

# Critical review of LCA by LG Electronics

The project and the LCA under review:

The critical review considers the LCA (Life cycle assessment) results presented in the report “LLGE-16T90SP-TUV-LCA report” dated: 10<sup>th</sup> Jan 2024. The report has been prepared by the company – LG Electronics

|                                                                                                                            |        |                                                                                                                                                                                                                                                                                                                                                                                     |         |
|----------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| Model                                                                                                                      |        | 16T90SP(Ref), 14T90S                                                                                                                                                                                                                                                                                                                                                                |         |
| Technology                                                                                                                 |        | LCD, OLED                                                                                                                                                                                                                                                                                                                                                                           |         |
| Function                                                                                                                   |        | performing logical operations and tasks or processing data using electronic circuits                                                                                                                                                                                                                                                                                                |         |
| Product category                                                                                                           |        | Notebook                                                                                                                                                                                                                                                                                                                                                                            |         |
| The description and justification of the functional unit (e.g. standards fulfilled by the reference product, test reports) |        | To performing logical operations and tasks or processing data using electronic circuits according to the appropriate usage scenario defined in the Korea Product Usage Scenarios Guideline of Notebook computer, EPD 019:2021(00):202103 during the 4-year lifetime of the product                                                                                                  |         |
| Application Scope                                                                                                          |        | The target market for reference products is US, South Korea etc.<br><br>The goal of this declaration is to inform the results of a Life Cycle Assessment of the reference product and to compare or review the life cycle assessment results of other products produced by referring to the same PCR.<br><br>This TÜV is primarily intended for business-to-business communication. |         |
| Idle-mode power                                                                                                            | 7.546W | Reference Life Time                                                                                                                                                                                                                                                                                                                                                                 | 4 years |
| Sleep-mode power                                                                                                           | 1.905W |                                                                                                                                                                                                                                                                                                                                                                                     |         |
| Off-mode power                                                                                                             | 0.478W |                                                                                                                                                                                                                                                                                                                                                                                     |         |

## 1. Executive summary

This is a critical review summary of the LCA report, which published on 10<sup>th</sup> January 2024, model number is 16T90SP\*, produced by LG Electronics. Performed by TÜV for LG Electronics, as part of the LGE's EPEAT project. For more details, see the full version of the LCA report.

*\*Note: Model 16T90SP is selected by LGE as the reference product in this study. One other model in the homogeneous environmental family (shown in the table below). Due to the fact that Model 16T90SP has the largest weight, the worst-case scenario was conducted. As a result, the product names for this critical review are collectively referred to as 16T90SP as the worst-case scenario.*

| Field                                                                      | Model name | SPEC | Weight(g) |
|----------------------------------------------------------------------------|------------|------|-----------|
| The Reference product                                                      | 16T90SP    | LCD  | 1,399     |
|                                                                            |            | OLED | 1,395     |
| The same homogeneous environmental family products<br>(Considered Product) | 14T90S     | OLED | 1,250     |

The aim of the review was to ensure that:

1. Relevant and realistic description of the LCA study;
2. The accuracy in basic models for the dominant parts of the life cycle (AD and EF check)
3. Relevance and representation of the data sources impacting in the most significant parts of the final result;
4. Selected characterization

The LCA result in the report has been judged relevant and where uncertainties exist, there is transparency for the reader, the main comments shall be modified and noticed in the next projects and has been of cosmetic character for easier understanding of the LCA study. The review comments but have not changed the final LCA study.

## 2. Standards and review criteria

The critical review was carried out according to the International Standards ISO 14040 and 14044 (International Organization for Standardization (ISO) 2006a, b).

The study was reviewed according to the following five aspects outlined in ISO 14040. It is assessed whether:

- "The methods used to carry out the study are consistent with this International Standard,
- the methods used to carry out the study are scientifically and technically valid,

- the data used are appropriate and reasonable in relation to the goal of the study,
- the interpretations reflect the limitations identified and the goal of the study, and
- the study report is transparent and consistent."

### 3. Review Processes

The task of the reviewer is to review the documentation and LCA report provided by LG Electronics including the four phases:

- Goal and scope definition,
- Inventory analysis,
- Impact assessment, and
- Interpretation

The goal of the study as such is not reviewed as this lies in the responsibility of the commissioner. However, it was reviewed whether the goal is stated explicitly and transparently. The definition of the scope is part of the critical review, the definition of the functional unit and boundaries defined as 1 LCD service life of 4 years.

$$TE_c = \{(OFF_{Ec} \times A_1) + (SLP_{Ec} \times A_2) + (ID_{Ec} \times A_3)\} \times D \times Y \times D_t \times 10^{-3}$$

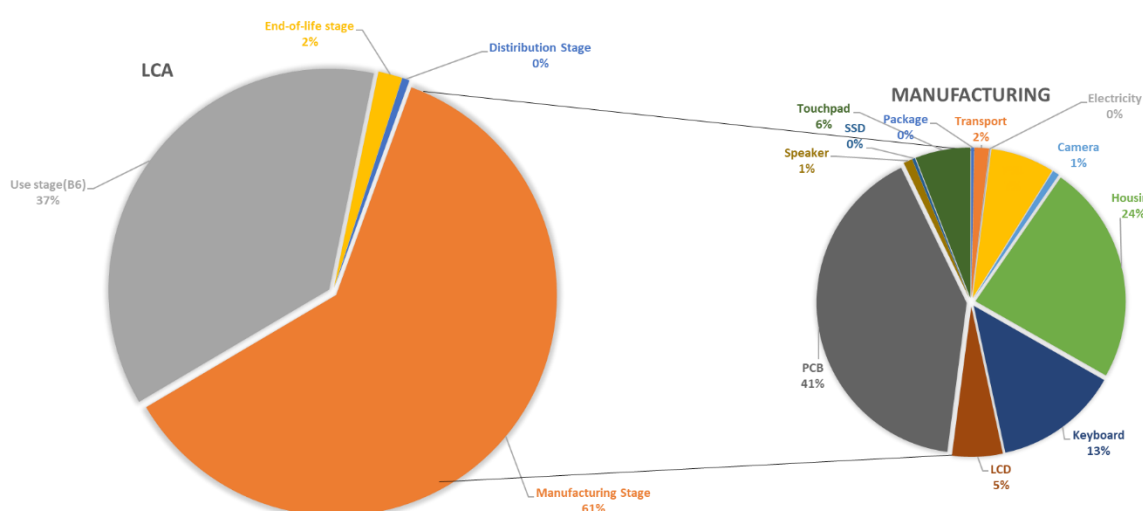
|                                |         |                 |       |
|--------------------------------|---------|-----------------|-------|
| <b>OFF_Ec(W)</b>               | 0.478   | <b>A1</b>       | 60%   |
| <b>SLP_Ec(W)</b>               | 1.905   | <b>A2</b>       | 10%   |
| <b>ID_Ec(W)</b>                | 7.546   | <b>A3</b>       | 30%   |
| <b>Reference Life Time(Dt)</b> | 4 years | <b>Tec(kWh)</b> | 96.05 |

The authors of the study provide access to all data necessary for an informed critical review. This holds also true for data provided by third parties and for confidential data. The review of the inventory analysis includes the inventory raw data (input data), the modelling approaches and selected inventory results.

| Category                                              | Unit (/product) | Stage    |                     |                     |               |                   |
|-------------------------------------------------------|-----------------|----------|---------------------|---------------------|---------------|-------------------|
|                                                       |                 | Total    | Distiribution Stage | Manufacturing Stage | Use stage(B6) | End-of-life stage |
| Climate change - total                                | kg CO2 eq       | 1.41E+02 | 7.60E-01            | 8.59E+01            | 5.17E+01      | 2.48E+00          |
| Climate change - fossil fuels                         | kg CO2 eq       | 1.39E+02 | 7.58E-01            | 8.51E+01            | 5.17E+01      | 1.54E+00          |
| Climate change - biogenics                            | kg CO2 eq       | 1.58E+00 | 1.10E-03            | 6.31E-01            | 1.39E-02      | 9.39E-01          |
| Climate change - land use and land use transformation | kg CO2 eq       | 1.10E-01 | 3.44E-04            | 1.05E-01            | 4.40E-03      | 6.90E-04          |
| Ozone depletion                                       | kgCFC-11 eq     | 8.31E-06 | 1.61E-07            | 6.50E-06            | 1.51E-06      | 1.42E-07          |
| Acidification                                         | mole H+ eq      | 6.47E-01 | 8.35E-03            | 4.40E-01            | 1.95E-01      | 3.34E-03          |
| Freshwater eutrophication                             | kg P eq         | 1.36E-01 | 4.97E-05            | 8.20E-02            | 5.37E-02      | 1.64E-04          |
| Marine aquatic eutrophication                         | kg N eq         | 1.40E-01 | 1.99E-03            | 9.93E-02            | 3.69E-02      | 1.79E-03          |

|                                          |                                     |          |          |          |          |          |
|------------------------------------------|-------------------------------------|----------|----------|----------|----------|----------|
| Terrestrial eutrophication               | mole N eq                           | 1.32E+00 | 2.21E-02 | 9.98E-01 | 2.88E-01 | 8.23E-03 |
| Photochemical ozone formation            | kg NMVOC eq                         | 3.25E-01 | 5.42E-03 | 2.39E-01 | 7.81E-02 | 2.20E-03 |
| Resource depletion - metals and minerals | kg Sb eq                            | 1.94E-02 | 2.24E-06 | 1.85E-02 | 8.09E-04 | 3.88E-06 |
| Resource depletion - fossils             | MJ                                  | 1.73E+03 | 1.08E+01 | 9.23E+02 | 7.87E+02 | 1.16E+01 |
| Water requirement                        | m3 eq.<br>deprivation<br>world wide | 2.17E+01 | 3.16E-02 | 1.43E+01 | 7.17E+00 | 1.26E-01 |
| Emission of fine particles               | incidence of<br>diseases            | 1.67E-05 | 5.03E-08 | 1.57E-05 | 8.47E-07 | 5.56E-08 |
| Ionizing radiation, human health         | kBq U235 eq                         | 1.31E+01 | 4.98E-02 | 7.24E+00 | 5.77E+00 | 4.75E-02 |
| Ecotoxicity(fresh water)                 | CTUe                                | 6.07E+03 | 8.58E+00 | 5.78E+03 | 2.67E+02 | 1.92E+01 |
| Human toxicity, carcinogenic effects     | CTUh                                | 1.69E-07 | 3.62E-10 | 1.56E-07 | 1.11E-08 | 8.68E-10 |
| Huamn toxicity, non-carcinogenic effects | CTUh                                | 2.85E-06 | 7.19E-09 | 2.51E-06 | 2.94E-07 | 3.18E-08 |
| Impacts related to land use/soil quality | Pt                                  | 6.00E+02 | 6.23E+00 | 4.50E+02 | 1.37E+02 | 6.69E+00 |

The review of the impact assessment includes the impact and characterization factors applied, the impact indicator results and, eventually, the normalized results. They also separate Non-hazardous and hazardous waste into assessment by using dataset.



Within the interpretation phase, the consistency of the modelling, the data used, and the conclusions is reviewed and checked whether it is in line with the goal and scope definition. Data quality aspects, significance, and sensitivity analyses as well as completeness checks are subject to the critical review too. LGE also analyzed the assumptions and limitations of their study.

#### a. Data collection

The report includes a detailed description of the production process and the foreground data. The underlying model of life cycle inventory data was provided in SimaPro. This facilitated the review considerably and is highly acknowledged.

The primary data mainly analyzed by field data, collected through on-site visits to manufacturing factories and questionnaires from suppliers, which is a normal procedure. Calculation is done by SimaPro and with the help of using Korea national LCI DB, all according to normal praxis. Some generic data relates to Ecoinvent v3.7.1 a databased often used among LCA practitioners. Here also could be seen data uncertain and assumptions. Following issues has been discussed needed to be commented here:

*“As there is no evidence of recovery, WEEE Directive Part 3: Minimum targets applicable by category from 15 August 2018 with reference to the categories listed in Annex III is used when calculating the amount of the bare product to be treated.”*

Instead of using dataset to calculate, it would be better to get the local recycle rate and ways data in the aim countries. Furthermore, the reviewer, it is not possible to fully ensure the correctness and validity of all calculations within such a review process.

#### **b. Impact assessment**

The impact assessment follows the classification and characterization as in normal praxis as that will be a result when using a specialist LCA tool for calculations (SimaPro). Normalization is done according to normal practice.

#### **c. Consistency of the methods with the ISO standards**

The functional unit and reference flow are considered appropriate for the goal and scope of this study. The LCA study of LCD intends to be used for external communication. Environmental communication is often complex and it's important to identify the target audience and their level of understanding of complex environmental information as a LCA result and based on that develop relevant communication strategies.

The system boundary is defined below, which is based on PCR-ed4-EN-2021 09 06. The life cycle stage contains the stages of Manufacturing, Distribution, Installation, Use (during the 4-year lifetime of the product), and End-of-Life. Input and output are considered in each stage.

#### **d. Assessment of the interpretation**

The interpretation considers the limitations due to the goal and scope of this study. Some scenarios e.g., on the electricity mix during production or the location of installation help to understand the influencing factors for the final results. For example, the product's factory in Nanjing, China, the study using “Electricity, high voltage electricity, high voltage, production mix, CN-JS” electricity factor, which selected the most accurate one. Using “Europe” factor in the using stage.

#### **e. Transparency and consistency of study report**

All relevant information could be found in the report (or the electronic data). The report is

clearly structured and well-readable. With the information, the report is acknowledged as transparent and consistent.

#### **4. The review result**

##### **a. The process of the review can be summarized as follows:**

- Most questions of the reviewer were answered sufficiently in their study report. There are not such revisions were made concerning any unclear statements and documentation in the report, LCI models and description of results. The critical review process took place in an open and constructive atmosphere. The final study report includes almost all the comments of the reviewer given in the earlier stages of the review process.
- The goal of the study as such was not reviewed as this lies in the responsibility of the commissioner. However, it was reviewed whether the goal is stated explicitly and transparently.
- The definition of the scope was part of the critical review, the definition of the functional unit, the system definition and its boundaries and the allocation approaches.
- The review of the inventory analysis includes the modelling in SimaPro 9.4.0.2, the database Ecoinvent v3.7.1, and Korea national LCI DB.
- The review of the impact assessment includes only the impact indicator results.
- Within the interpretation phase, the consistency of the modelling, was reviewed and checked whether they are in line with the goal and scope definition.
- It was not in the responsibility of the reviewer to check the report for formatting, layout, grammar, and spelling issues.

## **5. About the verifier: Kun Zhang**

### **WORK EXPERIENCE**

- 2019 – Now; SUSTAINABLE & BUSINESS DEVELOPMENT MANAGER – TÜV RHEINLAND  
I mainly responsible for the development of carbon-related verification and certification in the field of industrial products. Also build carbon asset management team for some clients. Participating in the team of energy-saving certification of industrial products. Identifying and seeking new carbon-related opportunities for our team. Getting related authorization from government administration.
- 2017 – 2019; TECHNICAL MANAGER – BV  
I work independently in Beijing office in expending new market. BV has built new strategic cooperation with three industrial associations, (it refers to industrial, environmental and investment areas) under my responsibility. These help BV finished 1 million RMB in certification, generated 500 potential clients in industry, and issued 50 million RMB “Green Bonds” in China.
- 2013 – 2017; CHINA QUALITY CERTIFICATION CENTRE  
Our department undertakes some national projects, and I am being a key member in these projects. Projects come from "National Development and Reform Commission"(NDRC) and “Administration of Quality Supervision Inspection and Quarantine” (AQSIQ). The AQSIQ project of “Rainwater Reuse” (1-year project) - I take the part of the system boundary and policy proposals of this project by using computer modeling analyses and determines.  
Our team initiates a number of National Standards with national lab experts and business representatives, e.g., <Safety Certification Rules for Faucets>; <Water Conservation Certification Rules for Faucets> and <Energy Efficiency Test and Evaluation Regulation for Boiler>. I played the role of analysing and studying abroad Standards and carry out our own criteria.

### **EDUCATION**

- 2011 – 2012 EDINBURGH UNIVERSITY, School of business, Carbon Management
- 2010 - 2011 HERIOT-WATT UNIVERSITY, School of Life-Science, Climate Change: Impact and Mitigation.
- 2006 - 2009 BEIJING YOUTH POLITICAL COLLEGE, Business school, International Business.

### **QUALIFICATION**

- Greenhouse Gas Auditor authorized by Chinese Certification and Accreditation Association (CCAA);
- CCAA registered lecturer (GHG related area).

## **Major Project Experiences**

|   | <b>Company Name</b>                                         | <b>Project Name</b>                                                                            | <b>Project Scale</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>Start Time</b> |
|---|-------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1 | Alibaba                                                     | Energy Expert platform                                                                         | Calculation method for Ali's Energy Expert platform                                                                                                                                                                                                                                                                                                                                     | 202302            |
| 2 | Yikong                                                      | Product environmental footprint related training and carbon footprint quantification projects. | According to the EU Product environmental footprint category rules (PEFCR), carbon related training and capability building were provided to relevant personnel of the organization and upstream and downstream suppliers, collecting the material input data, quantifying the environmental footprint of three vehicle power battery products, and issuing corresponding certificates. | 202211            |
| 3 | VOLKSWAGEN Group                                            | LCA critical review                                                                            | Verify the life cycle assessment reports of four vehicle model.                                                                                                                                                                                                                                                                                                                         | 202210            |
| 4 | Haier Group                                                 | Carbon related training; GHG verification; Carbon related platform construction                | Carbon related training (ISO14064-1) for Haier relevant personnel; Greenhouse gas verification for 52 factories according to ISO14064-3, and GHG related platform construction.                                                                                                                                                                                                         | 202206            |
| 5 | Morimatsu Group                                             | Carbon related training; GHG verification                                                      | Carbon related training (ISO14064-1) for Morimatsu relevant personnel; Organization level GHG verification according to ISO14064-3.                                                                                                                                                                                                                                                     | 202205            |
| 6 | Sailun Group                                                | Carbon related training; GHG verification and carbon footprint calculation                     | Carbon related training (ISO14064-1) for Sailun relevant personnel; GHG verification of 7 factories and carbon footprint calculation of 4 products according to ISO14064-3 and ISO14067.                                                                                                                                                                                                | 202202            |
| 7 | Jiangsu Guofu Hydrogen Energy Technology Equipment Co., Ltd | Carbon related training; GHG verification                                                      | Carbon related training (ISO14064-1) for Guofu relevant personnel; Organization level GHG verification according to ISO14064-3.                                                                                                                                                                                                                                                         | 202202            |
| 8 | Yanda (Haimen) Heavy Equipment Manufacturing Co. Ltd.       | Carbon related training; GHG verification                                                      | Carbon related training (ISO14064-1) for Yanda relevant personnel; Organization level GHG verification according to ISO14064-3.                                                                                                                                                                                                                                                         | 202110            |

## 6. Self-declaration of reviewer independence & competencies

(According to ISO/PDTS 14071, Annex B)

I (Kun Zhang), hereby declare that:

- I am not a full- or part-time employee of the study's commissioner or practitioner.
- I have not been involved in scoping or carrying out any of the work to conduct the study at hand, i.e. I have not been part of the commissioner's or practitioner's project team(s).
- I do not have vested financial, political, or other interests in the outcome of the study.
- My competencies relevant to the Critical Review at hand include knowledge of and proficiency in:
  - ISO 14040 and ISO 14044.
  - LCA methodology and practice, particularly in the context of LCI, (including data set generation and data set review, if applicable).
  - Critical Review practice.
  - The scientific disciplines relevant to the important impact categories of the study.
  - Environmental, technical, and other relevant performance aspects of the product system(s) assessed.
  - Language used for the study is English.

## 7. Conclusions

The reviewed LCA study was summarized in section 4, complies with the requirements of the ISO standards 14040 and 14044.

The goal and scope are appropriately defined. The methods used are scientifically and technically valid. The data used are appropriate and reasonable in view of the goal and scope of the study. The report is complete, clearly structured, and well-readable. Conclusions and recommendations are based on the results of the analyses, respecting the limitations described in the report.

I recommend submitting the entire report including this review report to the commissioner.

Kun Zhang 

Sustainable and energy expert in TÜV Rheinland (China) Ltd.

Beijing, China, 31<sup>st</sup> Jan. 2024