation)

Overview

Specific F-GHG emissions reduction efforts and/or goals	In 2014, Innolux (INX) reduced its F-GHG emissions to 0.123 MMTCE. An accumulated amount of 11,505,930 tCO_2e of F-GHGs were eliminated due to the employment of combustion local scrubbers between 2010 and 2014. In 2015, INX began focusing on installing more combustion local scrubbers and reducing PFC emissions to 0.116 MMTCE. INX attributes achieving its results to 1) optimizing manufacturing processes and thereby reducing the amount of F-GHGs needed and 2) replacing or installing local burn-type scrubbers at newly built factories and those constructed prior to 2003 to achieve better abatement. In 2010, INX's F-GHG emissions intensity in producing LCD panels was 0.0094 tons of CO_2e/m^2 of glass substrate. INX then set a new goal to further reduce F-GHG emissions intensity to 0.0089 tons of CO_2e/m^2 in 2013. In 2012, the F-GHG emissions intensity was 0.008558 tons of CO_2e/m^2 and in 2013, it dropped to 0.0073 tons of CO_2e/m^2. *Sources:* *INX* *2014 INX CSR Report (pages 44 and 53).* *(www.innolux.com/Files/CWSFiles/csr/2014_INX%20CSR%20report-en.pdf)* *"SF_6 Abatement Strategy in Taiwan". Presentation by Taiwan's Industrial Technology Research Institute (ITRI), 2004.*
+ F-GHG emissions reduction efforts/goals target the following key processes that emit F-GHGs	Etch and Clean processes. INX uses a small amount of fluorinated heat transfer fluids, but has not inventoried them. *Sources:* *INX* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
+ F-GHG emissions reduction efforts/goals target the following F-GHGs emitted	SF_6, PFCs, HFCs, NF_3. *Sources:* *INX's responses to the 2014 Carbon Disclosure Project Investor Questionnaire.* *TTLA presentation at APEC meeting, August 2012, Taiwan.*

Overview

Participation in national and/or international mandatory and/or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing

INX is a member of the Taiwanese TFT-LCD Association (TTLA). TTLA participates on behalf of Taiwan's LCD suppliers in the World Display Industry Cooperation Committee (WDICC), an international industry initiative that previously set goals to reduce F-GHG emissions (formerly the World LCD Industry Cooperation Committee).

In 2004, TTLA and Taiwan's Environmental Protection Agency signed a memorandum of understanding (MOU), agreeing to reduce F-GHGs emissions intensity to 0.0335 tons of CO_2e/m^2 of glass substrate area by 2010, using 2002 as the base year. This target reflected TTLA's collective goal, though INX also met the goal individually. In 2013, INX, together with TTLA, began discussion with the Taiwan EPA to initiate a second MOU to pursue additional commitments to voluntary reductions. In response to requests by Walmart, Dell and Lenovo from LCD panel suppliers to reduce carbon emissions voluntarily, INX is also participating through TTLA and the WDICC in an effort to set goals for a long-term reduction in F-GHG emissions in cooperation with panel manufacturers of other countries.

The TTLA and Taiwan's Industrial Development Bureau, Ministry of Economic Affairs signed a "Voluntary GHG Reduction Agreement," for 2011–2015, which aims to achieve additional GHG reductions by 12 million metric tons of CO_2e within 5 years. In Taiwan, F-GHG emission reductions by flat panel display manufacturers are still voluntary. However, as of 2012, Taiwan's EPA listed PFCs, HFCs, and SF_6 (including non-F-GHGs CO_2, CH_4, and N_2O) as air pollutants and has indicated that it will implement emissions control measures under the Air Pollution Control Act in the future. In 2013, INX discussed with the Taiwan EPA the methodology for developing Taiwan's carbon credit calculation as part of its forthcoming cap and trade program. INX indicated that in 2014, it would join Taiwan's "Clean Carbon Alliance" to gain a better understanding of management trends in Taiwan to reduce carbon-related risks and create more opportunities to develop carbon asset value.

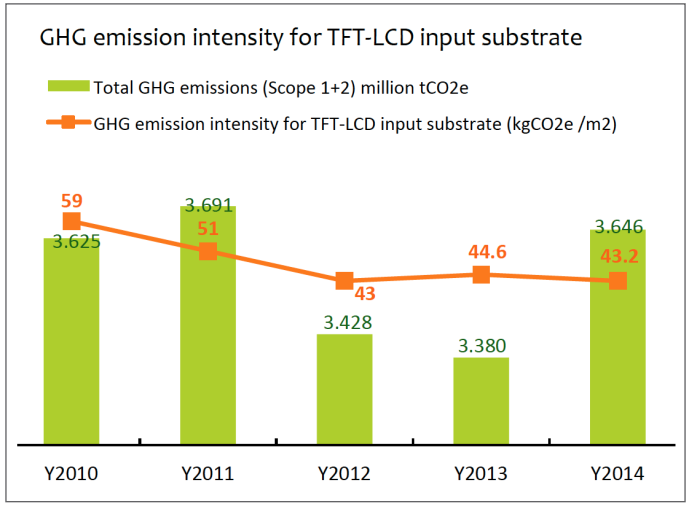
Sources:
INX's responses to the 2014 Carbon Disclosure Project Investor Questionnaire.

"SF_6 Abatement Strategy in Taiwan". Presentation by Taiwan's Industrial Technology Research Institute (ITRI), 2004.

TTLA

Corporate-wide GHG emissions reduction goals and reduction initiatives

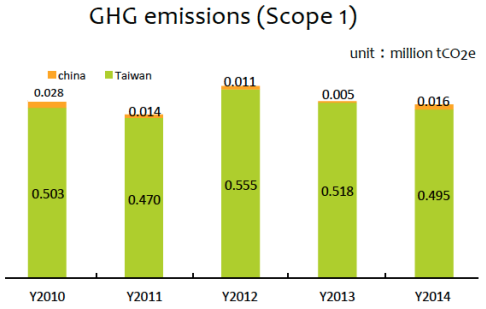
In manufacturing LCD panels, INX reduced the GHG emission intensity per unit area from 59 kg CO_2e/m^2 in 2010 to 43.2 kg CO_2e/m^2 in 2014, for a reduction of 26.7%. INX achieved a reduction of 3.1% from 2013 to 2014.



Statistical Analysis of GHG Inventory

Scope 1
Direct GHG Emission

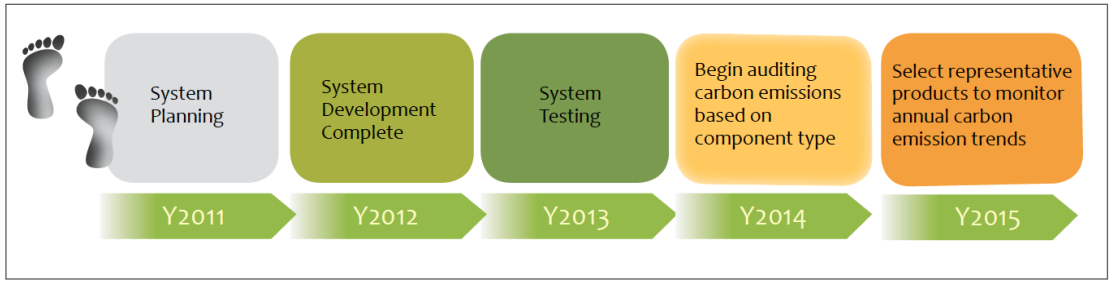
Inventory scope:
Quantitative and qualitative inventory of various PFCs, such as SF_6, NF_3, and CF_4, and fuels in public systems.
- Emission: **0.511** million tCO_2e in **2014**



Information assembled by the U.S Environmental Protection Agency's Office of Air and Radiation.
Current as of September 2016.

Overview

In addition, in 2013, INX released its own Product Carbon Footprint (PCF) system to help streamline calculations of emissions on a per product basis. After completing the PCF system, INX began building the component carbon emission database to facilitate an efficient assessment of product carbon emissions. In 2014, common vendors were classified based on product type, and the carbon emission of each component was inspected on the basis that the database must contain at least one vendor and one component in each category. Then, INX expanded its scope of inspections to obtain a more comprehensive component carbon emission database and to implement the database into the design stage of new products, enabling designers to select low-carbon materials to achieve low-carbon products. In 2015, according to INX's plans, INX selected representative products to track the annual changes in carbon emission to verify the effectiveness of its low-carbon green product management policies.



Sources:
INX's responses to the 2015 Carbon Disclosure Project Investor and Supply chain Questionnaires.

2014 INX CSR Report (pages 52 and 63).
(www.innolux.com/Files/CWSFiles/csr/2014_INX%20CSR%20report-en.pdf)

F-GHG Reduction Efforts

Process optimization

INX is optimizing the use of F-GHGs in the process chambers. Additional details not available.

Sources:
INX

TTLA presentation at APEC meeting, August 2012, Taiwan.

Use of alternatives

INX is using lower GWP gases, where possible. Additional details not available.

Sources:
INX

TTLA presentation at APEC meeting, August 2012, Taiwan.

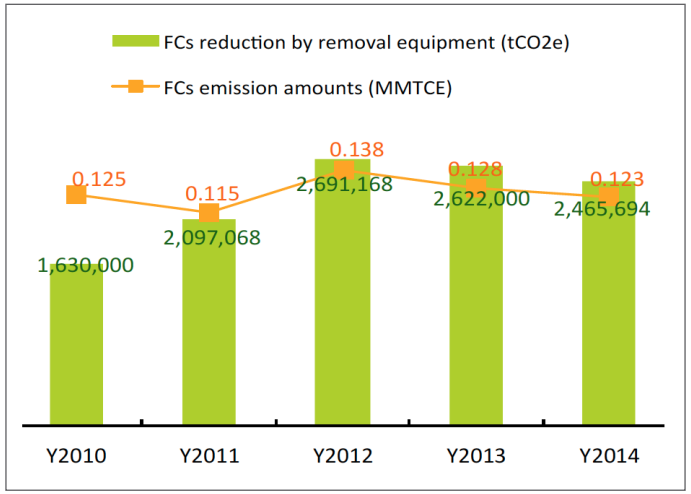
F-GHG Reduction Efforts		
	Capture and recycling	INX is working with Industrial Technology Research Institute of Taiwan to test SF_6 liquefaction recovery system. If it works, INX will expand the system across applicable fabs. *Source: INX*
	Abatement	
	+ Full or partial installation of abatement systems across all new generation fabs	INX has installed abatement systems in all newer generation fabs. In addition, fabs constructed prior to 2003 have also been successively equipped with burn type point of use (POU) abatement systems. For process emissions that use F-GHGs, INX has installed point of use abatement systems that are mostly combustion-type local scrubbers fitted to the back end of production machinery and some thermal-type local scrubbers on select equipment. Combustion local scrubbers use fuel and air to convert SF_6 and NF_3 into low-weight, highly soluble polar compounds under extreme heat, and then eliminate these compounds with water. Local scrubbers are able to eliminate 90% of F-GHG emissions. *Sources:* *2014 INX CSR Report (page 53).* *(www.innolux.com/Files/CWSFiles/csr/2014_INX%20CSR%20report-en.pdf)* *Taiwan Environmental Protection Administration. "The Initiative and Efforts from Electronic Corporations in Taiwan-Semiconductor and TFT-LCD." (http://unfccc.epa.gov.tw/unfccc/english/_uploads/downloads/05_The_Initiative_and_Efforts_form_Electronic_Industry_in_Taiwan.pdf)* *TTLA presentation at APEC meeting, August 2012, Taiwan.*
	+ Ensured that abatement systems are installed, operated, maintained, according to manufacturer specifications	Upon installation at the facility and before INX begins operating the abatement system, the abatement equipment manufacturer verifies that the system can meet the default DRE. *Sources:* *INX* *TTLA*

F-GHG Reduction Efforts	+ Indicate whether default factors or actual measurements were used to estimate the DRE Reported destruction or removal efficiency (DRE)	Default factors used. INX uses the 2006 IPCC Tier 2b Guidelines for National Greenhouse Gas Inventories for electronics industry emissions, which apply a 90 percent default DRE value for SF_6, CF_4, HFCs and PFCs abatement technologies and a 95 percent default DRE value for NF_3 abatement technologies. *Source:* *INX's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.*
	+ Practices for monitoring abatement systems	INX controls all processes to follow the standard in the whole process. Additional details not available. *Source: INX*
F-GHG Emissions Measurements	**Total annual F-GHG emissions in CO_2e, emitted across all flat panel display manufacturing fabs (2014)**	In 2014, F-GHGs represented 14 percent of INX's total GHG emissions. As part of its **2015** responses to the Carbon Disclosure Project, which discloses its GHG emissions from **Jan 1, 2014–Dec 31, 2014**, INX lists its total Scope 1 emissions. These Scope 1 emissions represent its organizational boundary, using an operational control approach that includes facilities within Taiwan and in other countries. Its F-GHG emissions, as reported, are as follows, in metric tons of CO_2e: HFCs: 14,487.88 (increase compared to 7,286.74 in CY 2013) PFCs: 23,634.83 (increase compared 20,052.59 in CY 2013) SF_6: 423,314.74 (decrease compared to 463,324.39 in CY 2013) **Important:** The emissions listed cannot be compared to the emissions from other suppliers because they may use different estimation methods and monitoring practices to calculate their emissions. These process emissions may also reflect manufacturing processes that create additional products other than large-area flat panel displays. *Sources:* *INX's responses to the 2015 Carbon Disclosure Project Investor and Supply Chain Questionnaires.* *2014 INX CSR Report (page 52).* *(www.innolux.com/Files/CWSFiles/csr/2014_INX%20CSR%20report-en.pdf)*

F-GHG Emissions Measurements

Total annual F-GHG emissions reductions and/or rate of emissions reductions

In 2014, INX reduced total annual F-GHG emissions by 2,465,694 tons of CO2e, similar to the 2,622,000 tons of CO_2e reduced in 2013.



Sources:
INX

2014 INX CSR Report (page 53).
(www.innolux.com/Files/CWSFiles/csr/2014_INX%20CSR%20report-en.pdf)

INX's responses to the 2014 Carbon Disclosure Project Investor and Supply Chain Questionnaires.

Methodology used to estimate F-GHG emissions

INX 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.

Source:
INX's responses to the 2014 Carbon Disclosure Project Investor Questionnaire.

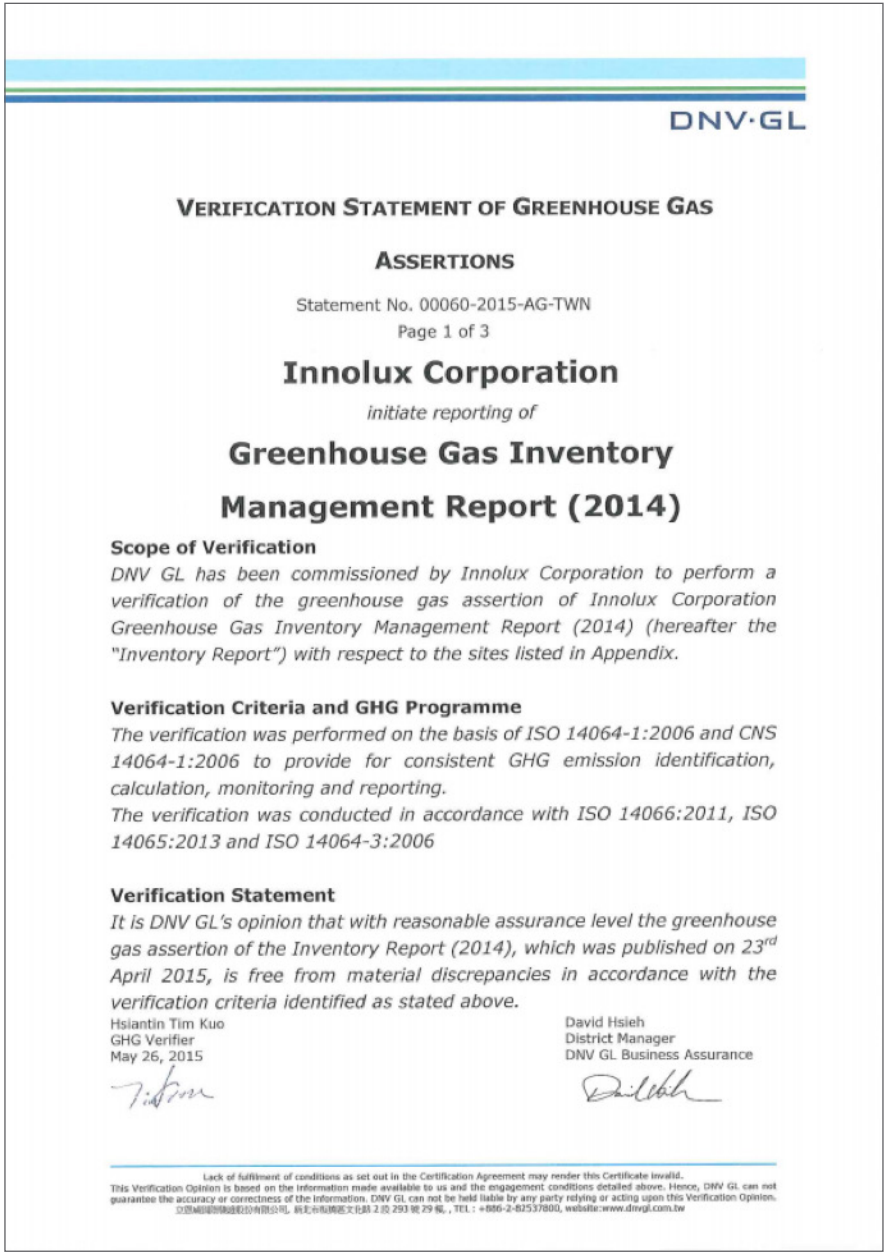
F-GHG Emissions Measurements

Third party assurance for F-GHG emissions estimates

INX received third party verification for its 2014 GHG inventory, which was verified in accordance with the ISO-14064-3 standard.

The following pages are part of INX's "Verification Statement of Greenhouse Gas Assertions" for 2014.

Source:
INX's responses to the 2015 Carbon Disclosure Project Investor.



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VERIFICATION STATEMENT OF GREENHOUSE GAS

ASSERTIONS

Statement No. 00060-2015-AG-TWN

Page 1 of 3

Innolux Corporation

initiate reporting of

Greenhouse Gas Inventory Management Report (2014)

Scope of Verification

DNV GL has been commissioned by Innolux Corporation to perform a verification of the greenhouse gas assertion of Innolux Corporation Greenhouse Gas Inventory Management Report (2014) (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 to provide for consistent GHG emission identification, calculation, monitoring and reporting.

The verification was conducted in accordance with ISO 14066:2011, ISO 14065:2013 and ISO 14064-3:2006

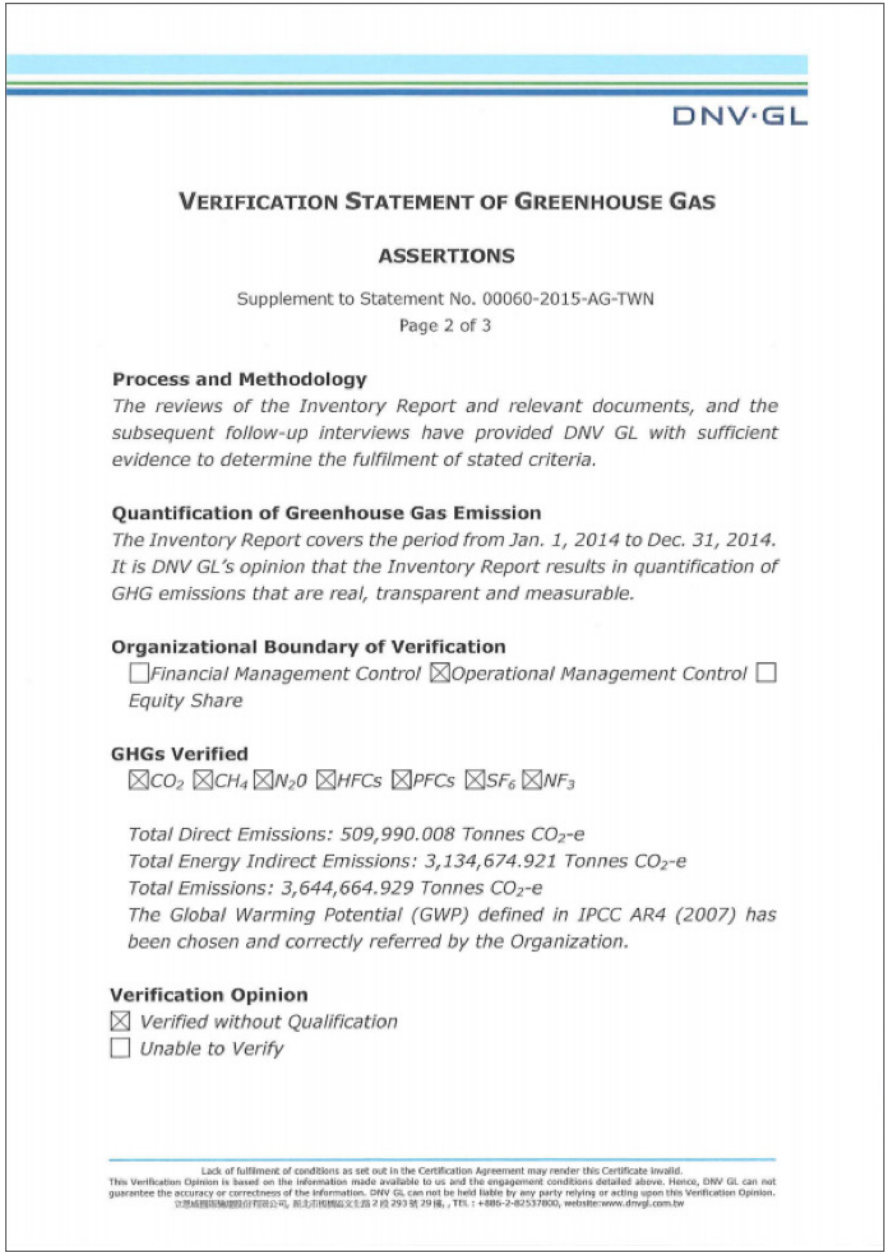
Verification Statement

It is DNV GL's opinion that with reasonable assurance level the greenhouse gas assertion of the Inventory Report (2014), which was published on 23rd April 2015, is free from material discrepancies in accordance with the verification criteria identified as stated above.

Hsiantin Tim Kuo
GHG Verifier
May 26, 2015

David Hsieh
District Manager
DNV GL Business Assurance

Lack of fulfilment 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 the engagement conditions detailed above. Hence, DNV GL can not guarantee the accuracy or correctness of the information. DNV GL can not be held liable by any party relying or acting upon this Verification Opinion.
[illegible], TEL: +886-2-82537800, website:www.dnvgl.com.tw



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VERIFICATION STATEMENT OF GREENHOUSE GAS

ASSERTIONS

Supplement to Statement No. 00060-2015-AG-TWN

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Process and Methodology

The reviews of the Inventory Report and relevant documents, and the subsequent follow-up interviews have provided DNV GL with sufficient evidence to determine the fulfilment of stated criteria.

Quantification of Greenhouse Gas Emission

The Inventory Report covers the period from Jan. 1, 2014 to Dec. 31, 2014. It is DNV GL's opinion that the Inventory Report results in quantification of GHG emissions that are real, transparent and measurable.

Organizational Boundary of Verification

☐ *Financial Management Control* ☒ *Operational Management Control* ☐ *Equity Share*

GHGs Verified

☒ CO_2 ☒ CH_4 ☒ N_20 ☒ *HFCs* ☒ *PFCs* ☒ SF_6 ☒ NF_3

Total Direct Emissions: 509,990.008 Tonnes CO_2-e
Total Energy Indirect Emissions: 3,134,674.921 Tonnes CO_2-e
Total Emissions: 3,644,664.929 Tonnes CO_2-e
The Global Warming Potential (GWP) defined in IPCC AR4 (2007) has been chosen and correctly referred by the Organization.

Verification Opinion

☒ *Verified without Qualification*
☐ *Unable to Verify*

DNV·GL

Verification Statement of Greenhouse Gas

Assertions

Supplement to Statement No. 00060-2015-AG-TWN

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Appendix

The greenhouse gas assertion of Innolux Corporation Greenhouse Gas Inventory Management Report (2014) with respect to the following sites:

Site	Address	Total Direct Emissions (Tonnes CO2-e)	Total Energy Indirect Emissions (Tonnes CO2-e)	Total Emission (Tonnes CO2-e)
Innolux Corporation-Head Quarter (T1)	No.160, Kesyue Rd., Jhunan Science Park, Miaoli County, Taiwan (R.O.C.)	36,365.791	130,273.556	166,639.347
Innolux Corporation- Jhunan Operation Center (T2)	No.168, Kesyue Rd., Jhunan Science Park, Miaoli County, Taiwan (R.O.C.)	18,639.140	221,272.508	239,911.648
Innolux Corporation-Fab T3	No. 12, Kejung Road, Jhunan Science Park, Miaoli County, Taiwan (R.O.C.)	33,432.935	119,398.672	152,831.607
Innolux Corporation-Fab Pingjen	No. 458, Jung Shing Road, PingJen, Taoyuan, Taiwan (R.O.C.)	15.815	17,742.754	17,758.569
Innolux Corporation-TOC	No.3, Sec. 1, Huansi Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	352.929	317,227.151	317,580.080
Innolux Corporation-Fab 1	No.1, Ciye Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	26,509.842	70,367.270	96,877.112
Innolux Corporation-Fab 2	No.2, Sec. 2, Huansi Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	56,793.006	86,226.375	143,019.381
Innolux Corporation-Fab 3	No.2, Sec. 2, Huansi Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	183,006.070	171,520.718	354,526.788
Innolux Corporation-Fab 4	No.3, Sec. 1, Huansi Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	26,181.168	281,788.132	307,969.300
Innolux Corporation-Fab 5	No.2, Sec. 2, Huansi Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	16,834.082	209,063.923	225,898.005
Innolux Corporation-Fab 6	No. 21, Zihlan Road, Sinshih District, Tainan City, Taiwan (R.O.C.)	38,249.865	405,332.200	443,582.065
Innolux Corporation-Fab 7	No.3, Sec. 1, Huansi Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	41,130.734	369,797.493	410,928.227
Innolux Corporation-Fab 8	No.11, Luke 10th Rd., Kaohsiung City , Southern Taiwan Science Park, Taiwan (R.O.C.)	16,800.994	206,346.186	223,147.180
Innolux Corporation-LCM	No.12, Nanke 8th Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	110.817	19,404.583	19,515.400
Innolux Corporation-C3	No.12, Nanke 8th Rd., Tainan City, Southern Taiwan Science Park, Taiwan(R.O.C)	176.133	35,491.452	35,667.585
Innolux Corporation-C5	No.3, Sec.1, Huansi Rd., Tainan City, Southern Taiwan Science Park, Taiwan(R.O.C)	117.491	8,713.421	8,830.912
Innolux Corporation-MOD 2	No.12, Nanke 8th Rd., Tainan City, Southern Taiwan Science Park, Taiwan (R.O.C.)	86.815	10,126.204	10,213.019
Innolux Corporation-Neihu Office	2F., No.35, Ln. 513, Ruiguang Rd., Neihu Dist., Taipei City, Taiwan (R.O.C.)	0.000	13.035	13.035
Innolux Corporation-Recreation	No. 22, Zihlan Road, Sinshih District, Tainan City, Taiwan (R.O.C.)	0.166	513.481	513.647
Ningbo Innolux Optoeletronics Ltd	No.16, YangZi River North Rd., Ningbo Export Processing Zone, China No.6, YangZi River South Rd., Ningbo Export Processing Zone, China	8,099.069	194,360.597	202,459.666
Ningbo Innolux Technology Ltd	No.9, YangZi River North Rd., Ningbo Export Processing Zone, China			
Ningbo Innolux Display Ltd	No.8 Cao'E River Rd.,Ningbo Free Trade South Zone,China			
Ningbo Innolux Logistics Ltd	No.8 ALi Shan Rd, Ningbo Export Processing Zone, China			
Foshan Innolux Optoeletronics Ltd	Xingye North Rd., Naihai Science & Technology Industry Garden, Naihai Foshan, Guangdong, 528237, China	5,693.330	163,720.378	169,413.708
NanJing Innolux Optoeletronics Ltd	No.93, Fu Cheng West Road, Jiangning Economic and Technical Development Zone, Nanjing, China	1,019.339	69,336.444	70,355.783
Shanghai Innolux Optoeletronics Ltd	No.272-2, Ba Sheng Road, New Customs, Wai Gao Qiao Free Trade Zone, Pudong, Shanghai, China	319.091	17,577.328	17,896.419
Kunpal Optoelectronics Co., Ltd	No.93, Fu Cheng West Road, Jiangning Economic and Technical Development Zone, Nanjing, China	3.820	4,309.733	4,313.553
Innocom Technology (Shenzhen) Co., Ltd	No.2, 2nd Donghuan Road, 10th Yousong Industrial District, Longhua, Baoan, Shenzhen City, Guangdong Province, China	51.566	4,751.327	4,802.893
Total		509,990.008	3,134,674.921	3,644,664.929

LG Display

Overview

Specific F-GHG emissions reduction efforts and/or goals	LG Display's F-GHG emissions reduction efforts are part of its broader goals to reduce corporate-wide GHG emissions. LG Display has installed F-GHG abatement systems to reduce NF_3 emissions from all of its flat panel display (LCD, OLED) manufacturing fabs, and SF_6 emissions from two of its flat panel display (LCD) manufacturing fabs. In 2014, LG Display developed an alternative gas application technology to using SF_6, thus reducing both F-GHG emissions and costs. *Sources:* *LG Display (response in 2014 regarding 2012/2013 data).* *LG Display 2013–2014 and 2014–2015 Sustainability Report. (www.lgdisplay.com/eng/sustainability/report#)* *LG Display's responses to the 2011 Carbon Disclosure Project Investor Questionnaire.* *"Point of Use Abatement Device to Reduce SF_6 emissions in LCD Manufacturing Operation in the Republic of Korea (South Korea)." LG Display's SF_6 Abatement Project. Clean Development Mechanism Project: 3440. (https://cdm.unfccc.int/Projects/DB/SGS-UKL1266943063.39/view)*
+ F-GHG emissions reduction efforts/goals target the following key processes that emit F-GHGs	Etch and Clean processes. Fluorinated heat transfer fluids are not used. *Sources:* *LG Display (response in 2014 regarding 2012/2013 data).* *Korea Display Industry Association.*
+ F-GHG emissions reduction efforts/goals target the following F-GHGs emitted	SF_6, PFCs, NF_3. (HFCs are not used in processes). *Sources:* *LG Display (response in 2014 regarding 2012/2013 data).* *LG Display's responses to the 2011 Carbon Disclosure Project Investor Questionnaire.*

Overview

Participation in national and/or international mandatory and/or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing

LG Display is a member of the Korea Display Industry Association (KDIA), where it participates in an environmental working group that promotes information exchange on GHG emissions reduction technologies and initiatives. KDIA represents Korea's flat panel display suppliers in the World Display device Industry Cooperation Committee (WDICC), an international industry initiative that previously set goals to reduce F-GHG emissions (formerly the World LCD Industry Cooperation Committee).

From 2010–April 2013, LG Display participated in a United Nations Clean Development Mechanism (CDM) Project to reduce SF_6 emissions at two of its manufacturing fabs. Between August 2010 and April 2011, LG Display was credited by the UNFCC for 557,053 tons of CO_2e in GHG reductions. As of April 2013, LG Display stopped the CDM project, such that there have been no more GHG reductions.

The South Korean government set a long term national GHG emissions reduction goal and set different reduction goals for various industries, including the display panel industry. In 2010, the government launched its GHG target management scheme, which regulates CO_2, HFCs, PFCs, and SF_6 (and non-FGHGs, N_2O and CH_4). In January 2015, the government launched a 'cap and trade' system for limiting and trading domestic GHG emissions, setting the amount of allowable greenhouse gas emissions for each company. Companies that incur higher costs for reducing GHG emissions have the option to purchase emissions permits in the market, whereas companies that would incur relatively lower costs for GHG mitigation may sell extra emissions permits. LG Display expects to gain profits by selling the additional permits to be earned from its participation in the CDM project. To prepare for participating in the cap and trade program, LG Display developed an alternative gas application technology to using SF_6, thus both reducing F-GHG emissions and reducing costs. As noted in LG Display's 2013 profile, the company had been investing in R&D for a substitution gas for the etching process, which most commonly uses SF_6.

Sources:
Korea Display Industry Association.

LG Display 2014–2015 Sustainability Report.
(http://www.lgdisplay.com/eng/sustainability/report#)

LG Display's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.

"Point of Use Abatement Device to Reduce SF_6 emissions in LCD Manufacturing Operation in the Republic of Korea (South Korea)." LG Display's SF_6 Abatement Project. Clean Development Mechanism Project: 3440.
(https://cdm.unfccc.int/Projects/DB/SGS-UKL1266943063.39/view)

Overview	**Corporate-wide GHG emissions reduction goals and reduction initiatives**	LG Display set a corporate-wide GHG reduction goal to reduce its GHG emissions intensity in metric tons of CO_2e per unit of production by 29 percent from 2009 to 2020 (as revised from 40 percent), including both Scope 1 and Scope 2 emissions from all domestic and 4 overseas operation sites. LG Display sets its goals in consultation with LG Corporation, which is the holding company. LG Corporation has been monitoring the results and LG Display's reduction target has been completed since 2010. LG Display participates in the Carbon Disclosure Project and most recently reported on its GHG management efforts in 2015 for its 2014 calendar year. *Sources:* *LG Display (response in 2014 regarding 2012/2013 data).* *LG Display's responses to the 2015 Carbon Disclosure Project Investor Questionnaire.*
F-GHG Reduction Efforts	**Process optimization**	LG Display has applied end-point detection and revised processes to optimize the use of F-GHGs. *Source:* *LG Display (response in 2014 regarding 2012/2013 data).*
	Use of alternatives	LG Display has applied NF_3 remote plasma source chamber clean (RPSC) to all CVD manufacturing lines. An ordinary chamber's NF_3 utilization rate is only 70 percent, however RPSC's NF_3 utilization rate is 97 percent. LG Display has also used F_2 in chamber cleaning on one of its manufacturing lines instead of NF_3. In addition, LG Display continues to research alternative etching gases with lower GWP than SF_6 for the dry etching process. *Sources:* *LG Display (response in 2014 regarding 2012/2013 data).* *LG Display's responses to the 2014 Carbon Disclosure Project Investor Questionnaire.*
	Capture and recycling	LG Display is currently developing new SF_6-concentrating and capturing technology with funding from industry and the South Korean government. *Source:* *LG Display (response in 2014 regarding 2012/2013 data).*

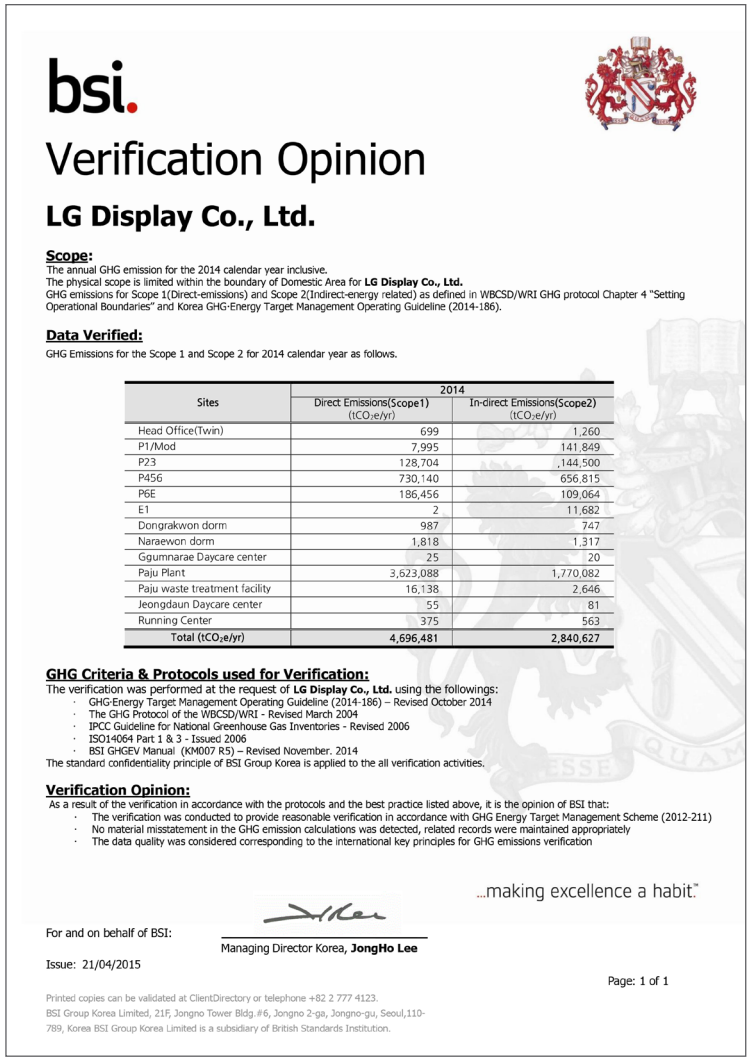
F-GHG Reduction Efforts

Abatement	
+ Full or partial installation of abatement systems across all new generation fabs	LG Display has installed F-GHG abatement systems on all lines of CVD tools and on two lines of etch tools. For NF_3 in CVD tools, electrically heated point of use systems are installed. For SF_6 and PFCs in etch tools, combustion-type centralized systems are installed. *Source:* *LG Display (response in 2014 regarding 2012/2013 data).*
+ Ensured that abatement systems are installed, operated, maintained, according to manufacturer specifications	Yes. At the construction stage, LG Display checks and monitors all items and processes in accordance with the specification. At the commissioning stage, LG Display confirms the performance of abatement in accordance with the guarantee condition of the manufacturer. At the operation stage, LG Display makes an operation contract with the manufacturer, and every year checks the operational performance. In the case of etch tools, LG Display is verified by a third party entity, which is the Designated Operational Entity of CDM projects. *Source:* *LG Display (response in 2014 regarding 2012/2013 data).*
+ Indicate whether default factors or actual measurements were used to estimate the DRE Reported destruction or removal efficiency (DRE)	Actual and default used. LG Display conducts actual measurements for its centralized abatement systems such as its SF_6 abatement projects under the CDM. Under the South Korean government's regulation, LG Display uses the 90 percent default DRE value from 2006 IPCC Tier 2b Guidelines for National Greenhouse Gas Inventories for electronics industry emissions for its SF_6, abatement technologies. In the case of NF_3, which is not regulated by Korean law, LG Display applies the 95 percent default DRE value for NF_3, also taken from the 2006 IPCC Tier 2b Guidelines, in WDICC activities. *Sources:* *LG Display (response in 2014 regarding 2012/2013 data).* *"Point of Use Abatement Device to Reduce SF_6 emissions in LCD Manufacturing Operation in the Republic of Korea (South Korea)." LG Display's SF_6 Abatement Project. Clean Development Mechanism Project: 3440. (https://cdm.unfccc.int/Projects/DB/SGS-UKL1266943063.39/view)*

F-GHG Reduction Efforts	+ Practices for monitoring abatement systems	For its centralized abatement systems, namely for its CDM project that destroys SF_6, LG Display employs a continuous monitoring (FTIR, Annabar system). For its POU systems, LG Display monitors the abatement systems on an as-needed basis. *Sources:* *LG Display (response in 2014 regarding 2012/2013 data).* *"Point of Use Abatement Device to Reduce SF_6 emissions in LCD Manufacturing Operation in the Republic of Korea (South Korea)." LG Display's SF_6 Abatement Project. Clean Development Mechanism Project: 3440. (https://cdm.unfccc.int/Projects/DB/SGS-UKL1266943063.39/view)*
F-GHG Emissions Measurements	**Total annual F-GHG emissions in CO_2e, emitted across all flat panel display manufacturing fabs (2013)**	The following data for 2013 was verified by a third party. Total amount of F-GHG emissions in metric tons of CO_2e: 3,891,229 (increase compared to 3,115,747 in CY 2012). SF_6 emissions: 3,846,096 (increase compared to 3,074,008 in CY 2012) PFCs emissions: 13,058 (increase compared to 5,833 in CY 2012) HFCs emissions: 0 (same as CY 2012) NF_3 emissions: 32,075 (decrease compared to 35,906 in CY 2012) F-GHG emissions for LG Display in 2014 were not publicly reported. **Important:** The emissions listed cannot be compared to the emissions from other suppliers because they may use different estimation methods and monitoring practices to calculate their emissions. In addition, these process emissions may encompass more than emissions associated only with flat panel display manufacturing. *Source:* *LG Display*

F-GHG Emissions Measurements

Total annual F-GHG emissions reductions and/or rate of emissions reductions	Total amount of F-GHG reductions in 2013 in metric tons of CO_2e: 888,404 (decrease in reductions compared to 1,825,238 in CY 2012). SF_6 reductions: 278,985 (decrease in reductions compared to 1,143,028 in CY 2012) PFCs reductions: 0 (same as CY 2012) HFCs reductions: 0 (same as CY 2012) NF_3 reductions: 609,420 (decrease in reductions compared to 682,210 in CY 2012) F-GHG emissions for LG Display in 2014 were not publicly reported. Equation for SF_6 reductions: = Emissions without destruction – Emissions with destruction. Equation for NF_3 reductions: = Emissions without Remote Plasma Source Chamber Clean (RPSC), destruction – Emissions with RPSC, destruction. **Important:** The reductions listed cannot be compared to the reductions from other suppliers because they may use different estimation methods and monitoring practices to calculate their reductions. *Source:* *LG Display (response in 2014 regarding 2012/2013 data).*
Methodology used to estimate F-GHG emissions	LG Display uses national GHGs emission estimation guidelines issued by the South Korean Ministry of Environment and estimates NF_3 emissions by using the 2006 IPCC Tier 2b guidelines. *Source:* *LG Display (response in 2014 regarding 2012/2013 data).*
Third party assurance for F-GHG emissions estimates	LG Display's GHG emissions, such as CO_2, N_2O, CH_4, HFCs, PFCs and SF_6 are assured by a third party in accordance with South Korean government regulations. Also, LG Display received third party assurance for its SF_6 abatement project under the CDM. However, NF_3 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 WDICC members.



bsi.

Verification Opinion

LG Display Co., Ltd.

Scope:
The annual GHG emission for the 2014 calendar year inclusive.
The physical scope is limited within the boundary of Domestic Area for **LG Display Co., Ltd.**
GHG emissions for Scope 1(Direct-emissions) and Scope 2(Indirect-energy related) as defined in WBCSD/WRI GHG protocol Chapter 4 "Setting Operational Boundaries" and Korea GHG·Energy Target Management Operating Guideline (2014-186).

Data Verified:
GHG Emissions for the Scope 1 and Scope 2 for 2014 calendar year as follows.

Sites	2014	
	Direct Emissions(Scope1) (tCO_2e/yr)	In-direct Emissions(Scope2) (tCO_2e/yr)
Head Office(Twin)	699	1,260
P1/Mod	7,995	141,849
P23	128,704	,144,500
P456	730,140	656,815
P6E	186,456	109,064
E1	2	11,682
Dongrakwon dorm	987	747
Naraewon dorm	1,818	1,317
Ggumnarae Daycare center	25	20
Paju Plant	3,623,088	1,770,082
Paju waste treatment facility	16,138	2,646
Jeongdaun Daycare center	55	81
Running Center	375	563
Total (tCO_2e/yr)	4,696,481	2,840,627

GHG Criteria & Protocols used for Verification:
The verification was performed at the request of **LG Display Co., Ltd.** using the followings:
- GHG·Energy Target Management Operating Guideline (2014-186) – Revised October 2014
- The GHG Protocol of the WBCSD/WRI - Revised March 2004
- IPCC Guideline for National Greenhouse Gas Inventories - Revised 2006
- ISO14064 Part 1 & 3 - Issued 2006
- BSI GHGEV Manual (KM007 R5) – Revised November. 2014

The standard confidentiality principle of BSI Group Korea is applied to the all verification activities.

Verification Opinion:
As a result of the verification in accordance with the protocols and the best practice listed above, it is the opinion of BSI that:
- The verification was conducted to provide reasonable verification in accordance with GHG Energy Target Management Scheme (2012-211)
- No material misstatement in the GHG emission calculations was detected, related records were maintained appropriately
- The data quality was considered corresponding to the international key principles for GHG emissions verification

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For and on behalf of BSI:

Managing Director Korea, **JongHo Lee**

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Sources:
LG Display (response in 2014 regarding 2012/2013 data).

"Point of Use Abatement Device to Reduce SF_6 emissions in LCD Manufacturing Operation in the Republic of Korea (South Korea)." LG Display's SF_6 Abatement Project. Clean Development Mechanism Project: 3440. (https://cdm.unfccc.int/Projects/DB/SGS-UKL1266943063.39/view)

PLD (Panasonic Liquid Crystal Display)

Overview

Specific F-GHG emissions reduction efforts and/or goals	Panasonic Liquid Crystal Display (PLD) considers installation of abatement systems to be the most effective and realistic technique to reduce F-GHG emissions. PLD established a 100 percent installation of abatement systems for both SF_6 and NF_3 from the start-up of the Himeji factory in 2010. Currently, because its production lines are integrated in the Himeji factory, PLD has a 100 percent rate of abatement system installation. PLD would like to continue studying while assessing technology trends both inside and outside the company for further improvements in the future. *Source:* *Panasonic Liquid Crystal Display (PLD)*
+ F-GHG emissions reduction efforts/goals target the following key processes that emit F-GHGs	Etch and Clean processes. PLD uses fluorinated heat transfer fluids for dry-etcher and exposure equipment. PLD manages leakage prevention properly with high sealability. *Source:* *Panasonic Liquid Crystal Display (PLD)*
+ F-GHG emissions reduction efforts/goals target the following F-GHGs emitted	SF_6, NF_3 *Source:* *Panasonic Liquid Crystal Display (PLD)*
Participation in national and/or international mandatory and/or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing	PLD is a member of the Japan Electronics & Information Technology Industries Association (JEITA), which participates on behalf of Japan's LCD suppliers in the World Display device Industry Cooperation Committee (WDICC), an international industry initiative that previously set goals to reduce F-GHG emissions (formerly the World LCD Industry Cooperation Committee). JEITA engages in WDICC activities to share information and promote activities to reduce F-GHG emissions via the installation of abatement systems and through other efforts. Japan's LCD industry set a collective goal to reduce F-GHG emissions 70 percent from 2000 to 2012. The Japanese government established a Greenhouse Gas Accounting, Reporting and Disclosure system as part of their Global Warming Countermeasures Law, where companies are required to report F-GHG emissions that exceed 3,000 tons of CO_2e. In addition, the government also established a target for reducing F-GHG emissions to help achieve GHG reduction targets under the Kyoto Protocol. *Source: JEITA*

Overview	**Corporate-wide GHG emissions reduction goals and reduction initiatives**	PLD participates in the CDP and most recently publicly reported on its GHG management efforts for its April 2014–March 2015 reporting fiscal year. *Source:* *Panasonic's responses to the 2015 CDP Climate Change Questionnaire.*
F-GHG Reduction Efforts	**Process optimization**	PLD is working on process optimization daily. Additional details not available. *Source:* *Panasonic Liquid Crystal Display (PLD)*
	Use of alternatives	PLD uses SF_6 as an etching gas, and NF_3 as a cleaning gas for Chemical Vapor Deposition (CVD). Regarding further improvements, PLD would like to assess technology trends and respond accordingly. *Source:* *Panasonic Liquid Crystal Display (PLD)*
	Capture and recycling	PLD will continue gathering information to proceed with discussion and review [of capture and recycling technologies]. *Source:* *Panasonic Liquid Crystal Display (PLD)*
	Abatement	
	+ Full or partial installation of abatement systems across all new generation fabs	PLD installs abatement systems to all CVD equipment and all dry-etchers. *Source:* *Panasonic Liquid Crystal Display (PLD)*
	+ Ensured that abatement systems are installed, operated, maintained, according to manufacturer specifications	PLD checks the performance at the time of installation of abatement systems, and operates them under proper management to ensure optimal results. *Source:* *Panasonic Liquid Crystal Display (PLD)*

F-GHG Reduction Efforts	+ Indicate whether default factors or actual measurements were used to estimate the DRE Reported destruction or removal efficiency (DRE)	The Sustainability Report by the Panasonic Group and CDP is calculated with reference to the abatement rate actually measured. However, the figures used in the calculation have great allowance and therefore the actual abatement efficiency is higher. *Source:* *Panasonic Liquid Crystal Display (PLD)*
	+ Practices for monitoring abatement systems	PLD checks the performance at the time of installation of abatement systems. *Source:* *Panasonic Liquid Crystal Display (PLD)*
F-GHG Emissions Measurements	**Total annual F-GHG emissions in CO_2e, emitted across all flat panel display manufacturing fabs (2014)**	PLD's F-GHG emissions are disclosed in the Panasonic Group's Sustainability Data Book 2015, and are also included in its reporting to the CDP. PLD's F-GHG emissions from its Himeji factory only, as reported from **April 1, 2014–March 31, 2015**, are as follows in tons of CO_2e: SF_6 emissions: 6,100 (an increase from FY2013, where emissions were 5,100) According to PLD, when calculated by the IPCC Tier 2b guidelines default factors used in the Questionnaire of JEITA Display Devices Environment Committee, F-GHG emissions are as follows in tons of CO_2e: SF_6 emissions: 8,900 (an increase from FY2013, where emissions were 6,900) NF_3 emissions: 2,700 (an increase from FY2013, where emissions were 1,700) **Important:** The emissions listed cannot be compared to the emissions from other suppliers because they may use different estimation methods and monitoring practices to calculate their emissions. *Sources:* *Panasonic Liquid Crystal Display (PLD)* *Sustainability Data Book 2015 by the Panasonic Group (www.panasonic.com/global/corporate/sustainability/downloads.html)*

F-GHG Emissions Measurements

Total annual F-GHG emissions reductions and/or rate of emissions reductions	Himeji factory has started production from the middle of 2010. PLD will continue monitoring the transition between the fiscal years. *Source:* *Panasonic Liquid Crystal Display (PLD)*
Methodology used to estimate F-GHG emissions	PLD estimates F-GHG emissions based on the Greenhouse Gas Accounting, Reporting and Disclosure system of the Japanese government. *Source:* *Panasonic Liquid Crystal Display (PLD)*
Third party assurance for F-GHG emissions estimates	The Sustainability Report by the Panasonic Group is audited by a third-party organization as described in the Report. *Source:* *Sustainability Data Book 2015 by the Panasonic Group.* *(www.panasonic.com/global/corporate/sustainability/downloads.html)*

Sharp

Overview

Specific F-GHG emissions reduction efforts and/or goals	Sharp has, as a part of F-GHG emission reduction activities, installed abatement systems on all F-GHG using process lines of all LCD manufacturing fabs, and has been maintaining the abatement systems appropriately. *Source:* *Sharp (Sharp Corporation)*
+ F-GHG emissions reduction efforts/goals target the following key processes that emit F-GHGs	Etch and Clean processes. Information on fluorinated heat transfer fluids not available. *Source:* *Nishida, et al. PFC Emission Reduction Strategy for the LCD Industry. Journal of the SID 13/10. 2005*
+ F-GHG emissions reduction efforts/goals target the following F-GHGs emitted	SF_6, PFCs (CF_4, C_2F_6, C_4F_8), HFCs (CHF_3), NF_3. *Source:* *Japan Electronics and Information Technology Industries Association (JEITA).*
Participation in national and/or international mandatory and/or voluntary efforts to reduce F-GHG emissions from flat panel display manufacturing	Sharp is a member of the Japan Electronics and Information Technology Industries Association (JEITA), which participates on behalf of Japan's LCD suppliers in the World Display device Industry Cooperation Committee (WDICC), an international industry initiative that previously set goals to reduce F-GHG emissions (formerly the World LCD Industry Cooperation Committee). JEITA engages in WDICC activities to share information and promote activities to reduce F-GHG emissions via the installation of abatement systems and through other efforts. Japan's LCD industry set a collective goal to reduce F-GHG emissions 70 percent from 2000 to 2012. The Japanese government established a Greenhouse Gas Accounting, Reporting and Disclosure system as part of their Global Warming Countermeasures Law, where companies are required to report F-GHG emissions that exceed 3,000 tons of CO_2e. In addition, the government also established a target for reducing F-GHG emissions to help achieve GHG reduction targets under the Kyoto Protocol. *Source: JEITA*

Overview	**Corporate-wide GHG emissions reduction goals and reduction initiatives**	Sharp set a goal to reduce absolute GHG emissions per year to below 2007 baseline fiscal year emissions levels for ten manufacturing fabs by 2011. Its most recent base year emissions were reported as 968,000 metric tons of CO_2e. Sharp also set another goal to reduce GHG emissions intensity by 35 percent per adjusted production units (tons of CO_2e/100 million yen) across the ten fabs by 2012. By end of fiscal year 2011, Sharp met both of its goals and reduced total emissions by 40 percent and emissions intensity by 42 percent. Sharp participates in the Carbon Disclosure Project and most recently publicly reported on its GHG management efforts in 2013 for its April 2013–March 2014 reporting year. *Source:* *Sharp's responses to the 2014 Carbon Disclosure Project Investor Questionnaire.*
F-GHG Reduction Efforts	**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. *Source:* *Sharp (Sharp Corporation)*
	Use of alternatives	Sharp has been collecting the latest information from relevant sources and researching the possibility of lower global warming potential (GWP) alternative gases usage. *Source:* *Sharp (Sharp Corporation)*
	Capture and recycling	Sharp implements the recycling of F-GHGs in some manufacturing processes. *Source:* *Sharp (Sharp Corporation)*

F-GHG Reduction Efforts

Abatement	
+ Full or partial installation of abatement systems across all new generation fabs	Sharp has installed abatement systems on all etching and cleaning process equipment. *Source:* *Sharp (Sharp Corporation)*
+ Ensured that abatement systems are installed, operated, maintained, according to manufacturer specifications	Sharp has been managing abatement systems appropriately during all installation, operation and maintenance processes, in cooperation with the abatement system manufacturing professionals. *Source:* *Sharp (Sharp Corporation)*
+ Indicate whether default factors or actual measurements were used to estimate the DRE Reported destruction or removal efficiency (DRE)	Sharp uses the IPCC Tier 2b Guidelines Default Factors to answer the questionnaire from JEITA. *Source:* *Sharp (Sharp Corporation)*
+ Practices for monitoring abatement systems	Sharp verifies the performance of abatement systems at the time of installation, and implements the maintenances and verifications for performance retention. *Source:* *Sharp (Sharp Corporation)*

F-GHG Emissions Measurements		
	Total annual F-GHG emissions in CO_2e, emitted across all flat panel display manufacturing fabs (2014)	The total amount of F-GHG emissions attributed to panel manufacturing is not publicly available. As part of its **2015** responses to the Sharp Corporation's Sustainability Report 2015, which discloses its corporate GHG emissions from **April 1, 2014–March 31, 2015**, Sharp lists its Scope 1 emissions. These Scope 1 emissions represent its organizational boundary, using a financial control approach, which includes factories and offices within Japan and in other countries. Sharp's F-GHG emissions, as reported, are as follows, in metric tons of CO_2e: HFCs: 7000 (no variation from FY 2014, where emissions were 7,000) PFCs: 42,000 (an increase from FY2014, where emissions were 32,000) SF_6: 48,000 (an increase from FY2014, where emissions were 41,000) **Important:** The emissions listed cannot be compared to the emissions from other suppliers because they may use different estimation methods and monitoring practices to calculate their emissions. These process emissions may also reflect manufacturing processes that create additional products other than large-area flat panel displays. *Sources:* *Sharp (Sharp Corporation)* *Sustainability Report 2015 by the Sharp Corporation.* *(www.sharp.co.jp/corporate/eco/report/ssr/index.html)*
	Total annual F-GHG emissions reductions and/or rate of emissions reductions	Sharp works to reduce F-GHG emissions in accordance with the targets of Ministry of Economy, Trade and Industry, JEITA and other industrial associations. *Source:* *Sharp (Sharp Corporation)*
	Methodology used to estimate F-GHG emissions	Sharp uses the IPCC Tier 2b Guidelines Default Factors to estimate F-GHG emissions. *Source:* *Sharp (Sharp Corporation)*
	Third party assurance for F-GHG emissions estimates	Sharp Sustainability Report is audited by a third-party organization. *Source:* *Sustainability Report 2015 by the Sharp Corporation.* *(www.sharp.co.jp/corporate/eco/report/ssr/index.html)*